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Adaptive Cooperation between Multiple Devices using Business Driven Patterns in CoT

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Abstract—*Cloud of Things is the integration of cloud computing and Internet of Things for the better development of the applications. Everyday, billions of data and information gets carried across different communications media and internet is the main medium of it. So individuals or organizations who think about business take advantage of these data in a business-driven approach and they try to collect, aggregate, summarize and statistically analyze data, so business driven approach helps them to know what products they may want to see and who among the people will be their target market and also it helps in keen appreciation of tiny details, spotting and tracing of industry trends and patterns, constant research on the needs and preferences of potential buyers. Model driven patterns helps in development of faster application in CoT but if there is any change in the requirement, then the whole application need to be developed again. To overcome this and to reuse application in multiple domain, paper focuses on use of business patterns along with the model driven patterns. Using this pattern it allows to develop the application which will be useful in any kind of business and use of cloud helps to grow the business at a higher level.*

Index Terms—*Cloud of Things, Business Patterns, IoT,AES*

I. INTRODUCTION

Cloud computing and IoT are emerging technologies, which are used in many companies for development of different application.IoT is the concept of basically connecting any device with an on and off switch to the Internet and/or to each other. This includes everything from cellphones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of. The IoT is a giant network of connected ”things” which also includes people. The relationship will be between people-people, people-things, and things-things. IoT is based on smart and self configuring nodes which are interconnected in a continuous changing and global network infrastructure but it has limited storage and processing capacity whereas in other hand cloud computing gives the platform for on demand access to various resources with greater capabilities in terms of storage and processing power. These two are complementary aspects of Internet which create CoT (Cloud of Things) where IoT can benefits from cloud's unlimited storage and processing capabilities and cloud can benefits from IoT by spreading its scope to manage real world service dynamically. Integration of these two requires smart gateway to perform complex tasks. So use of cloud along with IoT benefits for development of many application.

Since 2011, number of connected devices has already exceeded the number of people on Earth. Already, connected devices have reached 9 billion and are expected to grow more rapidly and reach 24 billion by 2020. Since, number of connected devices is rapidly increasing, so there is going to be a lot of data as well. Storing that data locally and temporarily will not be possible any more. There is going to be a need of rental storage space. Also, this huge amount of data must also be utilized in the way it deserved. Data must not only be processed to form information and further, to form knowledge, but it should be made a mean of wisdom for the user. This asks for more processing, which is not possible at the IoT end, where devices are low cost and light-weight[1].

Cloud along with the IoT supports to grow in a business by increasing its scope for the huge amount of data. Today most of the Buzz in IoT is focused on the difficult but approachable problems of connecting devices to cloud services, managing fleets of devices, passing data back to cloud based storage, and leveraging analytics to create insight. The market is already demanding that value creation from IoT, SaaS and MicroServices to escape the costs associated with bespoke IoT solutions and to speed up adoption of IoT solutions. While deployment of sensors and infrastructure is part of the cost, the majority of the solution cost is driven by the complexity of the physical world that IoT instruments[23].

Model driven patterns helps to build the application faster in CoT as the different patterns are used for different applications such as data pattern is used in data centric application, process driven pattern is used is workflow based system and role driven pattern are used in structural functions. Model driven is used in the applications development, but as in CoT, there is huge amount of data is generated always, so building the application using model driven patterns take more time because it works mainly on static data.

A business needs to constantly evaluate enterprise resource planning implementation and should have a distinct depart-ment to manage finance and human resources with principles that are sound.

These requirements in a business-driven approach should follow a business framework. This framework will guide the companys staff and talents so that all they do will be profitable for the company. The business framework will also make it easy for applications developer, especially if they are in-house

developers, to tailor cut their outputs to make the organizations function at its optimum. A business-driven approach involves keen appreciation of tiny details, spotting and tracing of industry trends and patterns, very careful and analytical planning, constant research on the needs and preferences of potential buyers and intensive use and investment of the latest in technology[23].

Business patterns are considered as micromodels detailing standard decompositions of reference models. Two types of business patterns are considered: process patterns and domain patterns. Note that process and domain patterns have a linguistic and a structural dimension, however process patterns add a behavioral dimension. Business patterns are utilized to facilitate the recognition of reusable portions of the business model, setting boundaries for the definition of reusable business services. Business patterns from reference models are a common denominator among organizations in a specific domain, and also within the same organization that is changing over time. Changeability is related to the ease of an architecture to change, but also with the ability of the architecture to remain invariant after a change.

Using business driven along with the model driven design helps to reuse the portion of design that can be applied to multiple domain-specific activities which helps in better development of the application.

II. Related Work

There are many ideas and methods which are used in development of the various applications.

Simon Mayor proposed a generalized approach by using semantic integration for interface with various smart devices. In this interaction is happened not only with components but also with physical things like button and softwares[5]. To build and rapid prototyping of context aware services Tao Gu proposes the Service-Oriented Context-Aware Middleware (SOCAM) architecture[6]. It support to access and interpret diffrent services easily. Soulimen Hasan proposes the approach for identifying semantic events for the Internet of things[7]. In this based on statistical model an abstract model is generated. All these approches are used for generating model using contextual information. To avoid complexities of large web based applications Mohammed Mukktar[8] proposes the use of model driven engineering to generate web application at abstract level. In this CIM belongs to business logic whereas PIM ans PSM belong to components. Business model here is different from executable system components. Zhang, H. proposes the idea of using MDA so as developer focus on business logic more rather than the technical details[9]. Kang, W proposes the use of ontology in MDA for the software development for semantic disposing[10]. Martin first gives the idea of use of EUD i.e the end user intuitive ways to modify the original application according to user requirements[11]. For this purpose UI centric approach is used and it focuses on adaptability and rapid changes. Liu, X. and Spahn, M also proposes the use of EUD, but most application failed to use of this due to situational integration and collaborations[12][13].

To develop application with incompatible services using cloud platform Martino proposes semantic services to identify au-tomatic service discovery[14]. But as only existing services are used and not composed, it gives low flexibility. All of these approaches are used basically for system configuration in building the application.

In cloud platform, execution of services concern not only about performance[15] but also the security and adaptability[16][17]. K. Votis[18] proposed the service oriented architecture for distribution and administration of nodes. To meet continuous changing requirements C. Xie combined both structural and operational semantics for services[19]. Mapping concepts to distributed environments S. Hallsteinsena[20] proposed a model driven development framework with adaption mechanism which gives seperarion of business logic and contectxual data. Kiev Gama[21] use SOC principles to integrate heterogeneous services to use the IoT services to realize dyanamic services. By using event process-ing language(EPL)[22] context aware template methods was proposed to enhance business performance. These methods are used for service executions in cloud platforms. Based on this metric, Lusa Lima propose an algorithm that improves the data gathering performance by generating constrained random walks, in which the probability mass function at each step reflects the available side information (e.g. the memory of past visited sites)[24].

All these approaches gives the supporting architecture that focus on service modeling and application integration but not gives a complete solution to build intelligent application.

III. PROBLEM DEFINITION

The application build using model driven approach is suit-able or works on static data. But as many IoT devices are used with cloud, the huge amount of data is generated which changes continuously and it is very hectic that every time whole application is required to change. Also today most of the Buzz in IoT is focused on the difficult problems of connecting devices to cloud services, managing fleets of devices, passing data back to cloud based storage.

IV. OUR CONTRIBUTION

Model driven design in CoT, using business patterns helps to use the re-usable portion of design that can be applied to multiple domain-specific activities which helps for faster development as well as it will helps to build the application on dynamic data. And also it can be accessed on any IP address and works well with the static IP address too.

V. SYSTEM OVERVIEW

Figure 1 gives the different layers in CoT such as infras-tructure layer, middle ware layer and service layer. The base layer is infrastructure layer which will help in managing the infrastructure i.e how many number of devices are used, what types of devices will be used etc. The heterogeneous data generated from these devices is vast which will be transfered to the middle ware layer , where data is gathered and abstracted

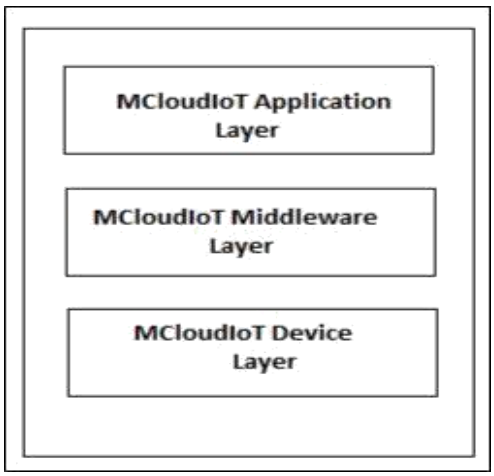

Fig. 1. Layers of CoT

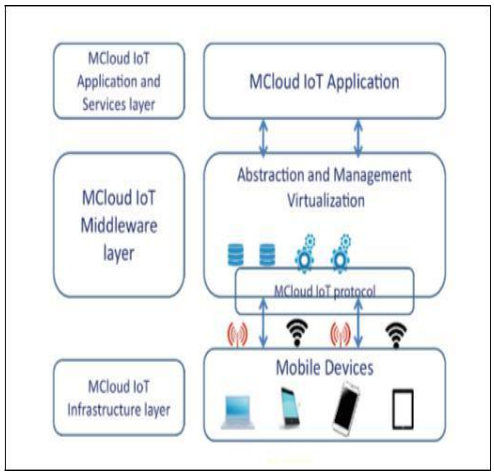

Fig. 2. Framework based on CoT Layers

model is formed from these data and managed. Different protocols used in CoT are, WirelessHART(Wireless High-way Addressable Remote Transducer), Zig Bee, IEEE 1451, 6LOWPAN(Low-power Wireless Personal Area Networks). Using this abstracted model and virtulisation, cloud based application is build and services are provided in application and service layer.

Figure 2 gives the actual framework based on layers of CoT, in base layer it gives the information about the devices and its capabilities and how these heterogeneous devices can operate in a single application. In middle layer, it uses the zigbee protocol to use different services provided by the cloud and also helps to maintain data on the cloud as well as it manages the different nodes used in the process. Finally using these device capabilities, interaction between them and data management of the cloud, the cloud based IoT application is formed in application layer.

The whole process is build on the cloud, it helps to build the application for huge amount of the data, and also the capacity of the application in terms of data can be extended whenever required. Based on this framework, a application is created which is helpful in business development for both businessman and client. Along with the cloud, the cooperation between the different devices is formed which helps in business process, and results in creation of application. The business framework will also make it easy for applications developer, especially if they are in-house developers, to tailor cut their outputs to make the organizations function at its optimum.

A. Process

1) Connectivity of RDS(SSMS) with Cloud :
   a) Create a database using relational database system.
   b) Launch a new instance and select an engine for database creation.
   c) Specify DB details.
   d) Configure Settings.
   e) Use generated endpoint for the connection of the database with cloud.
2) Cloud Enabled Business Application Development
   a) Login for client, businessman and Administrator who manages client and businessman details.
   b) Create windows for businessman and clients for daily meeting, appointment schedule and to check the clients associated with it.
   c) For security purpose, used AES(Advanced Encryption Standard) encryption to encrypt the name associated with specific businessman and vice versa.
3) Cooperation between the Devices
   a) Use GPS to locate the position of client and businessman to avoid conflicts between same kind of businessman and clients.
   b) When needed, send a message to a mobile.
   c) Use Modified Multi Routing Random Walk Strat-egy to locate clients in specified area.

Algorithm:Modified Multi Routing Random Walk Strate

```
covered area<- 0
matrix <- 0
while covered area ¡ area to cover do
    matrix(position)<- 1
for each quadrant do
    sumquadrant<- sum(matrix(quadrant))
    P robablity
    (size quadrant - sum quadrant <- quadrt) / ( quadrant)
end for
go to quadrant with probability P
robablity quadrant end while
```

VI. SYSTEM ANALYSIS

As to develop the application in CoT, business patterns are used along with the model driven design, it gives several benefits such as,

1) The application can be used in multiple domain as per the needs because the main purpose of using business patterns is reusability.
2) The system runs for dynamic data also, so it will be used in spite of the data change.

3) As today most of the Buzz in IoT is focused on the difficult problems of connecting devices to cloud services, passing thing data back to cloud based storage, this system is approachable to solve this problem.
4) For data storage purpose, cloud is used, therefore storage capacity will be increased whenever needed.
5) Multi Routing random walk algorithm, helps in connect-ing RDS with the application in less time.

A. Experimental Setup

The required constraint of the systems are,

Features	Constraints	Features
Pulse WIFI	Requires	Wi-Fi
ZigBee	Requires	150kb/s
25kb	Requires	150kb/s
2Mb	Requires	5Mb/s
0.5Mb	Requires	1.5Mb/s
Bluetooth	Excludes	C

Fig. 3. Required Constraints

B. Results Analysis

The performance of Modified Multi Routing random walk algorithm gives better results as it helps to avoid visited node again.

Algorithm	Best case	Avereage case	Worst case
Multi routing random walk strategy	O(1)	O(v)	O(n)
Modified Multi routing random walk strategy	O(1)	O(v+b)	O(n)

Fig. 4. Performance of Modified Multi Routing random walk algorithm

In above table v is common time period requires for the connection which is approximately 1000ms. In modified multi routing random walk algorithm it takes (v + b). Here b indicates extended(common time period + certain value) time period, and required time in between 1000ms to 2000ms. This algorithm takes slightly more time i.e 2-3 seconds,but it will definitely connect to the application before timeout period. In above graph, it shows that it takes 3sec at the speed of 1.5mb/s for connection.

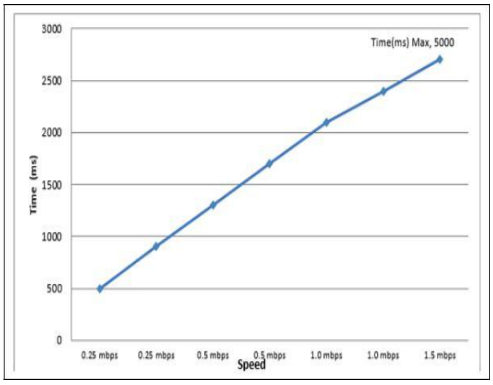

Fig. 5. Performance of Multi Routing Random Walk Algorithm

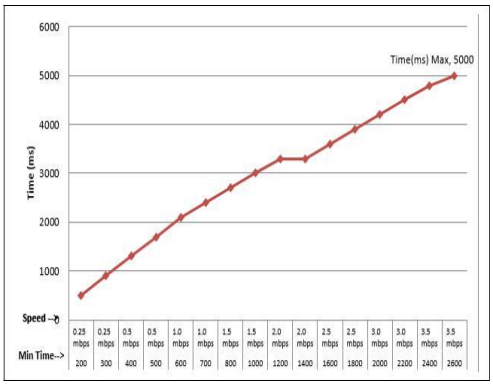

Fig. 6. Performance of Modified Multi Routing random walk algorithm

In modified multi routing algorithm, it shows that at 2.0mbps it requires constant time to connect to the database.

VII. Conclusion

CoT gives the tremendous opportunities to develop the application which user can access whenever wants. Model driven patterns helps in better application development in CoT, as different patterns are used according to the need, and use of business patterns along with the model patterns, helps in development of faster application. Using Algorithm as a service, it helps to solve the problems of connecting multiple devices to cloud services, storage of the data on the cloud. Modified multi routing algorithm takes quite more time than the standard multi routing algorithm, but advantage of modified algorithm is that in worst case also it connect to the application which is the difficult task in any application before timeout period.

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