GDMA: Generalized Domain Model Architecture of Internet of Things

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Abstract—**Internet of Things (IoT) refers to the world of intercommunication via distinctively recognizable smart objects forming a particular structure by integrating the physical world with the existing Internet, and is rapidly gaining popularity, with the increased adoption of smart phones and sensing devices. IoT domain comprises of several different models, which are often incompatible therefore one of the important challenges is to enable domain experts to easily specify applications for the IoT and to come up with retro fitting solutions to overpass the gap generated. As a first step towards developing a suitable programming abstraction, in this paper we propose Generalized Domain Model Architecture of Internet of Things to bridge the gap on existing architectural design that focuses to enhance the portability, interoperability and deployment of entities in a generalized podium.**

Keywords—***Internet of things; pervasive computing; domain model; generalized domain model architecture; internet protocol; ubiquitous computing; wireless sensor and actuator network; future internet of things .***

I. INTRODUCTION

Internet of Things, IoT has been described with several similar but non-identical definitions. One definition from among many states that IoT is: "A global network infrastructure, linking physical and virtual objects through the communication capabilities". The Internet of Things refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. In most organizations, information travels along familiar routes. Information is lodged in databases and analyzed in reports or also originates externally gathered from public sources, harvested from the Internet [2], or purchased from information suppliers. In order to make it effective, a generalize architecture should prevail that shall act as grounding or rather the foundation pillar to capture as many pertinent vantage points as possible. Establishing the common grounding encompasses the definition of IoT entities and describing their basic interactions and relationships with each other. The Reference Model of IoT [3] provides common understanding and describes essential building blocks as well as design choices to deal with conflicting requirements concerning functionality, performance, organization of components, deployment and security thereby generating several sub-models [8] that set the scope for important aspects of the IoT design space that can be filled up completely or extended, redefined or enhanced to certain extent to bridge the gap existing in the present scenario. The most profound model is the Domain Model that describes all the concepts that are pertinent in the foundation stoning of Internet of Things. All other models and the Reference Architecture are based on the concepts introduced in the Domain Model [1]. While certain other models such as Informational, Functional, communication or trust, security might be less critical in certain application scenarios, the Domain Model is mandatory for the working with IoT-A.

An important challenge to be dealt with in the domain of IoT is to facilitate the domain experts [2] (health-care professionals, architects, city planners, etc.) to develop IoT applications in their fields swiftly, with nominal hold up from skilled proficients. Alike issues have already been addressed in the fields of Wireless Sensor and Actuator Networks (WSANs) and Pervasive/Ubiquitous computing. While the main challenge in the former is the exceedingly large scale of the systems (thousands of largely alike nodes), the primary concern in the latter has been the heterogeneity of nodes and the major role that the user's own communication and dealings with these nodes plays in these systems (e.g. traditional "smart home" state of affairs wherein user work together with a smart put on view which works collectively with his refrigerator, washing machine, microwave, toaster and many such devices). The upcoming fields of IoT includes both WSANs as well as smart appliances, in addition to the elements of the "traditional" Internet for instance Web and database servers[9], revealing their functionalities as Web services etc. Consequently, an ideal application development construct of the IoT will facilitate (domain expert) developers to spontaneously spell out the affluent connections among enormously large figures of contrasting devices in the future Internet of Things.

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The larger goal of this research is to propose a suitable application development framework which addresses the challenges introduced above. This will most likely be achieved by a framing an innovative Generalized Domain Model Architecture that comprises of mostly all the basic real world objects which we call it as "entities", their relationship, association, decomposition and recursion mechanism that should fits if not specifically but approximately in all the areas to be explored in near future. For the same, the first logical step towards reaching the objective specified above is to construct a Generalized Domain Model Architecture (GDMA). The organization of paper is as follows: our main contribution i.e. GDMA presented in section II, followed by section III covering the benefits of GDMA, section IV emphasizes on the limitation and future scope of GDMA and finally section V concludes the paper with a stimulus to come across many other relevant and challenging areas of IoT.

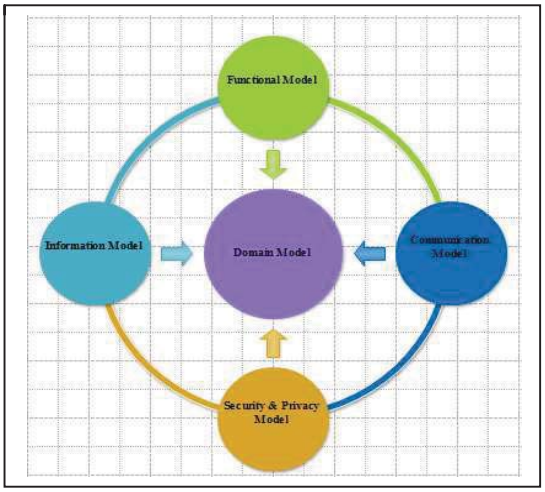

Fig. 1. The Reference Model of IoT.

II.Generalized Domain Model Architecture (GDMA)

Domain Model Architecture basically emphasizes the concepts belonging to a particular area of interest defining the crucial and vital attributes (abstraction) [6] of real world objects / entities and relationships between them thereby attaining the utmost importance in any reference model. The main purpose of a domain model is to engender a common understanding of the target domain in question. It is important for deducing the model diagram. It is meant to capture the key concepts and the relationships that are pertinent and applicable for various stakeholders concerned with the IoT.

The concept of Domain Model Architecture of Internet of Things has been tinted in this paper as "Entity-Relationship" concept using ER model representation. ER diagram is used to graphically illustrate the proposed Generalized Domain Model Architecture (GDMA). Our projected architecture includes the following concepts, which are specially used to model the "Entity", "Relationship" in the IoT. They are:

a) User essentially interacts with the Entity and seeks for the Services. Several users have been considered in this set-up such as Naïve, Sophisticated, Casual or Standalone users.
b) Service is categorized as Resource level, Virtual level and Integrated Level services that can invoke various services itself, analyze raw data which can be further stored in data store.
c) Entity is the genuine object further labeled as Physical Entity, Virtual Entity or Augmented Entity. The real world object acts on resources, associate with Services.
d) Computing Device signifies any device with computational capabilities is attached to Entity and can also analyze data and artifacts that are thereby stored in data store.
e) Data symbolizes the raw artifacts that additional needs to be processed that can be stored in database or database catalog where metadata comes into picture that draw attention to the self describing nature of data.
f) Data Store is nothing but the repository where significant data are cast off or it could take the form of a catalog where metadata such as the structure of data, file format and data representation schemes can be accumulated.
g) IoT Device bring into light, Sensors that senses the environment basically the entity, Tag that is used to identify the Entity and Actuators which acts on Entity thereby attaching itself to Entity. Further, IoT devices can access the existing data store.
h) Resource is software components that provide information about or enable the actuation on physical entities. Various resources categorized are Network resource and On-Service resource.
i) Cloud facilitates the provision of resources generally network resources, data store and services to the various Entities available in the IoT environment.

The notations used in model proposed is the traditional notations of Entity-Relationship model that depicts the Entity sets, relationship set, and cardinality mapping for the generalized scenario. In the model proposed below, the attributes of Entity set has not been highlighted as the attributes and its types totally depends on the specific application podium. The specific applications that will fit the Generalized Domain Model Architecture proposed is the future consideration of our work. Generalization is used to portray "is-a" relationship. Only the imperative specializations are shown, though others are feasible and possible. The cardinality ratio depicted in the model has been generalized thereby taking into account one to many ratios. Also, the participation of Entity set in the relation i.e. total or partial participation has not been highlighted in the generalized model which can be further depicted on specialized applications to be considered in future.

III. Benefits of Generalized Domain Model Architecture

The benefits of Domain Model are as follows:

A. Creation of Common Understanding of the Target

The different terminology used by different users in the IoT domain [9] can lead to perplexity, which can be assuaged by the usage of a common lexicon, standardized [4] [5] and as provided by a domain model architecture. This lexicon can be Depending on the specific applications, the type of sensors and devices can change but the intrinsic relationship between different entities they correspond to does not.

B. Modeling Invariant Properties

The domain model represents the invariant properties of the domain basically concepts and relationships which do not change from one application to the other. An illustration ofthis in the IoT domain can be the notion of a sensor attached to a device [4][5].

C. Modular Design

Application often needs to be broken down and further used by researchers, system programmers, even the domain experts.

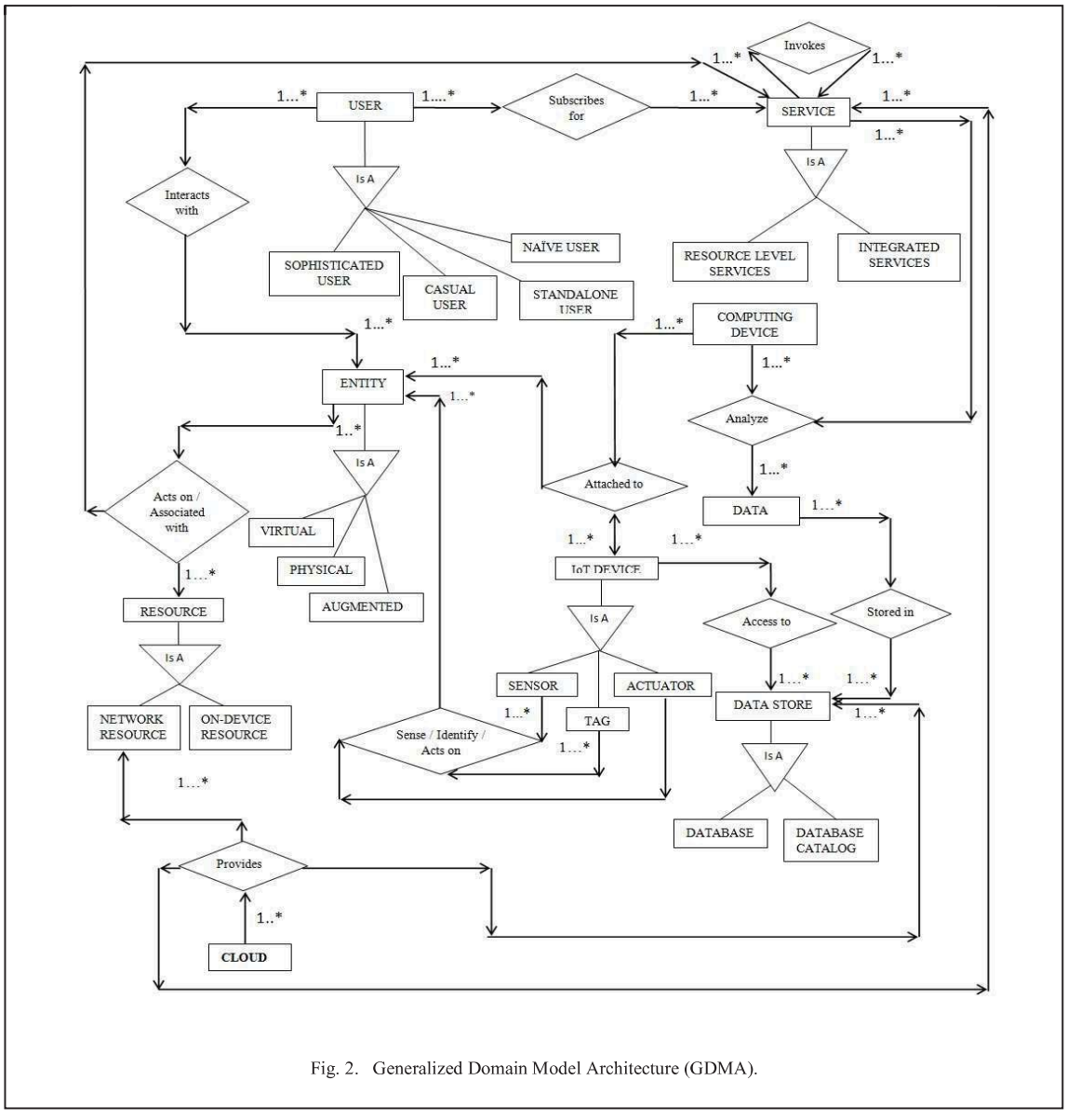

Fig. 2. Generalized Domain Model Architecture (GDMA).

decomposed in the system to project the behavior and internal working functionality of the system. A good domain model accelerates this modularity mechanism to identify the capabilities of each type of entity.

IV. Limitations and Future Scope of Generalized Domain Model Architecture

Being in the formative year in the IoT research podium, as a first step was to develop a framework for the Domain Model and encounter several challenges and issues thereby resulting in few limitations in our proposed work: There are few scenarios that has not being specifically highlighted rather the essential details has been projected in the model proposed above. Further, specific application has not been proposed nor detailed to proof the validity of the GDMA.

Our future work will proceed in the following directions: extensive literature survey to highlight various upcoming applications of IoT, and elaborating the various applications surveyed using the Generalized Domain Model Architecture proposed above.

V. Conlcusion

The Domain Models are available in the literature to establish the common understanding about the IoT's concepts, components and their relationship. The objective of this paper is to come up with the podium called Generalized Domain Model Architecture for Internet of Things and to propose the common understanding of the components of IoT that can be further used for any specialized applications. However, our future work aims to bridge the breach generated heading towards a fruitful conclusion to come across many other relevant and challenging areas of IoT.

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