



Report ITU-R M.2176
(07/2010)

Vision and requirements for the satellite radio interface(s) of IMT-Advanced

M Series
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***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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1 Introduction

International Mobile Telecommunications-Advanced (IMT-Advanced) systems are mobile systems that include the new capabilities of IMT that go beyond those of IMT-2000. Such systems provide access to a wide range of telecommunication services, including advanced mobile services supported by mobile and fixed networks, which are increasingly packet-based.

IMT-Advanced systems support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple user environments. IMT-Advanced also has capabilities for high-quality multimedia applications within a wide range of services and platforms providing a significant improvement in performance and quality of service.

The key features of IMT-Advanced are:

- a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high-quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, service and equipment;
- worldwide roaming capability;
- enhanced peak data rates (i.e. wideband) to support advanced services and applications.

These features enable IMT-Advanced to address evolving user needs.

The capabilities of IMT-Advanced systems are being continuously enhanced in line with user trends and technology developments.

The satellite component of IMT-Advanced will be an integral part of future IMT infrastructure with the optimized service delivery.

Regarding the development of terrestrial radio interface(s) of IMT-Advanced, ITU-R WP 5D has already developed the Reports ITU-R M.2133, ITU-R M.2134 and ITU-R M.1235 in order to define service and technical minimum requirement and present evaluation guideline and criteria for the terrestrial radio interface(s) of IMT-Advanced. However, it is indicated that ITU-R WP 5D did not take into consideration characteristics of satellite systems on its development of the related Reports. Therefore, the requirements and evaluation guidelines developed by WP 5D should be considered for the development of satellite radio interface(s) of IMT-Advanced and modified considering specific satellite characteristics, such as longer transmission time between satellite and earth terminal or earth station, if necessary.

2 Scope

The purpose of this Report is to build visions on the satellite component of IMT-Advanced in terms of application scenarios, service, system, radio interface and network aspects and the considered specific features, to address a high-level of the constraints placed on the satellite radio interface(s) of IMT-Advanced particularly with respect to service and technical requirements, and finally to provide evaluation criteria and methodology on the requirements in order to produce Recommendations for development of the satellite radio interface(s) of IMT-Advanced.

3 Structure of the Report

Section 4 provides a list of the documents that are related to this Report.

Section 5 provides a list of definitions, acronyms and abbreviations.

Section 6 describes visions on the satellite component of IMT-Advanced.

Section 7 defines requirements for the satellite radio interface(s) of IMT-Advanced.

Section 8 provides guidelines for evaluation of candidate satellite radio interface(s) of IMT-Advanced.

Section 9 provides a list of references.

4 Related ITU documents

Resolution ITU-R 57

Recommendation ITU-R M.1645

Recommendation ITU-R M.1822

Report ITU-R M.2133

Report ITU-R M.2134

Report ITU-R M.2135.

5 List of definitions, acronyms and abbreviations

5.1 Definitions

None.

5.2 Acronyms and abbreviations

3GPP	Third Generation Partnership Project
ACM	Adaptive Coding and Modulation
ARQ	Automatic Repeat request
CDMA	Code-Division Multiple Access
CGC	Complementary Ground Component
DL	Downlink
e.i.r.p.	Equivalent Isotropically Radiated Power
FDD	Frequency-Division Duplexing
FDMA	Frequency-Division Multiple Access
FEC	Forward Error Correction
FH	Frequency Hopping
G/T	Antenna Gain to noise Temperature ratio
HARQ	Hybrid Automatic Repeat request
IDMA	Interleave Division Multiple Access
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol

IPv6	Internet Protocol version 6
IMAP	Internet Message Access Protocol
IMT	International Mobile Telecommunications
ITS	Intelligent Transportation Systems
LMS	Land Mobile Satellite
LTE	Long-Term Evolution
MAC	Media Access Control
MCW	Multi-Codeword
MIMO	Multi-Input Multi-Output
MS	Mobile Station
MUD	Multi-User Detection
NGN	Next-Generation Network
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency-Division Multiplexing Access
PAPR	Peak to Average Power Ratio
PF	Proportional Fairness
PHY	Physical
PN	Pseudo Noise
QoS	Quality of Service
POP	Post Office Protocol
RF	Radio Frequency
RIT	Radio Interface Technology
RRM	Radio Resource Management
RNC	Radio Network Controller
RX	Receiver
SCW	Single Codeword
SDMA	Space-Division Multiple Access
SRIT	Set of Radio Interface Technology
STBC	Space-Time Block Coding
STC	Space-Time Coding
TDD	Time-Division Duplexing
TDMA	Time-Division Multiple Access
TX	Transmitter
UL	Uplink
UT	User Terminal
VoIP	Voice over Internet Protocol

6 Visions on the satellite component of IMT-Advanced

IMT-Advanced systems are mobile service systems that include the new capabilities of IMT going beyond those of IMT-2000. Such systems provide access to a wide range of telecommunication services, including advanced mobile services supported by mobile and fixed networks, which are increasingly packet-based. IMT-Advanced systems support low to high-mobility applications and a wide range of data in accordance with user and service demands in multiple user environments. IMT-Advanced also has capabilities for high quality multimedia applications in a wide range of services and platforms anywhere, providing a significant improvement in performance and quality of service.

In order to provide the seamless service in a global coverage, the satellite component of IMT-Advanced systems would be considered because the terrestrial component only would not be possible to be deployed all over the world.

The aim of this section is to define visions on satellite component of IMT-Advanced for an efficient IMT service delivery with respect to application scenarios, services, system, radio and network interface aspects, and to provide possible candidate system architectures.

6.1 Application scenarios

The application scenarios include:

- two-way communications using multibeam with frequency reuse scheme;
- interactive digital multimedia broadcasting using multibeam.

The two-way communications can be regarded as a coverage extension on service continuity of terrestrial part with vertical handover. One of the major advantages using satellite is its capability to provide a global coverage. It can offer services in certain regions outside terrestrial coverage. The areas not adequately covered by terrestrial part include physically isolated regions, gap of terrestrial network and areas where terrestrial collapses due to disaster. In the scenario of “two-way communications using multibeam with frequency reuse scheme”, handover technique between the satellite and terrestrial component of IMT-Advanced system would be the most important to consider. For the cost-effective vertical handover, future satellite radio interfaces of IMT-Advanced should be compatible and may have a high degree of commonality with an envisaged terrestrial interface. It would offer the possibility to reuse terrestrial part technology to minimize user terminal chipset and network equipment for low cost and fast development.

In addition, the satellite radio interface considered for “two-way communications” scenario with some adaptation with satellite environment can provide interactive multimedia broadcasting services, as the envisaged terrestrial radio interfaces of IMT-Advanced is being developed in order to handle efficiently multimedia broadcasting and multicasting services as well as a bidirectional communication services in a cellular system. In the “interactive multimedia broadcasting” scenario, an integrated satellite and CGC infrastructure would be required. Indeed, the satellite component of IMT-Advanced has an advantage over terrestrial component for delivery of same contents to spread over a wide geographical area.

6.2 Services aspects

The following high-level requirements are described in Recommendation ITU-R M.1822:

- Seamless connectivity
- Mobility management
- Interoperability
- Constant connections

- Applicability scalability
- Security
- Prioritization
- Location
- Broadcast/multicast
- Presence
- Usability including voice reconfiguration and user-friendly human-to-machine interface
- Support of a wide range of services.

The following list provides a wide range of telecommunication service offerings that will increase as new applications are developed based on the advancement of technology.

TABLE 1
IMT services and examples

User experience class	Service class	Example services
Conversational	Basic conversational	Voice telephony (including VoIP) Emergency calling Push-to-talk
	Rich conversational	Videoconference High-quality video telephony Remote collaboration e-education (e.g. video call to teacher) Consultation (e.g. video interaction with doctor) Mobile commerce
	Conversational low delay	Interactive gaming Consultation Priority service
Interactive	Interactive high delay	e-education (e.g. data search) Consultation (e.g. data search) Internet browsing Mobile commerce Location-based services ITS-enabled services
	Interactive low delay	Emergency calling e-mail (IMAP server access) Remote collaboration (e.g. desktop sharing) Public alerting (e.g. with feedback) Messaging (instant messaging) Mobile broadcasting/multicasting (mobile interactive personalized TV) Interactive gaming

TABLE 1 (*end*)

User experience class	Service class	Example services
Streaming	Streaming live	Emergency calling Public alerting e-education (e.g. remote lecture) Consultation (e.g. remote monitoring), Machine-to-machine (e.g. observation) Mobile broadcasting/multicasting Multimedia
	Streaming non-live	Mobile broadcasting/multicasting e-education (e.g. education movies) Multimedia Mobile commerce Remote collaboration
Background	Background	Messaging, Video messaging Public alerting e-mail (transfer RX/TX, e.g. POP) Machine-to-machine File transfer/download e-education (file download/upload) Consultation (file download/upload) Internet browsing Location-based service

The development of mobile telecommunication networks and the need for higher data rates allow the development of new user services and concurrently create the possibility to stay connected everywhere in the best possible condition. The services required for the satellite component of IMT-Advanced would be similar to that provided by terrestrial component assuming the new applications and new user services may appear.

To make provision for mobile broadcasting/multicasting services, specific satellite resources may be dedicated to them.

The system network layer has to support these different types of services with different requirements. Moreover, the satellite system constraints will give impacts on the latency, jitter and average and peak throughput and corresponding QoS parameters. And support of VoIP at the same level of QoS as on the terrestrial component may give a constraint on the satellite component of IMT-Advanced.

6.3 System aspects

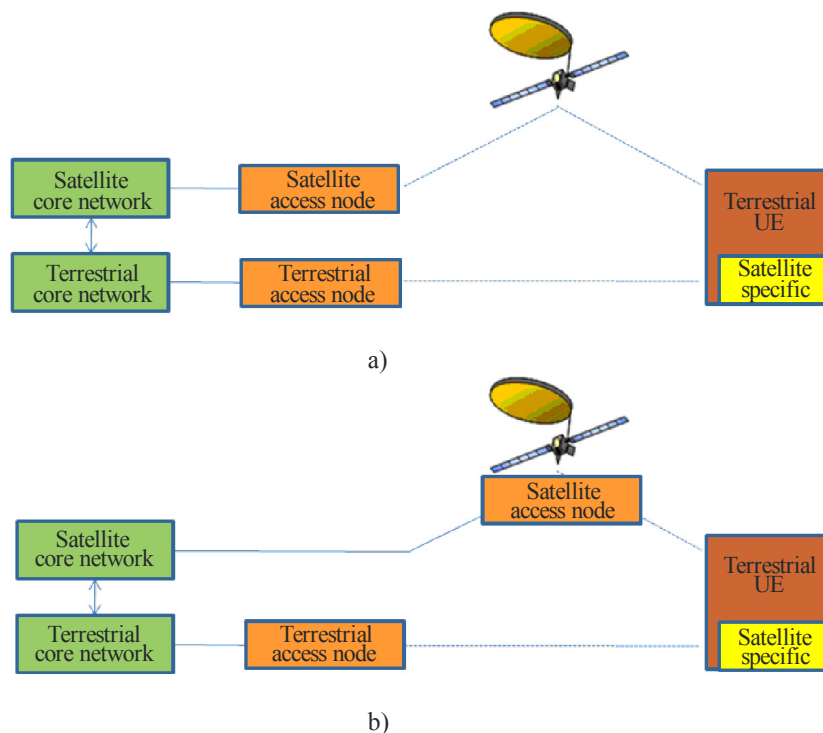
As mentioned before, the integration between satellite and terrestrial components of IMT-Advanced would be required in order to effectively utilize the respective areas of strength of each network within their traditional roles and mandate. An integrated satellite and terrestrial network can contribute to the emergence and utility of NGNs in providing ubiquitous and universal broadband versatile IP-based services to end users who will require generalized mobility, accessed in a seamless fashion and, ultimately, will dictate its realization through market forces. A typical large-scale integrated system comprises multi-beam satellites and a nationwide or regional ensemble of CGC and terrestrial component wherein both satellite and CGC segment communicate

with user equipment using a common set of MSS frequencies to handle broadcasting scenarios, while terrestrial components using a separate set of frequencies to provide ubiquitous coverage of broadband two-way communications to end users with generalized mobility requirements.

The satellite component of IMT-Advanced has sufficient power and receiver sensitivity to establish communications with end-user devices that are indistinguishable from the terrestrial component. Large satellite antennas, providing high-gain reconfigurable multi-beam are one of the key attributes of integrated systems. These features enable increase of spectrum reuse as well as communications via typical low-cost handheld terminals. User equipment of an integrated system should have a capability to select the relevant component – either the satellite- or terrestrial-based – on the receiving signal level and network availability to keep certain service quality over a wide and continuous service area. It would be preferable that the integrated system should have roaming capability with a unique user/subscriber identifier across both terrestrial and satellite system. Handover between satellite and terrestrial components in an integrated system should be carried out within the extent that execution of handover does not significantly decrease the system capacity or increase system complexity.

A concept for this integrated system is shown in Fig. 1.

FIGURE 1
Concept for the integrated system



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6.4 Radio interface aspects

The objective of the integrated IMT-Advanced system is to use, as far as possible, the same equipment and protocols, i.e. the same hardware, software and facilities for both satellite and terrestrial components of IMT-Advanced to minimize costs. Therefore, the techniques (access parameters, bit rates, protocols, etc.) adopted for the satellite system have to be similar to hardware commonality or even the same as those of the terrestrial component.