# SATELLITE COMPONENT OF 3. MOBILE COMMUNICATIONS GENERATION

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## I. Introduction

The current second generation digital mobile communications standards were developed primarily for narrowband voice services in highly populated areas almost 20 years ago. One mobile base station with its typical cell structure is capable of serving customers in a geographic area of 20 sqkm depending on the frequency used, the topographie of the service area and the number of customers served. In order to achieve universal service in one country, a mobile network operator must therefore install thousands of mobile base stations amounting to a multi-billion investments. Even in countries with a mobile penetration rate of 60%, like Finland, the mobile network operators never intended to reach 100% service coverage of the physical landscape. After ten years of experience with the second mobile generation, the mobile network operators expressed two additional needs for the third mobile generation: (i) higher data transmission rate since voice transmission is reaching its peak whereas data transmission over mobile networks is still increasing with double digit rates for the years to come, (ii) for lower density areas, the expensive mobile base station structure must be replaced by a mobile satellite component.

When the satellite community started to design global satellite networks in the mid-80ies, less than 1% of the population even in the

industrialized countries were using mobile phones. They intended to create a true universal mobile network, capable to serve everyone, everywhere on the globe with voice services. But, when ten years later Iridium launched its service, the terrestrial mobile networks had already tapped this hugh potential customer base and many European countries are hitting mobile penetration rates of more than 50%. Customers today want to use primarily their mobile handset and ask for satellite gateways provided by their mobile network operators in case they are cruising off-shore, or are travelling in remote areas. But, they are not interested to pay for a second handset and additional monthly service charges.

As a result, the International Telecommunications Union (ITU) and the regional standardization institutes, like ETSI in Europe, ARIM in Japan and ANSI in the Untied States started in the early 1990ies to work on the third mobile communications standard - International Mobile Communications – 2000 (IMT-2000)- referring not only to the date, but also to the frequency band allocated, 2 GHz with full broadband mobile multimedia capabilities and a satellite component. Among the countries in the European Union, Germany, Finland, the United Kingdom, and the Netherlands have opted for an early introduction of the third mobile generation. Outside Europe, Japan is a forerunner for all of Asia, whereas it is not expected that the U.S. will decide on an early, large-scale introduction of IMT-2000.

## II. Innovations of the Third Mobile Generation

### 1. Universal Personal Telecommunications

The free choice of terminal equipment and access technology in IMT-2000 is called Universal Personal Telecommunications (UPT). Apart from mobile telephones, in particular fixed network telephone equipment, networked computers and laptop computers, fax machines, car navigation systems, and PDA can be used as IMT-2000 terminal equipment. In addition to mobile radio, also data lines, fixed networks, cable TV, and broadcasting technologies can serve as access technology for IMT-2000.

### 2. Virtual Home Environment

The main objective of IMT-2000 is not the standardization of a network technology but rather building the platform for the Virtual Home Environment (VHE) with a wide- and narrowband IMT-2000 service portfolio tailored by the subscriber. A subscriber has access to his VHE, similar to a personalized home page on the Internet today, regardless of his respective location (at home, in the office, on the road), his terminal equipment (mobile, wireless, wireline), the access technology used. The VHE can be stored on the respective smartcard or in a centralized database of the service provider from where it can be retrieved at any time. The existing

mailbox services and the pager-type short message service of the second generation networks will be further enhanced to wideband services and may also include music and high-resolution pictures and graphics. The integration of Digital Audio Broadcasting (DAB) and Digital Video Broadcasting (DVB) into IMT-2000 is also currently being considered.

### 3. Extended Roaming and New Interconnections Modalities

In IMT-2000, roaming between different networks is supplemented by an upward and downward compatibility with the second generation mobile radio networks. An IMT-2000 user shall thus also be able to use a minimum offer of third generation services, such as Internet access in a second generation network of a different provider. A second generation user shall also have access to certain advanced services when using the third generation network of a different network operator. As a consequence of the free choice of access technology, technical and legal hurdles must be overcome before interconnection of different networks becomes a reality.

### 4. User Service Identity Module

As a rule, third generation handsets will contain a personalized integrated smartcard (subscriber identity module-SIM) as widely used in second generation TDMA-networks for authentication purposes. This is because not only network operators should be protected against unauthorized users but also users against unauthorized access to their user data by unauthorized third parties. In addition to the personal identification number (PIN), the various standardization institutes are currently also considering biometric access controls such as fingerprints and personal voice recognition. The former SIM card in this context is called User Service Identity Module (USIM). The ITU recommends all current second-generation mobile radio systems which do not use a smartcards yet, to introduce such smartcard in order to facilitate the transition to IMT-2000. Handsets will be capable to read more than one smartcard at a time so that a user will be able to receive services from different service providers via one network, simultaneously. In addition, each smartcard can hold additional data and further applications such as a common address book, encryption algorithms, or an "open purse". Java Applets, for instance, will make it possible for users to constantly change and update applications on a USIM online.

### 5. Extended Value Chain

In addition to network operators, value-added service providers and content providers will offer new wideband and narrowband services to the user. Comparable to the Internet, the network operator provides other service providers with a technical platform for the provision of services. The range of IMT-2000 services includes POTS, ISDN and

wideband services (up to 2 Mbps) and facilitates any combination of these services. The lack of safety often criticized in online banking transactions made via the Internet is remedied in the IMT-2000 context by issuing customer smartcards with e.g. bank-specific encryption algorithms, since several smartcards can be used simultaneously when accessing IT-2000 networks.

### 6. Extended Billing Possibilities

Billing of IMT-2000 services can be made depending on duration, distance, volume, quality, location, use of bandwidths (transmitted bits), or desired services. Billing can also be provided immediately after services have been used, at regular time intervals, or whenever a certain amount is reached. It will also be possible to use prepaid cards, or credit cards, and similar to the Internet free services might also be offered against for transmission of commercials and similar alternative modes of payment.

### 7. Extended Numbering

Service numbers can be organized according to a global, national, or regional scheme. Number portability will be guaranteed even if changing to a different service provider, provided that the new service provider offers its services in the same region. Service providers will also be able to change the network operator while keeping their assigned numbering blocks. Separate prefixes for the individual network operators as currently used in countries like Germany are no longer considered. Services can either be accessed by dialing numbers which is common practice in the current telephone network or, as in the Internet, via Protocol Headers. It will also possible for subscribers to establish private numbering plans (PNP) in order to set up corporate networks or virtual networks between friends and family members. Users included in such PNP can be called via numbers, short codes, voice instruction, or dialing the respective user's name.

## III. Satellite Component

### 1. Technical Standardization

The satellite mobile component of IMT-2000 is using the 1980-2010 MHz frequency spectrum for the up-link and 2170-2200 MHz spectrum for the down-link as identified by the World Administrative Radio Conference 1992 in Malaga-Torremolinos. Satellite frequencies are part of, or are located adjacent to terrestrial frequency bands (1885-2025 MHz and 2110-2200 MHz) and thus require only minimal modification in services and user terminals. GEO, LEO, and MEO systems are equally admitted as satellite component of the third mobile generation.

### 2. Service Capabilities

Compatibility of services is ensured within the IMT-2000 family, the usage of small pocket-terminal with worldwide roaming capabilities

foresees six different handover scenarios providing the same services in the terrestrial and in the satellite environment. (1. handover the service link, 2. handover the feeder link, 3. handover the feeder link and the service link, 4. handover from satellite to satellite, 5. handover from satellite to terrestrial component, 6. handover from the terrestrial to the satellite component). IMT-2000 supports roaming between the terrestrial and satellite components without specific request from the user. The user preferences with respect to the use of the satellite or terrestrial component is part of the subscription agreement. In order to facilitate roaming, the users can be reached by dialling a single telephone number, regardless of whether the mobile terminal is accessing the terrestrial or the satellite component at the time. Even though high bit rates for the satellite component are possible, the majority of terminals and services will have low bit rates around 64 kbit/s. IMT-2000 include four different two-way service configurations: (i) service directly to/from a mobile earth station (MES), (ii) service directly to/from a personal earth station (PES = handset), (iii) service to/from users connected by a local exchange via an MES, and (iv) service indirectly to/from a personal station communicating via an MES. The ITU numbering plan for S-PCS foresees so far the country code 881 to be shared amongst the S-PCS network operator, whereas INMARSAT is using the country code 87 for its services.

## 3. Potential Network Operators

Consortia like Globalstar GS-2, Macrocell, Horizon, Constellation and ICO Global Communications are currently actively evaluating business opportunities as IMT-2000 satellite operators in competition with the currently existing mobile satellite operators Iridium, Globalstar, Inmarsat-P since the massive potential IMT-2000 user base is a lucrative market.

| System | Satellites | Frequency | Bitrate | Status |
|---|---|---|---|---|
| GS-2 | 60 LEOs | 2 GHz | < 144kb/s | FCC appl. pending |
| Macrocell | 96 LEO | 2 GHz | 64 kb/s | FCC appl. pending |
| Horizon | 3 GEO | 2 GHz | 144 kb/s | FCC appl. pending |
| Constellation | 46 | 2 GHz | 28.8 kb/s | FCC appl. pending |

(See Erich Lutz, neue Satellitennetze, -dienste und –technologien, in: Handbuch der Telekommunikation, Hrsg. Franz Arnold)

## 4. Licensing Regime

Already in 1997 and independent from the discussions about the introduction of the third mobile generation, the European Union

adopted a Decision 710/97, O.J. L 105 as of April 23, 1997 regarding the co-ordinated licensing of satellite-based personal communication systems (S-PCS) in the European Union, which applies as well for IMT-2000 network operators. Traditionally, different telecommunications licenses are required for satellite and mobile network operator, while S-PCS network operators offer converged mobile and satellite services and receive one combined license. A S-PCS license will be granted for the entire satellite network, including the earth segment, the satellites, the up- and down-link. Within Europe, CEPT (European Conference of Postal and Telecommunications Administrations) is in charge with frequency allocation. According to the decision CEPT/ECTRA/DEC (97) 02, S-PCS licenses contain a milestone plan in order to monitor the exploitation of the frequencies in the most efficient way. The Milestone Review Committee will issue recommendations to the national regulatory authorities. The European Union member states will co-ordinate their licensing regimes according to the European Licensing Directive 97/13/EC O.J. L 117/15 in order to facilitate the European-wide introduction of S-PCS network operators. The idea is, that the network operators receive one license during a national licensing proceeding. From the beginning of this proceeding, the other national regulatory authorities will be notified about the status of the proceeding under the supervision of an EU-committee. The other regulatory authorities can comment on the license application and request certain obligations. The European Union adopted an extensive list of conditions for S-PCS network operators, including universal service obligations, interconnection duties, data protection obligations, publication of service charges, prior approval of subscriber agreements by regulatory authorities. After the first license has been granted by one regulatory authority, the other regulatory authorities extent the license to their country.

The Federal Communications Commission in the United States has licensed the first non-IMT-2000 PCS satellite operators, like Iridium, Globalstar and Odyssey.