Enhanced UMTS Services and Applications: a perspective beyond 3G

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ABSTRACT

This paper addresses aspects of classification, characterisation and deployment scenarios for services in Enhanced UMTS (E-UMTS), a possible UMTS evolution. Its goal is to get data rates up to 8-10 Mbps, supporting new services and applications, while giving the system much more capacity. One starts by putting the available data about target services and applications together, and presenting different perspectives for service classification. Then, characterisation parameters are presented, and foreseen services and applications are described. Finally, a definition of E-UMTS scenarios, to be used in E-UMTS performance analysis, is presented.

I. INTRODUCTION

WCDMA is emerging as the leading global 3G standard, and products based on it have just started to appear on the market. The current WCDMA specification supports data rates up to 2 Mb/s in indoor/small-cell-outdoor environments and up to 384 kb/s in wide area coverage, as well as supporting both high-rate packet data and high-rate circuit-switched applications. However, the standard will continue to evolve for several years and one of the possibilities for this evolution is HSDPA (high-speed downlink packet access [1]), which is currently a work item within 3GPP, and will satisfy the future demands for packet-data services.

The main goal of HSDPA is to allow WCDMA to support downlink peak data rates in the range of approximately 8-10 Mb/s for best effort packet-data services, far beyond the 2Mb/s requirement. Many new technologies are currently being considered for this first step of WCDMA development. Higher order modulation (16-QAM and 64-QAM), provides higher spectral efficiency in terms of bit/s/Hz compared to QPSK and can thus be used to provide peak data rates of the order of 10 Mb/s within the current 5 MHz WCDMA bandwidth. It means that, with 16-QAM, data rates can be multiplied by two, whereas, with 64-QAM, they can be multiplied by four, leading to a big improvement.

Enhanced UMTS (E-UMTS) research within the IST-SEACORN European project is taking the ideas from HSDPA as a starting point but it intends to extend the maximum achieved data rates in both directions. It will be introduced before fourth generation systems, such as MBS, hence E-UMTS is called a 3.5G system, and will be a first step to reach mobile broadband.

In this paper, one gives the nowadays visions of services and applications for Enhanced UMTS, and presents the contribution of our research for the definition of deployment scenarios. Current classifications of E-UMTS services and applications are presented in Section II. In Section III, after describing the service characteristics in detail, traffic, communication, service components and operation environment characterisation parameters are presented. In Section IV services are described and organised according to the ITU-T I.211 hierarchies and the types of information that support the communications. A definition of some E-UMTS deployment scenarios, corresponding to different envisaged markets is presented in Section V. Conclusions are drawn in Section VI.

II. CLASSIFICATION

This work is focused on the definition of Enhanced UMTS services and applications. Besides speech and message services, third-generation systems will provide additional streaming and conversational services. Streaming video combined with audio and conversational video were envisaged when designing third generation systems. Thus, future generations of applications should provide more advanced types of services, in different combinations. At this stage it is difficult to predict exactly which services will become more popular in the future. These applications will allow getting somewhere, feeling comfortable, being informed, having fun, doing e-commerce, providing car maintenance and travel assistance, having remote access to computers and databases, communicating in general, and supporting mobile emergency services.

Although some will be improved in future systems, other will not be desirable at all [1].

An application is defined as a task that requires communication of one or more information streams, between two or more parties that are geographically
separated, being characterised by the service attributes, and also by traffic and communications characteristics. A set of applications with similar characteristics, or a single application, can be classified as a service if they have a common set of characteristics [2].

A. ITU-T I.211 Recommendation

Applications and services can be divided into the following different groups: interactive (conversational, messaging and retrieval) and distribution (broadcast and cyclical) [2], [3].

Interactive services are those in which there is a two-way exchange of information between two subscribers or a subscriber and a service provider. It includes the conversational, messaging and retrieval categories.

- **Conversational services** provide bi-directional dialogue communication with bi-directional, real-time, end-to-end information transfer between two users or between a user and a service provider host. The flow of information may be bi-directional symmetric, bi-directional asymmetric and, in specific cases, unidirectional. Examples are video-telephony and videoconference.

- **Messaging services** offer user-to-user communication between individual users with store and forward. They are not in real time. Examples are video and voice mail.

- **Retrieval services** provide the user with the capability to retrieve information stored in information centres that, in general, is for public use. Examples are broadband retrieval services for film, audio information and archival information.

Distribution services are those whose information transfer is primarily one-way, from service provider to B-IDSN subscriber, including broadcast services, where the user has no control over the presentation of the information, and cyclical services, which allow the user some measure of presentation control.

- **Broadcast services** provide a continuous flow of information, distributed from a central source to an unlimited number of authorised receivers connected to the network. Each user can access this flow of information but has no control over it. An example is an application for broadcast of electronic newspaper.

Cyclical services allow distributing information from a central source to a large number of users. The information is provided as a sequence of information entities with cyclical repetition. The user can control start and order of presentation. Applications: teletext, electronic newspaper using public networks.

B. 3GPP QoS classes

According to 3GPP, UMTS attempts to fulfil the Quality of Service, QoS, request from applications or users. It has been establishing the following traffic classes [4]: conversational, streaming, interactive and background. The distinguishing factor of these classes is how delay-sensitive traffic is: the conversational class is the most delay-sensitive whereas background class is the less delay-sensitive.

**Conversational class** applications are transmitted as real-time connections. Communication is always performed between live end-users. This is the only type where the required characteristics are strictly imposed by human perception. The end-to-end delay is low (less than 200 ms) and the traffic is nearly symmetric. Examples of applications are speech service, video, telephony and voice over IP.

**Multimedia streaming** is a technique for transferring data such that it can be processed as a steady continuous stream (e.g., real-time viewing and listening of media). Hence, the client browser can start displaying the data before the entire file has been transmitted. In this class, applications are very asymmetric, e.g., web broadcast or video streaming on demand.

**Interactive class** is applied when the end-user (human or machine) is on line requesting data from remote equipment. It is characterised by the request response pattern of the end-user and the content of the packets must be transparently transferred (low bit error rate). Examples of human interaction are Web browsing, database retrieval, and server access. Examples of machine interaction with remote equipment are polling for measurement records and automatic data base enquiries. Some of the interactive class applications are: location-based services, and computer games.

Applications from the background class are more or less insensitive to delivery time. That is because the destination is not expecting the data within a certain time, so the delay can be from seconds to minutes. Applications, such as e-mail, SMS or downloading databases, can be delivered in background, since they do not require immediate action.

From these classifications, it is possible to establish a correspondence between 3GPP and I.211 classes:

- Conversational class is the same in both classifications. There is a bi-directional dialogue between live end-users.
- Multimedia streaming can be identified with retrieval and broadcast classes. Information is given in a continuous flow or streaming.
- Interactive class is a kind of the ITU-T retrieval class. Users request data from remote equipment.
- Background and messaging classes are closely related, e.g., they treat mail interchange.

C. UMTS Forum Services/ Applications

The UMTS Forum assumed that the market for UMTS comprises a wide area of applications, which are converted into six main service classes for this analysis. Some are seen as logical extensions of the 2nd generation mobile market while the others are addressing the new mobile multimedia market [5].

Referring to the purpose of services and applications, services on demand will be common in UMTS. In addition to the provision of multimedia, the user’s needs for the present telecommunication services will also be satisfied inside UMTS [6]. In [7] an updated perspective was proposed where, besides voice, applications are classified into content connectivity (Internet) and mobile ones. While the content
**connectivity** applications can be either mobile internet access or mobile intranet/extranet access, mobile applications are divided into three categories: customised infotainment, multimedia messaging services (MMS) and location based. More recently, a refinement of this approach was proposed in [8].

**III. SERVICE CHARACTERISATION**

Services can be classified obeying to their service characteristics [2], which are the following:

- **Intrinsic time dependency** - Time-based information must be presented at specific instants to convey its meaning, otherwise it is non-time-based.
- **Delivery requirements** - real-time applications, information requires to be delivered for immediate consumption, while non-real-time ones information is stored at the receiver points for later consumption.
- **Directionality** - Communications can be unidirectional or bi-directional. The latter can be symmetric/asymmetric.
- **Symmetry of the connection** - A connection can be symmetric or asymmetric.
- **Interactivity** - Describes its existence or not.
- **Number of parties** - One-to-one, one-to-many or multiparty.

In general, the requirements for supporting an application depend on both the intrinsic time dependency and delivery requirements. In addition to the described service characteristics, the remaining ones are presented.

- **traffic characteristics** [2]:
  - traffic generation process;
  - distribution of the duration;
  - average duration;
  - bit rate range and typical bit rate;
  - latency / delay.
- **communication requirements** [9]:
  - communication protocol;
  - switching mode;
  - burstiness;
  - class of service;
  - error guarantees.
- **service components** [2]:
  - distribution of the generation process;
  - distribution of duration;
  - average duration;
  - the number of times each one is assessed.
- **operation environments** [2]:
  - framework;
  - nature of applications – business or residential;
  - environment – indoors or outdoors;
  - mobility scenario;
  - service provision – public or private;
  - deployment scenario – set of services / applications operating simultaneously in the system.

From the details presented in [2], [10], here, one only highlights the following. According to the ITU-T I.211 Recommendation, different services are distinguished by the type of information that supports them, so that each of these types maps into a set of service components. Basic components are audio, video and data. Moreover, audio can be subdivided into voice and high-fidelity audio, video can be supported by interactive video and high definition video, whereas data can be low-, medium- or high-data rate.

From the communications characteristics, the burstiness is defined as the ratio between the peak bit rate and the average bit rate [11]. Operation environments can be divided into public and private, although some users of private environments can use the public ones.

**Public**-Business City Centre, Urban, Road, Public Transportation and Commercial Zones

**Private**-Emergency Dedicated (police, firemen, medical emergency), TV Broadcast Dedicated, Office Dedicated and Industry Dedicated

The possible nature of applications is Business, and Familiar, whereas the environments can be Indoors, Outdoors, and Trains. The scenarios of mobility are pedestrian, urban, main roads, and highways. The service provision can be public or private.

**IV. SERVICE PRESENTATION**

Services and applications are organised according to ITU-T I.211 Recommendation. A given application can be supported by different services. As a consequence, it can have different characteristics in terms of type of information (i.e., service components that support them) and service characteristics [2].

ITU-T I.211 identifies the following types of information: sound, moving pictures or video, document (multimedia), data, text, graphics and still images. Thus, services are organised in the following way, Table 1. Apart from data and multimedia retrieval, that are best effort, these E-UMTS services are mostly real-time ones.

**Table 1. Services hierarchies.**

<table>
<thead>
<tr>
<th>Service Hierarchies</th>
<th>Type of Information</th>
<th>Examples of Broadband Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive Services, Conversational</td>
<td>Moving Pictures And Sound</td>
<td>Video-telephony</td>
</tr>
<tr>
<td></td>
<td>Data</td>
<td>HD Video-telephony</td>
</tr>
<tr>
<td></td>
<td>Document (multimedia)</td>
<td>Videoconference</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISDN-Videoconference</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Video Surveillance</td>
</tr>
<tr>
<td>Interactive Services, Messaging</td>
<td>Mixed Document</td>
<td>Multimedia Mail</td>
</tr>
<tr>
<td>Interactive Services, Retrieval</td>
<td>Text, Data, Graphics, Sound, Still Images, Moving Pictures</td>
<td>Broadband Videotex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data Retrieval Service</td>
</tr>
<tr>
<td>Distribution Services, Cyclical</td>
<td>Text, Graphics, Sound and Still Images</td>
<td>Full Channel Broadcast Videography</td>
</tr>
</tbody>
</table>

**A. Services**

A description of these services follows:

- **Videotelephony** – person-to-person communication for the transfer of voice, video, images and documents.
- **Video conference** – multi-point person-to-group or
group-to-group very low data rate communication for the transfer of voice and video.

**ISDN videoconference** – multipoint narrowband person-to-group or group-to-group communication for the transfer of voice, moving pictures, still images and multimedia.

**Video surveillance** – Transmission of images and sound generated by surveillance cameras. The information delivery limited to a specific subscriber.

**High volume transfer** – transmission of computer files

**Mixed document communications services** – multimedia components (text, facsimile, images, voice, annotations, video components) communications between users at workstations.

**Multimedia mail** – communication via e-mail of mixed documents (multimedia).

**Broadband videotext** – user selected sound passages, high-resolution images of TV standard, and short video scenes, in addition to current text and simple graphics.

**Data and multimedia retrieval service** – retrieval of unrestricted data and multimedia.

**Full Channel Broadcast Videography** – cyclical communication of text, graphics, sound and still images.

### B. Applications

The applications one foresees to be the most widely used are the following:

**Video Telephony** – real-time video telephony one-to-one communication.

**Tele-education** – remote learning and training based on audio-visual information, e.g., virtual school and on-line science laboratories.

**Video Conferencing** – real-time high quality video conferencing.

**Tele-advertising** – interactive publicity based on the exchange of audio-visual information

**Mobile Video Surveillance** – localisation and communication with the person committed to monitoring the object of surveillance. It can be:

- **a) Alarm detection in Industrial Environment** – useful in industrial environments where men cannot be completely replaced, but their action is occasional and only in response to alarm conditions in certain factory locations. Multimedia information (video images, audio and data), related to the alarm condition, is transmitted as well as the data necessary to solve the problem that caused the alarm.
- **b) Security surveillance of property** – used in residential environments. House conditions and video/sound information is available to a person while travelling, giving him/her the ability of self-surveillance.

**Data File Transfer (FTP)** – usual FTP (file transfer protocol) functionalities. It allows the transfer of any type of data file between different types of computers or networks.

**Desktop Multimedia** – exchange of multimedia documents, e.g., a slide show containing text, still images, graphics, video and sound.

**Collaborative working** – flexible way of working which covers a wide range of work activities; all of them entail working remotely from an employer, or from a traditional place of work, for a significant proportion of work time. The user establishes a session via a service provider, activates and controls local and remote applications, and communicates with a collaborator through audio, video and data.

**Tele-working** – working from home or from anywhere (public transportation, airport waiting rooms). Its main advantage is flexibility; the ability to rapidly set up an employee at home for tele-working at a low cost. It may mean working at home but being in contact with colleagues at work and with customers through video/voice/data sessions. It also means collaboration between geographically separated persons, possibly a group of them.

**Electronic Mailbox Service for Multimedia** – transmission and storage of mixed documents containing text, graphics, voice and/or video components.

**E-commerce** – remote shopping based on audio-visual catalogues allowing the users to choose goods and services and to do electronic payment.

**Tourist Information** – the system would provide information in the form of multimedia documents (video, audio and data) to travellers arriving at a city or country. Special events as well as particular sites could be displayed so that a tourist would be able to choose his own path. It also allows for access to sophisticated booking/reservation systems would provide up-to-date information about hotels, restaurants and other entertainment places.

**Remote Procedure Call** – remote execution of computer programs for several purposes.

**Urban Guidance (Public Transport Information)** – to serve both the public transportation company and its users. Multimedia information and traffic forecasting service could be provided to a scheduling centre on the public transport company. The user of the public transportation has access to exact timetables of buses or trains as well as alternative routes to reach a specific location (including the estimated vehicle occupation).

**Assistance in Travel** –

- **a) City Guidance** – a person can have assistance to meet a given location, choosing the best path to meet a location and get information on the average time it takes to get there. Alternatively he/she can ask for alternative paths with some tourist attractions, and the application has the ability to show some images on them, besides providing him/her with the detailed maps where the location of the car is pointed out.
- **b) Traffic Advice and Road Conditions** – user-oriented information (data, video and audio comments) about the traffic conditions. Users can decide on the more convenient road to reach a specific destination, and get information about parking and traffic flow/forecast.

**Electronic newspaper** – newspapers are made available to users on their fixed/mobile terminal equipment. News can be organised so that users navigate according to their own interests. Special services like personalised journals can be provided on demand for this type of application.

Each application has a correspondence with the services previously presented, Table 2.
Table 2. Correspondence services/applications.

<table>
<thead>
<tr>
<th>Examples of Services</th>
<th>Examples of Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video-telephony</td>
<td>Various purposes</td>
</tr>
<tr>
<td>HD Video-telephony</td>
<td>Tele-education</td>
</tr>
<tr>
<td>Videoconference</td>
<td>Various purposes</td>
</tr>
<tr>
<td>ISDN-Teleconference</td>
<td>Tele-advertising</td>
</tr>
<tr>
<td>Video Surveillance</td>
<td>Mobile Video Surveillance</td>
</tr>
<tr>
<td>High Volume File Transfer-FTP</td>
<td>Data File Transfer (FTP)</td>
</tr>
<tr>
<td>Mixed Document Communications Service</td>
<td>Desktop Multimedia</td>
</tr>
<tr>
<td>Mobile Tele-working</td>
<td>Mobile Tele-working</td>
</tr>
<tr>
<td>Multimedia Mail</td>
<td>Electronic Mailbox Service for Multimedia</td>
</tr>
<tr>
<td>Broadband Videotex</td>
<td>E-commerce</td>
</tr>
<tr>
<td>Data Retrieval Service</td>
<td>Tourist Information</td>
</tr>
<tr>
<td>Multimedia Retrieval Service</td>
<td>Remote Procedure Call</td>
</tr>
<tr>
<td>Full Channel Broadcast Videography</td>
<td>Assistance in Travel</td>
</tr>
</tbody>
</table>

V. PROPOSAL OF DEPLOYMENT SCENARIOS

In E-UMTS, some scenarios have to be defined with a given mixture of applications, e.g., for multi-service tele-traffic analysis. The following three can already be proposed (with high associated mobility), with the highest foreseen usage and terminal mobility: Business City Centre, BCC, Urban, URB, and Roads, ROA. In [2], a correspondence between deployment scenarios and envisaged markets [2] is identified: BCC corresponds to the business market, URB to the residential one, while ROA corresponds to the mixed market. The proposed values for the usage of E-UMTS alone applications are presented based on the available data for UMTS, B-ISDN and HIPERLAN, as well as on some data from RACE-TITAN and RACE-MBS projects [2], Table 3. If one assumes that E-UMTS will operate in the context of reconfigurable systems, voice and low data rate applications (<128 kb/s) can be established through 2G systems, e.g., GSM/GPRS.

Table 3. Enhanced UMTS scenarios.

<table>
<thead>
<tr>
<th>Applications Usage [%]</th>
<th>Data Rate [kb/s]</th>
<th>E-UMTS usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BCC</td>
<td>URB</td>
</tr>
<tr>
<td>High Interactive Multimedia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video-telephony</td>
<td>128</td>
<td>9</td>
</tr>
<tr>
<td>Video-conference</td>
<td>128</td>
<td>4</td>
</tr>
<tr>
<td>Collaborative working &amp; tele-presence</td>
<td>128</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>37.6</td>
</tr>
<tr>
<td>Narrowband (i.e., low-MBS [10])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISDN Videoconference (Tele-advertising)</td>
<td>384</td>
<td>4</td>
</tr>
<tr>
<td>Data File Transfer (ftp)</td>
<td>384</td>
<td>7</td>
</tr>
<tr>
<td>Desktop Multimedia (Web browsing)</td>
<td>384</td>
<td>15</td>
</tr>
<tr>
<td>Broadband Videotex (E-commerce)</td>
<td>384</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>24.8</td>
</tr>
<tr>
<td>Wideband</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-mailbox for Multimedia</td>
<td>1024</td>
<td>3</td>
</tr>
<tr>
<td>Remote Procedure Call</td>
<td>1024</td>
<td>3</td>
</tr>
<tr>
<td>Mobile Tele-working</td>
<td>1536</td>
<td>7.3</td>
</tr>
<tr>
<td>Assistance in Travel</td>
<td>1536</td>
<td>3.6</td>
</tr>
<tr>
<td>Urban Guidance</td>
<td>1536</td>
<td>1.1</td>
</tr>
<tr>
<td>Mobile Video Surveillance</td>
<td>1536</td>
<td>0.4</td>
</tr>
<tr>
<td>Tourist information</td>
<td>1536</td>
<td>3.6</td>
</tr>
<tr>
<td>E-newspaper</td>
<td>1536</td>
<td>5</td>
</tr>
<tr>
<td>HD Videotelephony (Tele-education)</td>
<td>1920</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>37.6</td>
</tr>
</tbody>
</table>

In order to establish the service class associated with applications, envisaged data rates are introduced for all applications: High Interactive Multimedia (≤128 kb/s), Narrow-, [128, 384] kb/s, and Wideband (> 384 kb/s).

VI. CONCLUSIONS

The available data about target services and applications have been put together enabling some insight into new approaches for performance analysis in E-UMTS. Two different aspects of importance have been identified. On the one hand, different ways of classifying services and applications have been proposed. They distinguish between interactive and distribution services, i.e., between bi-directional and unidirectional ones, widely speaking. On the other, a taxonomy for applications characterisation parameters has been proposed, where the parameters are divided into five different types: service, traffic communications, service components and operation environments. In another level of classification, the types of information allow to set up of the audio, data and video service components. A complete description of the identified services and applications has been presented, and finally some E-UMTS deployment scenarios have been identified. However, one is aware that it is a very initial proposal.

REFERENCES