Wireless Technologies for Mobile Computing and Commerce

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INTRODUCTION

At the time of writing (1Q06) most countries have a small number (2-6) of major cellular operators offering competing 2.5G and 3G cellular services. In addition, there is a much larger number of operators of WiFi networks. In some cases, a major cellular operator, for example, Deutsche Telekomm and British Telecom, also offers a WiFi service. In other cases, WiFi services are provided by a proliferation of smaller network operators, such as restaurants, laundromats, airports, railways, community associations and municipal governments. Many organizations offer WiFi free of charge as a hospitality service, for example, restaurants. Cellular services offer ubiquitous, low data rate communications for mobile computing and commerce, whereas WiFi offers higher data rates, but less ubiquitous coverage, with limitations on mobility due to business as opposed to technology reasons.

Emerging networks for mobile computing and commerce include WiMAX and WiMobile (Wright, 2006), which offer higher data rates, lower costs and city-wide coverage with handoff of calls among multiple base stations. These new technologies may be deployed by the organizations that currently deploy cellular and WiFi networks, and also may give rise to a new group of competitive wireless network operators.

This article identifies the capabilities needed for mobile computing and commerce and assesses their technology and business implications. It identifies developments in the wireless networks that can be used for mobile computing and commerce, together with the services that can be provided over such networks. It provides a business analysis indicating which network operators can profitably deploy new networks, and which network operators need to establish business and technology links with each other so as to better serve their customers. The resulting range of next generation service, technologies and network operators available for mobile computing and commerce is identified.

WIRELESS NETWORK ARCHITECTURES

Figure 1 illustrates the network architectures for WiFi, Cellular, WiMAX and WiMobile, including the radio access network on the left and the wired core network on the right.

The cellular architecture is the most sophisticated in that the core network includes a circuit network (for legacy circuit switched voice calls), a packet network (for data calls) and an IP Multimedia Subsystem, IMS (for migration of all traffic onto the Internet).

These three networks essentially allow the cellular operator to maintain control over all calls to and from the mobile device, and hence derive revenue from them. In particular the IMS network contains servers for establishing voice and video calls over IP, authenticating users, maintaining records of the current location of a mobile user, accounting, and security. Cellular operators are migrating traffic from their circuit and packet networks onto the IMS.

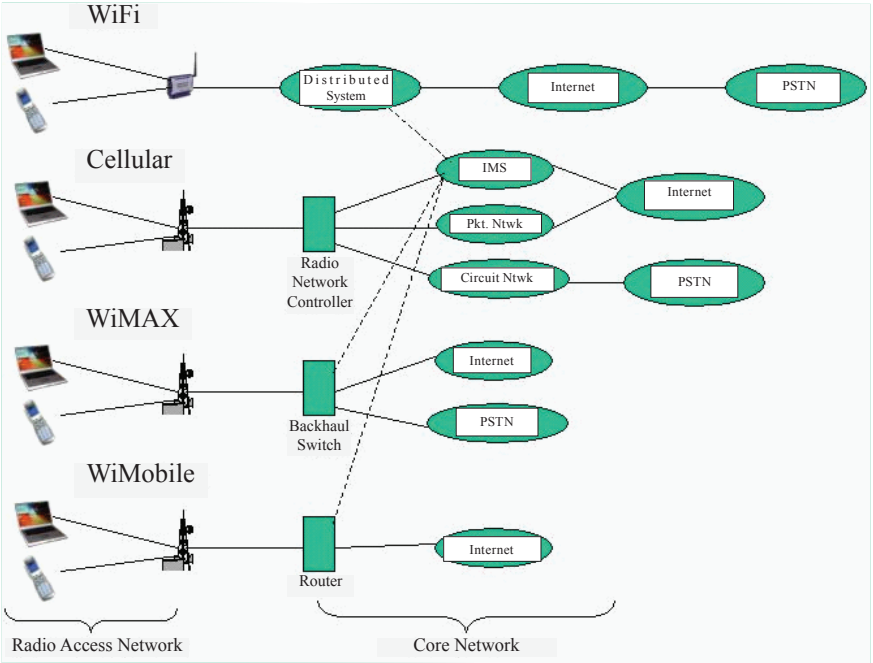
By contrast, WiFi (IEEE, 1999a, 1999b, 1999c, 2003), WiMAX (IEEE, 2006; Ghosh et al., 2005), and WiMobile (IEEE, 2006; Lawton, 2005) are simply radio access technologies and do not specify a core network. They therefore allow more direct access from a mobile device to the Internet. In particular, the WiMobile specification, which is under development at the time of writing, emphasizes that its design is being optimized for operation with IP. This more open access to the Internet allows a mobile user to set up, for instance, a VoIP call using a third party service without the involvement of the wireless network operator. As the user moves from one access point to another, the call can be maintained using Mobile IP, involving servers maintained by the user's ISP, not by the wireless network operator. Mobile IP can operate over diverse wireless access technologies as described by Benzaid et al. (2004).

If the operator of a WiFi, WiMAX or WiMobile network wishes to maintain more control over the traffic passing through their network and hence participate more in the revenue generated by that traffic, they can build an IMS network. Alternatively if they already operate a cellular network, they can provide access to their existing IMS network, as shown by the dashed lines in Figure 1.

REQUIREMENTS FOR MOBILE COMPUTING AND COMMERCE

Any wireless transmitter/receiver has a limited range in order to comply with government regulations regarding maximum power output. A mobile user therefore may move out of the

Figure 1. Wireless network architectures



range of its current wireless access point, and it is necessary to handoff the communication to another access point using either the same or a different wireless technology. Handing off the communication means that the current IP session is maintained, for example, the user continues to browse a Web site as a registered user, a VoIP call is not interrupted, and an enterprise user with a laptop-based secure VPN to an enterprise network continues to use the same VPN. There are four requirements in order to achieve handoff suited to mobile computing and commerce:

1. It must be possible to switch the call from one access point to another
2. If the user is receiving quality of service, QoS, for example, a guaranteed low latency, that QoS is maintained after the handoff, and an acceptable number of packets are lost during handoff.
3. If the access points are operated by different network operators, there must be a business arrangement between them regarding mediation of the billing for the call.
4. The organization deploying the wireless access network must be able to make a profit or to have a business model that focuses on hospitality service.

Requirements 1 and 2 are technology related and are discussed next, followed by the business requirements 3 and 4.

TECHNOLOGY ISSUES

A mobile device that is capable of using multiple wireless access technologies, such as those described above, can continuously scan its radio environment to search for access points that it could potentially use. Some of them may not be available, if, for instance, they are operated by companies with which the user does not have a subscription. In order to choose among the available access points within range the mobile device can apply criteria including: data rate, cost, ability to handoff seamlessly, and QoS; delay (important for voice) and packet loss rate (important for data). For instance, a mobile device with an interactive voice/video call in progress could choose the lowest cost network that provides acceptable delay. A device downloading a large data file could choose the network with the highest data rate given limitations on cost and packet loss rate. Once the network is selected, handoff is initiated.

Handoff among WiFi, WiMAX and WiMobile is handled by IEEE (2006). Handoff between cellular and one of these three technologies is complicated by the need to interwork with the cellular circuit, packet and IMS networks.

- In the case of WiFi, this interworking is provided by a specification from the industry consortium UMA, Unlicensed Mobile Access (2006), which is incorporated as part of the GSM cellular network specifications, release 6.