Enhancement of existing network infrastructure with Media on Demand functionality

Alisa Devlić, Hrvoje Vojnić

***Abstract*--With the evolution of radio access technologies that provide higher data transmission rates, the mobile market will introduce content rich multimedia services over mobile networks at the user instant needs. Media on demand (MoD) refers to the system that provides clients access to media and plays it back with little or no delay. Therefore it has to face numerous challenges, such as providing mobile streaming over various access networks and mobile terminals simultaneously to millions of mobile users across broad geographic area. It is expected that this technology will merge the communications and media industry, allowing movie producers and TV companies to stream their content over mobile operator's infrastructure and service providers generating attractive killer applications. In this article is presented a case study of integrating end-to-end multimedia delivery solution into existing Ericsson Mobility World Croatia network infrastructure. The problems and benefits of including new network entities are explored and the planned solution for the year 2003 is proposed.**

***Index terms*-- Media on Demand, mobile streaming, multimedia services**

I. INTRODUCTION

Mobile networks have evolved through the different evolution paths, as shown in figure 1 [1]. The generally accepted 3G migration path is to upgrade the GSM network to 2.5 General Packet Radio Service, and then the GSM/GPRS network will evolve into EDGE – Enhanced Data Rates for Global Evolution and finally into the Universal Mobile Telecommunication System (UMTS) with speeds up to the 2 Mbps. These technologies are briefly described in [2].

During the evolution of mobile networks, an evolution of mobile applications has been taking place. The requirements for data transmission rates [3] in mobile applications are as follows:

- 10 - 100 kbps for voice
- 64 - 100 kbps for Internet access
- 144 kbps - 2 Mbps for video

Fulfilling most of these requirements today with

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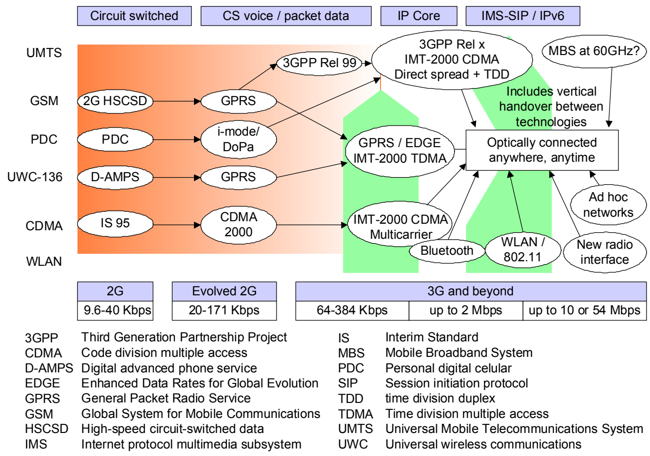

Fig.1 Mobile migration path

data transmission rates up to the 53.6 kbps (171.2 kbps theoretically [4] when the coding scheme 4 is used), GPRS had an exception role in providing a variety of new services, such as online chat, m-commerce, location-based services, etc. and contributing to the better acceptance of services among consumers. Also the need for offering users different sorts of content, that they used to download and access over Web, has been discovered. The content including text, images, animations, sounds and in the near future multimedia will have to be personalized (targeting specific user's needs) and delivered to mobile terminals with different processing and display capabilities.

In order to provide streaming of high quality multimedia content to mobile devices, 3rd generation of mobile networks with higher data rates and greater bandwidth has to be introduced. In addition, most of mobile multimedia applications have a demand for asymmetric bandwidth, meaning that a greater bandwidth is needed for downlink, while the uplink is mainly used for control information, such as user's selections and commands. UMTS meets these and other requirements, needed to become a global mobile multimedia communication standard.

This article gives an overview of Media on Demand functionality in the following section. In the section III related work considering improvements of streaming technology in the field of compression, intelligent routing and efficient delivery has been described. Section IV demonstrates a case study of integrating Media on Demand functionality into the existing network infrastructure on the example of Ericsson Mobility World Croatia. The problems and benefits of including new network entities are explored and the planned solution for the year 2003 is proposed. Finally the conclusion summarizes the work described in the article and gives references to the similar projects.

II. MEDIA ON DEMAND

Media on demand is, opposite to Multimedia Messaging Service [7] [8], needed in the interactive media applications when the access to media is required at the user instant needs, while the latter one delivers the media content asynchronously through the messaging service. The requirements that have been set in order to provide Media on Demand functionality include the increasing bandwidth in mobile environments, the increasing capabilities of mobile devices, and the better compression algorithms. While it wasn't possible to fulfill these requirements with the existing networks, 3GPP has defined 3GPP Packet-switched Streaming Services (PSS) as a framework for IP based streaming applications in 3G networks [9]. The problems needed to be solved were storing and processing the large amount of media data files that could potentially cause storage problems at the client side and the long start-up latency. Streaming service solves this issue by allowing streaming media to be consumed as it is received.

Applications that can be built on the top of streaming services can be classified in two categories: on demand (music, news on demand) and live information delivery applications (radio and television programs) [10].

General Service architecture is presented in figure 3 [13]. For its implementation at least streaming client and content server are required to be included. Other entities, such as: portals, profile servers and caching servers can be added to the architecture aiming to provide additional services and to improve their quality of service.

Portals are the common place from where multimedia streams can be run and controlled. Device profile servers store device profile descriptions that consist of terminal capabilities and/or user preferences. This information can be used to control the presentation of the streaming media content to a mobile user. The content itself is usually stored on content servers, located somewhere in the network.

The PSS include the following media codecs for video, still images, vector graphics, bitmap graphics, text, timed text, natural and synthetic audio, and speech:

- AMR narrow-band speech
- AMR wideband speech
- MPEG-4 AAC low complexity (AAC-LC) audio
- SP-MIDI (Scalable Polyphony MIDI)
- ITU-T H.263 video
- MPEG-4 visual simple profile video
- JPEG and GIF images
- XHTML-encoded formatted text

The protocol stack used in a PSS client includes protocols for session setup and control (Real Time

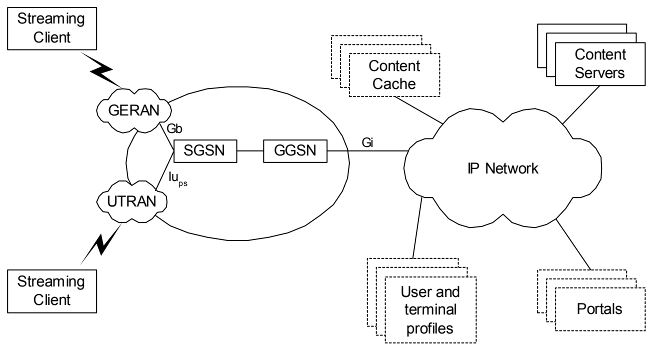

Fig. 3 PSS general architecture

Streaming Protocol (RTSP) and Session Description Protocol (SDP)), Hypertext Transfer Protocol (HTTP) for capability exchange, Synchronized Multimedia Integration Language (SMIL) for scene description, HTTP over TCP/IP for transporting of static data and RTP over UDP/IP for real time media transport.

Multimedia presentation consists of different media types synchronized in time and on display. In addition, synchronization format is separated from a display format, which is done in SMIL [11]. Therefore data streams are encoded as separated media objects, while SMIL just synchronizes them and associates hyperlinks with them.

The problems of heterogeneity of different radio access networks, the varying of QoS and speed in the connection and efficient delivery of streaming media content are addressed with several mechanisms [12] which are out of scope of this article.

QoS requirements shall be in accordance with requirements defined in [6]. PSS client shall be capable of requesting an appropriate level of QoS for the session. The QoS supplied may be limited by the local operator's access policy and/or network functionality. QoS issues in mobile networks will mainly depend on number of available timeslots (operator can provide dedicated timeslots for GPRS, but the total capacity will vary depending on number of active users in a cell). Also, network coverage will influence the overall quality perceived by end users.

III. RELATED WORK

The keys of improvement streaming media quality lie in unused bandwidth, intelligent routing and better compression [15]. One way to accomplish this is to use unused transmission capacity to buffer additional data that could in the case of Internet congestion or dropping of connection help the system to display the stored data, thereby avoiding its interruptions. In another development [15], software with dynamic intelligent routing has been made to avoid packet loss and delays due to the Internet congestion. New data compression technique that divides and classifies video files based on actual images rather than on data blocks has been created, saving time and eliminating the need to encode and decode object descriptions, and what is most important, reducing the actual amount of data transmitted. The related articles [5] [12] [16] deal with the latest research of reliable transfer of media over Internet and new data compression methods, problems and challenges of streaming multimedia content in 3G mobile communication systems, and innovative strategies for improvements of storage capacities, while saving network bandwidth, respectively.

IV. CASE STUDY

The Media on Demand (MoD) solution is planned to be integrated in the existing infrastructure of Ericsson Mobility World Croatia lab. The main purpose will be to experiment and test mobile multimedia applications which will mostly appear with the coming of 3rd generation mobile networks (EDGE, UMTS), and to demonstrate the capabilities of the platform for commercial use.

The solution of Ericsson system contains: content encoding tools, content streaming and download server(s), content delivery network, media player and bearer networks. The current architecture incorporates and extends the architecture standardized in 3GPP PSS Release 4, and future versions will follow the 3GPP approach and standardization track to ensure interoperability with the upcoming 3G and potentially 2.5G terminals. Specifically, the discussed system contains components with the following functionalities: they enable connection to multimedia requests, act as a proxy for HTTP requests and RTSP set-up, and stream the content to destination terminals.

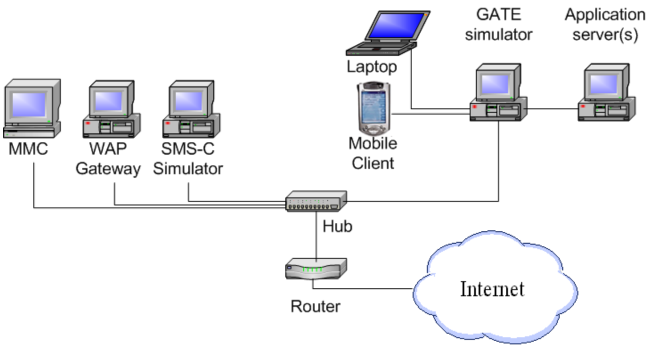

Fig.5. Ericsson Mobility World Croatia lab: current layout

Separate modules/components are responsible for connecting to external network using interfaces compliant with 3GPP specifications, making integration with the network easier. The O&M, authentication, billing and subscriber handling/database are also an integral part of the system. In a demo system, which will be installed in the Ericsson Mobility World lab, most of functionalities will be presented in the form of software modules on a single server.

Current situation in the Ericsson Mobility World lab is shown in fig.5. The lab capabilities include MMS testing (comprising MMC trial system and WAP gateway), SMS-C simulator (used to send notifications), and GATE simulator, used to simulate GPRS network conditions and monitor application behavior. Testing with GATE simulator is done by connecting client terminals via Ethernet/USB with GATE machine on one side and with content server(s) through Ethernet on other side. Thus, traffic (data packets) passes through GATE machine, where it can be monitored or influenced, using certain algorithms.

GATE simulator is a standard Ericsson Mobility World test system, aimed for any kind of applications targeted for wireless packet data networks. Additional application testing can be implemented in terms of load testing, which requires separate server.

In the proposed solution for the year 2003, as shown in fig.6, Instant Messaging and Presence Server (IMPS) and Load Testing Suite together with the MoD solution are planned to be integrated. Further details regarding their functionalities are out of the scope of this article. Demo terminals for streaming will be Pocket PC and/or Symbian-based.

There are two possible scenarios:

- PDA with PocketPC will be connected to a GPRS phone using Bluetooth, or
- GSM module will be plugged into the PDA to have a complete wireless experience.

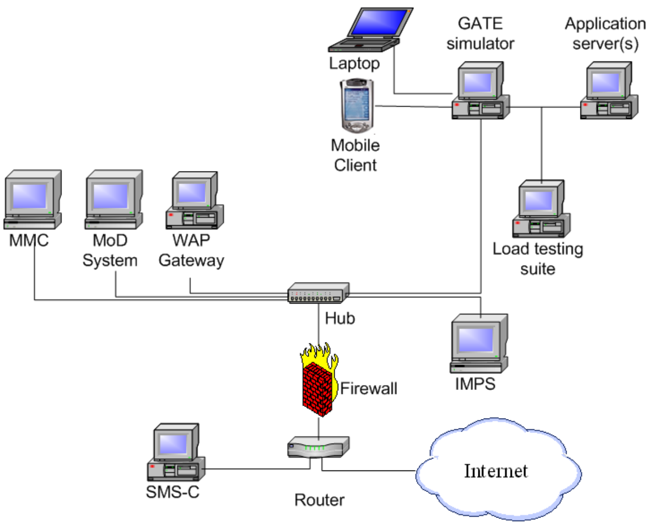

Fig.6. Proposed solution planned for the year 2003

Bluetooth could also be used as a transmission medium between the terminal and GATE network simulator; however it needs additional hardware which is not present. Since the capacity of the Bluetooth link is higher than the capacity of GPRS network, we assume that there could only be some impact in the connection setup phase. When using UMTS as the bearer network, Bluetooth could pose a bottleneck in the transmission due to its lower bandwidth.

The 3GPP SMIL player for Pocket PC [14] used on the destination terminal will also be part of the MoD solution, and will support different download techniques and different audio/video content formats (MPEG-4, AMR-NB, H.263). Symbian devices are in the testing phase.

Media content creation platform (based on Apple Macintosh system) will also be available, if required.

Regarding content transfer to destination terminal, there are several methods that can be chosen depending on the network bandwidth and desired/required QoS level:

- *Streaming* - delivers the content in the most efficient way, minimizing both user's waiting time for the content delivery and memory size used to hold a couple of seconds of multimedia, while imposing a more firm bandwidth limit to provide adequate QoS. Therefore it requires temporal buffering of content parts before playing it at the end user's terminal.
- *Download* - the content will be rendered at the user's side after completing its download from the web server, which takes more time and memory capacity than the previous method.
- *Progressive download* – user's player initiates requests for downloading parts of target file and upon finishing the current one, plays it while downloading the next one.
- *Resumed download* – during the creation or encoding of content, flags have been set on the blocks of content in order to safely resume a download at the point of interruption.

The MoD system will be implemented in the lab on a fast Ethernet LAN. It will be connected to the Internet through a firewall (as shown in fig.6). In this network setup, it will be possible to use the MoD system as a source server for content feed to the terminals, through GATE testing platform. Thus it will be possible to monitor and measure traffic (simulate real GPRS network conditions).

Testing will mainly consist of measuring performance of the MoD server over simulated, and over real network. Since the trial system already has some built-in limitations, we know the maximum capacity of the server; therefore we will measure the impact of network conditions on the end user, i.e. transmission errors and its repercussions on the media quality, network delays, interruptions, etc. The testing will be done according to a test document where procedures and expected results are described.

In this testing case, operator network is not involved as the streaming is done directly through the GATE server, which is connected to MoD system through Ethernet interface, and to the terminal via USB port interface. As this is only a network simulation, different scenarios can be tested and (simulated) network conditions are completely under control of the tester (in contrast to real network). On the other hand, a real network will always give a complete real-life testing environment, but its traffic parameters are inherently stochastic and non-repeatable for testing purposes.

The system will also be capable to adapt to network condition changes (interruptions, bandwidth changes, etc.), that will apply if an operator network is used. Since there are no dedicated data-slots in the GSM network, the available bandwidth will be the main issue. The bandwidth can be dynamically checked prior to data transfer, and if it is too low, streaming will not commence, and the user will receive a notification.

V. CONCLUSION

This paper briefly described Media on Demand functionality together with problems concerning its implementation in 2.5G and 3G mobile communication systems and the related work concerning latest research in this area as an introduction to case study of integrating MoD solution into the existing Ericsson Mobility World Croatia lab network infrastructure. The trial version of MoD solution will be installed in the lab, enabling the functionality needed for testing and demonstration purposes. The main purpose of this trial version will be to experiment and test potential mobile multimedia applications and demonstrating capabilities of the platform for commercial use. Finally, the planned layout of the lab for the year 2003 has been proposed, as well as benefits and limits of implementing this solution.

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