VIAVI Solutions

Case Study

Extend Your Ability to Test for 5G Anomalies in Real-World Environments

Summary

Troubleshooting random 5G Radio Frequency (RF) link problems can be difficult and time consuming. Before you can identify the cause of the problem, you must first duplicate the conditions under which the problem occurs. This process can be frustrating and time consuming without the proper equipment and the correct personnel available. Failure to identify the root cause of intermittent problems can mean they go unresolved months, years, or possibly may never be corrected. This is where the VIAVI "Ranger" System can help.

The Ranger System is part of the VIAVI CMP (Configurable Modular Platform) product line (https://www.viavisolutions.com/en-us/products/modular-axie). It's ability to record massive amounts of RF spectrum for extended periods of time, which can then be played back for on-site evaluation or shared remotely, can facilitate diagnosing elusive and / or intermittent problems. In so doing, Ranger can be used in combination with other 5G tools, such as the VIAVI CellAdvisor 5G (CA5G) and the OneAdvisor-800, to complement the capabilities of a customer's current range of 5G tools by giving them the ability to repeat, or even reconstruct, scenarios for in-depth analysis.

The ability to capture large amounts of data and share that data with personnel at remote locations gives infrastructure manufacturers and service providers the ability to troubleshoot a 5G Cell Tower's issues in situ. In so doing, they can avoid the expense and time loss of transporting subject matter experts on site, allowing them to resolve network issues quickly and providing real-world financial savings and higher customer satisfaction ratings. These capabilities make Ranger a must have for infrastructure manufacturers and service providers.

Case Study

An exercise was conducted in Stevenage, UK (headquarters for the VIAVI 5G Wireless Division) in 2020 involving recording an active 5G cell tower that services both the 'EE' and '3' networks. To perform the exercise, European Solutions Engineer Barry Hack used a battery-powered pure sinewave inverter to convert the Ranger into a portable system, allowing recordings to be captured in Stevenage (Figure 1) as well as throughout the city of Nottingham, UK. The Ranger's 200 MHz instantaneous bandwidth was able to capture the entire 5G band around 3.5 GHz (commonly used by UK and other European markets), thus capturing both the 'EE' and '3' channels in a single capture. The following recordings were taken:

- a 10 second recording at 200 MHz instantaneous bandwidth
- a 5 minute recording at 200 MHz instantaneous bandwidth
- a 25 minute, full 200 MHz bandwidth recording while driving through the city of Nottingham UK

In terms of memory storage, the 10 second recording translated to approximately 5 GBytes of data, while the 25 minute 'drive test' recording produced a single 1.4 TB file. Given its capacity to record up to 12.8 TB, this was no problem for the Ranger system.

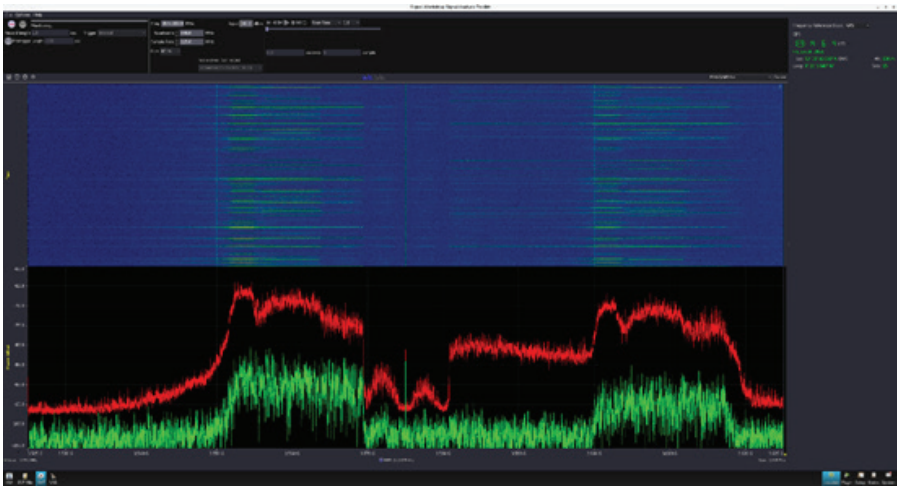

Figure 1. The Ranger live monitoring a Stevenage 5G cell site

The Ranger's GPS feature inserts highly accurate geolocation / time / date stamps into every recording (Figure 2) to facilitate precise time tracking, down to the sample.

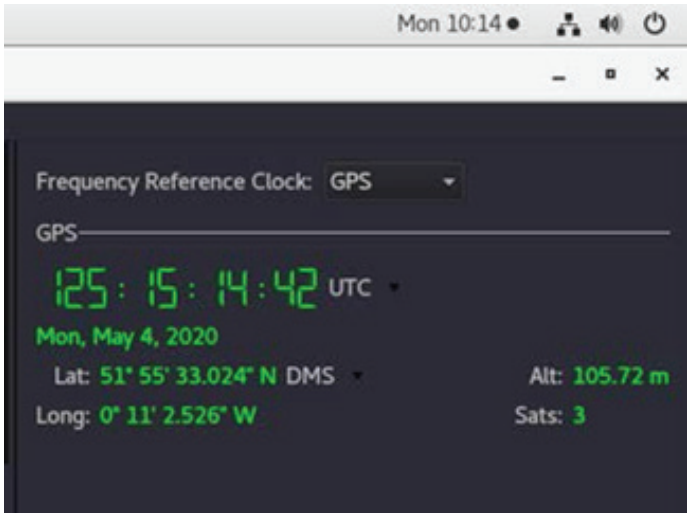

Figure 2. The Ranger's GNSS receiver information (example)

After the signal captures were acquired, these signals were taken back to the lab and played back at RF for post-analysis.

Post-Capture Analysis

The VIAVI Signal WorkShop™ (SWS) is the Ranger's waveform capture, analysis, creation, and playback software suite. Back in the office, the captured signals were played back using SWS's Vector Signal Player (VSP). The far right panel in Figure 3 shows VSP playing the file back as RF.

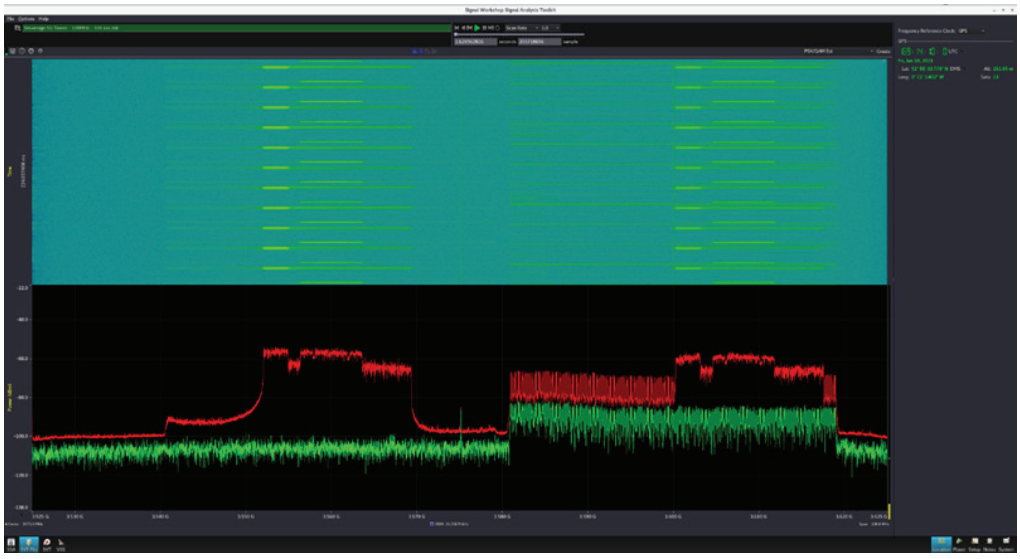

Figure 3. The Ranger's SWS displays captured file, while VSP (right panel) plays back the captured file at RF

The spectrum was then able to be analyzed using a VIAVI CA5G, which enabled visualization of the retransmitted spectrum, as well as facilitating further analysis of the 5G signals. The VIAVI CA5G applications engineer, Gilles Le-Breton, used SmartAccessAnywhere analysis soft panel (Figure 4) to remotely access the CA5G over a web conference from his office in France. In this manner, Gilles was able to decode both 'EE' and '3' downlink transmissions as if he were on site.

Figure 4 shows the Ranger's Vector Signal Player (VSP) being operated via VNC (in the background), while remotely viewing its output from the CA5G's SmartAccessAnywhere analysis soft panel (in the foreground). Thus, an

international team of unique subject matter experts were able to convene in ad hoc collaboration and recreate an actual field event with high fidelity in a laboratory environment.

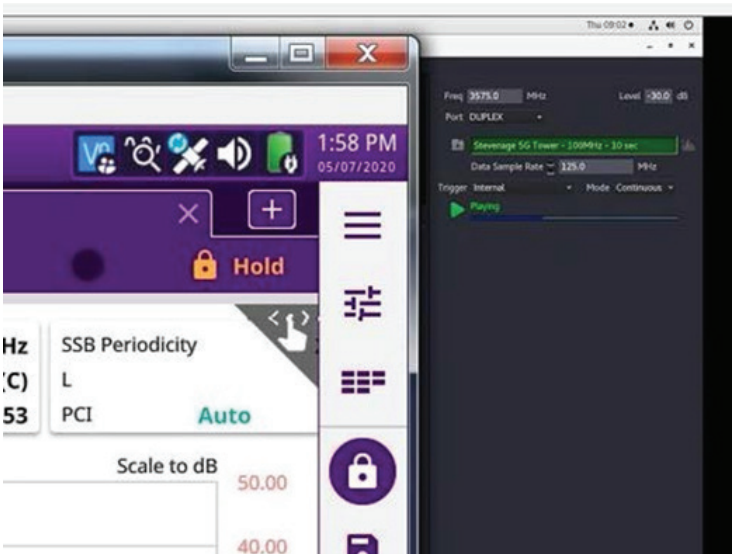

Figure 4. Remote Access to the Ranger via VNC and the CA5G via SmartAccessAnywhere

The results of their analysis showed that 'EE' followed the same structure as other European services. They also discovered that '3' consumed by far the biggest chunk of the spectrum, at roughly 100 MHz. Due to some anomalous or at least unexpected behaviors, they observed that '3' appeared to be running ***both*** 4G and 5G carriers simultaneously within their allocated spectrum (Figures 5 and 6).

The CA5G screen capture shown in Figure 5 shows that 'EE' consumed about 40 MHz of bandwidth (on the left side of the spectrum). The upper spectrum (circled in red) is the wider band of the '3' network, covering 100 MHz BW. Also, the Synchronization Signal Block (SSB) appears to be offset to one side, not in the middle of the channel (which is not typical).

Zooming in on the '3 network, shown in Figure 6, the CA5G screen capture highlights channel activity by indicating persistence of spectral activity through the dark blue color, while the yellow indicates peak.

Figure 5. The CA5G Spectrum-Bandwidth Analysis

Figure 6. Analysis '3' Network Channel Activity

Other VIAVI 5G experts were then called in to collaborate on investigating the quality of the 5G recordings and the Ranger's suitability for extended analysis. Their comments include the following:

"The first impression is very encouraging. We could find the settings of two distinct 5GNR signals of 40 MHz each inside the 200 MHz raw capture and playback of 'EE' and '3' (Figures 5 and 6). The 5GNR Beam Analysis and Carrier Scanner gave amazingly good readings from the Ranger recordings. All in all, I was very impressed by this exercise. It looks like both capture and playback are performed with very high fidelity (Figures 7-11). *And*, remember that the capture had been performed without an external bandpass filter, nor was the capture centered on the actual signal(s)." ***Gilles Le-Breton*** - *VIAVI CA5G expert based in France*

"The ability to perform field captures and post-analyze the signal in the lab is actually very cool, I am copying our RF Test Product Line Management Lead in South Korea for his awareness. He now has these IQ streams for 5G signals captured with the Ranger tool in case engineering wants to start looking at how they can use them within engineering. This provides an easy way to check out signals should the same method be required later for other sorts of more complex 5G signals (e.g. DSS, etc.) Of course, the Ranger's value in corporate collaboration does not end here, as these capture files can be ported into third party software, such as MATLAB or Mathcad for detailed, extended analysis, including demodulation." ***Genis Sanchez*** - *CellAdvisor Product Line Manager, VIAVI Spain*

"This will be of interest to our Tier 1 5G customers. The Ranger needs to be presented as part of our 5G portfolio going forward." ***Ulrich Mueller*** - *5G Account Manager Network Solutions Division, VIAVI Germany*

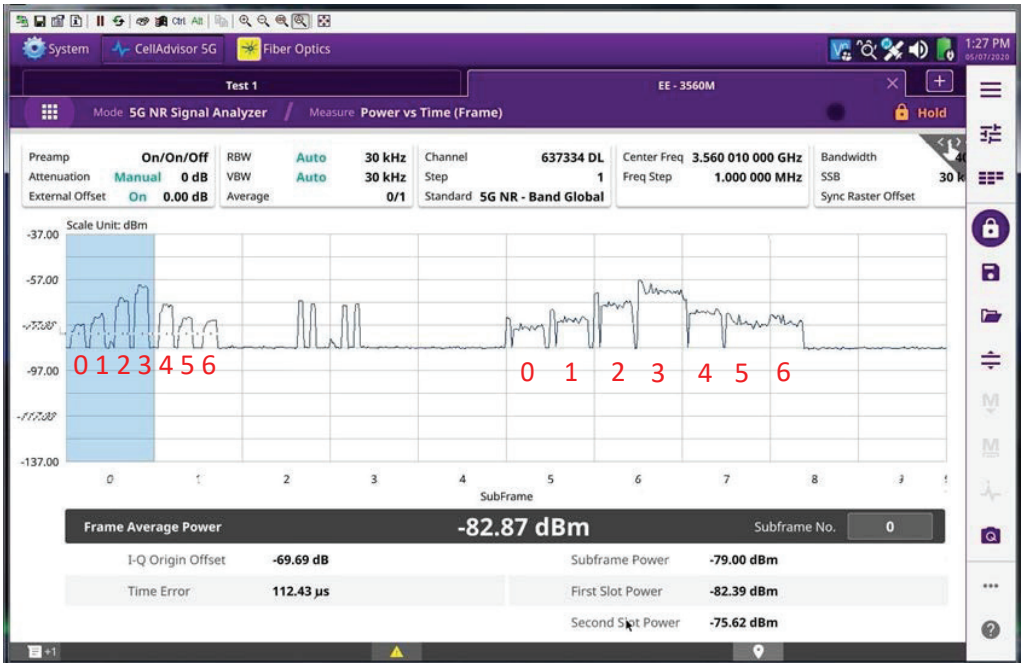

Figure 7. Above the 7 antenna array segments (marked in red) can be seen with their relative powers, antenna 3 is dominant

Figure 8 shows a screen capture from the CA5G Beam Analyzer being used to evaluate the '3' network. The results show good signal-to-noise ratio on '3' network for each of the beams (circled in red) from the second antenna, indicating the high fidelity of the Ranger off-air recording.

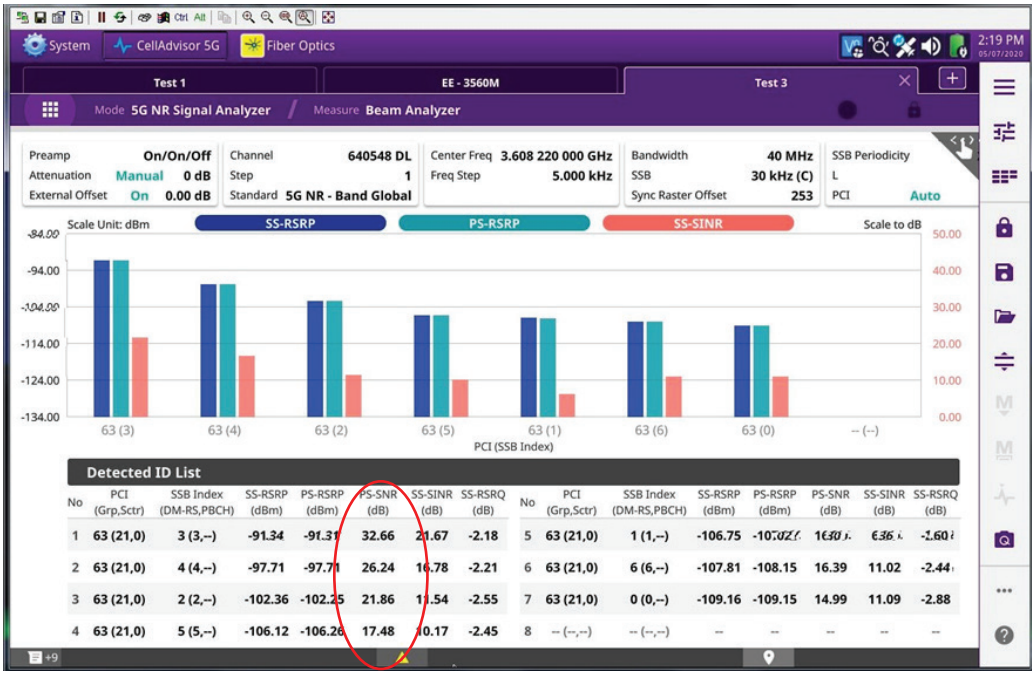

Figure 8. The CA5G Beam Analyzer '3' Network SCR Analysis

The CA5G screen capture in Figure 9 shows the 'EE' network, again, being retransmitted by the same Ranger playback file.

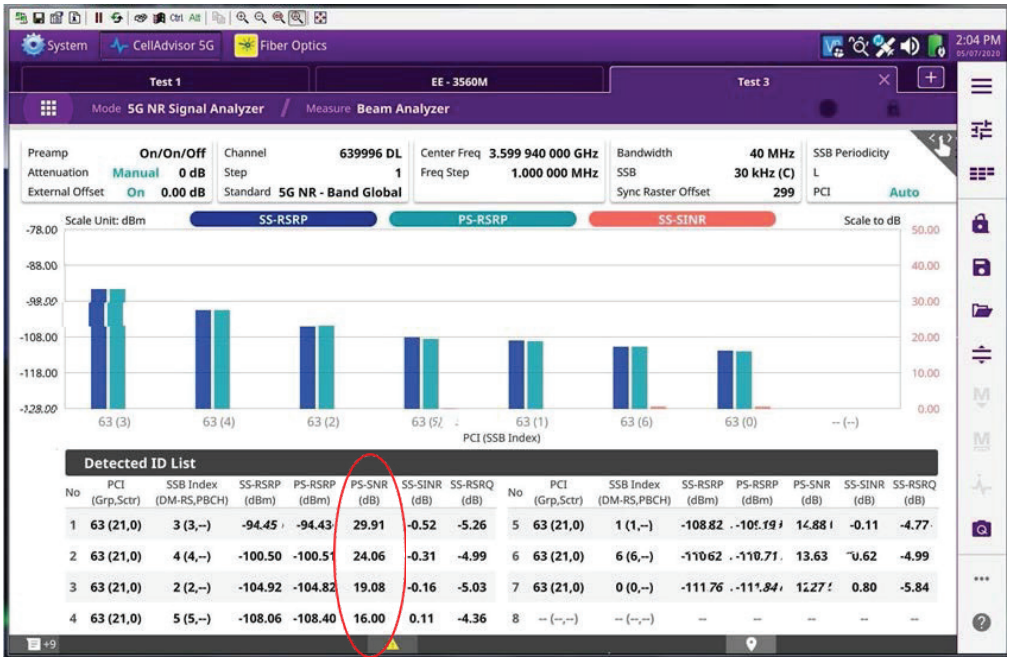

Figure 9. The CA5G Analysis on the 'EE' network

The Figure 10 CA5G screen capture shows more detail on each antenna element for the 'EE' network - note the excellent PS-SNR indicating a high fidelity recording of live field measurements.

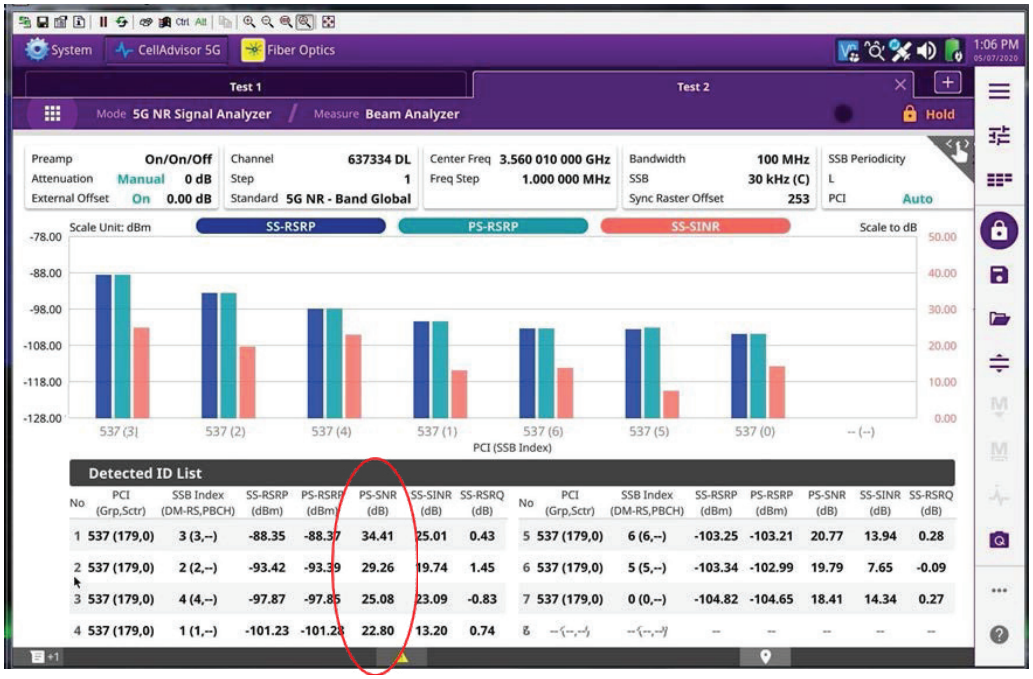

Figure 10. The CA5G analysis - 'EE' network antenna element

Figure 11 is a CA5G screen capture showing a visual representation of the fidelity of the QPSK constellation for a portion of the SSB, again from the same recording.

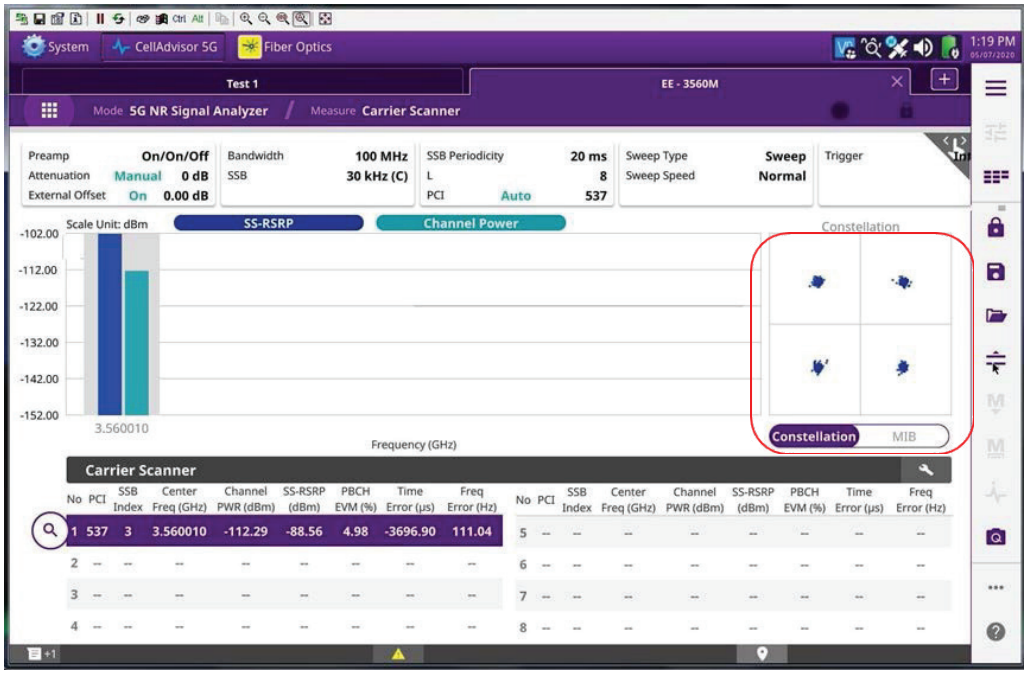

Figure 11. The CA5G QPSK constellation plot of SSB

Summary

- The Ranger extends the reach of the comprehensive VIAVI 5G portfolio, along with the OneAdvisor-800, CA5G, etc., by providing an excellent tool for collecting 5G RF recordings in the field and facilitating laboratory playback and analysis. This capability provides useful assistance in troubleshooting complex issues with emerging 5G live networks and can serve as the perfect transportable, shared-resource tool to extend the troubleshooting expert's reach throughout a deployment area, country, or geographic region.
- For OEM R&D or debug work, locally available technicians could drive to a problem cell site, make a recording, and send the recording to more highly skilled R&D team members at remote locations, giving them an opportunity to post-analyze the recording. The ability to involve team members at remote locations in the analysis process can represent large cost and time savings (versus having team members travel to the site).
- The ability to port the capture file's raw IQ pairs into customer-specific analysis software suites provides extended user-definable post-capture analysis.
- 4G / 5G decode, analysis, etc. is also required by military Electronic Warfare (EW) regiments and goverment entities. When combined with other analysis capabilities, Ranger and its software playback and analysis suite, Signal WorkShop, provides a compelling complement of tools for technical staff employed serving that market sector.

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