Multimedia on the move
– overview of relevant ACTS projects

W. Carter
Martel GmbH

H. Stewart
Italtel

The demand for information and entertainment on the move has grown spectacularly in recent years. The ubiquitous mobile phone meets some of these needs, but in a very limited way. Mobile multimedia services would meet our needs much more effectively.

Multimedia services are bandwidth-hungry and require much more downstream capacity than upstream capacity. A cost-effective approach to delivering such services can be offered by combining digital broadcasting technology, for the high-capacity downstream links, with relatively low-speed mobile telecoms technology for the upstream links.

The EU's ACTS programme has made major contributions to enhancing the technology, and to providing visions of the mobile interactive broadband services that could be offered to customers during the next decade. This article offers an overview of those achievements.

Introduction

The ACTS programme is the focus of the EU's research effort in advanced communications. It has made significant contributions to the development of ICT (Information and Communication Technologies) in Europe. A major feature of the ACTS programme has been the testing of advanced multimedia services in trials and experiments involving real users. Amongst these trials, many looked at the ways in which multimedia services could be delivered to mobile users.

Today's GSM telephones have a rudimentary data capability, but the bit-rate is a mere 9.6 kbit/s. The GSM packet data service, which is now being introduced, will increase the bit-rate to something like that offered by the fixed network, while the next generation of mobile services, due to be launched in 2001 or 2002, will offer bit-rates of up to 2 Mbit/s. However, multimedia services are usually asymmetric, requiring much more downstream than up-stream capacity. The combining of digital broadcasting technology, for high-capacity downstream links, with relatively low-speed mobile telecoms technology for the upstream links offers a cost-effective approach to delivering such services. The broadcast systems could include satellites for coun-

Original language: English
Manuscript received: 8/10/99.

try- or continent-wide coverage and millimetre-wave terrestrial transmitters for very high-capacity local services.

ACTS projects have explored a wide range of delivery options for mobile multimedia services. They have also developed tools for implementing "mobile-aware" services and have conducted field trials and public demonstrations of a number of prototype services. This article offers an overview of their achievements.

Bringing the Internet to mobile users

Mobile phone users now expect to be able to call from anywhere at any time. They will soon want to do more than talk – they will want their mobile phones linked up to their laptop or palmtop computers to offer the same kind of multimedia services as they can get from the fixed network. The MOMENTS project has brought that day closer by developing a wireless media highway for the distribution of multimedia to mobile terminals.

When MOMENTS started, Internet access was confined to fixed networks. The initial challenge was to develop enabling technologies for mobile multimedia services (including the client-server architecture, compression methods and electronic payment system) which were optimized for the narrowband mobile phone technology. The system developed used a unique way of presenting graphical information – integrating animation, 2D graphics and 3D graphics into a "scene graph" to access information over the web.

The project then moved on to conduct trials with end-users in existing GSM/DCS networks, and to evaluate the business opportunities for all players in the multimedia value chain, in a three-phase trial with the following service packages:

Phase 1: News, weather, airport, financial, events, mail and City information;

Phase 2: Map service, internet access, payment service using smartcards, traffic and entertainment information; as well as the *phase 1* services;

Phase 3: Location and SMS, as well as the *phase 1* and *2* services.

The trials involved over 100 users and ran for several months. They produced information regarding the behaviour patterns of users, their expectations and their experiences of new services. This information is proving to be valuable to players in the mobile multimedia value chain, as they develop their business plans. MOMENTS is continuing to develop these concepts further and promote them to the industry as a whole.

Combining DAB and GSM for mobile multimedia services

MOMENTS showed how we could deliver web information using narrowband techniques, but there is an increasing demand from travellers for information that requires a greater bandwidth. The MEMO project (see *Fig. 1)* showed how you could combine telecommunications and broadcasting techniques to deliver multimedia travel information to mobile users. It combined a GSM data link with a high-speed DAB channel to deliver multimedia information services to a notebook computer in a car or lorry.

The heart of the system is a smart gateway (called a Multi Network Server) between the Internet and the DAB network. It relays requests sent by customers to remote web servers. When the answers come back, it passes them on to a Broadcast Network Server, which assembles them into a multiplex for transmission over the DAB network at up to 1.5 Mbit/s.

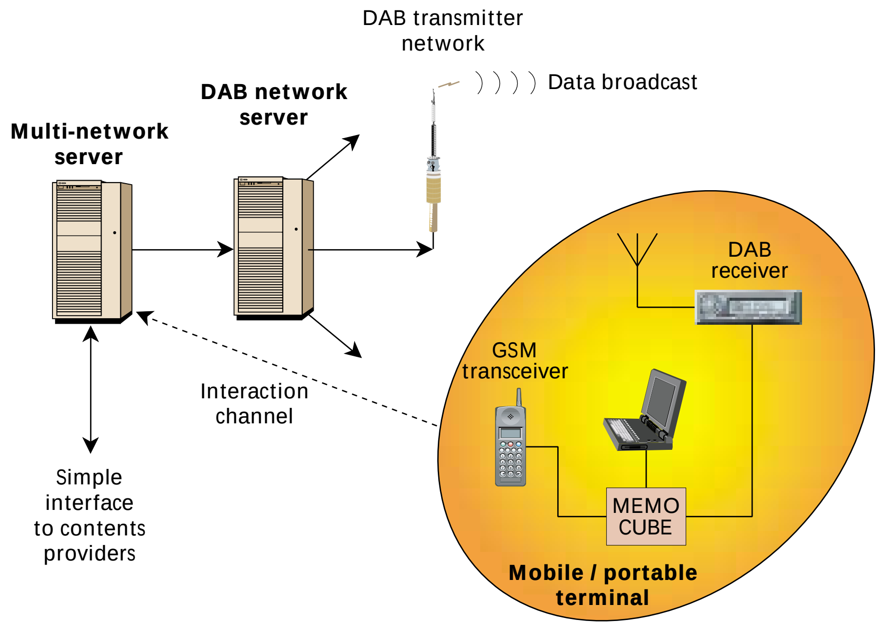


Figure 1
The MEMO system.

The terminal in the car or lorry is built around a module called the *Memo Cube*. This links a notebook computer to a GSM transceiver and a DAB receiver. Requests for information are sent out over the GSM link. The replies come back over the DAB network and the Memo Cube identifies the appropriate files from the broadcast multiplex and routes them to the notebook browser.

Users are provided with a range of mobile information services including:

- **Broadcast Services**: These include web pages of general information, scrolled in much the same way as teletext pages on a TV signal are scrolled. The terminal caches the local broadcast services as soon as it enters a new area so that access to individual pages is very quick

- **Interactive Broadcast Services**. These enhance the broadcast services with an interaction channel provided by the GSM phone. This allows the user to send and receive e-mail or call up pages which are not carried on the DAB broadcast multiplex.

- **Personal Services**: These use DAB as the downlink and the GSM phone as the uplink. In areas where the demand for such services is very large (e.g. along a railway line or motorway), the DAB network can be supplemented with smaller broadcast cells.

The trials clearly demonstrated how DAB can be combined with mobile phones to provide interactive multimedia services to mobile users, using available technology. DAB receivers are still expensive but volume production will overcome that problem. The services should soon be within the budget of highly mobile business users and, if the experience of GSM is anything to go by, it is only a matter of time before they become a standard feature of the family car.

Mobile reception of digital TV

DAB was designed with mobile reception in mind but digital TV was not. Mobile reception of DVB-T in cars, buses and trains would make possible a range of innovative broadband multimedia services at data rates of up to 15 Mbit/s. The MOTIVATE project has paved the way for such services by demonstrating mobile and portable reception of digital terrestrial TV in both single-frequency (SFN) and multi-frequency (MFN) networks.

MOTIVATE started by specifying the requirements for a reference receiver model for mobile reception. It then developed, implemented and tested receiver algorithms that were optimized for mobile reception. It also verified the open API specification for terrestrial receivers which forms part of the DVB Multimedia Home Platform (MHP), opening up the prospect of DVB-T receivers integrated in television sets, laptops and cars to provide the user interface for innovative Information Society applications.

MOTIVATE defined the performance parameters needed to achieve acceptable levels of service quality with particular types of receiver. These parameters are vital for designing the various types of DVB-T networks (MFN, large-area SFN, regional SFN, SFN with gap fillers) to handle mobile reception. The MOTIVATE partners included broadcasters in the United Kingdom, Spain, France, Germany and Italy, who were able to offer a wide variety of SFNs and MFNs for field trials of prototype mobile receivers.

MOTIVATE builds on the work of the VALIDATE project, which successfully verified the DVB specification for terrestrial broadcasting. The two projects worked together to present their achievements in a series of public demonstrations at major conferences.

At ECMAST '98 in Berlin, visitors were offered a 30-minute trip round the city in a Deutsche Telekom minibus, during which they could observe the superior quality of digital TV for

Abbreviations

ACTS	Advanced Communications Technologies and Services
API	Application programming interface
ATM	Asynchronous transfer mode
DAB	Digital Audio Broadcasting
DCS	Digital cellular system
DECT	Digital enhanced cordless telecommunications
DTTV	Digital terrestrial television
DVB	Digital Video Broadcasting
DVB-T	DVB - Terrestrial
ESA	European Space Agency
EU	European Union
GEO	Geostationary orbit
GSM	Global system for mobile communications
IBC	International Broadcasting Convention
JPEG	Joint Photographic Experts Group
LCD	Liquid crystal display
LEO	Low earth orbit satellite
MFN	Multi-frequency network
MHP	Multimedia home platform
MPEG	Moving Picture Experts Group
QoS	Quality of service
RAI	*Radiotelevisione Italiana*
SFN	Single-frequency network
SMS	Short message service
UMTS	Universal mobile telecommunicaton system

mobile reception. The signal was transmitted from Alexanderplatz in the centre of the city. An ordinary car antenna was used to feed the mobile receiver. The limits of mobile reception could be seen when the bus stopped under a railway bridge or in a narrow street facing away from the television tower. The MPEG-2 signal could not be recovered from the echoes and, thus, gap-filler transmitters would be needed to cover these areas.

MOTIVATE's Deutsche Telekom minibus was at work again at IBC '98 in Amsterdam. Its comparative demonstrations of mobile analogue and digital TV reception impressed seasoned media journalists such as Barry Fox (UK), who wrote *"One (receiver) is picking up analogue PAL and the other widescreen DTTV. The PAL picture is unwatchable, constantly rolling and breaking up. The digital set is rock steady."* (IBC Daily News, 15th September 1998.)

This year, the project went a stage further by equipping trams on Amsterdam's route 4 with mobile TV receivers. The tram route runs from Amsterdam Central Station to the RAI Centre, where IBC '99 took place. This made the demonstration highly visible to both conference delegates and the general public. 15-inch LCDs were used to show content which included IBC News with subtitles, Euronews, live IBC / RAI camera shots (taxi queue, RAI entrance etc.), captions, messages and logos.

The demonstrations showed clearly how developments in broadband digital transmission will help to realize the delivery of television, radio and multimedia services to individuals and groups on the move. The technology developed for the optimization of receiver algorithms for channel estimation, channel correction and time synchronization will lead to a new generation of DVB-T receivers, designed for the mobile environment. MOTIVATE is preparing guidelines for broadcasters and network operators on how to implement DVB-T networks for mobile receivers.

Over the past decade, mobile communications has changed the way we work and live and is now so popular that networks are reaching the limits of their capacity. New spectrum is needed and the network operators are looking hungrily at the frequencies used inefficiently by analogue TV. Digital TV makes much better use of the spectrum and – as MOTIVATE has proved – it is also able to support mobile services.

Exploring new broadcast bands

The ever-increasing demand for radio spectrum has encouraged broadcasters to explore new frequency bands. One such band (40.5 to 42.5 GHz) provides capacity for up to 200 digital TV channels or a flexible multiplex of broadcast and telecom services. Because of the high frequency and low power of the transmitters, the range is limited to a few km. Several ACTS projects have explored how this band might be exploited. The CRABS and CABSINET projects investigated how it could be used to deliver a "wireless cable" service to fixed locations, whereas the SAMBA project looked at using it for very high bit-rate mobile multimedia applications.

SAMBA developed a broadband 40 GHz cellular radio system, supporting bearer services at up to 34 Mbit/s. The radio network provides transparent ATM connections between mobile broadband terminals and the fixed ATM network. Two types of radio cells are used:

- an elongated "street-like" cell for vehicular applications;
- an elliptical "wide" cell for newsgathering applications (see *Fig. 2*).

The system allows broadband mobile communications to be maintained at speeds up to 50 km / h.

Following extensive laboratory and field tests , the system was used to provide public demonstrations of mobile broadband applications at Expo ’98 in Lisbon, Portugal. The platform used for these demonstrations consisted of a digital cellular radio network of two base stations and two mobiles – one being human-portable, the other being mounted in a vehicle.

Figure 2
The SAMBA broadcast application.

Two applications were demonstrated at Expo ’98. The first was electronic newsgathering. A base station was set up in a large theatre. A camera operator, with a digital camera and a backpack containing the transmitter, roamed the theatre sending broadcast-quality pictures over the ATM link. High-quality pictures could also be sent back to the camera operator – for example, so that he or she could see the picture being transmitted.

The second demonstration simulated information being exchanged between a hospital and an ambulance dealing with an emergency. The information included:

- patient records (e.g. X-rays) from the hospital to the ambulance;
- patient monitoring, including video, from the ambulance to the hospital;
- geographical information to route the ambulance to the nearest hospital with appropriate facilities for the patient.

Although the demonstrations were simulations, potential users were enthusiastic and could see clear benefits:

- for the broadcasters – greatly enhanced mobility within a fixed (but large) area;
- for the medical team – greatly enhanced ability to interchange information about patients in real-time.

The role of satellites

Over the last decade, satellites have revolutionized broadcasting, offering transnational coverage and an explosion in the number of available channels. Digital satellites will take this revolution a stage further, initially by offering near-on-demand services, but eventually by offering fully-interactive multimedia services.

Satellites have also entered the mobile telephony business. The architecture for the next generation of mobile services (UMTS) includes the option of satellite delivery, and ACTS projects have explored how both GEO and LEO satellites could serve future mobile users.

The SUMO project set up a testbed (see *Fig. 3)*, bringing together all the satellite components for a complete UMTS system. The testbed also included terrestrial radio access and an ATM-based core network to demonstrate S-UMTS interoperability with end-to-end interactive multimedia services. New application services were evaluated on the testbed, and performance was measured under a range of operating conditions.

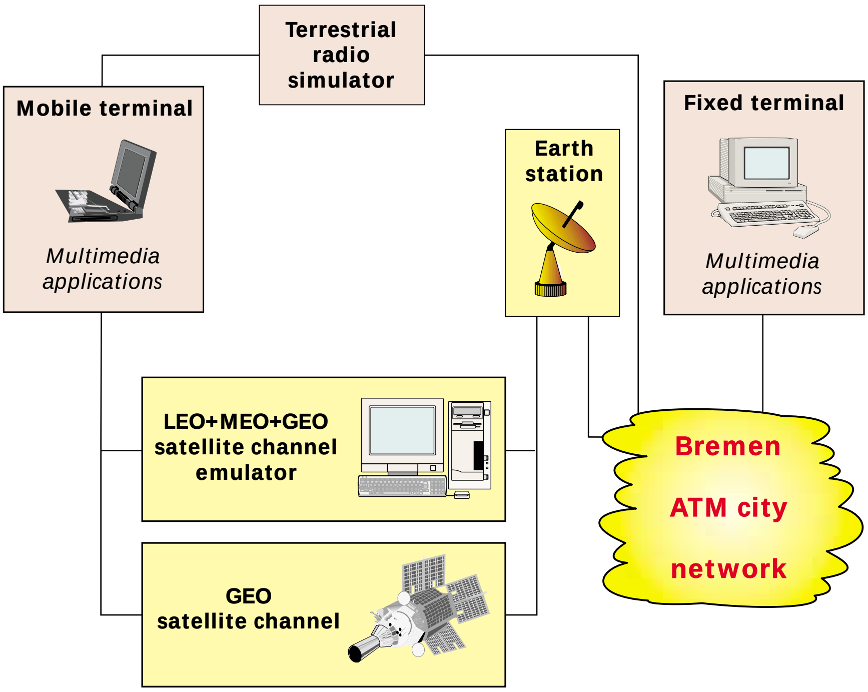


Figure 3
Simplified view of SUMO trials infrastructure.

The TOMAS project involved real groups of end-users in demonstrations of remote access to expertise, telediagnostics, videoconferencing, multimedia information exchange by journalists, and object surveillance. The TOMAS system was based on existing Inmarsat and ESA geostationary satellites. The Inmarsat system has enough power and bandwidth for global trials of services at bandwidths from 8 kbit/s to 384 kbit/s with an almost global coverage. The ESA systems can deliver services at up to 2 Mbit/s to Europe and Northern Africa. The TOMAS satellite testbed proved that satellites are a cost-effective platform for delivering multimedia services to business users and will be an essential component of future mobile systems.

A further project, ACCORD, set out to show how satellite and terrestrial systems could be integrated to provide truly global (indoor and outdoor, urban and rural) broadband services. The project integrated four terrestrial and satellite access systems with a core network (see *Fig. 4)*. The access segments were:

- the SECOMS network, designed to support mobile multimedia services over GEO satellites;
- the MEDIAN access system, providing a wireless extension of a fixed ATM network for indoor environments (W-LAN);
- the SAMBA radio network, interconnected to the fixed ATM network using Permanent Virtual Circuits,
- the EXODUS DECT wireless access system.

ACCORD also developed a Multi-Mode Terminal (MMT) capable of selecting the most appropriate access network. For example, a user in an indoor environment would be connected to a MEDIAN W-LAN link, whereas a user in a remote area without any terrestrial signals would be connected to a SECOMS satellite link. Inter-Segment HandOver is an essential feature of the ACCORD system. When the quality of the radio link falls below a given threshold, the MMT triggers a procedure for handing over the call seamlessly to a different access segment.

The MMT is suitable for use in many fields ranging from entertainment to work practices. For example, an MMT mounted on an ambulance could transmit the patient's real-time data to the hospital to communicate with an emergency doctor, while at the same time retrieving information from hospital databases. Along the path, the ambulance could first be connected via the SECOMS satellite link then, when entering an urban environment, could use the SAMBA digital cellular link and finally, in the hospital underpass, could exploit a MEDIAN W-LAN connection, the transitions being seamless.

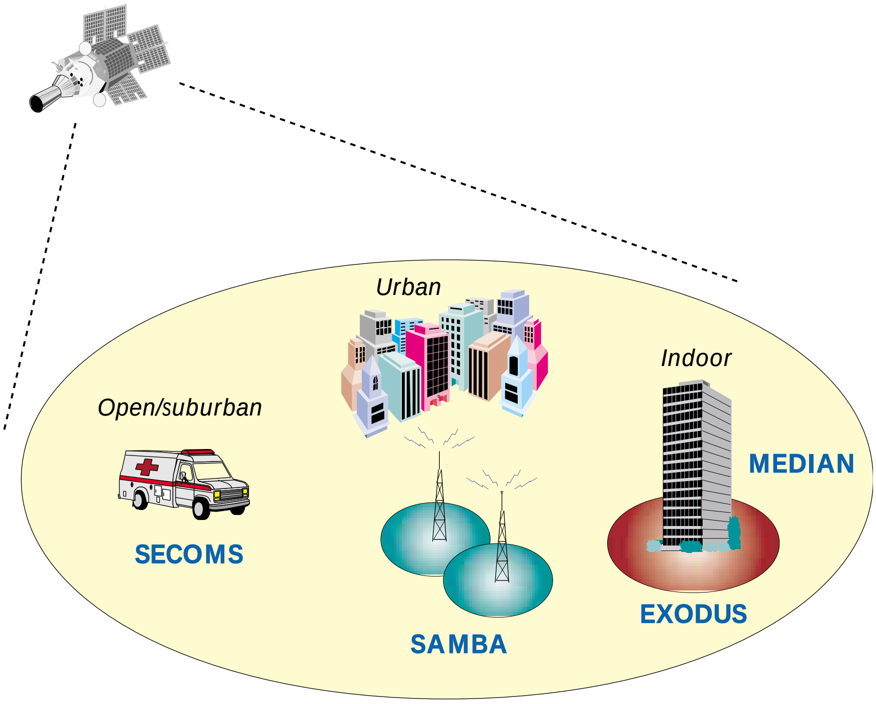


Figure 4
ACCORD – the system coverage.

Servicing the applications

ACTS projects did not simply look at the problems of delivering multimedia applications to mobile users. They also explored what users and service providers would want from these applications and promoted the adoption of a mobile API by the computer industry as well as by application and service developers and standards bodies.

The OnTheMove project solved the problems of seamlessly integrating different bearers, carriers and terminal types to support applications. It brought together partners covering the crucial business and research sectors of information technology, communication provisioning and mobile network operation, and developed a Mobile Application Support Environment (MASE) and a Mobile API for UMTS-compliant applications running on mobile devices.

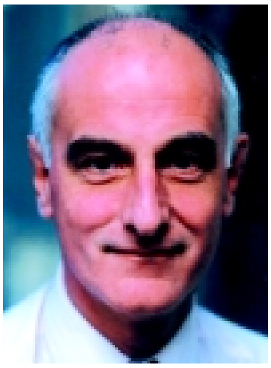
The concepts were validated by developing and demonstrating a "City Guide" service, enabling maps (of cities, for example) to be downloaded according to the location of the user.

A follow-up project, MOVE, enhanced the MASE architecture to handle the integration of real-time data (e.g. audio) with ongoing data sessions. Its Voice-Enabled Mobile Application Support Environment (VE-MASE) supports voice-enabled multimedia applications running on mobile devices using mobile Voice-over-IP (VoIP).

The VE-MASE runs on voice / data application servers, located in fixed networks, on mobility gateways acting as mediators between fixed and wireless network parts, and on mobile devices. The features include: collaborative web browsing, audio streaming over wireless networks (including transcoding), and the harmonization of new voice sessions and ongoing data sessions. This is done by scheduling real-time and non-real-time data while performing QoS trading for the complete transmission medium (e.g. voice and data).

Wes Carter *spent much of his earlier career working for a major network operator. During that time he was involved with the development of ATM from its pioneering days. He also played a major role in managing the relationship between the people who were planning and developing the network and the people responsible for operating the network.*

Mr Carter was involved with RACE from the Definition Phase into the Main Phase and managed a major sub-project which investigated the way that networks would have to evolve to introduce ATM. Since joining Martel, he has worked in the ACTSLINE project, providing a link between the trials and the key decision-makers in the broadcasting and network operator sectors who are potential end-users of ACTS technology.



Hill Stewart *is a consultant on communications and information technology. He is currently working for Italtel as the project manager of ACTSLINE, a project promoting the results of the ACTS programme to decision-makers outside the programme.*

Before this, he worked for BT over 25 years, leaving them in 1996 to work independently. Whilst working with BT he was active in promoting collaborative RTD activity within the European Union. This started with contributions on market pull to the RACE definition phase and has most recently involved programme integration studies for the ACTS and ESPRIT programmes.

Mr Stewart is currently rapporteur for the ACTS Horizontal Actions domain and Concertation Steering Committee.

The VE-MASE architecture was validated by the development of an application which provides a hotel-search service for mobile customers. It demonstrated how the VE-MASE can enhance a traditional website with VoIP features, so that a customer and a call-centre agent can exchange vocal and multimedia information in addition to the usual website services.

But we must have standards!

The ACTS programme is committed to the concept of open standards for advanced communications services and the work of the projects has resulted in over 1,200 contributions to official standards bodies or industry-based pre-standardization fora. Around a third of the contributions have been in the multimedia area. Significant contributions and, in many cases, leadership have been provided in areas such as DVB, H263+, JPEG2000, MPEG-2/4 and, recently, MPEG-7.

Projects such as DVBIRD and VALIDATE have made major contributions to the validation of the standards for digital video broadcasting. This work has been so successful that commercial services have been launched in a number of countries during the past year.

ACTS projects have also been highly active in developing and validating the standards for the next generation mobile systems (UMTS) which provide broadband mobile services anywhere at any time and support multimedia services and Internet access from remote areas, the car, the home, the boat and the aeroplane.

Conclusions

Mobile phone users now expect to be able to call from anywhere at any time. They will soon want to do more than talk – they will want their mobile phones linked to their laptop or palm-top computers to offer the same kind of multimedia services as they can get from the fixed and broadcast networks.

The ACTS programme has given very clear and visible demonstrations of what could be delivered using today's technology. It has also made major contributions to enhancing that technology and providing visions of the interactive broadband services that could be offered to customers during the next decade.

Management briefings on the results of the ACTS programme can be found at http://www.actsline.org together with links to more detailed information on the results of individual projects.