International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series Q

Supplement 66

(07/2014)

SERIES Q: SWITCHING AND SIGNALLING

ITU-T Q.1740-series – Supplement on scenarios and requirements in terms of services and deployments for IMT and IMS in developing countries

ITU-T Q-series Recommendations – Supplement 66

International Telecommunication Union

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR THE NGN	Q.3000–Q.3999

For further details, please refer to the list of ITU-T Recommendations.

Supplement 66 to ITU-T Q-series Recommendations

ITU-T Q.1740-series – Supplement on scenarios and requirements in terms of services and deployments for IMT and IMS in developing countries

Summary

International mobile telecommunications (IMT) and IP multimedia subsystem (IMS) are some of the technologies that have been developed to adequately respond to the demand for versatile telecommunication service offerings. The current demands include; high bit rates, high quality of service (QoS) and quality of experience (QoE), mobility, international (roaming) capability for multimedia services, compatibility (backward and forward), affordability, easy to use end user terminals and security, among others. Fundamentally, these networks are ubiquitous in nature and are based on Internet protocol (IP).

Developed countries have quickly implemented IMT in almost all their networks and the majority has also implemented IMS. Developing countries are much slower in implementing IMT and IMS. In this Supplement, information on the slow of IMT and IMS in developing countries is highlighted and some suggestions are made to overcome the challenges.

Supplement 66 to ITU-T Q-series Recommendations is limited to providing advisory information, especially to developing countries, on the requirements for migration to IMT and IMS, challenges to migration and some scenarios of migration to IMT and IMS drawn from feedback from developing countries.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q Suppl. 66	2014-07-18	13	11.1002/1000/12211

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Supplement 66 to ITU-T Q-series Recommendations

ITU-T Q.1740-series – Supplement on scenarios and requirements in terms of services and deployments for IMT and IMS in developing countries

1 Scope

There is a worldwide explosion in demand for increased bandwidth, mobility, multiple new applications, games, better quality of service and instant access to information. These demands are being driven by higher incomes and increased levels of computer literacy. While the explosion is most significant in developed countries, recent statistics show a growing demand among developing countries.

The most recent access technologies providing increased bandwidth for mobile networks related to international mobile telecommunications (IMT) are long term evolution (LTE) access technologies. In order to enable session based services such as voice over LTE (VoLTE) with a high level of quality, the IP multimedia subsystem (IMS) has gained significant relevancy in mobile telecommunication networks.

Many operators in developed countries have implemented these technologies. In developing countries these technologies have already been implemented by some mobile networks while others are in the process of implementing them; however the majority have yet to commence implementation. Some countries are still deploying legacy networks with architecture based on the seven layers of open system interconnection (OSI), while others have deployed state of the art networks based on next generation networks (NGN) with a simplified architecture of only two layers, the service layer and the transport layer. Reasons for slow implementation mostly relate to financing (initial capital investment) and economics (doubt as the whether the market will take up the services and recoup the investment). There is also reluctance due to insufficient understanding of the benefits of IMT and IMS.

Despite these drawbacks, it is the desire of many developing countries to evolve their networks and migrate their users enabling them to take advantage of the many services being provided by modern networks. Thus IMT and IMS systems are important to developing countries.

This Supplement has been provided in direct response to a request by developing countries for an examination of the issues relating to migration to IMT and IMS, to offer those countries guidance on migration and to present the best practices for the implementation of IMT and IMS in mobile networks.

A survey carried out in some developing countries concerning the status of IMT and IMS indicated that 76% of respondents were willing to migrate to IMT while 81% are planning to migrate to IMS. Over 64% of countries surveyed from Africa have implemented mobile networks capable of IMT and the rest are planning to implement IMT and IMS capable networks within two to five years. . The survey found fourteen countries in Africa which had implemented IMS in their mobile networks. Those countries were South Africa, Uganda, Morocco, Algeria, Namibia, Liberia, Angola, Cameroon, Ghana, Botswana, Côte d'Ivoire, Gambia, Nigeria and Rwanda. However a number of countries in Africa were in advanced stages of negotiation with vendors while others were in the testing stage.

The 2014 statistics on IMS in developing countries especially in Africa are incomplete, however, going purely by availability of IP networks as a basic requirement for IMS, 64% of countries in Africa are capable of implementing IMS and it is therefore just a question of making the decision to implement.

This Supplement aims at providing information and scenarios that are expected to be useful to those developing countries which are yet to migrate to or implement IMT and IMS in their mobile networks.

2 References

[ITU-T I.112] Recommendation ITU-T I.112 (1993), *Vocabulary of terms for ISDNs*

[ITU-T Q.1290] Recommendation ITU-T Q.1290 (1998), *Glossary of terms used in the definition of intelligent networks*

[ITU-T Q.1742.4] Recommendation ITU-T Q.1742.4 (2005), *IMT-2000 references (approved as of 30 June 2004) to ANSI-41 evolved core network with cdma2000 access network.*

[ITU-T Y.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions*.

[ITU-T Y.1401] Recommendation ITU-T Y.1401 (2008), *Principles of interworking*

[ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN*.

[ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks*.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

[ITU-R M.1308] Recommendation ITU-R M.1308 (1997), *Evolution of land mobile systems towards IMT-2000*

[ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000*.

[ITU-R M.1822] Recommendation ITU-R M.1822 (2007), *Framework for services supported by IMT*.

[ITU-R 56-1] Resolution ITU-R 56-1 (2012), *Naming for International Mobile Telecommunications*.

[ETSI TS 123 002] ETSI TS 123 002 V7.1.0 (2006), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Network architecture*.

[ETSI TS 123 228] ETSI TS 123 228 V7.3.0 (2006), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); IP Multimedia Subsystem (IMS); Stage 2*.

[ITU-R 57] Resolution ITU-R57 (2007), *Principles for the process of development of IMT‑Advanced*

[TIA-873.002] TIA-873.002-A (2006), *All-IP Core Multimedia Domain, IP Multimedia Subsystem – Stage 2*.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 evolution [ITU R M.1308]: A process of change and development of a mobile radio system towards enhanced capabilities.

3.1.2 evolution towards IMT-2000 [ITU R M.1308]: A process of change and development of a mobile radio system towards the capabilities and functionalities of IMT-2000.

3.1.3 integrated services digital network [ITU-T I.112]: An integrated services network that provides digital connections between user-network interfaces.

3.1.4 IP-based networks [ITU-T Y.1401]: A network in which IP is used as one of the Layer 3 protocols.

3.1.5 migration to IMT-2000 [ITU R M.1308]: Movement of users and/or service delivery from existing telecommunication network to IMT-2000.

3.1.6 next generation network [ITU-T Y.2001]: A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

3.1.7 public switched telephone network [ITU-T Q.1290]: A telecommunications network established to perform telephone services for the public subscribers.

3.1.8 ubiquitous networking [ITU-T Y.2002]: The ability for persons and/or devices to access services and communicate while minimizing technical restrictions regarding where, when and how these services are accessed, in the context of the service(s) subscribed to.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

1G	First Generation Network
2.5G	2.5 Generation Networks
2G	Second Generation Network
3G	Third Generation Network
4G	Fourth Generation Network
AMPS	Advanced Mobile Phone System
ANSI	American National Standards Institute
API	Application Programming Interface
ARPU	Average Revenue Per User
CAPEX	Capital Expenditures
CATV	Cable Television
CDMA	Code Division Multiple Access
CPE	Customer Premise Equipment
EDGE	Enhanced Data rates for GSM Evolution
EPC	Experiment Pointing Control
ETSI	European Telecommunications Standards Institute
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HSPA	High-Speed Packet Access
ICT	Information and Communication Technologies

IEC	International Electrotechnical Commission
IMS	IP Multimedia Subsystem
IMT	International Mobile Telecommunications
IN	Intelligent Network
IP	Internet Protocol
IPX	Internetwork Packet Exchange
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
LTE	Long Term Evolution
VoLTE	Voice over LTE
MMS	Multimedia Messaging Service
NEP	Network Equipment Provider
NGN	Next Generation Network
OCS	Outgoing Call Screening
OPEX	Operational Expenditures
OSI	Open System Interconnection
PHS	Personal Handyphone System
PSDN	Packet Switched Data Network
PSTN	Public Switched Telephone Network
QoE	Quality of Experience
QoS	Quality of Service
SG	Study Group
RA	Radiocommunication Assembly
SIGTRAN	Signalling Transport
SIP	Session Initiation Protocol
SMS	Short Message Service
SNA	Systems Network Architecture
SS7	Signalling System No. 7
TACS	Total Access Communication System
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TIA	Telecommunications Industry Association
TS	Time Slot
TSB	Telecommunication Standardization Bureau
UMTS	Universal Mobile Telecommunications System
VOIP	Voice over Internet Protocol

WACS West Africa Cable System

WAP Wireless Application Protocol

WCDMA Wideband Code Division Multiple Access

Wi-Fi Wireless Fidelity

WiMAX Worldwide Interoperability for Microwave Access

WLAN Wireless Local Area Network

WTSA World Telecommunication Standardization Assembly

xDSL x-type Digital Subscriber Line

5 Conventions

None.

6 Overview of IMT and IMS

6.1 IMT

6.1.1 Introduction to IMT

IMT access technologies enable mobile networks to have new capabilities that provide access to a wide range of telecommunication services including advanced mobile services supported by mobile and fixed networks (e.g., PSTN/ISDN/IP) as well as access to other services which are specific to mobile users. Most networks are increasingly packet-based. IMT 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.

Deployment of IMT systems started in the year 2000 following the introduction of ITU approved Recommendation ITU-R M.1457, which contains specifications for radio interfaces of IMT-2000. It was at this point that IMT was renamed IMT-2000. IMT-2000 is a third generation network (3G) mobile cellular technology and provides access by means of radio links.

To help meet the ever increasing demands for wireless communication and the expected higher data rates needed to meet user requirements, the ITU Radiocommunication Assembly (RA) approved Question ITU-R 229/8 on the future development of IMT-2000 and of systems beyond IMT-2000. This and other efforts have moved IMT from the initial IMT-2000 via IMT Advanced to IMT and Beyond.

All networks which do not have IMT capabilities are referred to as pre-IMT-2000 and ITU and other standardization bodies have made recommendations on the most feasible ways to evolve and migrate from pre-IMT-2000 to IMT-2000.

6.1.2 Benefits of IMT

The implementation of IMT has many benefits including:

– mobility;

– 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 IMT services with fixed networks;

– capability of interworking with other radio access systems;

– high quality mobile services;

– user equipment suitable for worldwide use;

– user-friendly applications, services and equipment;
– worldwide roaming capability;
– enhanced peak data rates to support advanced services and applications (100 Mbit/s for high mobility and 1 Giga bit per second for low mobility.

It is recognized that each country is unique and as such it will prioritize the benefits of implementing IMT and IMS to meet its national interests.

6.2 IMS

6.2.1 Introduction to IMS

The IP multimedia subsystem (IMS) is defined in [ETSI TS 123 228] and in [TIA-873.002] as a collection of core network functional entities for the support of session initiation Protocol (SIP)-based services. The Third Generation Partnership Project (3GPP) defines IMS as a generic architecture for offering multimedia and voice over IP services. In more general terms, IMS is a standardized IP-based architecture that supports multiple network types and multimedia applications.

6.2.2 Justification for IMT and IMS in the mobile networks of developing countries

IMT and IMS are without a doubt needed in the mobile networks of developing countries. The experience of countries that have implemented these technologies demonstrates many of the benefits of implementing these technologies in networks. The majority of benefits relate to:

– the modernization of mobile networks;
– the creation of new business opportunities (innovations);
– enriched QoS and QoE for consumers;
– increased bandwidth;
– efficient spectrum utilization;
– improved billing.

However each country must fully understand these technologies and identify their own national requirements justifying the implementation. Further justifications for the implementation of IMT and IMS that may be of particular relevance to developing countries are described below:

i) Growth of mobile networks in developing countries

In the recent past, there has been an unprecedented growth in mobile usage in many developing countries. In most developing countries, mobile connections have already surpassed fixed line connections. This is mainly due to the ease and more cost-effective rollout of mobile networks which are largely wireless, as compared to the rollout of a fixed network.

This development means mobile networks are now the *de facto* backbone networks in most developing countries and it is therefore very important that these networks adopt the most effective and most economical features available. IMT and IMS are now key features of modern mobile networks and as such should be the aspiration of every mobile network operator aiming to have the best.

ii) New business opportunities

IMT and IMS add capabilities and features in mobile networks that make it easier to launch new business and innovations. Given the growth (expansion of the networks and the subscriber growth) in mobile networks, especially in developing countries, mobile operators now have the opportunity to implement new business innovations. A good example is the mobile money platforms that are now very popular in the East and Central African regions. These business opportunities bring in additional hitherto non-traditional revenues.

iii) Tapping into revenues from roaming users

There is an increasing number of visitors to developing countries on business, tourism, educational or official duties. Most of these visitors wish to continue communicating in the same way as in their home countries, essentially by having the same access and services. IMT and IMS provide a certain level of confidence that this will be possible as such high-end roaming can easily be supported. On the other hand, where such applications are not supported, visitors will not be able to access them which represents a lost opportunity for the visited operator to earn revenue.

iv) Efficient utilization of resources

In developing countries especially, the resources required for the deployment of communications are increasingly becoming scarce. Resources to be considered include:

– the spectrum utilization for rolling out the last mile system;
– the high cost of electricity to run communications systems;
– the training and retention of skilled manpower; and
– the finances for the roll-out of new systems and services.

Many developing countries will therefore favour the implementation of systems and technologies that are resource efficient. IMT systems have been designed to be resource efficient, especially in spectrum utilization.

v) Platforms for global modern services and applications

Developing countries can no longer afford to remain islands of "old" networks and should not be left behind on new technological developments. They should be desirous of building platforms that can offer modern services and applications available everywhere in the world.

Additional justifications for embracing IMT and IMS include:

– providing a transition towards IMS based mobile networks;
– lower investment costs;
– supporting mobility of data services;
– supporting billing for data services;
– improved QoS and QoE.

6.3 Expected benefits from IMT and IMS for developing countries

While IMT and IMS offer many benefits, developing countries need to rationalize their expectations for implementing these technologies. When deciding on and justifying the implementation of IMT and IMS, developing countries need to carefully analyse, understand, balance and prioritize the benefits in order to get the best from the implementation.

Each developing country has unique expectations concerning benefits and these should play a key role on the decision for implementing IMT and IMS. For example, while most developed countries are keen on achieving high bit rates, quality of service and better utilization of scarce resources, the priority for most developing countries is in providing affordable services to their rural and underserved areas.

Generally, the most commonly expected benefits that most developing countries have concerning IMT and IMS as new technologies include:

– addressing convergence between mobile and fixed services;
– backward compatibility with existing networks;
– bring the country up-to-date with current technology (modernization);
– efficient utilization of electricity;
– meeting the need for affordable and economical solutions for rural communication needs;

– billing accuracy;
– QoE;
– QoS;
– security;
– spectrum efficiency for wireless technologies;
– support of modern services (data and multimedia) while maintaining voice services;
– increasing revenue streams from mobile operations.

Developing countries should therefore carefully examine IMT and IMS to see how well they respond to their unique requirements including the above benefits before they can wholly embrace implementation. Each developing country is encouraged to strike a balance on its priorities taking into account its unique national aspirations.

6.3.1 Specific benefits from the implementation of IMT

Specific benefits resulting from the implementation of IMT are described below:

i) Capabilities and services

IMT access technologies like LTE provide higher bandwidth for mobile networks for launching newer services such as multimedia services. IMT access technology further supports effective spectrum utilization which results in increased cost effectiveness.

Developing countries should thus be desirous to improve and modernise their telecommunication infrastructures which are largely based on telephone oriented services, such as PSTN/ISDN services.

ii) Operational features

Key features of IMT are described in [ITU-R M.1645], [ITU-R M.1822] and IMT-Adv/2Rev.1 and include the following:

– less capital intensive compared to fixed networks;
– easier to manage (day to day);
– improved reliability;
– a lot of commonly available support (similar systems);
– high degree of commonality of design worldwide;
– compatibility of services within IMT-2000 and with the fixed networks;
– high quality;
– small terminal for worldwide use;
– worldwide roaming capability;
– capability for multimedia applications and a wide range of services and terminals;
– better average revenue per user (ARPU).

iii) Catching up with modern trends (Technological and otherwise)

In developing countries, the task of bridging the digital divide arrived at a juncture where most of the countries were still grappling with the problem of providing voice access. Large-scale computerization and the growth of e-services require higher bandwidth availability on the local access network. In these developing countries, most of the access networks are likely to be implemented using wireless technology and therefore IMT systems have a unique advantage in these markets.

iv) Resource management

Developing countries have a responsibility to manage resources well. These days, developing countries are very concerned about whether the new technologies, innovations and systems utilize resources efficiently.

v) Electricity requirements

In keeping with the desire of developing countries to ensure efficient resource management the reduced electricity requirements of IMT systems are important. In many developing countries, electricity is expensive and only available in cities and major towns, leaving most rural areas without commercial mains supply electricity. These rural areas can only be serviced using alternative power sources such as solar and wind power. Electricity consumption is therefore a key factor in deciding on the type of communications systems to be adopted.

vi) Health and the environment

Many developing countries are now cautious about technologies and their effects on health. Developing countries are keen to be satisfied that new systems and technologies do not pose environmental or health risks.

vii) Consumer issues

On behalf of the consumer, governments in developing countries are usually concerned about:

– end user terminal size and cost;
– availability of end user terminal and after-sales services;
– service costs;
– QoS;
– QoE;
– availability;
– suitability for rural utilization;
– environmental and health issues;
– ease to use.

For any new system or technology to be considered favourably, it should be able to address the above issues.

Globally there is documented evidence that IMT operators are experiencing increasing growth in ARPU and most of it can be directly attributed to users adopting and using packet data services.[1]

6.3.2 Specific benefits from implementing IMS

Capabilities and services supported by IMS are numerous and include:

– combining voice, text, pictures and video in seamless call sessions;
– defining a number of network reference points to support operator-provided services and other security arrangements;
– offering significant ease-of-use to subscribers and allowing service providers to drive branding through a common interface while substantially reducing costs;
– supporting defined reference points within the underlying transport infrastructure for the enforcement of QoS negotiated by session signalling and for flow gating;
– supporting authentication as part of registration;

[1] 3G World Congress in Hong Kong June 2002 – "Mobile Services in Korea, 1X and Beyond", Wong Tong, President Samsung R&D Institute.

– supporting defined reference points for the collection of accounting data in support of charging and billing operations. These reference points also support the exchange of information in support of correlation of charging between IMS and the underlying transport;
– supporting multiple access operations and interworking with a variety of external networks (such as GSM, WCDMA and CDMA 2000) via defined reference points;
– supporting the registration of the user and the terminal device at a particular location in the network.

IMS assumes IP networks and is essentially used to enable and enhance capabilities for providing and managing new applications over networks. The implementation of IMS is mostly a choice by an operator as a way to improve revenues and operations.

It is recognized that each country is unique and as such it will prioritize the benefits of implementing IMT and IMS to meet its national interests.

7 Implementation of IMT and IMS in mobile networks of developing countries

7.1 Introduction

The steps to be followed when implementing IMT and IMS may differ from country to country according to the existing networks and the availability of resources such as spectrum.

Generally, implementation of IMT requires the availability and access to the IMT spectrum. This is a big challenge in some developing countries as they may not have anticipated these requirements and may have already assigned the resources. As a consequence there may be insufficient quantities of spectrum remaining in the required IMT bands. A number of developing countries have been able to overcome this problem by issuing 3G licenses in the higher bands which had not been allocated to other uses. Spectrum re-planning and reforming will therefore be necessary in some countries.

On the other hand, implementation of IMS assumes the availability of IP based networks. Fortunately, many developing countries are currently in the process of rolling out IP networks and it will be a next logical step for such countries to implement IMS.

Unlike IMT where governments may be involved, IMS is yet to catch the attention of many governments in developing countries and its implementation has been left solely to the operators.

Due to the high cost of implementing IMT and IMS, some developing countries are considering a shared infrastructure approach to reduce the cost burden on individual operators.

Detailed technical information on the implementation of both IMT and IMS can be found in the ITU Handbook on Migration to IMT-2000 Systems and information on the implementation of IMS for NGN can be found in [ITU-T Y.2012].

In developing countries, the rate of implementation of these new technologies and systems is still low. In a number of developing countries, some operators have recently invested in legacy networks and are reluctant to invest in new technologies before they recoup their investment. Furthermore, where governments in developing countries are part owners of networks, it is important to justify to them the need to spend additional money for newer technologies.

Reasons for the slow implementation differ from country to country but generally they relate to:

– insufficient information on the benefits of the new technologies and systems;
– lack of required capital;
– inability to pursue network owners to implement the technology;
– lack of infrastructure;
– expensive spectrum;

– unavailability of required spectrum;
– inadequate policies.

7.2 Technical considerations for IMT implementation

The ITU and other standards development organizations (SDO) have published technical papers on the implementation of IMT from typical existing networks and provided reasons, justification and Recommendations for each implementation path. However the general issues of particular importance for developing countries include:

– the state of existing networks;
– availability of IMT spectrum;
– capital.

Most of the technical considerations that are valid for developed countries are valid for developing countries. However the difference is that most developing countries have legacy networks in which they have invested a lot of money and which they do not want to write-off.

A major incentive for investors to implement IMT is the availability of spectrum. When there is availability of IMT spectrum at reasonable costs, the experience in many developing countries has been that there are many investors willing to establish networks. When engaging such investors, developing countries should make it a condition that the network being built must be capable of supporting the latest IMT capabilities.

7.3 Other considerations for IMT implementation in developing countries

Other important considerations for investors include:

– expansion requirements for the network to underserved areas;
– availability of funds;
– affordability;
– QoS;
– QoE.

Whereas developing countries may not need to specifically place a lot of attention on the above issues while implementing IMT, it is critical for developing countries to consider that it may be beneficial for them to think of IT networks as a solution for rural expansion, national coverage, affordability and improving QoS and QoE.

While it is not good practice to specify which technology an investor should deploy, developing countries can require specifications which favour technologies similar to those provided via IMT.

Since implementing IMT necessarily means acquisition of the requisite spectrum, developing countries should use it to leverage coverage, rural expansion, affordable services and improved QoS and QoE.

7.4 Technical considerations for implementing IMS

The ITU, 3GPP and other SDOs, have published technical papers on the implementation of IMS from typical existing networks. They provide reasons, justification and recommendations for each implementation path. However the general issues which are of particular importance for developing countries include:

– the state of existing networks;
– availability of IP networks.

Unlike IMT, IMS assumes an already existing IP network. It is therefore usually the operators of IP capable networks who find it worthwhile to implement IMS purely based on their own incentives and convictions to improve profitability.

7.5 Other implementation considerations for IMS in developing countries

Other considerations that have to be taken into account in a decision to implement IMS in developing countries include:

– requirements for rural expansion;

– availability of funds;

– affordability;

– QoS.

Leaving the decision to implement IMS to operators means that they will implement it if so inclined or when they can afford the investment. However this delay in waiting for the operators to make a decision may result in a consequent delay in the introduction of new services in the country and a loss of potential income from foreign visitors. It is important therefore, for governments to provide incentives for operators to implement IMS.

8 General recommendations on implementing IMT and IMS

General recommendations on implementing IMT and IMS are listed and described below:

i) Technical aspects

The technologies for both IMT and IMS are mature and stable therefore from a technical perspective, the implementation of IMT and IMS present minimal risks.

Spectrum availability and affordability is always an issue but remains within government control. An equitable balance should be achieved between the urgent need for the implementation of IMT and IMS versus a negotiated spectrum price to enable IMT and IMS implementation.

ii) Economic aspects

IMT and IMS both make sound economic sense. IMT networks are more cost effective in terms of implementation and they offer considerably better QoS and QoE while opening up opportunities for new services and higher speeds. They also offer a better choice for establishing networks in rural areas.

The main economic argument for IMS is that it supports new services and improved billing. In addition, in a world that is fast becoming a global village, IMS facilitates the desire of travellers to have the same communication experience wherever they go. Consequently developing countries stand to benefit more if they implement IMT and IMS.

iii) User experiences from other countries

A number of developing countries have successfully implemented IMT and IMS. There is therefore a rich data file of user experience which can be studied.

Many developing countries are making good use of infrastructure sharing in leveraging faster and more economical project implementation. Some countries have considered using infrastructure sharing for implementation of some of these beneficial but capital intensive IMT and IMS technologies and systems.

Appendix I

Analysis of information from countries

I.1 Background to the analysis

The state of affairs as far as mobile networks in Africa are concerned as of May 2014 is summarised in Table I.1. It can be seen that 69% of African countries have implemented IMT. This has been largely through issuance of 3G licenses. However, in most countries 3G coverage exists only in urban areas and hardly extends beyond the main city centres. This means that in many cases the majority of the population do not have access these new networks. In fact in most countries 2G coverage is greater than 3G coverage.

In the case of IMS, all of the countries with 3G are technically capable of IMS implementation, however there is little evidence on the ground to suggest that majority have implemented IMS. Only 26% of the countries with 3G have implemented IMS. These have done so mainly by implementing 4G LTE which assumes IMS capabilities.

Movement towards IMS has been slow. In many developing countries the decision to implement IMS is mainly the responsibility of the operator.

Table I.1 – Status of mobile networks in African countries as of May 2014

	Country	2G	3G	4G LTE	IMT	IMS
1	Algeria	Yes	Yes	Yes	Yes	Yes
2	Angola	Yes	Yes	Yes	Yes	Yes
3	Benin (Republic of)	Yes	Yes	No	No	No
4	Botswana (Republic of)	Yes	Yes	Yes	Yes	Yes
5	Burkina Faso	Yes	No	No	No	No
6	Burundi (Republic of)	Yes	Yes	No	No	No
7	Cabo Verde (Republic of)	Yes	No	No	No	No
8	Cameroon (Republic of)	Yes	No	Yes	Yes	Yes
9	Central African Republic	Yes	No	No	No	No
10	Chad (Republic of)	Yes	No	No	No	No
11	Comoros (Union of the)	Yes	No	No	No	No
12	Congo (Republic of the)	Yes	Yes	No	Yes	No
13	Côte d'Ivoire (Republic of)	Yes	Yes	Yes	Yes	Yes
14	Democratic Republic of the Congo	Yes	Yes	No	Yes	No
15	Djibouti (Republic of)	Yes	No	No	No	No
16	Egypt (Arab Republic of)	Yes	Yes	No	Yes	No
17	Equatorial Guinea (Republic of)	Yes	No	No	Yes	No
18	Eritrea	Yes	No	No	No	No
19	Ethiopia	Yes	Yes	No	Yes	No
20	Gabonese Republic	Yes	No	No	No	No
21	Gambia (Republic of the)	Yes	Yes	Yes	Yes	Yes
22	Ghana	Yes	Yes	Yes	Yes	Yes
23	Guinea (Republic of)	Yes	No	No	No	No

Table I.1 – Status of mobile networks in African countries as of May 2014

	Country	2G	3G	4G LTE	IMT	IMS
24	Guinea-Bissau (Republic of)	Yes	No	No	No	No
25	Kenya (Republic of)	Yes	Yes	No	Yes	No
26	Lesotho (Kingdom of)	Yes	Yes	No	Yes	No
27	Liberia (Republic of)	Yes	No	Yes	Yes	Yes
28	Libya	Yes	Yes	No	Yes	No
29	Madagascar (Republic of)	Yes	Yes	No	Yes	No
30	Malawi	Yes	Yes	No	Yes	No
31	Mali (Republic of)	Yes	Yes	No	Yes	No
32	Mauritania (Islamic Republic of)	Yes	Yes	No	Yes	No
33	Mauritius (Republic of)	Yes	Yes	No	Yes	No
34	Morocco (Kingdom of)	Yes	Yes	Yes	Yes	Yes
35	Mozambique (Republic of)	Yes	Yes	No	Yes	No
36	Namibia (Republic of)	Yes	Yes	Yes	Yes	Yes
37	Niger (Republic of the)	Yes	No	No	No	No
38	Nigeria (Federal Republic of)	Yes	Yes	Yes	Yes	Yes
39	Rwanda (Republic of)	Yes	Yes	Yes	Yes	Yes
40	Senegal (Republic of)	Yes	Yes	No	Yes	No
41	Seychelles (Republic of)	Yes	Yes	No	Yes	No
42	Sierra Leone	Yes	No	No	No	No
43	Somalia (Federal Republic of)	Yes	Yes	No	Yes	No
44	South Africa (Republic of)	Yes	Yes	Yes	Yes	Yes
45	South Sudan (Republic of)	Yes	Yes	No	Yes	No
46	Sudan (Republic of the)	Yes	Yes	No	Yes	No
47	Swaziland (Kingdom of)	Yes	Yes	No	Yes	No
48	Tanzania (United Republic of)	Yes	Yes	No	Yes	No
49	Togolese Republic	Yes	No	No	No	No
50	Tunisia	Yes	Yes	No	Yes	No
51	Uganda (Republic of)	Yes	Yes	Yes	Yes	Yes
52	Zambia (Republic of)	Yes	Yes	Yes	Yes	No
53	Zimbabwe (Republic of)	Yes	Yes	No	Yes	No

An ITU Questionnaire attached to ITU Circular letter 640 was sent out to both operators and regulators specifically of developing countries. The questionnaire was designed to collect information about the general status of migration and implementation of IMT and IMS in the mobile networks of developing countries. The questionnaire was also sent to equipment vendors and standardisation groups because they also do a lot of work in relation to the migration and implementation of IMT and IMS in developing countries. In the performance of their work they acquire a great deal of experience that can prove useful to other countries. Responses were received and analysed. The analysis provides some insight into IMT and IMS issues. This information has been collaborated with current information on network deployment mostly by African countries.

The responses, along with contributions to this work are used in the analysis to provide useful information on migration to IMT and IMS in developing countries.

An analysis of the current situation regarding the deployment of IMT and/or IMS in various developing countries is provided in clause I.2. This information is drawn mainly from information obtained from the ITU Questionnaire of ITU Circular letter 640 as well as from descriptions of scenarios raised by different developing countries. Based on this information a number of next logical steps towards implementation are introduced from which developing countries may choose. It should be noted that not all countries responded to the questionnaire and not all developing countries submitted their experiences or their plan. The analysis and information provided in this Supplement is limited according to the information that has been received to date and as time goes by it may be updated.

The responses show a good level of regulators who are concerned with IMT and IMS issues. This is not surprising as the work on IMT and IMS was requested mostly by regulators. A more complete analysis would have been acquired if there had been sufficient feedback from network owners and equipment vendors operating in developing countries. It is hoped that as this work progresses, more equipment vendors and more network owners will cooperate by providing their much needed experience.

I.2 Analysis of the responses to the ITU Questionnaire by regulators

I.2.1 Awareness of Study Group 13 work on future networks

The majority of respondents indicated awareness of the work of ITU-T SG 13 on future networks. Figure I.1 shows that 76% of the respondents were aware of the work of SG 13. This indicates a strong interest in the work of SG 13 by developing countries. In fact a similar indication can be seen in Figure I.2 which indicates awareness of IMT and IMS work which is also carried out by SG 13.

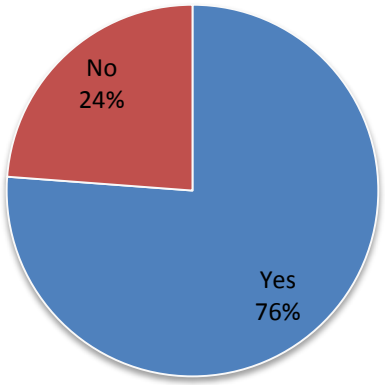

Figure I.1 – Awareness of the work of SG 13 on future networks

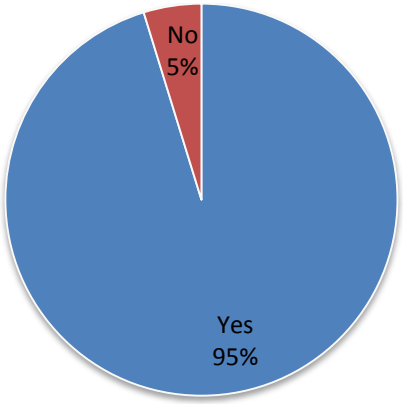

Figure I.2 – Awareness of the work of SG 13 on IMT and IMS

I.2.2 Migration to IMT and IMS

The regulators who responded show a strong support for migration to IMT and IMS. Figure I.3 shows that the percentage of those planning to migrate to IMT is 76%, while Figure I.4 shows that the percentage representing those planning to migrate to IMS is 81%.

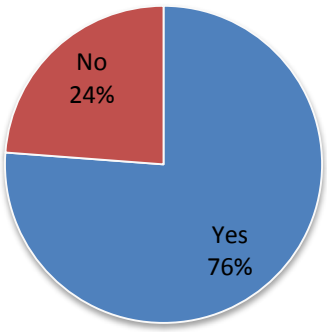

Figure I.3 – Plan to migrate to IMT

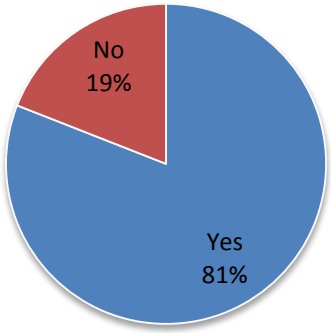

Figure I.4 – Plan to migrate to IMS

The regulators indicate a strong willingness to migrate to IMT and IMS. 76% of regulators indicate a willingness to migrate to IMT while 24% do not. It is not clear whether those represented by the 24% of regulators are not planning to migrate to IMT but are however willing to migrate to IMS or if they just are not interested in migrating at all. However given the level of awareness of IMT and of IMS issues among regulators, it is possible that some regulators just do not plan to migrate to IMT as a stage. There is need to understand why there is some unwillingness to migrate to IMT.

A large number (81%) of regulators have indicated willingness to migrate to IMS. This percentage and that of the 76% of regulators willing to migrate to IMT is a significant indication of a willingness among regulators in developing countries to migrate to IMT and IMS.

I.2.3 Mobile technologies employed in developing countries

As expected the most common technology employed, according to the respondents is GSM. Figure I.5 shows that GSM accounts for 37% of the mobile technologies employed in developing countries. WiMAX and CDMA each account for 21%. Other technologies which include PHS, AMPS, TDMA, WCDMA, HSPA and UMTS together account for 21%.

This spread shows there are many technologies being deployed by developing countries. Migration scenarios may differ from technology to technology. Developing countries need to be assured that the migration can work from whichever technology they are deploying. For the purposes of this Supplement, it is necessary to include as many varied migration scenarios as possible.

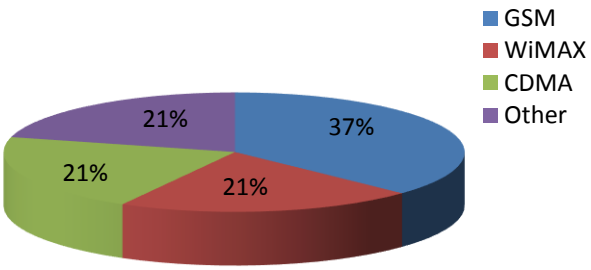

Figure I.5 – Mobile technologies employed in developing countries

I.2.4 Observations drawn from the responses to the ITU Questionnaire by regulators

The key messages that can be drawn from the responses of regulators to the ITU Questionnaire include:

1) Most regulators are aware of IMT and IMS.

2) They are planning to have networks in their jurisdictions migrate to IMT and IMS.

3) They show a preference to migrate to IMS rather than IMT.

4) There are various technologies being deployed and different migration scenarios are required. However the most prominent network type is GSM.

5) They are willing to support operators in their jurisdictions to migrate to IMT and IMS.

I.3 Analysis of the responses to the ITU Questionnaire by operators

The following responses concern operators who have networks in developing countries.

I.3.1 Deployment of IMT and IMS in networks

Figure I.6 indicates that the operators responding have deployed IMT and IMS in 50% of their networks in developing countries. This means that deployment of IMT and IMS in developing countries has not yet become standard. It has not yet reached a level where it is a priority for operators of networks in developing countries.

This accords with the submission of some operators that much as they are aware of IMT and IMS, demand is currently too low for IMT and IMS services. Currently to justify investments, most operators are deploying both IMT and IMS. This could mean that operators are deploying IMT first and then following this up with IMS. This needs to be confirmed in case it is a logical sequence that can be recommended for networks operators in developing countries.

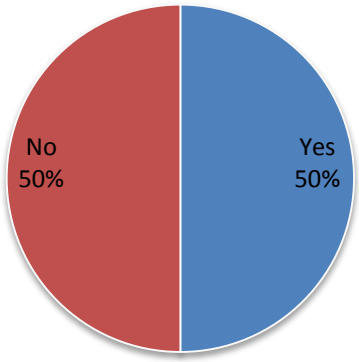

Figure I.6 – Deployment of IMT and IMS by operators

I.3.2 Experiencing problems with IMT or IMS

Some of the operator respondents indicated that they experienced problems with implementing IMT and IMS. Figure I.7 shows that 25% of operator respondents experienced problems implementing IMT, while no operator respondents indicated experiencing operational problems with implementing IMS.

Probably not much can be read into these statistics given the small number of respondents but it is an indicator that operators are having some operational problems with implementing IMT and IMS. The nature of the operational problems were not detailed.

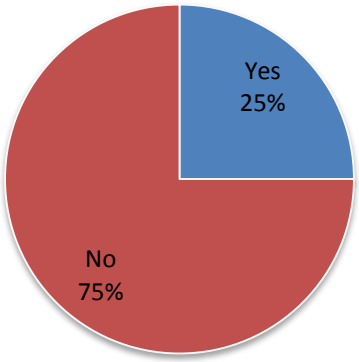

Figure I.7 – Operators that experienced problems with implementing IMT

I.3.3 Recommending migration to IMT or IMS

In their responses, operators indicated whether they would recommend migrating to either IMT or IMS. Figure I.8 shows that only 25% of the respondents indicated that they would recommend migration to IMT while 75% indicated they would recommend migration to IMS.

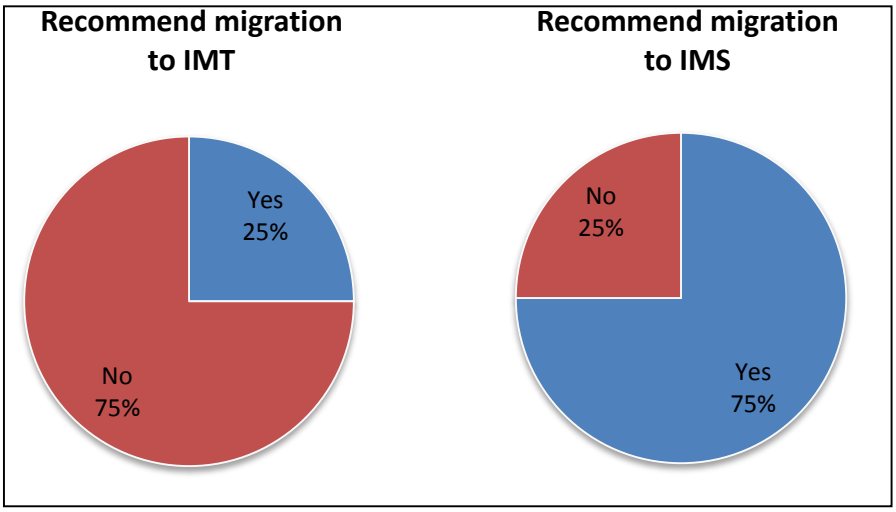

Figure I.8 – Recommend migration to IMT or IMS

There is an indication by the operators that migration to IMS is preferred over migration to IMT. A similar preference was also indicated by regulators. It could be that migration to IMT is no longer an issue as most networks in developing countries already have the basic functionalities of IMT and the next logical step is migration to IMS.

I.3.4 Observations drawn from responses to the ITU Questionnaire by operators

The key messages that can be drawn from the responses of operators (operating in developing countries) to the ITU Questionnaires include:

1) They are aware of IMT and IMS.

2) They are migrating their networks to IMT and IMS, however it is not yet the priority. There are reasons why migration has not yet been fully embraced.

3) Those who have migrated to IMT have experienced some problems. Those who have migrated to IMS have not experienced many problems.

4) The emphasis of migration is on IMS more than on IMT.

I.4 Analysis of contributions received to date

I.4.1 Types of networks deployed

Analysis of submitted contributions reveals a number of facts about the technologies deployed in the networks of developing countries. These technologies and their deployment frequency are illustrated in Figure I.9.

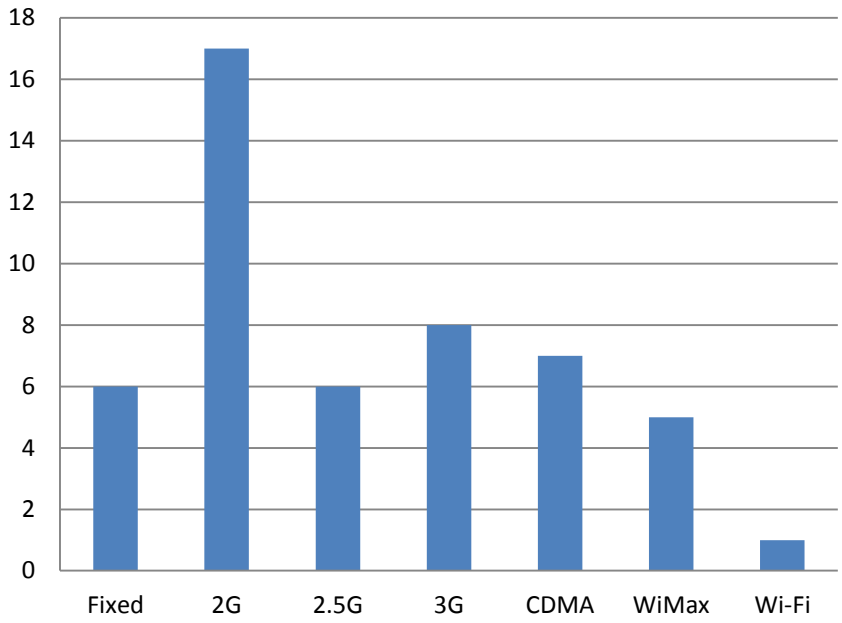

Figure I.9 – Common technologies deployed

Analysis of submitted contributions reveals that:

1) There are several technologies that have been deployed in developing countries. This implies that migration to IMT and IMS must be launched from these different technologies. Different scenarios therefore have to be presented to cover as many possible alternatives as possible.

2) Fixed technologies are still very much a part of the network topology of many developing countries. In fact for all of these countries that made contributions, each included fixed networks among the services where they want to implement migration to IMT and IMS. This may mean that developing countries also need information about migration to IMT and IMS from fixed technologies.

3) Apart from some few fixed networks, all the other networks are either already IMT capable or can easily upgraded to IMT. In fact most of the operators whose information is submitted have either 2G or 3G as one of the networks, which are IMT capable networks. This may be the reason why most of the emphasis from both regulators and operators in developing countries is on migration to IMS.

I.4.2 Challenges in implementing IMT and IMS

The submitted contributions indicated some common challenges in implementing IMT and IMS. These have been grouped for ease of analysis. Figure I.10 summarizes these challenges.

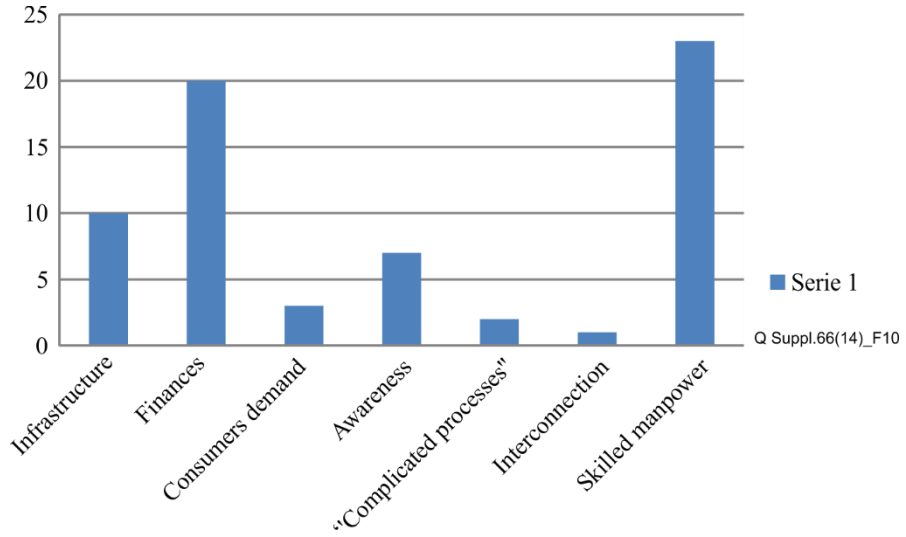

Figure I.10 –Challenges to implementing IMT and IMS

It can be observed that:

1) The key challenges include:
   - Need to upgrade and increase a network of modern infrastructure able to support IMT and IMS;
   - Need for finances for investment in IMT and IMS;
   - Lack of demand for IMS services by consumers;
   - Lack of adequate awareness of stakeholders such as regulators, operators and policy makers;
   - Complicated processes involved in migration;
   - Interconnection with fibre-optic cable;
   - Lack of skilled technical and managerial skills.
2) Lack of skilled manpower is one of the greatest challenges facing migration to IMT and IMS. This ranges from planning to implementation;
3) The need for finance is also mentioned among the major challenges. In fact all operators have their own costs relating to migration, depending on where they are coming from and the size of the network;
4) Consumer demand has been cited as being critical because most operators are claiming that much as they are aware of the benefits of migrating and that they would like to migrate, the customer demand is not great enough to justify investments in developing countries. This situation is very different in developed countries where customers drive demand for new services and the service provider responds. This coupled with the high investments required have proven to be a disincentive for operators considering migration to IMT and IMS;
5) Stakeholder awareness is also mentioned as one of the critical factors. Among operators there is still a critical lack of awareness of especially the benefits of migrating, while a number of regulators are not very aware of their roles in these migrations. Policy-makers are the worst off in as far as being aware is concerned.

I.5 Information about deployed mobile networks in the 53 African countries

Figure I.11 summarises information collected on the current status of mobile networks in African countries as of May 2014. The availability of 2G, 3G and 4G LTE networks in African countries is rapidly changing.

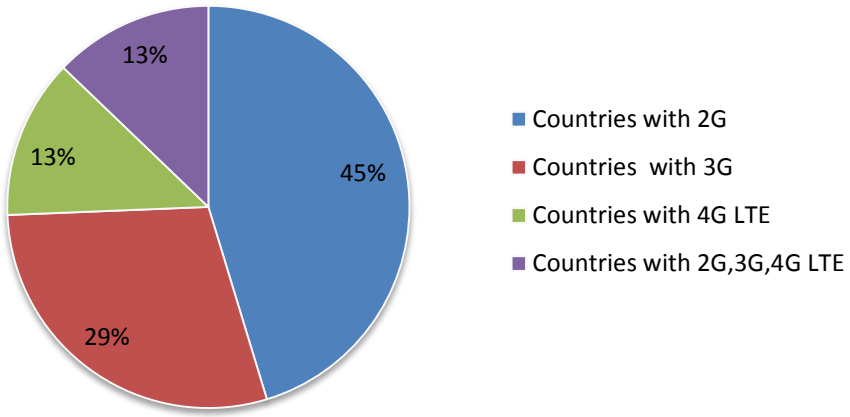

Figure I.11 – Current deployment of mobile networks in 53 African countries

Figure I.12 below shows that by May 2014 all countries with 3G and 4G LTE have mobile networks with IMT capabilities. Likewise since IMT networks are IP based, it is assumed that all of these networks (61%) are ready to implement IMS. However only those with 4G LTE (13%) are assumed to automatically have IMS capabilities as such capabilities are assumed in all 4G LTE networks.

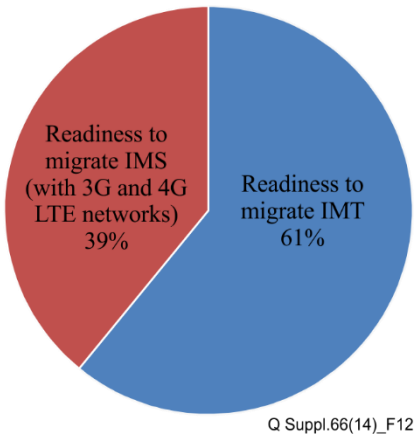

Figure I.12 – 3G and 4G LTE mobile networks with IMT capabilities

I.6 IMT and IMS implementation scenarios presented to date

The scenarios in Table I.2 below are a summary of those of operations which have been submitted. Of course there are many other possible scenarios and this table will be updated as and when others are received.

Table I.2 – Summary of emerging IMT and IMS implementation patterns in developing countries

Existing networks	Destination	Usual steps	Typical challenges
Legacy Fixed (CDMA 2000, WiMAX, etc.) and 2G	IMS via IMT	Step 1: Acquire 3G Step 2: Converge fixed and mobile Step 3: Implement IMT Step 4: Implement IMS	• Need for regulatory support to acquire 3G • May need cost benefit analysis to determine whether to replace fixed network or upgrade it • Investments in IN • Determine market uptake • Training for IMT and IMS
2G	IMS via IMT	Step 1: Acquire 3G Step 2: Implement IMT Step 3: Implement IMS	• Need regulatory support to acquire 3G • Determine market uptake • Training for IMT and IMS
2G and 3G	IMS via IMT	Step 1: Implement IMT Step 2: Implement IMS	• Determine market uptake • Training for IMT and IMS • Complexity in integration to different vendor nodes • Rollout involves replacing some nodes and upgrading others to suit the required versions
2G and 3G	Overlay LTE with EPC	• Implement IMT (HSPA+) • Implement overly LTE with EPC	Investment versus market uptake
2G and CDMA 2000	IMT	Step 1: Converge fixed and mobile Step 2: Implement IMT	Investment versus market uptake
2G and 3G	IMS	• Step 1: Implement VOIP and • SIGTRAN in the core network. • Step 2: Implement media gateways • Step 3: Implement an appropriate billing system.	• Security challenges due to the use of IP • Cost of CPEs • Cost of new network equipment • Upgrading of skills • Cost of upgrading

Bibliography

[b-ITU-T Q.1742.5] Recommendation ITU-T Q.1742.5 (2006), *IMT-2000 references (approved as of 31 December 2005) to ANSI-41 evolved core network with cdma2000 access network.*

[b-ITU-T Supplement 1 (Revision 1)] *Deployment of IMT-2000 Systems (approved as of 31 December 2005) to ANSI-41 evolved core network with cdma2000 access network.*

[b-ITU-T Y.2021] Recommendation ITU-T Y.2021 (2006), *IMS for Next Generation Networks-2000*

[b-ETSI ES 282 001] ETSI ES 282 001 V1.1.1 (2005), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture Release 1.*

[b-ETSI ES 282 007] ETSI ES 282 007 V.1.1.1 (2006), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Subsystem (IMS); Functional architecture.*

[b-ETSI ES 283 027] ETSI ES 283 027 V1.1.1 (2006), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Endorsement of the SIP-ISUP Interworking between the IP Multimedia (IM) Core Network (CN) subsystem and Circuit Switched (CS) networks.*

[b-ETSI TS 182 006] ETSI TS 182 006 V1.1.1 (2006), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Subsystem (IMS); Stage 2 description.*

[b-ITU Statistics] ITU Year Book of Statistics (2013), *ITU Year Book of Statistics;*
http://www.itu.int/en/ITUD/Statistics/Pages/publications/yb2013.aspx

[b-ITU Indicators databases] 18th Edition, World Telecommunication/ICT Indicators databases (2013), *World Telecommunication/ICT Indicators databases;*
http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

[b-ITU Mobile Cellular] ITU Mobile Cellular (2000-2013).

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	**Switching and signalling**
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2015