

# The Challenges of IMS Deployment at Telefónica Germany

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## ABSTRACT

The deployment of the IMS at Telefónica Germany (the third national integrated operator) went successfully live in early 2011. The IMS deployment required significant effort and targeted one of an operator's main businesses: telephony. The lessons we learned, the opportunities we saw, and the challenges we had to face are described in this article. Furthermore, the evolution of the IMS in our network is discussed, and we describe, from our experience, some of the benefits and challenges the IMS can bring to an operator.

## INTRODUCTION

The evolution of major public telecommunication networks in recent years follows a clear trend: the migration to IP as universal network technology. Mobile telephony networks are also expected to follow this path, which will require significant effort due to the dimension and complexity of those networks. This trend is known as next generation networks (NGNs). The main characteristics of an NGN have already been discussed in detail in different fora (e.g., [1]). Due to the use of IP, a common characteristic of NGNs is the support of any application, any device, and any access technology, wired or wireless.

The IP multimedia subsystem (IMS), originally designed as part of Third Generation Partnership Project (3GPP) standardization [2], has been widely accepted as the service control plane in NGNs. IMS orchestrates quality of service (QoS) in several layers, centralizes user authentication, authorization, and accounting, and sets the basis for subscription management.

IMS is seen by operators as a way to preserve a central position in the telecommunication services business. With the growth of the Internet, the ability to communicate and do business independent of the telecommunications operator has expanded with a model that degrades the operator to a "bit pipe." IMS gives operators a technical platform to maintain a central role in communication services in an "all-IP" network environment. However, it is still an open question for many operators whether this position can be maintained [3], whether the business case for introducing IMS can be justified, or whether the IMS is just an overly complicated way of

doing voice over IP (VoIP). Furthermore, practical experiences of operators introducing IMS are not yet widely discussed.

We try to address some of the issues mentioned above in the context of our experience deploying IMS at Telefónica Germany. The initial deployment in our fixed network, going live in early 2011 with some particular characteristics, among them multi-reseller, is the subject of this article. The lessons learned, the key issues we see for further evolution, and the challenges we had to face may be of interest to the industry. Furthermore, the research community may be interested in how research results in NGNs have been applied in productive environments.

Following this introduction, we present the technological and business context of our IMS deployment. Then we describe our solution, focusing on the challenges we had to face and identifying the engineering topics that occupied most of our effort. Furthermore, we discuss some design trade-offs and key issues for further evolution of the IMS. Finally, we provide our conclusions and discuss, from an operator strategy perspective, the benefits and evolution of the IMS.

## TECHNOLOGICAL AND BUSINESS CONTEXT

### TELEFÓNICA GERMANY: THE CONGLOMERATION OF 3 OPERATORS

Telefónica Germany is part of the Spanish telecommunication group "Telefónica S.A." The company offers post-paid and prepaid mobile telecommunication products to its private and business customers, including mobile data services. In addition, as an integrated communications provider, digital subscriber line (DSL) fixed network telephony and high-speed Internet are offered. Furthermore, Telefónica Germany has a wholesale local loop unbundling (LLU) business with hosted VoIP services offered to resellers.

Telefónica Germany's history (Fig. 1) has been a key factor in determining the timeline for introducing IMS. Since this history has been favorable to the case for IMS deployment, it is worth spending a few words to describe it.

In effect, Telefónica Germany consists of three operators, conglomerated via acquisitions.

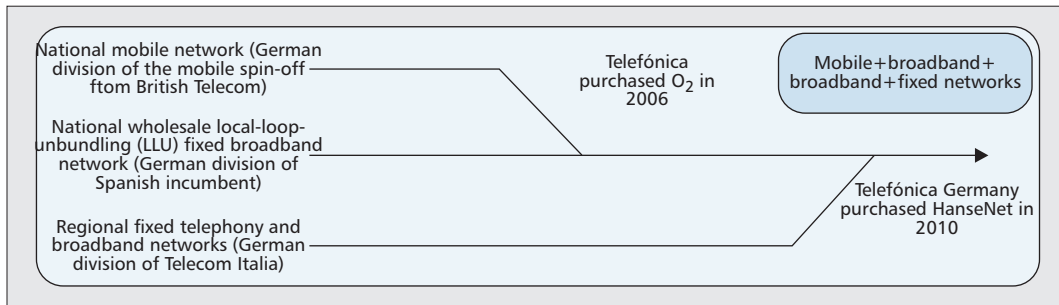


Figure 1. Evolution of Telefónica Germany.

In 2006, a mobile-only operator and a wholesale LLU and VoIP voice termination network operator (with no public switched telephone network [PSTN] assets) were merged after Telefónica S.A. purchased the O<sub>2</sub> group. In 2010, the third operator, HanseNet, was acquired, bringing more broadband assets along with VoIP and PSTN voice network infrastructure.

### IMS INTRODUCTION AT TELEFÓNICA GERMANY

Although following the 3GPP evolution path, O<sub>2</sub> initially had difficulty justifying the introduction of IMS as a mobile-only operator. No single new product business case justified the initial cost of introducing and integrating IMS, and the technical shift to IP-based voice and messaging (i.e. an evolution of the two core mobile services) was still very much on the horizon.

After having failed to justify the introduction of IMS in the mobile-only context, the tipping-point for IMS came when the new integrated operator was created by the acquisition of O<sub>2</sub> by Telefónica in 2006.

During 2007, a strategic assessment of various fixed mobile convergence scenarios concluded that cost benefits for IMS could be expected when three or more services are deployed. In addition, Telefónica's long-term group-wide strategy to evolve to an IMS-based NGN was in place. As the replacement of the standalone VoIP platform at Telefónica Germany became necessary in 2008, these factors provided the context for a strategic decision to be made for a deployment of IMS as a second-generation VoIP platform and a strategic enabler for future network convergence.

It is important to note that when the decision for IMS introduction was made, Telefónica Germany had no "legacy" PSTN assets, and there was therefore no discussion of whether existing investments in PSTN switching infrastructure should be replaced with an as yet unproven IMS architecture (a factor often complicating the business case for IMS). Furthermore, the VoIP platform in place was being used for first-line voice services and not, as in many incumbents at the time, to provide an additional second-line proposition with lower quality requirements. This meant that IMS was a natural choice as a scalable, standard, first-line IP-based voice platform for an operator with only VoIP in the fixed domain. It was only after IMS had been deployed that the evolution of PSTN switching equipment was added to the story, following the acquisition of HanseNet. With the IMS already in place, the

migration of the "legacy PSTN" to the IMS over time is a more or less obvious strategy. Furthermore, the path to IMS-based mobile voice in Long Term Evolution (LTE) wireless networks is far less challenging when an IMS is already integrated (and accompanied by a strategy to converge networks).

## ENGINEERING THE IMS, ARCHITECTURE, TRADEOFFS AND SIMPLIFICATIONS

The initial IMS deployment was dimensioned to provide services to around half a million subscribers, including resellers and own customers.

We initially considered looking for a "monolithic" IMS solution (i.e., where one vendor builds the whole IMS). This would simplify the IMS deployment as one single vendor could assume end-to-end responsibility. But we could not find any monolithic solution that was optimal in all aspects. For instance, only vendors that specialized in the multimedia telephony application server (MMTEL AS, a standard component used to deliver advanced telephony services over the IMS [4]) could provide multi-reseller solutions. So it came clear that the IMS was to be deployed using different building blocks from different vendors with Telefónica assuming the end-to-end design, control, and responsibility.

The way we divided our IMS is shown in Fig. 2. This division is a common best practice, followed by many operators and vendors; the different components will be detailed in the following sections.

Due to our multivendor deployment, adherence to standards was of special importance to ensure interworking. We observed that the standards were precise and clear enough, when they are respected, to ensure interworking, and this became an important factor when selecting our vendors. In this aspect, our expectations have been met.

The main challenges we faced in the IMS deployment were related to issues such as deployment and dimensioning, interconnection, QoS, and support of different types of terminals.

### THE BORDER OF THE IMS: THE SBCs

The first building block of our deployment is the session border controller (SBC), an industry de facto standard grouping and implementing many

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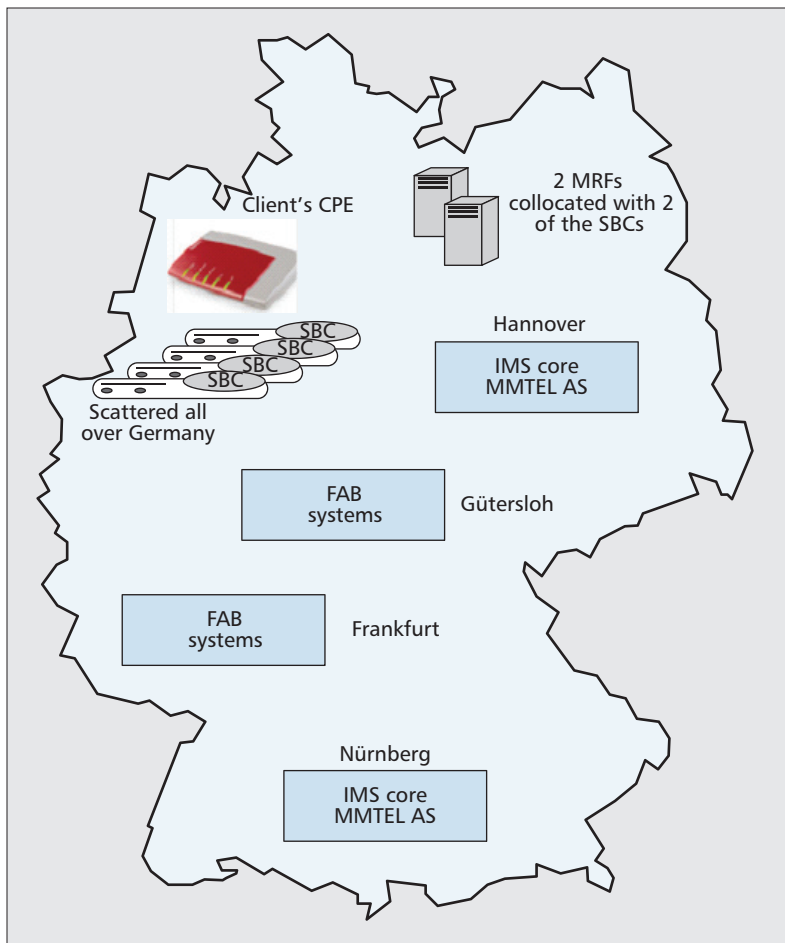


Figure 2. Physical distribution of the network nodes.

of the 3GPP-standardized functions that define the IMS borders; these borders being with either terminals or other networks.

The proxy call session control function (P-CSCF) defines the interface to the terminals and is logically distributed. SBCs implement the P-CSCF (and other functions) and are physically distributed all over Germany (Fig. 2). We have distributed the SBCs “evenly” following two main criteria: locate them “as close as possible” to the terminals (in terms of network delay), and make them serve a balanced number of customers; in densely populated regions we have even collocated several SBCs.

The way to assign terminals to the SBCs was a major engineering topic. First, load balancing and minimum network delay needed to be ensured. Second, the case of SBC failure needed to be handled. If an SBC fails, the region served by the SBC is impacted, and the terminals need to be reassigned to other SBCs. To meet these two goals, a mechanism based on DNS views was chosen. Terminals are assigned their serving SBC by matching the IP subnetwork to which the terminal is attached with a database containing the SBCs and the networks they should serve. Terminals are also assigned a secondary SBC; it is assigned randomly to ensure that in case the primary SBC fails, the terminals are evenly reallocated to the remaining SBCs. Note that the installed SBC capacity exceeds the required

capacity. If one SBC fails, the sum of the capacities of the other working SBCs can still handle all traffic.

In the original Session Initiation Protocol (SIP) model, the operator’s servers assist terminals in SIP session setup and therefore are in the SIP signaling path. Media, on the other hand, flows directly between terminals in a peer-to-peer fashion. IMS respects this model but also considers the case where media does not flow directly between terminals but traverses IMS infrastructure (the SBCs), and this option is the one followed by most operators, including Telefónica Germany. This approach is needed to implement “lawful interception,” a regulatory requirement, and also brings other benefits like protecting functions such as the media resource protecting function (MRF) from rogue endpoints that could otherwise flood them with media packets.

### SESSION CONTROL: IMS CORE

The central building block is the IMS core. The main elements of the IMS core platform are the CSCFs (except the P-CSCF, part of the SBC). The CSCFs are in charge of SIP session logic and state.

IMS core functions are, unfortunately, not logically distributed. Despite this, resiliency can be achieved by redundancy and physically distributing the nodes implementing those functions.

The distribution of IMS core nodes required a careful engineering study. We chose two core sites, Hannover and Nürnberg, evenly distributed in our network (Fig. 2), to ensure proper load balancing. Two sites provide resiliency at the cost of duplicating the needed capacity, but this is a common approach. More sites could have been deployed to reduce redundancy, but that was not considered advantageous. On one side, computer centers with enough power and bandwidth are scarce and expensive. On the other side, two sites are enough to cover Germany in terms of network delay and capacity.

### SUBSCRIBER DATA

CSCFs do not store user data, but instead obtain it from the home subscriber server (HSS), the operator’s core user database. With the initial deployment of IMS for fixed (landline) services, a dedicated HSS was deployed. In addition, the IMS was deployed with its own user provisioning and management systems.

For Telefónica, this means that there are now two large-scale core subscriber databases in place, the other being the home location register (HLR, actually, a predecessor of the HSS) used for mobile clients. An important question moving forward is if, when, and how to consolidate these databases when the IMS is used for mobile services. With the advent of LTE, the IMS will need to serve mobile customers that, during a “transition” phase (which is expected to last many years), will be accessing services via both LTE and “legacy” 2G and 3G networks. 3GPP standards solve this with both HLR and HSS as two functions of the same logical element; however, this does not account for a starting position of multiple databases in the network.

This will force careful integration and synchronization of user management and provisioning systems for the IMS and circuit-switched mobile networks. IT systems may be heavily impacted and this will be one of the major challenges when introducing voice over LTE and other IMS-based mobile services. This is a major topic and the strategy for subscriber data consolidation needs to be aligned with the strategy for IMS for mobile services. IT-related impacts should also not to be ignored.

### SERVICES, THE TELEPHONY MMTEL AS

Services are provided in the IMS by application servers (ASs). The VoIP AS platform includes two standard components: an MMTEL AS and an MRF.

The MMTEL AS is employed to offer supplementary telephony functions, such as call forwarding. The AS behaves as a back-to-back user agent controlling incoming and outgoing call legs. The MRF is used, controlled by the AS, to record or play media from/to the user, for instance, for the voice-to-mail service.

The dimensioning and deployment of the AS also presented interesting issues. Although these issues are related to our particular deployment and vendor selection, we believe they are general issues and therefore of interest to a wider audience.

Application servers in IMS have the option to use the HSS for storing specific user data over the Sh interface or in its own repository. In our case, the latter was used, and the repository was collocated with the AS. For capacity reasons, we needed to deploy several ASs. Each AS can handle only a subset of users — those stored in its collocated database — and, as a consequence, the ASs do not behave like a “pool,” meaning that one AS cannot “replace” another. Therefore, in order to ensure resiliency, we needed to duplicate the ASs and installed them in both core sites (Fig. 2). We are already planning to update the ASs to support the Sh interface to overcome this shortcoming.

The same service, such as voice, is provided in two “domains:” in the IMS accessed, for instance, using LTE, and in the circuit-switched system accessed, for instance, when using 2G. We expect that a key challenge will be ensuring service consistency when a customer is using different access technologies. Along with the afore-mentioned database consolidation issue, a key point is the question of interworking ASs in the IMS domain with, for example, IN-based services in the circuit-switched domain. In particular, if different servers are used for different domains, it will be a challenge to ensure the consistency of a subscriber’s data (e.g., call forwarding settings) especially if the servers store this information in internal, proprietary databases. This is another reason to update the AS to use the HSS (via the Sh interface) for storage of the relevant subscriber data. Servers from the circuit-switched domain would also access the HSS, the HSS is then the only database for both IMS and the circuit-switched domain, thus ensuring service consistency.

### TERMINALS: CPES

For the fixed voice service, customer premises equipment (CPE) is our IMS terminals (3GPP calls terminals user equipment [UE]). These CPE units implement a limited set of 3GPP standardized functionality for UE but also have additional features. The CPE is a DSL router and has voice “digitalization” capabilities. The CPE is a SIP client, with analog and integrated services digital network (ISDN) ports for the connection of legacy phones. In NGN terms [5], the CPE is a residential gateway in an NGN with DSL access network.

In our experience, CPE units are quite unique devices that do not strictly follow 3GPP standards. Integrating them in our network posed several challenges. For instance, different CPE units use different syntax for feature access codes (FACs), which are the short codes that a customer may dial to, for example, activate call forwarding. Also, we found that some CPE types do not fully support the Service Description Protocol (SDP) offer/answer model as mandated by RFC 3261; if those CPE types receive an initial INVITE request without SDP (delayed SDP offer/answer), they crash. Those, and other problems, were solved by the SBCs mediating between CPEs and the IMS core — a critical capability in practical deployments.

In the future, as IMS is extended to the mobile domain to provide voice services over LTE networks (and other wireless IP networks), we expect a massive proliferation of devices using the IMS for voice services. Whereas fixed domain CPE units are highly controlled by the operator and relatively small in number, there is an increasing number of devices acquired by customers from non-operator channels (e.g., from other operators or from general retail sources) in the mobile domain. As the number of devices grows, a strong adherence by device manufacturers to 3GPP standards will be essential, as it will not be possible for operators to use the SBC to mediate between the IMS and a large number of non-standard devices in the same way as the SBC has been used to “correct bad behavior” in fixed CPEs. In case of classical mobile devices with the IMS SIP-stack implemented in the chipset or operating system, we can expect a general adherence to standards and interoperability, and mass market devices will be tested by operators before release. In the case of downloadable apps, we expect a challenging environment, and it will be difficult to allow anything but operator-approved apps to use the IMS.

### FAB AND MULTI-RESELLER ASPECTS

From the standards perspective, fulfillment Assurance and billing (FAB) systems are outside of the IMS domain. They were, however, main characters in the IMS deployment and key to customizing the IMS solution to meet our needs, especially in multi-reseller aspects.

FAB systems were also made redundant and geographically distributed in two German cities: Gütersloh and Frankfurt (Fig. 2).

The multi-reseller environment required an isolation of data between the different resellers. Also, our FAB systems were made accessible to

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resellers. To this end, different application programming interfaces (APIs) and interfaces were defined allowing resellers to, among other things, provision, manage, and charge their clients.

The IMS stores user data in the HSS. The IMS user model does not include the concept of a reseller. Our approach is to use the domain part of the user's ID as a way to identify the reseller. We built an overlay between the HSS and FAB systems to ensure isolation of different resellers' data.

The MMTTEL AS also plays an important role in achieving a multi-reseller solution. Resellers are allowed to configure various aspects of the telephony service, but system policies (e.g., regulatory aspects) need to be enforced for all resellers.

The complexity of integrating the IMS with legacy IT systems for FAB should not be underestimated. This complexity was even compounded by the additional requirements to support multiple resellers. This turned out to be a serious challenge that caused significant delays in implementation and launch of IMS-based services. Since the reseller business is comparatively minor compared to our own DSL business, multi-reseller aspects could be considered at first sight to have caused unnecessary complexity. However, after the IMS had been deployed, HanseNet was acquired, and it was decided to migrate its VoIP infrastructure to the existing IMS. Thanks to the multi-reseller capability, this was almost straightforward, showing the value of the multi-reseller system even for "internal" services.

#### TELEPHONY AND SIP

SIP is a signaling protocol for IP networks and used in the IMS. It identifies users with SIP-universal resource identifiers (URIs) of the form `user@domain`. Telephone networks and the SS#7 signaling protocol suite use telephone numbers to identify devices. IMS-based telephony needs to integrate both "worlds" and much effort has been spent on standardizing and developing solutions to achieve this integration. In our experience, the reality is rather complicated and, as this situation is not specific to our deployment, we believe that the challenges we faced and the way we overcame them will be of general interest.

Firstly, CPEs were found not to support adequately the procedures defined in SIP for addressing telephone numbers instead of SIP URIs (namely, TEL URIs or the "user=phone" parameter). To cope with this, we provisioned our telephone numbers in the IMS as IMPUs (IMS public identity, the way to contact users) in the form of SIP URIs (`user@domain` with NO "user=phone" parameter). If the user part contains only numeric characters (a leading + is also "allowed"), it is interpreted as a telephone number: syntactically it is a SIP URI, but semantically the user part is interpreted as a telephone number. This was a simple and easy solution but not universal. There is a scenario (which would be quite rare) where this approach would fail: if a client wants to call not a telephone but a real SIP URI where the user part of the SIP URI contains only numbers. In our usage scenarios,

however, only calls to telephone numbers are foreseen.

#### BREAKOUT AND INTERCONNECTION

Telephony interconnection between different operators is strongly regulated in Germany. Those interconnections are well established, and operators are very reluctant to evolve them. Besides, IMS has breakout capabilities implemented, in our case, by the SBCs who provide interconnection to other networks using a different technology than the IMS, that is, the telephony network. As a result, little interest exists in direct IMS-to-IMS interconnections between different operators, and Telefónica did not implement any. The telephony network is currently the only possibility for our IMS to terminate off-net sessions (i.e., calls), even to other operators offering NGN voice services. The imminent launch of RCS in Europe (rich communication suite, communication services such as instant messaging or video share using the IMS) will, however, force IMS-to-IMS interconnections between operators as the telephony network cannot be used to route these services.

We are already planning IMS-to-IMS interconnections. SIP URIs will not completely replace, in the near future, telephone numbers as a way to identify users; hence, prior to any IMS-to-IMS interconnection, operators will need to interwork their ENUM databases, creating a global ENUM system. ENUM is a database used for translating telephone numbers to SIP URIs, following a DNS approach [6]. Although ENUM is just a part of the IMS interconnection problem, we think it is one of the most challenging and interesting ones; therefore, we briefly describe our experience.

Operators' ENUM databases should be interconnected, but this is not yet the case. Instead of providing a global resolution, ENUM is currently bound to the operator domain. This is also our case; our ENUM can just resolve our own telephone numbers. When a call needs to be routed and the destination number does not correspond to one of our customers, the ENUM query fails, the call is considered "off-net," and "broken out" to the telephony interconnect network who is responsible for routing the call to the destination operator. The main challenges to achieve a proper ENUM system are number portability and international ENUM resolution.

We expect that, in the mid-term, the interconnect infrastructure for "plain" telephony services and the interconnect infrastructure for new IMS-based services will evolve separately. On one hand, "legacy" telephony interconnect infrastructure must be maintained for national and international telephony service termination while operators migrate at different speeds to a fully NGN-based infrastructure. On the other hand, new IMS-based services require direct IMS-to-IMS interconnects. But we also expect that these future IMS-to-IMS interconnects will be used for voice calls too. On one side, this is technically meaningful: once the interconnect is set up, thanks to the IP paradigm, this can be employed for any service. On the other side, calls in LTE use high-definition audio codecs, which are not supported in telephony networks, so transcoding

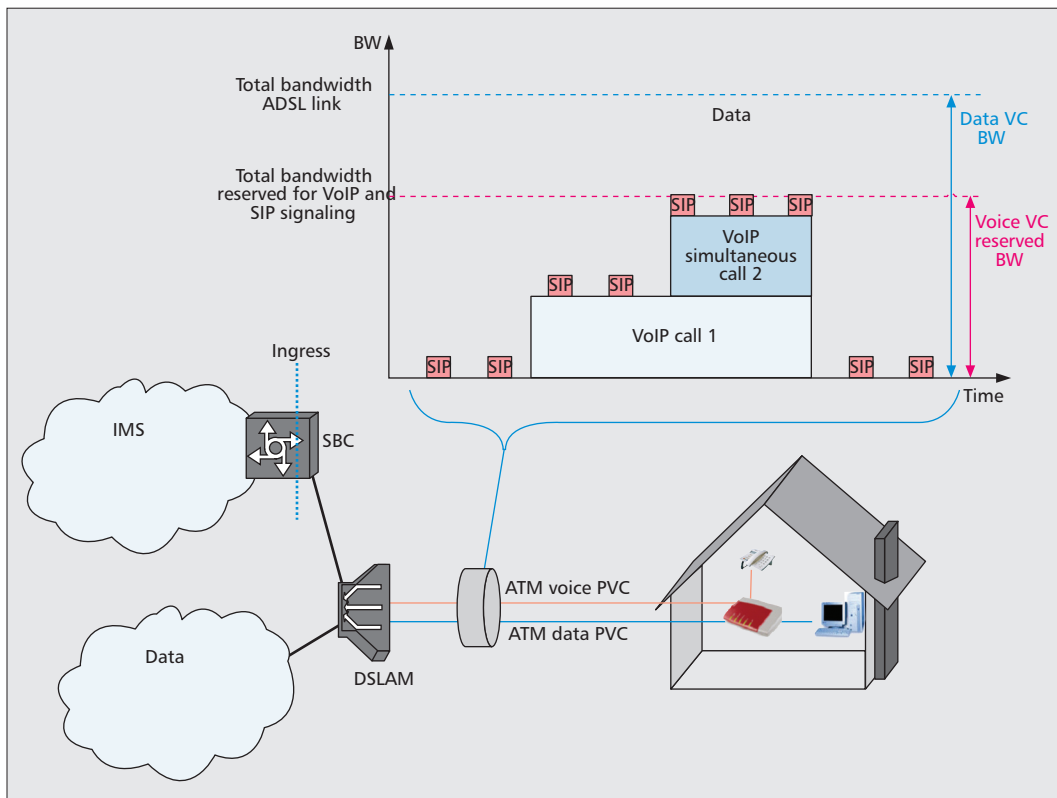


Figure 3. VoIP to the home, the CPE and QoS.

*In the past, VoIP has been perceived as a lower quality service compared with “classical” telephony. This is not acceptable for VoIP operators and quality needs can be assured if operators control their network end to end.*

at the network edges would be needed massively; if voice calls between different operators also employ IMS-to-IMS interconnects the transcoding problem would not appear.

### REGULATORY ASPECTS

We also faced problems related to the hard constraints of the German regulator. We describe them next.

The German dial plan [7] is especially complicated: mobile numbers, area codes, and fixed numbers do not have a predetermined length. To solve this problem, we needed to create a table with all the valid area codes in Germany (about 5000) in order to be able to distinguish the area code from the subscriber number. Furthermore, our MMTEL AS typically analyzes numbers based on length, which is a very common method. However, our conclusion is that in countries with complicated dial plans like Germany, this is not a satisfactory solution. When we evolve our MMTEL AS, we will require the vendor to implement advanced parsing techniques for the telephone numbers.

Emergency call handling was also a challenge. In Germany, the single European emergency number (112) must be reachable. However, calls to 112 are not routed to a central call center; according to German regulations, they must be routed to the station closest to the caller. This posed some challenges for the design of our IMS Core. An emergency-CSCF is combined with a routing determination function, which interacts with the Class IV interconnection network to ensure the proper routing of emergency calls.

As a general conclusion, we can say that a

close collaboration between people with “traditional” telephony backgrounds and experts in SIP and IMS was key for the success of the project.

### QoS

In the past, VoIP has been perceived as a lower-quality service compared to “classical” telephony. This is not acceptable for VoIP operators, and quality needs can be assured if operators control their network end to end.

In our IP core network, differentiated services (DiffServ) and multiprotocol label switching (MPLS) are used to differentiate traffic aggregates and provide them with the appropriate quality class. CPE units need to mark SIP and audio packets with the appropriate DiffServ code.

In the DSL access network, a more granular solution needed to be implemented, and this was of special relevance for some of our older DSL access lines that do not offer much bandwidth, especially in the uplink.

IMS defines dynamic and complex network reservation mechanisms to assure QoS, implemented by two functions, the Policy and Charging enforcement/rules function (PCEF and PCRF). PCEF and PCRF dynamically coordinate network resource reservation with SIP session setup. A very efficient solution is achieved; this is especially important in radio access links, where bandwidth needs to be carefully managed and shared. In our DSL fixed access, such fine network resource management is not needed; besides, available CPE types do not support it. We opted for a static network reservation that we explain next.

To achieve the full benefit of an IMS deployment, an operator must co-ordinate the evolution strategies of their different networks and assets, adapt their organization accordingly, and will face engineering challenges.

Telefónica developed a layer 2 QoS solution for DSL access (Fig. 3). The solution is based on having two asynchronous transfer mode (ATM) permanent virtual circuits (PVCs), one for our VoIP service, the other for other traffic ("Internet data"). The PVC for VoIP can provide sufficient bandwidth for up to two parallel voice calls – and SIP signaling. In order to restrict the number of parallel calls, a call capacity management service on the MMTEL AS is employed. By means of the above mechanisms quality of speech can always be assured.

Although, DSL fixed access technology has no severe bandwidth constraints and, as such, we had no need for dynamic policy control mechanisms in the xDSL access network, we are already deploying PCRF and PCEF functions as a prerequisite to offering voice services over LTE.

## CONCLUSIONS

Telefónica Germany initially introduced the IMS as a replacement of a standalone VoIP infrastructure. However, the long-term strategic goal is to use the IMS as a tool to converge different networks coming from operators that were conglomerated via acquisitions. The technical challenges we had to face were described in the article, along with the trade-offs we had to accept and how these decisions will influence the planned evolution of our IMS deployment.

For many operators, voice is still the first use case in the IMS and, therefore, the IMS is more mature in this aspect. However, the effort we needed to invest in deploying the IMS to offer a basic voice service was high. This initial effort can only pay off if further use cases are added to the IMS. This is Telefónica's aim: the IMS is a key element in the consolidation of all networks, mobile and fixed, and the IMS will host more services, like RCS.

Related to the first point, consolidation of networks, it is important to understand that a strategy for IMS introduction is related to and dependent on convergence and evolution strategies in other parts of the network. The IMS architecture does not, in itself, provide a full answer to a number of convergence challenges in other network layers (e.g., in the service layer, interconnect and termination layer, or the question of convergence of subscriber data storage).

In the fixed network domain, an IMS strategy should be accompanied by an NGN-evolution strategy for Class 4 interconnect and transit networks. In mobile telephony networks, the process of evolution to NGN is slower, but given the complexity of services typically already available in mobile networks, migrating to all-IP and IMS is perhaps even more challenging than in fixed networks. A particularly important question related to the evolution to IMS in mobile networks is how to ensure consistency of services across parallel circuit-switched and IMS networks over many years while subscribers are migrated from one technology to another.

When considering further services to be deployed on top of the IMS, reusability is the key point. IMS is a service enabling platform offering many features to services being deployed

on top of it. These features include session control, authentication, authorization, and accounting, and control the resources provided by the network (e.g., bandwidth). These features do not need to be replicated in all of the services, but can be reused, thus saving costs. This will make IMS applications more attractive than stand-alone ones. Moreover, by a proper integration of different applications, a service environment, attractive for customers can be created [8].

There are other points to consider when planning the IMS evolution and how to make it the universal service control platform in an operator's network. For instance, the challenge of convincing the overall business, including non-technical parts of a large operator, that an IMS strategy should be followed should not be underestimated. In our experience, it is not easy to maintain a mid-term IMS evolution course while short-term disruptive influences cause "Fear, Uncertainty and Doubt" throughout the organization. It is also not easy to maintain the interest of commercial units in the advanced features promised by IMS over a many-year transition period.

Finally, a key factor for IMS is an "organizational convergence," so that previously separated teams from fixed and mobile divisions (often from completely different companies) join forces to address the challenges that must be answered to enable technical convergence to take place.

So, answering to the question we raised in the introduction, yes, IMS is a relatively complicated way of doing VoIP when compared with a stand-alone solution. However, IMS is the standard way of providing VoIP in operators' networks, supporting both fixed and mobile services and with interworking, support for legacy networks, quality of service control and additional services. It is important to note that the full IMS architecture is complex because of these aspects; a small-scale deployment, or one limited to a single use case does not typically need the full set of IMS functions. IMS supports more than just voice and is expected to be more cost effective in the long term than multiple stand-alone solutions. However, to achieve the full benefit of an IMS deployment, an operator must coordinate the evolution strategies of their different networks and assets, adapt their organization accordingly and will face engineering challenges as described in this article.

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## BIOGRAPHIES

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KARSTEN SCHRÖDER started his career in telecommunications as project lead at mediaWays GmbH, a joint-venture between Bertelsmann and Debit Systemhaus, deploying white-labeled internet access for ISPs like AOL in Germany. Since 2002, he has held various management positions within the German subsidiaries of Telefónica S.A. As head of Converged Solutions, he is currently responsible for Telefónica Germany's IMS-based services and the underlying platforms and devices. His focus is on converged architecture supporting consistent services across different access technologies. He received his Diploma and Ph.D. degrees in communication technology from the University of Dortmund, Germany, in 1993 and 1997, respectively.