5G QUALITY OF EXPERIENCE

How to measure network performance and Quality of Experience in a 5G world

Providing operators with visibility of the quality of experience from a subscriber's point of view is something R&S MNT has been at the forefront of since the early days of mobile networks. In this article, Hanspeter Bobst, Vice-President, Mobile Networks Testing at Rohde & Schwarz considers the emergence of 5G, the necessity to rethink the approach to measuring network performance and the quality of experience delivered over 5G networks.

Background and current status

From the emergence of GSM to the global adoption of LTE, operators' focus has been on ensuring the quality of services delivered to subscribers. It followed that test solutions were developed which enabled the verification of network quality and provided detailed indicators to diagnose issues and to optimise performance. Historically, testing mobile networks has been built up from spectrum and physical layer parameters such as RSSI and SINR, to OSS and trace data and, latterly, smartphone-based solutions that measure the quality of services such as voice and video. With the emergence of 5G, alongside a leap in network performance and capabilities is the increasing likelihood that end the user will be a machine, not a human. That means that test approaches should be expanded to encompass machine-type communication: a revised concept for quality of experience and new techniques for testing performance must be developed.

The challenges of 5G use cases, network performance, and services

It is important to remember that 4G services will continue to evolve but also to recognise that the implementation of 5G will be very different from previous generations of cellular technology, particularly in the RAN. It starts with a consideration of the 5G use cases of eMBB, mMTC and URLLC which bring new dimensions in terms of real-time, higher-bandwidth, scalability etc and require a revised methodology and set of parameters to measure the Quality of Experience. This in turn this drives the performance of the network needed to support these uses cases. Finally, an expanded test methodology is needed to measure new parameters more accurately at higher frequencies and wider bandwidths and meet the challenge of how to quantify QoE, particularly where the end user will not be using a smartphone. We therefore need to re-think our approach to what constitutes QoE and how to measure it.

Smartphone-based test cases to measure the quality of eMBB will remain but for mMTC and URLLC, the end user will be a machine and the service will bring a new set of demanding parameters to measure. For machine-type communications, the traditional concept of quality of experience (QoE) will no longer appropriate because the end user is not a human and will not experience the service in an emotive way. We need a new interpretation and understanding of what constitutes quality of experience and how to map the consequences of changes in QoE for each application.

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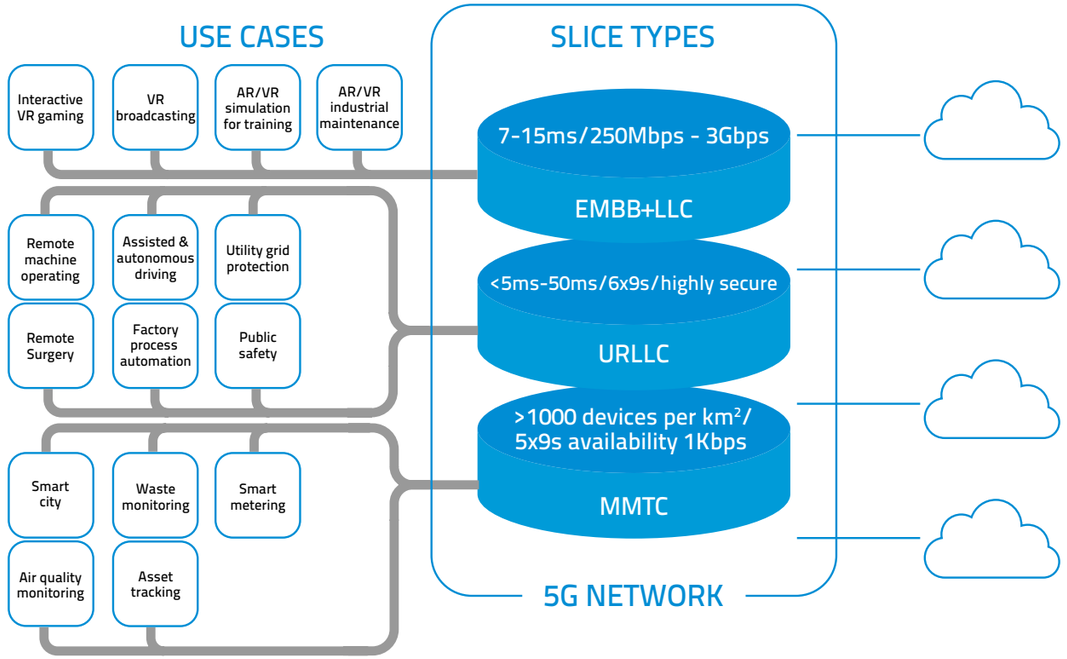
Implications for operators

The services and applications for these 5G use cases such as automotive, industry 4.0, AR, remote surgery etc are often more critical in nature and the consequences of degradation or loss of service become more serious, potentially life threatening. Therefore, operators must monitor networks with greater accuracy and in finer detail to pre-empt QoS issues. The challenge facing operators moves from ensuring subscriber satisfaction and compliance with SLAs to being able to guarantee the delivery of often critical services and legally prove that they meet this obligation to address questions of liability.

With each individual application potentially supported by a dedicated network slice, each with its own QoS definition, metrics and thresholds, operators' network monitoring requirements expand from a single one for their entire network to multiple, simultaneous performance and quality measurements.

Measuring 5G network slice performance

A much more diversified range of use cases, serviced by logical network slices, expands performance measurement requirements for operators



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Implications for test solution vendors

From the point of view of a test solution vendor, measuring QoE becomes more complex and more demanding in terms of the data acquisition of additional measurement parameters with greater precision in the RAN. This also drives the need to provide post-processing analytics that encompass new models for QoS and QoE measurement for the purposes of network benchmarking, optimisation and monitoring. It also follows that because of the critical nature of some applications, test solutions must be independent, transparent and traceable to certified international standards and not aligned to proprietary techniques or individual network equipment vendors.

5G introduces a new dimension and type of use cases; not only the physical test equipment required to sample the network, eg. a wider bandwidth scanner but also the methodology of what parameters to test for a specific application and how to post-process the data. There will be new KPIs that contribute to the evaluation of QoS and the other factors that feed into QoE. The process can be to build up QoE from the lower layers and use a model to define how QoS maps into QoE.

The key question is what does good QoE look like for a sensor in an industrial IoT deployment, or a connected car, or a VR device, or any specific 5G use case? In these use cases, we need to have a way of understanding if QoE is good or bad and what the thresholds are for this. For a simple example, take call setup time. What is an acceptable "set up time" for a sensor alarm, or an autonomous car, or in a remote medical use cases, for example? What may have been well defined in previous use cases, for example a subscriber viewing a YouTube video on their smartphone, may well not be transferable to 5G use cases. Attention will have to be given to the range of acceptable values of QoE for each specific application, below which it becomes a problem and above which brings no additional value.

Test Cases

So how do we set up QoE test cases for these new "user" experiences? First of all, we need to understand the requirements of the specific use case that define the factors and weightings that constitute QoE for that connected thing or device. Without knowing those underlying requirements, then the quality engineers do not know what to look for in terms of what aspects are important KPIs. So we need to characterise the parameters and KPIs, and define thresholds, creating good/bad KPIs for each application and use case. This is still at a very early stage. One approach would be to start at the PHY and logical layers and work up to the apps and use case, defining what needs to be measured.

One positive aspect is that this sort of understanding of use case QoE can drive the NOC to SOC transformation that operators are making. The SOC is important because it is via this service-driven environment that operators hope to differentiate their customer experiences. For example, a car manufacturer can understand which operators' network is best suited for its connected or autonomous cars. So we can see that active test and understanding of QoE per use case, allied to network operations, will be a key enabler of future 5G business cases.

As with operators' challenge mentioned earlier, test equipment vendors must produce solutions able to measure multiple virtual networks at the same time at the same location with different methodologies.

The role of standardisation organisations

International standards organisations such the ITU and ETSI are actively evolving their test models to cover these changes and this is something R&S is very actively engaging in. However, building 5G methodologies and standards is going to be complex when we consider of all these use cases and remember that operators already have 200-400 core KPIs to monitor, often making it very difficult in understanding QoE in a granular way. Therefore, this is another change in the QoS environment driven by 5G, where there will be many more parameters to monitor.

To evaluate and benchmark networks, KPIs are required that truly reflect the network's performance so that based on such KPIs it is possible to define a fair and transparent performance scoring method. ETSI has taken the driver's seat to discuss and define best practices for network benchmarking and scoring that enables the network to be characterised in a single, unified metric. The method provides the operator with visibility of the status of their network and identifies the factors that influence quality. The factors and weightings that influence the scoring method will be adapted for each 5G use case and application but the fundamental methodology is robust and will provide the industry with an independent reference against which 5G QoS/QoE can be measured.

Approach of R&S

The approach of R&S has two parts. Firstly to release test solutions that enable the technical aspects of 5G networks such as coverage, performance and operation and secondly to enhance our existing QoE methodologies to encompass 5G use cases. The solutions for testing technical aspects of the 5G RAN are already being used by operators as they move from from trials to the commercial deployment of 5G, while the QoE solutions from lower layers up to signalling are being developed in partnership with the operators and standardisation bodies.

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Conclusion

In conclusion, we need to push first to an understanding of what the requirements of each 5G use case are. Then we can build out key parameters and KPIs required to meet those requirements. Once we understand why we are testing certain parameters, we will then have the test methodology to quantify QoS according to those KPIs. Although we have seen that the requirement to test becomes more critical and it demands more accurate tools and complex methodology, R&S has the capability to test the network performance today to test the technical aspects of 5G networks and QoS/QoE of eMBB. And we are working towards the QoE for mMTCC and URLLC to ensure 5G applications function in accordance with their requirements. This ultimately enables mobile network operators to benefit from new 5G business models.

The 5G Measurement Challenge

- 5G use cases, particularly mMTC and URLLC demand a new way of measuring QoE for each individual application
- QoE has a different meaning in machine-type communications. A machine or connected thing's QoE needs to be interpreted.
- Each application brings a specific set of network performance characteristics to support it which need to be monitored
- Monitoring becomes more important to operators for critical 5G applications
- 5G testing adds a new dimension for both data acquisition and post-processing
- Active test and understanding of QoS per use case, allied to network operations, will be a key enabler of future 5G business cases