



## UMTS Networks Architecture Mobility

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**Abstract:** *Rapid advancements in Information and Communications Technology (ICT) have already had a profound impact on life in the 21st century. The growth of knowledgebase societies presents great opportunities and challenges for the social and economic health of all countries. New telecommunications technologies such as UMTS will play a central role in the smooth transition to an Information Society by providing people with fast, unlimited access to information and services at anytime, from anywhere.*

*The Universal Mobile Telecommunication System (UMTS) is a third generation (3G) mobile communications system that provides a range of broadband services to the world of wireless and mobile communications. The UMTS is designed to deliver pictures, graphics, video communications, and other multimedia information, as well as voice and data, to mobile wireless subscribers. UMTS also addresses the growing demand of mobile and Internet applications for new capacity in the overcrowded mobile communications sky. UMTS allows many more applications to be introduced to a worldwide base of users and provides a vital link between today's multiple GSM systems and the ultimate single worldwide standard for all mobile telecommunications, International Mobile Telecommunications-2000 (IMT-2000).*

**Keywords:** *Base station; eco-efficiency, GSM (Global System for Mobile Communication), mobile phone, UMTS (Universal Mobile Telecommunication System), 2G (Second Generation), 3G (Third Generation)*

### I. INTRODUCTION

UMTS is the convergence of mobile communications, Information Technology (IT) and multimedia technologies. UMTS creates new opportunities for network operators, service providers and content providers to generate revenue and seize market share. The benefit of UMTS is richer, more powerful communication.

UMTS is a suite of radio and network technologies that provide:

- better spectrum efficiency,
- high data transmission rates (up to 2 Mbit/s),
- worldwide roaming capability,
- the capability to offer new multimedia applications and services,
- interoperability with both fixed and mobile telecommunications services.

UMTS is the natural evolution from GSM and other second generation (2G) mobile systems. It provides interconnection with 2G networks as well as other terrestrial and satellite-based networks. UMTS presents a unique opportunity to cater to the needs of individuals in the Information Society. As a multi-national, multi-sector system that supports numerous protocols and transport technologies, UMTS eliminates barriers that one posed problems for communications and enables the creation and delivery of fully personalized communication services to both mass market and corporate users.

### II. UMTS STANDARD

UMTS is an International Mobile Telecommunications - 2000 (IMT-2000) 3G system. It is the 3rd generation Partnership Project is developing technical specifications or IMT-2000 and the International Telecommunication Union (ITU) framework for third-generation standards. 3GPP is a global co-operation between six organizational partners including European Telecommunications Standards Institute (ETSI), who are recognized as being the world's major standardization bodies. The 3G standardization environment. The other main IMT-2000 system proposed by the ITU is CDMA 2000. Operators with existing IS-95 networks will migrate to CDMA 2000. CDMA 2000 will be deployed in North America and Asia. CDMA 2000 is a narrowband system whereas UMTS, which uses WCDMA technology, is a wideband system. The first available release of CDMA 2000 does not provide transmission speeds recommended by the IMT-2000. However, the first UMTS release (3GPP Release 99) is on time and guarantees recommended speeds. CDMA 2000 will eventually deliver full IMT-2000 requirements.

### III. GOAL

Goal of the research is to assess the environmental sustainability of the UMTS network, which is currently being built by different telecommunication operators in different countries. In order to do this, a life cycle assessment was carried out. The goal of the LCA is to assess the environmental impacts caused by a call via the UMTS mobile phone system. The

results of the life cycle assessment (LCA) are used to quantify the environmental impact of the use and growth of the total UMTS mobile phone system and its components, thus making an assessment of its environmental impacts possible. All the components of the UMTS like the mobile phones, base stations, antennae and switching systems, and the components of the landline like cable system and switching centers, are assessed. The environmental impacts are assessed taking into account all major life cycle phases like raw material extraction, manufacturing, use, disassembly and disposal of the product and the needed infrastructure. A baseline environmental impact profile across the full life cycle of the GSM (Global System for Mobile Communication) was also done and allows the comparison between the two networks.

#### IV. UMTS 3G ARCHITECTURE

The UMTS 3G architecture is required to provide a greater level of performance to that of the original GSM network. However as many networks had migrated through the use of GPRS and EDGE, they already had the ability to carry data. Accordingly many of the elements required for the WCDMA / UMTS network architecture were seen as a migration. This considerably reduced the cost of implementing the UMTS network as many elements were in place or needed upgrading. With one of the major aims of UMTS being to be able to carry data, the UMTS network architecture was designed to enable a considerable improvement in data performance over that provided for GSM.

The UMTS network architecture can be divided into three main elements:

1. **User Equipment (UE):** The User Equipment or UE is the name given to what was previous termed the mobile, or cell phone. The new name was chosen because the considerably greater functionality that the UE could have. It could also be anything between a mobile phone used for talking to a data terminal attached to a computer with no voice capability.
2. **Radio Network Subsystem (RNS):** The RNS also known as the UMTS Radio Access Network, UTRAN, is the equivalent of the previous Base Station Subsystem or BSS in GSM. It provides and manages the air interface for the overall network.
3. **Core Network:** The core network provides all the central processing and management for the system. It is the equivalent of the GSM Network Switching Subsystem or NSS.

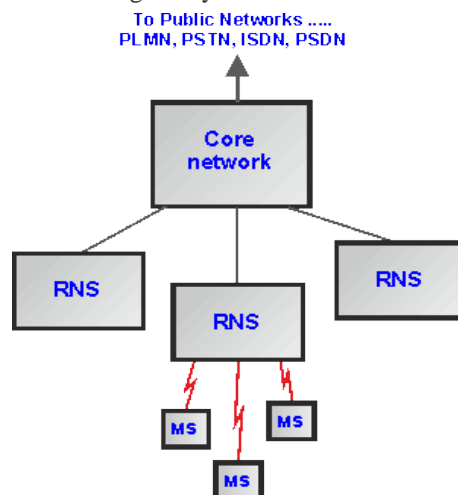


Fig. 1 UMTS Network Architecture Overview

#### V. USER EQUIPMENT

The USER Equipment or UE is a major element of the overall 3G UMTS network architecture. It forms the final interface with the user. In view of the far greater number of applications and facilities that it can perform, the decision was made to call it a user equipment rather than a mobile. However it is essentially the handset (in the broadest terminology), although having access to much higher speed data communications, it can be much more versatile, containing many more applications. It consists of a variety of different elements including RF circuitry, processing, antenna, battery, etc.

There are a number of elements within the UE that can be described separately:

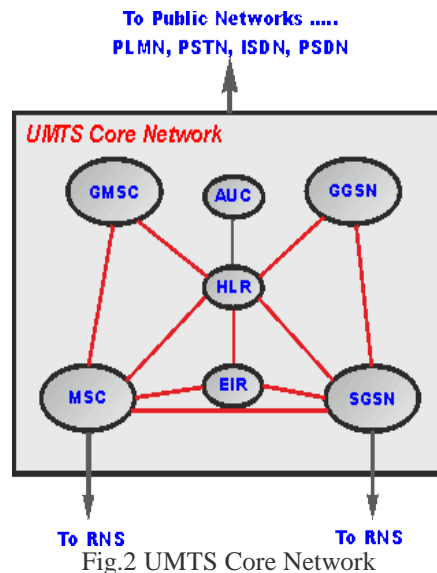
- **UE RF circuitry:** The RF areas handle all elements of the signal, both for the receiver and for the transmitter. One of the major challenges for the RF power amplifier was to reduce the power consumption. Accordingly to maintain battery life, measures were introduced into many of the designs to ensure the optimum efficiency.
- **Baseband processing:** The base-band signal processing consists mainly of digital circuitry. This is considerably more complicated than that used in phones for previous generations. Again this has been optimized to reduce the current consumption as far as possible.
- **Battery:** While current consumption has been minimized as far as possible within the circuitry of the phone, there has been an increase in current drain on the battery. With users expecting the same lifetime between charging batteries as experienced on the previous generation phones, this has necessitated the use of new and improved battery technology. Now Lithium Ion (Li-ion) batteries are used. These phones to remain small and relatively light while still retaining or even improving the overall life between charges.

- **Universal Subscriber Identity Module, USIM:** The UE also contains a SIM card, although in the case of UMTS it is termed a USIM (Universal Subscriber Identity Module). This is a more advanced version of the SIM card used in GSM and other systems, but embodies the same types of information. It contains the International Mobile Subscriber Identity number (IMSI) as well as the Mobile Station International ISDN Number (MSISDN).

## VI. 3G UMTS CORE NETWORK

The 3G UMTS core network architecture is a migration of that used for GSM with further elements overlaid to enable the additional functionality demanded by UMTS. In view of the different ways in which data may be carried, the UMTS core network may be split into two different areas:

Some network elements, particularly those that are associated with registration are shared by both domains and operate in the same way that they did with GSM.



- **Circuit switched elements:** These elements are primarily based on the GSM network entities and carry data in a circuit switched manner, i.e. a permanent channel for the duration of the call. The circuit switched elements of the UMTS core network architecture include the following network entities:
  - **Mobile switching centre (MSC):** This is essentially the same as that within GSM, and it manages the circuit switched calls under way.
  - **Gateway MSC (GMSC):** This is effectively the interface to the external networks.
- **Packet switched elements:** These network entities are designed to carry packet data. This enables much higher network usage as the capacity can be shared and data is carried as packets which are routed according to their destination. The packet switched elements of the 3G UMTS core network architecture include the following network entities:
  - **Serving GPRS Support Node (SGSN):** The SGSN provides a number of functions within the UMTS network architecture.
    - ✓ **Mobility management:** When a UE attaches to the Packet Switched domain of the UMTS Core Network, the SGSN generates MM information based on the mobile's current location.
    - ✓ **Session management:** The SGSN manages the data sessions providing the required quality of service and also managing what are termed the PDP (Packet data Protocol) contexts, i.e. the pipes over which the data is sent.
    - ✓ **Interaction with other areas of the network:** The SGSN is able to manage its elements within the network only by communicating with other areas of the network, e.g. MSC and other circuit switched areas.
    - ✓ **Billing:** The SGSN is also responsible billing. It achieves this by monitoring the flow of user data across the GPRS network. CDRs (Call Detail Records) are generated by the SGSN before being transferred to the charging entities (Charging Gateway Function, CGF).
  - **Gateway GPRS Support Node (GGSN):** Like the SGSN, this entity was also first introduced into the GPRS network. The Gateway GPRS Support Node (GGSN) is the central element within the UMTS packet switched network. It handles inter-working between the UMTS packet switched network and external packet switched networks.
  - **Home location register (HLR):** This database contains all the administrative information about each subscriber along with their last known location. In this way, the UMTS network is able to route calls to the relevant RNC / Node B.

- **Equipment identity register (EIR):** The EIR is the entity that decides whether a given UE equipment may be allowed onto the network. Each UE equipment has a number known as the International Mobile Equipment Identity.
- **Authentication centre (AuC) :** The AuC is a protected database that contains the secret key also contained in the user's USIM card.

## VII. RESULTS OF UMTS NETWORK EXPENDITURES

**Cumulative expenditures and emissions.** Table 5 shows selected cumulative resource expenditures and emissions of data transfer in the UMTS network for the two options of mobile phone to mobile phone and mobile phone to fixed network. The cumulative resource expenditures, on the one hand, provide information on the materials used (e.g. copper, which is mainly used in cables) and, on the other hand, on the need for primary energy carriers (e.g. uranium for nuclear power plants). The air emissions are partly due to processes and partly originate from energy generation. The CO<sub>2</sub> emissions are caused by the electricity demand, the use of plastics and from the fossil energy consumption.

Table 1: Selected cumulative resource expenditures and emissions of data transfer in the UMTS network

	Unit	Mobile phone to mobile phone, UMTS network	Mobile phone to fixed network, UMTS network
		Gbit	Gbit
<b>Resources</b>			
Copper	kg	0.07	0.12
Brown coal	kg	4.90	3.42
Hard coal	kg	4.94	3.96
Crude oil	kg	2.92	2.77
Uranium	kg	1.01E-03	7.65E-04
Natural gas	Nm <sup>3</sup>	1.32	1.13
Water	kg	3 880	2 320
<b>Emissions to air</b>			
NH <sub>3</sub>	kg	1.08E-04	8.20E-05
CH <sub>4</sub>	kg	0.05	0.04
CO <sub>2</sub>	kg	24.7	20.1
HCl	kg	0.003	0.002
NM VOC	kg	0.03	0.03
NO <sub>x</sub>	kg	0.06	0.05
SO <sub>x</sub>	kg	0.13	0.11
<b>Emissions to water</b>			
COD	kg	0.09	0.09
Sulfate	kg	1.37E-01	1.02E-01

## VIII. COMPARISON OF GSM AND UMTS

GSM is an abbreviation of Global System for Mobile communication, originally it is known as Group Special Mobile. It is mobile telephony system that sets the standards on how mobile telecommunications work. It encompasses everything in reference to mobile communications. However, in this context of comparing GSM and UMTS, we will refer to GSM as a service or technology. GSM is a second generation (2G) telecommunications technology which is launched early in the 90s. Today, in a global scale, GSM is still widely used mobile service. There are about 700 mobile networks that provide GSM services across more than 200 countries. Statistically, more than 80 percent of all global mobile connections are GSM.

UMTS is the third generation (3G) of mobile telecommunications technology. It is the latest commercially available technology that mobile phones, PDAs, and smart phones are using today. With this development, internet access (email and web browsing), video calling and messaging, and text messaging (SMS) are now possible along with traditional phone tasks. Imagine yourself traveling the world and still able to email, video conference, and watch streaming videos using your smart phone. Currently, it can offer transfer speeds of about 3.6 Mbits per second and even more, which can make data transfer seamless and downloads relatively fast. Unlike GSM, UMTS is mainly based on CDMA (Code Division Multiple Access) scheme and now combines it with TDMA. However, UMTS is still new as there are only a few areas and networks that support the technology. Even with countries that support it may have set different spectrum, thus interoperability does not work fully when moving from one nation to another nation with drastically different spectrum.

## IX. CONCLUSION

The demand for mobile communication services is globally on the rise. Mobile phone networks are being built rapidly and are mainly steered by economical and legislative drivers. Environmental aspects are mainly incorporated only for singular aspects like non-ionizing radiation of antennae and mobile phones, or the energy use of switching centers. A complete picture of the different environmental impacts of the UMTS. UMTS services are highly portable—they have been designed to roam easily. In addition, almost all UMTS services are UMTS/GSM dual-mode devices, so if a UMTS phone travels outside of UMTS coverage during a call the call may be transparently handed off to available GSM coverage. UMTS networks initially required a higher base station density. As UMTS gains in credibility and functionality, experts believe it will overtake GSM as the industry standard. UMTS is already able to operate at a higher frequency than GSM.

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