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A Multi-service Architecture to Support Mobile IP Applications over Heterogeneous Wireless Networks

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***Abstract*-- Wireless access of the Internet enables users to experience Web access, multimedia communication and entertainment services. These services will be assessable from a range of networks dependent on the QoS requirements of the application and location, which could be in the office, home or "on the move". This paper presents an architecture to support end user control of QoS over heterogeneous wireless networks. These wireless access networks will consist of various types and generations of cellular networks, and wireless local and personal area networks. The architecture described in this paper proposes a wireless resource manager that selects the "always best connected" access network technology consistent with the QoS requirements of the application, availability of network and service costs. It also supports dynamic allocation of access network preventing forced termination of session and allowing users to move between heterogeneous networks within sessions.**

***Index Terms*—Quality of Service, Wireless Networks**

I. Introduction

Wireless offers the convenience of personal communications and mobility. Traditionally wireless has been characterised by having a relatively narrow band access rate, much higher error rates and costs compared with wireline technologies. This landscape is now changing with the introduction of Third Generation (3G) cellular networks and low cost, broadband local and personal area networks [1]. There is also much research attention being directed on evolving the traditional "same service to all" provided by the Internet to the development of premium IP networks [2] for the provision of Quality of Service (QoS) required for multimedia services. The development of premium IP networks and improved broadband wireless technologies will encourage the convergence of mobile wireless technologies and the Internet to make the mobile Internet a ubiquitous multi-service network [3].

Service providers will increasingly off wireless users Web, multimedia information and entertainment services from a range of heterogeneous networks [4] with terminal devices establishing concurrent connections to multiple wireless networks. The connections used will depend upon application, location and user preference. Terminals will therefore have to be both multimode and multiband to connect to the heterogeneous networks and also hold user profiles provided by a Virtual Home Environment (VHE). The user profile will indicate the users preference for service quality verses service cost [5]. This will be necessary because wide area cellular networks will generally have lower bandwidth capabilities and higher costs than that of wireless local area networks (LANs). Wireless LANs are expected to be deployed only in public "hot spots" and be available in office and home environments whilst cellular networks will tend to have universal coverage with the broader band access initially being available in high-density areas.

Web based applications and multimedia traffic tend to generate very bursty traffic profiles [2] and therefore wireless systems will need to dynamically schedule connections according to the networks assessable at a specific location, the QoS requirements of the application, and the users preference for premium services and hence associated costs. In addition to this service and network heterogeneity the wireless system will need to allow the end user to have control of perceived QoS and to support handovers that prevent the forced termination of session as users move between access network technologies.

II. Features of Architecture

The features of the architecture are focused on being open to existing standards and being accessible to future QoS enabled applications and future wireless networks. From a multimedia applications perspective the architecture has been designed to interface with the Stream Control Transmission Protocol (SCTP) that has the benefit of providing a multipoint-to-multipoint connection. This allows the mobile terminal device to roam between heterogeneous networks whilst still maintaining sessions. The architecture supports end-to-end QoS for individual data flows by implementing the IntServ model and interfaces to the Reservation Resource Protocol (RSVP) for signaling. To ensure that it has a

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common interface to current and future wireless access networks each access network will interface onto a specific wireless bridging interface. These in turn interfaces onto a resource manager that performs an "Always Best Connected" (ABC) service for the application. The ABC selects the optimum network service for users dependent upon their location, personal preferences and availability of wireless access technology.

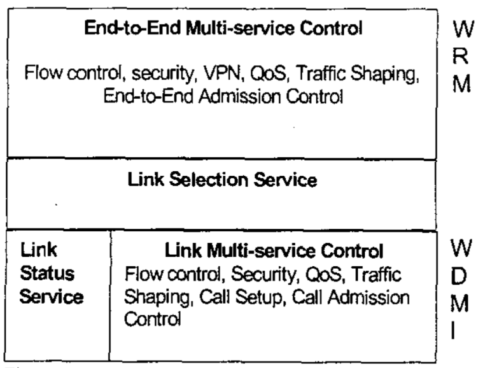

Figure 1

III. Multiservice Architecture

The Wireless Resource Manager (WRM) is the primary functional element of the architecture as is shown in Figure 1. The WRM considers the prevailing traffic and QoS requirements of the application and the state of the wireless channels to which it has access when deciding which network is the most suitable for the application. It has a modular hierarchical architecture with the WRM providing a generic network independent platform for QoS IP traffic and it interfaces onto Wireless Dependent Management Interfaces (WDMI) for specific wireless technologies.

Because multimedia applications can have multiple data flows each with different traffic and QoS requirements the WRM could simultaneously select more than one access network via specific WDMIs depending upon the suitability of the networks to support the individual data flows. This would have the benefit of employing the optimal wireless technology ranging from high-speed wireless LANs in data hot spots to wide area cellular technologies other areas.

For WRM to be successfully employed it will need to present a standard set of Application Program Interfaces (APIs) to mobile multimedia applications irrespective of current of future wireless access networks. To enable this openness of accessibility to multiple wireless technologies, a WDMI is being developed for each wireless technology such that they can present a consistent interface to the WRM as shown in Figure 2.

Portable wireless devices are severely constrained by battery power and to restrictions on bandwidth. These two factors contribute to the requirement that the WRM and individual WDMIs have minimal complexity in both processing and signaling overheads. The Third Generation Partnership Project (3GPP) has considered this problem and proposed [6] four service classes for UMTS networks, conversational, streaming, interactive, and background. These UMTS service classes will need to be augmented by the requirement to provide Location Based Services (LBS) applications. By classifying each data flow into a small set of possible classes the amount of negotiation between the mobile device and the access networks is minimised reducing both process complexity and control signaling. These additional two layers are only necessary in the wireless terminals the only increased functionality required by the wireless networks are for their access routers to be IntServ enabled.

The dynamic allocation of an access network is enabled by the WDMIs feeding back wireless status information to the WRM allowing it to negotiate with the QoS aware application for the most appropriate network to employ given the users preferences for quality and cost of service.

IV. Implementation

Planning is underway to implement the scheme on a Windows 2000 server with both an IEEE 802.11b wireless LAN and Bluetooth PAN interface. In addition, the server will be accessed by a GPRS network via the Internet. The terminals are laptop computers with the installed middleware consisting of a WRM and a WDMI for each wireless LAN and PAN interface.

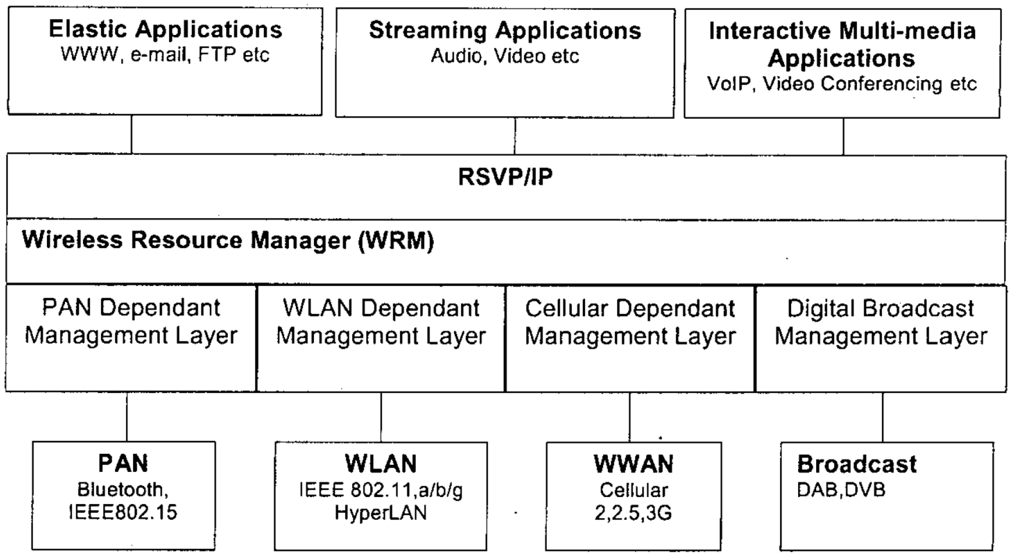

Figure 2

I. Conclusions

The proposed QoS enabled mobile wireless architecture is modular enabling it to be easily updated for future wireless networks. It has been designed to add minimal complexity to the terminal devices and the wireless networks only have to be enabled for IntServ.

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