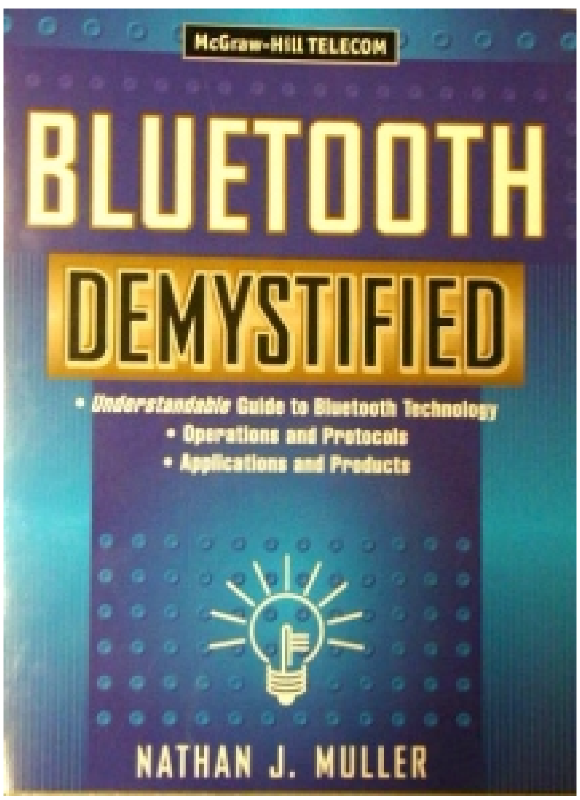
FURTHER READING

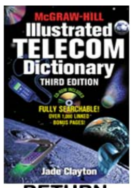
As a preview for further reading, the following reference has been provided from the pages of the book below:

Title: Bluetooth Demystified
Author: Nathan J. Muller
Publisher: McGraw-Hill

ISBN: 0071363238



Global 3G Initiative



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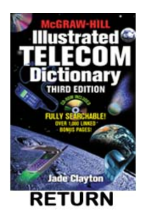
As noted, IMT-2000 will result in wireless access to the global telecommunication infrastructure through both satellite and terrestrial systems, serving fixed and mobile users in public and private networks. This initiative is being developed as a “family of systems” framework, defined as a federation of systems providing advanced service capabilities in a global roaming offering. The initiative aims to facilitate the evolution from today’s national and regional 2G systems that are incompatible with one another towards 3G systems that will provide users with genuine global service capabilities and interoperability. The role of the ITU is to provide direction to and coordinate the many related technological developments in this area to assist the convergence of competing national and regional wireless access technologies. Toward these ends, the ITU considered over a dozen national and regional proposals in an effort to select the key characteristics of the IMT-2000 set of radio interfaces.

Standards Development

In 1992, the World Radio Conference (WRC) identified the frequency bands 1885-2025 MHz and 2110-2200 MHz for future IMT-2000 systems. Of these, the bands 1980-2010 MHz and 2170-2200 MHz were intended for the satellite part of these future systems. With the agreement on frequency bands, along with other important standards in place, work at the ITU focused next on selecting the all-important air interface technology for the system, known as the radio transmission technology (RTT). The need for additional spectrum to cope with the increasing amount of broadband and increasingly interactive traffic of third-generation systems will be addressed at the World Radio Conference in 2000.

For the radio interface technology, the ITU considered 15 submissions from organizations and regional bodies around the world. These proposals were examined by special independent evaluation groups, which submitted their final evaluation reports to the ITU in September 1998. The final selection of key characteristics for the IMT-2000 radio interfaces occurred in March 1999. This led to the development of more detailed ITU specifications for IMT-2000.

The decision of the ITU was to provide essentially a single flexible standard with a choice of multiple-access methods, which include



CDMA, TDMA, and combined TDMA/CDMA—all potentially in combination with Space Division Multiple Access—to meet the many different mobile operational environments around the world. Although second-generation mobile systems involve both TDMA and CDMA technologies, very little use is currently being made of SDMA. However, the ITU expects the advent of adaptive antenna technology linked to systems designed to optimize performance in the space dimension to significantly enhance the performance of future systems.

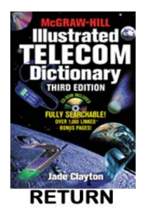
The IMT-2000 key characteristics are organized, for both the terrestrial and satellite components, into the RF part (front end), where impacts are primarily on the hardware part of the mobile terminal, and the baseband part, which is largely defined in software. In addition to RF and baseband, the satellite key characteristics also cover the architecture and system aspects. According to the ITU, the use of common components for the RF part of the terminals, together with flexible capabilities which are primarily software defined in baseband processing, should provide the mobile terminal functionality to cover the various radio interfaces needed in the twenty-first century as well as provide economies of scale in their production.

The ITU noted that there are already many multi-mode/multi-band mobile units appearing on the market to meet the evolution needs of today's systems and soon there should be negligible impact in areas such as power consumption, size, or cost due to the flexibility defined within the IMT-2000 standard.

The key characteristics of the radio transmission technology by themselves do not constitute an implementable specification but establish the major features and design parameters that will make it possible to develop the detailed specifications.

However, due to the constraints on satellite system design and deployment and because it was felt that little was to be gained at this time from harmonizing any of the satellite proposals, since they were already global, several satellite radio interfaces were included in the March 1999 agreement. Commonalities among elements of the satellite and terrestrial radio interfaces were sought and terrestrial/satellite commonality can be expected to increase further when the second phase of the IMT-2000 satellite component is ready for introduction.

The flexible approach to IMT-2000 implementation provides choice among multiple access methods within a single standard that will address the needs of the worldwide wireless community. Specifically, this approach allows operators to select those radio interfaces that will best address their specific regulatory, financial, and customer needs, while minimizing the impact of this flexibility on end-users.



Goals of IMT-2000

Under the IMT-2000 model, mobile telephony will no longer be based on a range of market-specific products, but will be founded on common standardized flexible platforms, which will meet the basic needs of major public, private, fixed, and mobile markets around the world. This approach should result in a longer product life cycle for core network and transmission components, and offer increased flexibility and cost effectiveness for network operators, service providers, and manufacturers.

In developing the family of systems that would be capable of meeting the future communications demands of mobile users, the architects of IMT-2000 identified several key issues to be addressed to ensure the success of the third generation of mobile systems.

HIGH SPEED

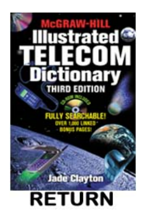
Any new system must be able to support high-speed broadband services, such as fast Internet access or multimedia-type applications. Demand for such services is already growing fast and—by some industry projections—the market for broadband services could be worth up to $10 billion by 2010. Users will expect to be able to access their favorite services just as easily from their mobile equipment as they can from their wireline equipment.

FLEXIBILITY

The next generation of integrated systems must be as flexible as possible, supporting new kinds of services such as universal personal numbering and satellite telephony, while providing for seamless roaming to and from IMT-2000-compatible terrestrial wireless networks. These and other features will greatly extend the reach of mobile systems, benefiting consumers and operators alike.

AFFORDABILITY

The system must be as affordable as today's mobile communications services, if not more so. The ITU recognizes that the economies of scale achievable with a single global standard would have the benefit of driving down the price to users. While important for all con-



sumers, affordability is vital to extending the penetration of telephony in developing countries. For third-generation equipment to be taken up quickly by consumers, it must deliver at least the same or better service than current systems, and it must be cheap. Even though economies of scale will inevitably bring prices down once sufficient volumes are achieved, if the systems are more expensive and do not initially offer much greater functionality, consumers will not buy.

COMPATIBILITY

Any new-generation system has to offer an effective evolutionary path for existing networks. While the advent of digital systems in the late 1980s and early 1990s often prompted the shutting down of first-generation analog networks, the enormous investments which have been made in developing the world's second-generation cellular networks over the last decade makes a similar scenario for adoption of third-generation systems completely untenable.

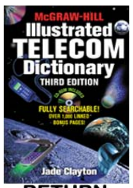
DIFFERENTIATION

In coordinating the design of the IMT-2000 framework, the ITU is also aware of the need to preserve a competitive domain for manufacturers in order to foster incentive and stimulate innovation—mindful that industrial organizations need to have the freedom to compete when it comes to technology. Accordingly, the aim of IMT-2000 standards is not to stifle the evolution of better technologies or innovative approaches, but to accommodate them.

Universal Mobile Telecommunications System

One of the major new 3G mobile systems being developed within the IMT-2000 framework is the Universal Mobile Telecommunications System (UMTS), which has been standardized by the European Telecommunications Standards Institute (ETSI). UMTS makes use of UTRA (UMTS Terrestrial Radio Access) as the basis for a global terrestrial radio access network. Europe and Japan are implementing UTRA in the paired bands 1920-1980 MHz and 2110-2170 MHz. Europe has also decided to implement UTRA in the unpaired bands 1900-1920 MHz and 2010-2025 MHz.

UMTS combines key elements of TDMA—about 80 percent of today's digital mobile market is TDMA-based—and CDMA technolo-



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gies with an integrated satellite component to deliver wideband multimedia capabilities over mobile communications networks. The transmission rate capability of UTRA will provide at least 144 Kbps for full-mobility applications in all environments, 384 Kbps for limited-mobility applications in the macro and micro cellular environments, and 2.048 Mbps for low-mobility applications particularly in the micro- and pico-cellular environments. The 2.048-Mbps rate may also be available for short-range or packet applications in the macro cellular environment.

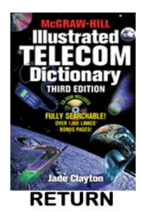
Because the UMTS incorporates the best elements of TDMA and CDMA, this 3G system provides a glimpse of how future wireless networks will be deployed and what possible services might be offered within the IMT-2000 family of systems.

UMTS OBJECTIVES

UMTS makes possible a wide variety of mobile services ranging from messaging to speech, data, and video communications, Internet and intranet access, and high bit-rate communication up to 2 Mbps. As such, UMTS is expected to take mobile communications well beyond the current range of wireline and wireless telephony, providing a platform that will be ready for implementation and operation in 2002.

UMTS is intended to provide globally available, personalized, and high-quality mobile communication services. Its design objectives include:

- Integration of residential, office, and cellular services into a single system, requiring one user terminal.
- Speech and service quality at least comparable to current fixed networks.
- Service capability up to multimedia.
- Separation of service provisioning and network operation.
- Number portability independent of network or service provider.
- The capacity and capability to serve over 50 percent of the population.
- Seamless and global radio coverage and radio bearer capabilities up to 144 Kbps and further to 2 Mbps.
- Radio resource flexibility to allow for competition within a frequency band.



DESCRIPTION

UMTS separates the roles of service provider, network operator, subscriber, and user. This separation of roles makes possible innovative new services, without requiring additional network investment from service providers. Each UMTS user has a unique network-independent identification number and several users and terminals can be associated with the same subscription. This enables one subscription and bill per household to include all members of the family as users with their own terminals. This would give children access to various communication services under their parents' account. This application would also be attractive for businesses, which require cost-efficient system operation—from subscriber/user management down to radio system—as well as adequate subscriber control over the user services.

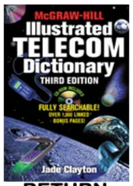
UMTS supports the creation of a flexible service rather than standardizing the implementations of services in detail. The provision of services is left to service providers and network operators to decide, according to the market demand. The subscriber—or the user when authorized by the subscriber—selects services into individual user service profiles, either with the subscription or interactively with the terminal.

UMTS supports its services with networking, broadcasting, directory, localization, and other system facilities, giving UMTS a clear competitive edge over mobile speech and restricted data services of earlier-generation networks. Being adept at providing new services, UMTS is also competitive in the cost of speech services and as a platform for new applications.

UMTS offers a high-quality radio connection capable of supporting several alternative speech codecs at 2 Kbps to 64 Kbps, as well as image, video, and data codecs. Also supported are advanced data protocols covering a large portion of Integrated Services Digital Network (ISDN) offerings. The concept includes variable and high bit rates up to 2 Mbps.

FUNCTIONAL MODEL

The UMTS functional model relies on distributed databases and processing, leaving room for service innovations without the need to alter implemented UMTS networks or existing UMTS terminals. This service-oriented model provides three main functions: management and operation of services, mobility and connection control, and network management.



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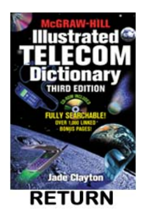
- **Management and Operation of Services**—A service data function (SDF) handles storage and access to service related data. A service control function (SCF) contains overall service and mobility control logic and service related data processing. A service switching function (SSF) invokes service logic—to request routing information, for example. A call control function (CCF) analyzes and processes service requests in addition to establishing, maintaining, and releasing calls.
- **Mobility and Connection Control**—Drawing on the contents of distributed databases, UMTS provides for the real-time matching of user service profiles to the available network services, radio capabilities, and terminal functions. This function will handle mobile subscriber registration, authentication, location updating, handoffs, and call routing to a roaming subscriber.
- **Network Management**—Under UMTS, the administration and processing of subscriber data, maintenance of the network, and charging, billing, and traffic statistics will remain within the traditional Telecommunications Management Network (TMN).

TMN consists of a series of interrelated national and international standards and agreements, which provide for the surveillance and control of telecommunications service provider networks on a worldwide scale. The result is the ability to achieve higher service quality, reduced costs, and faster product integration. TMN is also applicable in wireless communications, cable television networks, private overlay networks, and other large-scale, high-bandwidth communications networks. With regard to UTMS (and other 3G wireless networks) TMN will be enhanced to accommodate new requirements. In areas such as service profile management, routing, radio resource management between UMTS services, networks, and terminal capabilities, new TMN elements will be developed.

BEARER SERVICES

Under UMTS, four kinds of bearer services will be provided to support virtually any current and future application:

- **Class A**—This bearer service offers constant bit-rate (CBR) connections for isochronous (real-time) speech transmission. It provides a steady supply of bandwidth to ensure the highest quality speech.
- **Class B**—This bearer service offers variable bit-rate connections, which are suited for bursty traffic, such as transaction processing applications.



- **Class C**—This bearer service is a connection-oriented packet protocol, which can be used to support time-sensitive legacy data applications such as those based on IBM's SNA (Systems Network Architecture).
- **Class D**—This is a connectionless packet bearer service suitable for accessing data on the public Internet or private intranets.

TECHNOLOGY APPROACHES

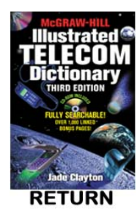
In developing the UMTS standard, there had been ongoing disagreement within the UMTS Forum about whether to use TD-CDMA (Time Division) or W-CDMA (Wideband) for the radio interface portion of the network.

TD-CDMA uses CDMA signal-spreading techniques to enhance the capacity offered by conventional TDMA technology. Digitized voice and data would be transmitted on a 1.6 MHz-wide channel using time-segmented TDMA technology. Each time slot of the TDMA channel would be individually coded using CDMA technology, thus supporting multiple users per time slot. The proposal establishes an economical and smooth network migration for existing GSM customers to the next-generation cellular standard. At the same time, the TD-CDMA solution allows CDMA technology to be integrated into the TDMA-based GSM structure worldwide, enabling GSM operators to compete for wideband multimedia services, while protecting their current and future investments.

W-CDMA, on the other hand, not only has the advantage of providing high capacity, but is the most widely deployed cellular technology. Proponents of W-CDMA had insisted that this be the air interface standard for UMTS. In January 1998, members of the UMTS Forum, which coordinates standards development, agreed to combine key elements of both TD-CDMA and W-CDMA cellular technologies into a unified solution, called UTRA. In the paired band (FDD—Frequency Division Duplex) of UMTS, the system adopts the radio access technique advocated by the W-CDMA group. In the unpaired band (TDD—Time Division Duplex) the UMTS system adopts the radio access technique advocated by the TD-CDMA group. UTRA offers a competitive continuation for GSM evolution to UMTS and will position UMTS as a leading member of the IMT-2000 family of systems.

APPLICATIONS

UMTS will comprise a new air interface and new radio components. The aim is to combine these in a modular way with new network



components and components from pre-UMTS fixed and mobile networks. This approach will allow new entrants to establish UMTS networks and afford existing operators a smooth migration by reusing parts of their existing infrastructure to the extent possible.

For the user, UMTS will provide adaptive multimode/multi-band terminals or terminals with a flexible air interface to enable global roaming across locations and with second generation systems. Software download to terminals may offer additional flexibility.

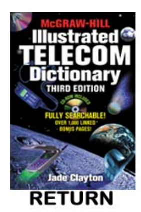
By harnessing the best in cellular, terrestrial, and satellite wideband technology, UMTS will guarantee access, from simple voice telephony to high-speed, high-quality multimedia services. It will deliver information directly to users and provide them with access to new and innovative services and applications. It will offer mobile personalized communications to the mass market regardless of location, network, or terminal used.

U.S. Participation in 3G

United States proposals submitted to the ITU for consideration as the RTT in the IMT-2000 framework included wideband versions of CDMA of which there are three competing standards in North America: wideband cdmaOne, WIMS W-CDMA, and WCDMA/NA. All three have been developed from second-generation digital wireless technologies, and are evolving to third-generation technologies that will best fit their networks. However, early on, WIMS W-CDMA and WCDMA/NA were merged into a single proposed standard and, along with wideband cdmaOne, submitted to the ITU for inclusion into its IMT-2000 family of systems concept for globally interconnected and interoperable 3G networks. A proposal for a TDMA solution for the RTT was also submitted by the Universal Wireless Communications Consortium (UWCC) in the United States.

CDMA Proposals

As noted, initially there were three competing WCDMA standards in North America: wideband cdmaOne, WIMS (Wireless Multimedia and Messaging Services) W-CDMA, and W-CDMA/NA (W-CDMA North America). Most wireless operators have chosen one of these in build-



ing out and enhancing their networks. Competition between these three viable standards has brought innovation in technologies, features, and services, as well as lowered prices.

Wideband cdmaOne technology was submitted to the ITU by the CDMA Development Group (CDG) as cdmaOne-2000. The WIMS W-CDMA technology was submitted to the ITU by AT&T Wireless, Hughes Network Systems, and InterDigital Communications Corporation, among others. The North American GSM Alliance, a group of 12 U.S. and one Canadian digital wireless PCS carriers, submitted the WCDMA/NA technology to the ITU.

There had been talk of combining all these technologies into a single, unified ITU submission. However, only the W-CDMA/NA and WIMS W-CDMA proposals were merged into what was referred to as the enhanced W-CDMA/NA proposal. This aligned proposal offers enhanced data capabilities, such as enabling packet data to be delivered to up to ten times as many users.

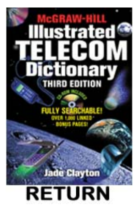
Supporters of the enhanced W-CDMA/NA, however, declined to unify their proposal with wideband cdmaOne, claiming that the necessary changes would have caused a significant degradation in system capacity and performance, affected additional capabilities, and probably raised the price of services to customers.

WIDEBAND cdmaONE

Under the proposed standard of the CDMA Development Group (CDG), wideband cdmaOne will use a CDMA air interface based on the existing TIA/EIA-95-B standard to provide wireline quality voice service and high-speed data services, ranging from 144 Kbps for mobile users to 2 Mbps for stationary users. It will fully support both packet- and circuit-switched communications such as Internet browsing and landline telephone services, respectively.

Support for wideband cdmaOne is not limited to North America. It is found among major wireless carriers in Japan. Korean carriers and manufacturers have also contributed to the development of wideband cdmaOne.

Advanced services require more capacity, robustness, and flexibility than narrowband technologies can provide. Accordingly, CDG and its members have completed work on a specification for a 64-Kbps data rate service. The 64-Kbps data capability will provide high speed Internet access in a mobile environment, a capability that cannot be matched by other narrowband digital technologies, including second-generation CDMA.



The CDG believes that mobile data rates of up to 144 Kbps and fixed peak rates beyond 1.5 Mbps are possible without degrading the system's voice-transmission capabilities or requiring additional spectrum. In other words, cdmaOne is expected to double capacity and provide a 1.5-Mbps data rate capability—all within the existing 1.25 MHz channel structure. At the same time, cdmaOne supports existing second-generation CDMA-based services, including speech coders, packet data services, circuit data services, fax services, Short Messaging Service (SMS), and over-the-air service activation and provisioning.

cdmaOne uses a physical-layer channel structure that shares much of the fundamental/supplemental channel structure from TIA/EIA-95-B. This design provides for simultaneous voice/data structure and procedures that are upwardly compatible with TIA/EIA-95-B.

cdmaOne extends support for multiple simultaneous services far beyond the services in TIA/EIA-95-B by providing much higher data rates and a sophisticated multimedia QoS control capability to support multiple voice/packet data/circuit data connections with differing performance requirements.

The cdmaOne system Medium Access Control (MAC) layer provides extensive enhancements to negotiate multimedia connections, operates multiple concurrent services, and manages QoS tradeoffs between multiple active services in an efficient, structured, and extensible manner. Delivery of these multiple concurrent data streams over the radio interface is accomplished by the cdmaOne Layer 1 (Physical Layer).

Layer 1 supports multiple supplemental channels that can be operated with varying QoS characteristics tailored to the individual service's requirements. For example, one channel can carry circuit data with low bit-error rate (BER) and low latency transmission requirements, while another channel carries packet data that can tolerate a much higher BER and relatively unconstrained latency.

The cdmaOne Physical Layer also supports a dedicated control channel (DCCH) that can be utilized in a number of flexible configurations to provide for independence for competing services (e.g., voice and data), while maintaining a high level of performance. High-speed data service negotiation procedures are extended far beyond TIA/EIA-95-B to include ATM/B-ISDN QoS parameters, including:

- Data rate requirements (CBR, ABR, VBR, etc.).
- Data rate symmetry/asymmetry requirements.
- Tolerable delay/latency characteristics.