IP Multimedia Subsystems (IMS)

Mojca Volk
Mitja Stular
Janez Bester
Andrej Kos
Saso Tomazic
Faculty of Electrical Engineering, University of Ljubljana, Ljubljana, Slovenia

Abstract
IP multimedia subsystem (IMS) represents a standardized next-generation reference system to provide an overlay global open service delivery platform (SDP) that enables provisioning of converged multimedia services.

Communications in a wider sense have become a vital element of modern society and are about serving to users with capabilities and services that meet their demands in a flexible and personalized fashion. Therefore, focus of new-age telecommunications solutions has changed from technologies, functionalities, protocols, and methods to users, services, personalization, and contents and it is the aim of telecommunications systems to provide adequate service environments.

Global evolution and convergence of communications systems have substantially redefined the concept of design, operation, management, and usage of networks and services, called next generation networks (NGN) concept.[1–4] Throughout years, in pursue of this concept, new technologies have emerged and real-world experiences have identified suitable methods and enablers to provide the anticipated network and service convergence in a uniform and mobile manner. As a result, various reference architectures and proposals have emerged that reflected contemporary research and development trends in different fields of telecommunications systems and applied latest technologies available.[5–8] One such standardized reference architecture is IP multimedia subsystem (IMS).

IMS represents a heterogeneous composition of proven telecommunications, Internet-oriented and real-time multimedia technologies to establish a standardized global overlay platform that enables provisioning of highly converged multimedia services to users, regardless of their location, time, or mode of accessibility. This in turn requires extensive overall system transformation that addresses nearly all aspects of system structure, its capabilities, and functions as well as service provisioning. Openness, standardization, and user orientation of such systems are reflected in global interconnection between different and separated communications and content solutions until now. Hence, such systems are capable to provide various types of users with flexible, personalized, and always-available home service environment.

With respect to existent telecommunications solutions, IMS represents a convergent core packet-data mobile service solution as an enhancement to UMTS technology for 3G mobile networks. However, through time, it has become the widely adopted universal reference core architecture that reuses different types of existent access technologies available both in fixed and mobile domain.

In the prospects of global convergence, mobility no longer represents characterization of system architecture, operation, and the belonging services, but indicates wireless nature of accessing to services and possibility of being mobile whereas using wireless or wire-line technologies. There are different types of wireless access technologies being promoted varying in range limits, capacities, and level of mobility. Most prominent are unlicensed mobile access (UMA), interworking-WLAN, and GPRS. In this respect, IMS serves as a core service solution that enables

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global mobility as a service, sold and provided to end users, but not limited in terms of mobile technologies and wireless or wired access.

FUNDAMENTALS OF NGNs CONCEPT

A packet-based network with the ability to provide telecommunications services based on various broadband quality of service (QoS) enabled transport technologies is defined as NGN where service-related functions are independent from transport-related technologies and general mobility promotes ubiquitous home service environment.

The architecture is divided into functionally separated strata characterized by the following requirements. Service provisioning with the appropriate control and management mechanisms is transparently decoupled and independent from packet-based transport functionalities providing broadband capabilities available via multiple last-mile technologies. Clear separation of transport, control, and service functionalities introduces possibility of mixing real-time and non-real-time service provisioning thus enabling complex multimedia service portfolio through a distributed and upgradeable future-proof converged communications domain.

The system provides a wide range of multimedia services based on various service technologies building flexible service development environment that exploits interface mechanisms to provide open interconnection capabilities to both legacy systems and outside service environments. Generally, the aim is to establish a personalized home service environment with support for generalized mobility and unrestricted access by users to different service and content providers while merging fixed and mobile domains into converged communications systems, supported with Internet-oriented principles.

IMS AS AN ENHANCEMENT TO MOBILE DOMAIN FOR 3G UMTS NETWORKS

In the past decades, interest in the mobile communications services and Internet has increased considerably and outpassed service consumption in other domains. Hereby, mobile domain evolution is further accelerated to meet user demands and accomplish standardized and open principles of next-generation communications paradigms.

Today, packet-based services can be accessed via 2G and 3G wireless networks. There are however constraints when providing multimedia and multi-session services. Another issue is the demand for continuous maintenance of QoS throughout the session with respect to possibly different QoS demands from endpoints inside a single session. The addressed issues can be circumvented via a standardized approach, offered through IMS. It is therefore reasonable to assume mergence of IP-based broadband packet networks and mobile networks to offer universal mobile multimedia services, also known as the all-IP vision.

Considering mobile domain evolution, common migration path is the following. Starting with 2G mobile network, the circuit-switched GSM has been upgraded with GPRS technology introducing packet-switched domain. Known as 2.5G solution, it provides enhanced mobile data capabilities. Furthermore, GSM/GPRS network is upgraded and supplemented with new air interface introducing high capacity and bit rates to enable genuine multimedia services environment of 3G, named UMTS. Two prominent technologies in this respect are enhanced data rates for GSM evolution (EDGE) for upgraded GPRS solutions and high-speed downlink packet access (HSDPA) for UMTS. In pursue of all-IP environment, UMTS architecture is further evolving. IMS has been introduced as an enhancement above circuit-switched and packet-switched domains.

IMS, presented by Third Generation Partnership Project (3GPP), represents evolved and standardized NGN concept with more detailed definition that implements new and already proven technologies, protocols, and principles, thus providing fundamental recommendations and detailed guidelines for network development and design. From evolutionary point of view, IMS represents an enhancement to mobile domain for 3G UMTS networks. Nevertheless, the concept has been widely adopted both in fixed and mobile domains and represents access-agnostic core control and application subsystem that is applied as an enhancement to various environments, e.g., fixed and mobile telecommunications networks, broadcasting systems, cable systems, etc. IMS is anticipated as the convergent core platform that assumes access agnosticism and global user and service mobility. As IMS characteristics greatly reflect its mobile origin ETSI, TISPAN presented an enhanced concept that meets also fixed domain requirements, known as ETSI TISPAN NGN.[9]

A complete solution that provides support for IMS services consists of user equipment (UE), IP-connectivity access networks (IP-CANs), and the specific functional entities of core IMS domain. Due to evolutionary reasons, most typical IP-CAN example is GPRS core network inside a packed-switched mobile system with GERAN/UTRAN. Another two IP-CAN options are newly adopted, UMA for mobile users and I-WLAN for nomadic users, which enable access over unlicensed spectrum by reusing existent WLAN equipment and interconnect via GPRS core network. The environment is represented in Fig. 1.

IMS ARCHITECTURE

Following NGN principles, the IMS architecture[2,6,10,11] consists of three strata as indicated in Fig. 2:

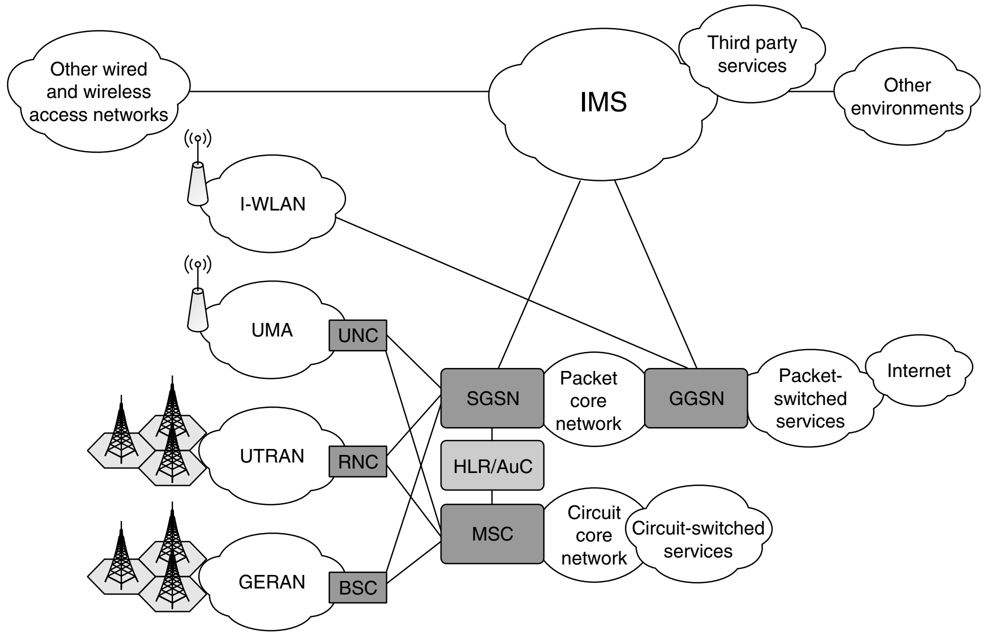

Fig. 1 Evolved mobile domain. UMTS network consists of circuit-switched, packet-switched, and IP IMS in its core segment. Existent circuit-switched (GERAN/UTRAN) access network and mobile switching centre as a core entity] and packet-switched [GERAN/ UTRAN) access network and service GPRS support node (SGSN) and gateway GGSN as core entities] segments are retained while IMS segment is introduced in parallel. Typical packet access segment technologies for mobile domain involve GPRS technology with GERAN/UTRAN radio part, UMA, and I-WLAN. Most important 2G/2.5G entities are shown that are used to access IMS services, i.e., RNC, BSC, UMA network controller (UNC), SGSN, and GGSN. Most common mobile solution exploits existent packet-switched segment to access IMS segment with its services.

- transport stratum, providing IP packet backbone and heterogeneous access networks domain;
- control stratum, enabling core functionalities for signaling, routing, inter-working, and service control purposes; and
- application stratum, providing an integrated service development, delivery, and execution environment.

Any type of telecommunications system regardless of its evolution stage encompasses a portfolio of basic services, required to accomplish essential communications, i.e., session control, service control, media handling, and interworking functions. In IMS, the respective entities are assigned to perform these functionalities. The next section presents brief description of their capabilities and roles.

Call/Session Control Function

Session control entities represent the key control stratum functionalities that provide control points for user authentication and authorization, session routing, and service control. They represent a packet-switched equivalent to mobile switching centre (MSC) entity of circuit-switched mobile domain. There are however three functionally different implementations that occur simultaneously in a complete IMS system: serving-SCF session control function (S-CSCF), proxy-CSCF (P-CSCF), and interrogating-CSCF (I-CSCF) (Fig. 3).

S-CSCF

Serving call/session control function entity provides session, service, and charging control for a user. S-CSCF, residing in home network, is assigned to a user upon registration procedure, regardless of current location of the user (inside home network or in a visited network) and is located inside signaling path of any further communication for this user.

S-CSCF represents a single point of service evocation and triggering toward application stratum via dedicated IMS service control (ISC) interface for a given user based on user and service information acquired from central user server [home subscriber server (HSS) entity].

P-CSCF

Proxy call/session control function entity resides at the edge of IMS network and represents the fist point of

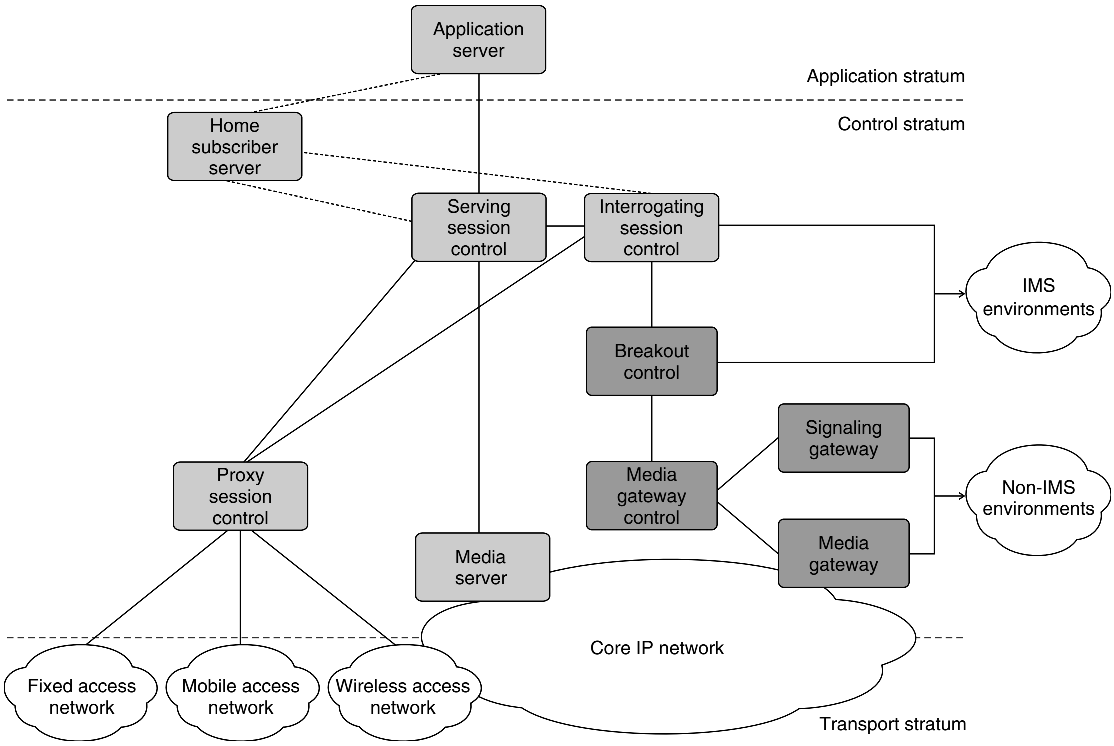

Fig. 2 IP IMS architecture outline. Architecture is composed of three strata and thus separates access and transport of media, call control and signaling, and application domain. Several entities are defined to perform session control, service provisioning, media handling, and inter-working functions. IMS represents an access-independent core subsystem, applicable to various communications environments. To accomplish communications services, it requires interconnection to other subsystems and/or other communications environments.

contact for requests, originating or terminating at user side. In most general scenario, user in a visited network contacts P-CSCF entity of the visited network which forwards session signaling to user's dedicated S-CSCF entity residing inside home network.

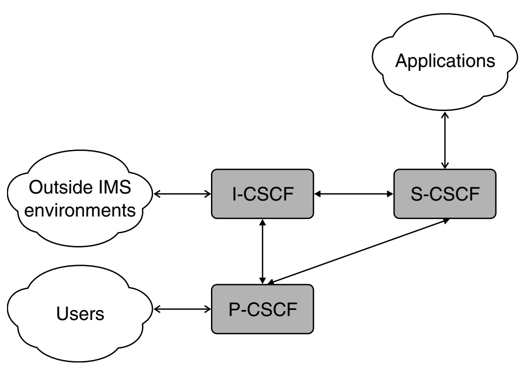

Fig. 3 CSCF. In IP IMS, three functionally different implementations occur. S-CSCF provides control functionalities for user authentication, session routing, and service control. P-CSCF represents the first point of contact in IMS from user side, while I-CSCF represents the first point of contact from other IMS environments.

I-CSCF

Interrogating call/session control function entity also resides at the edge of the IMS network and represents the first point of contact from outside IMS environments, i.e., registration requests and incoming requests toward native or visiting users inside home IMS network. P-CSCF is responsible for S-CSCF entity assignment in registration procedures. Also, it optionally implements inter-network gateway for network topology, configuration, and capability hiding toward other environments.

Application Server

Application stratum consists of different types of application server (AS) entities that provide functionalities to complete various multimedia services. In IMS, ASs occur in three forms: session initiation protocol AS (SIP AS), IP multimedia service switching function AS (IM-SSF AS), and open service access service capability server AS (OSA SCS AS) (Fig. 4).

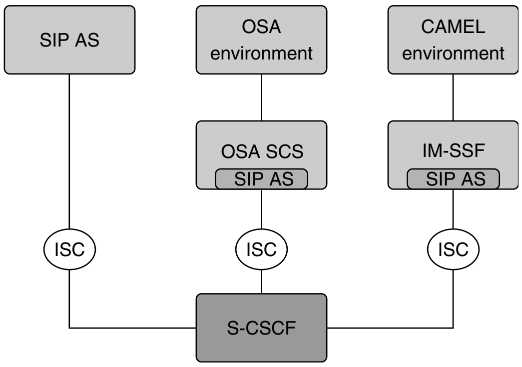

Fig. 4 IP IMS AS options. AS entities are considered the most important functionalities that provide value-added end-user multimedia services. Apart from native SIP-based services, executed within SIP ASs, services can be developed and deployed in different service development environments, e.g., Parlay/Parlay X, connected through APIs ASs (open service access service capability server application server—OSA SCS AS). Also, access to third-party service environments could be provided via gateway AS implementations [IP multimedia service switching function application server—IM-SSF AS for CAMEL environment]. All types of AS entities are, from underlying system point of view, treated uniformly as SIP AS entities via ISC interface.

SIP AS

SIP AS represents the most general AS type that hosts and executes service logic to provide end-user applications. It is based on SIP technology and referred to as service AS. Typical new generation services are deployed on SIP AS entities, e.g., instant messaging, presence services and push-to-anything.

IM-SSF AS

In pursue of openness of the system, apart from native ASs inside operator's environment, IMS users benefit from applications provided by other environments or outside ASs via dedicated gateway servers. These servers induce appropriate technology conversion and protocol mappings to accomplish complete interconnection. IM-SSF AS with gateway toward customized applications for mobile network enhanced logic (CAMEL) service environment is defined for IMS.

OSA SCS AS

If different interface technologies are implemented, that hide underlying telecommunications complexities are implemented and enable flexible service development and deployment, an environment is established, where multiple programming tools are available. In this way, service creation can be brought closer to Internet-oriented principles and computer programming paradigms while service deployment is greatly accelerated. OSA SCS AS is an AS type, which implements standardized application programming interfaces (APIs) that provide interface technology for Parlay/Parlay X environments.

Note that, from underlying IMS system point of view, all types of ASs are treated uniformly as SIP ASs via dedicated ISC interface.

The goal of application stratum with the belonging ASs is to establish service delivery platform (SDP) within/above IMS system. SDP is an integrated environment where service development, deployment, operation, management, and charging are enabled in a converged and controllable way. A heterogeneous range of telecommunications services and content provided through SDP are agnostic toward underlying telecommunications technologies, while SDP environment itself aims at openness in a secure and robust manner.

HSS

HSS represents a master database and an extended authentication, authorization, and accounting (AAA) server inside IMS network.

In this entity, information that represent a vital compound of session and service control processes are stored: user identification, addressing and numbering information, security information (e.g., access control information for authentication and authorization purposes), inter-system user location information, user profiles, and service profiles. HSS also generates security information required for authentication procedures, integrity control, and ciphering.

From a mobile domain point of view, a subset of HSS represents equivalent to home location register (HLR) and authentication centre (AuC) and serves to packet-switched domain [services for service GPRS support node (SGSN) and gateway GPRS support node (GGSN)] and to circuit-switched domain (services for MSC server) in parallel to authentication, service profile, and location information services for IMS domain (services for CSCF) (Fig. 5).

Gateway Control Functionalities and Gateway Functionalities (MGCF, BGCF, MGW and SGW)

Gateway control functionalities and gateway functionalities on control stratum of IMS network represent a group of entities providing interconnection capabilities toward outside non-IMS environments [e.g., public switched telephone network (PSTN), integrated services digital network (ISDN), and GSM]. Media gateway control function (MGCF) controls the operation of media gateways (MGWs) and signaling gateways (SGWs) and in cooperation with breakout gateway control function (BGCF) selects the appropriate gateways to complete the

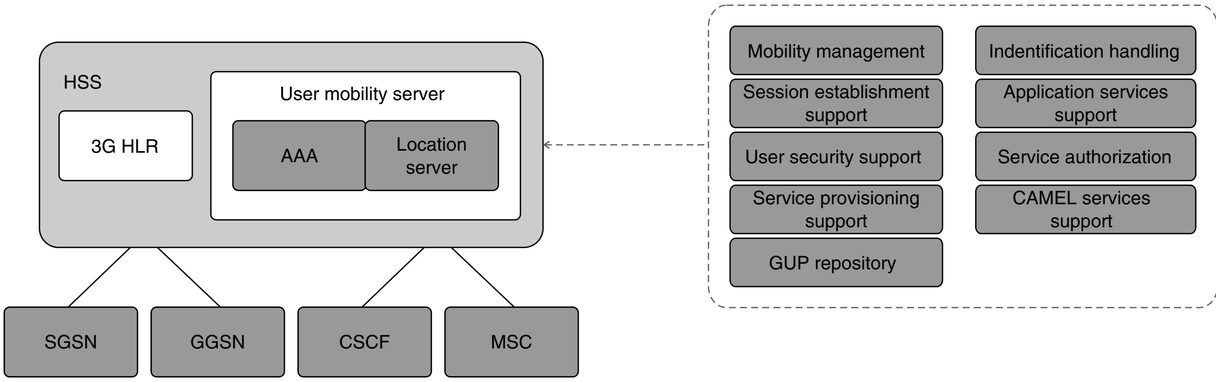

Fig. 5 Generic HSS structure, basic interconnections, and capabilities. HSS serves to support session control and management and is a shared entity for all subsystems inside heterogeneous communications environment, e.g., circuit-switched, packet-switched, and IP IMS domain of a migrated 3G mobile system.

communications toward outer environment. Also, MGCF routes incoming requests to appropriate S-CSCF entities based on routing information.

Media and signaling gateways perform media and signaling conversion between IMS domain and other non-IMS domains, respectively.

Media Server (MRFC, MRFP)

Multimedia resource function controller (MRFC) and multimedia resource function processor (MRFP) are entities that implement media server inside IMS network. It hosts resources that provide media handling capabilities, e.g., sourcing, mixing, and processing of media streams and floor control, to support provisioning of services such as conferencing, multimedia, announcements, etc.

IMPORTANT PRINCIPLES IN IMS

Interfaces and Protocols in IMS

IMS anticipates implementation of Internet-oriented protocols and interface technologies to establish a standardized and open service environment. Two principal protocols are defined.

Diameter protocol is strictly used in transactions involving user and application data handling or AAA procedures. For all other types of internal sessions and in communications toward other environments, SIP protocol is in use. It is appropriately extended to meet IMS requirements. Additionally, some legacy protocols can also be used with respect to eventual remains of existent solutions inside IMS system or as an interconnection requirement toward other (legacy, NGN, etc.) environments, e.g., H.323, SS7, MGC protocol (MGCP)/Megaco/H.248, and signaling transport (SIGTRAN).

Mutual interactions and mechanisms among IMS entities are precisely defined. The detailed definitions are provided through so-called reference points that specify the interface and the belonging functions. In IMS, several reference points between entities are defined, based on SIP and Diameter protocols.

User and Service Identities

End users and services inside IMS are identified in different ways through inter-dependent private and public identities and profiles (Fig. 6).

Every IMS user has one or more IP multimedia private identities (IMPIs) assigned. IMPI identity is unique, permanent, and global identity stored in HSS and it is used within home network to identify user's subscription but not the user himself. It is generally used for accounting purposes through mechanisms for registration, authorization, administration, and accounting.

Every IMS user has also one or more IP multimedia public identities (IMPUs) that is used for incoming communications requests (SIP routing in the direction toward the user). IMPU takes the form of SIP URI (Internet naming) or TelURI (telephone numbering).

Each IMS user can register into the IMS network from more locations or terminals simultaneously. Therefore, each private identity (IMPI) with unique IP address corresponds to one or more public identities (IMPU).

In HSS, user profiles are stored. They represent a collection of services data and user-related data, i.e., user identities and service profiles (subscribed services, their configuration, personalization information, etc.). Each IMPU corresponds to exactly one service profile while service profile could coincide with several IMPUs simultaneously.

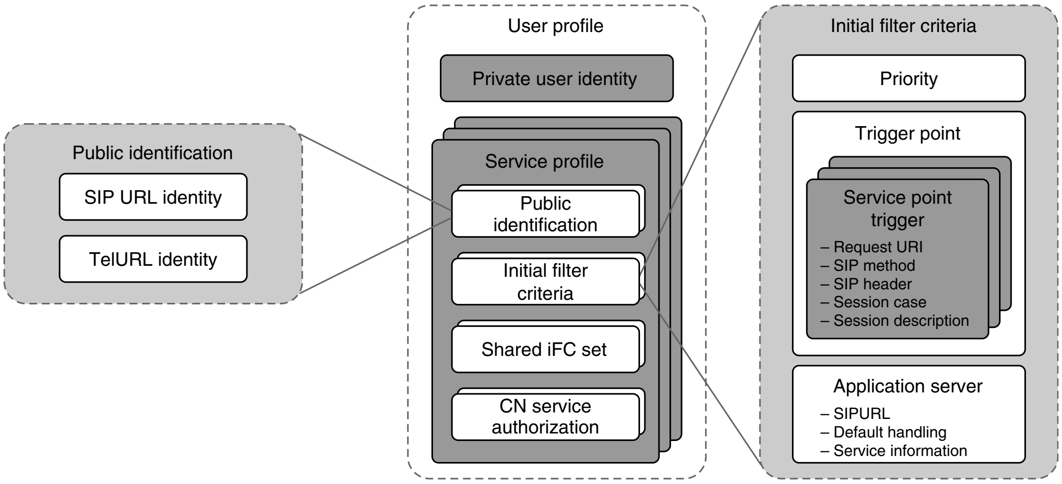

Fig. 6 User and service profiles. User profiles represent a collection of services data and user-related data, i.e., user identities and service profiles (subscribed services, their configuration, personalization information, etc.).

Registration, Basic Communication, and Service Control

Most important entities that enable the user to enter IMS network, communicate and use services, are S-/P-/I-CSCF, HSS, and AS. While AS provides service logic invocation and execution, CSCF is engaged in routing and service control based on user and service information, stored in HSS. These entities represent the base of IMS core network and are fundamental for any deployment of IMS environment (Fig. 7).

User registration into IMS system is generally treated separately from attachment to IP access network. It is assumed that IP-CAN bearer is already established prior to IMS registration. In the end-user terminal an element named IM services identify module (ISIM) is incorporated that represents a container of parameters and functionalities, required for registration procedure (e.g., IMPI, IMPU, home network domain name etc.). Registration and basic communication example for an IMS user are represented in Fig. 8. Most general case is assumed where user is located in visited networks.

Service control in IMS is provided through interactions between S-CSCF and AS via ISC interface. There are several possible ways of service control based on different mechanisms.

A local copy of user profile is saved inside S-CSCF and contains service profile with defined filter criteria. Based on priority and information of when a service should be provided to a user (service trigger points, filter criteria), the request is forwarded to specified AS. Based on SIP request filtering services such as black/white lists, IP PBX services, monitoring, prepaid services, etc. are provided.

Some services could be provided via direct session establishment between a user and an AS or service, accessible via public address. This type of service involves messaging, voice portals, conference services, presence services etc.

AS can also be the initiating side of the session. Service examples in this case are conference services, missed calls services, etc.

Generally, IMS assumes advanced multimedia real-time services that require a complex combination of different service control mechanisms for their operation.

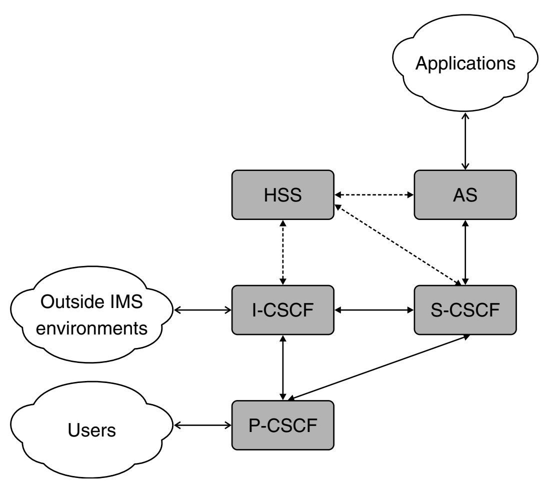

Fig. 7 Basic IP IMS entities. While AS provides service logic invocation and execution, S-CSCF is engaged in routing and service control based on user and service information, stored in HSS. P-CSCF and I-CSCF provide access functionalities.

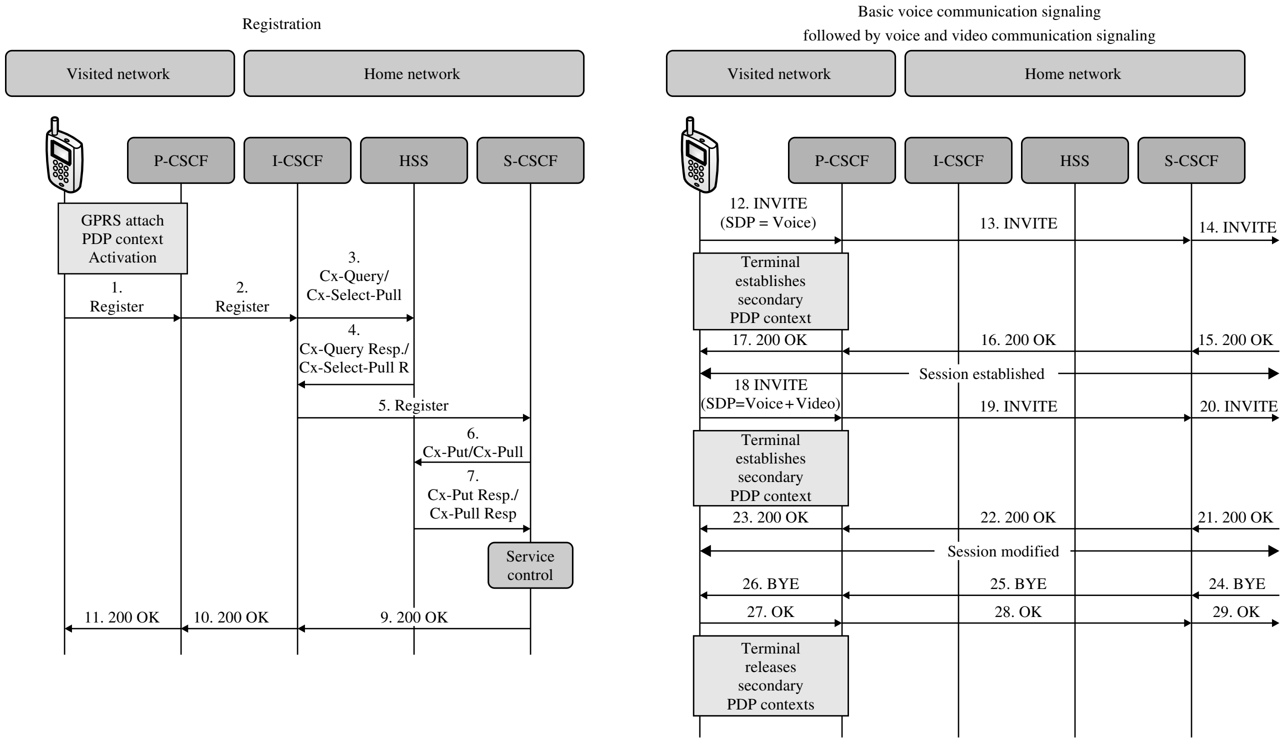

Fig. 8 Registration and basic communication of an IP IMS user with indicated IP-CAN establishment for gateway GPRS/UMTS. Message flow is SIP-based, procedures involve basic IMS entities, PDP context activation events are indicated.

Security

Security issues in IMS are considered completely separated from security issues regarding packet transport domain. In this respect, there are two separate security associations established to ensure safe and controlled communication and service provisioning to every user.

There are several security viewpoints in IMS. Authentication for end user in IMS is provided by S-CSCF based on user profile. To provide confidentiality protection, communication between UE and P-CSCF is encrypted. To protect SIP signaling messages between UE and P-CSCF, the involved parties exchange integrity keys. Data is verified for origin based on integrity key, verification is also used to detect if data has been tampered with or duplicated. The engaged security mechanisms are based on 3GPP-standardized IMS-authentication and key agreement (AKA) procedure.

Due to business sensitivity issues, network topology hiding is available that includes hiding of the number of S-CSCF entities, their capabilities, and the capabilities of the network. For this purpose, topology hiding internetwork gateway (THIG) functionality is implemented within I-CSCF.

Charging

Charging and billing represent key system functionalities and are provided on packet core, subsystem, and application levels.

Basic functions of charging infrastructure involve charging information generation and charging data collection, provided by network elements that are forwarded to appropriate charging and billing systems. Two charging architectures are defined for IMS subsystem: offline charging and online charging.

Offline charging functions generate call detail records (CDRs) and transfer them to billing system after the resource or the service usage process has been completed. Billing in this case is of non-real-time type.

When online charging is engaged, additional usage authorization is required, provided by online charging system (OCS). Billing in this case is provided in real-time, therefore, continuous interaction between billing system and usage control is anticipated.

Regardless of architecture type, charging can be based on one of the two charging principles. In event based charging case, charging is applied to SIP transactions between user and IMS system; messages, divert services, and content download services are charged in this way. Session-based charging assumes charging of SIP sessions. Voice calls, IMS session, and calls to voice mail are services based on session-based charging.

Mode of charging provided for IMS depends on involved entities and charging type. ASs, media servers, and S-CSCF support both online and offline types, while other entities provide only for offline charging. Interactions for charging purposes inside IMS are based on Diameter protocol.

MOBILE DOMAIN CHARACTERISTICS OF IMS AND IMPACT OF MOBILE ACCESS NETWORK ON IMS FUNCTIONALITIES AND OPERATION

When considering IMS in view of mobile domain, several parallels are evident. First, NGNs' general aim is providing global mobility to both users and services. This requires implementation of several mobile principles. Second, mobile origin itself is substantially reflected in functional composition of architecture and entities. Third, if mobile access technology is engaged, IMS entities and their procedures are affected in part. The latter is presented in this section.

In general, connections to IP-CAN and to IMS are considered independent. When user accesses IMS core network, it utilizes services provided by IP-CAN for packet-based communication. In IMS network, P-CSCF entity serves as an entry point from user domain. Therefore, prior to connection to IMS core, network user must obtain an IP-CAN connection to acquire its IP address(es) and learn P-CSCF address. As IMS is composed of an independent IP backbone that is implemented separately from access network backbone for security purposes, this presents two separate authentication/registration procedures for IP-CAN followed by procedures for IMS.

Examining prominent access technologies in mobile domain, engaged to access IMS core network and services, there are basically two distinctive groups: GPRS access network with GERAN/UTRAN/UMA radio segment for mobile solutions and I-WLAN via GPRS for nomadic solutions (Fig. 9). All of them exploit existent packet-switched access segment of typical GSM/GPRS networks and vary in radio segment. While GERAN and UTRAN remain as legacy access solutions, UMA and I-WLAN are newly introduced.

UMA defines a new radio segment in addition to GERAN/UTRAN while employing already available broadband access connections.[12] Even though treated as a competition, UMA in fact represents complementary solution for mobile and converged operators addressing foremost indoor usage reusing existent indoor WiFi networks, and thus enhances coverage and range issues of UMTS networks. I-WLAN also stands aside as a complement to UMA that exploits WiFi via available broadband connectivity, foremost for fixed and nomadic users. In this case, the solution does not employ GPRS access but is based on direct SIP-based tunneling connectivity toward core IMS.

The principle of access technology independence of IMS is very important. In this way, any specific requirements for mobile access should be dealt with by the access network alone. Nevertheless, there are some access-dependent particularities that affect IMS functionalities as well. Some most evident are presented in the following section for a common mobile IMS solution that uses GPRS access network with GERAN/UTRAN/UMA radio segment as an IP-CAN.

GPRS-specific Concepts of IMS

Within GPRS access network, IP-CAN bearers are provided via packet data protocol (PDP) context activation procedure (Fig. 10, Ref. 1). For IMS-related signaling, dedicated PDP context or a general purpose PDP context is established. P-CSCF discovery takes place after GPRS attachment procedure and after or as part of PDP context activation procedure for IMS signaling. When these procedures are completed, user is granted basic access connectivity with acquired IP addresses.

If one or more IP addresses change at any point later, user must re-register for IMS services. In event of loss of coverage, some types of PDP contexts are affected. In this case, P-CSCF indicates modification and reacts accordingly.

Apart from basic packet connectivity, additional features are available to support QoS and security. UE has the ability to request for prioritized handling over radio interface for IMS signaling. Signaling connections are restricted only to specified destinations, i.e., the assigned P-CSCF and to DNS (domain name server) and DHCP (dynamic host configuration protocol) servers inside IMS operator domain. IMS signaling flag is also available for determination of rules and restrictions that apply to PDP context at GGSN in addition to applied local GPRS policy.

Hereby, packet-based access network connectivity is ensured and user is granted the access to IMS core network starting with registration procedure as specified by IMS regardless of chosen access network technology.

CONCLUSIONS AND PROSPECTS

IMS as the next step in the evolution of NGNs extends beyond the definition of an upgraded and optimized

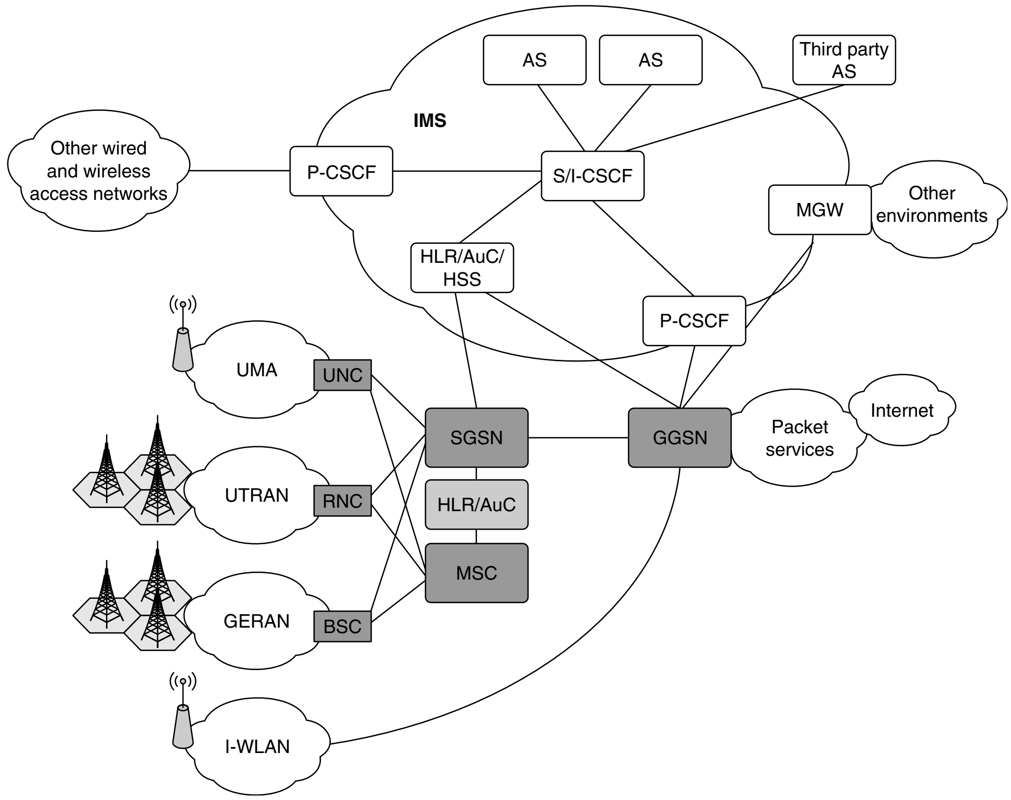

Fig. 9 A detailed schema of introducing IP IMS into mobile system. Existent circuit-switched (GERAN/UTRAN, and MSC as a core entity) and packet-switched [GERAN/UTRAN access network and service GPRS support node (SGSN) and gateway GPRS support node (GGSN) as core entities] segments are retained while IMS segment is introduced in parallel. Most common mobile solution exploits existent packet-switched segment to access IMS and its services.

solution, implementing newly available technologies, protocols, and services. It introduces a substantially remodeled concept where call control, transport, and access segments build an enabling infrastructure, on top of which value-added SDP is positioned. Implemented as SIP and Diameter-based architecture, it exploits initial horizontal nature of the belonging mechanisms and procedures, while pursuing controlled, secured and managed operation, and open interconnection.

Core IMS network presents a challenge to telecommunications operators and service providers when deciding their strategies for next-generation solutions. Even though most of the services available to end users could be achieved by means of alternative solutions eluding IMS implementation, particularly NGN, voice over Internet protocol (VoIP), and fixed mobile convergence (FMC), such strategies present problems of standardization, openness, universality, and limitations regarding the use of different technologies and service design. These addressed issues are in favor of implementing IMS. Also, standardized seamless mobility and the principle of home environment as the essential next-generation characteristics could today be provided in environment, presented by IMS.

The concept of mobility is no longer limited to access domain but has become one of the most important services in converged environments. From this point of view, IMS represents a corresponding and optimized solution due to its mobile origin, which is considerably reflected in architecture that implements basic mobility-enabling infrastructure. An integral IMS-based solution encompasses access agnostic and secure call control and service delivery infrastructure for convergent fixed-mobile communications, where mobility is an inherent characteristic, available to underlaying technologies and overlaying SDPs.

At the time of writing, there are several convergent initiatives evaluating available technologies to provide different scenarios to address mobile voice and multimedia service markets worldwide. The choice of available technologies is broad and differs in stage of evolution, ranging from GSM/GPRS to UMTS and alternative solutions, e.g., UMA and I-WLAN. If optimally combined, service

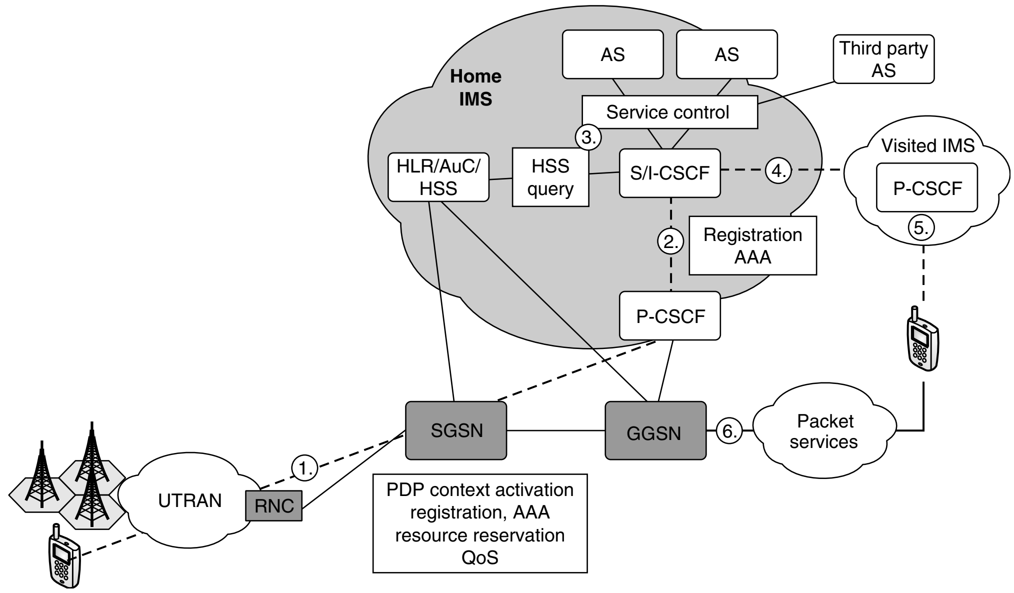

Fig. 10 Basic communications procedures for IP IMS services accessed via GPRS technology using UTRAN interface (example). Before connecting to IMS core network, user equipment acquires access network connectivity [attachment to GPRS access network, PDP context activation, AAA procedures, and management of QoS; refer to 1]. These procedures serve to establish packet-based bearer and provide user equipment with IP address(es) and proxy-call session control function (P-CSCF) address, required for the user equipment to enter IMS core network. Once connected to access network, user enters IMS domain starting with registration procedure where user is authenticated and authorized according to its profile (refer to 2). Afterward, services are provided to the user based on service control mechanisms (refer to 3). For this example, IMS communication between two users is represented where one user is located in visited IMS network. To complete the communication, appropriate interconnection mechanisms are applied (refer to 4, 5, and 6).

availability is extended and access agnosticism is addressed. With ever more global ubiquity and mobility of end-user services, convergence is underway, diminishing the fixed-wireless-nomadic-mobile differentiation. In this respect, inter-working is a major issue.

With these characteristics, IMS provides an open and flexible converged service environment, enhancing mobile communications systems with Internet-oriented paradigms and broadband capabilities to provide "full multimedia" 3G, 4G (fourth generation), and beyond.

There are, however, some issues remaining in 3G systems. There is a 4G initiative that aims at resolving these in order to provide customized personal mobile multimedia services based on integrated broadband wireless and mobile access solutions. The main emphasis will be on hybrid communications with ubiquitous high bandwidth multimedia and full-motion data and video services. Important issues such as inter-working at high speed, various UE, and alternative access technologies with increased capacity and withdrawal of remaining circuit-switched segments are to be resolved. 4G addresses primarily access segment, nevertheless it represents a step closer to global mobility and provisioning of home environment based on complete service portability. In this respect, IMS as core infrastructure represents a viable and possible choice.

ADDITIONAL READING

1. 3GPP homepage, http://www.3gpp.org.
2. ETSI homepage, http://portal.etsi.org/Portal_Common/home.aspwww.incodewireless.com.
3. IEEE homepage, http://www.ieee.org.
4. IMS forum homepage, http://www.imsforum.org.
5. Fraunhofer Institute for open communication systems homepage, http://www.fokus.fraunhofer.de/bereichsseiten/testbeds/ims_playground/index.php?lang=de.

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