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Working Party 8F

WG VISION

Preliminary draft new Recommendation (PDNR): Vision, framework and overall objectives of the future development of IMT-2000 and of systems beyond IMT-2000

7 [New Regulatory Impacts] (Editor's Note: the inclusion of this Section is subject to the receipt and review of additional contributions at the next meeting)

8 Spectrum Implications

9 PDNR text

considering

noting

recommends

1 General Objectives

2 Objectives for the future development of IMT-2000

3 Objectives for systems beyond IMT-2000

Editor's Notes:

1 The structure of this document was revised slightly during the 6th WP8F Meeting (Tokyo); in particular the subSections within Section 5 were changed which resulted in the movement of text. Contributions are invited to improve the flow of the text that may be needed as the result of these structural changes and related movement of text.

2 All data rates and dates should be reviewed for consistency throughout the document and are considered to be in square brackets.

3 All Section and figure numbers need to be cross checked with the associated text.

4 Editorial changes needed for readability.

5 Contributions for Sections 5.1.2, 7 and 9.

6 Contributions that suggest movements of text.

7 Contributions on services and applications for systems beyond IMT-2000.

Preliminary draft new Recommendation (PDNR): Vision, framework and overall objectives of the future development of IMT-2000 and of systems beyond IMT-2000

1 Preface

This Recommendation defines a vision framework and overall objectives for the future development of IMT-2000 and systems beyond IMT-2000. The specifications for the initial releases of IMT-2000 have been completed, and are defined in Recommendation ITU-R M.1457, which details the radio interfaces for IMT-2000. Based on this international framework, a number of countries are embarking on the licensing of terrestrial IMT-2000 networks, and commercial deployment of IMT-2000 system is expected to begin in 2001/2002.

Work is already underway to extend the capabilities of the initial releases towards fulfillment of the IMT-2000 requirements that are already evolving in line with market expectations and technology trends. The Question ITU-R 229/8 on future development of IMT-2000 and systems beyond IMT-2000, was formally approved by the ITU Radiocommunication Assembly and is assigned to ITU-R WP 8F. ITU-R WP 8F is tasked with documenting a vision of this ongoing enhancement of IMT-2000, and with the identification of a vision and some initial objectives for future systems beyond IMT-2000.

In defining the original IMT-2000 concept, various market studies were conducted in order to determine required capabilities for the IMT-2000 radio interfaces, services, applications and spectrum requirements. In creating a vision for the future development of IMT-2000 and systems beyond IMT-2000, it is again necessary to update the market forecasts in order to understand the requirements of the mobile communication customers, and hence define the extended capabilities (including the air-interface capabilities) needed from the networks. It is particularly important to establish market trends beyond the year 2010.

2 Scope

The purpose of this Recommendation is to define the vision, framework and overall objectives of future development of IMT-2000 and systems beyond IMT-2000. It is the foundation document in a series of Recommendations that will define such systems. The vision also captures the global market and technology trends, including the particular needs of developing countries. This vision will evolve over time and be further updated in subsequent revisions.

The Recommendation gives broad definition of the features of the future development of IMT-2000 systems and systems beyond under a number of headings as follows:

1 An evolutionary phase entitled in this Recommendation as the future development of IMT-2000. In the context of this recommendation, the future development of IMT-2000 refers to the enhancements to its technical capabilities, range of available services and breadth of applications that will be progressively introduced during the lifetime of the system. Such enhancements will probably include inter-working with other radio systems with complementary capabilities.

2 A subsequent phase entitled in this Recommendation as systems beyond IMT-2000. Systems beyond IMT-2000 are those future wireless telecommunications systems that, collectively, will provide the elements of a comprehensive telecommunications environment which includes cellular, fixed wireless access, and nomadic access with capabilities that significantly exceed, but include, those anticipated for fully developed IMT-2000 systems and other radio systems with which they interwork.

Recognising the importance of the emerging relationships amongst wireless platforms, this Recommendation includes these relationships within the vision for the future development of IMT-2000 and Systems Beyond. Such relationships will be opportunity-driven to begin with, but they will become more widespread and structured as time progresses. A key feature of the vision for Systems Beyond IMT-2000 is that it explicitly includes these relationships.

3 Related Recommendations

ITU-R M.687-2	International Mobile Telecommunications-2000 (IMT-2000)
ITU-R M.816-1	Framework for services supported on International Mobile Telecommunications-2000 (IMT-2000)
ITU-R M.1457-1	Detailed radio interfaces for IMT-2000
ITU-R M.818	Satellite operation within International Mobile Telecommunications-2000 (IMT-2000)
ITU-R M.819	International Mobile Telecommunications-2000 (IMT-2000) for developing countries
ITU-R M.1224	Vocabulary of terms for International Mobile Telecommunications-2000 (IMT-2000)

4 Market Trends

The number of subscribers for mobile communications has increased much faster than predicted, particularly for terrestrial use. In the year 2000 the number of mobile subscribers was higher than 400 million worldwide and for the year 2010 more than 1700 million mobile subscribers are anticipated.

The majority of traffic is changing from speech-oriented communications to multimedia communications. It is also generally expected that due to the dominating role of mobile wireless access, the number of portable handsets will exceed the number of PCs connected to the Internet. Therefore, mobile terminals will be the major person-machine interface in the future instead of the PC. Due to the dominating role of IP based data traffic in the future the networks and systems have to be designed for economic packet data transfer. The expected new data services are highly bandwidth consuming. This results in higher data rate requirements for future systems.

The major step from the second generation to IMT-2000 was the ability to support advanced and wideband multimedia services, including e-mail, file transfers, and distribution services like radio, TV and software provisioning (e.g. software download). These multimedia services can be symmetrical and asymmetrical services, real-time and non real-time services. External market studies have predicted that in Europe in the year 2010 more than 90 million mobile subscribers will use mobile multimedia services and will generate about 60 % of the traffic in terms of transmitted bits. [Editor's note: contributions are requested for other regions]

In IMT-2000 the combination and convergence of the different worlds Information Technology (IT) industry, media industry and telecommunications will integrate communication with IT. As a results, mobile communications together with IT will penetrate into the various fields of the society.

In future communications, two economically contradictive demands will arise; ubiquity and diversity. Open, global and ubiquitous communications make people free from spatial and temporal constraints. Versatile communication systems will also be required to realize customized services based on diverse individual needs. The flexibility of mobile IT can satisfy these demands simultaneously. Therefore, mobile IT can be seen to play a key fundamental role in the 21st century.

The user expectations are increasing with regard to a large variety of services and applications with different degree of quality of service (QoS), which is related to delay, data rate and bit error requirements. Therefore, seamless services and applications via different access systems and technologies that maximize the use of available spectrum will be the driving forces for future developments.

In addition, many types of objects as well as people will have network functions and will communicate with each other through networks. Therefore, different communication relationships such as person to person, machine to machine and mainly machine to person and vice versa, will determine mobile and wireless communications in the future.

Given the increasing demand for flexibility and individuality in society, the mean for the end-user might be assessed. Potentially, the value would be in the diversity of mobile applications, hidden from the complexity of the underlying communications schemes. This complexity would be absorbed into an intelligent personality management mechanism, which would learn and understand the needs of the user, and control the behavior of their reconfigurable terminals accordingly in terms of application behavior and access to future support services.

The trends from a service perspective include integration of services and convergence of service delivery mechanisms. In particular, three pillars (triple-C or CCC, since each pillar starts with the letter “C”) can characterize from a service perspective these trends of integration of services and convergence of service delivery mechanisms:

1 Connectivity (provision of a pipe, including intelligence in the network and the terminal).

2 Content (information, including push-pull).

3 Commerce (transactions).

These trends will result in new service delivery dynamics and a new paradigm in telecommunications where value added services such as those which are location dependent will provide enormous benefits to both the end users and the service providers.

5 Vision

The high level vision of the future development of IMT-2000 and systems beyond IMT-2000 is considered to be as follows:

– Future development of IMT-2000. The vision for the future development of IMT-2000 is that there will be a steady and continuous evolution. For example the current capabilities of some of the terrestrial radio interfaces are already being extended towards 10 Mb/s and it is anticipated that these will be extended even further over the next decade. The vision for the future development of IMT-2000 is to raise the down-stream transmission speed (from the base station to a terminal) to about [30] Mb/s by around the year [2005]. This is discussed in more detail in Section 5.2.

– Future development of IMT-2000 in relation with future development of other radio systems. In conjunction with the future development of IMT-2000 there may be an inter-relationship with other radio systems, for example wireless LANs, digital video broadcast, etc. This is discussed in more detail in Section 5.3.

– For systems beyond IMT-2000, there may be a requirement for a new complementary wireless access technology for the terrestrial component, sometime after the year [2010]. This will complement the future development of IMT-2000 and future development of other radio systems. Present digital cellular systems have evolved by adding more and more system capabilities and enhancements to make them resemble the capabilities of IMT-2000 systems. It is anticipated that with IMT-2000 there will also be a continuum of

enhancements that may render those systems practically indistinguishable from systems beyond IMT-2000, indeed, the user should see a continuous increase in capability. The vision for a potential new radio interface is to support up to [50-100 Mb/s] in the mobile environment and up to [1Gb/s] in the stationary environment in the down-stream transmission by around the year [2010] . This is discussed in Section 5.4.

In the future wireless service provision will be characterized by global mobile access (terminal and personal mobility), high quality of services (full coverage, intelligible, no drop and no/lower call blocking and latency), and easy and simple access to multimedia services for voice, data, message, video, world-wide web, GPS, etc. via one user terminal.

End-to-end secured services will be fully coordinated, via access control, authentication use of biometric sensors and/or smart card and mutual authentication, data integrity and encryption with no intermediate gateway(s) for decryption/re-encryption. User added encryption feature for higher level of security will be part of the system.

The vision for the future development of IMT-2000 is that there will be a steady and continuous evolution over the next 10 years. Beyond this timeframe, for systems beyond IMT-2000, there may be a requirement for a new wireless access technology for the terrestrial component, sometime after 2010.

It is expected that the further development of IMT-2000 will increase its capabilities for a considerable period. In the longer term, these capabilities will be complemented by the introduction of systems beyond IMT-2000. In this timeframe, for systems beyond IMT-2000, there may be a requirement for a new wireless access technology for the terrestrial component, sometime after 2010.

Considering how second generation systems have evolved by adding more and more system capabilities and enhancements to make them resemble the capabilities of IMT-2000 systems; it is possible that with third generation systems there may be a continuum of enhancements that will render those systems practically indistinguishable from future generation systems. Indeed, it is expected that it will be more difficult to identify distinct generation gaps and such a distinction may only be possible by looking back at some point in the future.

The vision from the user perspective can be implemented by integration of these different evolving and emerging access technologies in a common flexible and expandable platform to provide a multiplicity of possibilities for current and future services and applications to users in a single terminal. Systems beyond third generation will mainly be characterized by a horizontal communication model, where different access technologies as cellular, cordless, WLAN type systems, short range connectivity and wired systems will be combined on a common platform to complement each other in an optimum way for different service requirements and radio environments. Figure 5.1 shows the capabilities of IMT-2000 and systems beyond.

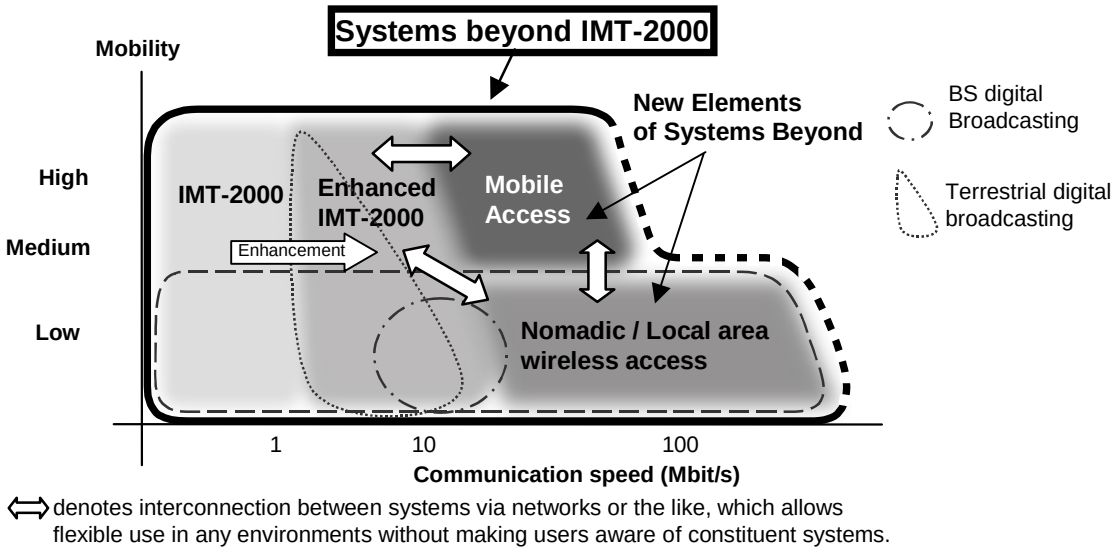

FIGURE 5-1

Illustration of Capabilities of IMT-2000 and Systems Beyond

[Editor's note: text must be consistent with Figure 5-1]

These access systems will be connected to a common, flexible and seamless core network. The mobility management will be part of a new Media Access System as interface between the core network and the particular access technology to connect a user via a single number for different access systems to the network. This will correspond to a generalized access network. Global roaming for all access technologies is required. The interworking between these different access systems in terms of horizontal and vertical handover and seamless services with service negotiation including mobility, security and QoS will be a key requirement, which will be handled in the newly developed Media Access System and the core network.

This vision ***"Optimally Connected Anywhere, Anytime"*** results in a seamless network (including a variety of interworking access systems), as seen in Figure 5-2 which are connected to a common IP based core network. The Media Access System connects each access system to a common core network. Due to the different application areas, cell ranges and radio environments the different access systems can be organized in a layered structure (according to Figure 5-3) similar to hierarchical cell structures in cellular mobile radio systems. However, in addition to different cell layers also different access technologies are complementing each other on a common platform. Multi mode terminals and new appliances are key components, which will be adaptive based on software defined radio technology using high signal processing power.

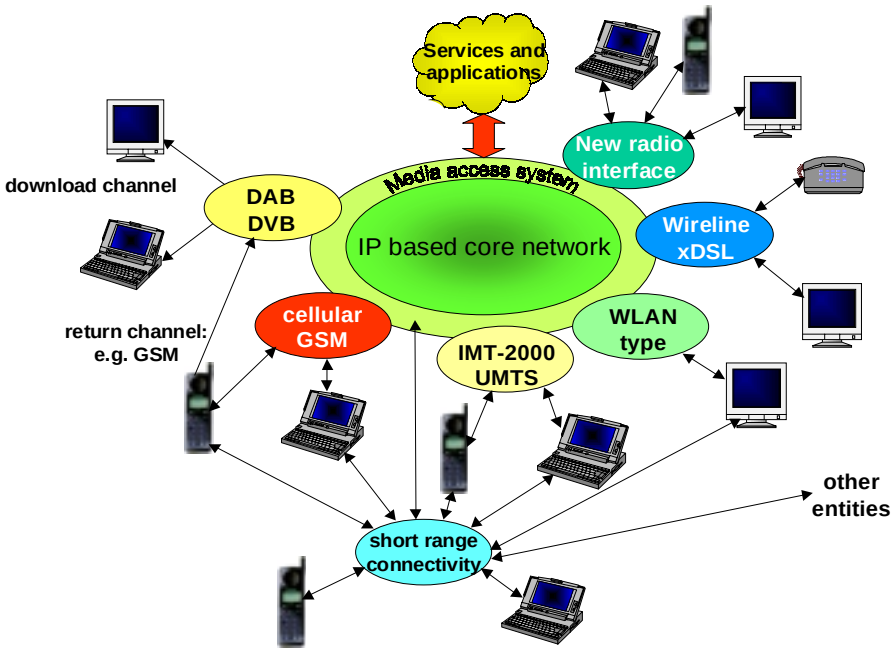

FIGURE 5-2

Seamless future network of Systems Beyond IMT-2000 including a variety of interworking access systems

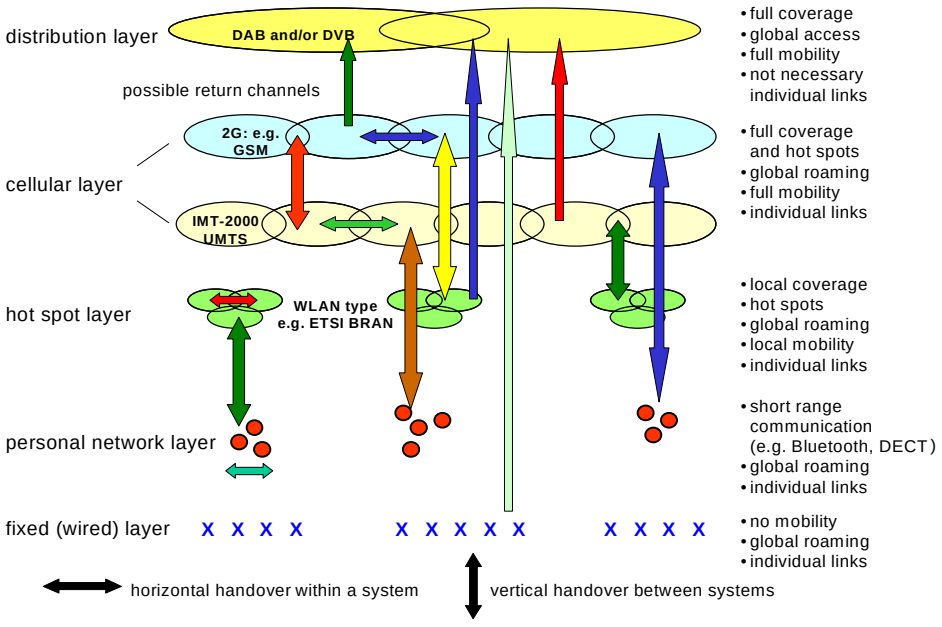

FIGURE 5-3

Illustration of complementary access systems

For realization of the seamless services, those different wireless access systems and wired systems may be combined on a common platform to complement each other in an optimum way for different service requirements and radio environments. In the future, new systems designed specifically to inter-work with IMT-2000 compliant core networks and, in particular, those forming an integral part of the terrestrial IMT-2000 core network, may be the most efficient in delivering IMT-2000 services.

5.1 High Level Requirements

In this Section the overall or general vision for the future development of IMT-2000 and systems beyond IMT-2000 is described from various perspectives of the user, content provider, service provider, network operator, and manufacturer. It is expected that additional spectrum will be made available and more complex air interface and networking technologies will be developed to satisfy the needs under these limited spectrum resources. Each potential wireless service provider will choose a set of technologies that are the best fit for their applications, implement a service network in a given frequency band, and offer a set of wireless services. Each user expects and desires certain sets of wireless services, capabilities and conveniences that will be offered by the future wireless system and network providers.

From the user perspective the vision for mobile communications can be described as a multi sphere level concept. In the first level the user connects all carried devices like a camera, phone, mirror glasses for images, watch etc. in a PAN (Personal Area Network) by short range connectivity systems. The second level links the immediate environment like a TV, a PC, a refrigerator etc. to the user. Level three ensures the direct communication to instant partners as other users and vehicles. Different wireless access systems like terrestrial systems, satellite systems and HAPS (High Altitude Platform Stations) are provided in level four for full area coverage. These levels are surrounded by the Cyber World (services and applications domain) in level five, where games, access to databases and the Internet, communication etc. are provided.

[UK comment: further explanation of the multi-sphere level concept is suggested]

This vision from the user perspective is the driving force for seamless services and applications via different access systems for future developments. Due to the future dominating role of IP based data traffic and applications, networks and systems have to be designed for economic packet data transfer. The fixed Internet penetration is growing in parallel to the mobile wireless access penetration. About 80 % of fixed Internet users are also using mobile communications. Therefore, these users want to get the same services also on mobile terminals. These services require a high degree of asymmetry between uplink and downlink especially for Internet type services with much higher expected capacity on the downlink.

From the user's viewpoint, it is important to cover a wide service area equivalent to the present IMT-2000 systems. It is necessary to cover vehicular environments as well as local area (indoor offices, homes and business premises). There are several radio operating environments, and radio systems are designed taking into account of the assumed operating environments. By taking advantage of seamless service, the service area in different environments can be covered in a complementary manner by several systems. The satellite and terrestrial components may operate in conjunction with one another to facilitate global coverage. The possibility to use of a common frequency band worldwide is a desirable goal. Economic deployment of systems in the entire coverage area with a radio interface optimized for:

– macro cells;

– micro cells;

– indoor, hot spots; and

– broadcast,

will be required.

Table 1 shows the dominant high-level objectives for the future development of IMT-2000 and systems beyond from the perspectives of users, application/content providers, service providers, network operators and equipment manufacturers. Based on these objectives, the demands on the end-to-end system concepts and corresponding enabling technologies may be derived.

TABLE 1

High-Level Objectives of Further Development to IMT-2000 and Systems Beyond IMT-2000

END USER HIGH LEVEL OBJECTIVES	
Ubiquitous mobile access	Robust connection is essential *Access to mobile-specific web, multimedia, broadband and broadcast content: seamless handoff between wireless access modes (user not interested in which ones).* Service discovery and transparent dynamic adaptation of applications to match available services and preference profiles; home country roaming will become an issue for users Global roaming (important for only a small subset of potential users)
Quality expectations vary to task	Service degradation and dropped service (e.g. broadcast TV, interactive games, voice telephony) must be managed. Similar levels of service are expected on the train as in the home. User must have high-level control where cost is concerned.
Ease of access to applications and services	Current technologies will set benchmarks (e.g. Internet download) Transparent discovery and switching between services and wireless access modes, based on an intelligent establishment and interpretation of user preferences and application requirements. However, some users will require more control for private vs. business use.
Low cost and relevant services and concise billing	Intelligent discovery, presentation and selection of service options and billing schemes; distribution of application processing between network and terminal to reduce terminal resource requirement. Billing should hide some of the inherent system complexity, i.e. only one bill. Set cost constraints for services
Technology comfort	User-friendly consumer product model versus computer (PC) model: even those with limited computer literacy can access services. Intelligent client-server management schemes must offer freedom from complex PC-like application installation and configuration; but users may still want some control; User-friendly handling of delays, disconnections and new connections via meaningful feedback to the user; Transparent handling of version/configuration control for application and system software (including wireless access stack software) and accountability of system to user for reconfiguration changes. Support expected from the service provider and operator in finding services and updating software. Intelligent use of battery resource, both locally (local application, display, sound) and in network access Simple UI and appealing aesthetic.
Reasonable equipment life	Expectation that terminal equipment will offer support for fast-evolving complexity and diversity of applications and services

APPLICATION DEVELOPER/CONTENT PROVIDER	
Common Execution Environment	Allowing development of applications and associated content independently of underlying network services and terminal capabilities: self-configuration via capability exchange
Application Diversity	Terminals capable of supporting fast-evolving complexity and diversity of applications and services; Utilization of increasing terminal resources to enrich application (eg spare DSP processing capacity)
SERVICE PROVIDER	
Fast, open service creation, validation and provisioning	Allowing development of services independently of underlying network services; Provisioning of validated services configured to underlying network and terminal capabilities
Inform user of services available	Requirement for an effective scheme to 'advertise' available services in a service discovery negotiation
Maintain connections and adapt to required QoS	*Ability to seamlessly switch connections to alternate wireless access schemes or alternate network operators both in call and in standby* *Dynamically modify resource allocation to maintain desired QoS over radio channels*
NETWORK OPERATOR	
Maximize utilization of allocated spectrum	Flexible allocation of spectrum according to differing user demands. Radio resource and network management to support coexistence of access schemes within allocated bands and spectrum sharing between operators.
Maintaining QoS	Maintenance of Quality of Service is a fundamental measure of network operator performance
Longevity and flexibility of network equipment	Supporting reconfiguration in the wireless access equipment and the media access fabric interfacing to the core network
Owning customers	Mechanisms to support operator control of terminals, at all levels
TERMINAL AND COMPONENT MANUFACTURER	
Economies of scale	Consolidation of product variants onto reconfigurable product platforms
Bug fix and software enhancement provisioning	Ability to download and install software to overcome bugs (software deficiencies) and enhance functionality/performance reduces recall costs and increases differentiation and revenue stream
Fast product creation	Reconfigurable IP authoring fostering maximized reuse, hardware/software code sign and platform-based IP integration methodology

5.1.1 Relationship of IMT-2000 and Systems Beyond IMT-2000 with Other Radio Systems

The world of wireless communications comprises a comprehensive range of technologies, services and applications that have come into existence to meet the particular needs of different market sectors and user environments. These different platforms are characterised by:

– the content and services they offer,

– the frequency bands in which they operate,

– the data rates they deliver,

– the degree of mobility they offer,

– their cost.

An individual person, or machine, can from time to time be a user on one or more of these platforms, either sequentially or simultaneously, depending on the task in hand. A commonality of services and applications across the different platforms is therefore beneficial to users, and this has stimulated the current trend towards convergence. Furthermore, a broadly similar user experience across the different platforms leads to a large-scale take up of products and services, common applications and content, and an ease and efficiency of use.

The increasing prevalence of IP-based applications is a key driver for this embryonic convergence, and stimulates the establishment of relationships between previously separate wireless platforms.

What form these relationships will take depends on what the market wants, but they might include, for example; hardware integration within a device, network inter-working, common access, authentication, accounting, common person-machine interfaces, portals, roaming and hand-over between platforms.

The formation of these relationships is distinct from the development of the IMT-2000 specifications. The formation of these relationships will need to take account of the characteristics and future development of the platforms, inter-related (or even interdependent) spectrum issues, and the respective regulatory environments.

Within IMT-2000 there are terrestrial cellular and satellite wireless access delivery mechanisms and integration between these two may occur depending upon market developments. There are also other access options such as:

– personal area networks

– the home area, such as wireless LAN and

– the wide area, such as digital broadcasting.

At some point in the future some operators, depending upon market considerations, will make substantial steps to deploy a seamless mix of technologies which could at various stages in time, subject to market considerations, incorporating satellite, WLAN, DAB, DVB and cellular elements. This will require the seamless integration of these systems in order for the user to be able to receive a variety of content via a variety of delivery mechanisms depending upon the particular terminal capabilities and location. For example there will be a choice of WLAN component chips, based on IEEE 802.11 and HIPERLAN 2 standards, which could be included in mobile terminals to extend their capabilities in certain areas. For example it should be possible for a user to send a video postcard using an IMT-2000 terminal to a Digital Television for another user to receive.

In the future, new systems designed specifically to inter-work with IMT-2000 compliant core networks and, in particular, those forming an integral part of the terrestrial IMT-2000 core network, may be the most efficient in delivering IMT-2000 services.

Furthermore, from a service context, IMT-2000 will complement other means of service delivery, including other mobile and fixed wireless access, wireline, broadcasting, etc., hence convergence of all these systems will need to be considered. There are also many emerging embedded applications and machine-to-machine communications, which will increase the demand for IMT-2000 systems. These relationships are described in Figure 5-4.

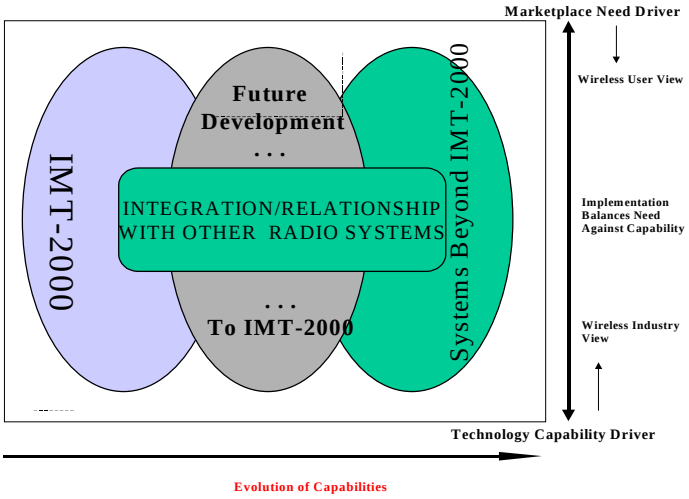

FIGURE 5-4

Relationship of IMT-2000, systems beyond, and other radio systems

Editor's note: this figure needs further review.

5.1.2 Vision of Coverage for the Population of the Globe

[Editor's Note : Input required to make Section 5.1.2 more concise.]

A study by the Yankee group (The 2000 Mobile User Survey, Part 1: U.S. Wireless Subscriber Preferences and Perceptions at the End of the Second Generation) points to price, **coverage** and quality as being the fundamental parameters behind end-users choosing a wireless provider for service. The satellite component continues to be a good complement to the terrestrial component since it fulfils the requirement of "anywhere" by virtue of its global coverage, but it cannot support "everyone" due to capacity, location and affordability limitations.

Hence, two aspects of coverage need to be distinguished:

– Geographical coverage, which the satellite component of IMT-2000 can readily support globally with certain limitations and the terrestrial component can support where required in response to market and institutional needs.

– Population coverage, or teledensity (teledensity is defined in Recommendation ITU-R F.1399). Ideally the teledensity should be equal to the population density in any given area.

It is the population coverage aspects (teledensity) where more attention is needed. If IMT-2000 is implemented without a global coverage vision it may remain a set of islands of various degrees of capabilities reminiscent of the early days of wireless, when neither coverage nor even basic service availability could be taken for granted.

Thus, it is imperative that the Vision for IMT-2000 and its evolution provides guidance to realize the goal of IMT-2000 to provide universal access to a full range of services for anyone, anywhere, anytime.

Figure 1 shows diagrammatically that the Vision needs to encompass the achievement of global coverage as well as the enhancement of service capabilities. What is meant by global coverage here is to make IMT-2000 available to all people in the world for business and personal use at affordable costs. 2G systems today cover only about 700 million people compared to a world population of 5 billion plus. The ITU's vision should be that IMT-2000 services be available to and affordable to all the people of the world by 2015.

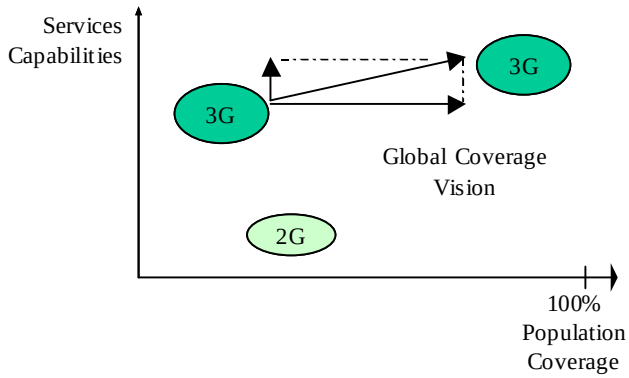

Figure 1. Emphasis on global coverage rather than capabilities

According to Merrill Lynch, the worldwide market penetration will be 30% in 2010 and of this 28 % will be IMT-2000 subscribers (UMTS Forum Report). This translates to approximately 2.25 billion wireless subscribers, falling far short of the goal of having a 100% coverage population-wise and accessibility to IMT-2000 services.

This means that technological development is needed to lower the cost and therefore increase the affordability factor. Creative solutions are needed to achieve the goal of 100% teledensity. There are also specific technology challenges, for example, in many developing countries there is no facility either to power or recharge the base station and the batteries. Among a number of technology solutions, we need a breakthrough in environmentally friendly fuel-cell technology to further increase the penetration.

Figure 2 shows possible targets for affordable availability of service capabilities for the world population (not to scale), indicating how major growth is needed on a wide scale. Population coverage needs to be extended, but not necessarily with the full capabilities for everyone, at least not initially. The figure shows an example of average cumulative distribution of services across the world population, normalized to the set of capabilities in 2015.

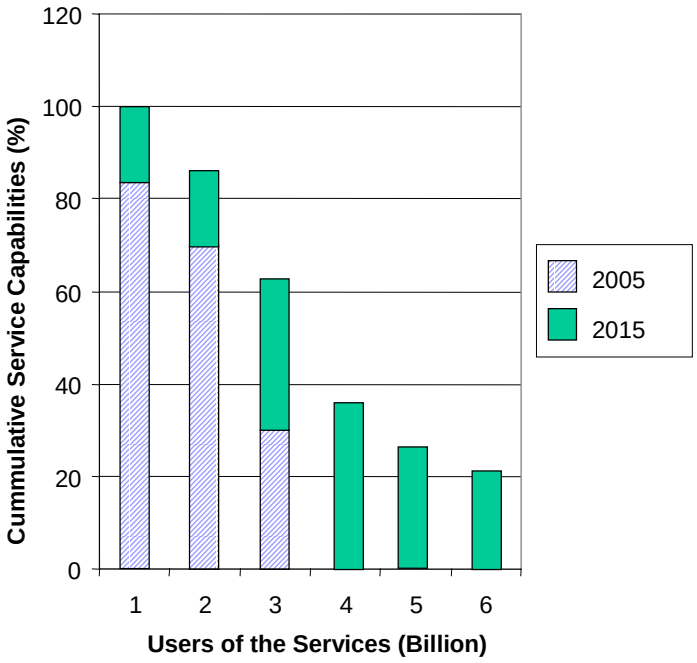

Figure 2. Possible targets for affordable availability of capabilities for the world population

Editor's note: This figure needs to be edited for spelling.

The coverage vision needs to include the following elements:

1 Interconnection requirements to make it easier the deployment of services (interoperability and interworking at the physical, network and service levels).

2 Proper packaging of capabilities for the development of institutional services such as telemedicine and tele-education.

Governments are in a good position to develop the necessary institutional services on a wide scale; but for that to happen the proper coverage and networking of capabilities needs to be established first.

5.1.3 Elements to Be Developed Further

Systems beyond IMT-2000 are realized by functional fusion of existing, enhanced and newly developed elements of cellular systems, nomadic wireless access systems and so forth with highly mutual affinity. Perspectives of the enhanced and newly developed elements can be summarized by the following:

1 As Systems beyond IMT-2000, enhanced IMT-2000 and new elements of systems beyond IMT-2000 will have the capability to interwork with one another and also with the other systems.

2 The enhanced IMT-2000 will raise service bit rates to about [30 Mbit/s] in around 2005.

3 The new elements of Systems beyond IMT-2000 will support service bit rates of about 50-100 Mbit/s in around 2010.

5.2 Future development of IMT-2000

A key element of the high level vision for the future development of IMT-2000 is that there will be a steady and continuous evolution and enhancement of IMT-2000 capabilities by operators

deploying and upgrading, separately, their chosen IMT-2000 technologies over at least the next 10 years. This would then be followed by further operation for possibly a further 10 years or more.

Terrestrial IMT-2000 systems are being enhanced and for instance many will incorporate an "all IP" network and the wireless access will offer increased capabilities such as up to 10 Mb/s. These are only initial enhancements, anticipated to be standardised by early in the year 2002, with further enhancements envisaged beyond this, such as the support of service bit rates of up to [30 Mb/s] under favourable circumstances.

The satellite component of IMT-2000 may further evolve to provide services in areas covered by cellular systems, complementary services, e.g. broadcasting, multicasting, and also in those areas not planned to be served by terrestrial systems.

As noted above, the convergence of services and delivery platforms in the ongoing enhancement of IMT-2000 will lead to more intelligent use of the communications media, where IMT-2000 will be able to offer the users what they need in any specific mobile environment. The range of applicability of IMT-2000 is very much wider than earlier mobile systems and is expected to include future enhancements which will offer increasingly superior capabilities and performance in low mobility environments.

5.3 Systems Beyond IMT-2000

Systems beyond IMT-2000 will provide highly sophisticated cellular services, which are beyond what can be achieved by enhancement of IMT-2000. There may be a requirement for a new wireless access technology, particularly for the cellular component.

Systems beyond IMT-2000 will handle a wide range of supported data rates according to economic and service demands with an AMBR of greater than [20 Mbit/s] for systems in multi-user and multi-cell environments and with terminals moving at vehicular speeds and support [50-100 Mbit/s] maximum.

Systems beyond IMT-2000 will support a wide range of symmetrical and asymmetrical services. They will also provide QoS for real time services and efficient transport of packet-oriented services, as well as the efficient support of broadcast and distribution services.

There may be a requirement for a new wireless access technology, particularly for the cellular component, sometime after the year 2010. In such a dynamic environment it is difficult to develop a detailed vision so far into the future but it is clear that this vision could be radical and challenge the perceptions of what may be considered viable by today's standards, and go beyond what can be achieved by the future enhancement of IMT-2000 working with other radio systems. For example the terrestrial component of systems beyond could be up to [100 Mb/s] wide area full mobility and [1 Gb/s] low mobility.

[Editor's note: Data rate requirements are distributed in the document and are not consistent. These requirements should be aligned and it is recommended to concentrate them in one Section]

The capabilities of systems beyond IMT-2000 are currently foreseen to include:

– terminal and personal mobility in variable environments

– efficient transport of packet oriented and comparable service quality and cost with wire-line services

– Global seamless support of wide range of services via different technologies, and support of roaming and hand-over different systems

– Support of a wide range of data rates according to economic and service demands from [2 Mbps] (full movement) up to about [20 Mbps] and beyond (stationary or nearly so) in new mobile systems

Requirements for Future Mobile Communications from the End-User Perspective:

– Economic deployment of systems in the entire coverage area with optimized radio interfaces for for different operating environments.

– Reconfigurability of network entities and terminals and flexible allocation of required system capacity.

Systems beyond IMT-2000 will mainly be characterized by a horizontal communication model, where different access technologies as cellular, cordless, WLAN type systems, short range connectivity and wired systems will be combined on a common platform to complement each other in an optimum way for different service requirements and radio environments.

5.4 Timelines/Phases

A very important aspect for the work of WP 8F is the development of approximate timelines for the future development of IMT-2000 and the conceptualization and development of systems beyond IMT-2000. Timelines may be considered from various perspectives:

1 Market trends, requirements and user demands;

2 Technical capabilities and technology developments that lead to planned enhancements of the radio transmission technologies for IMT-2000;

3 Standards Development;

4 Spectrum availability, including allowing sufficient time to re-locate systems that may be using the band;

5 Infrastructure deployment.

All five aspects are interrelated. The first four have been and continue to be addressed within WP 8F. The latter, infrastructure deployment, relates to the practical aspects of deploying new networks, which include the desire to minimize additional infrastructure investment and to allow time for customer adoption of the capabilities of a major new system, such as IMT-2000.

The timelines for these different perspectives is depicted in Figure 5-5. When discussing the time phase for systems beyond IMT-2000, it is important to specify the perspective, i.e. time at which the standards are completed, time at which spectrum must be available, time at which deployment starts, etc.

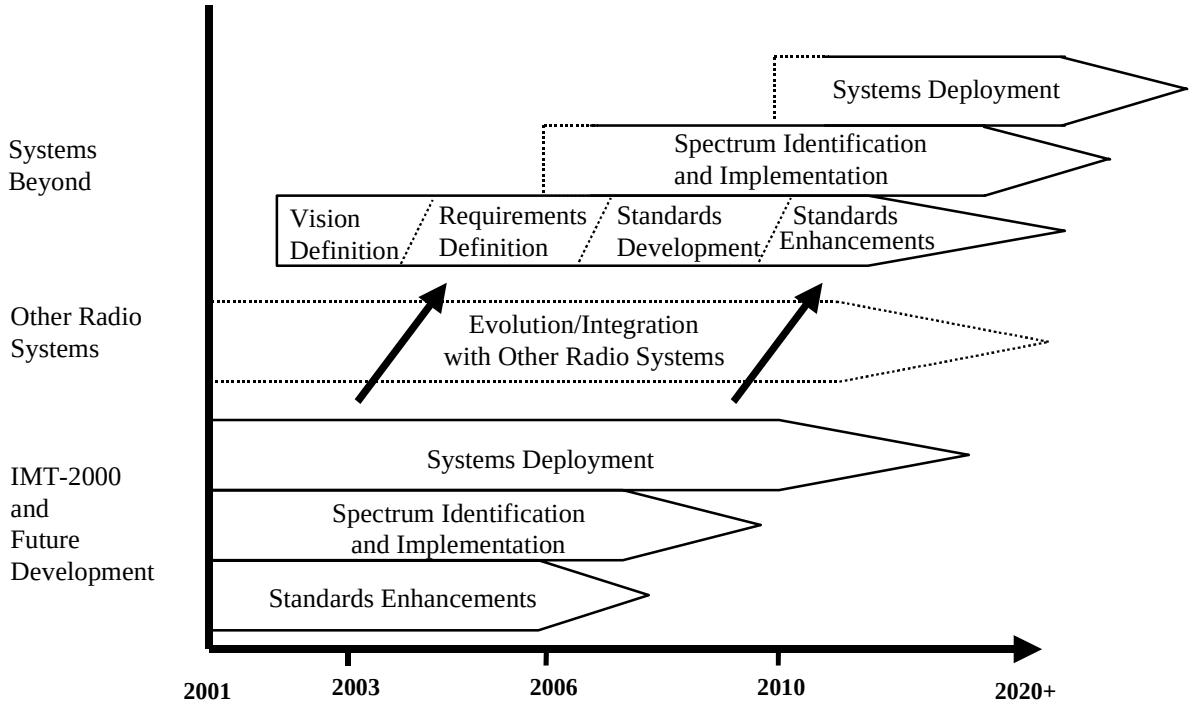

FIGURE 5.5

Phases and expected timelines for future development of IMT-2000 and systems beyond

The dotted lines in Figure 5.5 indicate that the exact starting point of the particular subject can not yet be fixed.

5.4.1 Near-Term and Medium term

The near- and medium-term correspond to Part A of Question 229/8, the future development of IMT-2000. The near-term of IMT-2000 deployment (up to approximately 2007) is distinguished by what are termed small changes to IMT-2000, i.e. these changes can be reflected in revisions to existing IMT-2000 M-Series Recommendations. In the medium term (up to 10+ years), it is envisaged that the future development of IMT-2000 will progress with the ongoing enhancement of the capabilities of the initial deployments, as demanded by the market and allowed by the status of technical developments. Further changes to the existing IMT-2000 M-Series Recommendations will be necessary to realize these enhanced capabilities and services. There could be significant progress towards harmonization of the radio interfaces It is envisaged that the bands identified by the WRC-2000 will be made available for IMT-2000 within this time-frame, subject to market demand and other considerations.

The near-term phase (up to 2007) is dominated by the growth in traffic within the existing cellular spectrum and small changes to IMT-2000. These changes may be considered as refinements to IMT-2000.

The medium term (2003 – 2010+) is characterized by deployment within new "IMT-2000" spectrum (spectrum identified by WRC-2000) and by the ongoing enhancement of the initial IMT-2000 capabilities , as demanded by the market and allowed by the status of technical developments.

There could be significant progress towards harmonization of the radio interfaces It is envisaged that the bands identified by the WRC-2000 will be made available for IMT-2000 within this time-frame, subject to market demand and other considerations.

5.4.2 Longer term

The longer term (approximately 2010+) corresponds to Part B of Question 229/8, and is associated with the introduction of systems with capabilities beyond those envisaged as being part of an "evolved" IMT-2000. It is envisaged that these systems will add significant new capabilities (possibly much higher user data rates) and they may need to be supported by additional frequency bands above 3 GHz. It is possible that some of the more basic capabilities of IMT-2000 will not be offered by the systems beyond IMT-2000. However, it is envisaged that certain core capabilities will be common to both evolved IMT-2000 and the systems beyond IMT-2000.

The longer term is associated with the introduction of systems beyond IMT-2000. Their capabilities will be beyond those envisaged as being appropriate to an "evolved" IMT-2000, possibly much higher user data rates, and they will probably be supported by additional frequency bands.

It is considered that systems beyond IMT-2000, which will be deployed around 2010, will primary have an impact on the market in 2015.

6 Technology Trends

When defining the vision and objectives for the future development of IMT-2000 and systems beyond, the significant technology trends need to be considered. This Section identifies and describes these trends from the viewpoint of developing the system concept and objectives. Technology development progress and issues to be solved are also discussed. It is expected that these technology trends will be further addressed in a separate Report, and that separate Recommendations may be developed for individual technologies, for example, software defined radios (SDRs). As a result, and consistent with the general approach taken in this document, technology trends will only be discussed in this Section at a very high level.

In the near and mid term, the future development of IMT-2000 systems and services will be influenced by a variety of technology trends. The development of the Internet, for example, has led to efforts to expand the use of IP-based protocols in both the core network and for wireless access. This will enable a greater variety of services to be delivered to end users and at higher speeds. In addition, advances in chip design and software functionality will eventually lead to user terminals and devices that are increasingly intelligent and able to work across a wide variety of networks providing integrated services. The coming generations of SDRs are an example of this trend. Operators and vendors are likewise developing ways to optimize the use of today's spectral resource through advances in hardware and software. Adaptive antenna technology, and corresponding software improvements, for example, may offer benefits as IMT-2000 is further developed.

Beyond IMT-2000, the technology trends that will affect the development of new or evolved radiocommunication systems are less clear. In general, improvements can be expected in network technologies, radio access systems, and terminal design. Of particular importance are those technologies that will allow much higher data speeds to be developed and that will allow the creative convergence/integration of a wide range of new services in multifunction, multimedia devices.

Some examples of possible key areas within which to identify technology trends are as follows:

1 System-related technologies

Voice over Internet Protocol; Software Defined Radio; System Platform for Mobile Service; Highly Reliable Network Architecture; Security, Cryptography, Billing, Authentication and Mobile Electric Commerce; Mobile ad hoc network technologies.

2 Application-related technologies

Next Generation Coding/Compression Technology; Dynamic variable-rate codecs; Mobile Agent Technology; Man machine interfaces including "intelligent" mobile terminals; Streaming Data Communication Technology; Contents Description Language; Application Development Environment Technology.

3 Advanced Wireless Access

Dynamic QoS Control; Error Control and Extra High Speed Cell Search; Multicast; IP Mobility Control; Seamless IP Packet Transmission; Link Adaptation; Entrance Link; Radio on fibre.

4 Efficient Utilization of Frequencies

Exploitation of Microwave Frequency Band; Common Usage of Frequency Band; Adaptive Dynamic Channel Assignment; Technologies against Interference and Fading; High Density Three Dimensional Cell Structure, Advanced Adaptive Array Antenna (AAAA); Technologies of Adaptive High-Efficiency Multilevel Modulation

5 Advanced Mobile Terminals

Wearable Terminal Technology; Highly Functional Display Device Technology; Voice Recognition Technology; Next Generation Semiconductor Device Technology; Enhancement of Sensitivity; System Platform for Mobile Terminals; Security Enhancement Technology for Mobile Terminals

6.1 Areas for investigation

In general, technology trends affecting the future development of IMT-2000 and systems beyond can be divided into three general categories: core network trends, radio access network trends, and device/terminal trends. It is considered that core network trends are being addressed in ITU-T Working Groups and thus will not be discussed here.

6.1.1 Technology trends affecting wireless access networks

Operators of commercial wireless systems are constantly updating their networks to take advantage of the latest technologies. Some of the forces that drive operators to upgrade include:

– increase capacity;
– improve coverage;
– better manage the access network;
– develop innovative new services;
– improve quality of service;
– reduce operating expenses.

These reasons are not mutually exclusive, and may be achieved through one, or a combination, of technological advances. For example, improvements in spectral efficiency can increase capacity while reducing expenses.

These needs, in turn, drive a number of technology trends and developments:

– Software - there is an increasingly important role of software in ensuring satisfactory mobile communications in spite of the inherent limitations of wireless access. Improvements in data compression techniques and the increasing use of intelligent data filtering, to minimize in particular the real time communications requirements to meet individual user actual needs at that particular location and time, will greatly improve the quality of service perceived by mobile users.

– SDR.

– Dynamically variable-rate codecs.

– Mobile ad hoc network technology to satisfy requirements for:

  – handover between the IMT-2000 cellular based network and ad hoc networks;

  – support of multimedia services;

  – QoS support;

  – security;

  – distributed MAC;

  – dynamic routing support;

  – mobility support;

  – energy efficiency (power conservation).

6.1.2 Technology trends affecting terminal design and development

The needs of operators to upgrade their services forces improvements in terminal/device design, but consumer demands also play an important role. Operators must ensure that the devices are compatible with their networks and their services/technologies. This implies improvements in coding, modulation, security/authentication, and power control, among others. Many such functions are now or will soon be controlled in software. For consumers, other factors are more important; they want smaller and lighter devices, longer battery life, better screens, and higher speeds - all of which support the development of innovative services. All these needs are reflected in trends that include the following:

– SDRs;

– RF MEMS;

– battery technology;

– increased functionality, including multimedia and integrated services;

– person-machine interfaces including "intelligent" mobile terminals;

– etc.

7 [New Regulatory Impacts]

8 Spectrum Implications

According to the system characteristics described in the previous Sections, systems beyond IMT-2000 aim to achieve service bit rates up to 100 Mbit/s.

Two key factors that should be taken into account are (a) high-speed mobility support and (b) broad area coverage, from the mobile communication user viewpoint.

With regard to the support of high mobility environment, the suitable frequency bands should be as close as possible to the existing frequency bands, taking into account the physical nature of the fading radio channels.

The use of a higher frequency band leads to cell size reduction. This results in difficulty for economical deployment of area coverage.

It can be concluded that the suitable frequency ranges for systems beyond IMT-2000 are the ones that are not far away from the existing frequency bands for mobile communication use, and can accommodate such a broadband spectrum.

[It is envisaged that future mobile systems will probably be supported by the additional frequency bands below 5-6 GHz in order to support high-speed transmission with high mobility.]

A critical consideration in realizing the vision for the future development of ITM-2000 and systems beyond is the availability of adequate spectrum to support future advanced services. When considering the requirements to support these systems, it is useful to consider the timelines, services, and technology trends discussed above, recognizing that these topics may be further developed in additional recommendations and reports. More specifically, in analysing the spectrum implications of the future development of IMT-2000 and systems beyond, many issues must be addressed, including, but not limited to:

– traffic projections and requirements;
– service and application requirements;
– spectrum efficiency;
– radio transmission characteristics (TDD/FDD, duplex direction, transmit/receive separation, etc.);
– global roaming requirements and harmonized use of spectrum;
– sharing and compatibility analysis;
– evolution of IMT-2000 systems;
– potential need for and identification of additional spectrum.

As resolved by Resolution 228 (WRC-2000), spectrum requirements should be determined and potential frequency bands identified. It is anticipated that IMT-2000 and its enhancements will continue to operate in the bands identified by the ITU at WARC-92 and WRC-2000. Systems beyond IMT-2000 may require spectrum in addition to that now identified for IMT-2000 uses.

In order to address these issues, the ITU will need to update existing, or develop new recommendations and/or reports. For example, the general implementation issues associated with the future development of IMT-2000 and the introduction of systems beyond IMT-2000 may be addressed by modifying Recommendation ITU-R M.1036. Some new recommendations and reports, however, will likely be needed to address the issues noted above. For example, Document 8F/375, Attachemtn 8.8 describes the preferred options for frequency arrangements for IMT-2000 systems in bands identified by WARC-92 and WRC-2000. Other, additional recommendations and/or reports will likely be needed to address other aspects of the spectrum implications of the future development of IMT-2000 and systems beyond.

9 PDNR text

[Editor's note: This text has not been reviewed. It is anticipated that this review will take place during the 7th meeting.]

The ITU Radiocommunication Assembly,

considering

a) Resolution 737 (WRC-2000);

b) Resolution 228 (WRC-2000);

c) Question ITU-R 229/8 on future development of IMT-2000 and systems beyond IMT-2000;

d) that the use of internationally agreed frequency bands facilitates the planning of national networks that can support worldwide roaming, and avoids the risk of harmful interference with other radio services;

e) the increasing importance of various types of non-voice telecommunication services;

f) that a phased approach was adopted in Recommendation ITU-R M.687 for IMT-2000 in which Phase 1, the initial phase of IMT-2000 operation, includes terrestrial services supported by data rates up to approximately 2 Mbit/s, and satellite services up to approximately 144 kbit/s, and Phase 2 is envisaged as augmenting Phase 1 with new services, some of which may require higher bit rates;

g) that standardized radio interfaces facilitate the roaming of mobile units between networks;

h) that the satellite component, as an integral part of IMT-2000, can facilitate in providing global coverage for IMT-2000;

j) that the distinction between fixed, mobile and broadcasting services is becoming increasingly blurred as services become increasingly integrated;

k) that new applications such as mobile multimedia services and mobile commerce are likely to drive the demand for mobile systems including IMT-2000 and beyond;

l) that spectrum for IMT-2000 is identified in S5.388 (WARC-92) and [S5.384A, S5.317A, S5.351A] (WRC-2000) of the Radio Regulations;

m) that WRC-03 will consider progress on studies on the ongoing enhancement of IMT-2000 and systems beyond, in line with Resolution 228 (WRC-2000), with a view to WRC-05/06 considering frequency allocations;

n) that S5.388A establishes that in Regions 1 and 3, the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz and, in Region 2, the bands 1 885-1 980 and 2 110-2 160 MHz may be used by high altitude platform stations as base stations to provide International Mobile Telecommunications-2000 (IMT-2000), in accordance with Resolution 221;

noting

a) that advances in technology will allow the capabilities of IMT-2000 to be extended and new systems beyond IMT-2000 to support new applications for new market sectors,

recommends

that, based on the considerations, the objectives for the ongoing enhancement of IMT-2000 and of systems beyond IMT-2000 should conform to the following objectives and characteristics:

1 General Objectives

1.1 the capabilities of IMT-2000 should continue to be developed to the extent demanded by the market and allowed for by technical advances, in the context of providing advanced multimedia services on a global basis;

1.2 [alongside the future development of IMT-2000, applications beyond IMT-2000 should be considered to support new applications and market opportunities not likely to be provided by IMT-2000];

1.3 the future development of IMT-2000 comprises the near- and medium-term time frame, up to 10 or 15 years from now;

1.4 systems beyond IMT-2000 comprise the long-term time frame, more than 10 years from now;

1.5 terminal and personal mobility are supported in both future development of and systems beyond IMT-2000

1.6 services in various radio operating environments are available (high/low tier movement, indoor, satellite, etc.)

1.7 a wide range of data rates is supported according to economic and service demands from [2 Mbit/s] (full movement) up to about [20 Mbit/s] and beyond (stationary or nearly so) in new mobile systems

1.8 the future development of and systems beyond IMT-2000 are based on defined service capabilities, rather than on defined services

1.9 Improved Quality of Service (QOS) management capabilities for multi-media services to support operator’s requirements to provide high-quality service to end-users

1.8 Increased operator flexibility to dynamically allocate system resources amongst users

2 Objectives for the Future Development of IMT-2000:

2.1

2.2 [Enhancements to IMT-2000 wireless access methods should focus on revision of the existing radio interfaces;]

2.3 [Enhancements to IMT-2000 wireless access methods should be compatible with frequency identifications and usage for IMT-2000 (WARC-92, WRC-2000)];

2.4 the target information bit rate should be an averaged maximum possible bit rate (AMBR) less than 20 Mb/s in multi-user and multi-cell environments;

2.5 global roaming is to be provided across IMT-2000 and other systems and networks in the medium-term;

2.6 Future development of IMT-2000 should provide a cost-effective method of migrating or evolving 1st and 2nd generation cellular systems towards IMT-2000

2.7 IP-packet data should be supported for both real time and non-real time applications for “medium-term developments

2.8 Security protocols must support a single user having multiple IMT-2000 devices that are in use simultaneously

2.9 Revisions to existing ITU M.Series Recommendations on IMT-2000 or development of new M.Series Recommendations or reports should reflect the future development of IMT-2000 on aspects such as:

2.9.1 Vision and Objectives of the Ongoing Enhancement of IMT-2000 and of Systems beyond IMT-2000

2.9.2 CPM Text

2.9.3 Spectrum considerations, spectrum calculation methodology, and spectrum requirements

2.9.4 Framework for services

2.9.5 Operational characteristics, management framework, performance, quality of service requirements, and security requirements

2.9.6 Network architecture

2.9.7 Framework for the radio interface(s) and radio interface requirements

2.9.8 Evolution and modularity principles

2.9.9 Integration of systems (e.g., Bluetooth and wireless terminals) and convergence of services (e.g., broadcasting and mobile services)

2.9.10 Key characteristics

2.9.11 Evaluation guidelines

2.9.12 Global core specifications

2.9.13 Technology Enablers

3. Objectives for Systems Beyond IMT-2000

3.1 Systems beyond IMT-2000 will likely deploy wireless access method distinct from those in Rec. ITU-R M.1457

3.2 Additional spectrum beyond that identified at WARC-92 and WRC-2000 may need to be available for systems beyond IMT-2000

3.3 that the target information bit rate should be an averaged maximum possible bit rate (AMBR) greater than 20 Mb/s in multi-user and multi-cell environments;

3.4 Security protocols must support a single user having multiple IMT-2000 devices that are in use simultaneously

3.5 *Networking aspects of systems beyond IMT-2000 should be based IP technologies or more advanced technologies*

3.6 Flexible allocation of required system capacity is available

3.7 Seamless service via different technologies is provided via global roaming and hand-over support to other different systems

3.8 QoS for real time services and efficient transport of packet-oriented services is provided comparable quality with wire-line network

3.9 A wide range of services including symmetrical and asymmetrical services is supported on a global basis

3.10 A significant portion of the system complexity is in the base station to simplify terminal implementation

3.11 Network entities and terminals can be reconfigured

3.12 Revisions to existing ITU M.Series Recommendations on IMT-2000 or development of new M.Series Recommendations or reports should reflect the development of systems beyond IMT-2000 on aspects such as:

3.12.1 Vision and Objectives of the Ongoing Enhancement of IMT-2000 and of Systems Beyond IMT-2000

3.12.2 CPM Text

3.12.3 Spectrum considerations, spectrum calculation methodology, and spectrum requirements

3.12.4 Framework for services

3.12.5 Operational characteristics, management framework, performance, quality of service requirements, and security requirements

3.12.6 Network architecture

3.12.7 Framework for the radio interface(s) and radio interface requirements

3.12.8 Evolution and modularity principles

3.12.9 Integration of systems (e.g., Bluetooth and wireless terminals) and convergence of services (e.g., broadcasting and mobile services)

3.12.10 Key characteristics

3.12.11 Evaluation guidelines

3.12.12 Core specifications

3.12.13 Technology Enablers

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