Guest Editors' Introduction

Ubiquitous Mobile Computing

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Recent advances in hardware and software technologies have created a plethora of mobile devices with a wide range of communication, computing, and storage capabilities. We are just beginning to explore the possibility of creating a world of ubiquitous mobile computing that keeps people connected to Internet applications and services at all times, regardless of their location or access device.

Such a worldview challenges traditional thinking in several ways:

- Mobility must be built-in, not added as an afterthought, to all communication infrastructures and computing devices.
- It is no longer sufficient to deliver services to the desktop; mobile users will demand the same service for all connected devices through various forms of interaction.
- As mobile devices increase in power, they will shift from client devices to powerful mobile servers with unique local content and services.

The first step toward creating a world of ubiquitous mobile computing is seamlessly combining today's wireless networking technologies — general packet radio service (GPRS), code-division multiple access (CDMA),[1] third-generation wireless (3G), 802.11,[2] and so on.

These technologies are available today for many high-end mobile devices. For example, RIM's Blackberry 6710 (www.blackberry.com) and PocketPC phones (such as Siemens SX56, www.siemens.com) integrate voice and data to let mobile users make phone calls and access email and the Web. Because the devices use dual-band GPRS–GSM, mobile users can roam in North America, Europe, and Asia. The Toshiba e740 (www.toshiba.com) PocketPC device also has built-in wireless LAN capability and can be extended with a small Bluetooth (www.bluetooth.com) Secure Digital (SD, www.sdcard.org) card to chat with other nearby Bluetooth devices. We also expect multiple wireless networking technologies (such as combination GPRS/WLAN cards) to become popular.

The Articles

The articles in this issue examine how we can improve today's infrastructure to help

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realize such a vision; they also offer a glimpse of the innovative mobile applications that will change the way we live and interact in the next decade.

Smooth IP handover or IP mobility[3] are crucial when a mobile user roams from one environment to another with different wireless characteristics or pricing concerns. In the first article in this issue's theme section, Matsuoka, Yoshimura, and Ohya describe a robust IP soft-handover method based on a new transport-layer protocol. The mobile multimedia streaming protocol (MMSP) supports multihoming and bicasting in combination with forward-error correction (FEC). The proposed architecture could enhance mobility and increase the quality of multimedia streaming applications over wireless networks.

Next, Luo et al. demonstrate a seamless handoff method for secure IP communications between 802.11 WLAN and cellular networks. Their Internet Roaming architecture uses corporate directories and user databases for authentication and authorization, another issue of crucial importance for public use.[4] This is especially important in light of the global deployment of public wireless LANS, such as Cometa Networks' efforts in the US (www.cometanetworks.com).

Bellavista, Corradi, and Montanari present a middleware approach that addresses some key design issues facing mobile-application developers. The Colomba approach supports dynamic resource-binding strategies that can be defined and modified during service provisioning, according to local resource availability, user preferences, and terminal hardware and software characteristics. The middleware separates binding and application concerns and enables mobile applications to adapt to changing environments without application-logic changes.

Finally, Kanter presents one possible vision of the future of context-aware mobile computing. The sophisticated GeoBots architecture combines virtual and physical objects in complex interactions with users via a heterogeneous wireless network that includes 802.11b and GPRS. The article illustrates the range of technical issues that must be addressed to enable context-aware user interactions utilizing information from the user, network, and sensors.

Challenges Ahead

New mobile applications will take advantage of ubiquitous wireless networking to create virtual worlds we can interact with while walking, in our cars, or on public transit. To realize the potential of ubiquitous mobile computing, applications designers still face many challenges:

- *Content transcoding*. How should content be converted and adapted for delivery to mobile devices with limited hardware, software, and communication capabilities?
- *Authentication*. How do applications properly authenticate mobile users when they come in from different channels?
- *Security and privacy*. How can we deliver content securely on insecure wireless channels and adhere to corporate security policies or personal privacy preferences?[4]
- *Profiles and personalization*. How can we personalize mobile applications based on the environment context and user and device profiles?
- *Performance*. What are the bottlenecks in the application architecture or the content path?

As mobile devices become more powerful, peer-to-peer mobile computing will be an increasingly important paradigm. P2P platforms such as JXTA (www.jxta.org) and other new incarnations will create mobile applications beyond our imaginations. We expect that these trends in mobile devices and applications will profoundly impact computing structures and network designs.

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