DIF8914 Distributed Information Systems

Issues for Development of Mobile Multimedia Systems

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Abstract

The popularity and evolution of mobile devices like laptops, mobile phones and Personal Digital Assistants (PDA), and the evolution of fast mobile networks in the last decade, have made it possible to increase the complexity of mobile applications and services provided to end-users. It is also a spectacular growth in multimedia communication especially via the World Wide Web. The current state of the art has however been that the user has to make a choice between mobility and multimedia due to non-functional limitations. This essay will explore some of the current technology of mobile devices, mobile networks and multimedia systems, and will based on the exploration outline some issues for development of mobile multimedia systems.

1 Introduction

The popularity and evolution of mobile computing devices like laptops, mobile phones and Personal Digital Assistants (PDA), and fast mobile networks in the last decade, have made it possible to increase the range and complexity of mobile applications and services provided to end-users of these kinds of equipments. GSM can for example be used to exchange voice and low speed data. Likewise it has been a spectacular growth in multimedia communication especially via the World Wide Web. Fixed users easily receive typical multimedia data like text, audio, still (graphics) and moving pictures (video, animations). The current state of the art has however been that the user has to make a choice between mobility and multimedia due to non-functional limitations related to mobile communication.

One of the reasons for the need of mobile multimedia is that many people spend more and more time from their home office and often need access to their company resources and up-to-date information. The large and growing number of Internet users ensures that Internet and Web technology will be the main information delivery channel. Web technology has potential to become a universal user interface metaphor for various devices with embedded WWW server technology integrated in the operating systems [6] .

The typical mobile network services provided today (using wireless networks like GSM) are designed for only voice and data transmission, video services is not defined yet. The services are therefore not able to transmit large data amounts (like video), but are more dependent of keeping the communication channels stable and within a certain quality of service (QoS) while a mobile device is in motion (see [CDK01] for a thorough introduction to QoS). The mobile devices are mostly used to peer-to-peer and group communication, short messages (SMS), email services and limited Internet access. PDA's and mobile phones are converging to offer more or less the same kind of local services. Mobile devices connect to mobile networks to communicate with servers providing many kind of information including multimedia

content. Mobile multimedia applications however make significant demands on their communications subsystems, stretching many wireless networks to their limit.

Future environments will consist of a heterogeneous mix of wired and wireless networks and end-systems. This diversity of infrastructure makes it difficult to develop and support applications that operate within it.

Functional requirements for mobile multimedia are to a large degree dependent of the application area that wants to provide multimedia content and not so influenced by the fact that the application in addition should be mobile. The mobility part may therefore be seen as a non-functional requirement for the application to be developed. The essay will therefore only present typical functional requirements that should be common for most multimedia application, whether mobile or not, and outline which non-functional issues and requirements that must be taken into account in order to provide the multimedia functionality to mobile and/or nomadic equipments. See [BS97] for a more thorough presentation of requirements for development of distributed multimedia applications.

This essay is organised in the following manner: Section 2 presents some application areas for mobile multimedia. Section 3 describes the terminology and explore the current state of art technology for mobility and multimedia. Section 4 outlines the issues related to the development of mobile applications in general and mobile multimedia in general. Section 5 concludes the essay.

2 Applications

Mobile multimedia application are suitable for non-standard work situations where professionals runs into complex problems that are not solvable with known procedures and requiring more expertise. For instance in crisis situations like emergency services, medical assistance and disaster management, where remote support may be important. Such situations may require a combination of mobile communication of speech, audio and video, and a combination of synchronous and asynchronous communication.

Mobile multimedia can be applied in many areas of life like education, support for mobile work processes, video encyclopaedias/libraries for entertainment or non-scholar education etc. Location-aware mobile devices (linked to e.g. the Global Positioning System (GPS) and/or other location sensors) may provide location services like e.g. map services, path finding, all kind of service look-ups and resource acquirement/adaptation related to a users need etc. E.g. finding free parking lots for disabled people close to the current or certain location.

3 Terminology and Technology

This section describes the terminology and technology that set the context for development issues contained in this essay.

3.1 Mobility

The term mobility can be interpreted in several ways. [Roman00] distinguishes between physical and logical mobility, where physical mobility entails the physical movement of a mobile terminal, and where logical mobility involves mobile units of

code and state that migrate among hosts. Mobile computing has traditionally meant physical mobility, which is the ability of a moving terminal to access telecommunication services from different locations, and the capability of the network to identify and locate that terminal. [Roman00] views from a software perspective, mobile computing to be the study of systems in which computational components may change location. Nomadic computing is a different term that has been used related to physical mobility. In nomadic computing, systems consist of a fixed core network where mobile units connect to it via base stations. Examples of such systems are the cellular structure of mobile phone networks and wireless local area networks (LAN). In addition is it ad hoc networks that exclusively consist of mobile terminals. In ad hoc networks, mobile terminals are connected to each other when they are within communication range.
The term wireless has also been used together with mobile computing. Mobile networks are wireless networks, but all wireless network clients do not move like in wireless LANs.

3.2 Multimedia

The term multimedia means that there are more than one media type involved in the communication, e.g. text and graphics, voice, animations, video and audio. [BS97] defines multimedia to denote the property of handling a variety of representation media in an integrated manner. This means that the various sources of media types are integrated into a single system framework. [BS97] also distinguishes between continuous media types like video, animations, voice and audio, with an implied temporal dimension, and discrete media types like text and graphics, without any temporal dimension. For mobile multimedia systems, the former represents the greatest challenge.
Hypermedia is another term used related to multimedia. Hypermedia requires that the user is able to interact with the presentation. The simplest form of hypermedia is hypertext where the user is able to follow textual links. The most common provider of hypermedia content is the World Wide Web.
Continuous media types can be represented in either digital or analogous format. To be able to integrate the different media types in a single multimedia framework, the digital representation is vital. The bandwidth requirements are quite different for the different media types (as shown in [BS97], p.18), but compression techniques for image and video may be reduced considerably by removing redundancy. JPEG, MPEG and H.261 are the three most important standards for compression of images and video. Compression is however a great challenge in mobile networks where the quality of service (e.g. bit error rate) may vary significantly.

3.3 Mobile terminals

Figure 1: Handheld devices [Kylanpää98]

Mobile terminals range from small handheld devices like mobile phones and personal digital assistants, to more powerful computers like laptops. All the mobile devices have certain constraints that must be taken into account when developing applications. The devices are designed to minimize power consumption. The processors are special-made for low power consumption and are typically slower than the ones used in desktop computers. Some type of devices does not have any secondary storage available causing a limited storage capacity. The size of the screens and keyboards may be very small and specialised to keep the device size on a minimum. Some models do not have any keyboard at all and require some other input devices like handwriting or speech recognition.
Handheld devices have very limited set of software available. This is because of the storage constraint, which makes it impossible to store large complex applications in the device.

3.4 Mobile networks

The mobile communications systems have evolved a lot from the first generation analogue systems with low speed, incompatible networks and heavy mobile devices with short battery life. In Europe the second-generation Global System for Mobile communications (GSM) technology emerged as a standard allowing cross-country communications. GSM enabled full digital communication over radio channels with portable devices. The size and weight of the mobile devices decreased and the batteries lasted longer. The third-generation mobile communication systems are in progress and 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) [Krikelis00]. The driving force behind the third generation systems is the support for enhanced multimedia communications, and the changes in local area networks that enable distribution of all wireless services to the users. Wireless LAN technology like the Bluetooth technology and HomeRF (Home Radio Frequency) are examples of the development of wireless communication technology that may support multimedia services.

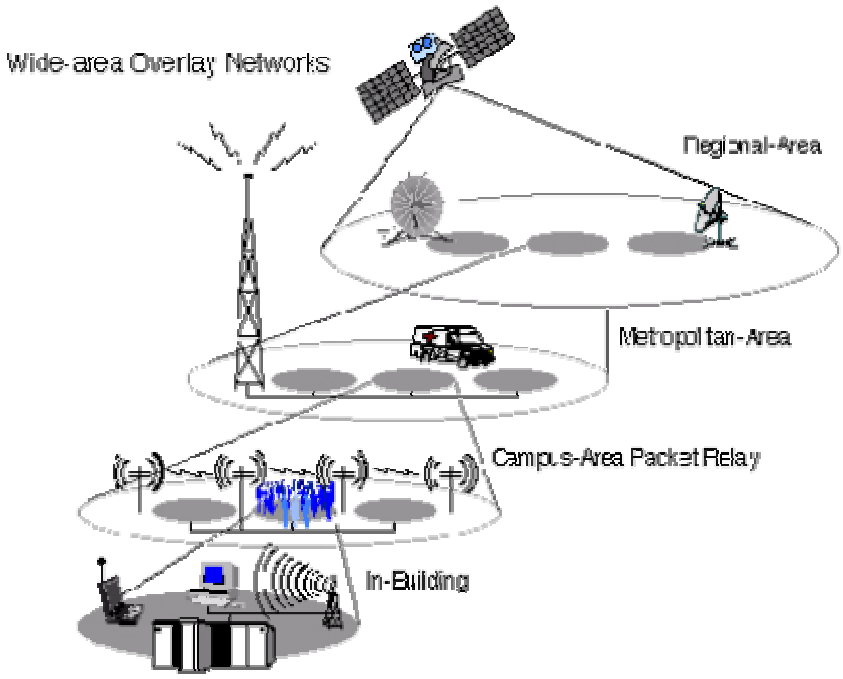

Figure 2: Mobile overlay network [Kylanpää98]

3.5 The Wireless Application Protocol – WAP

The Wireless Application Protocol (WAP) architecture extends the wired Internet model for wireless, hand-held browsers. A WAP-gateway must be added in order to handle HTTP requests and responses within WAP domain. The WAP gateway is responsible for interfacing the wireless bearer network to the wired Internet.

The WAP architecture includes the WTP protocol, a wireless counterpart of HTTP, the WML browser, and a WML script i.e. substitute for HTML and JavaScript.

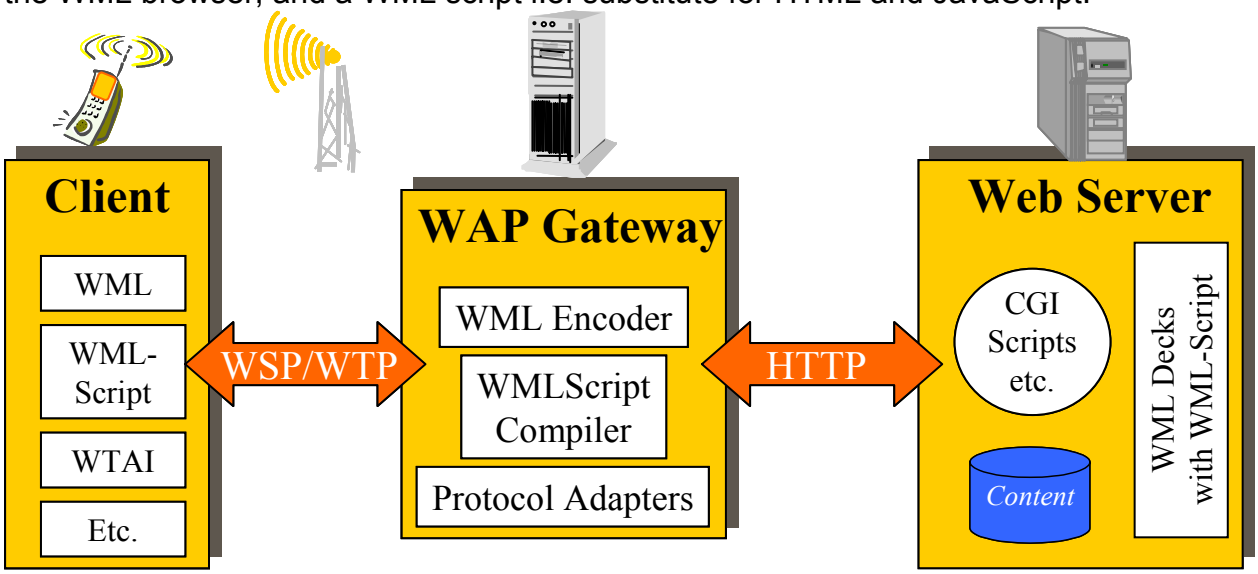

Figure 3: The WAP Architecture [13]

3.6 Content formats

This section explores the typical formats to deploy multimedia content from the Web. The first section describes the most common mark-up language HTML; the next section describes XML; and the last section WML

3.6.1 HyperText Markup Language - HTML

HTML is the *lingua franca* for publishing hypertext on the World Wide Web. It is a non-proprietary format based upon SGML, and can be created and processed by a wide range of tools, from simple plain text editors to sophisticated WYSIWYG authoring tools [7]. HTML uses tags to structure text into headings, paragraphs, lists, hypertext links, frames, tables etc.

One particular problem with the current HTML has been the use of mark-up language features like tables for layout purposes. This approach mixes document structure and formatting and makes it very hard to develop Web browsers using non-conventional output method like speech [Kylanpää98]. Cascaded style sheets [9] have been used as a solution to split the formatting information from the document structure. It is also possible to make media specific style sheets to support for example printing.

The traditional multimedia formats on the web has mostly been text and images, but audio, animations and video formats are also available (the formats are marked as mime-types in an HTML document). In addition, proprietary multimedia formats like Shockwave that require the user to download and install some plug-ins or ActiveX control offer extended multimedia content. Scalable vector graphics (SGL) will soon get standard for animated Web content. Synchronization of different media elements can be done using the SMIL presentation format [10].

3.6.2 Extensible Markup Language - XML

XML is a W3C [11] standard based on SGML and HTML. SGML is widely used for large documentation projects. XML has guided by the experince of HTML, taken the best parts of SGML, and is at least as powerful as SGML.

The following description of XML is partly taken from [8]:

XML is a set of rules, guidelines, conventions for designing text formats for data like spreadsheets, address books, technical drawings etc., in a way that produces files that are easy to generate and are computer readable. These data are unambiguous, extensibility, support internationalisation/localisation, and are platform independent.

XML makes, like HTML, use of tags and attributes, but while HTML specifies what each tag and attribute means, XML uses the tags only to delimit pieces of data. The interpretation of the data is left completely to the application that reads it.

XML files are not meant to be read by humans. They are text files to allow experts to more easily debug applications, may use a simple text editor to fix a broken XML file. But the rules for XML files are much stricter than for HTML. A forgotten tag, or an attribute without quotes makes the file unusable, while in HTML such practice is often explicitly allowed, or at least tolerated. Applications are not allowed to try to

second-guess the creator of a broken XML file; if the file is broken, an application has to stop right there and issue an error.

XML is a family of technologies where the XML 1.0 specification defines what tags and attributes are. Around XML 1.0, there is a growing set of optional modules that provide sets of tags and attributes, or guidelines for specific tasks (some still under development):

- ***Xlink*** that describes a standard way to add hyperlinks to an XML file.
- ***XPointer*** and ***XFragments*** (also still being developed) are syntaxes for pointing to parts of an XML document.
- ***CSS***, is a style sheet language applicable to XML as it is to HTML.
- ***XSL*** is an advanced language for expressing style sheets. It is based on ***XSLT***, a transformation language that is often useful outside XSL as well, for rearranging, adding or deleting tags and attributes.
- ***DOM*** is a standard set of function calls for manipulating XML (and HTML) files from a programming language.
- ***XML Namespaces*** is a specification that describes how you can associate a URL with every single tag and attribute in an XML document. The application that reads the URL interpretes how the to handle it
- XML Schema helps the developers to precisely define their own XML-based formats.

Since XML is a text format, and it uses <tags> to delimit the data, XML files are nearly always larger than comparable binary formats. That was a conscious decision by the XML developers [8]. The textual overhead may however cause problems for devices with small memory and limitied disc space.

3.6.3 Wireless Markup Language - WML

WML is a lightweight tag-based document language and is specified as an XML document type. WML is in comparison to HTML, more optimised for use by hand-held mobile terminals. WML notices the constraints of small narrowband devices such as small display, narrowband network, and limited computational resources and user input facilities [Kylanpää98].

The WML includes the following:

- The information is organized into a set of cards and decks. Cards specify units of user interaction (such as a text entry or a choice menu). A deck consist of a set of cards, and is the unit of content transmission and it is identified by a URL (such as a HTML page)
- Supports text and images
- Inter-card navigation and linking
- State management and string parameterisation.

4 Development Issues for Mobile Multimedia Systems

This section will present and partly discuss issues and requirements related to mobile applications in general and to mobile multimedia applications in particular. First of all there are some issues that must be taken into account in the development of mobile applications independent of the evolution of mobile terminals and network bandwidth [Nakajima97]:

- Mobile terminals do not have the same hardware resources as a traditional stationary terminal. Typical constraints are e.g. less powerful CPU, memory limitations, small display, limited input capabilities and power supply.
- Wireless network properties are different from wired networks.
- The operating environment of mobile terminals may change drastically when replacing replaceable devices during the execution of applications.

Other issues are related to the marketplace for mobile applications:

- Applications must be as easy as a phone to use that implies that they must be easier to use than a PC.
- Solutions must provide significant value at low incremental cost.
- Needs at the handset are not the same as at the desktop.

This implies that inferior applications and services will lose to those optimized for wireless terminals.

[BS97] presents four main challenges or requirements for multimedia in a distributed environment, which also applies to mobile environments:

- Support for continuous media. Continuous media types have a temporal dimension (as described in Section 3.2), and require continuous data transfer over relatively long periods of time.
- A sophisticated quality of service management. This is vital to have a reliable and sustained transmission of data, especially for continuous media types.
- Real-time synchronization. Continuous media types must be presented with a required throughput, jitter and latency characteristic (intra-media synchronization). In addition may it be real-time constraints across more than one media type.(inter-media synchronization). E.g. synchronization between audio and video, or text subtitles and video sequences.
- Multiparty communications. E.g. the support for both wired and wireless devices, different hardware characteristics and quality of service requirements, the ability to join or leave multimedia channels at run-time.

Applications designed for the fixed network have not been adaptable to operation in mobile systems, which are constrained by lower throughput, higher bit error rates and restricted terminal capabilities. The provision of so called mobile aware applications, capable of yielding to the hostile mobile operating environment, has been very low.

If we are planning to support mobile access to multimedia services we have to make some design decisions: Should we build separate applications and Web pages for mobile users or is it possible to use existing applications and content material? The

answer depends on the nature of the service that we are planning to support. If the service is important part of the mobile users' workflow it is probably best to create separate applications or Web pages for mobile users. If these pages are only used for casual surfing or if we do not have control to these Web pages we have to use the original material also for mobile access [Kylanpää98].

Based on this discussion it is important to develop techniques that can be used to adapt web content to be usable with mobile handheld devices and wireless networks. Servers must be capable to dynamically optimise content presentation formats and the HTTP/WAP depending on the resources and constraints of the handheld devices and mobile networks. This include for e.g. animations or video to filter the number of frames sent to the handheld device to be within the capabilities of the receiver, change the resolution of the single frames or pictures to match the display of the receiving terminal. Compression techniques are also an important area of research to provide more and better pictures within the constraints of the wireless network and devices. The compression techniques must be robust against errors that are typical of a wireless channel. Awareness of the processing time and the required software on the mobile devices must however be taken to into account (because of the slower processors, the battery consumption and the limited memory space).

To limit the amount of processing on the mobile devices, the mobile multimedia applications must be split to perform the most resource-demanding part on stationary computers, leaving only the user input/output to the mobile devices. This implies that servers must prepare the content before sending it to the client.

Another issue is related to the costs of interaction and bandwidth consumption. The multimedia content should be available offline in wireless networks requiring paid connections based on consumed connection time (like GSM). In this setting, the content is "ordered", and then downloaded before closing the connection. UMTS is designed to let the wireless devices be online all the time to the same price and will if the quality of service is good enough avoid using local memory on the mobile terminals, especially for streaming content like video.

It is also important to encompass the notion of reactive or adaptive behaviour in this context. Applications should be able to tailor their behaviour in response to changes in the level of service being provided by their underlying support infrastructure.

5 Conclusions

This essay has briefly explored the current state of the art of mobile multimedia and related technologies and based on these, presented some issues and requirements for the support of multimedia in mobile terminals. The forthcoming third generation mobile communication system, UMTS, will be very important to the success of mobile applications in general and of mobile multimedia application in particular. Similar the evolution of handheld, mobile devices with improved computation, memory and power capacity is very important to serve the growing demands for mobile applications.
The future multimedia applications will probably service demands and needs in many areas of the professional, public and private life. Both technological and commercial issues must be solved in order to provide successful mobile services and applications.

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Additional resources

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[2] http://www.comp.lancs.ac.uk/computing/research/mpg/most/
[3] http://www.umts-forum.org/
[4] http://www-mobile.ecs.soton.ac.uk/index.html
[5] http://www.wmmforum.com/
[6] http://www.vtt.fi/tte/projects/mobmulti/links.html
[7] http://www.w3.org/MarkUp/
[8] http://www.w3.org/XML/
[9] http://www.w3.org/Style/
[10] http://www.w3.org/AudioVideo/
[11] http://www.w3.org/
[12] http://www.w3.org/Mobile/
[13] http://www.wapforum.org/