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Application and Location Specific Models for Fog Based IOT Platform for Smart Cities

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ABSTRACT

The Internet of Things (IoT) is a paradigm where everyday objects are equipped with sensing, identifying, communicating and processing capabilities that will allow them to network with other devices and services over the Internet to accomplish some objective. Fog computing is extension of cloud computing paradigm to edge of network, which is a more highly visualized platform which provides computation, storage, and networking services between end IoT devices and back-end cloud servers. Fog like computational and storage buffers, which are located, locally between the IoT nodes and the cloud infrastructure process a significant amount of regional data to reduce huge network latency and overhead at the backend cloud infrastructure. In this paper we are going to propose Fog to be the appropriate platform for critical Internet of Things (IoT) services and applications for Smart cities.
Keywords : Cloud Computing Paradigm, Fog Computing, IoT, IoT Nodes, Network Latency.

I. INTRODUCTION

Internet today is not what it was yesterday and indeed tomorrow, it will not be what it is today. It is under a constant phase of evolution and change, we are moving in to Web 3.0 i.e. Semantic web .The goal of Semantic Web is to markup web content which makes it understandable by machines, allowing machines and search engines to behave more intelligently, so that the standardized web content will be better readable and allow machines to process and communicate and share data on their own, without need the of human support. Semantic web is the great enabler of IoT. The basic idea behind IoT is to make everyday objects smarter, by the addition of capabilities of sensing, identifying, networking and processing that will allow them to communicate with one another and other devices and services over the Internet to achieve some objective. It's certain, these smart devices face challenges rooted from computational power, bandwidth and storage, battery which directly affects Quality of Service (QoS) and user experience. To reduce the burden of limited resources and functionality of smart devices(or IOT nodes),Cloud computing came as a promising technological paradigm, delivering services of infrastructure, platform and software capabilities and ready to apply applications with elastic resources and all of these at a low cost. Merger of these paradigms of IoT and Cloud have opened up for new opportunities and business models but still there are issues related to mobility support, latency and location awareness.

Fog computing which acts as an intermediate layer between IoT nodes and backend Cloud each taken as separate layer, is proposed to enable computing at the edge of the network. It delivers low latency services and applications to end users and machines. Fog computing is still in its infant stage.

II. OVERVIEW OF FOG COMPUTING

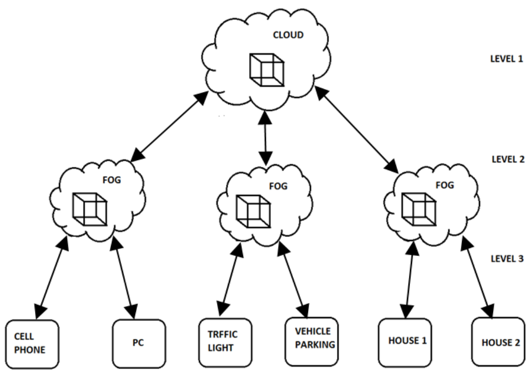

Figure1. Fog computing paradigm as a 3 level hierarchy

The main advantage of Cloud computing is that it is not required by the enterprises and their end users specifying details, such as storage resources, computation limitation and network communication cost to access the services of cloud. However this ease becomes a problem for latency-sensitive applications, which demands nodes in the vicinity to meet their delay requirements. Location awareness, mobility support and low latency requirements can hardly be satisfied by the current Cloud computing paradigm as more and more bandwidth hungry, complex devices are getting involved. Fog computing is proposed to address these problems as it provides low latency, location awareness, and improves quality-of-services (QoS) for streaming and real time applications. Based on the perspective of Cisco, Fog Computing is a highly virtualized platform which provides computing, storage, and networking services between traditional Cloud Computing Data Centers and end user devices, typically, but not exclusively located at the edge of network. IoT devices and hubs usually off loads its tasks to the nearest fog node, fog nodes are able to provide location-awareness and low latency to users and third-party application developers.

Cloud and Fog both provide data, storage, computation and application services to end-users. The distinguishing factor of Fog computing is by its proximity to end-users, the dense geographical distribution and its support for mobility. Fig. 1 describes the basic understanding of Fog computing paradigm as a 3 level hierarchy. Smart things are attached to one of the Fog devices and these could be interconnected and each connected to a bigger Cloud.

III. FOG COMPUTING FOR SMART CITIES

Over the last decade, significant research into the technologies needed to support Smart Cities has been carried out, with a focus on using information and communication technologies to manage city infrastructures like building management, energy monitoring, transportation, traffic control, and pollution monitoring. Cloud-based IoT hubs that provide an easy-to-use service access point to the emerging data infrastructure of a city is already proposed. The major drawback is the problems with their mobility support and latency. By providing Fog paradigm in extension to Cloud computing paradigm can address these issues and provide a better Quality of Service (QoS).

From a smart city service provision perspective, IoT devices constantly make their services accessible at the city cloud level and even at the fog level. Interested third-party smart city applications (e.g., traffic monitoring systems) on the other end of the system, will make use of these services based on protocols for service discovery and access, and their preferences in terms of quality of service requirements.

In this paper, we are going to propose Fog based IoT models for smart cities. We are going to use two approaches 1) Application Specific 2) Location Specific.

A. SMART CITY HUBS

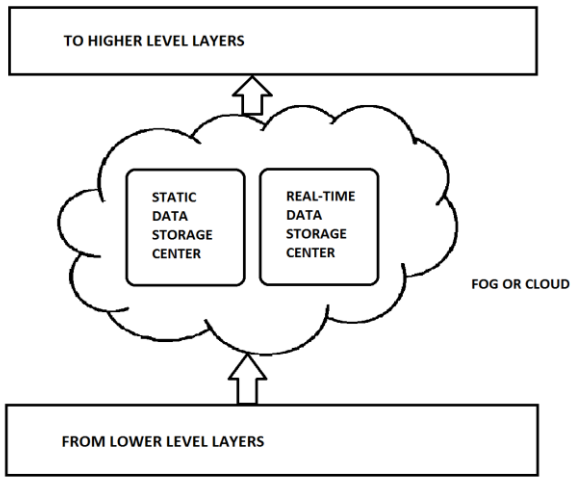

Figure 2. Fog-based hubs

Fog-based hubs offer a promising approach to developing an IoT centric framework for smart cities. They support the system-of-systems approach to smart cities whereby Cloud based hub can integrate a number to Fog based hubs and they again can integrate a number of sub-systems that collectively make up the complete smart city software infrastructures. These hubs offer a consistent and easy-to-use interface for emerging IoT infrastructure within the city or a locality or even for a particular type of service that systems integrators and application developers can use. Hubs which are either Cloud based and/or Fog based hubs also offer a framework to integrate both static and real time data sets from people, government, community groups and participatory sensing systems. Applications accessing these hubs can use this data to adapt themselves to current or expected conditions. This model can address issues in multi-modal transportation, urban waste management, load management and smart traffic control. Application developers can more easily create reusable applications that work in multiple application modes and even for multiplicities.

B. PROPOSED FOG MODELS FOR SMART CITIES

We have modeled two approaches for Smart cities
i) Application Specific and ii) Location Specific

i. Application Specific Model

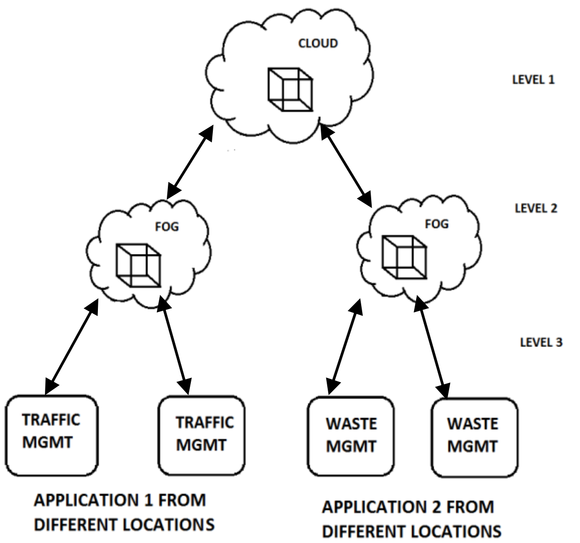

Figure 3. Application specific model.

It is clear that, Fog based platform designed to support smart cities will need to address the complex set of existing services and applications that any city infrastructure entails. Hence it is highly required to design Fog centres specific to particular application for variety of areas such as traffic management, licensing, water and sewerage, citizen engagement etc. in a single city. This makes control and co-ordination of specific service more secure, reliable and centric. Complete information of specific service will be available for further utilization. Fig. shows application centric model where each Fog manages unique application which has both static data storage and real-time data storage units where static data storage units store information like static routes and placement of IoT nodes in the complete city which generally does not change frequently and real-time data storage units will be handling data which change extensively with time and are to be addressed specifically. Third-party players can utilize allowed information from both static and real-time data centers, specific to an area (ex. Traffic management) and can develop wide range of applications for the use of different departments of Govt., general public or organizations which require them to offer high- end services. This model is mainly proposed to deliver high Quality of Service (QoS) and application specific information to the end user.

2. Location Specific Model

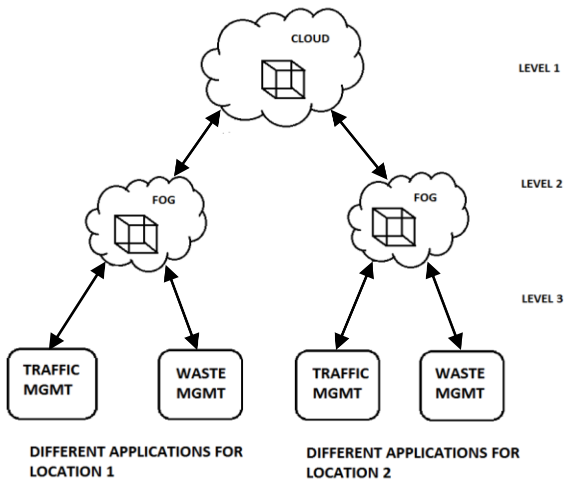

Figure 4. Location specific model

As Smart City infrastructure evolves, it will need to address the issue of federated or integrated areas where each Fog will not be service-area specific but location specific. It means each Fog will be addressing multiple areas ranging traffic management, licensing, water and sewerage, citizen engagement etc. This model is mainly proposed to address latency specific and bandwidth hungry applications as Fogs are located more nearer to IoT nodes. Infrastructure of Location Specific Model is similar to that of Application Specific Model, which contains both static data storage and real-time data storage units. Application developers rather concentrate on location of IoT nodes and a single Application can address multiple areas as users may be interested to know data specific to a location of smart city. This model is mainly proposed to deliver low latency, location awareness and high Quality of Service (QoS) to the end user.

IV. CONCLUSION

In this paper we have presented two approaches for fog computing i.e. application and location specific models on IoT platform for smart cities. The main advantages of both the approaches is they provide low latency, location awareness, and improves quality-of-services (QoS) for streaming and real time applications when compared to Cloud based approach.Third-party players can utilize allowed information from both static and real-time data centers, specific to an area (ex. Traffic management) and can develop wide range of applications for the use of different departments of Govt., general public or organizations which require them to offer high- end services for smart cities. Fog based approach can be utilized in various fields in future and have to be protected from security threats. Considerable amount of research has to be done on extensions and further improvements of proposed models and care also has to be taken on security and privacy issues.

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