A Fog Based Agile Distribution of IoT Application(s) using Chef

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Abstract

The concept of Fog computing has encompassed a new dimension in the IoT related research and created new possibilities to different heterogeneous devices to be well-equipped with multi-dimensional applications. In recent years the fast growing field of IoT applications demand for vibrant and mobile computing services to facilitate Quality of Services (Qos) to the end user. This paper addresses the issue of providing a scalable and agile distribution of different heterogeneous and multi-vendor IoT applications in Fog.

1. Introduction

The conceptual IoT has a diverse range of applications to enhance the usability of the heterogeneous entities of the IoT network. According to the recent study [7] by Gartner estimates that around 26 Billion IoT devices will be connected to the IoT network by the year of 2020. There are some existing challenging issues in IoT related research like Heterogeneity, Scalability, Interoperability, and Security and Privacy [8] and in near future a new challenging issue will arise, which is to manage and deploy the umpteen range of applications to fuel the demand for services that will be required by the increasing number of IoT devices. Nowadays, cloud service providers mainly concentrating on the development of different IoT based applications and deployment of the services for IoT in the cloud environment. In [9] the authors have proposed an approach to virtualize the physical objects in the cloud environment to enhance the energy efficiency of the Green-IoT network and also application driven approach for Green-IoT network. But the emergence of Cisco Fog helps the IoT devices to closely collaborate with the service providers in the Fog for better performance and Quality of Services (QoS).Moreover, Fog inherits the similar services of the Cloud but resides within a close proximity range from the highly portable physical IoT devices. In [1] the authors have envisioned portability of different cloud application with Chef which is a popular platform for managing and deploying applications to the cloud. They have considered the benefits of using cloud services for mass deployment and mobility of the applications.

The main contributions of this paper are,

- Implementing SaaS alike cloud service in the Fog to manage and deploy diverse range of IoT applications
- Envisioned local fog service package to lessen the dependency on cloud services in order to provide better Quality of Service(QoS)
- Implementing the Chef [2] platform in Fog to increase the manageability, mobility and availability of IoT applications within a close proximity range to devices

2. System Model

Fig. 1 illustrates the proposed Fog based system model

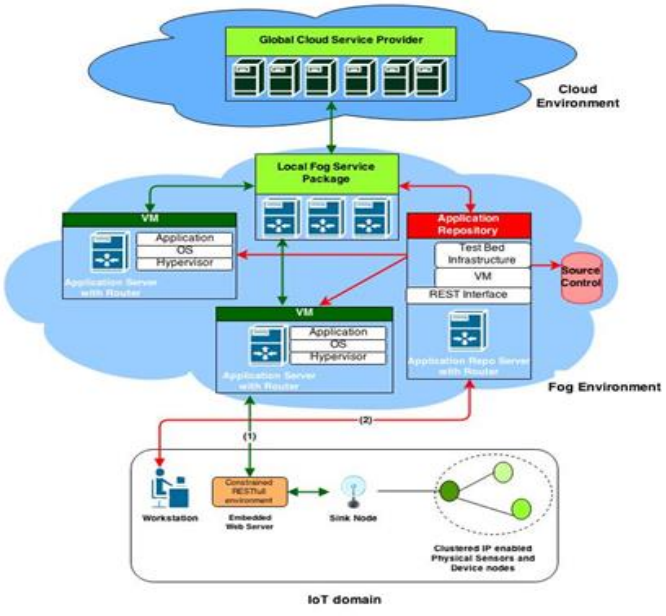

Fig 1. System model for Fog based IoT application distribution

and depicts the components are described below,

2.1 Global Cloud Service Provider

Different vendors from different geographic locations can host and provide their services through Cloud. Since Cloud is accessible from anywhere and can provide a whole computing solution including not only data storage and computation but also application services, different Cloud vendors and service providers intent to manage and host their products and services in the Cloud.

2.2 Fog Environment

Cloud computing provides a variety of services and the core IoT is largely dependent on Cloud to become more efficient to manage data and different IoT centric web applications [4]. But IoT demands for less latency in service, mobility and location awareness in order to provide real time services and the existing cloud computing model cannot deliver such specialized requirements. Thus Fog computing has come into lime light to face off the requirements of newly emerged IoT paradigm [5]. Fog is closely coupled with the IoT physical devices and sensor devices to provide better performance metrics than Cloud. Furthermore, Cloud is extended to Fog in order to virtualize the platform to facilitate enhanced computing capability, data storing and networking services to the IoT end-user or devices compare to Cloud [6].

2.3 Local Fog Service Package

The proposed local fog service package bridges the gap between Cloud service provider and IoT devices or users in terms of service availability to simplify the IoT application distribution. In the proposed model, local fog service package is used instead of Cloud service packages in the Cloud for IoT application and services. Since Fog is the more adjunct to the end user, a potential solution has been proposed in order to eradicate the hindrance of mobility that is required for IoT driven network and applications. In case of new service provided by the global cloud service provider, the local fog service package pulls the new service on the request made by the IoT domain which resided in the corresponding Fog. It can also be noted that the local fog service provider packages can be shared across neighboring Fog under different circumstances.

2.4 Application Server with Router

The chef-client is installed in every Fog nodes, in general case application servers. The application servers are managed by the application repository and the chef-client maintain a run-list provided by the application repository in order to receive client specific configuration data.

2.5 Application Repository

In our scenario we have installed the chef server in the application repository within the Fog environment. The proposed Test Bed Infrastructure which belongs to the application repository is hosting the chef server. The repository is the centralized point of issuing IoT application configuration data or policy and also facilitates versioning and deploying features in IoT application to the VMs residing in the Fog. The application repository has the REST interface so that it can be accessed directly by the admin for the purpose of IoT application development.

2.6 IoT domain

In our paper, the following components are used to demonstrate the IoT domain scenario.

2.6.1 Workstation

The workstation is equipped with knife, written in Ruby programming language and a component in chef environment to manage the Fog nodes and which is the medium to interact with the hosted chef application servers. An admin user can use the workstation to develop new cookbooks and recipes, in other words fundamental unit of configuration and policy distribution [3]. It can also access source control to manage code versioning, node bootstrap operation and the knife can upload new version of code to the application servers or Fog nodes.

2.6.2 Embedded Web Server

The embedded web server hosts the constrained RESTfull environment which follows the trivial client/server architecture and is prominently used nowadays to extend the range of connectivity of heterogeneous sensor devices and actuators in the IoT domain. The conceptual REST architecture has standardized a way to access the resources by using unique URI (Uniform Resource Identifier. The protocol that has been used across REST architecture is HTTP. The embedded server is capable of assigning URI for each of the connected devices with the server and thus makes the devices accessible to the client side using Internet.

2.6.3 Physical Devices

In IoT physical devices should be IP enabled and that includes both sensor and physical devices within the IoT network. Usually sensor or RFID devices run on low memory and limited data processing capable environment and thus it is implicated to the user or developer community to categorize those devices by discretely considering device capability. In this context, we have considered the capability of a cluster of resource constrained sensor devices in terms of less connectivity and low powered characteristics. Furthermore, we have also considered the representative of the cluster, sink nodes with the higher capability to transmit the aggregated data generated by the sensors and low powered actuators which are merely used as relay nodes. Data flow produced by the relay nodes are collectively transmitted by the sink nodes to the embedded web server for further processing in the Fog environment.

3. Experimental Results

The experimental results are based on the implementation of the Fog based distribution of IoT Application using chef platform. Fig. 2, Fig 3 and Fig 4 show different phases of the implementation of application in the IoT environment.

Fig 2. Fog node bootstrap using knife in workstation

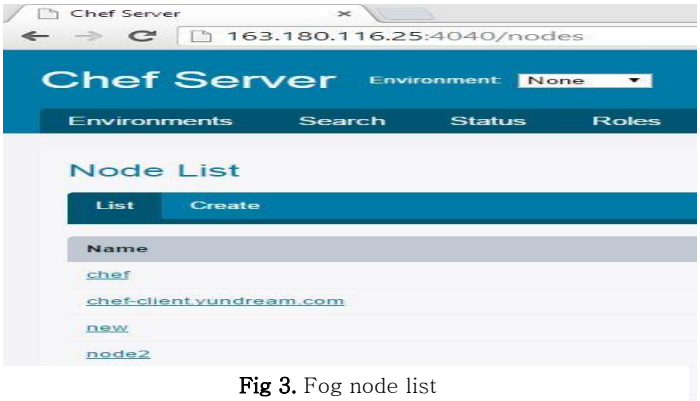

Fig 3. Fog node list

4. Conclusion

The proposed system model for Fog based distribution of IoT

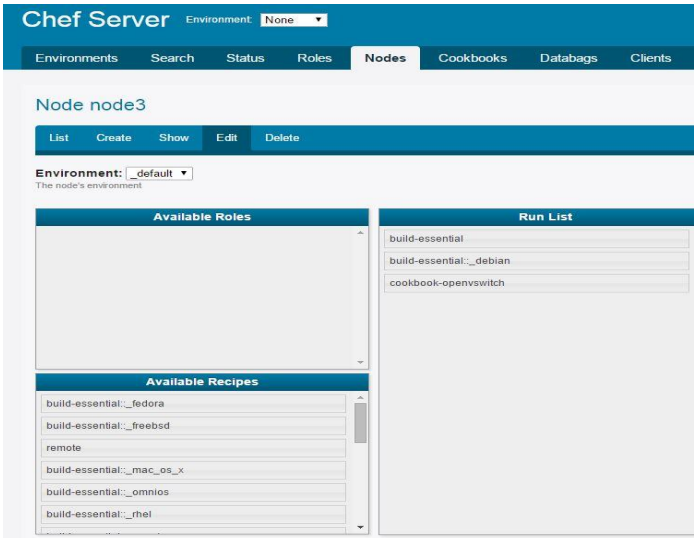

Fig 4. Run-list of an application server or Fog node

applications using Chef Platform ensures highly scalable and manageable scheme to retain the Quality of Service (QoS) to end user. The implementation of the system model depicts the way to manage different infrastructures in the Fog environment for advancing towards further development in this research.

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