IMS Interoperability and Conformance Aspects

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ABSTRACT

In this article, we take a closer look at interoperability and conformance aspects when using 3GPP IMS, ETSI TISPAN NGN, and related OMA Service enablers.

Considering the increasingly important role of 3GPP IMS within mobile and NGN (next generation network) contexts, we highlight the importance of interoperability and conformance testing of IMS products.

INTRODUCTION

The IP multimedia subsystem (IMS) is standardized by the 3rd Generation Partnership Project (3GPP). It is based on SIP (Session Initiation Protocol), which is standardized in IETF (Internet Engineering Task Force). The 3GPP specifications define the basic call control protocol aspects, emphasize especially the differences to the IETF SIP protocol, and define also other specific 3GPP related aspects like PDP context activation and P-CSCF discovery as well as the handling of SDP during call setup. TISPAN (telecommunications and Internet converged services and protocols for advanced networks) reuses the 3GPP IMS for its NGN specifications, which enables the same applications to be deployed over fixed and mobile networks. The Open Mobile Alliance (OMA) standards consortium has defined application enablers that use 3GPP IMS.

WHY ARE INTEROPERABILITY AND CONFORMANCE TESTING IMPORTANT?

Interoperability is defined as the capability of two or more systems from different vendors to work together.

As a first step, testing is the responsibility of the body that standardizes the technology to assure interoperability. It is important to avoid the launch of specifications too early (immature) as an error in the specifications is multiplied by the number of companies implementing them. Currently, OMA is the only standards body running interoperability tests as a major part of its enabler approval program, including enabler specifications for applications over 3GPP IMS. Interoperability tests for this phase usually are made with prototype implementations and usually are focused on areas where there is uncertainty about the workability of the solution specified. Due to the increasing complexity of the specifications currently being written, it is becoming common to test the full spectrum of the specifications because unpredicted issues always arise.

The second step of interoperability testing belongs more to the individual vendors before they launch a device/server product to the market. A vendor seeks to verify minimally whether its product is interoperable with the major players in the respective market.

As end-user devices, that is, terminals, are operated in large numbers, it is paramount that they behave according to specifications. The compliance for terminals is verified by conformance testing.

To achieve magnitudes of scale for a new communication system, it is important for different implementations to get to market quickly. This makes interoperability a critical aspect for time-to-market of new systems. Without good interoperability, customers face problems when trying to operate their devices on different networks and therefore would be less interested in, and possibly discouraged from, using a new system.

IP MULTIMEDIA SUBSYSTEM (IMS)

3GPP introduced IMS in its Release 5 specification [1] for controlling packet switched multimedia services with SIP [2]. IMS provides an abstraction layer above the access and transport network technologies. Moreover, it separates the planes of service control and transport. Additionally, it provides common functionality such as charging support, quality of service (QoS), session and service control, and subscriber management and mobility management for IP based multimedia services through well-defined reference points to the higher service layer(s). This way, services can rely on existing functionality and can reuse so-called service enablers such as presence. Thus, advanced services become easier to develop and easier to deploy quickly.

In principle, the service control logic consists mainly of:

- Home Subscription Server (HSS), which stores the IMS service subscription contained in the initial filter criteria (iFC) that is associated with each subscriber's profile.
- Call session control function (CSCF), which can either play the role of a proxy (P), interrogating (I), or serving (S) CSCF.

When looking at the current telecom industry trend towards fixed mobile convergence (FMC) services, IMS is very appealing as it provides a common service control infrastructure tying together different heterogeneous and possibly complementary access network technologies — 3GPP defined IMS as being access network agnostic. As long as the network access is provided via a suitable IP core access network (IP-CAN), users can access their subscribed services. This is one reason why standards organizations such as ITU-T and ETSI TISPAN reuse 3GPP IMS for their NGN specifications.

3GPP Interoperability

Interoperability Aspects for IMS

Interoperability testing itself is beyond the scope of the 3GPP organization. A discussion about IMS interoperability testing and specifications within 3GPP in December 2005 confirmed this.

The interoperability on IMS as a supporting service infrastructure itself is difficult to perform as IMS requires an application to exercise it. Thus far, in the testing program performed in OMA, only the PoC and presence applications use the IMS as SIP/IP core.

For the PoC service, many test events already took place where several IMS platforms were tested against different PoC clients with their IMS client embedded. Also, the NNI (network-network interface) was tested where two IMS servers must provide a tunnel for clients in different servers.

In this way, IMS interoperability testing is performed directly between different user equipment (UE) and network vendors (providing IMS and specific service equipment), as well as involved operators. This testing takes place under OMA enabler testing conditions and in bilateral agreements. Moreover, 3GPP defines terminal conformance testing, which is an important base for successful interoperability testing.

For interoperability testing, the devices are connected according to the standardized IMS architecture.

Terminal Conformance Testing

3GPP defines terminal conformance specifications for functionality defined in the 3GPP core specifications. This includes all protocol layers, starting from the physical layer to the application specific protocol layers, such as IMS call control (SIP, SDP). The RAN plenary approved a work item to define conformance testing for IMS call control (IMS CC) in June 2005. Since then, a number of test cases were defined for PDP context establishment, P-CSCF discovery, IMS registration (including subscription and notification), mobile originated/mobile terminated (MO/MT) call establishment, SigComp (signaling compression for SIP) and emergency call handling. The core definitions for IMS call control are contained in 3GPP TS 24.229 [2]. So far, test cases were defined for IMS 3GPP Release 5, but work for 3GPP Release 6 is already planned. For the existing Release 5 test cases, a valid Release 6 user equipment (UE) should not unfairly fail. In addition test cases for early IMS UEs are included or are considered for the near future: IPv4 and early IMS security. Both early UE features are not part of the 3GPP IMS specifications, but technical reports exist in 3GPP (TRs 23.981 and 33.978) describing how UEs and networks supporting those features should behave. The test cases are defined in a radio access independent way so that the test cases can be applied for terminals supporting different radio access systems, for example, WCDMA, GSM/GPRS.

An IMS call control test case has a textual description but includes a test procedure in 3GPP TS 34.229-1 [3]. The applicability of the test cases for different types of terminals is described in 3GPP TS 34.229-2 [3]. The test model, as depicted in Fig. 1 and the formal test language description using TTCN-3 (tree and tabular combined notation), are defined in 3GPP TS 34.229-3 [3].

ETSI MCC TF 160 (Mobile Competence Centre Task Force 160) is preparing a reference implementation for IMS call control testing that should be used by test system vendors to obtain test systems with results that can be reproduced between different test systems.

It is expected that 3GPP RAN5 will continue to develop conformance test specifications for those IMS related application enablers for which the core specifications are created within 3GPP, for example, for VCC (voice call continuity), CSICS (CS interworking with IMS), and MMTEL (multimedia telephony).

In addition ETSI created a SIP test suite using TTCN-3 that covers most of the basic SIP functionality according to the corresponding IETF RFCs. This also includes the behavior of network nodes. For details, see ETSI TS 102 027-1, -2, -3.

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ETSI TISPAN NGN Interoperability

ETSI TISPAN plays a leading role in specifying NGN. For its infrastructure, it reuses 3GPP IMS. TISPAN Working Group 6 (the competence center for testing within TISPAN) and manages and coordinates the development of testing specifications for NGN. With ETSI TISPAN NGN Release 1 focused mainly on the wire line world, the main concern for interoperability and testing is migrating legacy circuit switched networks to future NGNs.

TISPAN WG6 approaches protocol related testing by specifying three main steps:

- The protocol implementation conformance statement (PICS)

TISPAN WG6 continues to exert a tremendous amount of effort on test specifications for supplementary services, ISUP, and OSA Parlay implementations. Each aspect is relevant and paramount for the current industry trend of migrating legacy CS networks to the next generation PS networks.

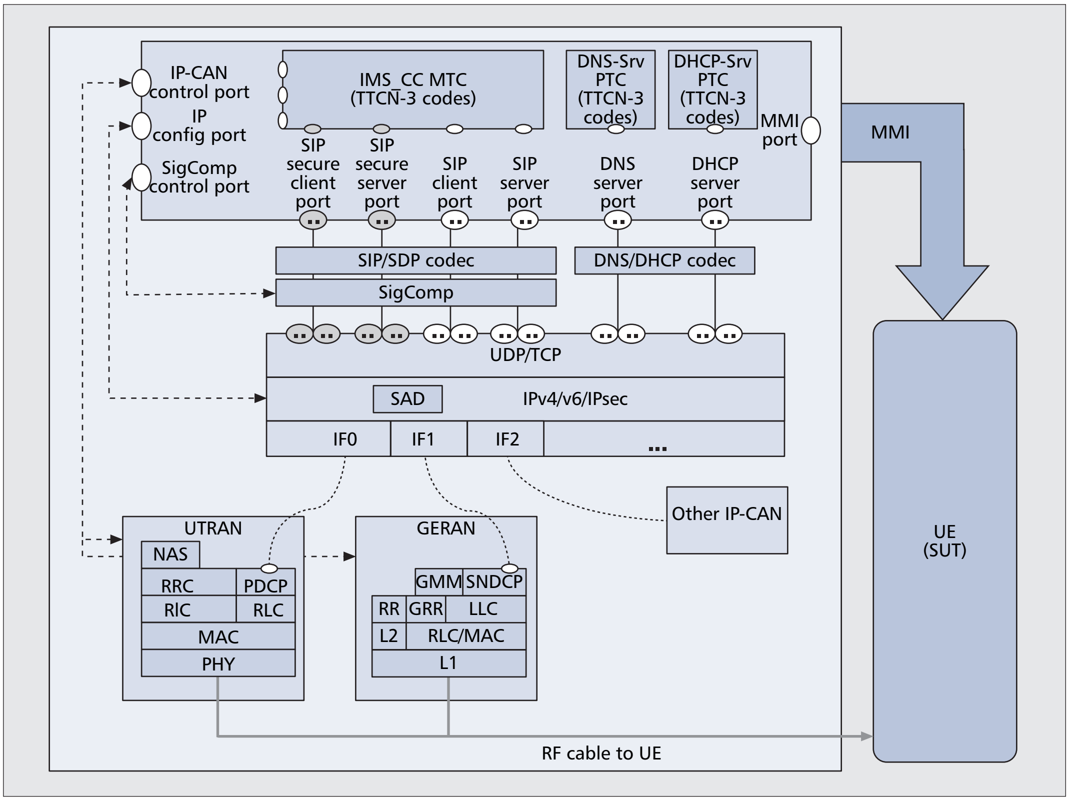

Figure 1. *IMS CC test model (3GPP TS 34.229-3).*

- The test suite structure and test purposes (TSS&TP)
- The abstract test suite (ATS) and partial protocol implementation eXtra information for testing (PIXIT) pro forma specification.

WG6 often separates the test specifications according to the three main steps. However, often the three main steps are subdivided further for semantic reasons. Especially, the subsequent open service access/ parlay test specifications — enabling third party access to the IMS network services — were subject to this fine grained partitioning.

The OSA API implementation conformance statement (ICS) for Parlay 3 is specified in ES 202 170. The corresponding TSS&TP ES 202 196 is spread over 12 parts using a divide-and-conquer approach. The Conformance Statement for Parlay 4 Implementation is defined in ES 202 363, and a corresponding specification for TSS&TP is contained in ES 202 388, which is divided into 14 documents — very similar to the division of the Parlay 3 TSS&TP. The work related to Parlay 3 and Parlay 4 is finished, and the related documents were published.

Although TISPAN WG 6 finalized and published its work related to OSA Parlay, its work on the subsequent topics is ongoing.

Network integration testing between SIP and ISDN/PSTN network signaling protocols are covered in TS 186 001.

Interworking between SIP and Bearer Independent Call Control protocol (BICC) or ISDN user part (ISUP) is covered in TS 186 002, which consists of five documents for protocol implementation conformance statement, test suite structure, and test purposes. The three different ISUP Profiles A, B, and C are covered. The related SIP — ISUP interworking between IP multimedia (IM), core network (CN) subsystem, and circuit switched networks is covered in TS 186 009.

TS 102 364 deals with ISDN/PSTN network integration testing for H.323 based trunking, and TS 102 169 focuses on network integration testing between H.323, ISDN and PSTN.

The SIGTRAN protocols are tested in TS 186 004, and TS 102 547 covers network performance objective tests for IP-based voice services. Additionally, a performance benchmark for NGN platform components is included in TS 186 008.

TISPAN WG6 also specifies interworking for Supplementary Services. The following are the technical specifications for testing supplementary services:

- TS 186 005 covers terminating identification presentation (TIP) and terminating identification restriction (TIR).
- Three documents associated with TS 186 006 cover originating identification presentation (OIP) and originating identification restriction (OIR).
- TS 186 007 covers Communication HOLD.
- TS 186 010 covers Conferencing using IMS.

In summary, TISPAN WG6 continues to exert a tremendous amount of effort on test specifications for supplementary services, ISUP, and OSA Parlay implementations. Each aspect is relevant and paramount for the current industry trend of migrating legacy CS networks to the next generation PS networks.

OMA INTEROPERABILITY

The aspect of interoperability is taken very serious by OMA. Past experience during the WAP times — especially with MMS —proved the need to validate specifications before releasing them.

The complexity of the produced enablers and the popularity of the testing events (called test fests) forced the creation of proper conformance testing prior to the test fests. This is an effort to ensure that an immature implementation would be filtered and would not cause test fest participants to lose time in bilateral test sessions.

The aim of conformance testing is to reveal potential problems before the interoperability events and to encourage companies to develop uniform and consistent implementations to minimize issues at the test fests. A side effect is the cost and time required to develop both an approved test suite and a validated conformance test tool.

The interoperability testing of IMS is not an objective of OMA. Instead this is left to the organization that specifies IMS. However, as the interoperability testing of the PoC enabler, for example, also performs an interoperability testing of IMS, some IMS interoperability issues already were found. This shows that there are ambiguities in the IMS specifications that led to different implementations and problems different vendors' implementations must solve in order to interoperate.

OMA leveraged the use of both the SIP protocol and the IMS architecture, in a detailed study, to ensure that service enablers based on SIP are developed in an interoperable manner [4]. The reusability of the IMS interfaces is defined within the context of the OMA service environment (OSE) [5].

OMA specifies several service enablers that rely on the capabilities of an underlying SIP/IP core network and that reference the 3GPP IMS specifications for certain functionality. The SIP/IP core is understood as a service layer containing a number of SIP proxies and SIP registrars. It performs the following functions to support SIP-based service enablers developed in OMA, for example [6]:

- Routes the SIP signaling between the PoC client and the PoC server.
- Provides discovery and address resolution services, including E.164 address resolution.
- Supports SIP compression.
- Performs authentication and authorization of the PoC user at the PoC client, based on the PoC user's service profile.
- Maintains the registration state.
- Provides support for identity privacy on the control plane.
- Provides charging information.
- Provides capabilities to lawful interception.

When SIP/IP core is based on the 3GPP IMS, the SIP/IP core architecture is specified in [1]. To ensure the interoperability of OMA service enablers, the interoperability of IMS systems in different providers' networks is crucial to ensure that the previously listed functions are working properly. OMA has the potential to define service enablers that use IMS capabilities for its SIP-based service enablers in a consistent and effective way. Those enablers, for example, are presence SIMPLE V1.0, IM SIP/ SIMPLE V1.0, push-to-talk over cellular PoC V1.0, and SIP push V1.0.

Example PoC V1.0 enabler specification testing:

The PoC enabler is specified as a SIP-based service enabler utilizing IMS/MMD capabilities (defined in 3GPP and 3GPP2), as well as standard protocols defined by the IETF. The principle mandatory features of the PoC version 1.0 enabler are:

- On-demand PoC session handling for one-to-one communication
- Pre-arranged PoC groups
- Chat group and ad hoc PoC group communication
- Instant personal alert (receiving)
- Incoming PoC session barring
- Different answer modes (manual, automatic)
- Media transport
- Control via RTP/RTCP

Additionally, the PoC enabler supports optional features such as group advertisement, pre-established PoC sessions, simultaneous PoC sessions, scheduling of RTCP packages, talk burst queuing and priority (e.g., positioning, status), media adaptation/transcoding, and others. During the technical development phase, the liaison with ongoing work in 3GPP and 3GPP2, as well as with IETF, were improved to ensure the enabler features with regard to, for example, session control over the SIP framework, media interoperability, and optional integration with presence.

In February 2005, the PoC Version V1.0 enabler was approved as candidate enabler. From May 2005 until March 2006, the enabler was tested at several interoperability (IOP) test fests in OMA. Those tests were targeted mainly to identify problems within the service enabler to be tested. However, issues with the underlying infrastructure for 3GPP-IMS and IETF-SIP specifications and the interworking with the service enabler also must be raised if applicable. The last test fest, in March 2006, tested 11 implementations (seven clients and four servers).

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CONCLUSION

All major standards bodies — including 3GPP, ETSI TISPAN, and OMA —have recognized and are addressing the need for testing the interoperability between implementations of standards. The focus in 3GPP is on conformance of terminals implementing the IMS call control protocols. The focus in TISPAN is on interoperability for migrating legacy circuit switched networks. The focus in OMA is on application enabler interoperability.

The IOP program of OMA is a good example of how to avoid constant bug fix releases for specifications and how to help companies avoid

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the development of solutions based on wrong assumptions and presuppositions. Several IMS implementations exist, but due to the lack of an exhaustive testing program, interoperability issues still are found, forcing IMS implementation service releases and rendering several implementations obsolete.

It is understandable that it is difficult to exercise a complex platform such as IMS without applications using it. To circumvent this problem, exhaustive conformance test tools, capable of testing all specification parts and simulating realistic usage of the platform, must be developed.

References

[1] 3GPP, "Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Stage 2," TS 23.228.

[2] 3GPP, "Technical Specification Group Core Network and Terminals; IP Multimedia Call Control Protocol Based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3," TS 24.229.

[3] 3GPP, "Technical Specification Group Radio Access Network; Internet Protocol (IP) Multimedia Call Control Protocol Based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); User Equipment (UE) Conformance Specification; Part 1: Protocol Conformance Specification; Part 2: Implementation Conformance Statement (ICS) Pro Forma Specification; Part 3: Abstract Test Suites (ATS)," TS 34.229-1/-2/-3.

[4] IP Multimedia Subsystem (IMS in OMA) v. 1.0; http://www.openmobilealliance.org/release_program/ims_v1_0.html

[5] OMA Service Environment (OSE) v. 1.0.3; http://www.openmobilealliance.org/release_program/ose_ad.html

[6] OMA Push-to-Talk over Cellular v. 1.0; http://www.openmobilealliance.org/release_program/poc-v1_0.html

Biographies

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