

Multimedia Applications

Argy Krikilis
Aspex Microsystems Ltd.
Brunel University
Uxbridge, Middlesex, UK
argy.krikilis@aspex.co.uk

Considerations for a new generation of mobile multimedia communication systems

The simultaneous evolution of mobile communications and multimedia applications points toward a future where both technologies play a significant role in shaping mobile multimedia communication. However, the destiny of mobile communications and, to a great extent, of sophisticated mobile multimedia, heavily depends on the success of the emerging third generation of mobile communication systems.

MOBILE COMMUNICATION EVOLUTION

The first generation of mobile communication systems appeared in the early 1980s. Those that used direct analog voice modulation techniques had transmission rates of approximately 2.4 Kbits per second and were limited by their large size and short battery life. Furthermore, different countries used different systems.

In the early 1990s, the technical evolution of microelectronics enabled full digital communication over the radio channel with portable devices. System designers added these new capabilities to the newly designed second-generation mobile communication systems. In parallel, Europe's global system for mobile communications (GSM) emerged as a standard and became the world's main mobile system, serving 70 million users in Europe and over 120 million users in 110 countries with over 200 networks. GSM was the first system to allow cross-country mobile communications.

The unprecedented growth of worldwide mobile and wireless markets, coupled with advances in digital communications technology and the accelerated development of services taking place in fixed networks, led to the inevitable design of the third-generation systems. This generation refers to all known mobile communication groups (such as cellular, satellite, paging, and private mobile radio systems) as a common system called UMTS (Universal Mobile Telecommunications System).

The two previous generations were deployed at a 1-GHz-spectrum domain, with only a few exceptions to higher frequencies when the earlier allocations became congested. The third-generation licenses that the radio regulation authorities have announced allocate a new spectrum for UMTS use in the 2-GHz area. The initial data rates will be 2 Mbits/sec for local-area or low-mobility conditions, independent of the environment. The wide-area services will be limited to between 144

and 384 Kbits/sec. UMTS systems support user speeds up to 500 kilometers per hour. Provisional timetables for the third generation call for rates of up to 10 Mbits/sec for local-area-mobility services by 2005 and everywhere by 2010.

SUPPORTING MOBILE MULTIMEDIA COMMUNICATIONS

Support for enhanced multimedia communications in mobile environments is the driving force behind the third generation of mobile communication systems and the changes in local area networks that make it possible to distribute all wireless services to users. The latter evolves the LANs toward wireless local area networks that can support multimedia services. Examples of such developments are Bluetooth and HomeRF (Home Radio Frequency).

The Bluetooth technology (www.bluetooth.com) replaces the many proprietary cables that interconnect devices with one universal short-range radio link. Bluetooth replaces the cable that connects printers, desktops, fax machines, cellular phones, laptops, keyboards, joysticks, and virtually any other digital device with a radio link. Bluetooth radios operate in the unlicensed ISM (Industrial Scientific Medical) band at 2.45 GHz, which is available worldwide, with a combined data rate of 1 Mbit/sec.

HomeRF is a specification for wireless digital communication between PCs and consumer electronic devices around the home (www.homerf.org). The HomeRF communication system provides flexibility and mobility, and enables interoperability between many different consumer electronic devices from different manufacturers. A new protocol under development, called Swap (Shared Wireless Access Protocol), supports HomeRF. The system carries both voice and data traffic and can interoperate with the Public Switched Telephone Network and the Internet. It operates in the 2.4-GHz band, uses digital frequency-hopping spread-spectrum radio, and can support up to 127 devices per network.

TOWARD THE SUCCESS OF A NEW GENERATION

The successful introduction of third-generation mobile systems depends on matching the offered services to user needs (applications) and on cost-effectively providing those services. Evolutionary enhancements of existing mobile multimedia systems cannot guarantee the development of the innovative

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approaches required in future systems. Increasingly, we need a multidisciplinary approach that better focuses on user aspects. I consider five of these aspects.

APPLICATIONS

Future mobile multimedia applications will be suitable for nonstandard work situations—that is, those situations in which the professional runs into a complex problem he cannot solve with known procedures and for which he lacks some expertise. This typically occurs in crisis situations in organizations or a community (for example, emergency services, medical assistance, and disaster management). We need to carry out field studies for typical application, so that we can catalogue the actions of mobile workers. We can then use these observations to build scenarios to describe the support required for a variety of roles in daily work practices. In particular, the scenarios should concern remote support through mobile communication using different modalities (speech, audio, or video) and ways of interaction (synchronous or asynchronous).

USER INTERFACE AND TRANSPARENCY

Communication from one office to another is relatively straightforward with today's technology. However, when one of the parties wishing to communicate is based outside of the office, remoteness and insufficient infrastructure can limit the effectiveness of their communications. Wearable computers could improve this situation, particularly when a mobile video transmission system can provide a visual link.

Devices such as head-mounted displays can present visual information transparently with reference to the environment, blending received visual information with essential background visual details. Problems associated with rendering visual information transparently need effective solutions, because visual information cannot be projected in just any part of the field of view.

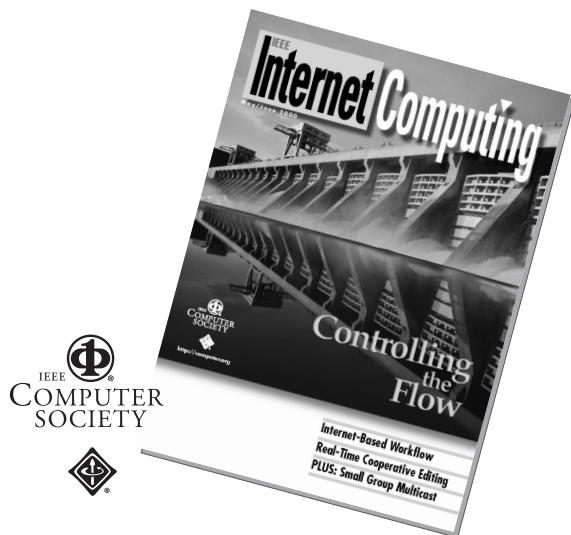
COMPRESSION

Most compression methods perform well on a transmission channel with a very low bit-error rate, but many of them are inadequate for a wireless channel, where errors are the rule rather than the exception. Very low bit-rate compression should not be the prime objective, because information communication emphasizes sufficient quality to perform tasks, which depends strongly on the context. A far more important objective is compression (in collaboration with the transmission system) that is as robust as possible against the errors that are typical of a wireless channel. This might be possible with the help of the video-analysis tools that are being used in MPEG multimedia applications.

TRANSMISSION PROTOCOLS

All Open System Interconnection layers implement measures that deal with the adverse conditions of wireless chan-

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nels. The OSI objective, which is difficult to maintain in all forms of mobile communications, is for the higher layers to operate without knowing how the lower layers provide a service to them. Forward error correction and automatic repeat request at the link layer can minimize transmission errors. However, such measures can adversely affect the delay and throughput performance that the higher layers experience. A hierarchical protocol structure that provides different qualities of service to the various traffic streams in mobile multimedia communications offers better results.

The hierarchy is realizable with a hybrid TDM/FDM (Time Division Multiplexing/Frequency Division Multiplexing) technique in which frames (the largest unit of data) are subsequently composed of packets, fragments, and radio data units. The hierarchical approach allows for easy future expansion, both in terms of the allocated bandwidth and accommodating technological advances in modulation and coding.

Additional improvements to transmission protocols are possible by combining multiple receivers in a virtual cellular network. A VCN is an area of a predetermined size, formed virtually around a mobile station. The basic principle is that multiple base stations can listen to one mobile device, and, vice versa, multiple base stations can send data to one mobile device. The VCN concept greatly enhances the quality of mobile transmissions. Future transmission protocols must consider a VCN for supporting the links between base stations and mobile users. Such a concept implies that, at every instant, each active mobile station is in contact with multiple base stations.

BROADBAND RADIO TRANSMISSION

The heterogeneity of broadband services required for indoor and outdoor environments, combined with varying degrees of mobility, dominate the demands of future mobile systems. The sophistication supported in such services will considerably increase the amount of information exchanged in mobile multimedia applications. More information requires higher data rates to meet the challenges of the information society.

In the context of mobile services, one constraint in realizing the needs of the information society is the availability of frequency spectrum. The scarcity of spectrum and the new technical possibilities in recent years have drawn attention worldwide to the millimeter band. We need to consider new modulation schemes—such as Orthogonal Frequency Division Multiplexing, which can cope with multipath-reception problems.

Mobile communications are evolving quickly. While the data rate is increasing, different services centered on multimedia applications are continually being integrated. Developing future generations of mobile multimedia communication requires a multidisciplinary approach in which user aspects get as much attention as the technological challenges. The need for experimental platforms that can support typical application scenarios for future services is of critical importance. The feedback from such experimentation will shape the future—and to a great degree, the destiny—of mobile multimedia applications. ■■■