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Towards an Optimized Scheme for Mobile Subscribers Based on Cloud Computing

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Abstract

Recently, deploying the publish/subscribe model over Peer-to-Peer networks have been widely used for mobile applications. However, transfer delay and network load remain the challenging issues to consider for mobile subscribers because of their dynamic nature. In this paper, we propose an approach handling mobile subscribers over a Peer-to-Peer architecture, and we illustrate its extension to cloud federation. This extension achieves the realization of a large number of virtual computing clusters, running as into a single cloud organization. Extensive simulation results revealed how our approach can significantly improve transfer delay, and network load compared to previous approaches while applying a wide range of workload parameters, such as frequency of movements, and publication rate.

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Keywords: Mobile Computing; Peer-to-Peer Systems; Wireless Networks; Cloud Computing; Publish/Subscribe

1. Introduction

The development of PDAs[1] and the quick spread of the internet of things[2] have led to an important growth of the number of connected users. These users are consumers and producers of data at the same time. Moreover, the devices are more and more available with low prices, and the network provider is more and more increasing the coverage and the bandwidth. For this reason, internet connectivity is more and more ubiquitous[3]. Hence, a huge quantity of data is exchanged across the internet services with the need of clients to retrieve data once is published. To achieve such a requirement, the use of the publish/subscribe (pub/sub) pattern[4] in communication protocols becomes a necessity.

The pub/sub systems are specified by their scalability and flexibility in distributed mobile environments[5]. In fact, the characteristics of these systems facilitate their application for mobile information. Indeed, the communicating parties can interact in the system without being aware of one another. Moreover, this paradigm is more suitable to the disconnected operation than the point to point paradigm. The majority of the pub/sub systems are developed for fixed networks and there is no support for the mobility of the subscriber. Thus, there is a crucial demand for enhancing this paradigm to mobile distributed network. In fact, the typical aim of the pub/sub paradigm is to propagate the information from the publishers to the subscribers while keeping the communication anonymous and decoupled.

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Indeed, this forwarding is assured by a set of brokers over a Peer-to-Peer (P2P) network. However, the deployment of pub/sub systems in dynamic environments causes several challenges, such as running out of battery, load on the brokers and low network connectivity. Such circumstances may affect the performance of the system. To overcome the problems induced by such changes and improve the adaptation of the system, we propose the management of mobile subscribers between brokers.

The pub/sub paradigm illustrated in Fig. 1, includes two categories of clients, the first is called publisher and produces information, and the second, the subscriber consumes the information. Hence, communication occurs by sending information from the producers to the consumers through a set of brokers. Brokers are responsible for the routing of information to interested consumers. The publishers send their information as publications. While, the subscribers send their interest as subscriptions. The specificity of the pub/sub paradigm is the decoupling between the interacting parties in flow, space, and time. The decoupling in flow resides in the fact that the consumers could be notified at the same time that the publishers send other notifications. Hence, the interacting parties can communicate independently. The decoupling in space is the ability of the publisher and the subscriber to communicate without knowing each other. The decoupling in time is the capacity of the interacting parties to communicate without being connected together. These decoupling characteristics facilitate the scalability and the flexibility of the pub/sub paradigm. Hence, this paradigm is considered as the best candidate to cope with mobile environments.

The pub/sub systems may be classified into three categories according to the subscription model. The first category is the topic-based system, the second is the type-based system. These two categories suffer from limited expressiveness. The third category is the content-based model which resolves the problem of expressiveness. The architecture of the overlay of brokers can be constructed in a centralized or a distributed way. When it consists in a centralized architecture, there is a single broker for joining the consumers and the producers. Hence, this may risk to have a congestion in the performance. Moreover, the failure of this central broker implies the failure of the system. Consequently, the scalability of the system may be affected. In contrast, when it consists in a distributed architecture, there is a collection of brokers organized in a distributed way, which contribute together to routing messages to the interested subscribers. Thereby, the interacting parties are attributed to a set of attached brokers in a distributed P2P architecture. This type of architecture is scalable and significantly reduces the network load.

Critical resources and data are managed by pub/sub systems. In the cloud computing paradigm, resources are provided and allocated as services. Hence, the pub/sub systems can exploit the services provided by the cloud computing to execute the needed resources. In order to exploit multiple resources from independent cloud providers, cloud federation appeared to satisfy such a requirement. Therefore, the distributed virtual computing clusters are running as into a single cloud. This model handle scalability limits of a single cloud. In such a situation, it is important to use particular networking technologies that support the communication between cloud suppliers. In fact, the pub/sub paradigm is effective to support such a communication.

The extension of the pub/sub paradigm in mobile environments includes two categories of mobility: The first is the code mobility which consists of the movement of the code from one host to another. The second is the host mobility that corresponds to the movement from one access point to another. In our work, we have examined the host mobility. In fact, the trend that a subscriber connects to the same broker all the time is no longer credible. During the roaming, the subscriber disconnects from one access point and connects to another one. Hence, during this movement, the subscriber risks to be disconnected for a lap of time. This disconnection may occur due to the lack of battery or the absence of connectivity. During these disconnection periods, the subscriber risks to lose messages. Thereby, the problem of mobility should be treated by pub/sub systems.

Three categories are found for approaches supporting the subscriber's mobility in the pub/sub systems. This classification is based on the time and the manner that cached subscriptions and matching events are transferred from the old to the new broker. Thus, these categories are: reactive approaches[6,7], durable subscriptions[8,9], and proactive approaches[10,11]. In this paper, we adopt a proactive approach based on the predictive selection of the least loaded brokers to reduce the buffer cost and the delay of transfer. Then, we propose to extend this approach to the application of cloud federation.

This paper is organized as follows. Section 2 gives an overview of the approaches treating the mobility in pub/sub systems. Section 3 highlights the basic idea our approach for handling mobile subscribers and its extension to cloud federation. Section 4 summarizes the experimental results validating the efficiency of our approach. Finally, the conclusion is presented in section 5.