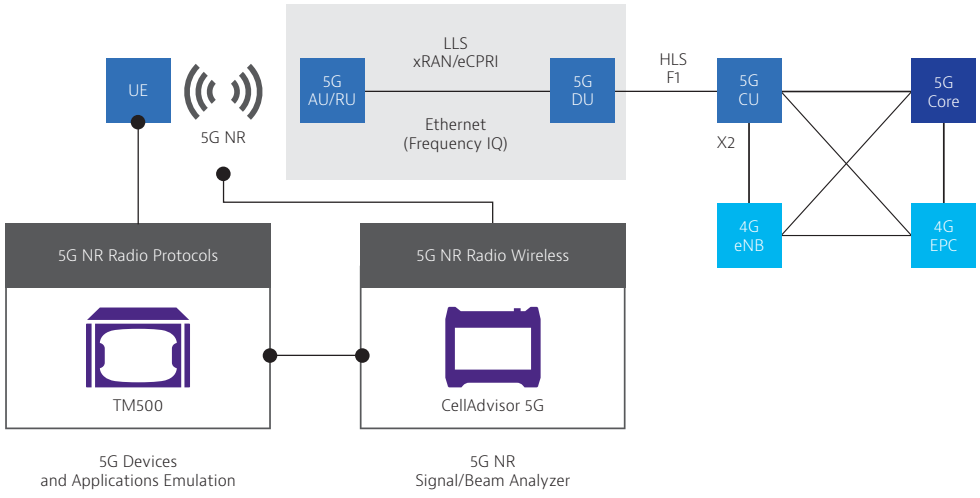
VIAVI Solutions

Brochure

Monitor and Troubleshoot 5G RF Channel Performance During Traffic Testing with the VIAVI Lab to Field™ Solution

Continuous monitoring of the RF interface between VIAVI TM500 Test UE(s) and the 4G/5G RAN provides immediate insight into unexpected RF behavior that may impact UE performance. VIAVI Lab to Field saves hours of root cause analysis by immediately tracing traffic issues to RF anomalies.



There is an expectation that 5G will be an innovation platform that provides the ability to bring new services to market quickly. This will enable service providers to take advantage of market opportunities and dynamically meet changing consumer and business needs. However, deploying and supporting 5G's complex network architecture will not be a trivial exercise. 5G is causing major changes across the entire network, from RAN architecture to 3D beamforming, and active antennas to software-defined network components. All elements need to support stringent application-driven timing and latency requirements. Mission critical applications demand a network which cannot fail, and ensuring network quality will be at the core of deployment. Time-to-market and network quality will depend on the rigor of test and measurement during the complete life cycle of the network. Performing comprehensive verification during the lab validation stage will ensure a smooth and efficient deployment and launch of the network.

Higher order modulation and MIMO schemes such as 256 QAM and 8x8 MIMO are fundamental to delivering the high throughput targets of 5G NR eMBB. Errors introduced at the RF level in the measurement system or due to (e/g)NB failures can lead to missing target throughputs in the lab environment, falsely indicating problems with the (e/g)NB scheduler.

Benefits

- Full 5G NR NSA test coverage from RAN to Core characterizes performance with network KPIs
- Reliably validate (e/g)NB test configuration prior to starting UE traffic test, increasing test efficiency
- Identify downlink signal stability and beam performance issues potentially impacting UE results
- Quickly identify UE performance issues caused by carrier and beam related problems
- Incremental testing approach de-risks validation, reducing time to market

Features

- End to end 5G NR testing with configurable data applications per UE and 5G Core simulation
- Measurement and reporting of available carriers and common beams
- Real-time monitoring of carrier and common beam performance indicators
- Time correlate UE traffic and carrier/beam key performance indicators
- Support for open/closed loop testing, decoupled/coupled UL/DL, low/high-layer test modes

Combined Capability Benefits of TM500 and CellAdvisor 5G for 5G NSA Performance Validation

VIAVI TM500 and CellAdvisor 5G Introduction

VIAVI TM500 is the market leader in lab test UEs and first to market with 5G test solutions. TM500 is the de facto standard in its class, in use with almost every base station manufacturer across the world.

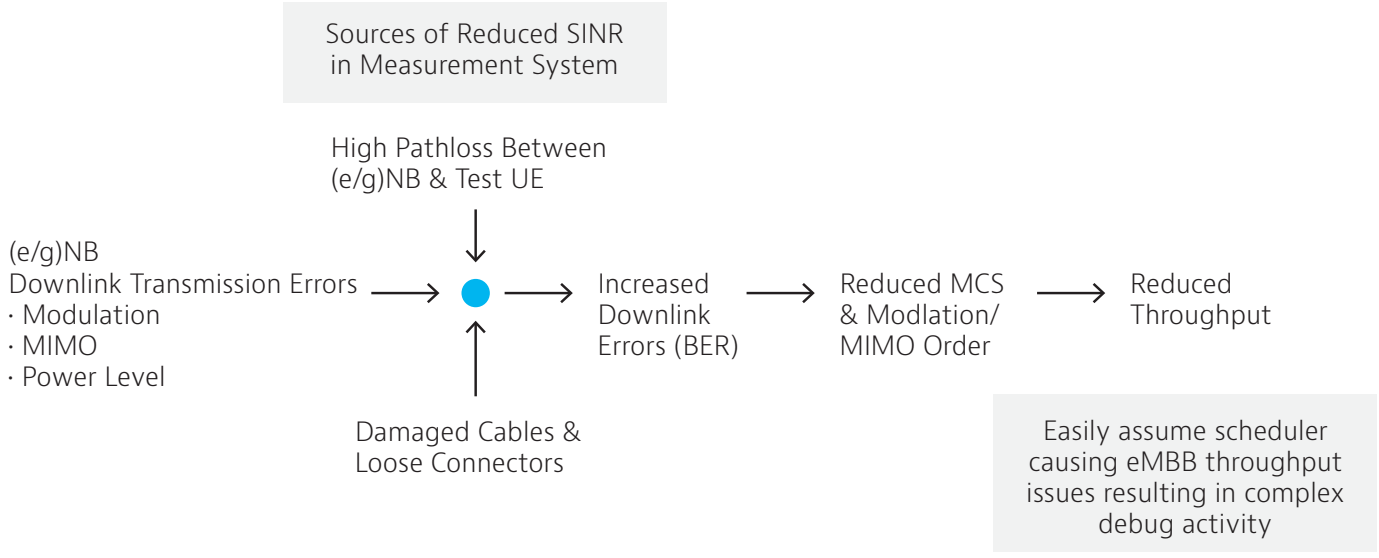
- Full Stack 3GPP NSA & SA support
- Sub-6 GHz & mmWave supporting 100 to 200 MHz bandwidths
- eMBB use cases with 4 to 8 carriers and thousands of 5G NR UEs
- Multiple antenna configuration support including 2, 4 and 8 layers with up to 256 QAM
- Massive MIMO, MU-MIMO

VIAVI CellAdvisor™ 5G is the ideal field portable solution to validate 5G radio access. The main test functions listed below validate that signals from the gNB transmitters comply with 3GPP requirements.

- Real-time spectrum and interference analysis with persistence display for 5G FR1 (Sub-6 GHz) and FR2 (mmWave)
- 5G carrier scanner measuring up to eight 5G carriers' power as well as strongest beam power level and corresponding identifier (ID)
- 5G beam analyzer measuring individual beams and indicating corresponding identifier, power level, and signal-to-noise ratio
- 5G route map for coverage verification, mapping in real time the physical cell identity (PCI) and beam strength, as well as providing coverage data for post-processing

Common Sources of RF Impairments in a Typical Lab Environment

During normal traffic, RF centric problems will often manifest themselves as a temporary or persistent drop in throughput to the UE. Throughput may also be impacted by problems with the (e/g)NB scheduler, which is totally unrelated to link power or noise, but is a software optimization problem. Being able to quickly identify the RF link as the root cause of a throughput problem means you do not need to investigate the scheduler as a potential source of the problem, avoiding a much more complex troubleshooting activity.



To avoid these kinds of measurement problems, before using a UE simulator product such as TM500 to execute test cases that may need to run for many hours or even days, it is essential to ensure that RF signals are being received properly, particularly if long cables are needed to connect to the (e/g)NB. 5G adds additional complexity with lab setups requiring multiple TM500 and (e/g)NBs with different bands, sub-carrier spacings and bandwidths up to 100 MHz. In addition, to test mmWave in the lab, mmWave to sub-6 GHz downconverters are often used to facilitate testing in a conducted (cabled) environment.

To ensure that RF signals are being properly received, time consuming pre-verification tests need to be performed when a new system is installed in the lab or while troubleshooting specific tests that are sensitive to changes in the RF signal behavior. The time required for these pre-checks is a major pain point for testers in the lab. The complexity of doing mmWave RF chamber tests can result in these tests being costly, time consuming, and not repeatable.

In the rest of the paper we expand on how the TM500 in combination with CellAdvisor 5G can help accelerate these kinds of tests, reduce pain points, and help improve the quality and consistency of results.

Accelerate Laboratory Pre-verification Checks

Before using a UE simulator product such as the TM500, it is essential to ensure that RF signals can be properly received:

- The (e/g)NB and UE emulator can be a far distance apart, requiring long cables which can affect power levels
- When the cables are connected, the use of RF attenuators, splitters, and couplers can also affect the power levels and in some cases add noise and reduce the RF signal quality received by the UE
- While testing the (e/g)NB it is not guaranteed that the modulation quality and carrier center frequencies are correct and stable, errors that could be due to a faulty setup or erroneous (e/g)NodeB configuration/operation

With VIAVI CellAdvisor 5G complementing the TM500, not only can operators and NEMs validate leading 3GPP features with thousands of UEs, but they can also quickly and easily calibrate each setup, do quick pre-checks, and engage in troubleshooting to ensure the RF environment is correct before long duration tests commence.

Enhancing and Accelerating Troubleshooting for Signal Quality Sensitive Features

When the TM500 and (e/g)NB system are set up and running, technicians may need to execute specific tests where results are sensitive to RF signal quality (power level and modulation quality). In particular, this can often be an issue when a feature is tested for the first time and the expected performance is not obtained. For higher order MIMO such as 4x4 and 8x8, where the power is split between the antennas, small fluctuations in the RF signal quality at high modulation coding schemes (MCS) can affect the expected data rates. MCS that use high modulation schemes such as 256QAM are particularly sensitive to RF signal quality. In the process of troubleshooting, it may be falsely concluded that the (e/g)NB has a scheduler problem, whereas the true root cause is poor signal quality due to low power levels, poor modulation quality, or excessive noise.

With VIAVI CellAdvisor 5G, the RF performance of the (e/g)NB can be continuously monitored throughout testing to quickly identify when measured throughput problems are a result of RF issues. This capability, in combination with the leading features supported in the TM500, can reduce troubleshooting time by allowing rapid validation of the quality of the RF signal—including power level and modulation quality—to identify any unexpected impairments that may be impacting signal sensitive tests.

Simplify the Setup of mmWave RF Chamber Tests

5G promises the benefit of mmWave technology to allow mobile operators to provide fixed wireless broadband services in enterprise and rural areas. Coupled with Massive MIMO, mmWave presents opportunities that are a viable alternative to fixed cable broadband services. The testing and validation of mmWave and Massive MIMO is, however, complex, costly, and often unreliable in an RF chamber. Ensuring that the chamber horn antennas and converters are positioned correctly to ensure the quality of the signal being received by the TM500 can be time consuming and can benefit from using CellAdvisor 5G for verifying the RF level of each beam and locating the horn antennas at the maximum power point of the beams.

One of the challenges of mmWave testing, even in an RF chamber, is to map the beam coverage and quality. In an outdoor environment, CellAdvisor 5G can show a layout of the beam intensity with the assistance of its built-in GPS receiver, which can be connected to a GPS antenna. In an RF chamber, CellAdvisor 5G can measure the different beam strengths at various locations within the chamber. The modulation quality and many other parameters can be checked as well, significantly reducing the time to validate mmWave and beam-forming.

Measurement and Reporting of Available Carriers and Common Beams

Utilizing CellAdvisor 5G to quickly validate the 5G NSA lab test setup before starting a traffic profile can detect issues such as poor/broken cable connections and errors with (e/g)NB configuration, allowing these problems to be corrected before the traffic profile starts. Addressing these problems pre-test eliminates debug associated with failed traffic test cases due to incorrect (e/g)NB configuration. Figure 1 shows a carrier aggregation scenario where path losses are similar for both carriers. All carriers (PCIs of 41, 42, 43, and 44) are showing similar and in range measurements for RF KPIs Channel Power, SS-RSRP, and PBCH-EVM.

RF cable connections for a previously good setup can be inadvertently disconnected, loosened, or otherwise impacted. The results of cable connection issues range from a carrier being missing entirely to poor UE performance due to excessive RF noise. UE performance impacts associated with cabling issues are very time consuming to troubleshoot as the root cause is not usually clear based on call processing statistics. CellAdvisor 5G directly measures and identifies key RF KPIs as shown in Figure 2 that are different from other carriers in the setup or out of the expected range, which can quickly identify RF cabling issues or (e/g)NB Downlink RF performance problems without needing to trace them back based on failed traffic statistics.

A key feature of CellAdvisor 5G is the beam analyzer. This measurement capability provides the PCI along with SSB Index and measures the SS-RSRP, PS-RSRP, SS-SINR, and SS-RSRQ for the eight strongest beams visible to CellAdvisor 5G. The Beam Analyzer can ensure that all expected common beams are visible to the UE, eliminating problems associated with common beam configuration in the gNB or similar gNB common beam transmission failures.

The beam analyzer can also be used to measure the different beam characteristics at various locations within the RF test chamber, ensuring horn antennas are positioned properly to provide the best downlink signal to the test UE.

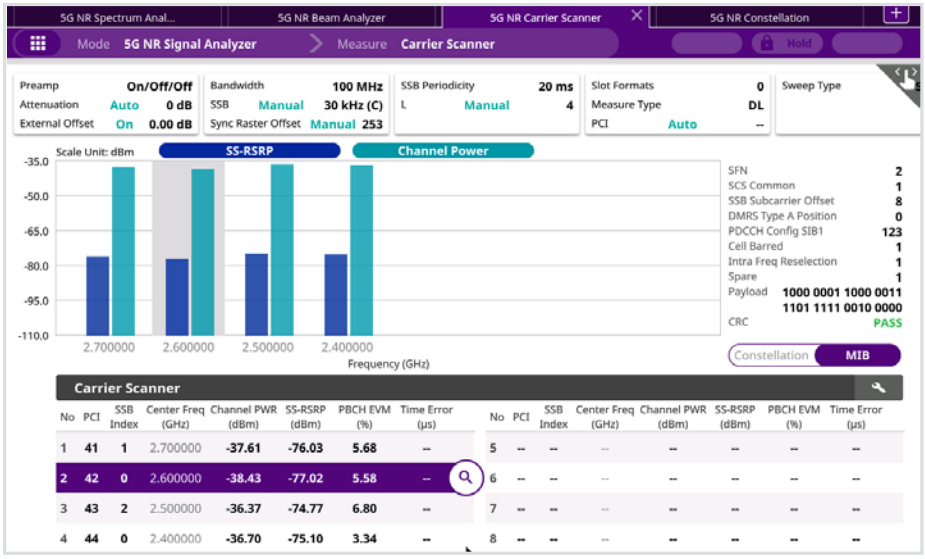


Figure 1: 5G Carrier aggregation scenario where path losses and signal quality are similar for all carriers

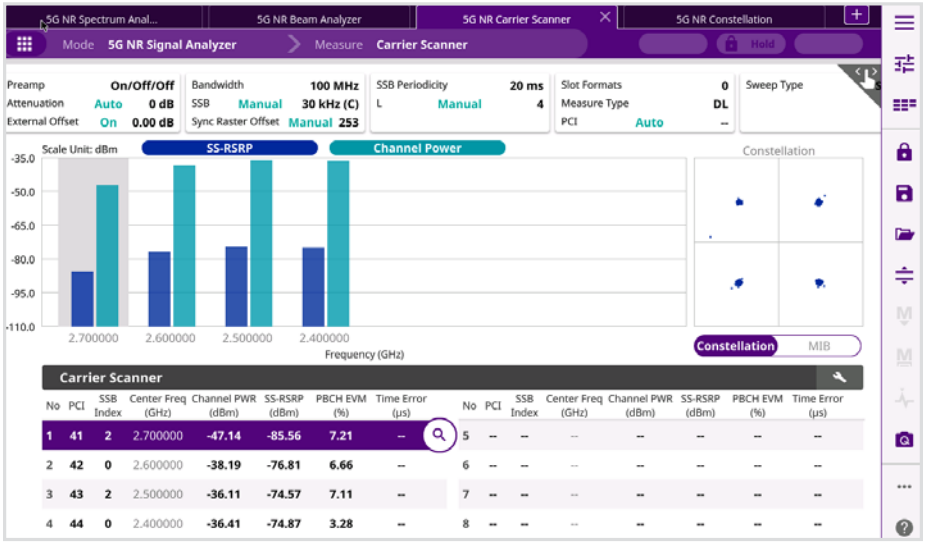


Figure 2: Quickly identify carriers with degraded channel power, SS-RSRP, and EVM relative to others in the test

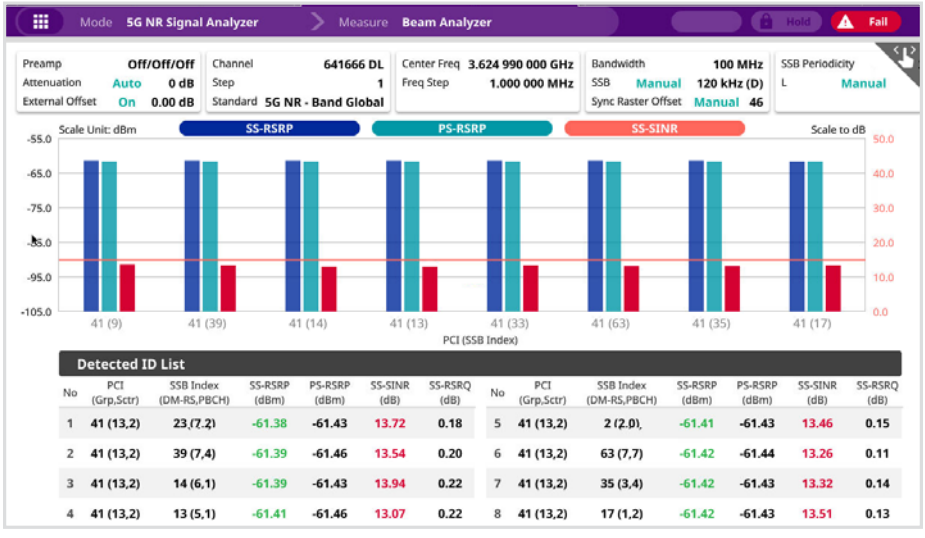


Figure 3: Identify the PCI along with SSB Index and the SS-RSRP, PS-RSRP, SS-SINR, and SS-RSRQ for the eight strongest beams

Real-time Monitoring of Carrier and Common Beam Performance Indicators

Failures in the (e/g)NB can result in brief outages or reductions in performance on a specific carrier or beam which often manifest themselves as a temporary drop in throughput or some related application-specific performance issue. There are many potential causes for a temporary reduction in throughput in a Radio Access Network, some of which are associated with poor downlink RF performance. The real-time carrier monitoring capabilities of CellAdvisor 5G real-time spectrum analyzer, carrier scanner, and beam analyzer allow RF measurements to be continuously recorded in real-time during the execution of a traffic profile. Recorded RF performance information can be evaluated quickly following failure of a test case to help identify the root cause of throughput or other related UE application performance issues when they are caused by problems with the (e/g)NB downlink RF.

Figure 4 shows CellAdvisor 5G real-time spectrum analyzer capturing a time gap in the transmission of the downlink signal on one carrier within a multi-carrier 5G setup.

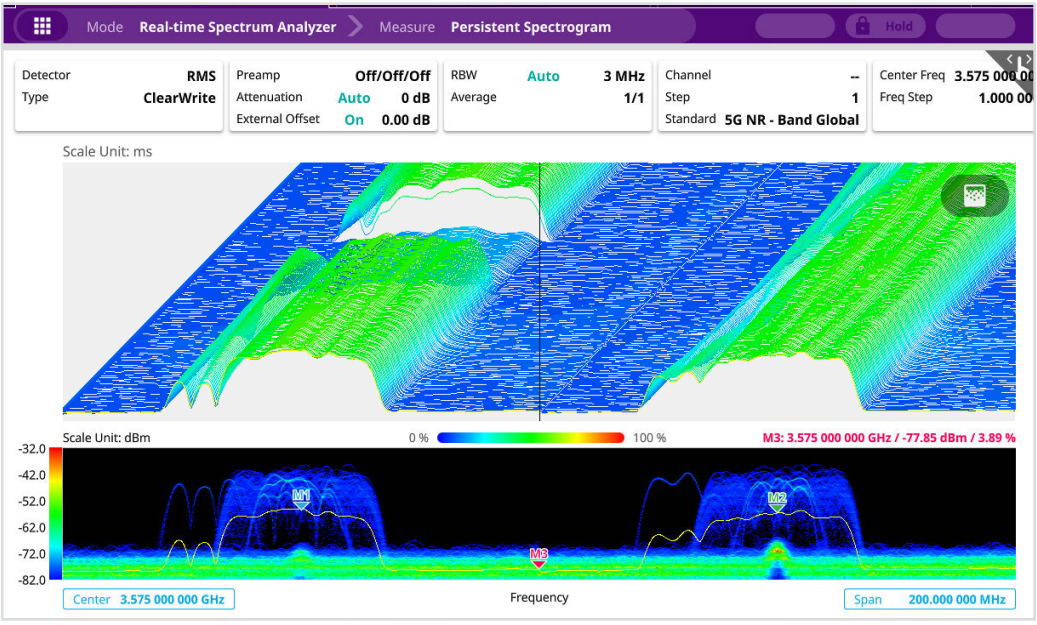


Figure 4: Temporary reduction in transmitted RF power on one carrier captured by CellAdvisor 5G persistent spectrogram

Real-time Spectrum Analyzer Shows RF Signal Over Time

CellAdvisor 5G real-time spectrum analyzer with persistent spectrogram graphically shows utilization of the 5G NR carrier over time. The spectrogram display provides the user with a view across the entire 5G NR carrier of how power is distributed over time. This capability provides insight on which subcarriers and hence resource blocks are preferred by the downlink scheduler. The increased utilization of the lower end of the 5G NR carrier in Figure 5 demonstrates a preference of the gNB to transmit data utilizing these particular sub-carriers.

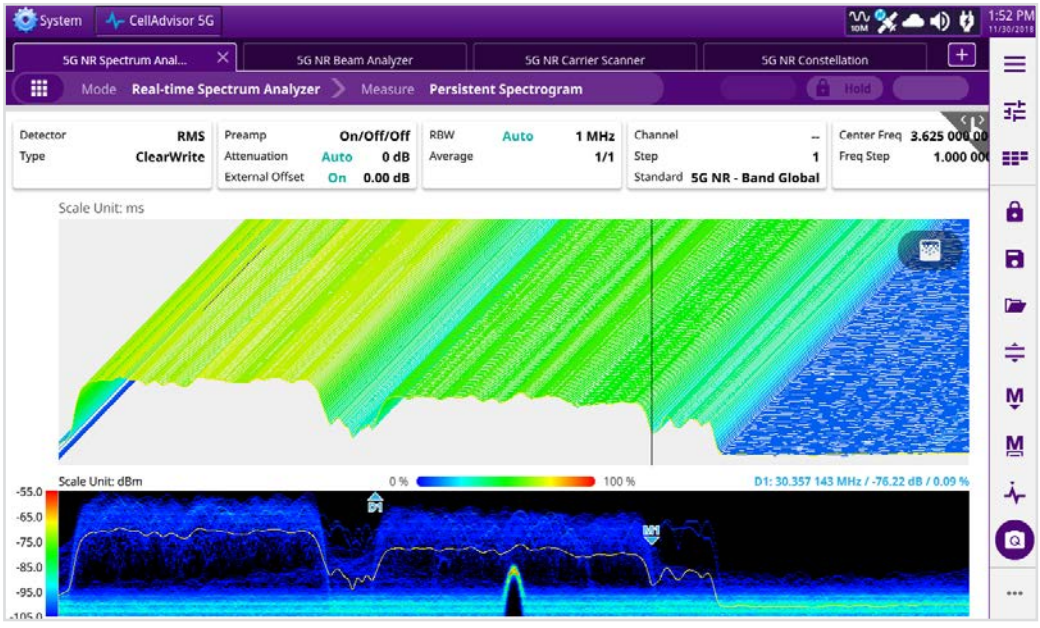


Figure 5: Preference by gNB for resource blocks at lower end of 5G spectrum highlighted by CellAdvisor 5G

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