USAGE OF UBISOAP MIDDLEWARE FOR UBIQUITOUS NETWORK

A. Mohana Lakshmi*
S. Athi Narayanan*

Abstract—
The concept of ubiSOAP middleware strives to provide ubiquitous networking to services. ubiSOAP defines two-layer architecture : network-agnostic connectivity, WS-oriented communication in ubiquitous networking environment. The ubiquitous networking of services remains challenged by the inherent mobility and resource constraints of the devices. Here we discuss about the design, implementation and experiment of the ubiSOAP middleware. To achieve ubiquitous networking of services a network agnostic connectivity is enabled in our project.

Keywords—Service architecture, Network agnostic, WS-Oriented communication, ubiSOAP middleware.

* PSN College of Engineering and Technology, Tirunelveli

I. INTRODUCTION

THE vision of ubiquitous computing has centered on potential benefits of widely distributed input and output devices. With network connectivity being embedded in most computing devices and networked device may seamlessly consume but also provide software applications aver the network. *Service-Oriented Computing (SOC)* then introduces natural design abstraction to deal with ubiquitous networking environments. In addition, the concrete instantiation of SOC paradigms provided by web Services (WS) technologies by mean of web based/XML based open standards(e.g., WSDL, UDDI, HTTP, SOAP) may be exploited for concrete implementation of ubiquitous services. Supporting WS access in ubiquitous networking environments is still challenging.

In fact such a kind of networking environments both service consumers and providers often run on resource-scarce platforms (e.g., personal digital assistants and mobile phones), which have limited CPU power, memory, and battery life. Moreover, these devices are usually interconnected through one or more heterogeneous wireless links, which compares to wired networks, are characterized by lower bandwidth, higher error rates, anf frequency disconnections. The former issue has led to the introduction of lightweight middleware enabling base WS oriented communication patterns among wireless portable devices (i.e., SOAP-based messaging and dynamic service discovery). The later issue has further led to examine specific SOAP transports. However, while WS standards and implementations targeting widearea domains are effective technologies, supporting WS access in ubiquitous networking environments is still challenging. In fact, in such kind of networking environments both service consumers and providers often run on resource-scarce platforms (e.g., personal digital assistants and mobile phones), which have limited CPU power, memory ,and battery life. Moreover, these devices are usually interconnected through one or more heterogeneous wireless links, which compared to wired networks, are characterized by lower bandwidth, higher error rates, and frequent disconnections.

A key feature of ubiquitous networking environments is the diversity of radio links available on portable devices, which may be exploited toward ubiquitous connectivity. Specifically, as nodes get directly connected via multiple radio links, thorough scheduling and handover across those links allow enhancing overall connectivity and actually making it ubiquitous. This call for making services network agnostic, so that the underlying middleware takes care of scheduling exchanged messages over the embedded links in a way that best matches *Quality of Service (QoS)* requirements and further ensures service continuity through vertical handover. In this setting, a primary requirement for supporting service-oriented middleware is to provide a comprehensive networking abstraction that allows application to be unaware of the actual underlying networks while exploiting their diversities in terms of both functional and extra functional properties.

This paper introduces the ubiSOAP middleware, which strives to provide ubiquitous networking to services. Specifically, ubiSOAP defines two-layer architecture which respectively provides *network-agnostic connectivity* and *WS-Oriented communication* in ubiquitous networking environments. The ubiSOAP communication middleware aims at effectively exploiting the diverse network technologies at once in order to create an integrated multiradio networking environment, hence offering network-agnostic connectivity to services. This requires addressing a number of critical issues such as *network availability, user and application QoS requirements,* and *vertical handover*. Vertical handover is particularly important with respect to the service continuity requirement.

II. NETWORK-AGNOSTIC CONNECTIVITY

The ubiSOAP network-agnostic connectivity layer provides Multiradio Networking functionality by means of two entities (i) Multiradio Networking Daemon is the main entity implementing all the provided features, and (ii) Multiradio networking API allows for an easy and transparent access to the functionalities offered by MRN-Daemon.

Specifically, the network-agnostic connectivity layer offers the core functionalities to effectively manage the underlying multiradio environment through :(A) a network-agnostic addressing scheme together with (B) QoS-aware network link selection, and (C) base unicast and multicast communication schemes.

A. Network-agnostic Addressing

Devices embedding multiple network interfaces may have multiple IP addresses, at least one for each active interface. Thus, in order to identify uniquely a given ubiLET in the network we associate it with a Multiradio Networking Address (MRN@). The MRN@ of a ubiLET instance is specifically the application's Unique ID, which maps into the actual set of IP addresses (precisely, network ID   IP addresses) bound to the device that runs the given instance. ubiSOAP network-agnostic connectivity layer provides the following operations to generate and manage MRN@s:

Registration - allows a ubiLET to register itself within the network-agnostic connectivity layer and generates the MRN@ that uniquely identifies it.

Management - is in charge of managing at runtime the mapping between the MRN@ and the actual set of IP-Addresses. When a device moves from a point of attachment to a new one (e.g., it detaches from a network and reconnects to a new one), such a mapping changes as result of the vertical-handover procedure. Hence, all the ongoing communications (both outgoing and incoming) might break. If a moving device hosts only service consumers, then all the communications are outgoing and can be managed locally by simply switching the associated connections to the new accessed network.

Lookup - allows ubiLETs to retrieve the actual set of IP addresses related to a given MRN@. Exploiting the Ethernet Address Resolution Protocol (ARP) idea ,if the resolution of MRN@ is not cached or needs to be updated, a request is multicasted to all the networks currently accessible and, if the device bound to the given MRN@ is reached, it will directly reply to the requester by supplying the MRN@ mapping.

B. Qos-aware Network Link Selection

Next to MRN@ addressing, it is crucial to activate and select the best possible networks (among those available) with respect to required QoS. Specifically, QoS is defined by means of a set of pairs <QoS_{attr}; QoS_{value}> where attributes are grouped in two subsets: (i) quantitative attributes that describe the performance provided by the networks—i.e., bitrate, packet loss transfer delay, and signal strength—and allows for networks ranking, and (ii) qualitative attributes that describe those characteristics of the network that do not affect the network performance but should be considered— i.e., power consumption, price, coverage area.

C. Base Unicast and Multicast Communication

Once defined the MRN@ addressing scheme and the operations enabling the network link selection, the network-agnostic connectivity layer provides two base communication facilities: synchronous unicast and asynchronous multicast.

ubiSOAP synchronous unicast allows for point-to-point communication between two ubiLETs sharing at least one network. Specifically, it is provided by means of a logical stream channel that is used by the ubiLETs to read/write the packets belonging to the ongoing communication.

ubiSOAP asynchronous multicast allows for one-to-many communication within a group of ubiLETs sharing at least one network. Specifically, it is provided by means of multicast packets that are sent to all members of a given group.

III. SYSTEM ARCHITECTURE

Devices embedding multiple network interfaces may have multiple IP addresses, at least one for each active interface. Thus, in order to identify uniquely a given ubiLET in the network we associate it with a Multiradio Networking Address (MRN@). The MRN@ of a ubiLET instance is specifically the application's Unique ID, which maps into the actual set of IP addresses bound to the device that runs the given instance.

Interface activation allows ubiLETs to activate the best possible interfaces (among those available) with respect to the required QoS. Specifically, the interface activation algorithm compares the QoS requirement specified by the application as a QoSInfo profile) with the QoSInfo of each available interface in ints. If an interface satisfies the requirement, within a given approximation expressed in percentage (i.e., matching accuracy), then it is activated. Note that, since the interfaces are switched off, QoS refers to the theoretic values of a network interface as declared by the manufacturer.

Network selection is performed during the establishment of the communication and takes into account both the QoS required by the ubiLET that is instantiating the communication and the set of networks active on the remote ubiLET (as given by the destination's MRN@). Specifically, the network selection algorithm first selects all the networks (among the available ones) that both satisfy the QoS requirements (req) and allow for reaching the destination (dest), and then sorts in descending- order the resulting set of networks with respect to the matching accuracy. Hence, since networks are arranged in a descending-order list, the first of the list is the one that best fits the requirement posed by the application. The ubiSOAP communication middleware aims at effectively exploiting the diverse network technologies at once in order to create an integrated multi-radio networking environment, hence offering *network-agnostic connectivity* to services. The IP address is modified accordingly in order to route packets to the new network.

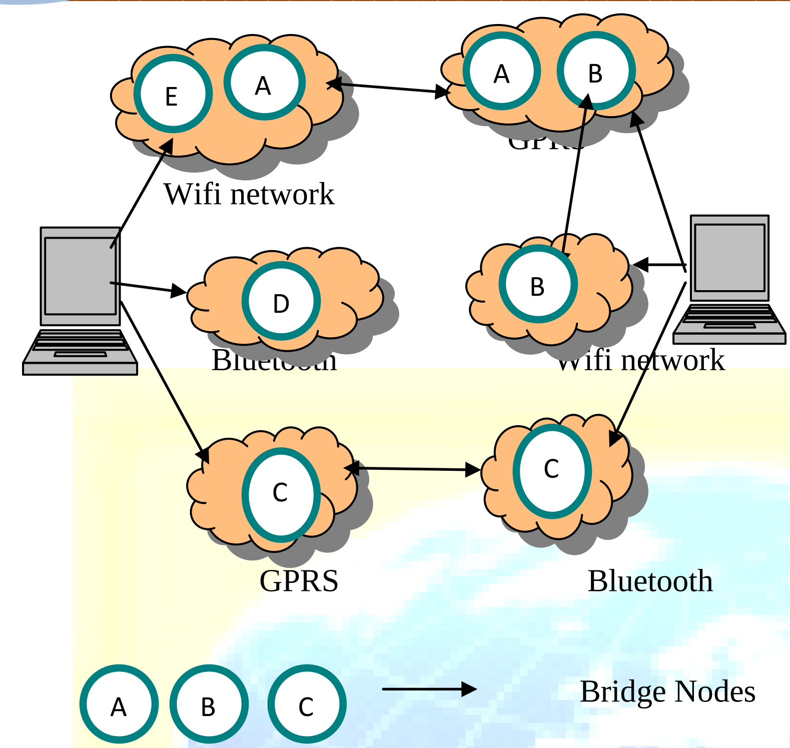

Fig. 1 System Architecture

Both the systems act as *service provider* and *service consumer*. The performance of SOAP transports. In particular, it has been shown that the performance of default SOAP over HTTP is poor in wireless environments, further leading to study alternative transports such as TCP [12] and UDP [4]. While SOAP over UDP clearly offers the best response time, SOAP over TCP has the advantage of built-in reliability and is suitable for applications with short requests. ubiSOAP thus realizes SOAP-over-TCP unicast messaging as a tradeoffs solution.

IV. MODULES DESCRIPTION

The network-agnostic connectivity layer offers the core functionalities to effectively manage the underlying multiradio environment through the modules that were described.

A. Network Creation

Create two wireless portable devices with the radio interface, radio interface is nothing but the how many network connectivity available for the device. For each radio interface have to assign the ID.

B. Network Agnostic Connectivity

Network agnostic connectivity provided to manage the multiradio networking. UbiLET layer (i.e. application layer) is register with WiFi and Bluetooth multiradio networking. Network agnostic connectivity layer offers two types of communication asynchronous multicast and synchronous unicast between UbiSOAP sender and receiver.

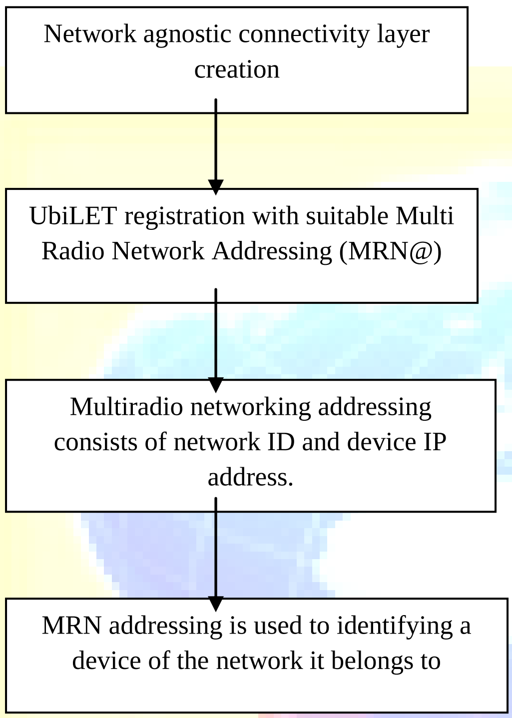

Fig. 2 Network-agnostic Connectivity

C. Multinetwork Overlay

Consider the two wireless devices; A device can access the services hosted only in the networks it belongs to (service provider and consumer should be directly reachable to each other). If the device wants to access the services hosted in other network (to which it does not belong to). In order to access the service hosted in other network, overlay network concept is introduced in UbiSOAP, which is able to bridge the heterogeneous network .A bridge device is found, which is present in both the networks.

D. Synchronous Unicast Communication

The ubiSOAP point-to-point transport is a connection-oriented transport for supporting communication between a service consumer and a service provider. The steps performed by the network-agnostic connectivity layer to provide syn-chronous unicast communication between two ubiLETs (namely ubiSender, and ubiReceiver):

1. ubiReceiver listens for incoming connections (accept) and ubiSender connects to it by means of its MRN@ (MRN@_r).

2. The connection request (MNIP.CON) is forwarded through the network to the ubiReceiver's MRN-Daemon (MRN_R).

3.MRNR accepts the connection, and returns toubiReceiver an input stream (inS) for reading the incoming packets flow related to the ongoing communication.

4. MRNR acknowledges ubiSender about the connection establishment and MRN_S returns to ubiSender an output stream (outS).

5. ubiSender uses outS to send messages to ubiReceiver.

E. Asynchronous Multicast Communication

The ubiSOAP group transport is a connectionless transport for one-way communication between multiple peers in multinetwork configurations. The ubiSOAP group transport interacts with the network-agnostic connectivity layer to send group messages based on an MRN addressing identifying the group, and with the SOAP engine to deliver the group's messages to the registered services. The steps performed by the network-agnostic connectivity layer to provide asynchronous multicast communication among ubiLETs of a given group.

1. All $ubiReceiver_i$ implement the handler interface (h) and register it to a specific group name g.

2. ubiSender invokes the multicast method (mult) by providing the packet to be sent (pck) and the group name to which the packet belongs (g).

3. The pck packet is injected by MRN_S into all the networks currently available and then delivered to all MRN_i within such networks.

4.All MRN_i receive the packet and passes it to $ubiReceiver_i$ by means of call-back.

F. Ubiquitous Service Discovery

When both the client and the service simultaneously change the complete set of IP address associated to their MRN addressing (and no direct link exists) the session will break and the client needs to perform a service discovery.

V. TECHNIQUES

Interface activation allows ubiLETs to activate the best possible interfaces (among those available) with respect to the required QoS. Specifically, the interface activation algorithm compares the QoS requirement specified by the application as a QoSInfo profile) with the QoSInfo of each available interface in ints. If an interface satisfies the requirement, within a given approximation expressed in percentage (i.e., matching accuracy), then it is activated. Note that, since the interfaces are switched off, QoS refers to the theoretic values of a network interface as declared by the manufacturer.

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VI. RELATED WORK

Work related to ubiSOAP is manifolds and range different research areas from ubiquitous computing to wireless WS technologies and multiradio networks integration. However, to the best of our knowledge, ubiSOAP is the first attempt to consider all these aspects together to offer an integrated set of middleware facilities for achieving service provision in ubiquitous networking environments. The literature about ubiquitous and pervasive computing proposes plenty of different middleware classes each addressing a specific issue: (i) Context-aware middleware deals with leveraging context information to provide user-centric computation, (ii) Mobile computing middleware aims at providing communication and coordination of distributed mobile-components, and (iii) Adaptive middleware enables software to adapt its structure and behavior dynamically in response to changes in its execution environment. However, each middleware provides an ad hoc approach, whereas standard-compliant solutions are still missing. On the contrary, ubiSOAP aims at providing a communication layer enabling WS-* standards within ubiquitous networking environments. The widespread adoption of WS technologies combined with mobile networking has led to investigate the definition of architectures dedicated to mobile WS.

VII. CONCLUSION

Service-oriented computing appears as a promising paradigm for ubiquitous computing systems that shall seamlessly integrate the functionalities offered by networked resources, both mobile and stationary, both resource rich and resource constrained. This paper has introduced a network-agnostic connectivity layer, which leverages multiradio networking by means of a special addressing scheme for networked services, namely MRN@, a QoS-aware network selection mechanism and both unicast and multicast communication facilities.

The ubiSOAP communication layer implements two different SOAP transports, namely ubiSOAP point-to-point and ubiSOAP group, which leverage network-agnostic connectivity to enable the ubiquitous networking of WS deployed on various devices—e.g., PDAs and smart phones—embedding multiple radio interfaces. Furthermore, in order to make the SOC paradigm effectively ubiquitous, ubiSOAP provides also an ubiSD-S, which allows services to be published and discovered in the ubiquitous networking environment.

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