5G Broadcast for mobile TV in a nutshell

ROHDE&SCHWARZ

eBook | Version 01.01

Introduction

We live in times of dynamic change within the broadcast and electronics industries. If we believe what we read in the magazines, many tried and trusted broadcast technologies are being consigned to the scrap heap and replaced by IP-based solutions. However, Rohde&Schwarz believes in looking beyond the headlines to judge the true substance of a debate. The company prefers to take its time, consider its options and decide carefully where the best paths lie in the technology landscape. Sometimes, new technologies compliment established ones: you do not necessarily need to cannibalize one business model to create another. One such case is that of digital terrestrial transmission (DTT) – still the world's most popular mass broadcast technology, which seems doomed to be replaced by IP-based systems.

This eBook explains why the latest mobile telecommunications technologies are a perfect partner for DTT and how they can put it on a completely new and significant growth path.

What do you know about mobile communications standards?

Currently, one of the hottest topics in the broadcast industry is the convergence between traditional broadcast technologies and new mobile telecommunications technologies. Of particular interest is 5G Broadcast and the considerable potential it offers to forward-thinking broadcasters. However, few broadcast executives count themselves as mobile communications specialists – very few know exactly what the 4G or 3G standards are or how they are defined, let alone the new 5G standard.

In the early days of mobile telecommunications, there were a number of different national bodies that spent time developing their own standards for their own countries or regions. This led to a situation where European phones would not work in America or Asia and expensive multistandard phones were needed for international travel.

The solution came several years ago when a number of standards bodies and mobile telecom operators got together to form the 3G Partnership Project (3GPP) to develop future generations of mobile telephone systems with a general agreement to use the same standards worldwide. 3G was the first of these new collaborative endeavors to be released

3G smartphones can operate more or less seamlessly anywhere in the world, not only as a voice system but also for data distribution and internet access.

Long Term Evolution – LTE

Building on this success, the 3G mobile standard was enhanced as part of the Long Term Evolution (LTE) initiative. LTE provides significantly higher throughput and better reception capabilities compared with the original 3G system. However, there was not a single LTE specification or 4G release, as the work of the 3GPP group had been split into a number of work packages that allow individual parts to be enhanced independently from other parts.

All the work packages are publicly available on the 3GPP website. There are a huge number of specifications that are grouped into a number of different work modules and subspecifications. Some of these standards are more or less fixed, some are undergoing significant revision and some have become obsolete.

Periodically, a formal release may be made that generates a new baseline with the new features once they have undergone peer review and compatibility testing.

The core LTE performance supports up to 300 Mbit/s downlink and 75 Mbit/s uplink along with many options for lower bandwidths at lower cost and/or reduced reliability/coverage. In practice, few deployed systems support anywhere near the top speeds and consumers only have a small fraction of the bandwidth, as it is shared between multiple users.

eMBMS

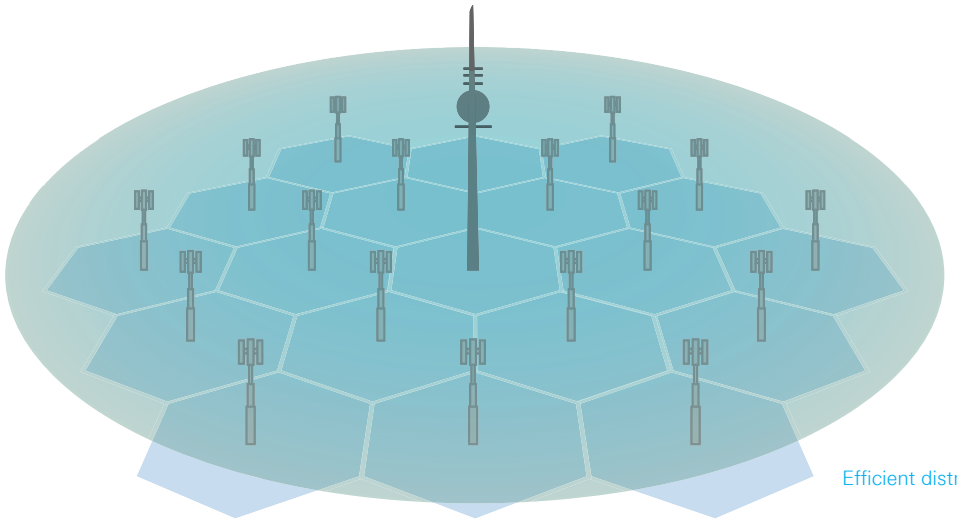
eMBMS, also known as "LTE Broadcast", only operates across an LTE radio link and adds the capability for a service provider to reserve part of the downlink bandwidth to be broadcast to and received/viewed by all handsets in a cell.

eMBMS throughput was limited to 4 Mbit/s, which enabled only a few channels to be sent, and it was still not possible for a handset on, for example, Vodafone to receive a broadcast from Deutsche Telekom. In other words, every service provider had to reserve their own bandwidth even when the broadcast content was the same. A variation of the MPEG-DASH format used for OTT services was used, as the video was not streamed but sent as individual files (or "chunks") of about e.g. 10 seconds each. Unlike with a true OTT service, 3GPP-DASH is a fixed bit rate stream of fixed resolution over a fixed preallocated bandwidth.

There have been a number of trials of eMBMS, mostly for various events at sports stadiums that enable spectators to have access to their own private replays or viewpoints. There has been no commercial deployment beyond these events.

eMBMS using SFN cells was introduced in Release 13 to increase the permitted coverage area beyond the 7 km typically offered by telecommunications nodes, but again it is rarely deployed outside of very small areas.

One reason for only having small areas is that in practice the throughput receivable by an app/handset drops rapidly beyond a certain distance from a base station. This is rarely an issue for voice or SMS messages but is a major limitation for multimedia and broadcast use cases.



Efficient distribution beyond cell limits. © 5G Project

5G – the next generation mobile communications system

The commercial requirements for 5G radio links were developed to cover a wide range of user applications, bandwidths and spectra. Other potential applications range from the IoT with < 10 bit/s and 10-year battery life to 10 Gbit/s with < 1 ms latency for VR headsets or in studio cameras. Possible uses include broadband connections, autonomous cars, smart traffic systems and monitoring applications.

These uses have different requirements and therefore can use different radio technologies and hence different radio frequencies, including sharing bandwidths with e.g. Wi-Fi. Sharing unlicensed spectra allows a licensed radio link to use other unlicensed spectra as well as its own bandwidth. Using a local Wi-Fi connection with a wired internet/broadband connection can significantly increase the throughput receivable by the handset as well as offloading bandwidth from the radio link to the fixed broadband connection.

Nano cells

5G also enables multiple cell sizes as well as Wi-Fi or other data links. A main base station could cover a wide area for general access by e.g. a car. As the car approaches a dead spot such as in an urban area, it is possible to switch the connection from the large cell to a nano cell within a building.

When the driver leaves the car and enters a house or office, the link can then be switched to a Wi-Fi connection. This flexibility significantly increases the overall bandwidth and number of connections across the 5G ecosystem by offloading data and connections wherever possible.

5G also supports directed beamforming/switching with MIMO arrays to provide highly focused signals in specific areas or even to track a car on the move in a highly congested area. This would help to ensure continuous connectivity for autonomous vehicles even in areas with a high density of radio use, since the same frequencies could be reused in very close proximity to each other.

The big breakthrough – Release 14

In mid-2017, Release 14 was the first defined release of 5G, but did not cover all the planned features, with many more releases expected over the next few years. It includes an enhanced broadcast mode, sometimes referred to as "Further evolved MBMS" (FeMBMS).

FeMBMS addresses several issues with eMBMS. These include:

- A true broadcast mode that allows all handsets to access a broadcast service on any other service provider's network, thus eliminating duplication of content
- The ability to view a broadcast service without the need for a SIM card or subscription
- Resolutions and formats brought in line with (conventional) broadcast formats
- The ability to stream existing broadcast content over IP via FeMBMS. In other words, the transport stream currently connected to a conventional RF broadcast transmitter can now also be connected to systems without any modification at all

Previously, eMBMS with 3GPP-DASH was essentially laid on top of the existing 3G/4G protocols, which required complex interfaces for handset manufacturers and service providers.

FeMBMS can easily be implemented via the deployment of the "Tower Overlay" approach and improved by the usage of the supplemental downlink (SDL) feature.

The Tower Overlay system is used in order to offload popular services from cellular networks, thereby decreasing the operational cost of such networks. This can be achieved by using high-power, high-tower (HPHT) transmitters whose signals act as an overlay to the cellular networks.

These transmitters provide a backward compatible migration path from conventional TV broadcasts to Tower Overlay as well as cooperative spectrum usage and the reuse of existing transmitter sites.

The concept behind this is a high-power, high-tower site to broadcast TV content across very wide areas (> 50 km) together with regular 5G cells to provide unicast and other services in much smaller cells (< 7 km) in the same area.

In addition, supplemental downlink is a feature proposed by Qualcomm R&D's HSPA+ program for enhancing downlink capacity in Release 9 (and later).

Essentially, the idea is to boost downlink capacity by utilizing unpaired spectra as additional carriers along with the original paired downlink and uplink carriers.

In Release 9, the SDL feature allowed a single carrier to be used in an unpaired band along with the serving cell's paired spectrum. Release 10 permitted the use of up to three supplemental carriers in the unpaired band along with the serving carriers in the paired band.

In 3GPP working groups, the European Broadcast Union (EBU) and Qualcomm are currently focusing on defining SDL bands that will be used as dedicated bands for FeMBMS.

"The 5G standard offers a unique opportunity to intelligently link the strengths of broadcasting transmission with the extensive opportunities in mobile communications. We are actively involved in this groundbreaking research project, contributing our leading technological expertise in terrestrial transmitter technology and mobile communications T&M technology in order to create the basis for efficiently transmitting media content to mobile and portable devices."

Manfred Reitmeier, Senior Director of R&D Transmitter Systems at Rohde&Schwarz

5G test site for TV broadcasting in the Bavarian Oberland

In Europe, the 5G Media Initiative has been established by leading companies and organizations to harness the potential of the future 5G standard for the media industry through research and development. Partners include Kathrein-Werke KG, Nokia, Rohde&Schwarz, Telefónica, MUGLER, the broadcasters Bayerischer Rundfunk (BR) and Südwestrundfunk (SWR), the Friedrich-Alexander University Erlangen-Nuremberg (FAU), the Fraunhofer Institute for Integrated Circuits (IIS), the Institute for Communications Technology (IfN) of the Technical University of Braunschweig, the Institute for Broadcast Technology (IRT), and Cadami, a Munich-based startup.

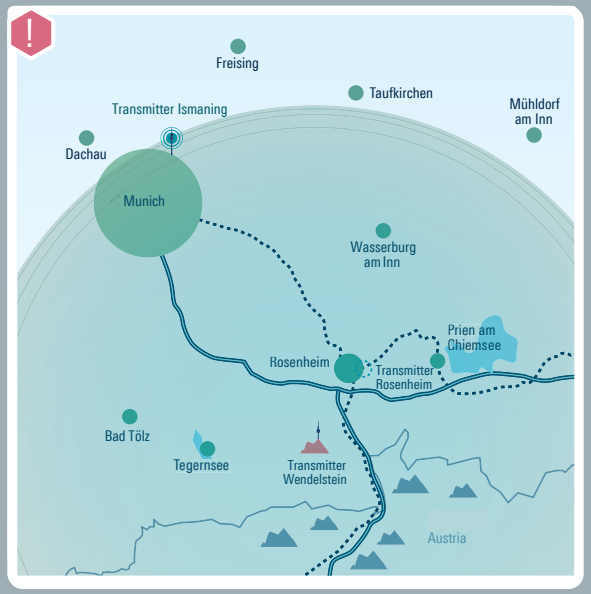
The 5G Media Initiative brings together media, research and industry to exchange knowledge and expertise, to find common ground and to initiate research projects.

A 5G Broadcast test site is now being set up in the Bavarian Oberland as part of the Bavarian research project “5G Today”. Under the leadership of the Institute for Broadcast Technology, project partners Kathrein and Rohde&Schwarz are investigating large-scale TV broadcasts in the FeMBMS mode over 5G networks. The project is supported by Telefónica Germany and Bayerischer Rundfunk, the Bavarian state broadcaster that is operating the 5G FeMBMS broadcast network as a test site at its transmitter sites.

The new 5G network standard is a key technology for a future with highly automated vehicles and devices connected to each other via the internet of things. 5G also offers great potential for the efficient distribution of media content. The introduction of 5G could open up a worldwide market with millions of smartphones and tablets acting as potential TV receivers for live TV services, media libraries, social networks and many other media services. With the cooperation of European broadcasters and industry players, international standardization work to enable efficient broadcasting in large 4G and 5G networks was completed in June 2017.

Large and small transmitter cells are combined to create a large coverage area. The first test broadcasts using TV signals are expected to take place in the first quarter of 2019. They will be simultaneously broadcast on channel 56 from the BR's Wendelstein station and other locations in the Munich area. Until then, components for transmission and reception will be developed and installed, and theoretical studies and preliminary investigations will take place.

5G TODAY



5G test site for TV broadcasting in the Bavarian Oberland © 5G Today

"As a global network operator and a member of the Next Generation Mobile Networks (NGMN) Alliance, we want to support testing of media content distribution over modern and converged 5G networks. That's why, if needed, we will give 5G Today another 700 MHz spectrum, one of the 5G frequency bands prioritized by the European Commission," explains Jaime Lluch, Director Radio Access Network at Telefónica Germany.

Ralf Exler, Head of Innovation Management at Kathrein, feels that this project plays an important role in the convergence of broadcasting and mobile communications: "Young people in particular want to receive broadcast content on all user devices. The new standard brings the convergent network a little bit closer." Customers do not have to worry about how they receive content. "In 5G Today, we will be optimizing the antennas and network parameters in the field and conducting test drives in order to be able to offer innovative technology to our automotive customers."

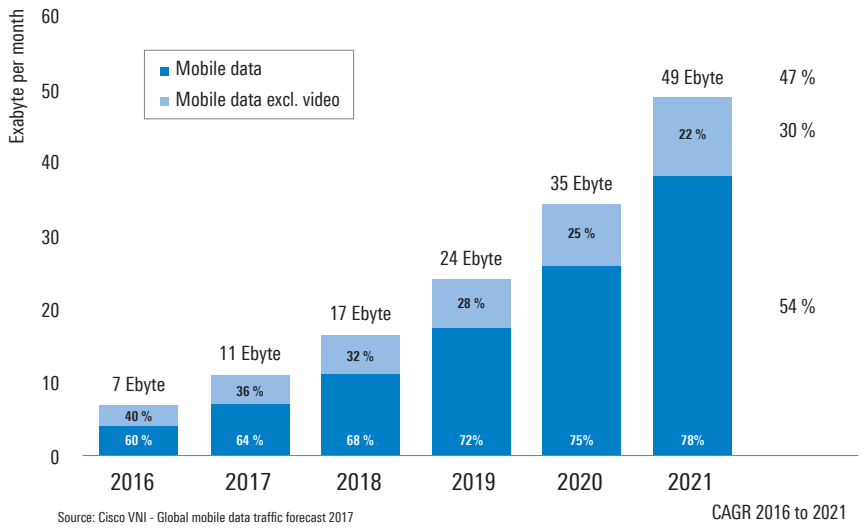
The 5G Today research project will be funded by the Bavarian Research Foundation over the course of 28 months.

"With the development of 5G, the standard approaches the classic parameters of a broadcasting system, which will enable widespread and economic distribution of television programs. We welcome the opportunity offered by the 5G Today project to test the network of the future with our existing broadcasting infrastructure."

Prof. Birgit Spanner-Ulmer, Director Production and Technology at BR

5G: Requirements for mobile communications systems continue to grow

Global mobile data traffic forecast 2017 (cellular traffic only)



Source: Cisco VNI - Global mobile data traffic forecast 2017

At the other extreme is the use of very small 5G cells to ensure coverage in congested/urban areas. Significant investments in this low-power, low-throughput (LPLT) concept have already been made in some countries and major cities.

Although deploying a 5G Broadcast system as a link between a handset and a base station seems straightforward, an extensive hierarchical data infrastructure is required to enable data and voice services around the globe.

The EBU's view of the future video ecosystem identifies a range of different applications and use cases from existing broadcast scenarios to a future of user-generated content as well as very high bit rate technologies.

One area where significant development is possible is in automotive industries. With the advent of 5G, car drivers will benefit added value data ranging from enhanced traffic information to map updates and even car firmware updates. 5G can create connected vehicle networks where driver safety is improved by enhanced awareness, such as local road conditions, warnings of incidents ahead and driver alerts to reduce speed. New augmented reality technology enables head-up displays and even autonomous driving and navigation.

The technology required by these automotive applications is still being shaped, but it is similar in many ways to that required by mobile TV broadcasting applications.

The EBU's position on 5G Broadcast

The EBU has offered three different scenarios

- The simplest case is where 5G services are simply an additional delivery system alongside existing systems with some niche applications such as delivery to (private/in-home) VR headsets. However, the timescale for commercial deployment of public 5G video services is not yet clear due to the cost and complexity of the infrastructure needed.
- A second scenario envisages a distribution infrastructure based solely around the different 5G capabilities, offering a potentially seamless link with future 5G studio infrastructures. End user delivery could still be based on conventional broadcast or broadband delivery, moving to 5G delivery as infrastructure rollout continues.
- Thirdly, the EBU envisages that at some point in the future 5G could completely replace existing distribution infrastructure and offer a completely seamless user experience across all types of content and display devices.

"Together with the EBU, BBC, RAI and SWR and industry partners, we have defined the broadcasting requirements for 5G and successfully incorporated them in the international standard. Requirements include a 100 percent broadcasting mode and increased channel spacing. We are pleased that the 5G Today project allows us to implement and evaluate standardization results at a test site."

Jochen Mezger, General Manager of the Business Area Network Technologies at IRT

Conclusion

Opportunities for broadcasters arise from FeMBMS (LTE Broadcast) because of the direct access to TV and other rich media content by a broad spectrum of mobile devices. Furthermore, broadcast network operators have the opportunity to become part of the general communications systems of the future:

5G is expected to become a fundamental technology for many industries similar to how IP already has.

Rohde&Schwarz has committed significant resources to the research and development of 5G Broadcast services. The company is actively engaged with several mobile service providers and network operators worldwide. The company is actively seeking dialog with a broad range of organizations – please contact us if you are interested in getting more information.

About Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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PD 5215.2695.92 | Version 01.01 | January 2019 (as)

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5215.2695.92 01.01 PDP 1 en