

Comparing the Performance and Accuracy of Scanning Receivers and Mobile Handset Based Solutions for WCDMA Field Measurements

Introduction

The purpose of this paper is to outline the advantages of using dedicated scanning receivers for the field testing of wireless mobile networks. As test mobile handsets become more advanced, some of these devices include scanning capabilities that could be initially thought of as potential replacement for the critical measurements provided by dedicated, purpose designed scanning receivers.

Faced with these two options, engineers, finding it difficult to choose the best test equipment for network measurement and optimization may erroneously choose the lower priced scanner without knowing the true benefits of industry grade scanning receivers. The cost of an inefficient and poor quality network can far outweigh the price difference of these tools.

Additionally, technical specifications can vary from vendor to vendor making it increasingly difficult to accurately compare performance and accuracy. For example, one particular handset in scanning mode has indicated the following performance specification:

“Acquisition time: 20 ms (typical, i.e. about 50 cells are measured each second)”

While this performance parameter may initially appear to be comparable to those of dedicated scanning receivers, we will illustrate why this conclusion is incorrect. The specification above lists the acquisition time to be 20 msec. Typically, the acquisition time is the process required to detect a new signal. However, based on the additional information provided in parenthesis, it follows that this specification refers to the number of scrambling codes being measured, and not to the time required to acquire a new one. Thus, 20 msec is not the same scanning period as typically defined on the specifications for a dedicated scanning receiver. Since each Top-N scan normally reports multiple scrambling codes, the scanning rate of the test mobile is much slower than shown. This paper will articulate a number of advantages of using a dedicated scanning receiver over a handset based solution in scanning mode. For additional information, please contact a PCTEL sales representative at RFS.Sales@PCTEL.com.

Test Campaign and Equipment Used

The test campaign that provided the data in support of this paper consisted of several drive tests conducted in a major metropolitan area, both in urban and suburban environments. Additional testing in a controlled laboratory environment complemented the field tests.

- a) The test mobile handset used in the test is a high performance mobile that can be utilized in either traditional mode (collects system information) or scanning mode. It is important to note that the handset can only be used in one mode at a time. In order to collect both system information messages and scanning receiver data, two handsets are required. It is also important to realize that not all handsets have scanning capabilities.

APPLICATION NOTE


- b) The dedicated WCDMA scanning receiver was used in its “high dynamic range” mode characterized by the following specifications: Measurement dynamic range of -26 dB for Ec/Io at 90% detection rate; and top-N scanning period of 20 ms typical for up to 32 scrambling codes.

Comparison of Mobile Handset to Scanning Receiver

The discussion that follows will show some of the advantages of using a dedicated scanning receiver over a mobile handset with a scanning mode. The data presented was obtained directly from the mobile handset and scanning receiver during the test campaign. After a quick review, the handset data seems to meet its documented specifications and in some cases overachieves.

The handset measured signal levels as low as -30 dB and multiple servers were detected in each scan. The scanning receiver achieved -26 dB and indicated a similar number of servers. Additionally, it seems as though the handset exceeds the scanning receiver’s measurement speed.

Upon closer review of the data (see tables below) a concerning trend emerges with the mobile handset data. As can be seen with the “Number of Servers” data, the Io values repeat a number a times for the mobile, however, this behavior is not seen with the scanning receiver data.

Mobile Handset Data			Repeated values	Scanner Data		
Time	# of Servers	Io		Time	# of Server	Io
43:58.1	9	-82.40		43:58.1	8	-66.72
43:58.1	9	-82.40		43:58.1	8	-67.72
43:58.1	9	-82.40		43:58.1	9	-67.56
43:58.1	9	-82.40		43:58.1	7	-65.23
43:58.1	9	-82.40		43:58.1	6	-65.41
43:58.1	9	-82.40		43:58.1	9	-68.03
43:58.1	8	-80.73		43:58.1	9	-68.05
43:58.1	8	-81.11		43:58.1	8	-66.56
43:58.1	8	-81.01		43:58.1	9	-68.26
43:58.1	8	-80.53		43:58.1	9	-68.35

Analyzing the “nth Best Server (Ec/Io) data shows the repetitive nature of the mobile handset data as well, and the absence of this behavior with scanning receiver data (see tables below).

Mobile Handset - n th Best Server (Ec/Io)								
1	2	3	4	5	6	7	8	9
-13.19	-14.81	-15.93	-20.6	-16.85	-18.92	-18.94	-19.61	-29.94
-14.81	-15.93	-20.6	-16.31	-16.85	-18.92	-18.94	-19.61	-29.94
-14.81	-15.93	-20.6	-16.31	-17.78	-18.92	-18.94	-19.61	-29.94
-13.28	-14.81	-15.93	-16.31	-17.78	-18.92	-18.94	-19.61	-29.94
-13.28	-15.93	-15.75	-16.31	-17.78	-18.92	-18.94	-19.61	-29.94
-13.28	-15.93	-15.75	-16.31	-16.5	-17.78	-18.94	-19.61	-29.94
-13.28	-15.93	-15.75	-16.31	-16.5	-17.78	-19.98	-19.61	-29.94
-13.28	-15.93	-15.75	-16.31	-16.5	-17.78	-19.98	-19.61	-29.94

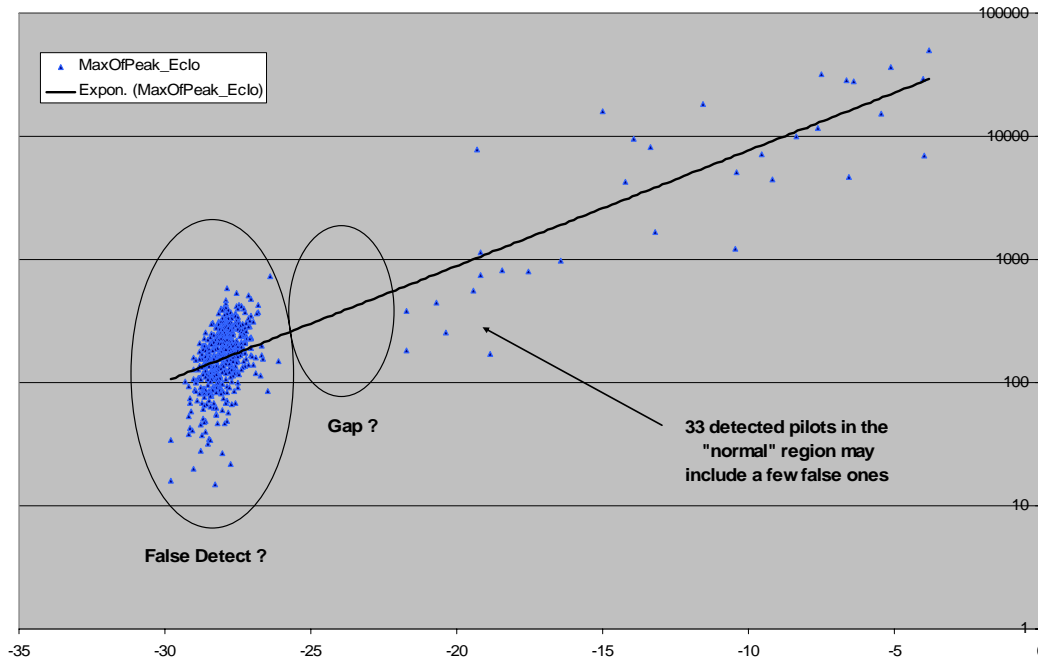
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Scanning Receiver - n th Best Server (Ec/Io)								
1	2	3	4	5	6	7	8	9
-13.57	-13.66	-21.31	-23.23	-21.39	-23.83	-25.89		
-12.19	-12.48	-18.87	-22.41	-19.86	-20.19	-23.22		
-11.02	-11.21	-17.92	-20.39	-18.84	-19.36	-24.56	-24.91	
-9.81	-10.34	-17.87	-18.26	-20.62	-18.73	-21.45	-23.02	-25.49
-10.55	-10.99	-19.25	-21.48	-19.71	-20.44	-23.35	-24.19	-25.35
-12.25	-12.31	-18.73	-19.99	-23.27	-21.55	-24.36		
-13.68	-13.91	-19.91	-21.69	-22.76	-23.08	-25.10		
-12.10	-12.78	-19.51	-21.20	-20.79	-22.38	-24.29	-25.58	-25.91

A more attentive look at the drive test data reveals that the mobile handset measurements for each pilot are repeated from 9 to 14, or more, times (on average 11 times). It is highly unlikely that the repeated measurements are unique samples, and it is plausible that the handset simply repeated the measurement until a new measurement was available.

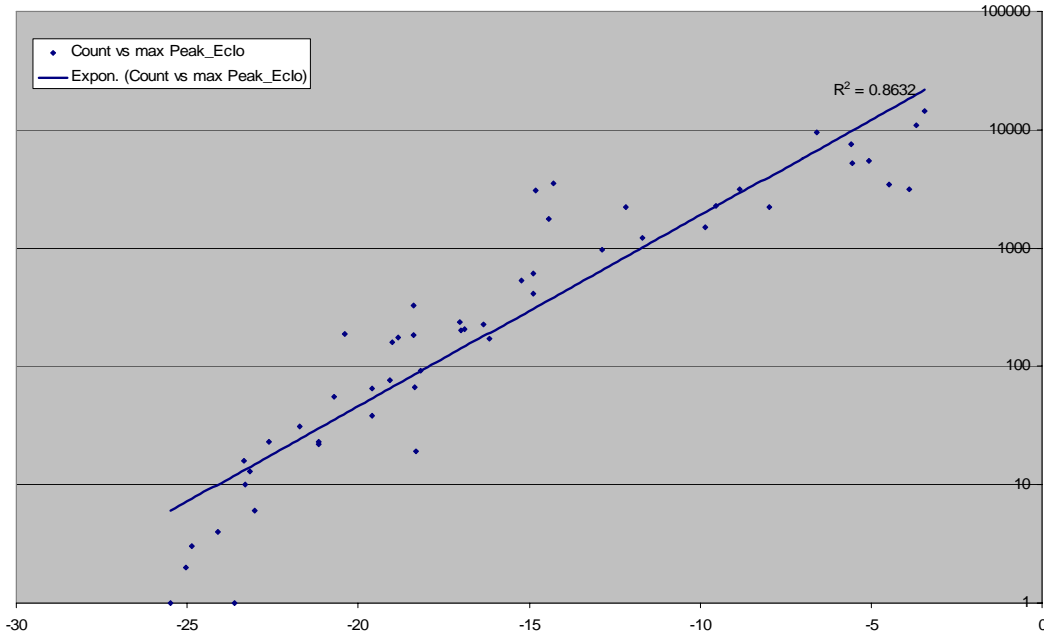
In analyzing the Top-N pilot data, the mobile handset reported identifying 509 unique pilots during the drive test compared to 52 pilots found by the scanning receiver. While the behavior of the Top-N scan remains too complex to yield simple quantified performance metrics, the data were reformatted to show performance for each of the detected pilots as well as for the totality of all measurements, no matter in what order scrambling codes were measured in individual scans. The following two plots show the distribution of the relative strength of the detected pilot.

Mobile Handset - Distribution of the 509 decoded pilots over the maximum peak value of the pilot



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Scanning Receiver - Distribution of the 52 decoded pilots over the maximum peak value of the pilot



In looking at the two pilot distribution plots above, it is clear that the mobile handset, while seeing a larger number of pilots, is actually reporting a significant number of false detections. The scanning receiver on the other hand reported no false detections during the drive campaign.

When taking into account, (1) the repeated nature of the mobile handset data, (2) the number of false detections, and (3) the valid detection range (i.e. no false detects) of the reported information, the following performance differences between the two devices begins to materialize:

<i>Parameter</i>	<i>Mobile Handset</i>	<i>Scanning Receiver</i>
Scan rate Top-N Cells/unit time	12 - 15 scans/sec 84 - 105 pilots/sec	45 -50 scans/sec 400 pilots/sec
Ec/Io level after which pilot detection rate starts to degrade	-17 dB	-26 dB
Maximum number of servers reliably detected and measured in each Top-N scan	7	12
Ec/Io threshold of false detections	-21 dB	No false detections observed

Conclusions

In order to have the best possible network, it is important to utilize the best drive testing equipment. Most experienced network engineers agree that in order to optimize the network both a handset and a scanning receiver are required. The handset is used to collect the system information messages and it provides a view of the network as seen by the customer's handset. The scanning receiver will accurately, reliably, and at high measurement speeds show all signals in the area including those that are not in use by the handset.

As described in this paper, the scanning receiver outperforms the mobile handset (in scan mode) in a number of very important ways:

- Scanning rate and corresponding density of valid collected data,
- Deeper dynamic range with fewer false detects,
- Visibility of a larger number of “Best Servers”, and
- Accuracy of the pilot measurements that have been detected.

Now that some handsets include a scanning mode, it is important to know the differences between a mobile handset in scanning mode and a dedicated, purpose-designed scanning receiver. Engineers may be tempted to believe that using a handset as a scanning receiver is a good cost savings measure, as it is possible to collect both scanner and system information data with the same device. However, the price difference between a technically inferior handset-only based systems and true scanning receivers does not accurately represent the true cost to the operator – revenue lost with an inferior network is far greater than savings on a handset-only based solution.

A mobile handset and a scanning receiver are singularly built pieces of equipment with specific purposes in mind. Adoption of one device to satisfy the objectives of the other will always result in trade-offs (performance, quality, etc.). Taking advantage of the design consideration of both devices would naturally yield a far superior drive test system.