Testing IP-based wireless voice services

Mobile networks from the fourth generation (LTE / LTE-A) on use the Internet protocol for all services. Another infrastructure is required in addition to IP to ensure that traditional services such as voice communications continue to function. A 4G device only becomes a "phone" with the help of the IP multimedia subsystem. The R&S®CMW 500 wideband radio communication tester can solve a variety of test-related problems.

All-IP communications opens up a whole new world of applications in mobile communications, but it also means that the circuit-switched services that were common in 2G (GSM) and 3G (UMTS) networks for voice transmission are no longer available. Instead, voice signals have to be packed in IP packets. In the past year, data services finally overtook voice telephony as the most important source of revenue for network operators, but voice telephony still accounts for a considerable share and cannot be technologically neglected. Most importantly, the voice quality cannot fall below the accustomed standard. In practice, such legacy services often cause problems in IP-based networks because packet loss, jitter and packet delays can occur during transmission. Ideally, the receiver should compensate for these effects since – in the case of telephony – they considerably impact the voice quality. 3GPP-based networks such as LTE offer the ability to separate IP-based services on the transport layer and to provide an ensured quality of service (QoS) as needed. This is handled by a dedicated bearer that is triggered by the service in use. A dedicated bearer is a type of virtual channel with its own network address (port range) and specified performance characteristics. The prerequisite for this functionality is a high level of integration of services in the wireless device or modem.

Services such as Skype and FaceTime already offer functions like video telephony and messaging services. Such functions set user expectations, but since these over-the-top (OTT) applications lack the aforementioned integration, they cannot ensure a certain QoS and therefore do not always deliver a satisfactory user experience. The user is also dependent on the proliferation of the application because the different services are generally not interoperable. The absence of mechanisms for handling emergency calls is also a significant drawback of these applications. Consequently, for voice support in LTE, appropriate mechanisms and architectures must be implemented in the mobile networks to ensure high quality for new features like video telephony as well as tried and trusted features such as classic telephony and emergency calls.

Network architecture with integrated IMS

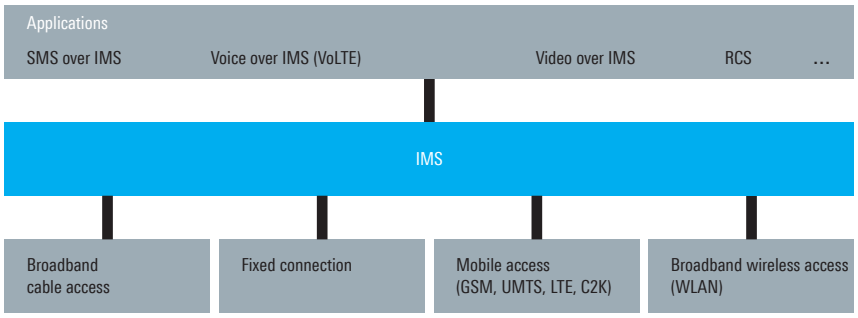

Fig. 1: IMS as key technology in mobile networks.

The IP multimedia subsystem

A key technology for integrating voice services in an LTE network is the IP multimedia subsystem (IMS). IMS offers a framework that supports IP-based multimedia services. IMS requires new network elements in the network architecture (Fig. 1).

IMS was developed by 3GPP during the UMTS standardization. It was since improved and is now also used for LTE voice services (voice over LTE, VoLTE) (Fig. 2). The session initiation protocol (SIP) is the base protocol of IMS. SIP uses an IP network to establish the connection between subscribers. To ensure a consistently high QoS, network operators have now started to roll out VoLTE services for voice and video telephony

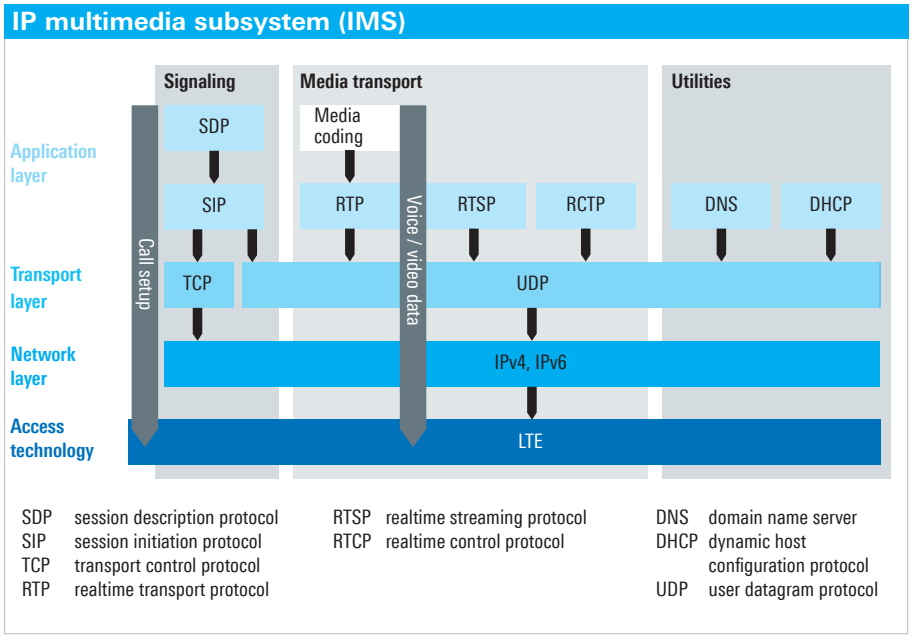

Fig. 2: IMS protocol structure.

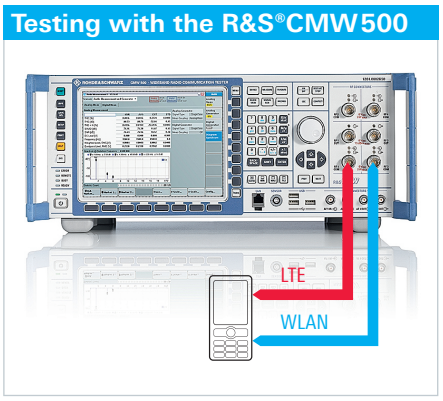

Fig. 3: Parallel testing of LTE and WLAN with the R&S®CMW500 wideband radio communication tester.

based on IMS – with a guaranteed seamless transition to circuit-switched services, i. e. to 2G and 3G networks.

They are also working to ensure uninterrupted service and to integrate WLANs during the transition from outside to inside. Voice over WLAN (VoWLAN) is a network operator driven technology that also uses SIP/IMS to route voice over WLAN access points. Instead of using the network operator's closest base station for the call, the voice packets are tunneled through the Internet to a gateway provided by the network operator. This evolved packet data gateway (ePDG) creates a link between the LTE network and WLAN. IMS and upcoming generations of smartphones that support all of these mechanisms as standard will enable uninterrupted and high-quality voice service for all available access technologies.

VoLTE, VoWLAN and WLAN traffic offload testing with the R&S®CMW500

The R&S®CMW500 wideband radio communication tester comes with everything needed to test these mechanisms on mobile devices (Fig. 3). On the data application unit, the tester provides all access technologies and all necessary servers, such as an ePDG and an IMS server (Fig. 4). It tests the handover between LTE and WLAN as well as single radio voice call continuity (SRVCC), i. e. the handover between LTE and legacy networks such as GSM and UMTS.

Since mid-2015, the integrated IMS server has offered the ability to test several DUTs (IMS subscribers) in parallel. Now true end-to-end media connections between two mobile devices can also be tested.

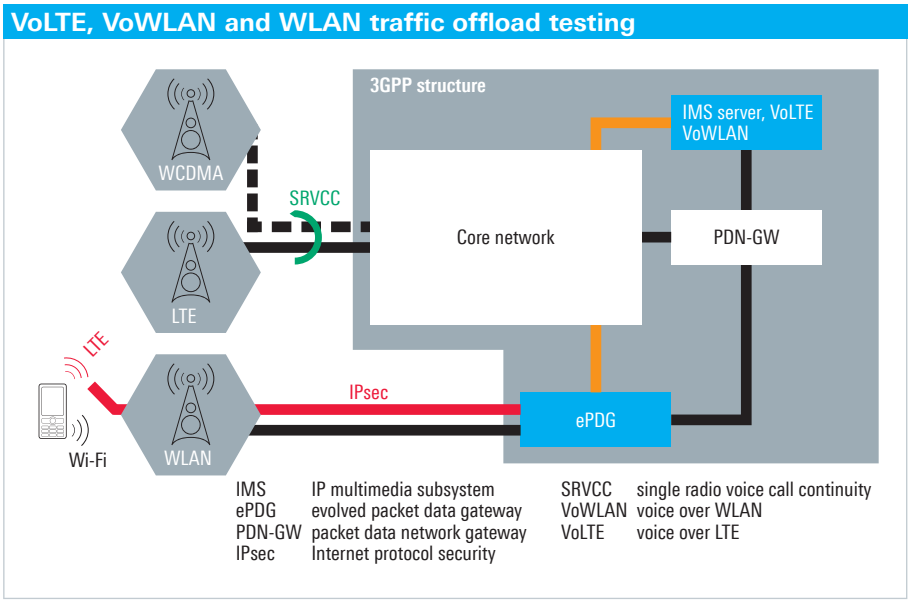

Fig. 4: LTE/WLAN traffic offload via an ePDG.

Testing with multiple virtual remote stations

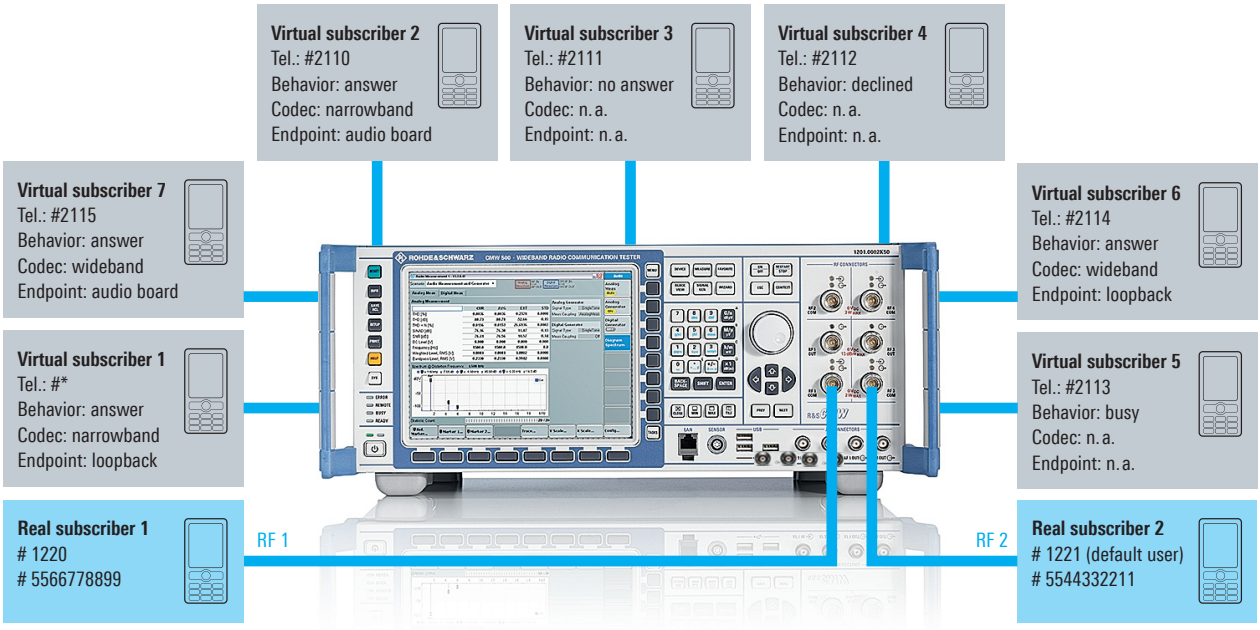

Fig. 5: The virtual subscriber concept in the IMS server of the R&S®CMW500 allows testing under a variety of scenarios.

The new virtual subscriber concept allows users to create and test multiple virtual remote stations that have different characteristics and functionalities. A variety of scenarios such as codecs, error rates, etc. can be verified quickly and effectively. Real phones with different firmware can be tested against each other (Fig. 5).

The flexibility of IP and IMS enables network operators to easily and affordably integrate new audio and video codecs into the existing architecture. The new audio codec enhanced voice service (EVS) in particular is a milestone on the road to high-quality audio connections. At its highest quality level, EVS can transmit the entire human audible frequency range (Fig. 6). The R&S®CMW500 with the R&S®CMW-KS104 option supports EVS-based voice over IMS calls for various wireless technologies, e. g. LTE and WLAN.

Typical codec bandwidths

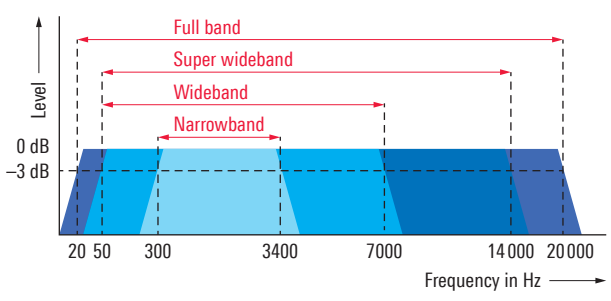

Fig. 6: Typical transmission bandwidth of voice codes. The new EVS codec covers everything.

Precise VoLTE and VoWLAN analysis

The flexibility of IP-based communications also comes with unwanted side effects such as jitter and packet loss. The data is buffered in the receiver in order to minimize or eliminate these effects. To test the effectiveness of implemented measures, the R&S®CMW500 tester's data application unit offers IP impairments to deliberately cause such errors and IP analysis to analyze them. The R&S®CMW-KM051 deep packet inspection option allows users to verify the configured jitter profiles and measure the data loss. Combining and simultaneously analyzing the three areas of RF, protocols and data in one device enables users to precisely analyze the VoLTE and VoWLAN processes for errors. IP analysis can be used to correlate data packets from OTT applications to the corresponding applications and draw conclusions about their communications behavior (see below).

Focus on quality of experience

An important criterion when evaluating smartphones is their single-charge battery life. Batteries with higher capacity are too large and heavy to install in smartphones. Developers have to increasingly focus on the current drain of individual hardware components and especially applications. Application requirements and the modem's network settings need to be compatible.

Functions such as discontinuous reception (DRX), which is a power saving mode in LTE, reduces the power consumption and must also be tested in connection with VoLTE. Rohde & Schwarz offers a fully automated solution based on the R&S®CMWrun test sequencer software and R&S®CMW-KT051 software package. In the test setup in Fig. 7, instead of using the built-in batteries the R&S®NGMO2 remote controlled power supply, which is also a precise digital voltmeter, supplies the smartphone with power. IP-based events can be correlated with the smartphone's power consumption. The R&S®CMW500 tester's deep packet inspection engine enables users to quickly see the correlation between an application, its data traffic and power consumption. Ineffective applications with optimization potential are easy to identify.

The setup in Fig. 7 can be extended for VoLTE by adding the R&S®UPV audio analyzer, making it possible to monitor the power consumption during a VoLTE call while simultaneously measuring the audio quality.

Summary

LTE networks and WLAN transmit voice just like other data: as a packet-switched IP stream. Special measures are needed to ensure the necessary QoS. Thanks to state-of-the-art network simulation and the R&S®CMW500 measurement capabilities, wireless device manufacturers can analyze the VoLTE and VoWLAN features of a device in detail. The tester's integrated data application unit with integrated servers for IMS and ePDG allows users to test the proper interaction between hardware and software for WLAN offload or SRVCC scenarios in a reproducible laboratory environment. Event-controlled power consumption measurements on smartphones show improvement potential in hardware components and applications. Network operators can identify error sources early on by accurately measuring the VoLTE performance under specific network characteristics. Mobile phone manufacturers and network operators have a universal tool to test various parameters with regard to functionality, voice quality and other relevant data in the lab before bringing a device to market.

Christian Hof; Stefan Diebenbusch

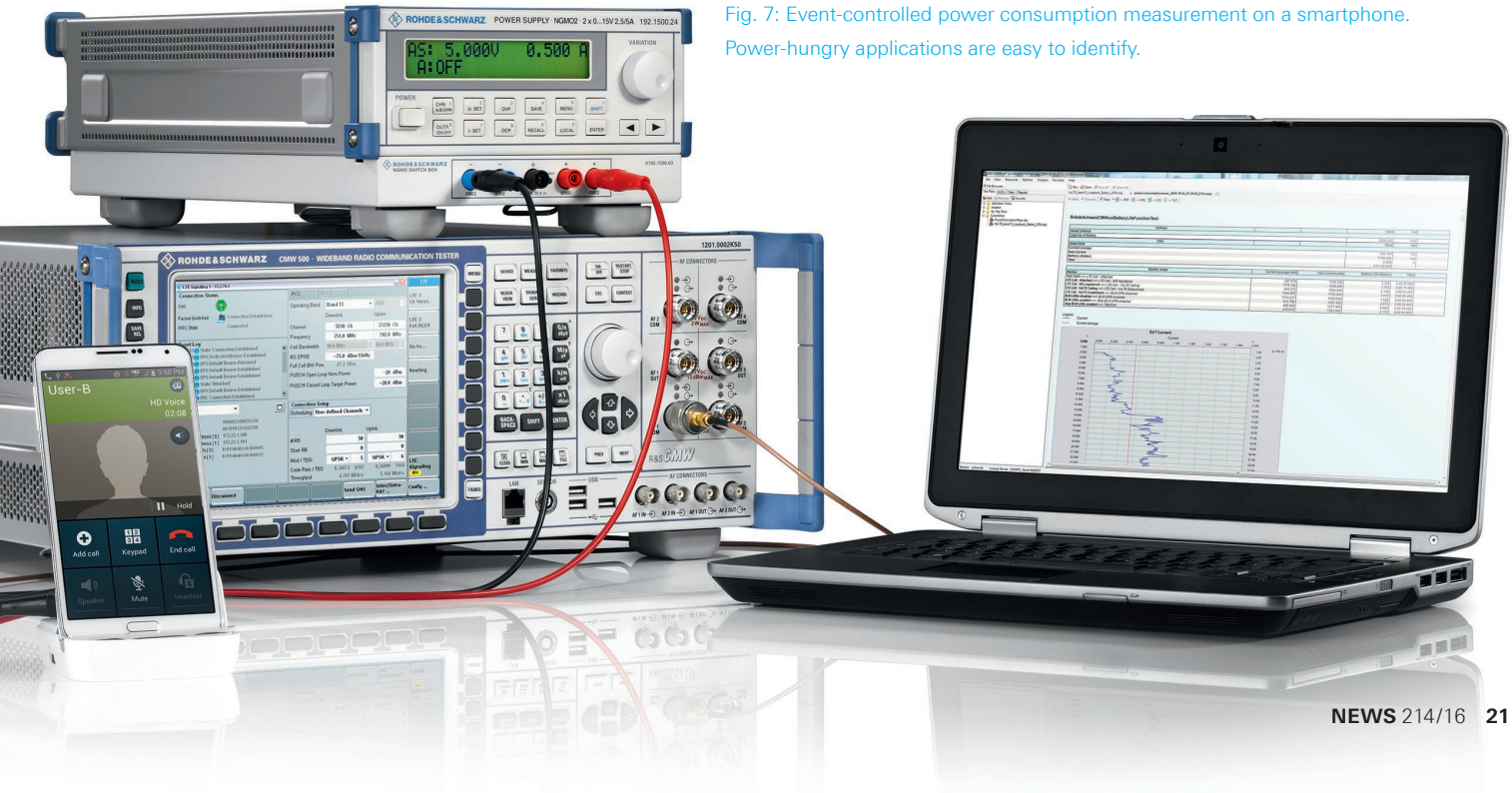

Fig. 7: Event-controlled power consumption measurement on a smartphone. Power-hungry applications are easy to identify.