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Qos-Driven Architectural Mining for Publish/Subscribe Systems Deployed on MANET

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Abstract

An important issue in distributed systems is to improve the information dissemination, especially in the Publish/Subscribe systems deployed in mobile ad hoc networks (MANET). In fact, the achievement of this goal needs to take into account various problems such as the failure of the communication system and the degradation of the quality of service (QoS). We focus on QoS problem, we address possible solutions to ensure efficient and reliable communication systems. We propose reconfiguration actions rules which are applicable to a network having QoS degradation. We use graphs to model the distributed system and graph transformation engine (GMTE) to execute rules of reconfiguration. The generated solution is selected according to various evaluation criteria in order to satisfy the requirements of system in terms of QoS.

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1. Introduction

A Publish/Subscribe system, also known as event-based system, has been adopted as a key technology for the effective information dissemination on a large scale. This system consists of a set of distributed nodes playing the role of an event service, producers and consumers. The event service is a set of dispatchers responsible for the distribution and the routing of notifications from producers to consumers. This system is highly scalable because it supports a large number of participants (producers and consumers) and is characterized by a three dimension decoupling: in time, space and synchronization.

Publish/subscribe systems may be used on Ad hoc network (MANET), which is formed by a large number of mobile units/equipments communicating via wireless interfaces. This network is characterized by the absence of infrastructure and the easy and rapid deployment of mobile entities by establishing direct exchanges. In this network, the energy constraint is very important because the nodes are powered by batteries with limited useful life. Moreover, the bandwidth is limited because the communication medium is wireless. All these characteristics, introduces several constraint to the publish/subscribe system when deployed on MANET. In fact, nodes mobility causes performance degradation of the logical link. In addition, the autonomy of nodes affects the performance of logical entities (dis-

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patchers, producers and consumers). This matter affects the performance of the logical network (entities and logical links) and thus, causes a degradation of the QoS parameters at the logic level. It is therefore imperative to maintain a good QoS and to repair the degradation with the appropriate methods. This may be done by introducing reconfiguration actions in the system in order to re-establish system functionality. Doing this, we propose three adaptation actions detailed bellow. However, what reconfiguration action is more appropriate to the faulting network? It'a beneficial to combine two or three reconfiguration actions?

In this paper, we answer to all these questions by proposing an approach witch consists in evaluating the proposed reconfiguration actions by means of a graph and rules policies modeling. The proposed approach allows the exploration of all possible deployment solutions of reconfiguration policies and the selection of a deployment solution that improves the network' state. Several selection criteria are used in order to select the most appropriate solution.

The following of the paper is organized as follow: In Section 2, we list the related work. In Section 3, we introduce a case study motivating the proposed approach. Then we describe our approach in Section 4. In Section 5, we present the implementation, and in Section 6, we explain the evaluation related to the proposed case study. In Section 7, we conclude and we present future work.

2. Related Work

After a scanning of related work proposing remedial actions and methods of architectures evaluation, we found that in the middleware side, the majority of existing research activities permit partial improvement of QoS that and may introduce other problems affecting the system state. The majority of these activities are divided in two categories. The first category concerns the self-healing systems that maintain connectivity between dispatchers in the middleware level by repairing node or link. Among these systems, we cite REDS[1] and Pusman[2] which are based on the substitution of the failed dispatcher by another one ensuring a better QoS. However, the the failure of an access point cannot be repaired in these systems.

The second category aims to periodically ensuring system performance by satisfying some QoS requirements. Among these systems, we cite IndiQoS[3], Harmony[4] and SystemQ[5]. IndiQos, by introducing QoS attributes in subscriptions, uses resource reservation approach in order to control latency. However, this inclusion can prevent the delivery of notification if it does not check these QoS attributes. In addition, IndiQos relies on alert messages which cause a loss of time and resources especially in MANET.

Harmony uses the "proactive best-path" technique to determine the shortest route leading to each destination based on a monitoring agent that measures latencies. However, this technique does not determine whether the current route maintains QoS requirement specified by the application. Harmony also uses a technique "Multipath" which forwards the events on two routes to increase reliability. However, this technique can cause network congestion due to the redundancy of information.

The SystemQ applies the substitution of logical links and uses a technique of comparing the distances between logical nodes to periodically optimize routes in order to minimize latency. However, the substitution of link is sometimes useless if latency will increase and not decrease with a minimum distance. As already mentioned, these systems provide locally QoS requirements but there is no guarantee for the overall network. Thus, these systems are unable to satisfy our goal to ensure a good functioning of a Publish/Subscribe system deployed on MANET with the maintaining of QoS required when sending messages.

Several reasch studies have already been done in the study of Publish/Subscribe paradigm to enhance to QoS in MANET such as the work of Denko et al.[6] and Cherkasova et al.[7] . Basically, the starting point of these approaches relies on the hypothesis that QoS maintenance may be improved thanks to a dynamic location of the brokers on the nodes. Our starting point is similar and considers that the broker location may be driven by two main criteria: the mobility of the hosting nodes, and the QoS observed between nodes hosting adjacent brokers along the data path. When the mobility is increasing, we assume that there is a serious risk of QoS degradation between the broker and its neighbor brokers, and that the broker location has to be reconsidered. Similarly, when the observed latency between two adjacent brokers is increasing, we assume that this denotes a problem and that is time to reconsider the broker location. Reconfiguration actions may then be introduced to ensure system survivability according to each QoS degradation cause. In fact, adaptation can be accomplished by migrating a non stable broker to another node in the