NEWS

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ROHDE&SCHWARZ

Keeping an eye on video quality

Broadcasters and streaming service providers use automatic systems to monitor their transmissions – from the playout center, on the road and in the cloud

General purpose

Analog RF and microwave signal generator pushes performance limits

General purpose

Highly sensitive probe helps reduce power consumption of wireless devices

Monitoring

Handheld antenna takes the bearings of transmitters and interference sources

NEWS

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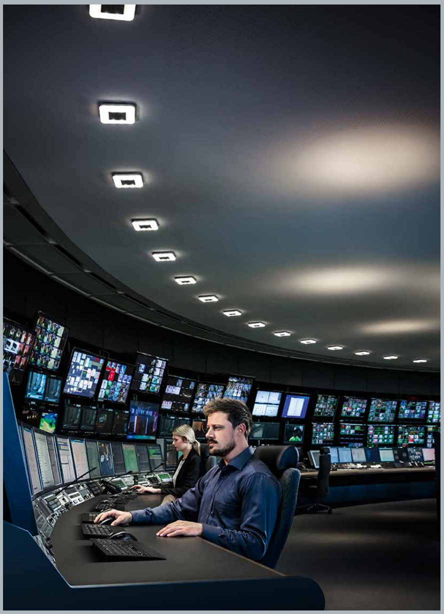
Cover feature

If you have access to a fast network and good signal strength, then you expect YouTube videos to start immediately and run without any hitches when you view them on your smartphone. In most cases that is also what you get, because major video service providers know the importance of satisfactory user experience and invest accordingly in their infrastructure. The same is true of network operators, which in case of doubt are often held responsible for poor performance even though they only transmit the data. As a provider, it is better to proactively check video quality on site instead of waiting for complaints from angry users. For this you do not need to deploy an army of testers on the streets to click through the services and give their subjective assessments – automated methods have been available for quite some time. Mobile measurement solutions that easily fit in a backpack do the job quickly and objectively. The article starting on page 8 describes the technologies deployed in these solutions. Mobile video consumption is a relatively new phenomenon, so users are still willing to accept some limitations, but they definitely expect conventional television to have the same high quality and reliability as power from the wall outlet. But what is conventional? Streaming services have been gaining ground for quite a while. TV providers and distributors are confronted with the growing diversification of the broadcasting landscape and a plethora of media formats. If you want to maintain an overview of content and quality in this chaotic situation, you need monitoring solutions that can handle everything that arrives at their input. R&S®PRISMON is this sort of allrounder. It doesn’t even need any cable jacks because it is a pure software solution that optionally resides in the cloud and can be used everywhere. This innovation met with industry acclaim at the recent NAB show in Las Vegas. In the article starting on page 42, you can read what led the experts to this assessment.



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Overview
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Wireless

General purpose

With the high-end R&S®SMA100B analog RF and microwave generator, it is no longer necessary to compromise between output power and spectral purity (page 16).

R&S®PRISMON responds to the diversification in broadcast and streaming by providing a convergent monitoring solution (page 42).

Used together with a portable monitoring receiver, the R&S®HE400 directional antenna can precisely locate transmitters and interference sources (page 50).

First solution for NB-IoT coverage measurements

When mobile phone users run into coverage holes, they can generally find an area with base station coverage nearby. Machines and other stationary wireless subscriber devices do not have that option. They have to have reliable coverage in their operating areas. Equipment in unfavorable locations, such as a smart power meter in a basement, represents an additional difficulty for wireless connections. That is why wireless coverage is even more crucial to the Internet of Things than human-centered wireless communications. More than ever, network operators must ensure that their infrastructures reach (machine) users. Network scanners can verify that this is the case. The latest update to the R&S®ROMES4 drive test software enables all Rohde & Schwarz network scanners to run NB-IoT coverage measurements in line with LTE Cat NB1. Unlike subscriber devices, network scanners do not log on to networks. They produce measurement results based on channel-specific analysis of on-site RF conditions. Scanners are more accurate than wireless devices and cover the entire wireless spectrum, providing insight into possible interference between locally available wireless services. However, an active network connection via a mobile device is needed to test performance parameters such as latency and throughput of specific networks. A software extension is available for this task.

New board makes R&S®CMW500 perfect for 4.5G tests

For years, the R&S®CMW500 wideband radio communication tester has been a tried and trusted allrounder for testing wireless products in development and production. The R&S®CMW500 is continually updated to keep pace with the new features regularly introduced by different standards (especially 3GPP) to enhance network performance in expectation of the launch of 5G. The new R&S®CMW-B500I signaling board equips the platform to meet the challenges of 3GPP releases 13 and 14 (LTE-Advanced Pro/4.5G). In combination with the R&S®CMW-B450H option, the tester can handle data rates up to 2 Gbit/s. The board can be double-loaded in order to, for example, emulate four LTE cells simultaneously. It handles all cellular and non-cellular standards that will be supported by the R&S®CMW500 and replaces the previous fading board, offering an expanded range of functions. The latest high-speed train (HST) channel models and sophisticated SCME fading, which was previously handled by costly external faders, are now selectable fading profiles. All new testers contain the R&S®CMW-B500I board. Older instruments can be retrofitted.

High-end simulator for demanding GNSS scenarios

Location based services have been booming since manufacturers started integrating GNSS receivers into almost every mobile device and other mobile facilities. The rising requirements of these receivers have resulted in higher demands on T&M equipment. Live signals are unusable as GNSS testing sources since they are location- and time-dependent and can only be received in obstruction-free environments. What is needed are simulators that can reproducibly emulate any imaginable receiving condition. Although relatively simple solutions are sufficient for testing GNSS modules in production, development lab simulations can quickly become quite complex when demanding scenarios need to be tested. Simulators in these environments must integrate all aspects and influences along the signal path in a live-like manner, i.e. the satellites with their specific characteristics (GPS, GLONASS, BeiDou, Galileo, SBAS, QZSS), the atmosphere (ionosphere, troposphere), ground conditions (obscuration, multipath propagation) and receiver operating conditions (moving profile, antenna characteristics, interference). The new high-end GNSS simulator based on the R&S®SMW200A vector signal generator can do all this. Its ability to simulate multiconstellation, multifrequency, multi-antenna and interference scenarios make it the answer to ever more complex test requirements.

Signal analysis with up to 5 GHz bandwidth

New frequency extensions allow the R&S®FSW signal and spectrum analyzer to handle high-resolution radar measurements and R&D tasks related to 5G. The R&S®FSW-B2001 option makes it the first instrument in the world to feature a 2 GHz internal analysis bandwidth. It can be used across the entire frequency range of the 43 GHz and 50 GHz base units and is compatible with a number of analysis options. It has long been possible to use the wide bandwidth at even higher frequencies by coupling the R&S®RTO2044 oscilloscope (for I/Q data) with the R&S®FSW. This does require the R&S®FSW-B2000 option. In combination with the R&S®RTO2064 oscilloscope, the R&S®FSW-B5000 option offers even more bandwidth (5 GHz) for the 85 GHz model. Equipping the R&S®FSW85 with the R&S®FSW-B90G option extends its upper frequency limit to 90 GHz to cover the entire E band. Typical applications for these new options include measurements on automotive FMCW radars, on frequency agile, ultrashort pulsed radars, on 802.11ay Wi-Fi signals and on waveform candidates for 5G.

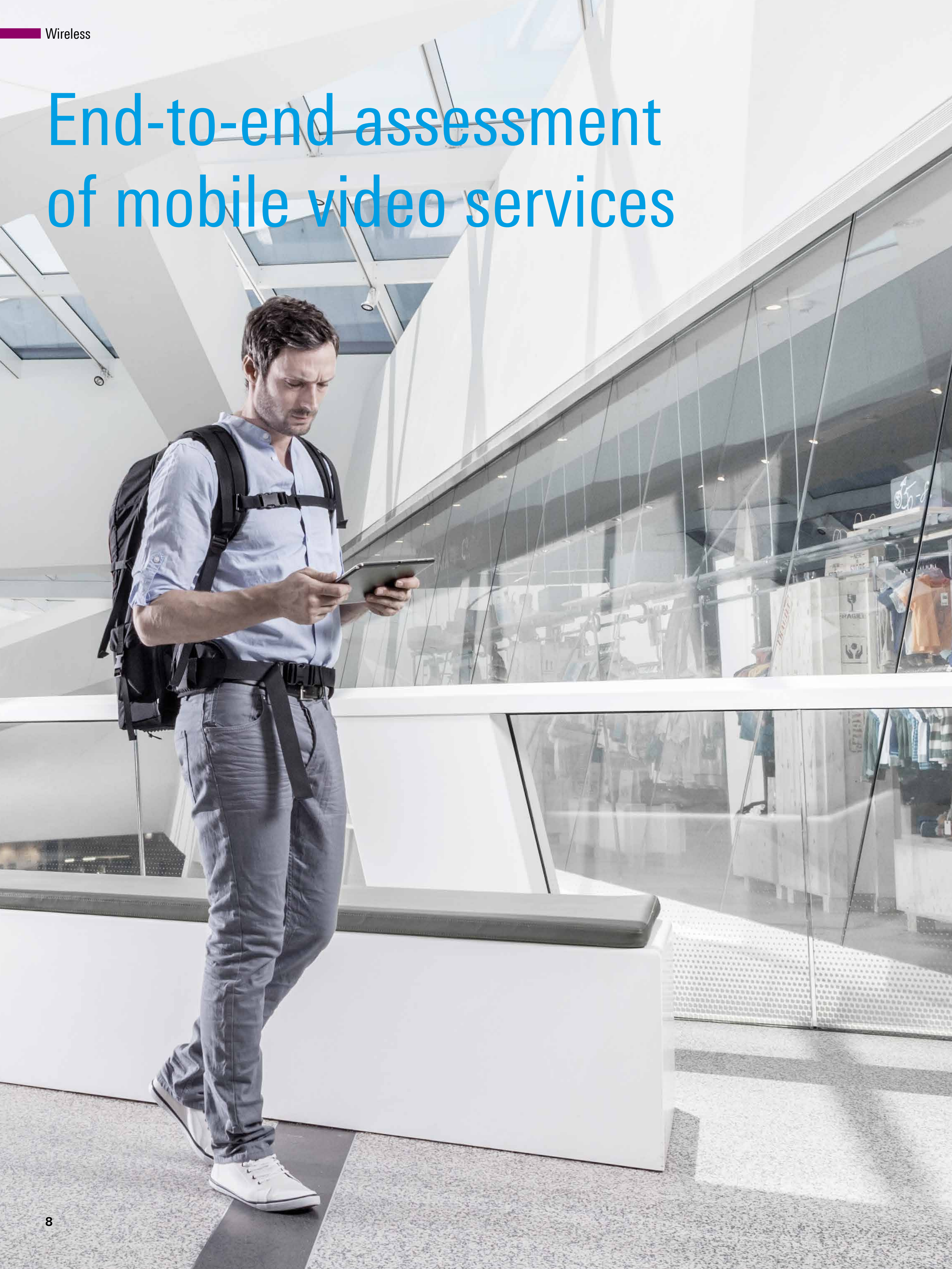
Highly convenient directional power measurements

Directional power meters are looped into transmission paths to measure forward and reflected power levels and verify that transmitters are emitting the required power and/or identify interfering reflections along the paths to antennas. Such power meters must have neutral RF properties, meaning that they cannot affect the signal due to insertion loss or poor impedance matching. The R&S®NRT-Z sensors have been closely meeting this requirement for years. Available up to 4 GHz and 120 W continuous power (300 W peak), they measure the power levels of every signal waveform shape with outstanding accuracy. They can be operated with a USB adapter on a computer or, even more conveniently, on the new R&S®NRT2 control unit. Equipped with a modern 5" touchscreen, this instrument provides all relevant data at a glance on a configurable display. In the forward direction, the parameters are average power, average burst power and peak envelope power (PEP) which can also be displayed as net values (forward minus reflected values), crest factor and CCDF. The reflected wave delivers measured values for reflected power, return loss, reflection ratio, reflection coefficient and SWR. Forward and reflected power levels are automatically scaled and displayed numerically and in a bar chart (with or without limit lines). The R&S®NRT2 is remote control compatible with its predecessor, the R&S®NRT.

New media server for file-based workflows

The studio and broadcast world is undergoing a radical transition from tape-based to file-based workflows. Client server architectures from the IT world serve as a template for this evolution and are being tailored to the special needs of the industry. Hardwired proprietary devices are being replaced by IP-networked components that offer functions such as transcoding and storage as virtual services in a network. The fully redesigned R&S®VENICE media server for channel playout and studio/live applications was designed with such environments in mind. The server features a hybrid design to enable smooth migration. R&S®VENICE can process IP signals while simultaneously handling the traditional SDI format. The system can be integrated via FIMS or VDCP. Interoperability based on open standards was a key development objective. Top reliability was another. The new Rohde & Schwarz virtual storage access technology ensures interference-free operation, especially when used in combination with the R&S®SpycerBox Cell storage solution. R&S®VENICE simultaneously supports all input/output formats up to UHD-1/HDR. A powerful tool set with features such as de-interlacing, entering and exporting closed captions, and Dolby E decoding eliminates the need for many additional hardware and software products.

End-to-end assessment of mobile video services



Videos are the most popular web content and have long formed the bulk of the data volume in mobile networks. Which is why not only video consumers but also video service providers and network operators have a vested interest in a high quality of experience. Mobile measuring systems assess this automatically and just as reliably as human viewers.

Today, mobile video is a much-discussed topic, albeit not a new one. Even shortly after the turn of the millennium, i.e. long before the first smartphone, it was possible to access and stream videos from media servers using QuickTime® or RealPlayer®. For these UDP/RTP-based transmissions, the term streaming in the sense of realtime transmission was indeed appropriate because the limited capacity in mobile networks meant that video could only be transmitted highly compressed and successively in realtime. Neither buffering under increased transmission speed nor enhanced error correction was possible. These limitations existed despite modest image sizes, typically QCIF (144 × 176) or QVGA (240 × 320). Other mobile video technologies such as DVB-H were just as unsuccessful as these early streaming services.

Mobile video did not achieve a reasonable degree of acceptance until the advent of HSPA transmission technology and VGA display sizes (480 × 640) and higher. This was less than ten years ago. But since then, use has grown exponentially and now dominates the amount of data in networks (Fig. 1). The reason is naturally the increased transport capacity of mobile networks and the availability of less expensive data plans, but mainly it is due to the widespread use of high-resolution, large-format smartphones as central access devices to practically all media. As a result, video is increasingly used as a primary source of information. It is not without reason that today YouTube is the second most frequently used search engine, right behind Google.

Generally, mobile video services are not the primary services offered by network operators. They largely function independently of telecommunications norms and standards. Contents, servers and applications are made available by independent service providers who simply use the mobile network to transport data (known as OTT services). The data is normally encrypted and transported using proprietary protocols on the application layer. The video compression technique is also service-specific. All information exchange between app and service takes place under the direction of the video service and is subject to continuous optimization and adaptation. It is therefore almost impossible to provide accurate and detailed information on the many video services available on the market. Instead, principal techniques will be briefly presented and the need for a perceptive assessment of the service quality explained.

Use of mobile services

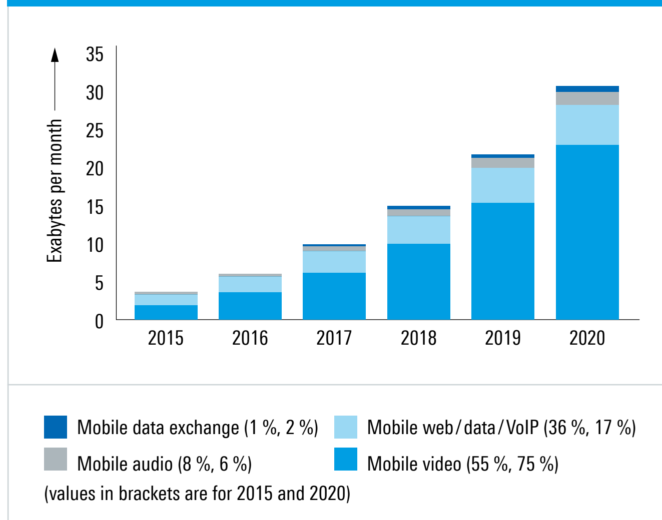


Fig. 1: Growth of data traffic in mobile networks. The data volume of video services is increasing sharply, both in relative and absolute terms (source: Ericsson Mobility Report 2017).

The perceived quality of a video service can be roughly determined based on the following criteria:

- Is the service available?
- How long is the delay between the request and when the video starts (time to first picture)?
- To what extent do unwanted interruptions occur (stalling)?
- How high are the image resolution and quality? To what extent is the image quality affected by
  - Compression losses (blurring due to compression and/or reduced resolution, reduced frame rate), blocking artifacts
  - Transmission errors (artifacts, corrupt images, brief stalling)

Desynchronization effects between audio and video may also occur.

Technical background for video transmission on mobile devices

The majority of requested videos are coder-compressed video files that are stored on a server waiting to be called up (video on demand as opposed to live video). Streaming is the term that is widely used to describe transmission to the consumer device but to be precise, this term only means the continuous transmission and realtime processing on the consumer device. But unlike the early days of mobile video mentioned above, today data is transmitted in larger sections and buffered.

The entire video can in principle be downloaded as a file and then viewed after it has been fully received. However, users are unwilling to accept the annoying waiting times. The progressive download technique provides a solution to the problem. The video starts as soon as the first section is available on the smartphone, while the rest of the video continues to be downloaded from the server in the background. Using this strategy (if there is sufficient channel capacity), the complete video will be available on the device after just a short time. The advantage is clear: once loaded, connection quality is irrelevant and the video can play without interruption.

However, users often do not watch videos to the end so a complete download would be a waste of transmission capacity. The solution is a compromise between the need to buffer sections of the video to ensure interruption-free playback and the desire to be economical with the available transmission capacity.

First of all, a large initial section of the video file is saved. If it is apparent that the viewer wants to continue to watch the video, the next section is downloaded when a certain playback point is reached. The length of each loaded section ranges from a few seconds to minutes, depending on the philosophy of the video service. The trend is moving toward shorter sections and is therefore again approaching the streaming ideal. However, unlike realtime streaming, a large section of the video remains in the buffer so that long gaps in the connection can be bridged (Fig. 2).

From a technical viewpoint, video on demand is still a file download that does not require realtime transmission. Data transfer is mostly based on the reliable TCP/HTTP protocol, which prevents the loss of data and is supported by all operating systems. One exception is YouTube which is moving towards Google's QUIC protocol. For performance reasons, UDP instead of TCP is used on the transport layer and this can potentially lead to data losses. On the application layer, however, QUIC has implemented mechanisms that prevent losses.

Compared to video on demand, live video still plays a minor role in the network as far as volume is concerned, but places greater realtime demands on the transmission path. Typical applications include video telephony, images from surveillance cameras and video-assisted remote control systems. How narrowly the term realtime is to be interpreted in each case depends on the application. In the private domain, TV and live video are of primary importance in social media. In both cases, the realtime requirements are less strict and a time delay of a few seconds is accepted. For this reason, transmission can take place on the same technical basis as for video on demand. The only difference is that the storage and reload intervals are reduced to just a few seconds.

The technique of using staggered, section-by-section transmission also makes it easy to adapt the bit rate to the transmission channel. Each section of video can be delivered with the appropriate compression (e.g. in line with the DASH method) based on the current channel capacity. If things get tight on the transmission path, the video section is delivered with lower resolution or higher compression, thereby reducing the data rate. This does affect the image quality, but pauses caused by emptying the buffer memory would be even more annoying.

Download strategies

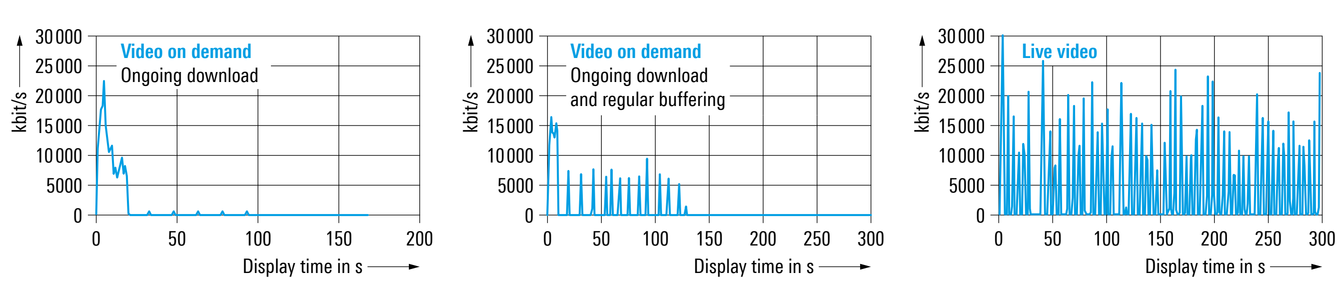


Fig. 2: Three examples of data transmission measurements for video services.

The video provider is responsible for defining whether the client on the smartphone or the server decides what channel information to use as the basis for selecting the appropriate compression level, defining the time constants that regulate this behavior, and all other details. The mobile network only provides the means of transmission; the video service reacts to the given situation, with the primary objective of avoiding image freezing while maintaining a high image quality (depending on channel capacity). The compression methods used are not lossless. A varying amount of detail will be lost depending on the coding scheme and compression level. In the best case, the effects remain below the perception threshold. If greater compression is necessary, blurring occurs, which becomes more evident in moving scenes. Even greater compression causes annoying artifacts such as pixelation blocks and absent color shading.

The data stream is only of limited help when assessing quality

Essentially, the technical makeup of a video service is irrelevant – ultimately what counts is what the viewer sees, i.e. the much quoted quality of experience. The question is how to assess this using technical methods.

The size of a video file in relation to the playback time and the associated bit rate provide only limited information because the individual codecs function at different levels of efficiency, i.e. transmit different image qualities at the same bit rate. Most codecs have multiple quality levels known as profiles. Profiles define the calculation effort that goes into the compression. More complex compression can result in a greater level of detail for the same data volume. Finally, the image content also affects data volume. Large-format images in a stationary scene can be encoded more effectively than small-format images with high motion, brightness and color dynamics.

The server and app react to any change in the network and image material by adjusting their settings in a feedback loop. An assessment tool based only on data flow analysis and no knowledge of image and application metadata would not be able to provide reliable information on quality from the end customer's perspective. And even if service-specific meta information were accessible, the change dynamics in this industry are so great that the analysis tool manufacturer would hardly be able to develop his software fast enough to keep up (see box). Plus, the majority of today's video services already use encryption on the transport layer. Mere analysis of the received bitstream can only deliver a small amount of the information necessary for a quality assessment. The alternative is, quite literally, there for all to see: the displayed image itself serves as the source for analysis. Everything that happened prior to display, such as compressing, transmitting and decoding the video and preparing it for display, is reflected in

In with the new – the latest evolution of video standards

MPEG-4 (part 2), H.264 and H.265 are familiar standardized video codecs. For a long time, MPEG-4 (part 2) was the standard of choice for IPTV and DVD-Video. The next development step to H.264 (AVC) made HDTV practicable and is also used for the Blu-ray Disc format. The most recent standard codec is H.265 (HEVC), which is used by standards such as DVB-T2 and will establish itself as the codec for UHD1 transmissions (4K) because it is able to deliver acceptable image quality even with an extremely high degree of compression.

There are also proprietary, mostly open (but not standardized) codecs such as Google's VP9 which, from a quality viewpoint, is somewhere between H.264 and H.265 and is at present the only codec used by YouTube. The transition to AV1 (a VP9-based, open source video codec from the Alliance for Open Media) is expected in the near future. When development is complete, AV1 will without doubt be adopted by YouTube and most likely also by other video service providers such as Netflix. There is currently a general trend among the major Internet players to move away from the classic standardization work in ITU and MPEG. Instead, they are discussing and adopting coding and transmission standards within the framework of mergers and consortia. Since every service maintains its own technical ecosystem and does not need to ensure compatibility with others, codecs (just like the communications between server and app) are usually changed without notice or disclosure.

YouTube is a perfect example. Less than two years ago, YouTube transmitted MPEG-4 coded videos in 3GP format via unencrypted TCP connections. Since then, videos have been encrypted, initially using TLS and later using Google's own SPDY protocol. Videos were also recoded with H.264. Some time later, there was the transition to MPEG DASH in order to allow adaptive bit rates. Another step was to again recode the videos, this time with VP9, Google's own video codec. Then, at the beginning of 2017 – for Android smartphones – YouTube abandoned TCP in favor of UDP and the QUIC application protocol. This list of changes only relates to the measures concerning the transmission of videos. With practically every new app version, YouTube also changes the way in which the buffer memory in the smartphone is managed, i.e. the rules that define how much and when data is buffered as well as the criteria according to which the bit rate is changed.

Other video services continually make similar adjustments. In order to compare the quality of different services without being influenced by the evolution of a service, all measurement methods, assessment methods and criteria used have to be measurable for all services over a long period of time and include all components that play a role along the transmission path.

the image and can be taken into account in the analysis. The only important thing is what the viewer ultimately sees. But to be able to analyze the screen content, it is necessary to access to the mobile device's image memory – a difficult, but manageable challenge on smartphones.

Rating	English	German	French	Spanish
5	excellent	ausgezeichnet	excellente	excelente
4	good	gut	bonne	buena
3	fair	ordentlich	assez bonne	regular
2	poor	dürftig	médiocre	mediocre
1	bad	schlecht	mauvaise	mala

Fig. 3: Commonly used international ratings for MOS.

Ultimately, what counts is what the viewer sees

As already mentioned, the time from when a video is requested to when playback begins (time to first picture) is an essential parameter when assessing service quality. Due to data buffering, the display does not start when the first data package is received on the IP layer – it starts much later. This time delay can only be measured by looking at the screen or in the image memory.

It is also not possible to (accurately) diagnose emptying of the buffer memory from the received data stream since you do not know how full the memory is nor if warping measures are used. You also have to look at the display to see if the video freezes or stalls. The measured display time of each image is used as the basis.

Assessment of the actual image remains a challenge in itself. It requires technical methods known as perceptual objective video quality models that take the peculiarities of human perception into consideration.

Perceptual objective video quality models

Perceptual objective video quality models evaluate not only the frames according to various criteria, but also motion patterns over long image sequences, in the same way as a person reacts to static and dynamic aspects. The analysis may be complex, but the result is simple. In the end, it is summarized as an overall value on a quality scale. For example, the internationally recognized absolute quality scale describes the quality as a value between 1 (bad) and 5 (excellent) (Fig. 3). The average of many individual assessments is the mean opinion score (MOS).

A simple example of perceptual objective analysis is the assessment of stalling. The more dynamic a scene is, the more annoying image freezing will be. In a scene with very little movement, stalling will result in the loss of just a small amount of information, and may not be perceived at all in the case of a static subject such as a landscape. With a sports broadcast, on the other hand, even brief interruptions will be perceived as extremely annoying. The perceptual objective measure for the motion aspect is referred to as jerkiness; it weights the display duration of an image with the movement in the video and returns a single value that represents the loss of information and the annoyance of waiting.

The environment in which a disruption occurs is also decisive in assessing the disruption. Artifacts in the image foreground or in a moving object (attraction areas) result in a much more negative assessment than a block formation in an extremely bright or extremely dark image area where such artifacts are less noticeable.

Video codecs also employ perceptual objective strategies in order to use the characteristics of video content to optimize compression, e.g. to encode certain attractive areas in the image with a greater level of detail while permitting a greater loss of detail in unattractive areas.

Fields of application for standardized video quality models

The widespread use of IPTV has created a greater need to measure video quality at various distribution points in the network. Many video quality estimators have recently been developed for this purpose. Although these estimators only analyze the video bitstream, they provide sufficiently precise results for these applications (Fig. 4). If the bitstream is not encrypted, content information (display duration of a frame, compression structures) as well as metadata (codec type and profile, packet size) can be used, and it may even be possible to decode the image. In the case of an encrypted bitstream, the amount of information that can be evaluated is severely restricted. How severely depends on whether the encryption affects only the actual video data and on which protocol hierarchy level it is applied.

Bitstream-based methods are intended for monitoring applications. Here, the video does not have to be known nor available in decoded form. Current methods are described in ITU P.1201, P.1202.1/.2 and in P.1203.1-4.

In the case of end-to-end tests (particularly in mobile communications), image-based models have the advantage, as explained above. They are the most accurate in representing the user experience because they are based on human perception and are able to analyze the image. Current HD-compatible measurement methods can be found in ITU J.341 and ITU J.343.1-6. A basic distinction can be made between reference-based and reference-free methods. Reference-based methods (picture-based, full reference methods, Fig. 5) have access to the source video and can calculate perception-relevant differences to the received video image by image and even pixel by pixel, and combine them to obtain a quality value. Such methods are described in ITU J.341 and ITU J.343.5/.6 (see also the article on page 42). To use these methods, however, reference videos must be previously uploaded to the server of the video service to be tested. During the quality measurement, these videos are compared with the same videos stored on the measuring instrument. This method is supported by services that permit private videos to be loaded and streamed (e.g. YouTube), but not usually by professional providers (e.g. Netflix). Reference-based methods are also unsuitable for assessing live video because there is no previous playback source available.

In contrast, reference-free methods (picture-based, no reference methods) do not need any a-priori knowledge of the source video. The received and decoded video is analyzed for typical disturbances (jerkiness, loss of detail, compression distortion, etc.) and this information is used to calculate the quality value. Standardized methods are described in ITU J.343.1/.2.

The advantage of these methods is their broad range of applications since they function irrespective of the transmission path. This is why ETSI TS 102 250-2 recommends the use of J.343.1 for all types of mobile video streaming services.

The secure transmission methods used almost exclusively for mobile video streaming today do prevent bit errors that in the past resulted in severe artifacts and image errors and also

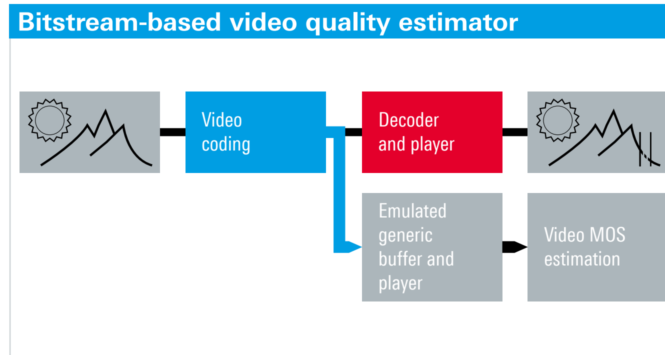


Fig. 4: Bitstream-based quality estimators use a small amount of metadata and heuristic methods to derive an MOS.

reduce the problems of compression artifacts (loss of image details, blurred movements) and stalling, i.e. the freezing of moving images. But with the growing popularity of video telephony with its strict realtime requirements, non-secured (i.e. lossy) transmission is again becoming more prevalent on mobile devices. Many of the current measurement methods are prepared for this.

Structure and application of ITU J.343.1 in Rohde & Schwarz products

The quality measurement method in line with ITU J.343.1 is a SwissQual/Rohde & Schwarz in-house development. It was successfully tested and standardized in 2014 by the ITU and has since been implemented in the Rohde & Schwarz mobile network testing Android-based test applications. Some meta information from the video stream is also available to the method. A jerkiness value is calculated from the movement and display duration of the individual frames, and a loss of detail is calculated from information indicating the complexity of the images. At the end, the video quality is assessed on an MOS scale from 1 (bad) to 5 (excellent).

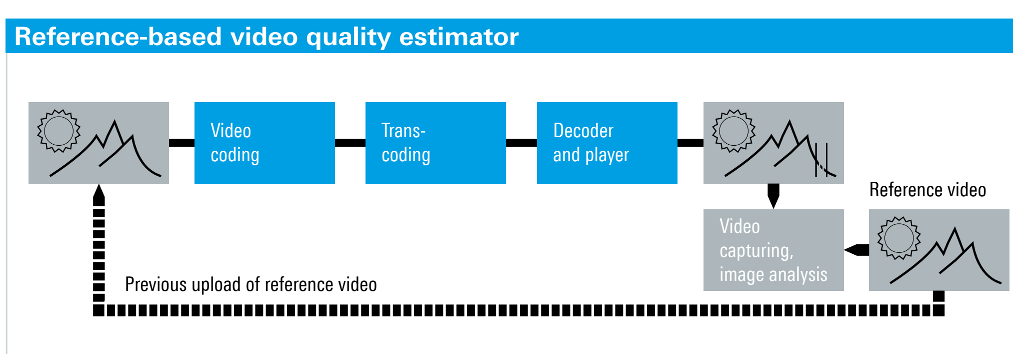


Fig. 5: In reference-based methods, a streamed video is compared with the original stored on the measuring instrument.

During development, a priority was ensuring that the measurement method could be used in realtime applications. The implementation analyzes only the current video frame in relation to a history comprising just a few images. Despite this constraint, the image assessment must be extremely quick so that it is completed before the next frame: with 25 frames per second, only 40 ms are available to analyze a 3 Mbyte image.

The method also obtains other information from the video signal. Stalling is detected, and the image size and video codec used are also recognized (Fig. 6). The data of the deeper protocol layers is also recorded. This results not only in the cumulative quality value, but also in a lot of information that can be used to optimize the transmission path and efficiently troubleshoot in the event of problems.

Video quality assessment is the main task when assessing a video service in general. The measurement applications support fully automatic control of YouTube, including YouTube live video as the most commonly used video service, as well as AT&T's own DirecTV service. It is even possible to test almost any other video service in a semiautomatic measurement application. This allows you to quickly respond to new offerings as well as to assess and optimize regionally important video services.

The video test applications are supported by the QualiPoc product family. This family includes R&S®ROMES and QualiPoc Handheld for network optimization tasks, QualiPoc Remote Control for autonomous network monitoring, and especially the FreeRider walk test solutions and SwissQual Benchmarker as benchmarking systems.

Video analysis in line with ITU J.343.1

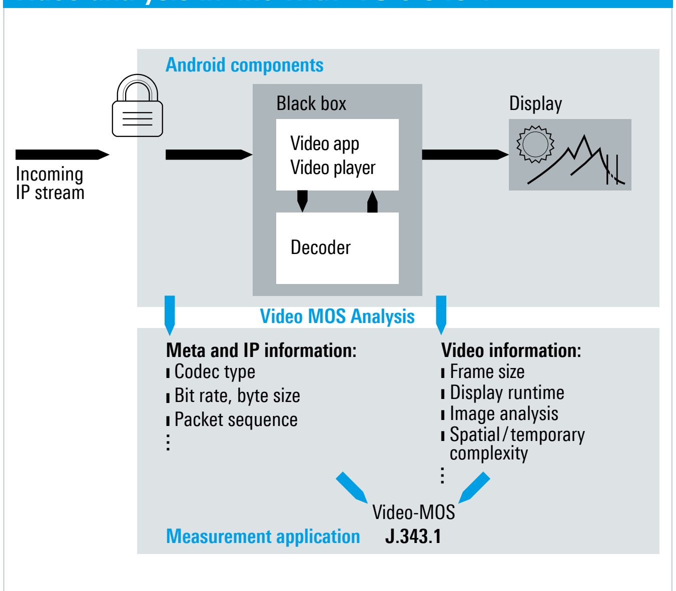


Fig. 6: Video analysis in line with ITU J.343.1 is based on the images themselves as well as a small amount of metadata.

Quality of experience is more than just image quality

Image quality may be the most important criterion when assessing a video service, but it is not the only one. Whether a service can be accessed, how long it takes to access it, as well as information on the loading progress are assessed. In order to gain an overall picture, Rohde&Schwarz mobile network testing products include a test sequence that measures the video quality by simulating the actual usage behavior – from starting the video application on the smartphone to requesting a certain video to analyzing the displayed images (Fig. 7). If waiting time plays a role in the real world, then the maximum waiting times of a hypothetical average user are used. If these times are exceeded, the test is regarded as "failed" in cases where the video never became visible, or as "dropped" in cases where the video froze for a long period of time. Such abort criteria are indispensable for an automated test sequence.

The test sequence can be followed precisely in the test log on the smartphone (Fig. 8, left side). A successful test returns the overall quality (MOS) and other aspects such as jerkiness and freezing (stalling) (Fig. 8, right side). Many other measured values are collected in the background, including image rate, image resolution, the protocols used and the IP and trace log

Test sequence for a QualiPoc product

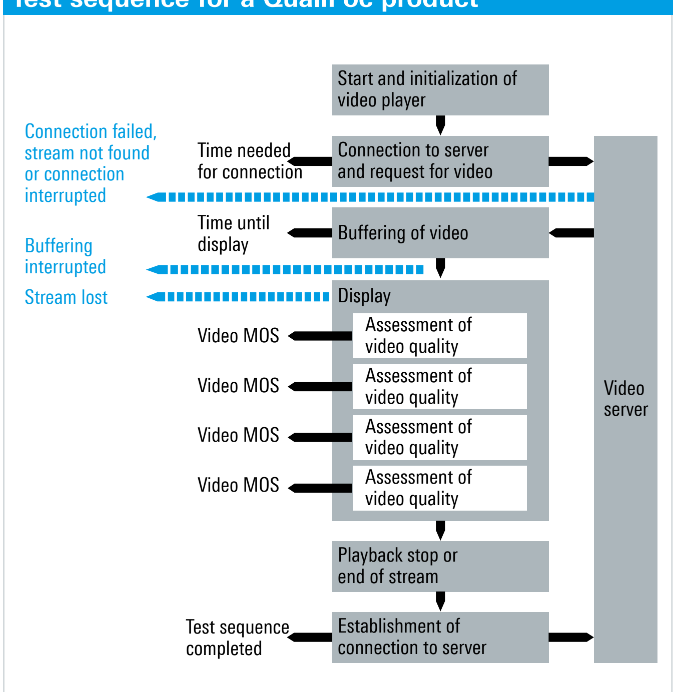
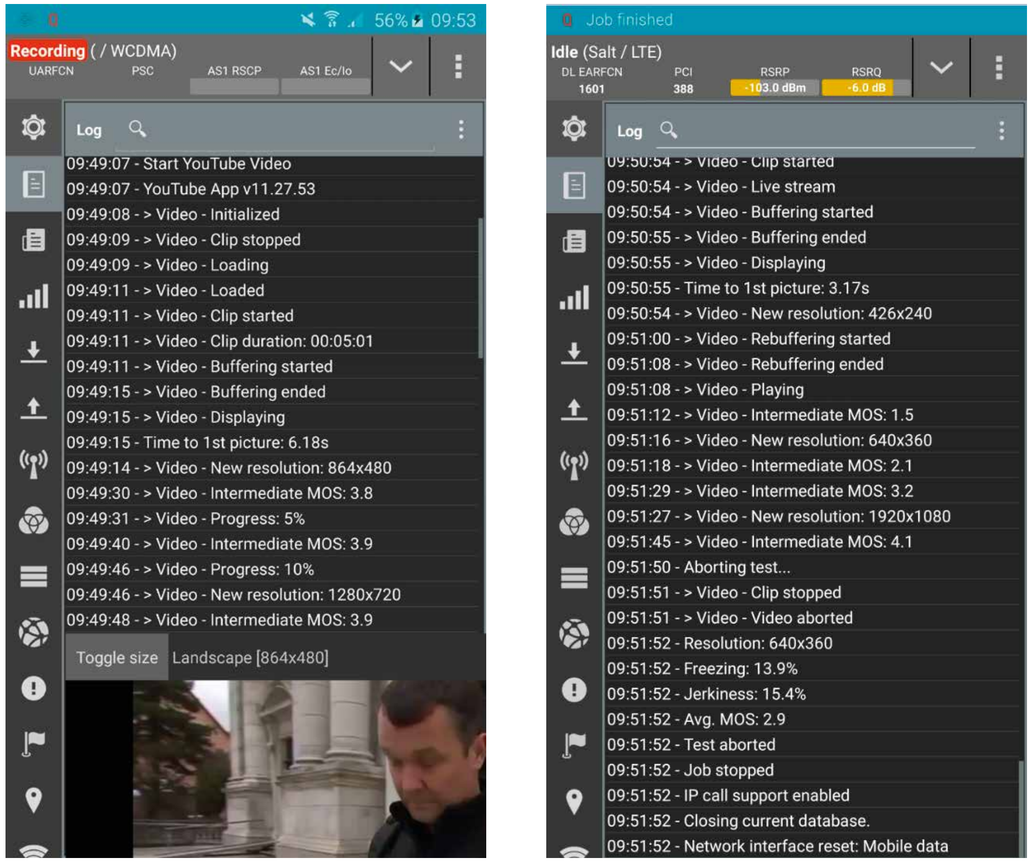


Fig. 7: Measurement of a video service from start of the application to establishment of the connection.

Fig. 8: Realtime analysis of a YouTube video with QualiPoc as per the flowchart in Fig. 7.



files. As a result, the user not only has access to the measured values for video quality, but also to all the information required to optimize the transmission path.

Summary and future developments

Videos have long accounted for the bulk of data transported in mobile networks, and forecasts predict continued dramatic growth. Network operators and video service providers therefore have a vested interest in keeping video consumers happy by ensuring that their services are of high technical quality. Automatic test systems quickly and reliably determine the level of quality. In the mobile sector, reference-free perceptual objective analysis methods have proven effective as an alternative to measuring video quality. These methods deliver meaningful results with a computational effort that can be achieved even by smartphones and are therefore inexpensive and uncomplicated to use.

Although realtime applications such as video telephony do not play a major role at present, this will change in the foreseeable future. The upcoming, virtually latency-free 5G mobile standard will enable and facilitate realtime applications in high quality, e.g. video transmissions for telemedicine. Reliable, high path quality is essential. The current Rohde&Schwarz mobile network testing monitoring products are ready for these applications.

Dr. Jens Berger; Dr. Silvio Borer

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The no-compromise solution

In multisport competitions, most athletes have some weakness in one or the other discipline. However, this is not the case with the new R&S®SMA100B analog signal generator. With top scores in every aspect, the new signal generator stands alone in front of the competition.

Fig. 1: With the high-end R&S®SMA100B analog RF and microwave generator, engineers no longer have to compromise between output power and spectral purity.

R&D engineers must often push the limits of what is technically feasible to build a product with the best possible characteristics. In the field of electronics, an analog signal source is commonly the solution of choice for maximizing the potential of a design or verifying its performance. Ideally, this signal source should have sufficiently high performance to avoid influencing the measurement results. For example, engineers who test A/D and D/A converters need signals with the highest possible spurious-free dynamic range (SFDR) as well as the lowest possible wideband noise. For radar engineers, minimal phase noise is the most important requirement. When working with large test setups with high cable losses, the signal source needs high output power to avoid using performance-degrading external amplifiers. Unfortunately, until now, all commercially available signal generators have entailed some sort of compromise; no instrument existed that could simultaneously satisfy all of these criteria.

When Rohde & Schwarz decided to develop a successor to its R&S®SMA100A and R&S®SMF100A RF and microwave signal generators, it set itself a simple but very ambitious goal: the new instrument should deliver top characteristics – but without any complicated dependencies between them. The result is the R&S®SMA100B, which combines uncompromisingly high output power with unprecedented signal quality (Figs. 1 and 5).

The following examples illustrate typical applications where the instrument's strengths come into play.

ADC/DAC component testing

Each new generation of A/D and D/A converters brings higher maximum clock frequencies and higher effective resolution. In order to test such high-performance components, the spectral purity of the source for the clock and test signals must exceed that of the device under test (DUT). The R&S®SMA100B generates extremely pure signals with SFDR < 100 dBc for a 1 GHz carrier frequency and < 80 dBc for a 10 GHz carrier frequency. This is an improvement of 10 dB to 18 dB over the previous generation of instruments, and also clearly exceeds the specifications of all comparable instruments on the market. As seen in Fig. 2, the measured nonharmonic suppression is well below the guaranteed values.

Nonharmonics

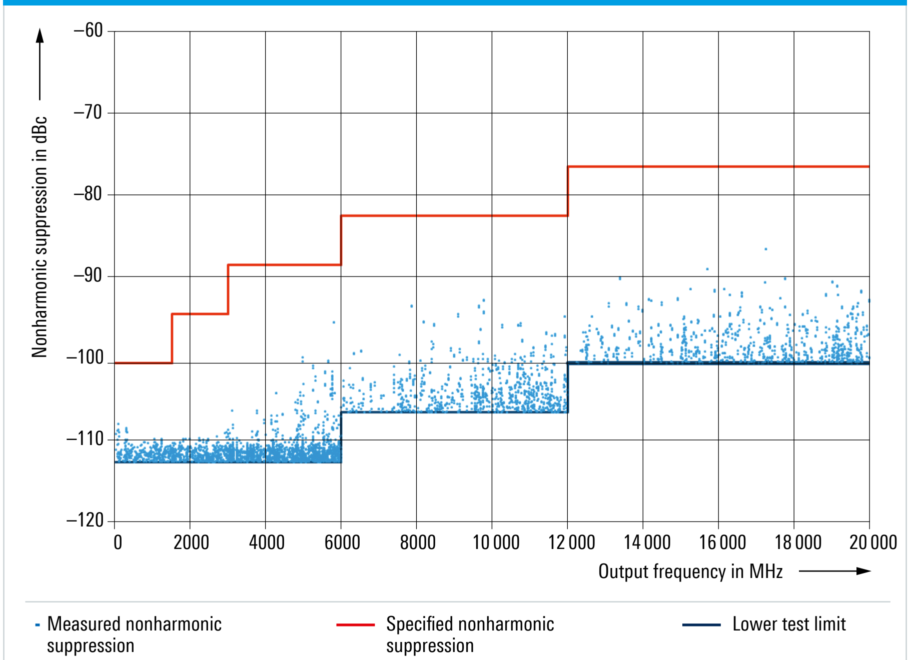


Fig. 2: Measured nonharmonic suppression of the R&S®SMA100B with the R&S®SMAB-B711 option along with specified values.

Single sideband phase noise at 10 GHz

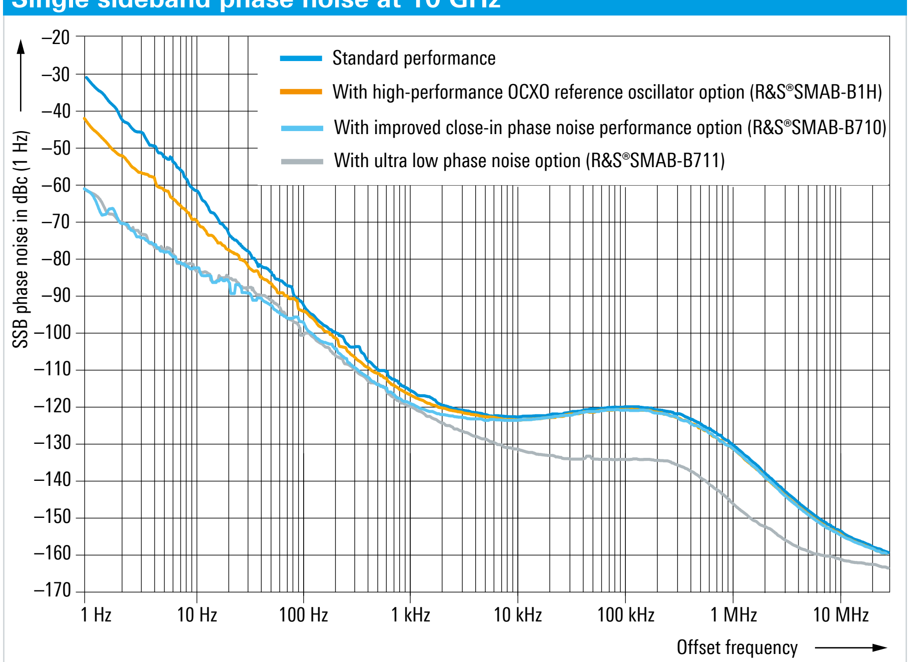


Fig. 3: Single sideband phase noise of the R&S®SMA100B at 10 GHz.

High sampling frequency and resolution require a signal source with very low wideband noise. The reason is that it takes clock signals with low wideband noise to avoid degrading the signal-to-noise ratio of the ADC's sampled input signal. This applies especially to ADCs that use undersampling. In the R&S®SMA100B, an optimized RF design has been combined with a new and fully digital amplitude control loop to ensure typical wideband noise of –160 dBc/Hz for a 10 GHz carrier frequency. Until now, such a value has been attained only by a few very specialized signal sources.

When testing ADCs, two signal sources are commonly required: the first source delivers the clock for the DUT and the second source delivers the analog input signal. The R&S®SMA100B has both. The optional clock synthesizer provides a second, fully independent signal source up to 6 GHz with extremely low phase and wideband noise. This option has been optimized for the clock inputs of ADCs. Its frequency can be set independently of the main signal. A common 1 GHz reference is used to achieve very high phase stability between the clock output signal and the main synthesizer signal. In addition, the signal type, amplitude and DC offset can all be set to support common unbalanced and differential clock interfaces.

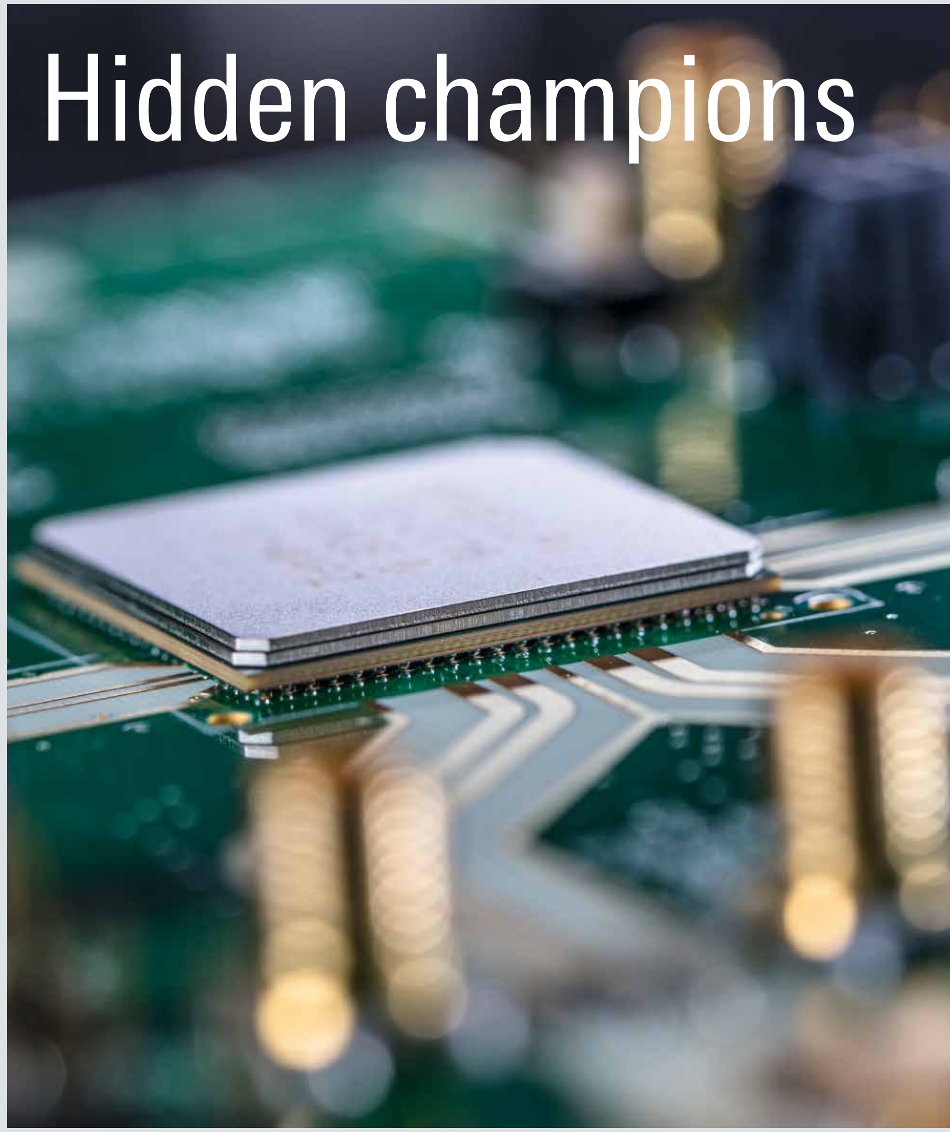
High-end radar development

When designing and testing high-end radar systems, detection sensitivity is often limited by the phase noise of the RF signal source. The R&S®SMA100B has multiple options available that can improve the phase noise in order to fulfill even the most demanding requirements (Fig. 3). The close-in phase noise can be as low as typ. –60 dBc/Hz for a 1 Hz offset and 10 GHz carrier frequency. For applications requiring the lowest possible phase noise across the entire offset range, an option with a YIG oscillator is available that can be used to attain a value of –132 dBc/Hz (typ.) for a 10 GHz output frequency at offsets from 10 kHz to 100 kHz. The R&S®SMA100B is clearly in a league of its own when it comes to phase noise performance.

When testing radar systems, fast and well-controlled RF pulses are essential. With 5 ns (typ.) rise/fall time and better than 80 dB pulse dynamic range, the R&S®SMA100B is ideal for radar applications. State-of-the-art radar receivers must normally also be tested with very narrow pulses that have high level stability and level repeatability. The pulse modulator in the R&S®SMA100B was designed especially for this purpose. It can control the amplitudes of pulses down to 100 ns pulse length from the very first pulse on, even in situations with a small duty cycle.

Production testing of microwave amplifiers

When testing power amplifiers, sufficient drive power is crucial. In the past, microwave signal generators were typically unable to produce sufficient drive power on their own and needed costly external amplifiers. The R&S®SMA100B, however, has built-in power amplifiers, either as standard or optional (Fig. 4). Three output power levels are available. In cases where the standard version is not adequate, a high output power option of up to +35 dBm can be activated with a keycode (no factory service required). The ultra high output power option (factory installation required) increases the level up to +38 dBm (for a 6 GHz model). No previously available general purpose signal generator could deliver such high output power.



Internally developed components are the key to building a winner like the R&S®SMA100B

It all started with a (lofty) objective: 10 dB more output power with 10 dB less phase noise and nonharmonics along with much lower harmonic distortion compared with our top model at that time, the R&S®SMA100A. We wanted the new generator to not only far surpass its predecessor but also to set new standards on the market.

During the first stage in the definition phase, the instrument concept was developed and the key components were identified along with their required specifications. This was a challenge for the design team since at this point the requirements were still often changing, making it necessary to fundamentally modify the concept.

It took intensive market research into component availability and frequent discussions with component suppliers in order to define the requirements for the key components early on and to

Measured maximum output power

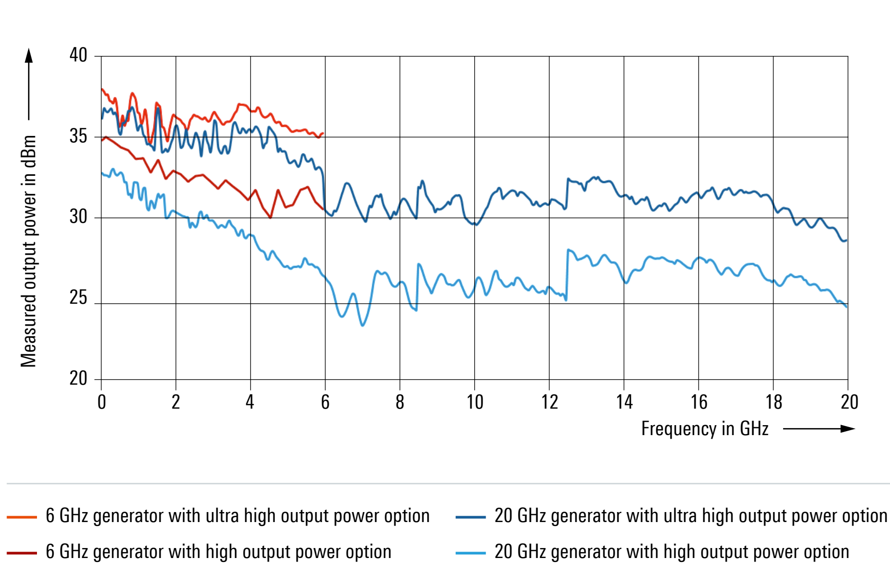


Fig. 4: Measured maximum output power of the R&S®SMA100B.

Due to the built-in lowpass filters, harmonics suppression of typ. –65 dBc is ensured up to high power levels for all output power options. With its unparalleled combination of very high output power, low harmonics and extremely low wideband noise, the R&S®SMA100B makes external amplifiers and filters unnecessary, eliminating the need for complicated and expensive test setups.

Rugged and easy-to-use

In automated production environments, it is important to minimize downtime due to servicing and repairs. One typical wear factor in microwave generators has been eliminated in the R&S®SMA100B: the mechanical step attenuator. For signal generators up to 6 GHz, an electronic (i.e. maintenance-free) step attenuator has been standard for more than a decade. The R&S®SMA100B is now introducing this technology into the world of microwave generators. Its electronic attenuator, a standard feature, allows very fast and wear-free level settings even at microwave frequencies up to 20 GHz.

The R&S®SMA100B can be ordered with a size of two or three height units (Fig. 5). Both models come with a touch-operated graphical user interface. The 2 HU instrument saves space in rack installations; the 3 HU model is recommended for laboratory applications due to its larger display and front-panel connectors.

Daniel Blaschke; Jürgen Ostermeier

Fig. 5: Slim design for rack applications or with front-panel connectors for the laboratory bench: both models use the same advanced technology.

coordinate the roadmaps of development partners. This was important especially because the long lead times for newly developed ASICs could potentially jeopardize the scheduling of the overall project.

In instances where components classified by Rohde & Schwarz as strategically important are not commercially available with adequate quality, the internal development process is launched. Though the cost of internally developed components is high, there are a number of benefits: besides the customized features, the company has exclusive access to the component and can use it in other instruments with relatively low production costs. Consequently, technology developed for high-end instruments can be transferred in a subsequent stage to medium-priced (or even budget) instruments.

For many years, Rohde & Schwarz has operated a mixed-signal design center staffed by a highly efficient and innovation-oriented team of chip designers specialized in developing key components with performance that exceeds the limits of commercially available products. Rohde & Schwarz collaborates closely with a number of leading semiconductor manufacturers and is able to pick and choose among a wide variety of state-of-the-art semiconductor processes (e.g. GaN or SiGe) to meet technical requirements.

Due to the extremely demanding technical requirements for the R&S®SMA100B, the company developed numerous key components internally. The most important ones are briefly presented here.

YIG oscillator: As part of a research project sponsored by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology, an entirely new oscillator based on an optimized SiGe transistor was developed in cooperation with the Institute of Microwaves and Photonics (LHFT) at the University of Erlangen-Nuremberg as well as other partners (Infineon AG, Innovent e.V.). Despite its very compact design, this device sets new standards for phase noise across its entire tuning range. For some years now, Rohde & Schwarz has successfully deployed the technology for manufacturing these critical high-quality YIG resonators, and this technology was further developed in cooperation with Innovent e.V. The YIG resonator and transistor are key components in oscillators. Cooperation with our trusted external partners in this research project was the logical next step in further improving the performance of the Rohde & Schwarz YIG oscillators.

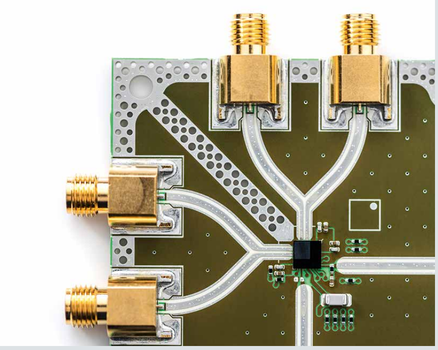
Frequency dividers: In order to achieve extremely low phase noise in the synthesizer, a very low-noise oscillator is needed along with high-frequency wideband frequency dividers with very low phase noise and wideband noise. The company possesses significant expertise in this area based on many years of ongoing development of fast, low-noise divider components. For the R&S®SMA100B, the company developed a new generation of divider components. An innovative architecture was combined with new circuit concepts implemented using an SiGe semiconductor process to set new standards in the area of phase noise. The performance is 10 dB better than the predecessor modules, thereby surpassing all commercially available components.

Amplifiers: To be able to produce extremely high output power levels ranging up to 10 W in this frequency range, it was imperative to develop new power amplifiers based on the latest GaN technology. This technology can be used to generate power across a very wide frequency range – without having to make compromises in the areas of noise and harmonics. It was also necessary to break new ground with the packaging in order to effectively handle the high dissipated power of the power amplifiers and ensure proper cooling on the printed board.

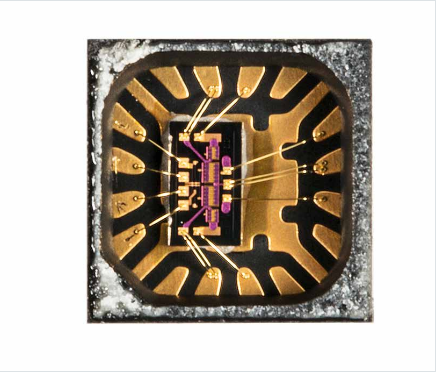
Switches: Although they are often overlooked, the electronic switches are just as crucial as the high-power amplifiers. Since switches are used to combine the different signal paths at the output of the instrument, they must be capable of handling high power of up to 10 W with very low losses and distortion. Rohde & Schwarz was the first to build these switches based on GaN technology.

The fully electronic 20 GHz step attenuator imposed further requirements on the switches, creating an almost insurmountable problem. In order to implement this module, the switches needed to simultaneously provide very high isolation, low transmission loss, low distortion, very high switching speed and a signal bandwidth of 8 kHz to 20 GHz. In face of the contradictory nature of these requirements, it quickly became clear that not all of them could be satisfied by a single switch design without a substantial loss of instrument performance. The solution involved combining an entirely new step attenuator architecture with various switch topologies and technologies. Different switch structures were developed using CMOS, GaN and AlGaAs technologies to achieve the optimum result for each application. This was the only way to build the first electronic step attenuator for use up to 20 GHz in a signal generator. Without any relay bypass, it delivers very high output power with extremely low harmonic distortion. Such performance was achieved in the past only with mechanical step attenuators. The benefits for the customer are clear: very short setting times without any wear and tear.

YIG oscillator.



Frequency divider on evaluation board.



GaN switch.

GaN power amplifier.

Effective debugging of USB 3.1 and PCIe interfaces

The 6 GHz R&S®RTO oscilloscope measures fast digital interfaces, including USB 3.1 Gen 1 and PCIe 2.0, at data rates of up to 5 Gbit/s. This makes it ideal for testing the signal integrity of high-speed data lines as well as for debugging at the protocol level.

Clear trend: integration of fast communications interfaces

Growing data volumes and continually increasing processing and transmission speeds represent major challenges for board designers. The most widely used fast data interfaces are the DDR memory interfaces (DDR2, DDR3 and DDR4, including the low-power variants) and the USB and PCI Express (PCIe) serial communications interfaces.

USB is now used everywhere, with applications ranging from standard PC and consumer electronics to automotive, industrial and medical technology. The USB interface not only offers higher data rates of 5 Gbit/s for the USB 3.1 Gen 1 (SuperSpeed) standard and 10 Gbit/s for the Gen 2 (SuperSpeed+) standard, it also has improved power supply and charging functionality thanks to the USB Power Delivery specification. Another key innovation is the uniform connector. The USB Type-C™ slim plug can be connected in any orientation and is suitable for mobile devices. It features fast data rates, handles up to 100 W (5 A and 20 V power delivery modes) and even supports DisplayPort and Thunderbolt.

The PCIe interface is also enjoying more widespread use. Originally developed for the computer industry, it is now found in many embedded applications for connecting auxiliary devices and components to the CPU or for converting from USB or UART to PCIe. The powerful PCIe 4.0 (Gen 4) is nearly ready for introduction and offers a maximum data rate of 16 GT/s. However, embedded applications are adequately served by the first and second generation interfaces, which operate at 2.5 GT/s and 5 GT/s respectively. Each new interface generation generally supports the operating modes of earlier generations. That is why devices frequently boast Gen 2 or Gen 3 interfaces yet operate at the first generation's maximum data rate of only 2.5 GT/s during dedicated operation and must be tested accordingly.

Challenge: signal integrity

Secure data transmission via a digital serial interface such as USB or PCIe relies on error-free transmission of binary signals in the physical layer. The key components in the transmission chain are the transmitters, transmission line and receivers. Developers must ensure that signals in these components comply with the relevant interface standards.

In practice, the challenge lies primarily in the board design. On the one hand, the signal integrity of the transmission line has to be considered because the plugs, vias and relays, for example, could affect the transmission of signals over PCB lines or cables. On the other hand, the fast data interface must be protected against interference from nearby components. Adjacent signal lines that lie too closely together, for example, could result in crosstalk even though USB and PCIe use differential signaling.

In most cases, transmitters and receivers are standard components whose specifications have been tested by the manufacturer. However, this does not rule out faults in the wiring or problems with the quality and stability of the reference clock or the power supply, which is why these must also be tested during board development.

Using eye diagrams and histograms to ensure signal integrity

Displaying the digital signal in an eye diagram is an effective way of assessing the signal quality. The signal bits are written separately on top of each other and accumulated into a diagram. A typical eye diagram is a result of the many bit transitions from 0 to 1 and 1 to 0 (Fig. 1). A number of quality parameters for a signal transmission can be determined from the diagram. For example, the horizontal axis shows the eye opening over time and the jitter at the sides of the eye (bit transitions) while the vertical axis shows the vertical eye opening and noise.

USB and PCIe interface standards define masks for eye diagram tests that make it easy to assess whether the minimum required eye opening for reliable data transmission is provided. Fig. 2 shows an example from the PCIe CEM Gen 2 specification at a data rate of 2.5 Gbit/s.

Histograms enable circuit designers to identify valuable details about jitter distribution and amplitude noise by observing the bit transitions horizontally and the eye center vertically. An example measurement using the 6 GHz R&S®RTO oscilloscope is shown in Fig. 3. The test signal comes from a PC plug-in board with a PCIe Gen 2 interface (2.5 GT/s mode). The R&S®RTO acquires waveforms much faster than other instruments on the market. It can acquire several million bits

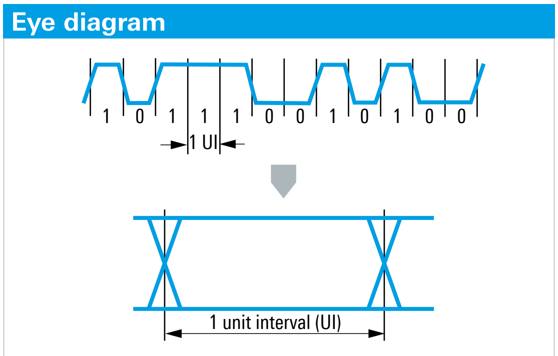
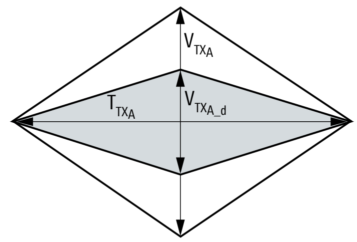


Fig. 1: Eye diagram of a data signal (UI = 1/data rate).

Definition of an eye mask



Parameter	Min.	Max.	Unit
V_{TXA}	514	1200	mV
V_{TXA_d}	360		mV
T_{TXA}	287		ps

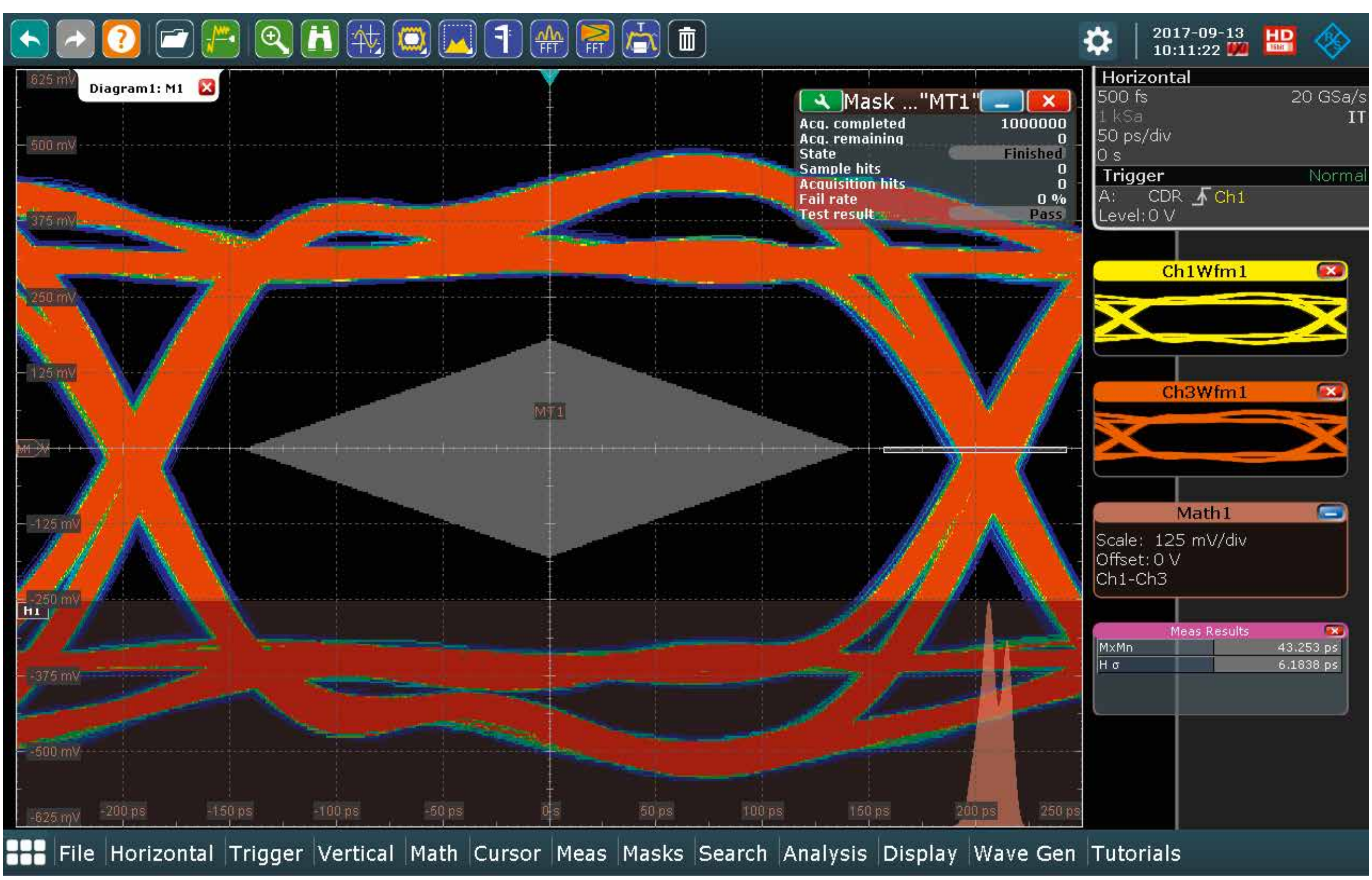
Fig. 2: Eye mask from the PCIe 2.0 specification (2.5 GT/s mode).

within seconds and use them to display the eye diagram. The color coding for persistence makes it possible to see both frequent and rare signal sequences. A mask is positioned at the center of the eye as defined in the PCIe specification. The software acquires violations of the eye pattern and shows details such as the number of acquired waveforms, mask violations and error rates. In the histogram, a Gaussian jitter distribution can be seen on the right edge of the eye. The histogram is also good for other measurements such as peak-to-peak jitter (max.-to-min.) and RMS jitter (standard deviation).

CDR trigger for fast eye diagram tests

A time reference is required in order to correctly overlay the bit sequences for the eye diagram. In addition to transmitting data, parallel data interfaces such as the DDR memory interface also transmit a clock signal that defines the precise start and end times for the transmission of each data bit. Serial data buses such as USB or PCIe embed the reference clock in the data signal. The receiver has to use clock data recovery (CDR) to extract the embedded clock. It then uses the extracted clock signal to sample the incoming data stream.

Fig. 3: Eye diagram of a signal as specified in PCIe Gen 2 (2.5 GT/s), including mask test and histogram; measured with an R&S®RTO2064 oscilloscope.



CDR uses a regulating component such as a phase-locked loop (PLL) or delay-locked loop (DLL) to follow frequency variations – typically less than 1 MHz up to 10 MHz. While this ability to flatten out frequency variations is excellent for stable data transmission, it makes testing more difficult. The traditional approach of using the test instrument's clock as the reference reduces the test margin and can even make testing impossible. Some standards also use frequency modulation, such as the spread spectrum clocking used by PCIe (~30 kHz triangular modulation), to reduce electrical emissions.

For all of these reasons, it is necessary to take the behavior of the receiver's CDR into consideration in order to successfully test embedded clock signals. R&S®RTO users are a step ahead here because the oscilloscope uses the R&S®RTO-K13 hardware CDR option to display the eye diagram. Its behavior with respect to PLL order, bandwidth and damping can be configured to test in line with different protocol specifications that describe the receiver's CDR in detail (Fig. 4). With this hardware CDR option, the clock signal extracted from the CDR is used as the trigger source (Fig. 5), effectively ensuring that the data bits are synchronized with the embedded clock signals. With a UI offset of 0.5, the trigger point in the center of the eye is configurable (Fig. 4).

Thanks to the R&S®RTO oscilloscope's high acquisition rate of up to 1 million waveforms per second, the hardware CDR can very quickly overlay a large number of data bits to produce an eye diagram so that the results have a high statistical reliability. Traditional software CDR analysis is performed during postprocessing of the individual waveforms and is therefore more time-consuming. Another advantage of the R&S®RTO solution is that its hardware CDR runs continuously with consistent behavior across all waveform acquisitions. In contrast, the PLL algorithm of a software CDR must restart with each acquisition, rendering the samples at the start of the waveform unusable.

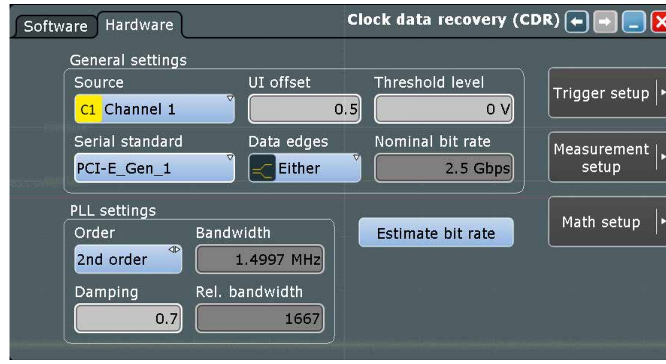


Fig. 4: The R&S®RTO oscilloscope's configurable hardware CDR.

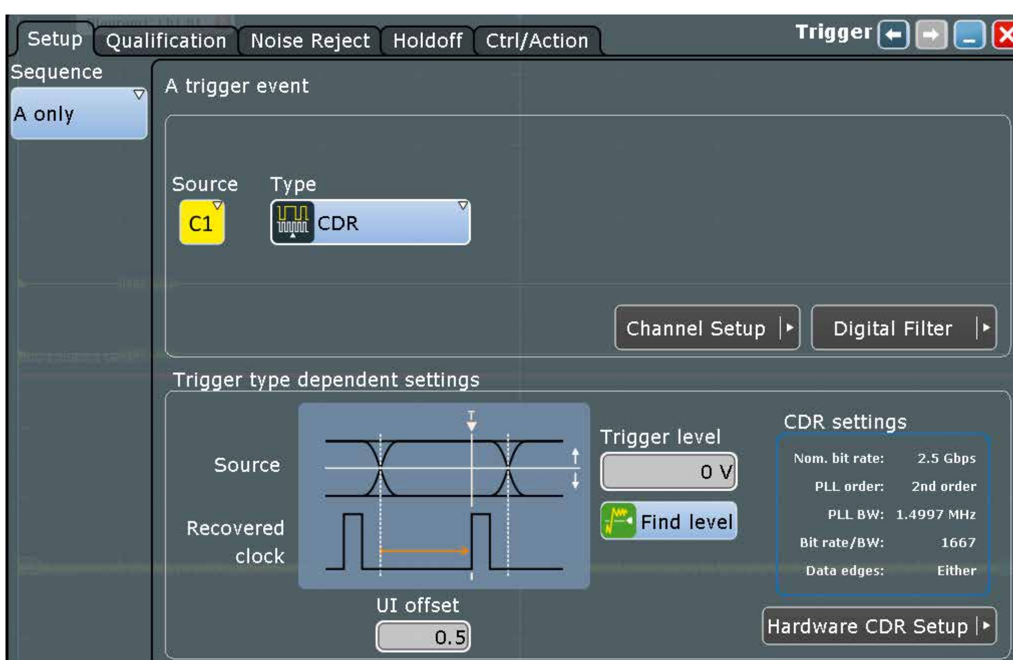


Fig. 5: Selecting the CDR as the trigger source when using the R&S®RTO-K13 hardware CDR option.

Preventing contacting errors

Correct probe contacting is key to obtaining reliable results when measuring fast signals. The modular probes from Rohde & Schwarz, such as the R&S®RT-ZM broadband probe, provide a variety of tip modules to support different contacting methods (Fig. 6). The most common method is to solder-in a tip module (Fig. 7). For all methods, the contacts should be kept as short as possible to minimize additional inductance and capacitance. This also applies for soldered connections; the solder contacts should not exceed two to three millimeters in length.

Fast data interfaces primarily use differential lines for signal transmission. A differential probe is used to tap the two V_P and V_N signals. An additional ground connection is highly recommended to ensure a stable and reliable test environment with minimal parasitic effects and a good common mode rejection ratio (CMRR) [*].

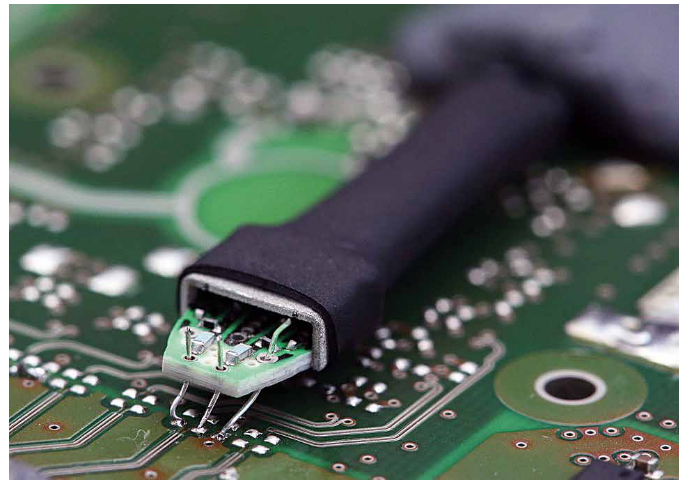
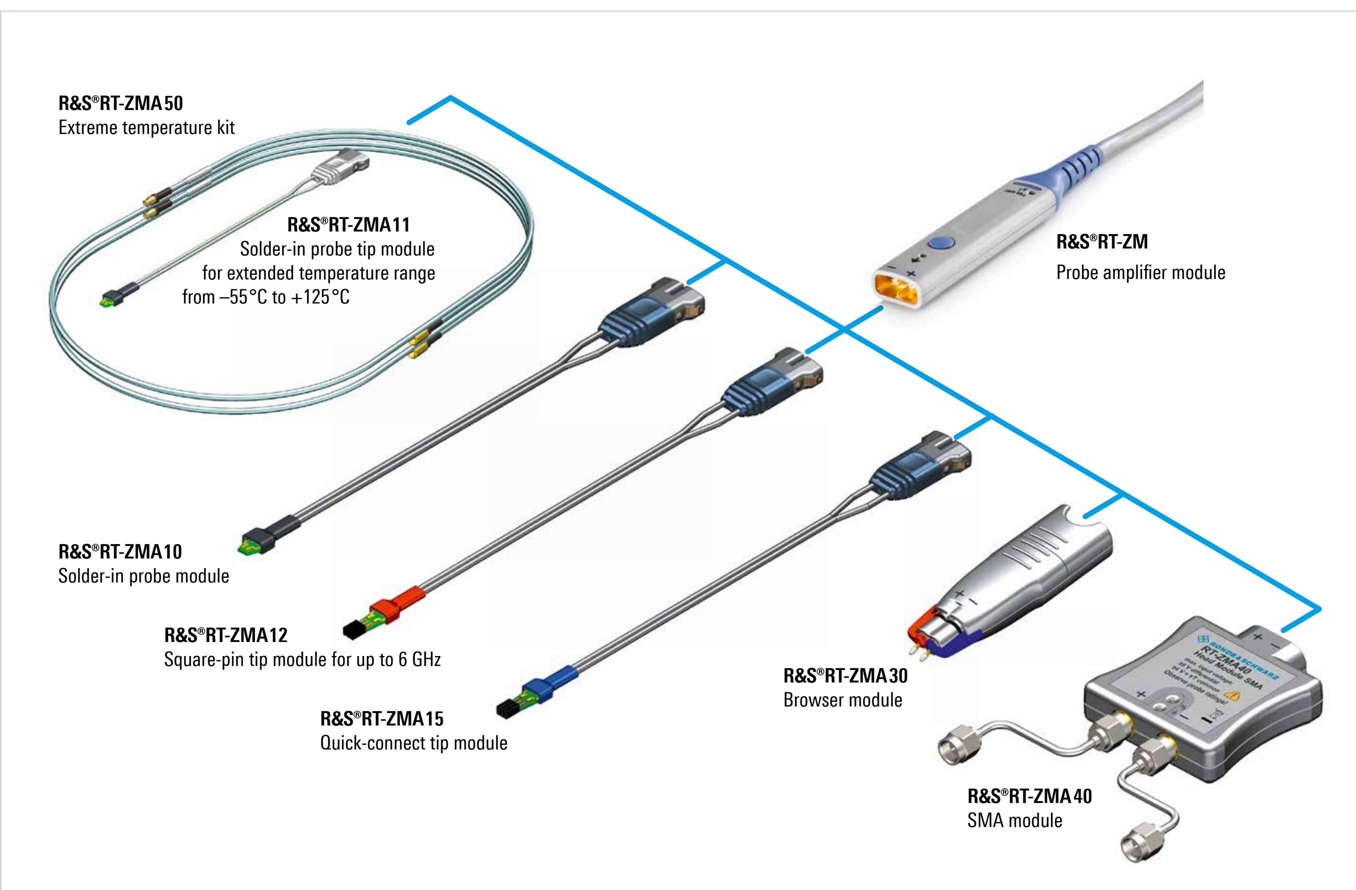


Fig. 7: Using the R&S®RT-ZMA10 solder-in tip module to contact a high-speed interface.

Fig. 6: Selection of tip modules for the R&S®RT-ZM modular broadband probe.



If the R&S®RT-ZM broadband probe is connected to the V_P and V_N signals and also to ground, the oscilloscope's multimode functionality allows users to easily switch from a differential measurement to a single-ended measurement at V_P and V_N or to directly measure the common mode voltage without having to change the connection (Fig. 8).

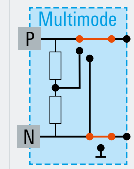
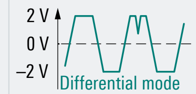
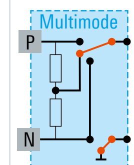
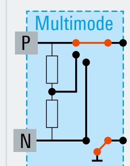
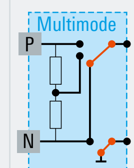
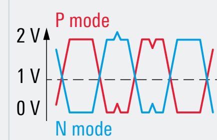
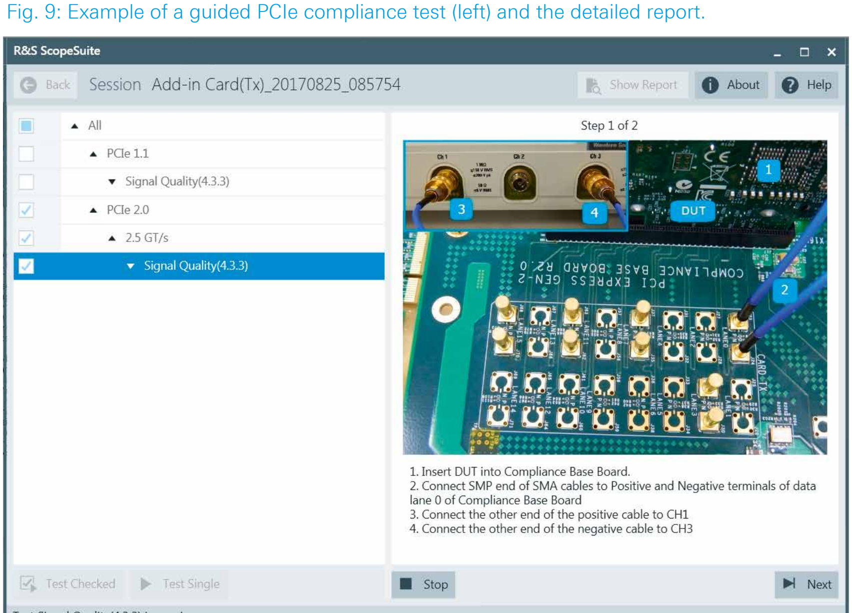
Measurement mode			Description
Differential mode (DM)			Voltage between P pin and N pin: $V_{DM} = V_P - V_N$ 
Common mode (CM)			Average signal voltage between P and N pins and ground: $V_{CM} = \frac{V_P + V_N}{2}$ 
Single-ended mode	Single-ended P 	Single-ended N 	Voltage between P pin or N pin and ground 

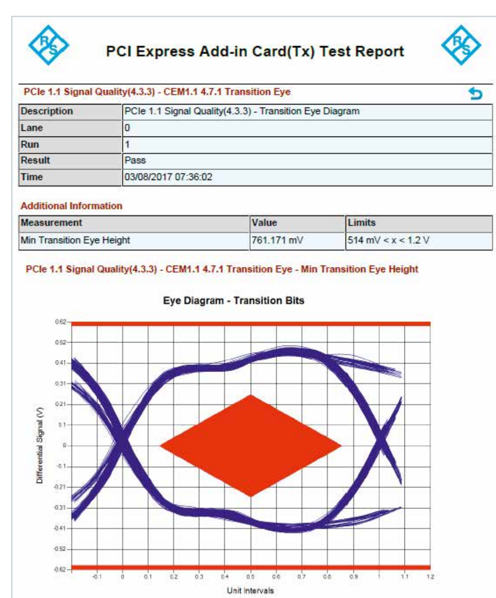
Fig. 8: The R&S®RT-ZM broadband probe's multimode configurations.

Compliance tests for USB and PCIe

Standardization committees such as the USB Implementers Forum (USB-IF) and PCISig define compliance tests for their data interfaces. For signal integrity measurements, these tests typically require that the oscilloscope bandwidth cover the fifth harmonic of the data signal. In the case of a high-speed USB data signal at a data rate of 480 Mbit/s, for example, a suitable oscilloscope would need a minimum bandwidth of 1.2 GHz (480 Mbit/s is equivalent to 240 MHz, which is multiplied by 5). The R&S®RTO with 6 GHz bandwidth supports compliance tests up to a maximum data rate of 2.5 Gbit/s. For such tests, Rohde & Schwarz offers software options that guide users through the measurements and then output the results in a report (Fig. 9). The R&S®RTO-K24 option is available for USB 2.0. The R&S®RTO-K81 option covers PCIe compliance tests for interface generations 1 and 2 up to a maximum data rate of 2.5 Gbit/s.

Fig. 9: Example of a guided PCIe compliance test (left) and the detailed report.





PCI Express Add-in Card(Tx) Test Report

PCIe 1.1 Signal Quality(4.3.3) - CEM1.1 4.7.1 Transition Eye

Description	PCIe 1.1 Signal Quality(4.3.3) - Transition Eye Diagram
Lane	0
Run	1
Result	Pass
Time	03/08/2017 07:36:02

Additional Information

Measurement	Value	Limits
Min Transition Eye Height	761.171 mV	514 mV < x < 1.2 V

PCIe 1.1 Signal Quality(4.3.3) - CEM1.1 4.7.1 Transition Eye - Min Transition Eye Height

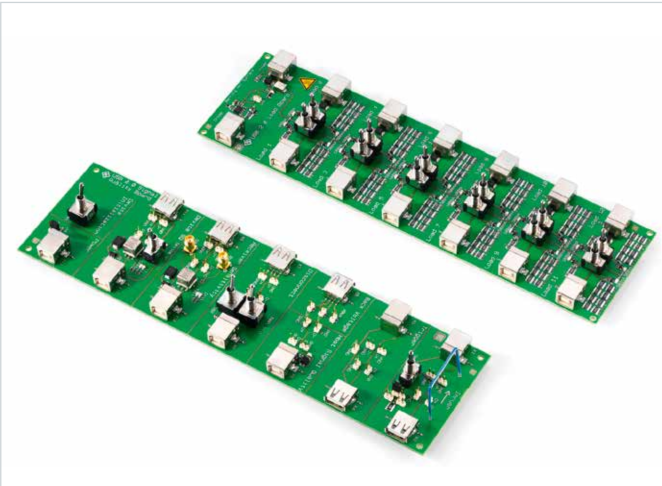


Fig. 10: USB 2.0 test fixture set from Rohde & Schwarz.

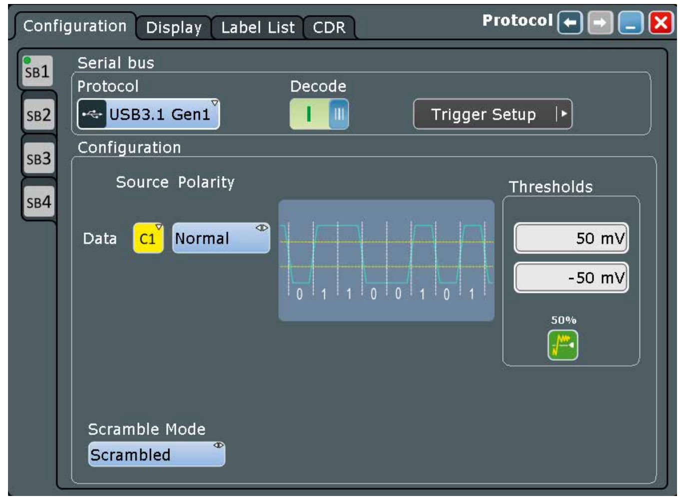


Fig. 11: Configuration dialog when using the R&S®RTO-K61 option to decode USB 3.1 Gen1.

During compliance testing, test fixtures are used to contact the DUT. For USB 2.0 tests, Rohde & Schwarz offers the R&S®RT-ZF1 test fixture set (Fig. 10) which supports the various test environments and provides suitable contacting for high-speed and legacy tests for USB devices, hubs and hosts. The high-speed signal quality test additionally requires the "USB 2.0 hi-speed signal quality test fixture" set, which is available only from USB.org.

Certified test fixtures for PCIe are generally available only from the PCISig consortium, both for testing PCIe motherboards (PCI Express compliance load board – CLB) and testing add-in cards (PCI Express compliance base board – CBB). The CLB/CBB test fixtures are available for each PCIe generation. The later generation fixtures support the earlier generations.

Using protocol triggering and decoding to debug during startup

For circuits with USB or PCIe interfaces, it is important to check the signal integrity and analyze the protocol data. Typically, errors often occur when establishing the interface connection between the transmitter and receiver and when receiving faulty data. Serial interfaces such as USB and PCIe run through a handshake procedure when establishing the connection. During this procedure, the two transmission partners report their capabilities regarding data rate, etc. and agree upon suitable transfer functions.

A protocol decoding option for the R&S®RTO oscilloscope allows developers to acquire and assess these sequences in detail. Targeted triggering on individual protocol elements makes it possible to acquire data from other interfaces and function blocks and to analyze their timing.

An example is a protocol analysis of a USB 3.1 Gen1 interface using the R&S®RTO-K61 trigger and decoding option. Fig. 11 illustrates how easy it is to configure the decoding. The user selects the channel and polarity of the differential signal (very important if the signal needs to be inverted because the probe was soldered in backwards) and then simply ensures that the switching thresholds for the logical one and zero lie correctly in the center of the data signal in order to provide reliable decoding results. The software defines the PLL configuration for the CDR based on the relevant USB standard. Using the extracted embedded clock signal as the reference clock, the software defines the bit and word boundaries for each waveform acquisition in order to decode the data.

An example result is shown in Fig. 13. The top of the screenshot shows data bursts with zoomed details. The decoding is shown in the center of the screenshot with zoomed protocol details. The individual protocol elements are color-coded for easier readability. Protocol data can also be listed in a table. Additional protocol details are available for each data frame.

It is also possible to trigger on protocol details. As shown in Fig. 12, the user can select many different protocol elements, including frame start, frame contents and frame errors, as the trigger type. Through targeted triggering on individual protocol elements, data from other interfaces and function blocks can be acquired time-correlated and then analyzed. This is how cross-interference from other functional units such as serial interfaces, analog sensors, radio interfaces, power supplies, etc. can be detected in densely packed embedded designs. Rohde & Schwarz oscilloscopes support this type of complex debugging with their multi-domain capability. The oscilloscope's traditional time domain analysis functionality is combined with additional protocol, logic and spectrum analysis functions and even function and pattern generators – all in a single instrument.

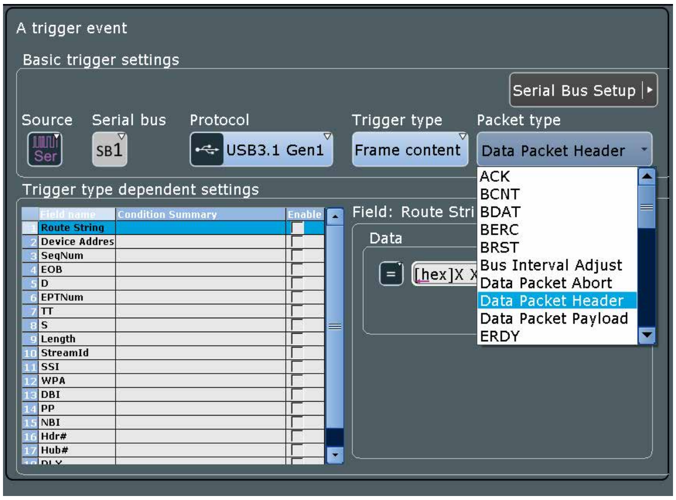


Fig. 12: Configuring the trigger type to be a data packet header in line with USB 3.1 Gen 1.

Summary

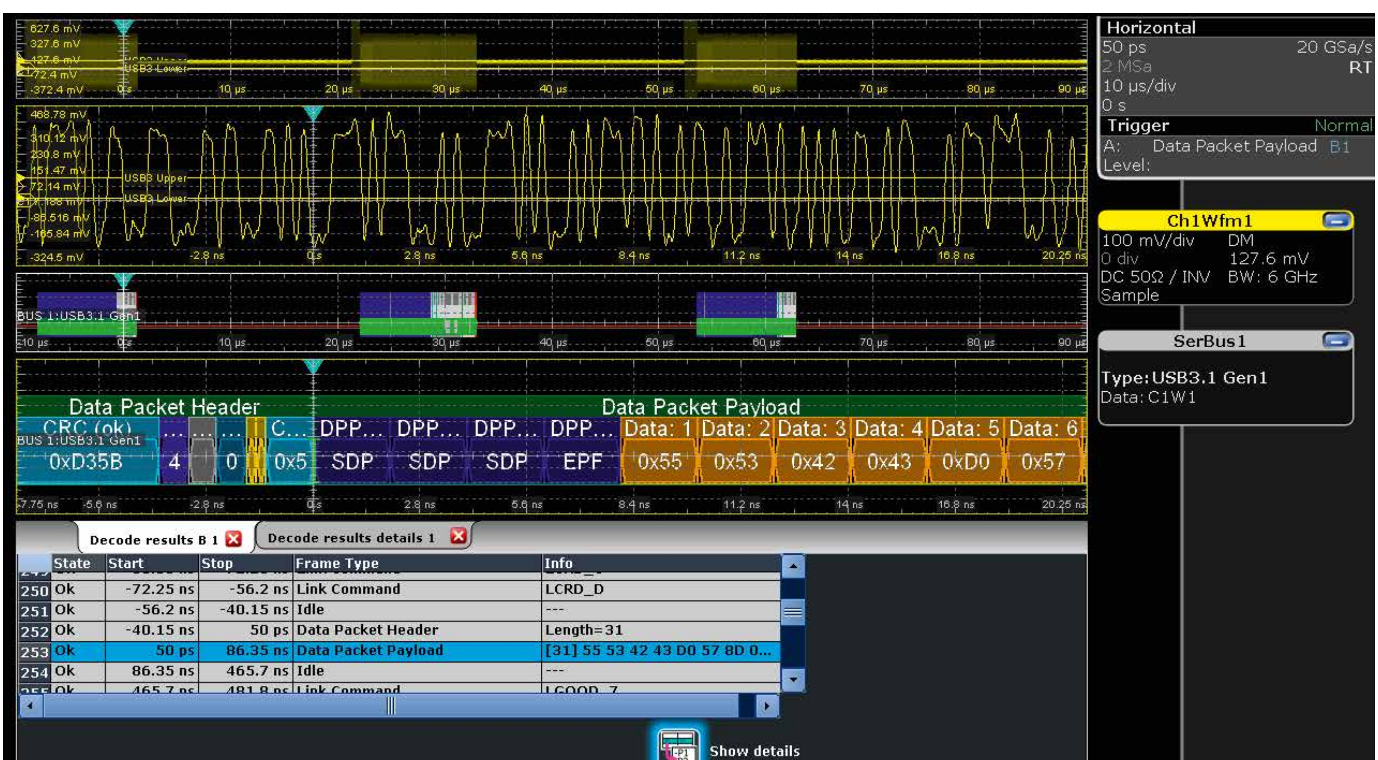
The integration of fast data buses presents new challenges for circuit developers during design and testing. Rohde & Schwarz offers a compact test solution consisting of the 6 GHz R&S®RTO and modular broadband probes to support users when debugging signal integrity problems and analyzing protocol data. The high acquisition rate combined with powerful analysis tools such as mask tests and histograms plus a variety of options such as hardware CDR and protocol triggering/decoding lead to fast results.

Guido Schulze

References

* Application Card "Optimized differential measurements on high-speed interfaces".

Fig. 13: Example of data decoding in line with USB 3.1 Gen 1.



New probe helps minimize power consumption of wireless devices

Modern oscilloscopes offer just about everything an electronics designer needs: large bandwidths, automatic digital protocol decoding and a broad range of analysis capabilities. However, these instruments are reaching their limits when it comes to optimizing the power consumption of IoT modules or measuring very small signals. The R&S®RT-ZVC multi-channel power probe solves this problem.

Long battery life is a key convenience feature in mobile devices, Internet of Things (IoT) modules and wearables. To minimize power consumption, many of these products are optimized for very low quiescent currents; they consume additional power only during periods of activity, which are typically short. A very high dynamic range is therefore required to measure the total power consumption. Often, multiple measurement channels are needed since the various modules used in the electronic circuits of complex products are active at varying times. The R&S®RT-ZVC02/04 multi-channel power probe addresses these applications and can additionally measure signals in the microvolt range.

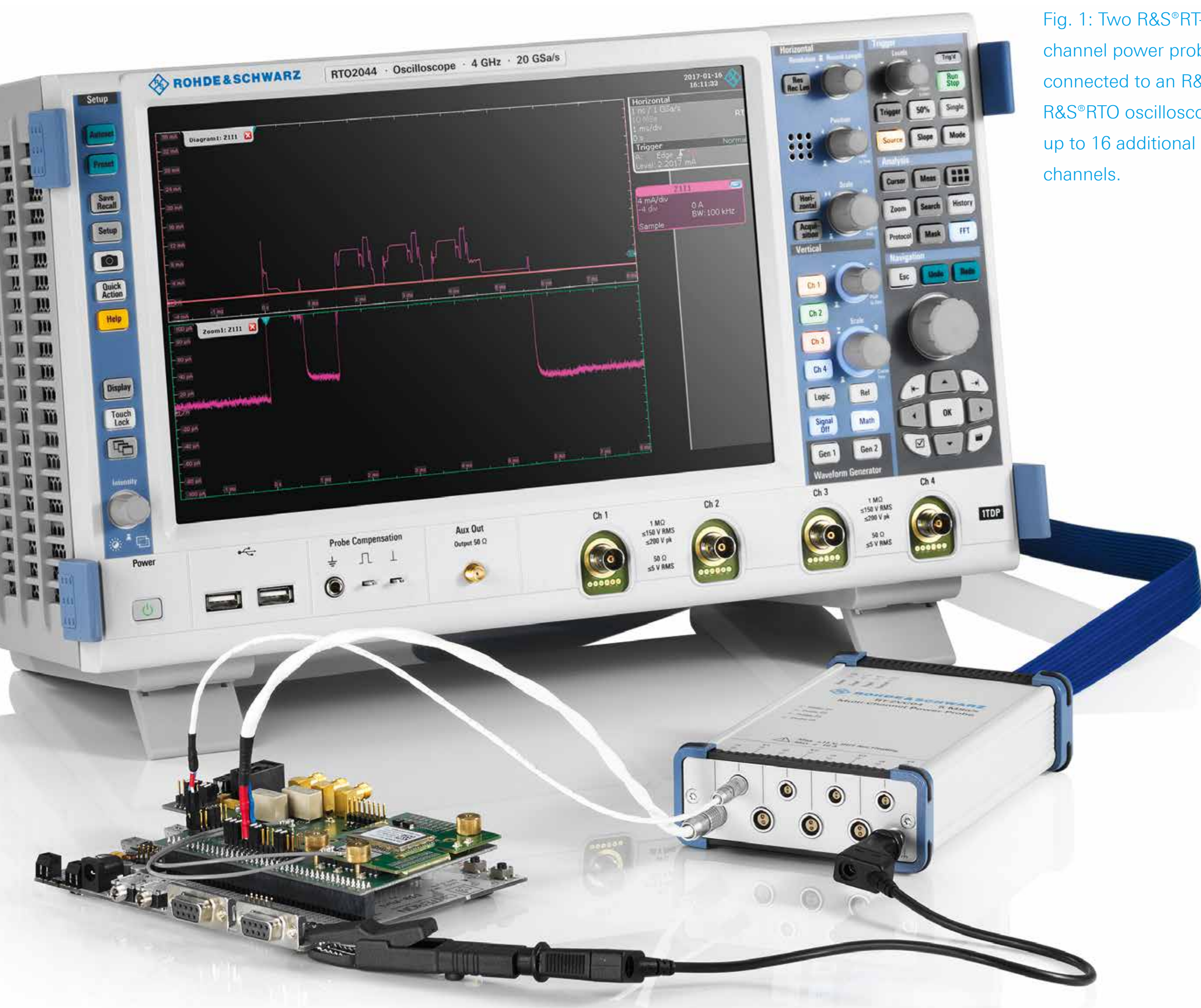


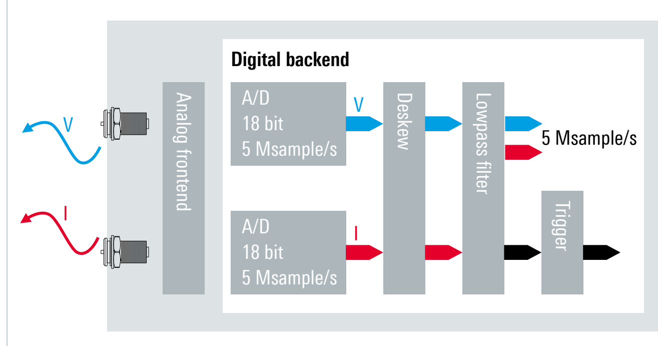
Fig. 1: Two R&S®RT-ZVC multi-channel power probes can be connected to an R&S®RTE or R&S®RTO oscilloscope to provide up to 16 additional measurement channels.

Highly sensitive acquisition system with 18-bit resolution

The R&S®RT-ZVC 02/04 multi-channel power probes (Figs. 1 and 2) comprise an acquisition system with a very high dynamic range for measuring up to four currents and four voltages (Fig. 3). In each current and voltage channel, an 18-bit A/D converter acquires signals at a rate of 5 Msample/s at 1 MHz analog bandwidth. As a result, short current and voltage pulses are easily captured over a wide dynamic range. When measuring very small signals, a variable, digital low-pass filter can be activated to reduce system noise.

Measured data is transferred to an R&S®RTE or R&S®RTO oscilloscope via the digital logic interface and displayed time-synchronously with the analog channels. Nearly all of the oscilloscope's measurement and analysis functions are also available for use on the R&S®RT-ZVC channels. A trigger unit integrated into the probe allows triggering on any input signal.

Digital acquisition system



Current measurement ranges

	Shunt
±4.5 µA; ±45 µA	10 kΩ
±4.5 mA; ±45 mA	10 Ω
±4.5 A; ±10 A	10 mΩ
±45 mV; ±450 mV (depending on shunt value)	external

Voltage measurement ranges

±1.88 V
±3.75 V
±7.5 V
±15 V

Fig. 3: The R&S®RT-ZVC probe's digital acquisition system provides 18-bit resolution, a 5 Msample/s sampling rate and 1 MHz bandwidth. Each voltage and current input pair forms a high dynamic range power measurement system.

Internal and external shunts for current measurement

Three switchable built-in shunts provide full-scale current measurement ranges from 4.5 µA to 10 A (Fig. 3). The probe has differential inputs. Each input can operate at any potential within ±15 V. The shunts are fully calibrated and exhibit a measurement uncertainty as low as 0.2 %.

For full flexibility, designers can also use an external shunt, which should ideally be integrated in the test design right from the start. External shunts are supported by a dedicated operating mode and make it possible to tailor the measurement range to the actual application. Switchable gain factors provide additional flexibility with respect to the measurement range.

Fig. 2: The R&S®RT-ZVC is available with 2 × 2 and 2 × 4 channels.

Example: optimizing the battery life of IoT modules

Minimizing power consumption during the design of electronic modules and devices has become a quality-critical issue. A long battery life is crucial especially in the IoT domain, but also for medical equipment, consumer electronics such as radio headphones, and building automation products such as smoke detectors. Many of these devices typically have long quiescent phases with very low power consumption, alternating with periodic, often very brief active phases with medium or high power consumption (Fig. 4).

To minimize the average total power consumption of such devices, it is necessary to measure their power consumption during both the quiescent and the active phases. This is where the R&S®RT-ZVC multi-channel power probe comes into play. Its high vertical resolution and optional lowpass filtering deliver a very wide dynamic range. In conjunction with the broad range of measurement functions provided by modern oscilloscopes, a wide variety of analyses can be carried out. Typical measurements include average power consumption during quiescent phases and total power consumption during phases of activity (Fig. 5). The expected battery life can easily be determined based on this data.

Typical power consumption of IoT modules

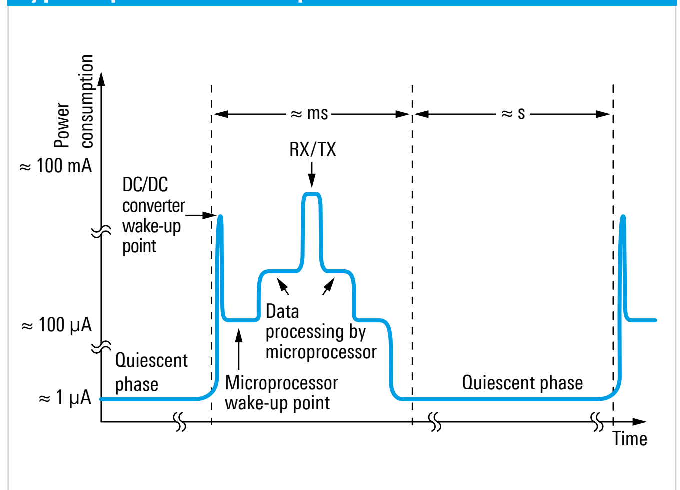
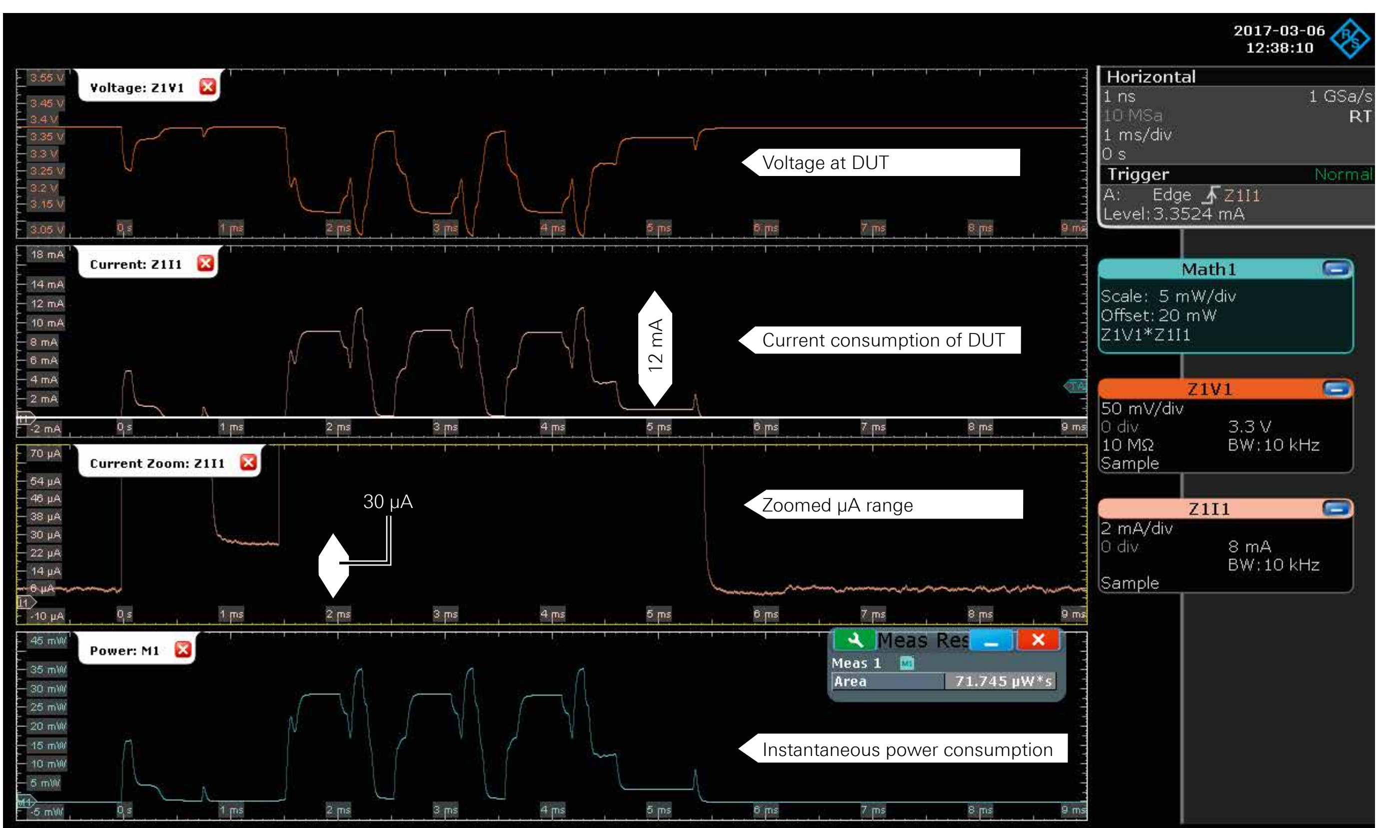


Fig. 4: The power consumption measured on an IoT module typically exhibits long quiescent phases with very low power consumption and brief phases of high power consumption.

Fig. 5: The R&S®RT-ZVC probes provide a very high dynamic range, allowing a module's current consumption to be measured in active and quiescent condition, in this example 12 mA and 30 µA.



In the case of complex mobile devices such as cell phones or tablets, power consumption can be further reduced by disconnecting modules temporarily not needed from the power supply and activating them only when necessary. Each R&S®RTE and R&S®RTO oscilloscope supports two R&S®RT-ZVC probes, allowing current and voltage signals to be measured at eight points in parallel. The standard oscilloscope channels remain available for acquiring control signals. In this way, the power consumption of individual modules of a complex electronic system can be measured and correlated with control signals and serial control protocols.

Example: measuring very small signals

When the probe is operated with an external shunt, the current measurement input turns into a highly sensitive voltmeter. This operating mode yields the highest sensitivity, with 18-bit resolution at ±45 mV full-scale input voltage. This makes it possible to measure very small signals with low noise and high sensitivity. Fig. 6 shows a cardiac signal pulse with a voltage as low as 200 µV (V_{pp}), which the probe acquires easily with low noise.

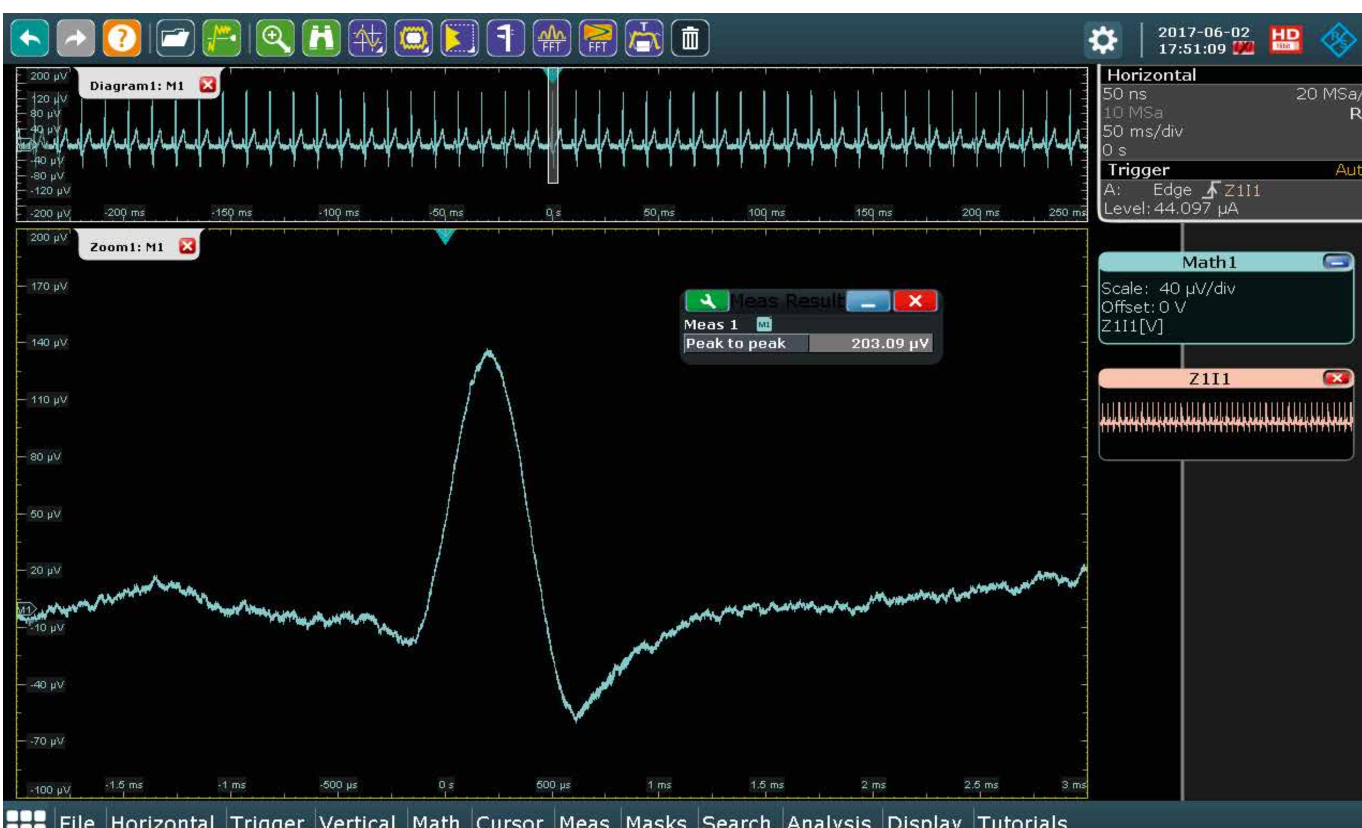
Flexible connectivity options

The probe comes with a high-quality, shielded cable for each channel along with a set of solder-in cables and pins. Optionally available are 4 mm connector cables of different lengths as well as BNC connector cables for standard oscilloscope probes or current probes to extend the input voltage and current measurement ranges.

The R&S®RT-ZVC multi-channel power probe is available for the R&S®RTE and R&S®RTO oscilloscopes along with a model for use in combination with an R&S®CMW500 protocol tester. In configurations with an R&S®CMW500, it is possible to correlate wireless protocols with application software running on IoT devices. This means that designers can use a single power probe for oscilloscope measurements during embedded system design and subsequently for analyzing and optimizing the power consumption of these systems when developing IoT system applications.

Dr. Markus Herdin

Fig. 6: Operating the probe with an external shunt turns the current measurement input into a highly sensitive voltmeter. As a result, even very small signals such as a 200 µV cardiac pulse can easily be measured.



Switch and conquer

For years, the R&S®OSP open switch and control platform has offered an elegant and versatile solution for dynamically connecting RF sources and loads. New switch modules target the upper microwave range, where wireless communications and radar applications continually unlock new frequency bands.

When working with RF test systems, it is often necessary to interconnect components under software control to meet the requirements of a given situation. The R&S®OSP open switch and control platform has performed these tasks reliably for years. It is available with or without front panel controls and display and can be enhanced with a 19" extension unit to carry out arbitrarily complex switch and control tasks. Rohde & Schwarz now offers a new addition – a compact satellite unit that performs switching tasks close to the DUT (Fig. 1). Figs. 2 and 3 provide an overview of the currently available RF coaxial relay modules that can be integrated into the platform.

Ever higher, ever more versatile

Next generation wireless communications technologies such as 5G as well as radar applications are moving into ever higher frequency ranges, and RF switches follow this trend. New modules for the R&S®OSP platform target the upper microwave range. Particular importance currently attaches to the 5G range around 39 GHz, which is covered by various types of relays up to 40 GHz (Fig. 2). The 50 GHz and 67 GHz modules are ideal when higher frequencies are needed or to address other types of applications. The 6-pole 50 GHz relay is a global first. Unlike competitor models, it is a true SP6T multiposition relay, where all ports have identical RF parameter values. The 50 GHz and 67 GHz relays use higher-quality materials and are produced in smaller quantities, which is reflected by their price.

The R&S®OSP-B133 N (f) SP6T multiposition relay extends the company’s existing portfolio up to 12.4 GHz and switches power levels as a function of frequency, e.g. up to 700 W (1 GHz) and 200 W (12.4 GHz). The relay increases the flexibility of systems using N connections and can, for example, connect a generator to multiple, different amplifiers in EMC test systems. The R&S®OSP-B133 is considerably larger than the previous multiposition relays with SMA connectors, so

	Type	0 Hz	9 kHz	to →	6 GHz	8 GHz	10 GHz	12.4 GHz	18 GHz	40 GHz*	50 GHz**	67 GHz**
Solid-state relays (SSR)	SPDT		6 × SPDT, 1 W: **R&S®OSP-B107**									
			6 × SPDT, 1 W, terminated: **R&S®OSP-B127**									
	DP3T		3 × DP3T, 10 W, terminated: **R&S®OSP-B142**									
	SP6T		3 × SP6T, 1 W, terminated: **R&S®OSP-B128**									
Electro-mechan-ical relays	SPDT	3 × BNC + 3 × SPDT (N): **R&S®OSP-B106**; 2 × SPDT (N): **-B131**; 6 × SPDT (N): **-B132**										
	DPDT	2 × DPDT, failsafe: **R&S®OSP-B136**										
	SP6T	1 × SP6T, failsafe: **R&S®OSP-N133**										
	SPDT	latching: **R&S®OSP-B101 L**; failsafe: **R&S®OSP-B101**								**OSP-B111**	**OSP-B111 UL**	**OSP-B111 VL**
		terminated, failsafe: **R&S®OSP-B121**								**OSP-B121 H**		
	DPDT	failsafe: **R&S®OSP-B116**								**OSP-B116 H**		
	SP6T	latching: **R&S®OSP-B102L**; failsafe: **R&S®OSP-B102**								**OSP-B112**	**OSP-B112 UL**	
		terminated, failsafe: **R&S®OSP-B122**; failsafe: **R&S®OSP-B126**								**OSP-B122 H**		
	SP8T +	failsafe: **R&S®OSP-B119**										
	2 × SPDT	failsafe, terminated, SP8T: **R&S®OSP-B129**										
	SPDT +	failsafe, terminated, 6 × SPDT + 1 × SP6T: **R&S®OSP-B123**; 3 × SPDT + 2 × SP6T: **R&S®OSP-B124**										
	SP8T	6 × SPDT + 3 × SP6T: **R&S®OSP-B125**										
Connector type		**N**							**SMA**	2.92 mm	2.4 mm	1.85 mm

Fig. 2: Currently available R&S®OSP modules with RF coaxial relays (* failsafe; ** latching).

the R&S®OSP platform had to be modified. The module can therefore only be integrated into platforms manufactured in March 2017 or later.

Switch where you need it

The R&S®OSP130 (with front panel controls and display) and the R&S®OSP120 base units can be expanded via CAN bus with up to four R&S®OSP150 extension units. The extension units, which possess no control system of their own, can be used to enhance the base platform's functionality by adding

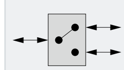
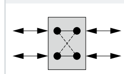
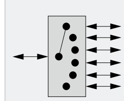
	Relay types
	**SPDT** (single-pole double-throw) changeover relay
	**DPDT** (double-pole double-throw) crossover or transfer switch)
	**SPnT** (single-pole n-throw) multiposition relay

Fig. 3: Basic RF relay types.

Fig. 1: R&S®OSP130 base unit with front panel controls and display together with the new R&S®OSP-B200S2 satellite unit.

more modules or to implement remote switching applications. However, the R&S®OSP150 19" enclosure is too large for some remote switching tasks. That is why Rohde & Schwarz developed the R&S®OSP-B200S2 satellite unit. It can perform less complex switch and control tasks directly at the DUT or the antennas and is also more favorably priced.

The satellite unit has two slots for connecting two single-width or one double-width module. The modules are remotely controlled from a driver module via a serial electrical bus cable or a fiber-optic link (FOL) (Fig. 4). The electrical cable can bridge distances of up to 10 m and also powers the satellite unit with 28 V operating voltage. In contrast, the fiber-optic link permits larger distances of up to 25 m and produces no electromagnetic radiation. It requires an external power supply on the satellite unit.

Gert Heuer

Possible combinations of R&S®OSP base, extension and satellite units

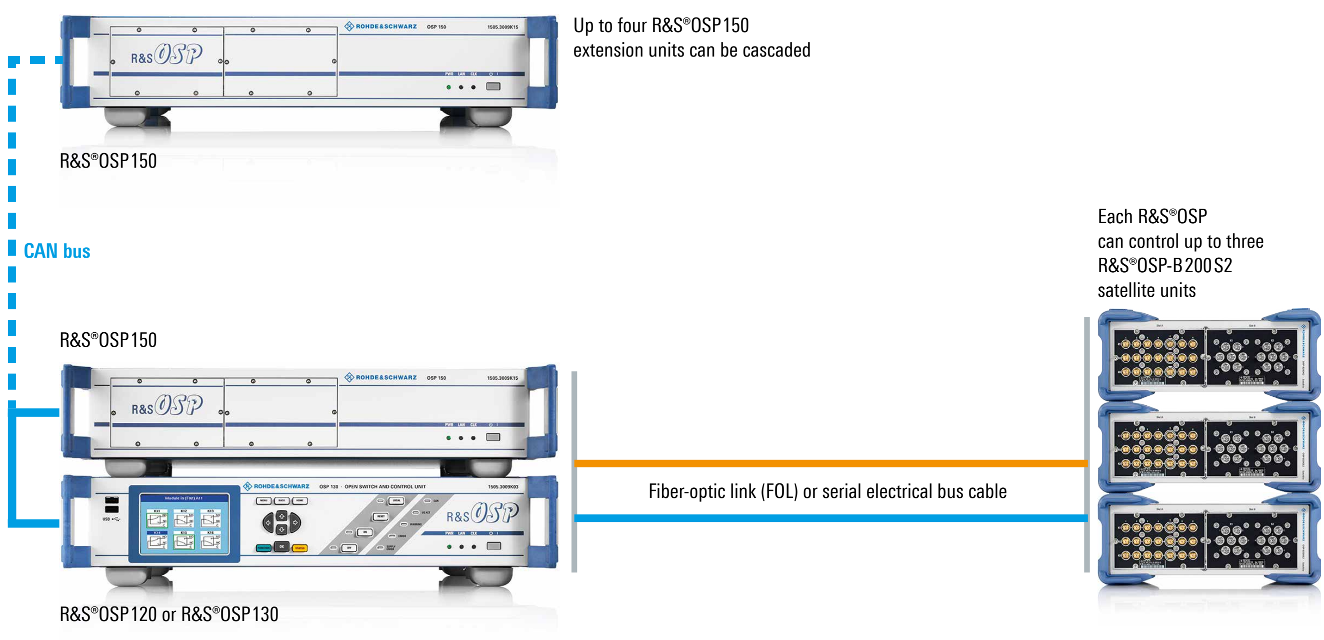


Fig. 4: Satellite units can be connected to an R&S®OSP base or extension unit to enable switch operations close to the DUT.

Modules with relays with N connectors: R&S®OSP-B131, R&S®OSP-B133, R&S®OSP-B136.

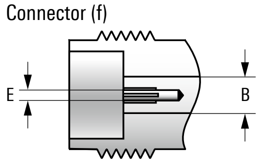
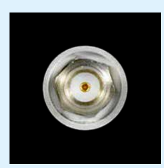
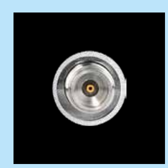
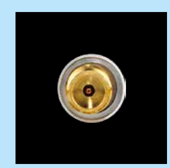
Common RF connector types

The optimal diameter of the dielectric insulator and that of the center contact (f) of the coaxial cable directly depend on the wavelength and consequently on the maximum cutoff frequency of the RF signal. As a result, different types of connectors are used, depending on the frequency and the switched average power.

BNC connectors are favorites for low-frequency signals; a BNC connector is also used in the R&S®OSP-B106 LF relay. N-type and 7/16 connectors are used to switch higher power levels.

For RF signals up to 18 GHz, SMA connectors with a diameter of 4.1 mm are commonly used. The 2.92 mm, 2.4 mm and 1.85 mm connectors for frequencies from 40 GHz to 67 GHz are based on the SMA (the millimeter value indicates the diameter of the dielectric insulator). These connectors offer partly compatible mechanical data, but differ with respect to their RF characteristics. The SMA (4.1 mm) and the 2.92 mm connectors have identical center contacts (f) and threads, but different dielectric insulator diameters; the same applies to the 2.4 mm and 1.85 mm connectors. The RF cable/connector combination must however always be selected to match the frequency range to be used.

It is important to note that the average power (cold switching) decreases drastically toward higher frequencies for all types of connectors.

Connector type		N	SMA	2.92 mm (K)	2.4 mm	1.85 mm (V)
Diameter of dielectric insulator (B)		7 mm	4.1 mm			
Frequency (GHz)	Cable	DC to 12.4 GHz (optionally to 18 GHz)	DC to 18 GHz	DC to 40 GHz	DC to 50 GHz	DC to 67 GHz
	Relay		DC to 18 GHz (optionally to 26.5 GHz)			
Connector (f) 						
Diameter of center contact (f) E		1.6 mm	0.92 mm		0.51 mm	
Thread		5/8-24UNEF-2A	¼-36UNS-2		M7 × 0.75-6	
Max. average power at max. frequency		e.g. 200 W (12.4 GHz)	100 W (18 GHz)	10 W	5 W	1 W
		e.g. 700 W (1 GHz)	40 W (26.5 GHz)			

mechanically compatible

Mechanical data and RF characteristics of different types of RF connectors (f).

New modules for 40 GHz and above: R&S®OSP-B111VL, R&S®OSP-B112UL, R&S®OSP-B116H.

In brief

S-parameter measurements as easy as ABC

Many network analysis applications focus solely on measuring S-parameters. The new, cost-effective R&S®ZNLE vector network analyzer makes S-parameter measurements as easy as ABC.

Only 24 cm in depth and weighing 6 kg, the new R&S®ZNLE vector network analyzer is the lightest and most compact instrument in its class (Fig. 1). In spite of its compact dimensions, the R&S®ZNLE includes a complete S-parameter test set for bidirectional two-port measurements on passive components, along with a 10.1" WXGA touchscreen. There is no need for an external PC to configure measurements. The R&S®ZNLE is a full-featured network analyzer that comes in two models for the frequency ranges from 1 MHz to 3 GHz (R&S®ZNLE3) and to 6 GHz (R&S®ZNLE6).

An automatic calibration unit makes calibration quick and easy. Wizards assist users both during calibration and when configuring measurements. This saves time, also when getting acquainted with the instrument features. Should any questions arise, a context-sensitive help menu provides detailed information about all instrument functions.

The simple, clearly structured user interface lets users arrange diagrams, traces and channels in any desired combination. The large touchscreen offers sufficient space for displaying multiple traces, which can be dragged and dropped as required. A multi-touch zoom function can be used to enlarge trace sections of interest, eliminating the need to change start and stop frequencies or level ranges. Instead of loading one setup at a time, several instrument setups can be loaded and kept in memory simultaneously. As a result, different measurement tasks can be handled faster.

Low trace noise is a prerequisite for stable, repeatable measurements. The R&S®ZNLE offers best-in-class performance of typically 0.001 dB at 10 kHz IF bandwidth. This excellent figure makes it possible to use larger bandwidths than conventional instruments, significantly accelerating measurements. Measurement time is just 9.6 ms for 201 points at 100 kHz bandwidth, with the instrument fully calibrated. Data transfer time during remote operation is virtually negligible, since the data measured during a sweep is transferred to the controller while the next sweep is in progress. Another highlight is the wide dynamic range of typically 120 dB.

The R&S®ZNLE offers embedding/deembedding functions for components that need to be tested on a board or in a test fixture.

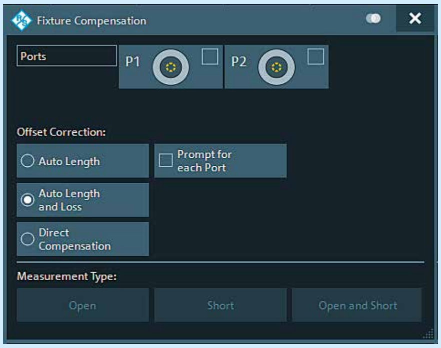


Fig. 2: Deembedding options provided by the R&S®ZNLE.

These functions compensate, for example, for feed lines, strip lines and similar. The "auto length and loss" and "fixture compensation" functions shift the calibration plane at the end of the coaxial cable toward the device under test (Fig. 2). If a DUT has to be characterized together with its matching network, the R&S®ZNLE can embed the DUT into a virtual matching network to provide real-world conditions. This is done using either a predefined matching network or a network defined in an *.s2p file.

Andreas Henkel

Fig. 1: The compact, lightweight R&S®ZNLE vector network analyzer measures S-parameters with ease and accuracy.

The night that brought sharper pictures

Overnight from March 28 to March 29, 2017, one of the biggest equipment upgrades in the history of German broadcasting took place. Anyone turning on their terrestrial television after this upgrade has enjoyed significantly better picture quality.

It is relatively rare for a major public infrastructure to be switched off from one moment to the next and immediately be replaced with a new infrastructure. However, this is exactly what happened in Germany this past March during the transition from digital terrestrial television (DVB-T) to the new DVB-T2 standard. The next morning, the old receivers were useless because the signals they needed were no longer available. Naturally, there was a huge information campaign well in advance of day X to inform the population about the change, ensuring that no one was taken by surprise. Least of all, of course, the companies involved since they had long been preparing for the transition – including Rohde & Schwarz, the main transmitter supplier. There was plenty of time to plan and prepare for the technology transition since the DVB-T2 transmitters were installed alongside the existing infrastructure.

The initial phase involved 69 locations that had to accommodate more than 400 new transmitters. Roughly 360 of these transmitters were supplied by Rohde & Schwarz. During the night leading up to March 29, the network operators deployed 200 technicians to manage the simultaneous startup of the new equipment. When broadcasting of the morning program started, DVB-T2 was on the air in Germany. Unlike the transition from analog to digital terrestrial television (DVB-T), which started in 2003 and took many years to complete, DVB-T2 coverage was immediately available in all of Germany's metropolitan areas. Expansion will take place in several steps until spring 2019 when the maximum configuration will be reached.

Rohde & Schwarz will supply R&S®THU9 liquid-cooled high-power transmitters and R&S®TMU9 air-cooled medium-power transmitters. Several different network operators are involved in the actual broadcasting. The private company Media Broadcast GmbH obtained all of its transmitters from Rohde & Schwarz. It broadcasts programs for private stations and the public station ZDF. The ARD broadcasting companies operate their own transmitters. They divided the procurement process into six batches. Rohde & Schwarz won the three batches with the largest coverage areas. Two R&S®AVHE100 headends from Rohde & Schwarz were also put into operation. One is used by a major ARD broadcasting company whose requirement specification presented the engineers with a very challenging task that could only be solved thanks to the flexibility of the software-based headend. The broadcaster in question broadcasts two regional programs that are largely identical with only some variations in the individual programming. Instead of broadcasting two complete, bandwidth-hungry programs, the identical parts of the program are broadcast once with different station IDs in the metadata, but with very high picture quality. Only when broadcasting of the regional programs starts are the channels separated with slightly higher picture compression. The transition had to be unnoticeable to the viewers.

The main reason for introducing DVB-T2 was to allow an upgrade to the HD format with its state-of-the-art picture quality. Germany has consistently followed this approach, becoming the first DVB-T2 country to use the best performing codec available (H.265/HEVC). This codec provides twice the compression of the usual H.264 standard with the same picture quality, or much better picture quality at the same data rate. To ensure equally good audio quality, the innovative Dolby Digital Plus is available as an audio option. Thanks to this combination of high-quality picture and sound engineering, Germany is currently the world leader in advanced broadcasting technology for DVB-T2.

Volker Bach

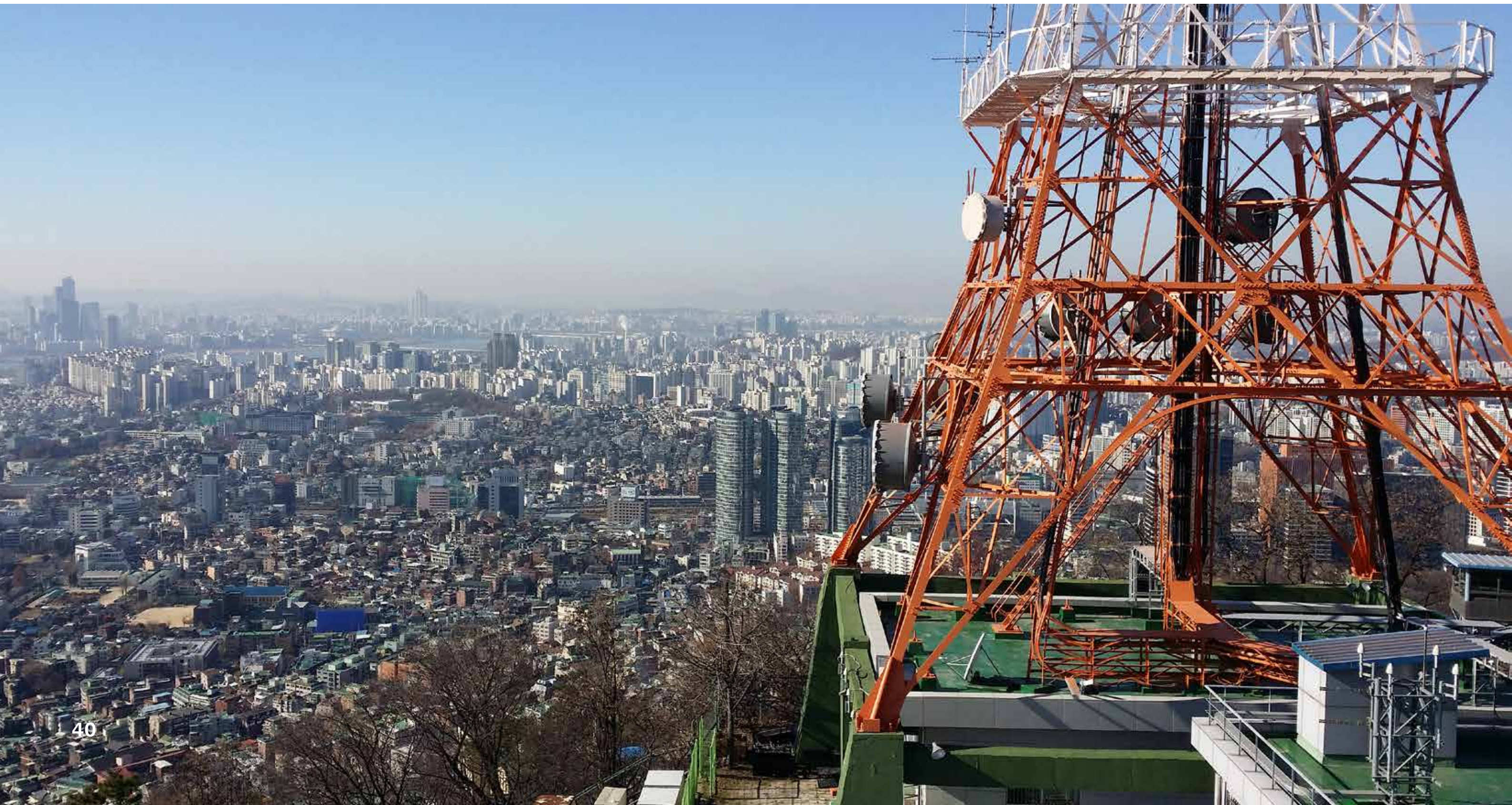
The powerful 60 kW transmitter system installed in the Munich Olympic Tower ensures the best DVB-T2 receiving conditions for the greater Munich area.

UHDTV and the Olympics

All large-format TVs sold in recent years are UHD-ready, but 4K program content is still hard to find. As the host country of the Olympic Winter Games 2018, South Korea is taking advantage of the occasion to launch a UHD campaign – and relying on transmitters from Rohde & Schwarz.

Like most countries, South Korea discontinued analog terrestrial television several years ago, and in late 2012 they migrated to digital broadcasting based on the ATSC standard. Since there were already signs of a UHD technology breakthrough back then, initially at the TV end (in large part due to the efforts of Korean manufacturers), the three terrestrial broadcast network operators – public broadcaster KBS and private broadcasters MBC and SBS – started transmitting trial UHD programs as early as 2014 in order to get acquainted with the technology and to see how well it worked in practice. Market surveys indicated that the tech-savvy Korean viewers definitely appeared to be ready for it. At that time, the only UHD-capable technology for terrestrial broadcasting was the DVB-T2 standard, which was already available in Rohde & Schwarz transmitters. These transmitters were therefore used for the trials. In the meantime, however, the ATSC standardization committees had defined version 3.0 to the point that implementation in products was imminent. The Korean state organizations that address this topic – the Next Generation Broadcasting Forum (NGBF) and the Telecommunications Technology Association (TTA) – ultimately opted for nationwide adherence to the ATSC family of standards and to implement an ATSC 3.0 network. From a performance perspective, there is not much difference between the ATSC 3.0 and DVB-T2 standards. They have similar spectral efficiency and allow the use of advanced video encoding. With a consistent focus on the Internet protocol (IP) in the baseband, however, ATSC 3.0 is the first IP-native broadcasting standard. Rohde & Schwarz has broken new ground in signal processing by developing the R&S®SDE900, the world's first IT server-based exciter (see box). It allows the full scope of the standard's flexibility to be utilized.

Fig. 1: Together with three other stations, the Namsan broadcasting station provides UHDTV coverage for the Seoul metropolitan area.



Seoul Broadcasting System (SBS) was not only the first South Korean broadcaster to employ the new broadcasting technology, it was the very first broadcaster ever to do so. At the kickoff, in December 2016 viewers could follow a short track speed skating World Cup competition via terrestrial reception in UHD quality, broadcast by an R&S®THU9 high-power transmitter located on Gwanak Mountain. Together with the three stations Namsan (Fig. 1), Yongmoon and Gwanggyo, which are also equipped with Rohde&Schwarz transmitters, the Gwanak transmitter provides single-frequency network (SFN) coverage in the Seoul region.

Whereas the first phase of the Korean UHD project focused on the Seoul capital region where about half of the fifty million residents live, the second phase aims to achieve 77 % coverage by the end of 2017, including the metropolitan areas of Busan, Gwangyu, Daegu, Daejeon and Ulsan and also the Olympic site. The goal is 90 % coverage by 2020. All three network operators are participating in this expansion and have opted for Rohde&Schwarz transmitters. The second phase is the installation of 27 transmitter systems in the 5 kW and 2 kW power classes in a customer-specific backup configuration. Everything has to be delivered quickly and put into operation by the end of 2017. There can be no delays, since the Olympic Winter Games will start promptly on February 9 in Pyeongchang city – and with them a new era of television.

The world's first server-based exciter

For ATSC 3.0 broadcasting, Rohde&Schwarz launched the world's first server-based exciter solution – an ingenious choice since ATSC 3.0 was developed with the aim of integrating IP technologies (Fig. 2). Broadcast network operators benefit from the high flexibility of this approach because it not only ensures future-proof solutions with regard to the evolution of ATSC, but also potentially allows the integration of other standards.

The flat plug-in makes it easy to upgrade the current R&S®Tx9 transmitter generation to the new standard. A purely software-based encoder generates the I/Q modulation data and feeds it to the R&S®TCE90x exciter, which in turn generates the COFDM waveform using the most powerful precorrection on the market. The entire solution offers the high level of signal quality expected from Rohde&Schwarz.

Fang Yang; Johannes Sinnhuber

From ATSC 1.0 to ATSC 3.0

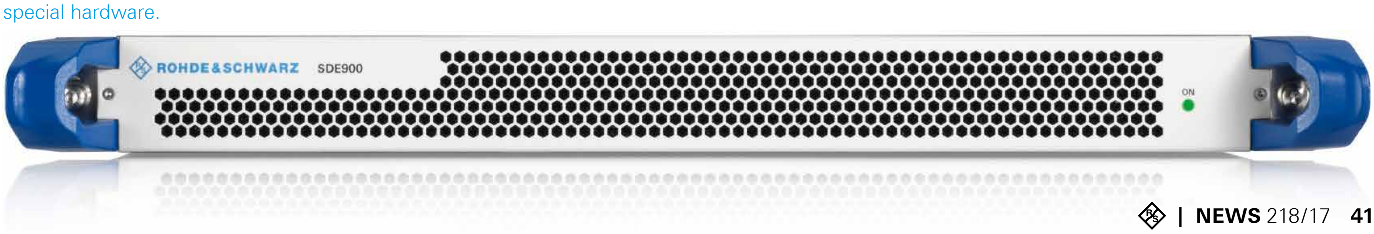
Advanced Television Systems Committee (ATSC) standards are a set of standards for digital terrestrial television. The ATSC is an international, non-profit organization based in the U.S. The first ATSC standard was drafted in the mid-1990s, at the same time as the first DVB standard. ATSC 1.0 provided for exclusively MPEG-2 coded video content and a fixed data rate of 19.39 Mbit/s. It was later amended slightly to support MPEG-4 video (H.264) as well. The physical layer is based on eight-level vestigial sideband modulation (8VSB*) on a single carrier. The RF channel bandwidth is specified as 6 MHz. Due to the single-carrier modulation, the possibility of implementing single-frequency networks (SFN) is very limited. In contrast, the new ATSC 3.0 standard (version 2.0 was never officially approved) is based on modern orthogonal frequency division multiplexing (OFDM), so it can also be used to set up single-frequency networks.

The general design goals for ATSC 3.0 were reliable transmission of high-resolution broadcast formats for reception by both fixed and mobile devices as well as more efficient and flexible spectrum utilization. Higher spectral efficiency is primarily achieved by means of non-uniform modulation and forward error correction (FEC).

Thanks to the consistent use of IP in the baseband and in the protocol layers, the standard allows the broadcasting service to be augmented with other IP sources. For example, it is theoretically possible to combine the picture content of an ATSC 3.0 broadcast with a sound track that reaches the user over the Internet via unicast.

* The digit 8 stands for the eight possible digital symbols that can be transmitted using this modulation method.

Fig. 2: A pioneering approach in a deceptively simple package: the server-based R&S®SDE900 baseband unit utilizes standard IT components instead of special hardware.



Convergent content monitoring for broadcast and streaming services

In the heterogeneous world of broadcast and streaming services with its ever growing, fast moving standards, flexibility and cost efficiency are winning factors. The new R&S®PRISMON audio/video content monitoring and multiviewer solution helps service providers solve these challenges.

Content monitoring: yesterday and today

In the past, classic content monitoring for TV and sound broadcasting services was virtually one-dimensional, with uniform and dedicated transmission technologies and media formats (Fig. 1). TVs and radios were tailored to these technologies and formats and featured no true intelligence of their own nor network connectivity. As a result, the requirements on audio/video content monitoring and multiviewing systems were more or less static. The architecture of these systems was largely hardware-based. Solutions of this type are usually inflexible and not able to cope with dynamically developing customer requirements and application scenarios.

Today's world of broadcast and streaming services, however, is multidimensional and heterogeneous (Fig. 2) – a fact that creates several trends and challenges. On the protocol side, IP technology is moving into the realms of production and contribution[1)], with new standards such as SMPTE 2022-6/7, SMPTE 2110-20/30, AIMS (Alliance for IP Media Solutions) and ASPEN (Adaptive Sample Picture Encapsulation). Especially in the area of distribution[1)], an increasing number and variety of intelligent end user equipment for media services (e.g. streaming) is driving an upswing in the number of over-the-top (OTT) protocols[2)] to be supported.

On the infrastructure side, migration from broadcast-specific equipment to standard, commercial off-the-shelf IT (COTS IT) equipment is underway to save costs in the transition phase and eventually enable virtualization and cloud-based delivery of playout, encoding and distribution functions. The broadcast and media services market as a whole is undergoing a paradigm shift toward IP technology. This, in turn, has an impact on how monitoring and multiviewing tasks are performed.

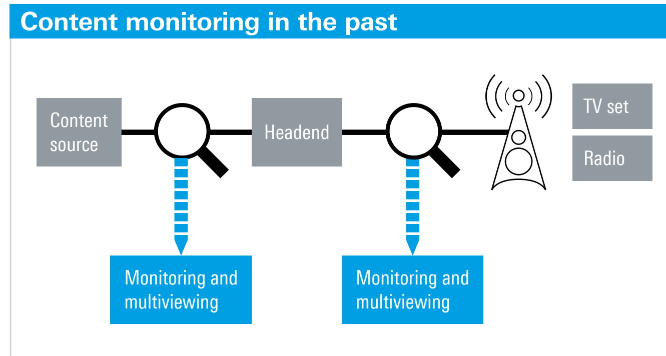


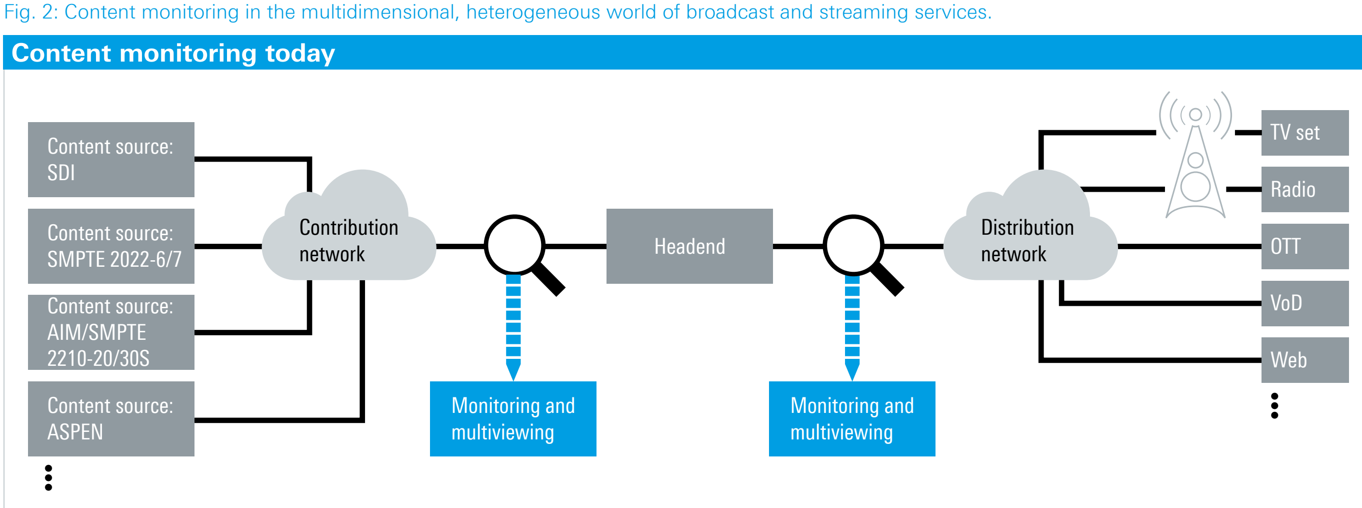
Fig. 1: Classic content monitoring in a one-dimensional, uniform TV and sound broadcasting world.

The new R&S®PRISMON solution

R&S®PRISMON offers users a universal solution for automated monitoring of media content for broadcast and streaming services. It is fully software-based and takes an innovative multistandard, multiprotocol approach. R&S®PRISMON has evolved from the BMM-810 multiviewer and content monitoring system, which was developed by GMIT GmbH, a wholly owned Rohde & Schwarz subsidiary, and was launched in August 2010. Several hundred BMM-810 systems are still in use in over 20 countries. The capabilities of the BMM-810 were integrated into R&S®PRISMON and significantly enhanced while increasing the number and types of platforms available for hardware- and cloud-based deployments.

Unlike many competitor solutions, which involve various dedicated devices to cover specific contents and transmission formats, R&S®PRISMON offers next generation convergent audio/video monitoring and multiviewing for broadcast

Fig. 2: Content monitoring in the multidimensional, heterogeneous world of broadcast and streaming services.



and streaming services in a single product. R&S®PRISMON addresses the following target groups:
- Broadcast and OTT service providers
- Content providers
- Playout network operators
- Satellite network operators
- Terrestrial network operators
- Cable network operators
- Internet service providers and telecommunications network operators
- Mobile network operators

These target groups have for years been faced with a growing diversity of signals and protocols and with deploying the appropriate monitoring tools to match them. R&S®PRISMON drastically reduces the number of required monitoring devices and provides a convergent, service-centric monitoring workflow (Fig. 3). The system offers the following benefits and options:
- Combined, service-centric monitoring and output of status information for channels transmitted over several different distribution networks; some of these channels may employ variable resolutions and codecs
- Single-source solution for broadcast and OTT/streaming application scenarios
- Uniform, convergent system for both regular operation and training
- Transferable software licenses for subsequent, cost-effective cloud migration

R&S®PRISMON technology in a nutshell

System design principles

R&S®PRISMON relies on state-of-the-art design principles, enabling it to meet present and future requirements:
- Fully software-based solution with hardware-agnostic programming for fast and flexible adaptation to changing requirements and for integrating new features, e.g. new media encoding and transport formats
- Platform operating on COTS IT hardware (Fig. 4) or on an open virtualization format (OVF) compatible hypervisor, generating CAPEX and OPEX savings over proprietary hardware platforms
- Extensive use of IP-based transport and signaling protocols to leverage the established TCP/IP protocol suite framework

Content monitoring with R&S®PRISMON

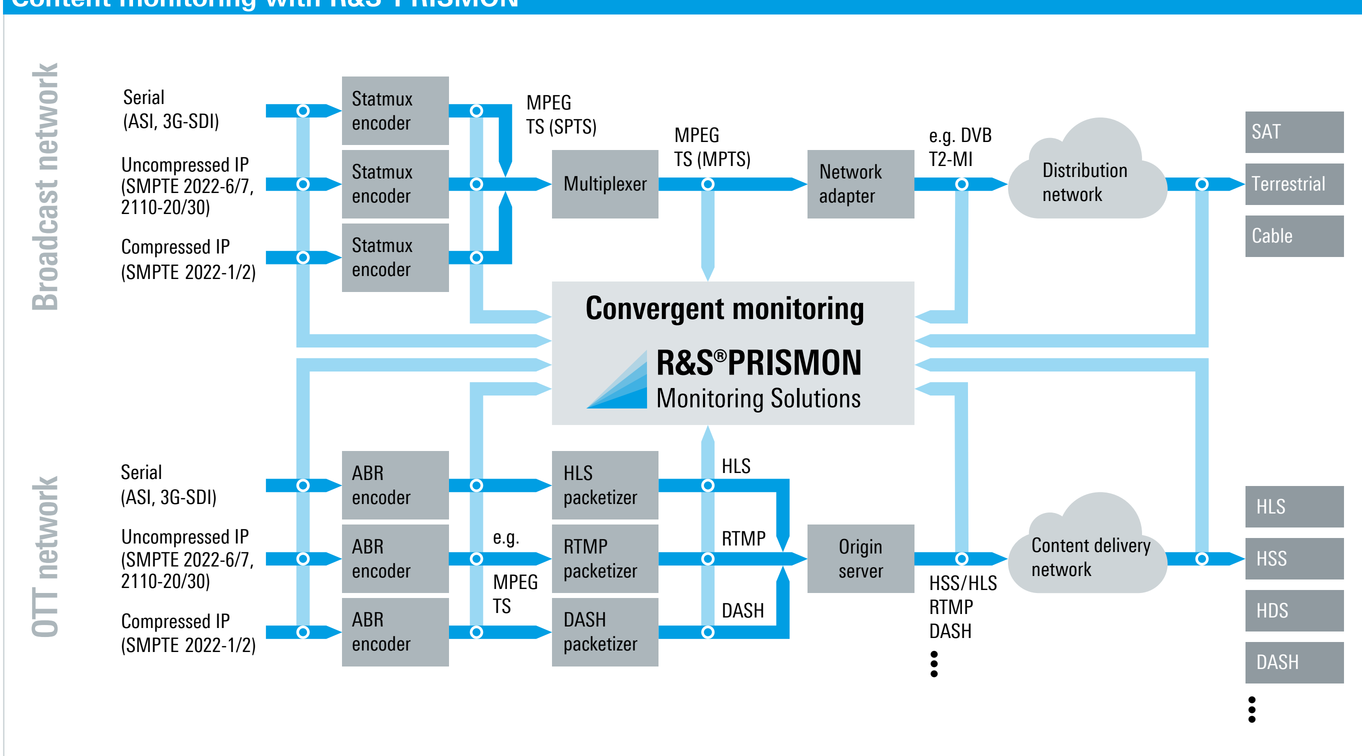


Fig. 3: Convergent, service-centric content monitoring across multiple, different networks using R&S®PRISMON.

- Integration of legacy formats and signals through interface cards to provide backward compatibility and investment protection for existing equipment
- Open, modular software architecture allowing flexible system modifications and extensions as well as agile development
- Scalable platform, allowing users to benefit from the steadily growing computing power of universal COTS multicore CPUs

Based on these design principles, R&S®PRISMON supports advanced streaming technologies in OTT scenarios (distribution) as well as new IP-based transport technologies and mezzanine compression methods[3], that are replacing classic SDI signals (contribution). Legacy technologies such as SDI and ASI can be integrated using dedicated interface cards to enable monitoring of hybrid scenarios with a mix of legacy signals and new, IP-based transport formats while migrating to IP.

Key architectural building blocks

Fig. 5 illustrates the basic architecture of an extendable software framework and its key functional building blocks for convergent content monitoring. The R&S®PRISMON software operates as a standard application on a Linux operating system (Ubuntu).

R&S®PRISMON made its debut at the National Association of Broadcasters (NAB) Show in Las Vegas in April 2017. Right away, the product gained remarkable attention and recognition from both customers and industry. In particular, it won NewBay Media's Best of Show Award, presented at the 2017 NAB Show by TV Technology magazine. NewBay Media's Best of Show Award winners are selected by a panel of engineers and industry experts based on criteria such as innovation, feature set, cost efficiency and performance in serving the industry.

R&S®PRISMON key features

- Multistandard, multiprotocol support for unprecedented flexibility (e.g. SDI, SMPTE 2022-1/2, SMPTE 2022-6/7, SMPTE 2110-20/30, AIMS, ASPEN, OTT protocol suite, DVB)
- Support of a broad range of application scenarios in playout/contribution and distribution environments on a single platform
- Fully software-based solution for future-proof expandability
- Cloud support via hypervisor platform, and orchestration[4]-ready design for dynamic and flexible allocation of monitoring capacity
- Secure integration with cloud-based remote video wall service

Fig. 4: R&S®PRISMON installed on a COTS IT server.

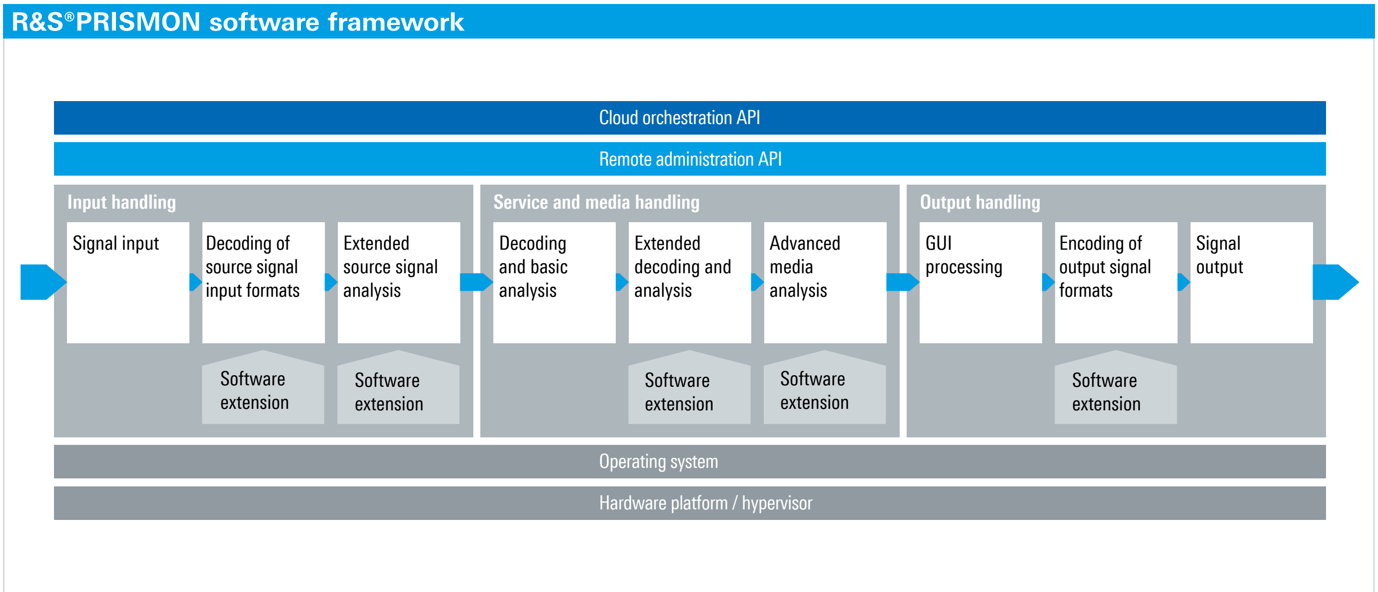


Fig. 5: Key functional building blocks of R&S®PRISMON solution.

The operating system can be installed on a COTS IT server hardware platform or on a hypervisor that supports the open virtualization format for portable virtual machines. OVF quickly and flexibly deploys hypervisor instances in a straightforward manner for private and public cloud installations.

The R&S®PRISMON software framework includes the following key architectural building blocks:

Input handling

The "signal" input module handles diverse physical media such as Ethernet as well as IP transport. It accepts media transport streams either as IP unicast or IP multicast. The "decoding of source signal input formats" module plays a key role in the Rohde & Schwarz approach to convergent content monitoring since it harmonizes the handling of an ever growing array of formats for IP-based media transport for all environments. It also provides interface drivers for handling legacy formats such as SDI and ASI. Future source signal formats can be incorporated via software plugins.

Service and media handling

The "decoding and basic analysis" module decodes received audio/video content and performs a basic check for signal defects and quality. The optional "extended decoding and analysis" module can process more complex or new (mezzanine) encoding formats such as HEVC, J2K, TICO, etc. When new decoders or even more powerful analysis functions are needed, the functionality of this module can be further extended by adding suitable software plugins. As computing power in IT server platforms and clouds steadily grows, there is no need to develop costly specialized, often proprietary hardware to handle advanced coding formats.

Output handling

The "GUI processing" module handles tasks such as the layout and logic of the tiles for the multiviewer display. It also controls the output of any measured parameter values together with the monitored audio/video content in a given tile. The dynamically compiled image on the multiviewer screen can be further processed by the "encoding of output signal formats" module, for example to output the rendered image to a video screen via HDMI or to provide multiple IP-based video streams.

Remote administration API

R&S®PRISMON supports an HTTP-based application programming interface (API) for remote configuration and administration of monitoring instances and remote automation of monitoring tasks. This includes email notification of user-defined recipients in response to user-defined errors and alarms.

Cloud orchestration API

R&S®PRISMON will soon be equipped with an open API for integrating monitoring instances as software-as-a-service (SaaS) building blocks into a cloud-based end-to-end workflow, together with other functional instances such as playout, encoding/transcoding/decoding, insertion of ads and logos, digital rights management (DRM), etc. (see Fig. 5).

Use case examples

R&S®PRISMON supports a broad range of application scenarios in playout/contribution and distribution environments – a fact well illustrated by the following two use cases.

Video quality assurance and measurements

Video quality measurements are complex, expensive and time-consuming, yet indispensable for broadcast and streaming media service providers to ensure customer satisfaction. Delivering high-quality content to customers while optimally balancing bandwidth needs per channel is key to the commercial success of any service provider. R&S®PRISMON makes objective video quality measurements on video feeds a quick and easy task – both in the lab and in live network environments. It supports multiple parallel measurements using quasi-standard metrics such as peak signal-to-noise ratio (PSNR) and structural similarity (SSIM) index. These measurements can be used for video encoder benchmarking, video quality live monitoring and assurance, and video production and transport analysis and optimization.

Besides providing the measured video quality as a numerical value, R&S®PRISMON generates a heat map, highlighting areas and intensity of poor quality in realtime. This is illustrated by the channel tiles with red pixel blocks in the middle of the multiviewer screen in Fig. 6. This monitoring function quickly reveals any encoding artifacts or other deviations – even if they only affect small areas. Even less experienced users can interpret results easily.

R&S®PRISMON can perform multiple video quality measurements in parallel, displaying results side by side on a single multiviewer screen. This makes sequential, one-by-one encoder benchmarking superfluous, dramatically reducing the time and effort required to improve video quality.

Video content compare function to monitor the signal flow

The video content compare function is a unique selling point of R&S®PRISMON. It provides automated, simultaneous, convergent monitoring of multiple, heterogeneous media streams carrying identical content.

In heterogeneous environments, broadcast and streaming service providers are faced with the challenge of distributing identical content with different resolutions over different types

Fig. 6: Sample screenshot of a video live quality measurement with R&S®PRISMON.

of networks. Due to the complexity of combined Ethernet switching and IP routing, there is a risk of transporting content over the wrong paths. In one potential critical scenario, adult-rated content could be erroneously delivered over a children's TV channel. The ability to automatically monitor the content of an outgoing channel by comparing it against a known, good reference channel can prevent errors of this type.

Direct analysis focusing on individual pixels would be too inaccurate and would trigger a number of false alarms. The video content compare function employs a more objective method of content recognition. It automatically compares the media stream to be analyzed with a reference stream, using characteristic criteria such as moving objects, scene cuts and average luminance level (Fig. 7). Depending on the result of the comparison, the function can trigger a predefined action, e.g. in the example of inappropriate content being delivered over a children's TV channel, program delivery could be stopped.

Integration of cloud services for secure remote content monitoring

Broadcast and streaming service providers face yet another challenge – they must enable secure remote content monitoring performed by operating personnel from outside the traditional master control rooms. Rohde & Schwarz has developed a convenient solution to this problem (Fig. 8). A virtual multiviewer wall cloud service referred to as virtuWall centrally collects monitoring data from various R&S®PRISMON instances that act as probes for the local audio/video contents. Probes can be distributed across multiple locations, e.g. in master

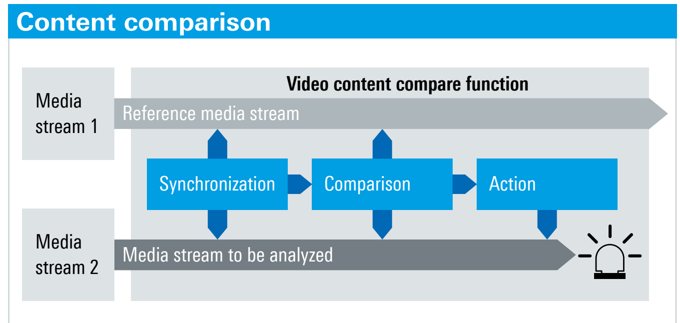


Fig. 7: Key steps of video content compare algorithm.

control rooms at different sites of a service provider. They are linked to the central cloud service via IP connections. If necessary, these IP connections can be secured using IPSec encryption or a similar technique.

In the cloud, overall monitoring status information and a multiviewer image are generated from the monitoring data collected from the various probes. The central cloud service also acts as a proxy that distributes the consolidated monitoring information to the mobile monitoring clients.

Mobile clients can connect to the central monitoring proxy either locally via WLAN or remotely via a wireless, secure connection. Mobile clients must authenticate themselves with the central proxy to be granted read-only access. Once a mobile client is securely connected, the proxy pushes the

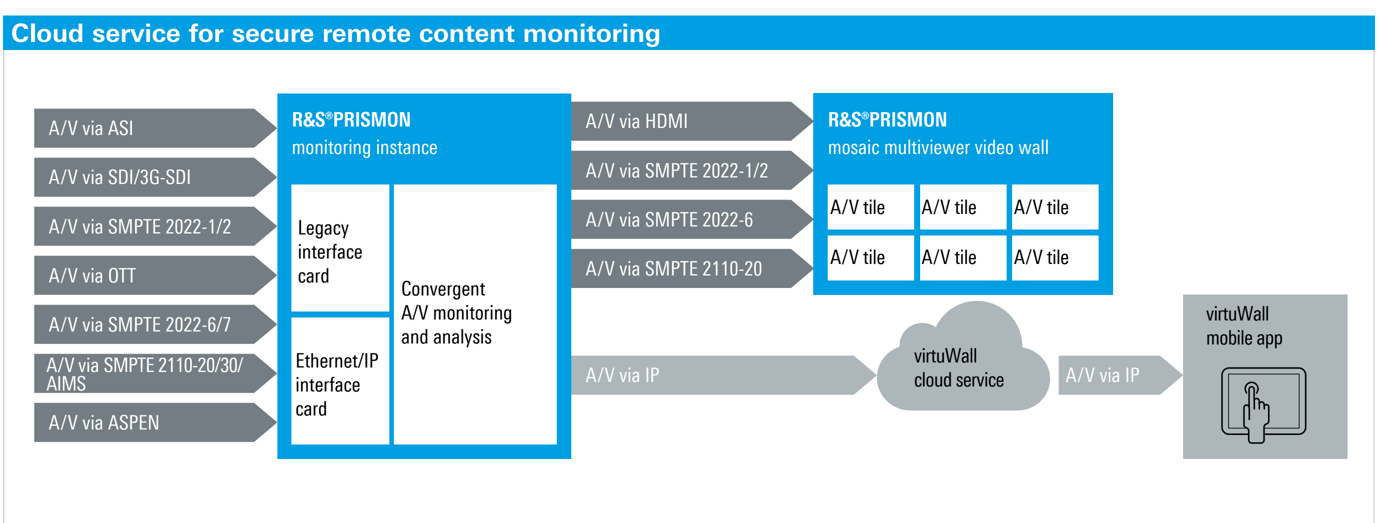


Fig. 8: Secure remote content monitoring – sample scenario with R&S®PRISMON and a virtuWall cloud server.

compiled information to the virtuWall app installed on the client, which can be a commercial tablet or smartphone. The virtuWall app provides monitoring/service personnel on or off a service provider's premises with complete information about all broadcast and streaming services and the transmitted audio/video contents.

Fig. 9 shows two sample screenshots with typical information delivered by the virtuWall app. The first page provides a quick overview of all monitored channels. Users can tap a channel group to display more detailed monitoring data together with an enlarged multiviewer image in mosaic style.

The innovative solution of combining R&S®PRISMON with a mobile cloud service lowers OPEX since fewer manned monitoring stations are required and some of the on-shift personnel can even perform their tasks off the service provider's premises.

Despite all security measures built into R&S®PRISMON and the virtuWall cloud service, implementation and operation of this solution requires ongoing consultation and close supervision by cybersecurity experts since new threats and attack vectors are constantly arising, posing a challenge for all existing security concepts. The Rohde & Schwarz subsidiary Cybersecurity GmbH provides customers with the necessary expertise from a single source.

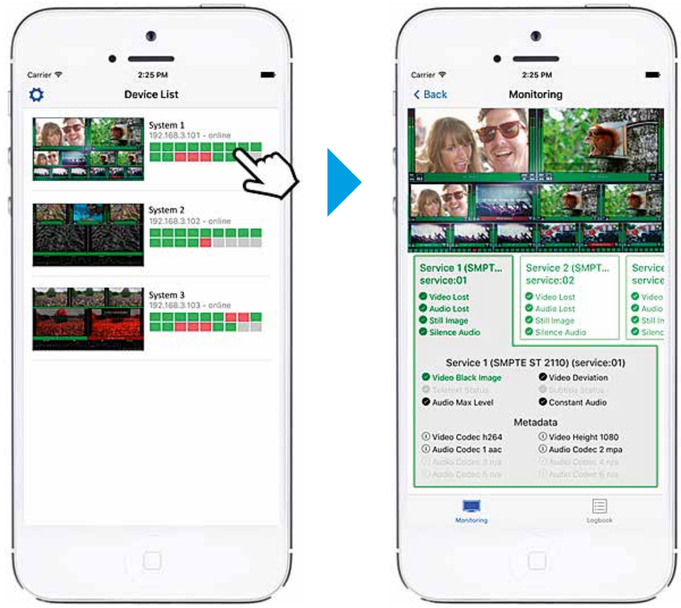


Fig. 9: Sample screenshots of the mobile virtuWall app for secure remote content monitoring from a mobile client (tablet or smartphone).

R&S®PRISMON is fully software-based. Its modular software framework and plugin approach ensure future-proof expandability so that new transport protocols and media formats can be included quickly and cost-effectively.

Summary

R&S®PRISMON responds to the increasing diversification of the audio and video protocol and format landscape by providing a convergent monitoring solution for all broadcast and streaming services. The solution offers content providers and network operators a simple and powerful tool for monitoring any number and type of transmitted audio/video contents irrespective of the distribution channel – using a single device.

The R&S®PRISMON software can be installed on a COTS IT server platform that can integrate even legacy formats via I/O cards. Alternatively, the software can be virtualized in a cloud. The range of functions is identical for both options. A feature currently unique on the market is the R&S®PRISMON virtuWall extension that transmits monitoring information via a cloud service to mobile user equipment, enabling operating personnel to perform monitoring tasks from a remote location.

Dr. Markus Lautenbacher

1) Contribution refers to the transmission of media content between geographically distributed locations of a media network, e.g. between a content provider and a satellite operator. In contrast, distribution refers to the transmission of content to end user equipment.
2) Over-the-top (OTT) services transport data over an IP network without the network operator being involved in providing the service (YouTube, Skype, etc.).
3) Mezzanine compression methods (mezzanine: in between, in the middle) compress data sufficiently to achieve a significant reduction in required memory and transmission volume while generating a high-quality compressed product that is suitable for archiving and conversion to other data formats.
4) Cloud orchestration: technical and administrative measures aimed at integrating cloud applications into corporate environments in a secure and controlled manner.

Interference hunting made easy – with the R&S®HE400 handheld directional antenna

Fig. 1: Five plug-in modules are currently available for the R&S®HE400. Shown here is the R&S®HE400 VHF module with the R&S®PR100 portable receiver.

The R&S®HE400 handheld directional antenna replaces its highly acclaimed predecessor, the R&S®HE300, whose various models served the market well for almost 10 years. Used together with the R&S®PR100 portable receiver or the R&S®FSH and R&S®FPH handheld spectrum analyzers, the antenna can precisely locate transmitters and interference sources.

Many different user groups appreciate portable radiomonitoring equipment that can also be used to (manually) take bearings. Users range from mobile network operators and regulatory authorities to facility security companies, armed forces and intelligence services. Depending on the actual application, either the receiver or one of the spectrum analyzers is used – the new R&S®HE400 antenna is compatible with all of them.

Lightweight, compact and intuitive to use

The R&S®HE400 comes with a handle, a receiver-specific cable set and one of five currently available plug-in modules that together cover the frequency range from 8.3 kHz to 8 GHz (Fig. 1). The handle and antenna modules are made of PC/ABS plastic or aluminum for low weight (approx. 1 kg) combined with high impact resistance. The antenna is supplied from the receiver or spectrum analyzer, which further reduces the weight since batteries are not required in the antenna.

The ergonomic handle rests comfortably in your hand and the two controls (trigger button and toggle button) are easy to reach with thumb and index finger. For prolonged work periods, the armrest included with the antenna should be used; it simply attaches to the handle (Fig. 2). The toggle button activates the low-noise amplifier (LNA) integrated into the handle. The handle also includes an electronic compass and a dual GPS/GLONASS receiver. Positions and bearings obtained in this manner are transmitted to the connected receiver, which also automatically recognizes the type of antenna module that is plugged and the status of the LNA. Field strength values are therefore always displayed correctly – without requiring any user settings (Fig. 3).

To start a measurement or action that was predefined in the receiver, the user simply presses the trigger button on the handle. The position of the transmitter can be calculated using triangulation and displayed on a map.

Modules and cables

Fig. 4 shows the available antenna modules. In addition to the familiar loop modules for HF and VHF that were also available for the R&S®HE300 and a broadband log-periodic module for UHF and SHF, there are two new modules.

The R&S®HE400UWB ultrawideband module covers the extremely wide frequency range from 30 MHz to 6 GHz. In many applications, this module greatly simplifies antenna handling since it eliminates the need to exchange modules. The R&S®HE400UWB combines two separate antennas in a single radome. The antennas are interconnected via a diplexer.

Fig. 2: The attachable armrest allows fatigue-free operation over long periods of time.

Fig. 3: R&S®PR100 display showing the field strength, compass and GPS data.

Plug-in modules for the R&S®HE400

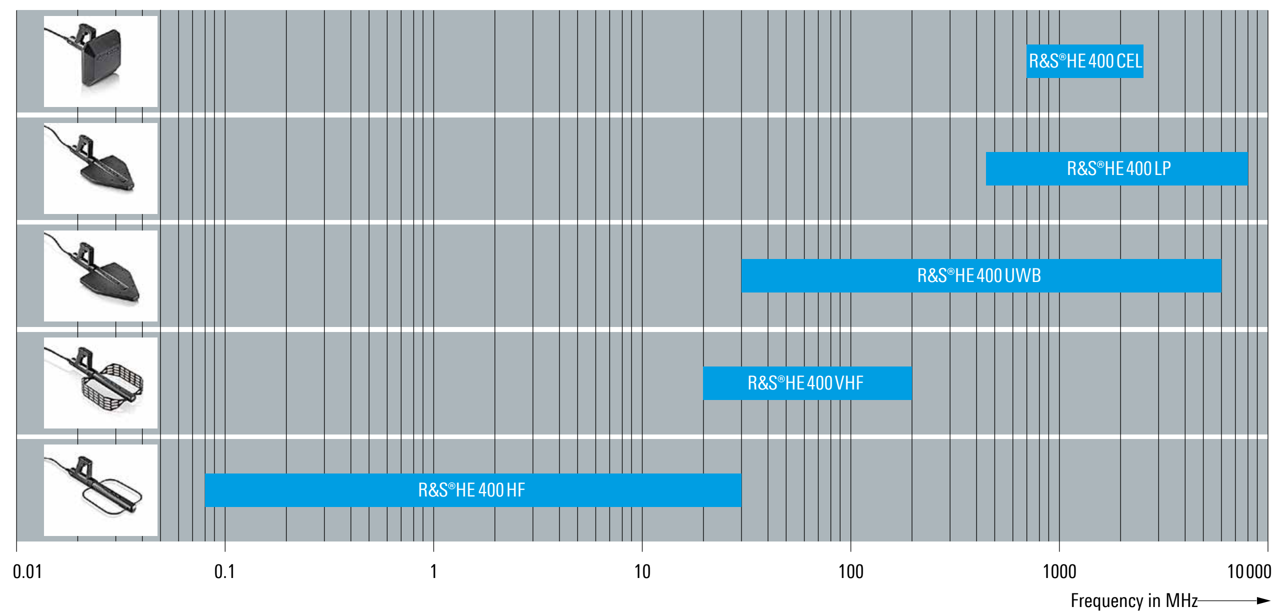


Fig. 4: Available antenna modules by frequency range.

The R&S®HE400CEL cellular module is designed specifically for the cellular bands from 700 MHz to 2.5 GHz. This module uses a special, more precise direction finding method than, for example, log-periodic or loop antennas. At the press of a button on the handle, the broadband dipoles that are next to each other can be switched between normal mode and delta mode. In normal mode, the dipoles work in-phase, producing a relatively broad radiation pattern to the front. In delta mode, the two dipoles are excited out-of-phase, producing a radiation pattern with a steep notch in the line-of-sight direction.(Fig. 5).

In practice, normal mode is used to determine the general direction. The user then switches to delta mode and moves the antenna only in the angular range of the previously determined maximum. Thanks to the very narrow notch in the radiation pattern, minimum-signal direction finding can be used to precisely determine the direction.

Configuration and accessories

The R&S®HE400 can be configured to meet customer-specific requirements. The antenna modules listed in Fig. 4 are simple to plug in and secure with a locking nut. Receiver-specific cable sets are available to connect to one of the three currently supported receiver devices. These cable sets can be quickly assembled by the user and are also easy to exchange during servicing.

Radiation patterns of the R&S®HE400CEL module

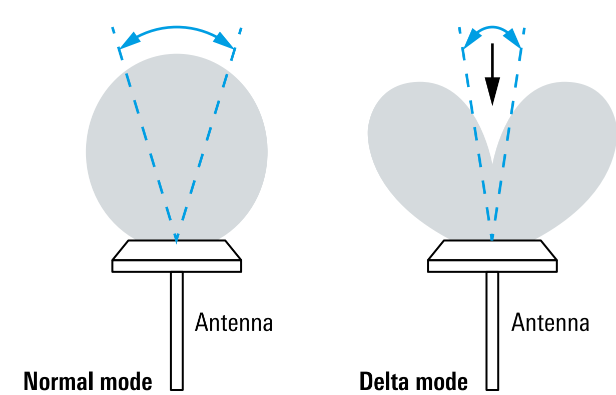


Fig. 5: Delta mode precisely determines the direction of a transmitter based on a minimum signal.

Fig. 6: Everything within reach. The transport case has room for all of the antenna modules and the receiver.

Available accessories include a rugged transport case with room for the antenna handle, all antenna modules and the R&S®PR100 monitoring receiver (Fig. 6). Two compact transport bags for transporting two or four modules are also available. The handle has a threaded socket that is used to mount the antenna on a tripod such as the lightweight R&S®HE400Z4 with spherical head.

Maik Reckeweg

R&S®HE400 – key features

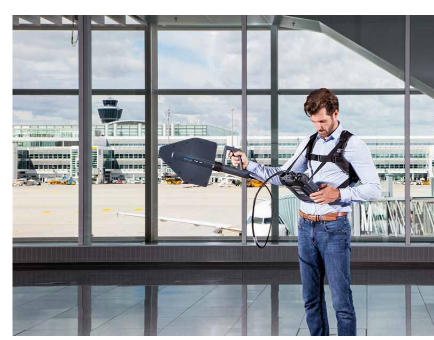
Wide frequency range
- 8.3 kHz to 8 GHz via five exchangeable antenna modules
- Ultrawideband module from 30 MHz to 6 GHz

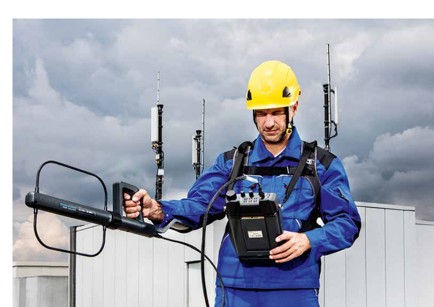
Very comfortable to use
- Ergonomic shape combined with low weight
- Attachable armrest
- Easy-to-access controls

Extensive integrated functionality
- Sensitive preamplifier (LNA)
- GPS/GLONASS receiver
- Electronic compass
- Polarization and module recognition

Extremely precise direction finding
- Distinctive, forward-directed radiation patterns
- Exact minimum-signal direction finding with the R&S®HE400CEL module's special delta mode

Accessories
- Transport case and various transport bags
- Lightweight tripod with spherical head
- Receiver-specific cable sets





Application examples
Left: R&S®HE400CEL for measurements in the cellular bands. The removable armrest prevents fatigue while working with the antenna.
Top right: R&S®HE400UWB ultrawideband module during bug hunting.
Bottom right: R&S®HE400HF during interference hunting in the cellular range.

Broadcaster SWR digitizes their tape archive with encoding and storage solution from Rohde & Schwarz

Rohde & Schwarz has started a major migration project for digitization of the video archives of the German broadcaster Südwestrundfunk (SWR). For this, Rohde & Schwarz is working closely with the Swiss-based retro-archiving specialist Jordi AG. SWR's archiving challenge is massive: the broadcaster needs to archive over 40,000 tape hours of content every year. To alleviate growing tape aging issues, the broadcaster decided to digitize their entire tape-based archives. After evaluating several systems, SWR opted for the ADAM migration system from Jordi, combined with R&S®VENICE video servers and the R&S®SpycerBox modular storage system. ADAM automatically handles all workflow steps from tape insertion to storage of archive files. The R&S®VENICE servers perform encoding in the archive format, while the R&S®SpycerBox Cell and R&S®SpycerBox Ultra TL provide storage capacity. The turnkey system is 40 times faster than previous manual workflows, and it is so reliable that it can work autonomously for 72 hours – enough for unattended operation over the weekend.

German armed forces procure SVFuA

Rohde & Schwarz has been awarded a contract from the German Federal Ministry of Defense to equip initially 50 command vehicles with the joint radio system of the German armed forces (SVFuA). SVFuA is an advanced software defined radio system certified in accordance with the internationally accepted Software Communications Architecture (SCA) standard. Initially, 50 vehicles (PUMA and BOXER) will be equipped. Rohde & Schwarz will produce and deliver this first installment by 2020. The procurement contract allows the German armed forces to order additional systems within seven years. With the acquisition of SVFuA, the German armed forces are taking the first step in modernizing the tactical communications of the German army within the framework of the MoTaKo program. To provide long-term support for this, Rohde & Schwarz will establish a joint venture with Rheinmetall AG in order to submit a tender as a general contractor. Both German companies offer a broad portfolio of trustworthy technology and years of experience in complex projects.

The BOXER armored transport vehicle is one of two platforms that will be equipped with the first installment of SVFuA.

First HD Radio transmitter from Rohde & Schwarz for the USA

WYCT FM in Pensacola, Florida, is the first radio station to install an R&S®THR9 transmitter with the HD Radio option. HD Radio is a popular analog/digital hybrid standard, primarily used in the USA, that was developed at the same time as the European DAB system. An HD Radio signal can be processed by any analog FM or AM receiver, but it additionally carries the program content in digital form to enable a gradual migration to digital coverage. At WYCT, the liquid-cooled high-power transmitter replaces a 43-year-old air-cooled transmitter. Energy/cost savings and very low heat dissipation in the transmitter room were the decisive factors behind the purchase. In addition, the R&S®THR9 has a significantly smaller footprint than the previous transmitter. Now, WYCT can enlarge its audience, because the R&S®THR9 HD Radio transmitter delivers a significantly stronger digital signal than the previous transmitter, providing five times the coverage. This boosts the penetration of HD Radio in consumer households.

Very happy with their new transmitter: Dave Hoxeng (WYCT proprietor, left) and Briton Smith.

ESG, Diehl Defence and Rohde & Schwarz cooperate on drone defense

With booming sales figures and unrestricted use, drones pose a serious security risk. With this in mind, ESG Elektroniksystem- und Logistik-GmbH, Diehl Defence and Rohde & Schwarz signed a cooperative agreement in the area of drone defense. Building on experience from successful cooperation during both the 2015 G7 Summit in Elmau and the U.S. presidential visit to Hanover in 2016, the companies want to coordinate their efforts even more closely and provide fully customized, bundled solutions based on their experience in the fields of radar, radiomonitoring, electromagnetic countermeasures, command and control information systems and position mapping. The GUARDION drone defense system integrates the position fixing and defense capabilities of the cooperation partners into customized, scalable solutions. For further information, visit www.Drohnenabwehr.de.

Tesat-Spacecom presents supplier award

For the third time now, after 2009 and 2013, the Rohde & Schwarz Teisnach plant has received the Supplier Award from Airbus subsidiary Tesat-Spacecom, the European market leader in communications payloads for satellites. This award acknowledges the plant's achievements with regard to quality, delivery reliability and flexibility. The company from Backnang in the German state of Baden-Württemberg relies on more than just facts and figures. Interpersonal factors are also relevant: for example, how does collaboration between purchaser and supplier work? What about communication? And how fast is the response time? "Rohde & Schwarz Teisnach also scored highly with regard to reliability," says Hans-Dieter Collissy, Head of Purchasing at Tesat-Spacecom. The business relationship between the Teisnach plant and Tesat-Spacecom has existed for over 20 years. The plant produces electromechanical modules and components, such as waveguides for transmission to and from satellites.

TESAT SPACECOM

Finnish air traffic control upgrades radio systems with Rohde & Schwarz

Finavia, which operates the Finnish airports as well as the national air traffic control system, is modernizing its ATC radio equipment with Rohde & Schwarz R&S®Series 4200 devices. The existing equipment, also from Rohde & Schwarz, must be replaced because it has reached the end of its lifecycle after many years of service and because European aviation radio regulations now require a change to 8.33 kHz channel spacing. Rohde & Schwarz submitted the winning bid in the international tender process. The upgrade involves 69 locations and includes the delivery and installation of 450 radios. Although ATC radio systems are still analog, Rohde & Schwarz has long since converted all its technology to digital, based on an IP foundation. This not only gives the systems very high configuration flexibility and makes them future-proof, but also offers features that can only be implemented with digital signal processing, such as the detection of simultaneous transmissions (DSiT) on a single radio channel.

Rohde & Schwarz is supplying 450 R&S®Series 4200 ATC radios to Finavia.

Rohde & Schwarz acquires Motama technology

Rohde & Schwarz subsidiary GMIT GmbH has acquired the technology of the Saarbrücken-based streaming specialist Motama GmbH. This acquisition expands the Berlin-based company's product portfolio, in particular for interruption-free transmission of audio and video content over IP networks. Motama's unique RelayCaster protocol minimizes packet losses, an essential condition for achieving high quality of service (QoS). RelayCaster and other Motama products are now available via the Rohde & Schwarz distribution network. Motama technology will also be integrated into the Rohde & Schwarz broadcast and media technology portfolio and further developed.