WHY SHOULD WE USE RF SCANNERS?

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1. Introduction

According to the latest Ericsson Mobility Report, by December 2025 there will be 730 million mobile subscriptions in Latin America, out of which 80% will be LTE and 5G NR. Comprehensive performance monitoring and optimization of the mobile networks that will support these subscriptions will continue to be relevant for the years to come.

Currently, mobile network operators' RF optimization teams have at their disposal multiple tools that provide valuable data to assess the network's performance: traffic/event statistics, UE measurement reports data, signaling probe data, historical alarms, customer feedback via digital channels, amongst others. Even though these tools provide abundant useful information, direct measurements over the air interface ("Drive Tests") are still one of the main instruments for diagnosis and performance optimization of mobile networks, especially at the Radio Frequency level.

The deployment of new technologies leads mobile network operators, network equipment vendors and RF optimization firms to invest in new testing equipment. It is crucial to ensure proper selection of this equipment, ensuring that they allow correct measurement collection with the least investment.

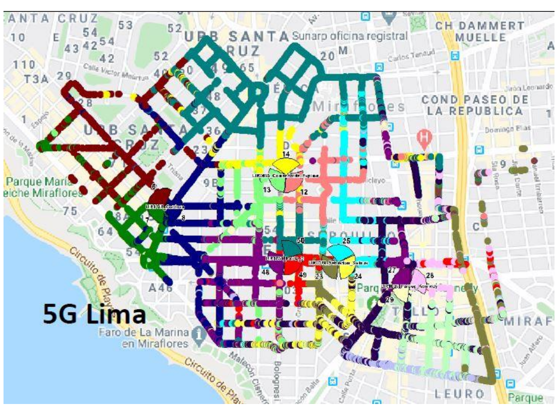

Figure 1 Best Server drive test plot for a 5G measurement collected in Lima, Peru using Celplan' s CellDigitizer Scanner

In this article we will briefly discuss the most common tools used to measure coverage and quality of mobile networks, emphasizing the importance of using a RF Scanner to rigorously evaluate these indicators.

2. Measuring coverage on mobile networks

Drive Test measurements aim to evaluate cellular network performance from a user's point of view, with an emphasis on the air interface. The results of the measurement are analyzed by RF engineers, who generate and implement actions that improve the quality of the service provided by the operator.

The typical equipment configuration in a drive test measurement consists of a computer with specialized collection software *(TEMS Investigation, Nemo Outdoor, Genex Probe, ROMES,* among others), to which one or more test terminals (typically smartphones compatible with the collection software), scanner and GPS are connected. The RF team in charge of data collection sets up the measurement under certain parameters and then collects measurements in a vehicle over a previously defined route.

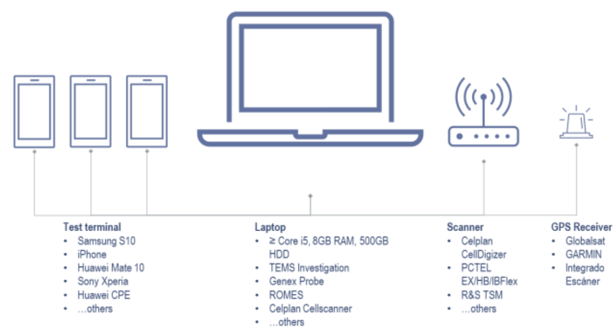

Figure 2 Basic diagram Drive Test equipment set up

Not all the components in the diagram above are always used. For instance, there are collection software solutions that run directly into the test terminals, removing the need for the laptop computer.

Note that in the diagram we include a RF scanner. This specialized device allows us to make more accurate measurements of signal levels. This equipment reports metrics "similar" to what a test terminal shows, with some key differences that we will explore in the next section.

Figure 3 CellDigitizer Scanner, Celplan

3. Scanner vs Mobile test terminal

If test terminals allow to perform measurements of signal strength and signal-to-noise ratio, then why should we use a scanner? The answer is that commercial mobile terminals have limitations in assessing RF conditions. Scanners, on the other hand, are designed specifically for this type of measurement, providing information that exceeds the capabilities of commercial mobiles.

In the following table we summarize the main differences between the two equipment types:

Scanner	Test terminal
Measures signal strength, signal-to-noise ratio per channel/code.	In addition to measuring signal strength and SNR, it evaluates access performance, retention, integrity, and mobility.
Measures all selected channels (frequencies)	Measures the channel where the mobile is camped or connected. It only measures different frequencies under certain conditions and does not do so continuously.
High dynamic range. Presence of dominant cells does not affect the ability to detect weak cells.	Lower dynamic range.
Typical precision of ± 1 dB*	Typical precision of ± 4.5 dB (± 9dB in “extreme conditions”) *†
High measurement speed (> 50 channels/second).	Lower measurement speed.
Periodic calibration allows maintaining the equipment’s accuracy over time.	It cannot be calibrated
Measurements are network independent.	Measurements depend on network configuration. Logical parameters not configured correctly can prevent measuring cells that are actually on service.
They do not require SIM cards, less organizational effort for maintenance	Requires provisioned SIM cards.
There is no impact on the network.	Uses network resources.
Flexibility to measure competitors' network frequencies.	To measure competitor networks, it requires simcard and that the bands are compatible.
Robust detection in inter-cell interference scenarios with the same PCI/PSC	Heavily affected by Co-PSC / PCI interference
Allows RSSI measurements over multiple frequency ranges, including uplink	It does not allow to measure the uplink
High cost	Low cost

Table 1 Feature comparison RF Scanner vs Test terminal

** Accuracy for LTE RSRP. It may vary for other metrics/technologies.*
† Value required by standard 3GPP TS 36.133 V15.9.0 (2019-12)

4. Why do we need a scanner?

Usually before starting a project or an optimization service, there is always the question of whether we need a scanner, given that its cost is significantly higher than performing the measurements with a commercial terminal.

Many people claim that with the terminal you can evaluate the user's behavior, since that is normally the most important thing in measuring the network quality.

As we can see in Table 1, adding a scanner in the test protocol allows access to more accurate information on the state of the network in terms of radio conditions. It is recommended to use this tool along with test terminals in order to make a comprehensive evaluation of the quality of the network at RF level.

The scanner is mainly used for troubleshooting and network optimization. The hardware and algorithms of a scanner are designed exclusively to perform measurements and collect all signals. On the contrary, the terminals have algorithms that due to their size, processing power and additional functions do not allow them to reach the details achieved by a scanner.

When there are failures in a network, scanners allow measurements and information to be collected, while a mobile terminal cannot register to the network.

The test terminals take the information from the signaling channels by measuring the channels indicated by the neighbor lists. The terminal is limited to the information received from the network and based on this data it performs its measurements, thus not detecting another cell that may be present and is not defined in the network.

Scanners can measure any signal on the radio interface independently of the mobile network, allowing other cells or signals to be found. The scanner can help reduce the time dedicated to optimizing the network and further show fault detection events, especially in expansion or swap projects.

Being independent of the network, a scanner can:

- Detect interference from own or external networks.
- It is useful in measurements in country border areas or where spectrum is shared with other operators.
- Allows you to identify undefined neighboring cells.
- There is no influence of network signaling.

On the other hand, scanners allow the evaluation of the entire frequency spectrum. Scanners allow you to scan multiple frequencies and technologies simultaneously, a useful feature especially for detecting external interference.

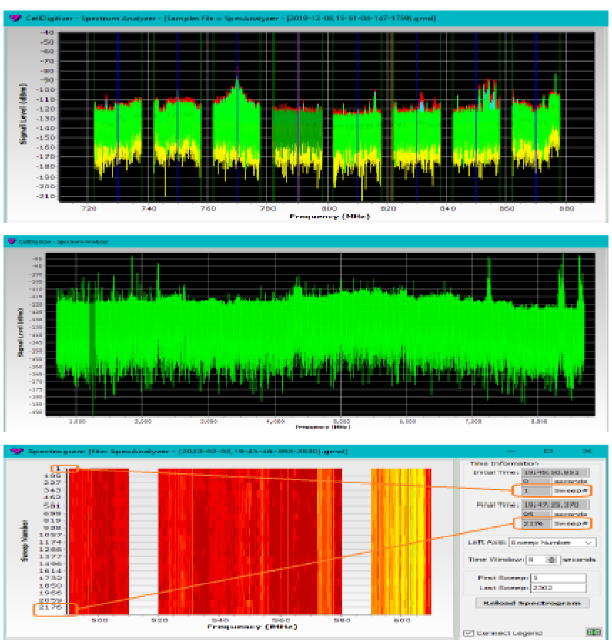

Figure 4 Spectrum analysis with CelDigitizer scanner and CellSpectrum software, from Celplan

5. What about 5G?

For 5G deployments, the use of Drive Test measurements with scanners and test terminals will continue to be relevant in the coming years.

Just like LTE deployments a few years ago, during the early stages of implementation of the new 5G networks, the availability of massive and valid self-generated data will be limited (OSS statistics, measurement reports, etc.), so operators must rely on field measurements to optimize the networks from the beginning.

The higher base station density expected with 5G increases the need for scanners to collect reliable measurements, given the limitations of mobile terminals.

Finally, from a data analysis point of view, the features of the new 5G air interface pose new challenges for RF engineers who have just operated LTE networks. The widespread use of mass MIMO technologies, as well as beamforming, introduces new variables that we must take into consideration during the analysis of logs collected in 5G Drive Tests. In a future article we will explore this topic in more depth.

6. Conclusions

The use of mobile terminals for Drive Test measurements will always be important, as they are the closest representation of the user's perception of the service provided by mobile networks. However, to effectively control signal strength and interference conditions is highly recommended using specialized equipment such as a scanner.

We will soon be publishing a brief study where we´ll show, with examples from live networks, some of the concepts presented in the article.

If you found it interesting, we invite you to share it!