Real-Time Service Provisioning in Spontaneous Mobile Networks

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***Abstract*— Real-time applications in spontaneous mobile networks (often called mobile ad hoc networks) are a major technical challenge. On one hand, mobile devices and wireless connections between them are becoming ubiquitous, and real-time applications such as games or Voice-over-IP would be very attractive to their users. On the other hand, providing real-time services in such an environment is quite difficult since the provisioning procedures must cope with the high level of device heterogeneity, degree of mobility, and take limited device resources into account.**

In this paper, we introduce SIRAMON, a generic, decentralized service provisioning framework for spontaneous mobile networks. SIRAMON integrates the required functions to deal with the whole life-cycle of services. SIRAMON offers sufficient capabilities to specify, deploy, instantiate and manage not only trivial but also complex services like real-time mobile group applications.

I. Introduction

Spontaneous[1] mobile networks or MANETs (Mobile Ad hoc NETwork) have been receiving much attention recently due to their immense field of application. These networks are often built from a collection of diverse mobile devices connected to each other via wireless links. The devices form a multi-hop network communicating spontaneously without relying on any pre-existing infrastructure or central administration.

So far, applications of MANETs have been envisioned mainly in the field of emergency and military situations. However, MANETs offer many more possibilities. Real-time applications, such as online games (cf. Figure 1), group-work, multimedia entertainment or Voice-over-IP, are the most attractive candidates to be used over mobile networks [1].

[1]We are using the terms *spontaneous*, *ad hoc* and *self-organized* in the same meaning in this paper

Fig. 1. Distributed Online Game in a Mobil Ad Hoc Network

On the other hand, providing real-time services in such environment is an extremely difficult task, because of the lack of central infrastructure; the high level of device heterogeneity; the degree of mobility and the resource constraints of devices, which demands for the support of a generic service provisioning framework.

II. Related Work

To standardize the functions of service advertisement and service/resource lookup several proposals have been developed (e.g., Sun's Jini [2], Service Location Protocol (SLP) [3] of IETF). However, these proposals are mostly based on the use of a central directory. Moreover, almost all of them include the client-server paradigm and mainly focus on resource/service provided by devices (e.g., printers or fax-machines) which restricts their applicability in mobile networks.

In contrast, some recently appeared new proposals directly target infrastructureless networks. The Konark system [4] is a middleware designed specifically for

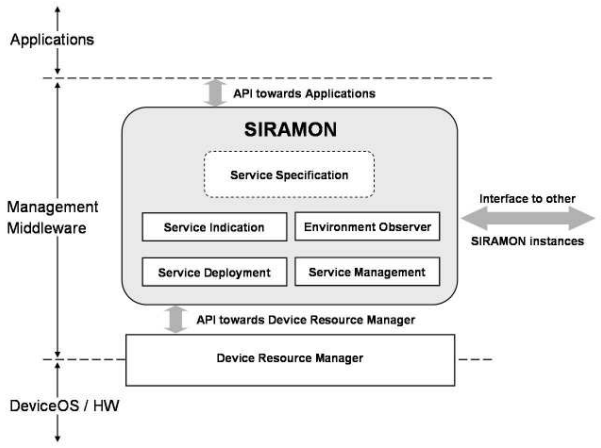

Fig. 2. Coarse-Grained Model of an Ad Hoc Node with SIRAMON

service discovery and delivery of device independent services. The distributed service discovery architecture [5] is a different solution which relies on a virtual backbone for locating and registering available services. However, these systems don't cover the whole life-cycle of service provisioning.

The Web Services architecture [6] is the most widely used and referenced current work on distributed service provisioning. However, this approach requires central infrastructure with permanent servers and often powerful devices with sufficient computation and communication capabilities which is not the case in mobile networks.

III. SIRAMON

The lack of a solution motivated us to propose a new, generic service provisioning framework for spontaneous mobile networks, called SIRAMON (Service provIsioning fRAMework for self-Organized Networks) [7], [8]. According to our mobile ad hoc node model, see Figure 2, we introduced a management middleware containing SIRAMON and providing transparent APIs (Application Programming Interface) towards the applications and, through a resource manager, towards the device OS/HW.

SIRAMON is based on a modular and distributed design. The proposed modules are the following: (i) *Service Specification*; (ii) *Service Indication*; (iii) *Service Deployment*; (iv) *Service Management*; (v) *Environment Observer*.

Service Specification contains the used Service Model which describes the role of the device in the service, the functions and connections of service elements to build the service. Service Indication is responsible for service advertisement if the node hosts a service, or service lookup if the node intends to use a service. By the Service Deployment module, creation, installation and configuration of services are carried out. The Service Management component controls the service maintenance, reconfiguration and termination functions. And the Environment Observer module deals with the monitoring of the node resources and the service context.

SIRAMON instances running on different nodes are communicating over a signalling channel. Furthermore, all devices have to be furnished with SIRAMON in advance and the required software of the application should be found on at least one networking node.

With its design, SIRAMON constitutes a distributed service provisioning entity of the mobile ad hoc network.

IV. Conclusions and Future Work

In this paper, we discussed the relevance of real-time applications to and the difficulties of provisioning them in a mobile ad hoc environment. Moreover, we introduced SIRAMON, a new, generic service provisioning framework which can cope with these difficulties. SIRAMON, with its decentralized, modular design suits well to mobile ad hoc environments and is flexible enough to provide even complex services, such as real-time mobile group applications.

Currently we are about to setup an international research project based on SIRAMON with the topic of *Multiplayer Game Support in Mobile Ad Hoc Networks*.

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