Harmonization, Mobility Management, and Fixed-Mobile Convergence: Studies in the ITU-T Special Study Group on "IMT-2000 and Beyond"

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Abstract: **The various sectors of the International Telecommunication Union (ITU) have been addressing the evolution of third-generation and future wireless systems in the context of a comprehensive International Mobile Telecommunications 2000 (IMT-2000) project, and within the ITU's Telecommunication Standardization Sector (ITU-T) a Special Study Group on "IMT-2000 and Beyond" has been established to address the network aspects of these emerging wireless systems.**

The Special Study Group (SSG) is playing a global role in this general area, in which a number of regional standards development organizations and a variety of industry forums are also active. This paper provides background information on the SSG and describes the SSG's ongoing work addressing medium-term issues relating to convergence of fixed and mobile systems and the harmonization of evolving IMT-2000 systems. The paper also addresses related mobility management aspects.

Index Terms: **Fixed-mobile convergence, IMT-2000 network standards, mobility management, network harmonization.**

I. INTRODUCTION

The various sectors of the International Telecommunication Union (ITU) have been addressing the evolution of third-generation and future wireless systems in the context of a comprehensive International Mobile Telecommunications 2000 (IMT-2000) project, and within the ITU's Telecommunication Standardization Sector (ITU-T) a Special Study Group has been established to address the network aspects of these emerging wireless systems.

The ITU-T's Special Study Group on "IMT-2000 and Beyond" was established in October 2000 at the World Telecommunication Standardization Assembly 2000 (WTSA-2000) held in Montreal (Canada). Since then, the Special Study Group (SSG) has held five meetings (the first two in Geneva (Switzerland) in December 2000 and May 2001, with subsequent sessions in Rio de Janeiro (Brazil) in August/September 2001, Ottawa (Canada) in May 2002, and again in Geneva in November 2002. The next meeting will take place in Geneva in June 2003.

The ITU-T's Special Study Group on "IMT-2000 and Beyond" (also referred to as the SSG) was given a mandate within the work program of the ITU-T to study the evolution of third-generation (3G) wireless systems and to initiate studies on aspects relating to systems beyond IMT-2000. Central to the SSG studies are the analysis of current systems and the development of long-term vision for future systems, complemented by views on the harmonization of evolving 3G systems in a medium-term timeframe together with consideration of the convergence of fixed and mobile telecommunication systems. In all of these studies, mobility management is a key element.

In this context, an essential consideration is the interplay between the network infrastructures supporting mobility and the increasingly pervasive influence, more generally, of networks and applications making use of the suite of protocols related to the Internet Protocol (IP).

Understanding the relationship between the evolving Internet and the use of IP-based infrastructures together with the ongoing evolution of wireless systems is a significant challenge. This is reflected in the debates which surround some of the topics being discussed here. What appears generally agreed is the need to move forward on the basis of a good understanding of end-user requirements.

Both mobile systems and IP-based applications are experiencing rapid growth, despite uncertainties in the telecom sector generally. Exactly how these systems will be shaped as the future unfolds is a complex matter to assess. Nonetheless, the ITU-T's SSG is striving to address the challenges of harmonization and convergence in a medium-term context.

II. HISTORICAL BACKGROUND

A. Emergence of Global IMT-2000 Standards in the ITU

The concept for IMT-2000 (International Mobile Telecommunications 2000) as the third generation (3G) system for mobile communications was born at the ITU in the late 1980s. Originally it was known as FPLMTS (Future Public Land Mobile Telecommunication Systems), and the name IMT-2000 was adopted by the ITU in 1997. After more than ten years of hard work under the leadership of the ITU, a historic decision was taken in the year 2000 with the unanimous approval of ITU-R Recommendation M.1457 [1] containing the technical specifica-

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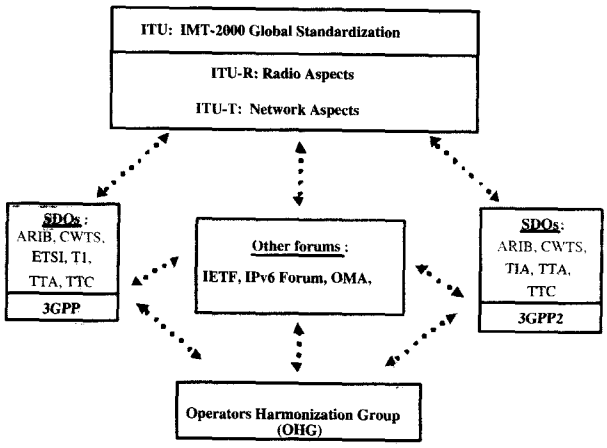

Fig. 1. IMT-2000 standardization environment and collaborative linkages.

tions for five radio transmission technologies (radio interfaces) for IMT-2000. The frequency spectrum between 400 MHz and 3 GHz is technically suitable for 3G mobile systems, and the ITU has specified the spectrum in the 1885 - 2200 MHz band for IMT-2000. Additional bands which may be deployed for IMT-2000 were further identified at the last World Radio Conference (WRC).

IMT-2000 is intended to form the basis for third generation (3G) wireless systems which will consolidate today's diverse and incompatible mobile environments into a seamless radio and network infrastructure capable of offering a wide range of telecommunication services on a global scale. IMT-2000 offers the capability of providing value-added services and applications on the basis of a single set of standards. The system envisages a platform for distributing converged fixed, mobile, voice, data, Internet access and multimedia services. One of its key visions is to provide seamless global roaming, enabling users to move across borders and between different 3G mobile networks while using the same number and handset. Also, IMT-2000 standards specify target data rates of 2Mb/s for stationary or walking users and 348 kb/s for moving vehicles; however, such target data rates may not be achievable in initial IMT-2000 implementations.

Within the ITU, *the radio aspects* for IMT-2000, especially the selection of Radio Transmission Technology (radio interface) and the spectrum usage, are addressed in the Radiocommunication Sector (ITU-R), whereas the network aspects which includes definition of network signaling interfaces, services, numbering and identities, quality of service, security, operations and network management for IMT-2000 are addressed by the Telecommunication Standardization Sector (ITU-T). The specifications are captured in ITU Recommendations (voluntary standards) which have a global scope and provide the essential backbone for world-wide telecommunications.

As illustrated in Fig. 1, the detailed specification of 3G mobile systems is a collaborative effort between the ITU and various regional/national standards development organizations (SDOs) including CWTS (China), ETSI (Europe), TTC (Japan), TIA and T1 Committees (North America), and TTA (South Korea). The 3G mobile specification work in the regional/national SDOs is conducted and co-ordinated by two 3G Partnership Projects (3GPP and 3GPP2). There are also collaborative linkages with other bodies such as the Internet Engineering Task Force (IETF). The Operators Harmonization Group (OHG) provides guidance for maximizing harmony between technical specifications being developed in these multiple forums.

Until the end of year 2000, the standardization work on the network aspects of IMT-2000 was led by Working Party 3/11 within ITU-T Study Group 11; Working Party 3/11 was responsible for the specification of IMT-2000 signaling interfaces and also for co-ordination of all IMT-2000 network-related activities within ITU-T (e.g., numbering, identities, quality of service, security, and network management). Given the importance and urgency of this activity within ITU-T, a separate Special Study Group on "IMT-2000 and Beyond" (the SSG) was established to carry out and co-ordinate this work within ITU.

Further detailed background information can be found in reference [2].

B. Emerging View of IMT-2000 as a Family of Systems

The five IMT-2000 radio interfaces standardized by ITU-R and contained in ITU-R Recommendation M.1457 include some radio technologies that are completely new as well as others which are derived from existing 2G radio technologies. IMT-2000 network technologies on the other hand, will need to evolve from the existing wireless and wireline networks, because it will not be cost-effective to replace the extensive 2G network infrastructures already in place by a completely new one. This has led to the *IMT-2000 Family of Systems* concept which was adopted in ITU-T Recommendation Q.1701 [3] and reflects the industry view that there will be multiple IMT-2000 systems, each of them belonging to one of the family member groups within the IMT-2000 family.

As illustrated in Fig. 2, the IMT-2000 Family of Systems is a federation of IMT-2000 family members, each system or network within an IMT-2000 family member will provide IMT-2000 services and capabilities to its users. An IMT-2000 family member is characterized by the ability of its member systems to provide service to the subscribers of systems belonging to any other IMT-2000 family member who has roamed into its coverage area.

Under this concept, a network belonging to an individual family member may have its own intra-system specifications - e.g., in terms of distribution of functions over physical entities (i.e., physical architecture), security mechanisms & procedures, signaling protocols, etc. However, in order to qualify as IMT-2000 networks, they should integrate and incorporate the IMT-2000 functions into the physical entities and support associated signaling interfaces necessary to provide IMT-2000 service and network capabilities. The key characteristics of an IMT-2000 family member system or network are summarized below whereby a family member system or network is expected to:

- support one of the radio interfaces specified in ITU-R Recommendation M.1457;
- have evolved from an existing wireless/wireline system;
- support ITU-prescribed service and network capabilities;

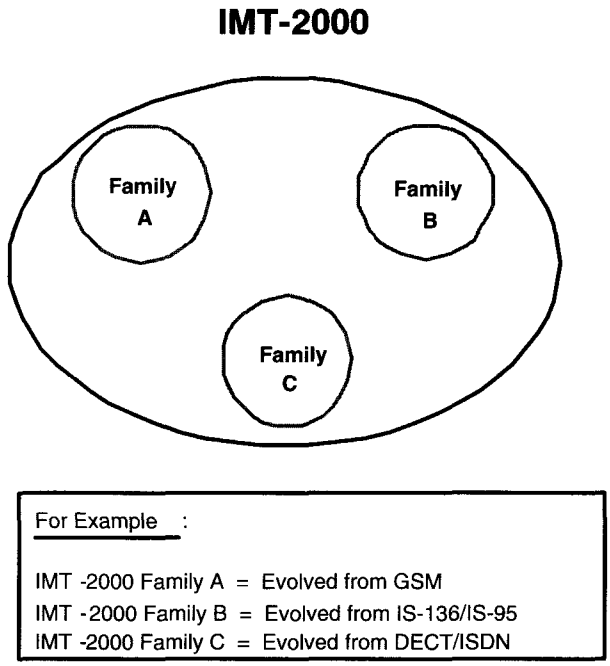

Fig. 2. Concept of IMT-2000 family of systems.

- support global roaming; and
- support ITU-defined signaling interfaces.

IMT-2000 will not be a single monolithic global system but a collection of 3G mobile networks operating in different frequency bands, supporting one of five radio interfaces defined by ITU-R, and utilizing network infrastructures built upon the existing wireless, wireline, and IP-based networks. Individual 3G operators will select appropriate radio and network technologies based on a business model that suits their individual operating environment. The opportunities for convergence of fixed and mobile networks and for harmonization of evolving 3G networks towards a single multi-functional, multi-service network are recognized and are being addressed in the ongoing studies of the ITU-T's SSG.

C. Establishment of the SSG by WTSA-2000

During the year 2000, a consensus emerged on the need to develop a much greater focus on IMT-2000 in ITU-T, and the WTSA-2000 decided to establish a study group to address network aspects in order to provide a clear focal point within the ITU-T and to demonstrate the high importance the ITU membership and management place on the harmonious evolution of IMT-2000 systems.

There had been debate on how best to structure the work, proposals having included a traditional study group and a new type of project group. As is often the case in the standards community, a compromise solution was adopted. The Special Study Group (SSG) was given the powers of a traditional study group but was to be much less constrained by traditional procedures. In fact, it was to provide a somewhat experimental environment in which the ITU-T could try out some novel work methods and different types of output documentation.

D. The Global Role of the Special Study Group (SSG)

As part of the ITU, which is a specialized agency of the United Nations, the Special Study Group has a rather more diverse membership than many of the other bodies which address more technical aspects of standardization in this area. This diversity yields the advantages and strengths of bringing together viewpoints from a large number of vendors, operators and regulators from around the world, with participants representing a range of developed and developing countries.

The interests of developing countries are particularly strong in this group, because of the importance of wireless systems in the development of their infrastructure. Moreover, representatives from these countries are extremely interested in ensuring that the evolution of standards relating to IP-based technologies (and especially the synergy of IP-based technology with evolving wireless systems) fully addresses their needs and concerns.

Developing countries are showing substantial interest in the application of mobile telecommunications towards the upgrading of their internal infrastructures. Indeed, the WTSA-2000 mandate for the Special Study Group includes several points related to assisting the ITU Development Sector (ITU-D) in this regard. It is worth noting that several members of the SSG's management team represent the developing parts of the world; their active participation ensures that the Special Study Group is responding to this mandate and that the work of the SSG provides appropriate support to developing countries in developing their mobile telecommunications infrastructure.

E. The Challenge and Complexity

Of course, with such a wide range of interests in the SSG it can sometimes be difficult to achieve sharp focus and to identify the essential objectives and priorities in advancing the work. Moreover, in light of competing business sensitivities (driven by huge investments in systems already deployed and large sums paid to secure licenses for new systems) there are considerable pressures to slow efforts to make changes or to evolve towards more harmonized systems. This is a reality to be faced, and is felt particularly in the area of work on harmonization and convergence.

Nonetheless, it has at the same time also been recognized that resolving the complex issues surrounding harmonization and convergence is vitally important - as can be seen by several recent efforts (such as the Operators Harmonization Group (OHG) Workshop in Toronto in April 2002 and the establishment of the Open Mobile Alliance (OMA) in June 2002).

III. ORGANIZATION OF WORK IN THE SSG

The detailed work of the SSG is organized under the following eight Study Questions:

- *Q.1 Service and Network Capability Requirements and Network Architecture.*
- *Q.2 NNI Mobility Management Protocol (Stage 3).*
- *Q.3 Identification of Existing and Evolving IMT-2000 Systems.*
- *Q.4 Interworking Functions to be used with Existing and Evolving IMT-2000 Systems.*

Q.5 To participate in the Preparation of a Handbook on IMT-2000.
Q.6 Harmonization of Evolving IMT-2000 Systems.
Q.7 Convergence of Fixed and Existing IMT-2000 Systems.
Q.8 Special Study Group Working Procedures.

Long-term vision work under Question 1/SSG has led to ITU-T Recommendation Q.1702 *(Long-Term Vision of Network Aspects for Systems Beyond IMT-2000)* [4] which was approved in July 2002. Rec. Q.1702 addresses systems for initial deployment around the year 2010, exact timings depending on market evolution. Related Recommendations currently being developed include Draft Rec. Q.SCFN *(Service Capabilities Framework of Network Aspects for Systems Beyond IMT-2000)*, Draft Rec. Q.NCRB *(ITU-T Network Capabilities Requirements for Systems Beyond IMT-2000)*, and Draft Rec. Q.FNAB *(Long-Term High-Level Functional Network Architecture for Beyond IMT-2000 Systems)*.

With regard to existing IMT-2000 systems, Q.3/SSG is developing ITU-T reference documents, and during 2002 Q.3/SSG's first deliverable was approved as Recommendation Q.1741.1 *(IMT-2000 References to Release 1999 of GSM evolved UMTS Core Network with UTRAN Access Network)* [5]. Two other documents now in the final stages of approval are Draft Rec. Q.1741.2 *(IMT-2000 References to Release 4 of GSM evolved UMTS Core Network with UTRAN Access Network)* and Draft Rec. Q.1742.1 *(IMT-2000 References to ANSI-41 evolved Core Network with cdma2000 Access Network)*. Meanwhile, Question 5/SSG has been developing material on network aspects for inclusion in the ITU's planned handbook on deployment of IMT-2000 systems.

Questions 6/SSG and 7/SSG are focussing on medium-term issues (in the timeframe of the years 2005-2010). Draft documents being considered under these two Study Questions are *Harmonization of Evolving IMT-2000 Systems* under Question 6/SSG and *Principles and requirements for convergence of public fixed networks and existing IMT-2000 networks* under Question 7/SSG. Related work under Question 2/SSG is expected to lead to the completion of a *Technical Report on Mobility Management Requirements*.

In advancing work in all of its study areas, the SSG is in the process of developing appropriate relationships with a variety of other organizations - such as:

- the Third-Generation Partnership Projects (3GPP and 3GPP2);
- various regional Standards Development Organizations (SDOs);
- industry forums including the UMTS Forum and the Open Mobile Alliance (OMA);
- the Internet Engineering Task Force (IETF);
- other ITU-T Study Groups, ITU-R, and ITU-D.

IV. HARMONIZATION OF EVOLVING WIRELESS SYSTEMS

A. General

The radio-access aspects of IMT-2000 systems have been extensively addressed - and significantly harmonized - in the ITU-R. The ITU-T is responsible for those aspects of IMT-2000 relating to the network infrastructure used to interconnect mobile users.

There has been substantial work on the core network aspects in regional standards bodies (in particular, in the context of the two partnership projects (3GPP and 3GPP2)), and the two principal families of IMT-2000 systems continue to evolve. To better support global roaming and ease of use for subscribers, as well as to facilitate network planning and deployment by operators, there is scope for the different family members to harmonize their standards - with a view to minimizing or eliminating differences. The role of ITU-T in this area has been slowly achieving greater clarity and focus, the topic being addressed under Question 6/SSG (Harmonization of Evolving IMT-2000 Systems).

The focus of regional standards bodies has tended to be driven by fairly near-term market needs in this rapidly changing environment. Although these bodies have paid some attention to more long-term aspects, a broader ITU-T effort is perhaps better able to deal with the longer-term and more global aspects. The main advantage which the ITU can bring is a global endorsement of its outputs, but it is fair to say that the large number of forums dealing with various aspects of this topic area has led to a dilution of resources - which has put considerable pressure on the ITU-T.

Within the SSG, Study Question 6/SSG is addressing harmonization of network standards in the medium-term timeframe of 2005-2010. A major objective of this activity is the development of common network solutions that can facilitate cost-effective IMT-2000 network deployments based on standardized open interfaces, so as to stimulate the commercial uptake of IMT-2000 multi-media services and provide users with seamless global roaming across all evolving IMT-2000 systems.

The Question 6/SSG experts group has begun studying the degree of harmonization of evolving IMT-2000 networks. The SSG's work on global harmonization of IMT-2000 systems will include considerations relating to service provisioning, mobility management, session control, and bearer control. In the medium-term, there is demand to support roaming for voice and data but not necessarily a significant requirement for support of roaming for multimedia services. Other key aspects of harmonization studies will include quality of service (QoS), the provision of emergency services, and requirements for identities, numbering, and addressing.

B. SSG Approach to Harmonization

The purpose of harmonization studies is to ensure a smooth evolution from the existing systems towards the long-term vision of Rec. Q.1702. This requires a careful analysis of the existing systems and the future vision, as well as a good understanding of changing expectations of end users, possible new regulatory requirements, and opportunities presented by new technologies and systems concepts.

In order to approach harmonization in a concrete manner, areas of commonality and differences must be identified for the existing IMT-2000 systems. From this perspective, architectures and protocol models are being examined, and key aspects such as the following will be compared:

- call/session control (handling of SIP signalling messages),
- mechanisms for authentication and authorization,
- accounting, charging and billing,
- management of QoS (and related IP-based "policy" rules),
- support for E911 and other emergency services,
- handling of geographic location service(s),
- media gateway functionalities,
- interworking mechanisms with the PSTN,
- mobility-management mechanisms.

A fundamental objective of harmonizing core-network architectures (from the control and services standpoint) is to minimize (ideally to eliminate) regional or country differences in any open interface between the functional entities. Harmonized architectures need not be identical, but each should support global access to services when roaming regardless of access type. In order to ensure the widest level of services for subscribers, harmonized architectures should support globally accessible services within the capabilities of the terminal, the access technology and the serving network, via:

- the support of common protocols and open APIs,
- the support of concepts such as VHE,
- a common representation of user service profiles (i.e., XML),
- access to services from any network or server utilizing service brokering.

Harmonization can bring benefits to users, vendors, and network operators. For example, in Korea the drive to a single open IP-based network, independent of access technology offers users a wider variety of services and reduced costs, offers vendors the benefits of an open architecture, and offers network operators cost reductions because of the open interfaces in a single core network and related simplification of network and service management capabilities. Considerable benefits would be derived from migration towards a single open IP-based network which would enable seamless integration of multiple access networks (cdma 2000, WCDMA, and WLAN, etc) and thereby meet the needs of users, operators and vendors.

C. Packet Core Network

Moving towards a packet core network should help in achieving one of the underlying objectives in establishing seamless global roaming in the context of "IMT-2000 and Beyond" and to facilitate the development of harmonized global standards to enable the introduction of a range of innovative multimedia services in the context of converged mobile and fixed networks utilizing a common all-IP infrastructure.

As the SSG work proceeds to develop harmonization proposals, end-to-end service capability requirements for the anticipated range of services (including considerations of management, numbering, quality-of-service, performance, reliability, security, and certain key aspects of the access technologies) will be addressed. In addition, significant focus will be placed on IP-related matters and ensuring proper linkages with anticipated Next Generation Network (NGN) architectures.

The current 3GPP and 3GPP2 architectures support common mobility management functions but have different network mobility management schemes, with 3GPP2 using Mobile-IP tunnelling protocols and 3GPP using GPRS tunnelling protocols. From the standpoint of the basic reference models, the 3GPP and 3GPP2 architectures incorporate similar IP multimedia functions providing for IP transport at all interfaces and supporting media and signalling gateways. Also, the same call/session-control protocol (the Session Initiation Protocol (SIP)) is a common feature, as is the mandate to support IPv6 addressing. Moreover, support of multimedia services in both cases includes third-party services integration.

V. MOBILITY MANAGEMENT CONSIDERATIONS

A. Scope of Mobility Management Aspects within SSG

One of the main goals of IMT-2000 systems is to better support global roaming of its users thereby providing seamless service offerings between different IMT-2000 networks (3GPP, 3GPP2, IP network, etc.,). An important aspect of this is of course the Virtual Home Environment (VHE) concept which is closely associated with mobility management, i.e., it does not make any sense to talk about VHE unless it includes support of a mobile (meaning here fully mobile, i.e., seamless services while moving) or nomadic (stationary while connected) user. In addition, 'True' VHE also implies a certain move towards convergence of fixed and mobile systems at the logical level where cellular mobility is offered within mobile systems and discrete mobility within fixed as a first step. These important goals strongly imply that evolution of currently existing mobility protocols needs to be considered at the NNI (Network to Network Interface) in order to facilitate the mobility of the users at network interfaces where all these different families of networks would be inter-connected. As one can easily understand, this is not currently possible because of lack of a global mobility scheme (i.e., each family is working within its own domain). Moreover, with the rapid growth of IP networks and the support of mobility over these networks (e.g., Mobile IP, SIP mobility, H.323 mobility, etc.,), making this global scheme is becoming a real challenge. Therefore, Study Question 2/SSG (on Mobility Management), within the SSG, has started working on the above issues to build this global mobility scheme.

B. The SSG Approach to Move Towards a More Global Mobility Scheme

Since different families of networks (3GPPs, WLAN, IP, etc.) may co-exist to support mobility, it is important to first have a clear snapshot of the different existing mobility protocols in those networks as a starting point. When looking at the actual picture of current fixed and mobile systems evolving towards IP, one can easily understand that mobility management is supported in two ways. Cellular terminal mobility is still supported via MAP protocols, which are specific to cellular networks. However, new protocols such as Mobile IP are more and more used for discrete 'user' mobility in IP networks. In addition, SIP already supports limited discrete mobility (e.g., nomadic users). Thus, IP-based solutions are becoming more and more applicable to different types of networks (fixed, mobile, etc.) as well and indeed will constitute valuable candidates for common mo-

bility protocol solutions over these IP-based networks. However, no one can so far guarantee whether these protocols are really fit for inter-family roaming (without any enhancement) across those various IP-based core networks (3GPPs, WLAN, etc.). Therefore, analyses of these protocols are to be carried out and their capabilities clearly identified and compared before moving further on. Candidate protocols to be considered are UMTS MAP, ANSI MAP, Mobile IP, SIP Mobile, etc. This list is of course not exhaustive.

Secondly, based on the initial analyses, extensions to these new protocols are to be identified in order to support discrete mobility for existing and evolving fixed and mobile networks.

In addition, mobility involves a database management scheme to retrieve subscriber information for setting up calls or sessions. Here also, this is supported in two ways. MAP is currently used in cellular networks for this purpose; however, protocols such as LDAP or DIAMETER are used for data management in IP networks. When roaming from one network to another common retrieval of user information will be necessary to provide a seamless service to the user. Therefore, a common data model between fixed and mobile should be worked out to allow this feature. Extensions if needed to these protocols should be identified and forwarded to the proper standards bodies (IETF, 3GPPs, ITU-T SG11, ITU-T SG16, etc) in order to take them into account in their recommendations (e.g., if enhancements to DIAMETER are needed, this has to be forwarded to IETF).

And then as a long-term goal, a single Mobility Management protocol scheme will also be considered for the common NNI, and be derived if possible from the different evolving ones studied previously.

VI. CONVERGENCE OF FIXED AND MOBILE SYSTEMS

The global objective of Question 7/SSG is to study network aspects for the convergence of fixed networks and existing IMT-2000 systems: this would provide the foundation for migration paths to interoperable and harmonized network architectures to support services transparently to users across different network access arrangements (subject to regulatory agreements).

A major step in the future service offering will be the consistent service provision for users - i.e., users will be regarded as a single person when they use different access technologies, allowing them to use and manage consistently their services across the current network boundaries. At present, users may be able to roam between similar public wireless accesses, and nomadism is allowed between some fixed accesses, with strong limitations; however mobility management is currently possible within homogenous environment and in particular in mobile networks. In the future, users will be offered more and more access technologies (e.g., WLAN is emerging as a public access technology) and they will require soon to move between different fixed (e.g., xDSL to cable) and public wireless access of various technologies (e.g., UMTS to WLAN) and to get access consistently to their set of services.

The broad objective of ITU-T SSG is to work in the areas that enable global roaming for the user, and access for the user to the same set of services across different IMT-2000 family and fixed network boundaries. In this context, global roaming should be achieved irrespective of the access mechanism or the technology. An IMT-2000 mobile network user should be able to register in a fixed network as a roamer and be able to get the same set of services that he usually gets in his home network, except terminal mobility. Suitable mechanisms to support a foreign subscriber's registration and authentication, and access to the service profile server of the home network by the visiting fixed network, are under study in Q.7/SSG. This is the form of mobile/fixed convergence that would be appreciated in areas where 3G radio technology is not available. This would provide the means to extend 3G services to other access arrangements such as fixed access for IMT-2000 users.

For example, the recent development of interworking between WLAN and 3G systems in 3GPP is relevant in this context: WLAN is initially a radio technology, for private networks, but it can also be connected to fixed public access in hotspots, and it is now considered as a public access for nomadic users as well. 3GPP is currently developing technical specifications with a wide range of possible implementation scenarios, beyond the current 3G systems. In particular, some scenarios enable the development of services for different access types (WLAN, UTRAN, etc.) in a converged way.

In order to support the global roaming requirement, the scope of the work on convergence between fixed and mobile systems encompasses the provision of the following functions: identification and authentication, access control and authorization function, location management, IP address allocation and management, user environment management (user environment is defined as the global "access network + terminal"), which is a first stage of Virtual Home Environment in a fixed - mobile network environment.

Moreover, the development of user profiles is a key issue for the development of network solutions for mobility management and user environment as well. The introduction of mobility in fixed networks and of fixed-mobile services requires a single user profile (from a functional point of view), which contains common user data (i.e., data needed in both fixed and mobile environments) and which can be accessed by fixed and mobile networks entities, via a central entity (e.g., call servers, SCPs, switches, etc.).

"Fixed wireless access (FWA)" was highlighted as an important topic during the SSG's meeting in Rio de Janeiro, and it is expected that further work will be done to document the basic requirements for FWA - in particular, for interconnection network evolution is required to support such access technologies.

The group is expected to document requirements for mobility across fixed and mobile networks and to address questions such as the missing network capabilities which are needed.

VII. CONCLUDING REMARKS

The Special Study Group on "IMT-2000 and Beyond" was established to meet market needs and to provide a focal point for wireless network studies within the ITU-T. From its inception, the group has been careful to avoid duplication of work being carried out elsewhere, and to some extent this has been a source of delay in tackling some of the pressing issues. Nonetheless,

the SSG has made a good start at developing results which will benefit mobile telecommunications on a global basis. The SSG can be expected to significantly influence the future evolution of regional standardization efforts.

The authors believe that the SSG - being part of the ITU (the United Nations specialized agency responsible for telecommunications) - has a valuable role to play in the evolution of standards for wireless networks. The SSG provides a significant opportunity to foster both global harmonization of mobile telecommunications standards and the convergence of fixed and mobile systems, and all parties should work together to take advantage of this opportunity.

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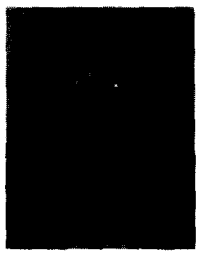
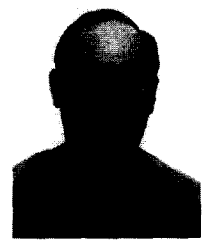
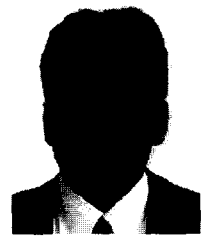


Young Kyun Kim has been Senior Vice President, Global Standards & Strategy of Samsung Electronics since August 1999. In this capacity, he is responsible for overall global standards and strategy within Samsung Electronics, which cover IMT-2000 & beyond, optical and IP network, and 4G advanced system research. He is a Vice Chairman of ITU-T SSG on "IMT-2000 & Beyond" with a focus on network harmonization and convergence. He has served as Vice Chairman of the ASTAP for the standard activities of the Asia-Pacific region and also as Chairman of APT IMT Forum. He has been a steering member of 3GPP PCG/OP, 3GPP2 SC/OP, CDG, OMA and WWRF. Prior to joining Samsung Electronics, he served as ITU-R Program Manager at INTELSAT, Washington, DC, representing INTELSAT at the ITU-R SG 8, SG4, CPM, and WRC. He has been a Senior Member of IEEE since 1984 and holds B.S from Seoul National Univ., Korea, M.S. from Rutgers Univ. and Ph.D. from Duke Univ., both in USA.

Raj Pandya worked in the Systems Engineering Division of Bell-Northern Research and Nortel Networks for over twenty years. His research activities during this period included teletraffic modeling of telecommunication systems and networks, mobile network modeling and performance, and Personal Communication Services. From 1990 to 1992, he was on assignment as Director of Teletraffic Research Center, University of Adelaide, Australia. He has been active in the telecommunications standards activities of the ITU since 1980 and held the position of Chairman of the Working Party responsible for developing signaling standards for IMT-2000 for years 1997 to 2000. He holds a Masters degree in Radio Physics and Electronics from University of Calcutta, India, a Masters degree in Electrical Engineering from University of Toronto, Toronto, Canada and a Ph.D. in Electrical Engineering from Carleton University, Ottawa, Canada. He has published numerous papers on performance modeling of communications networks and emerging wireless network technologies and standards including books on Mobile and Personal Communication Systems and Services (2000) and Introduction to WLLs: application and deployment for fixed and broadband services (2003), published by the IEEE Press. Currently he is a consultant on mobile communications networks.



Bruce Pettitt is a mathematician by training; he received a B.Sc. from McGill University (Canada) and a Ph.D. from the University of Durham (England); in 1983 he began working with Bell-Northern Research (BNR) on telecommunication systems planning and performance studies; he was with BNR and later Nortel Networks until early 2002. In particular, he has worked on low-bit-rate speech-coding, traffic engineering for Signalling System Number 7 and Intelligent Networks, third-generation wireless networks, and general quality-of-service and performance studies in the context of IP-based networks). Over the years, he became increasingly involved in various standardization activities. Since early 2002, he has been working as a consultant on telecommunication standards and is currently Rapporteur for Q.6/SSG in the ITU-T.



Jean-Claude Samou holds a Ph.D. Degree in Computer Science from the Ecole Nationale Superieure des Telecommunications (ENST Paris). He was R&D Manager in the Network Architecture Laboratory at FTR&D (formerly known as CNET in France) and is currently managing at the Network Architecture & Planning Branch of France Telecom (BRX/DAP) activities on mobility in future communication networks such as New Generation Networks (NGN) and Full 3G.IP networks. Previously, he was intensively involved in the standardization work on GSM standards at the national level and at ETSI where he also acted as editor for several ETSI recommendations. He is currently an active member at ITU-T Special Study Group on IMT-2000 and beyond and acting as the ITU SSG Question 2 Rapporteur on mobility management protocols for IMT-2000. In addition, he holds patents and has authored or co-authored numerous publications in the above areas. Prior to joining FTR&D in 1989, he served as a Research Officer in various projects on Robotics and Artificial Intelligence at the Indian Institute of Sciences (Bangalore-India).