Effects of Multi-Technology Scanning on Data Density

As global data usage expands, cellular operators are creating multi-technology 2G/3G/4G networks that require parallel investment in infrastructure, operations, and maintenance. For example, although LTE infrastructure expenditures are set to grow 81% through 2015, WCDMA is still expected to take up 70% of infrastructure spending.[1] While operators continue to invest in multiple networks, they can reduce the need for additional infrastructure by effectively designing and optimizing all network technologies. High density drive test data is crucial to this process, since it gives engineers and post-processing tools enough data points over a given area to accurately characterize the network.

To characterize multi-technology networks, operators need drive test equipment that provides good data density for all technologies. However, scanning receivers designed for single-technology networks will not produce the same data density when scanning three technologies. Operators relying on these scanners must conduct additional drive tests to obtain the same data density or suffer the costs associated with unidentified network problem areas.

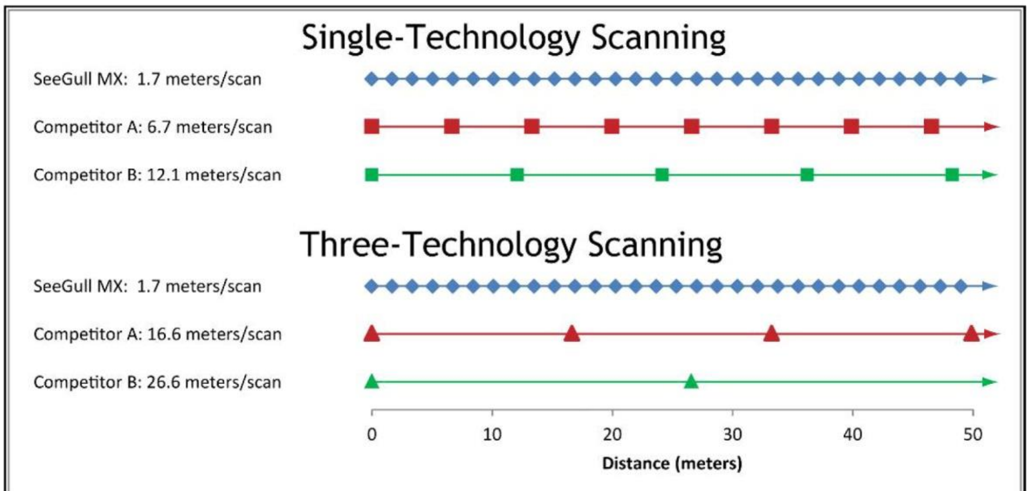

Figure 1: PCTEL SeeGull MX vs. Competitors A and B LTE Data Density at 60 mph, assuming 7-8 cell IDs. Each mark represents a data point. Source: PCTEL lab results, Feb.-Mar. 2011.

PCTEL's SeeGull® MX is designed specifically for multi-technology networks. Its concurrent scanning capabilities maintain data density by measuring and processing up to three technologies in parallel. In contrast, competitor data density is reduced by 2-3 times when measuring three technologies (**Figure 1**). Since its high data density is undiminished by multi-technology scanning, SeeGull MX is the best solution for operators looking to gather data on all network technologies in a single drive test.

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[1] Tracy Ford, "W-CDMA to generate most revenue through 2015, Dell'Oro says," RCRWireless, July 29, 2011, http://www.rcrwireless.com/article/20110729INFRASTRUCTURE/110729910/W-CDMA-to-generate-most-revenue-through-2015--Dell-Oro-says.

Why Does Data Density Matter?

Operators use scanning receivers to get a picture of the network's RF environment. Think of each measurement point collected by the scanner as a pixel. Data density is analogous to resolution, as determined by the total number of pixels. Poor data density makes it difficult or impossible for engineers, propagation models, and post-processing tools to clearly see the network. As a result, poor coverage or interference problems blend in with the surrounding environment, as illustrated in **Figure 2**.

Figure 2: Depiction, for illustration purposes only, of a network as seen with high data density (left) and low data density (right). Low density can cause differences in coverage or the presence of interference to blend in with the surrounding environment.

How Does Concurrency Help Data Density?

Data density is a function of the speed at which the drive test vehicle is moving and the speed at which the scanner collects data. Conducting slower drive tests is both impractical and expensive, so the best way to achieve high data density is to use scanning receivers that can maintain high scan speeds. **Table 1** shows the effects of three-technology scanning on LTE scan rates for the PCTEL SeeGull MX and two competitor products. The MX scans a single technology up to 5 times faster than the competitors. With three technologies, competitor scan speed drops, and the MX is up to 14 times faster. Inferior scanning receivers may claim to scan multiple technologies simultaneously, but they actually scan each technology sequentially. Concurrency allows the MX to truly scan multiple technologies simultaneously, maintaining scan speeds and, therefore, data density.

	Single-Technology Scanning				Multi-Technology Scanning			
	1-2 Cell IDs	3-4 Cell IDs	7-8 Cell IDs	15-16 Cell IDs	1-2 Cell IDs	3-4 Cell IDs	7-8 Cell IDs	15-16 Cell IDs
SeeGull MX	50.0	28.6	15.9	8.6	50.0	28.6	15.9	8.6
Competitor A	9.3	6.1	4.0	2.3	3.7	2.4	1.6	0.9
Competitor B	8.4	3.9	2.2	1.2	4.0	1.8	1.0	0.6

Table 1: PCTEL SeeGull MX and Competitors A and B LTE Scan Rate in scans per second by number of cell IDs detected. Source: PCTEL lab results, Feb.-Mar. 2011.

APPLICATION NOTE

Effects of Data Density on Drive Test Results

To test the value of concurrency, PCTEL conducted suburban drive tests of LTE, WCDMA, and GSM signals across multiple bands for each protocol. The PCTEL SeeGull MX, with its high scan rate, provides a detailed picture of the network environment. Competitive products with slower scan speeds result not only in a lower-resolution picture of the network, but also in unreliable or inaccurate data. Optimization efforts based on this inaccurate data may be ineffective, and may even result in reduced network performance.

Figure 3 shows Reference Signal Received Power (RSRP) data collected by the SeeGull MX in a vehicle traveling approximately 40 mph, with 8 cell IDs detected. The MX detected extreme volatility in the RF environment, with 31 dBm variations in RSRP in a 200 meter area. The red line representing competitor scan speeds reveals how low density can result in essentially random data. For example, a scanner collecting data at different times in the period from 40-80 meters might have shown RSRP levels of around -115 dBm instead of -103 dBm.

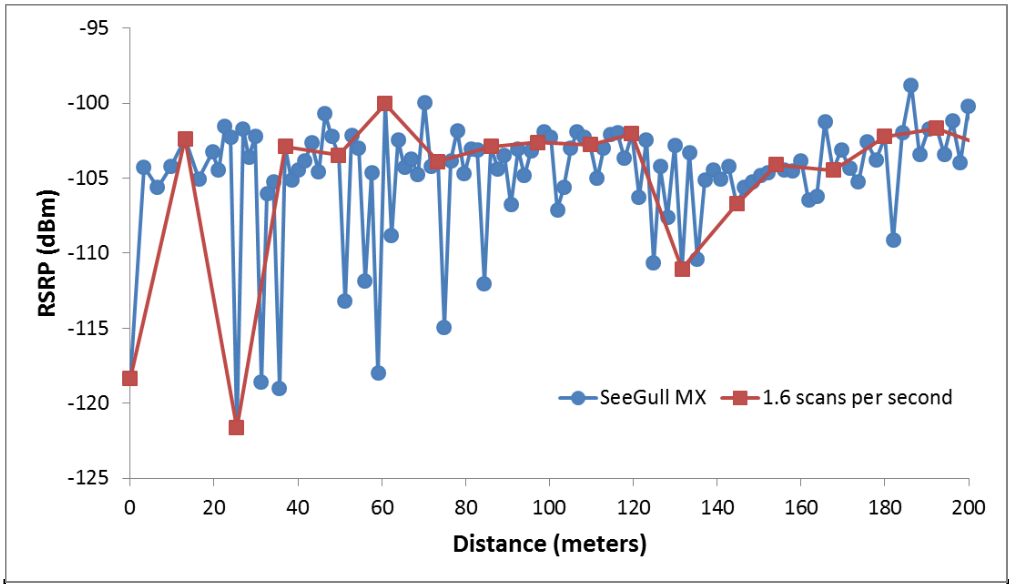


Figure 3: PCTEL SeeGull MX drive test data, June 2011. The blue line shows all data points collected by the MX. The red line includes one data point every 1.6 seconds from the same data set in order to isolate the effects of slower scan speeds, as found in Table 1 for Competitor A with 3-technology scanning, 7-8 cell IDs, and one band per technology.

Binning data by distance is a potential solution to the measurement difficulties posed by volatile signals. As shown in **Figure 4**, binning allows drive test and post-processing tools to correct for fast fading and other effects which result in signal volatility. However, low data density scanning may not produce enough data points for effective binning. In this example, the MX is able to effectively average multiple data points where slower scan speeds would result in less than one data point per bin. Regardless of whether an application uses binned or raw data, low data density produces an ineffective network characterization.

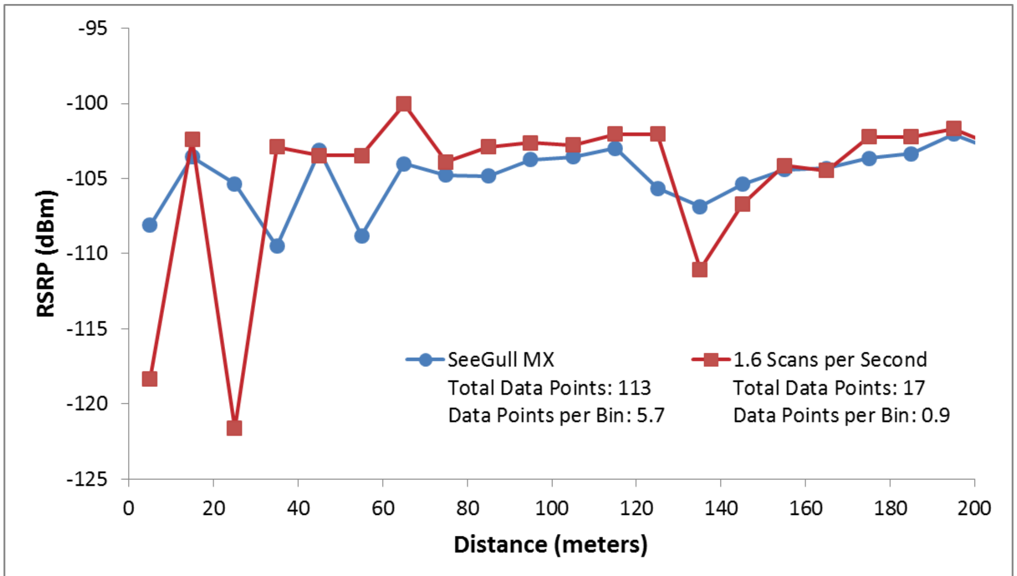
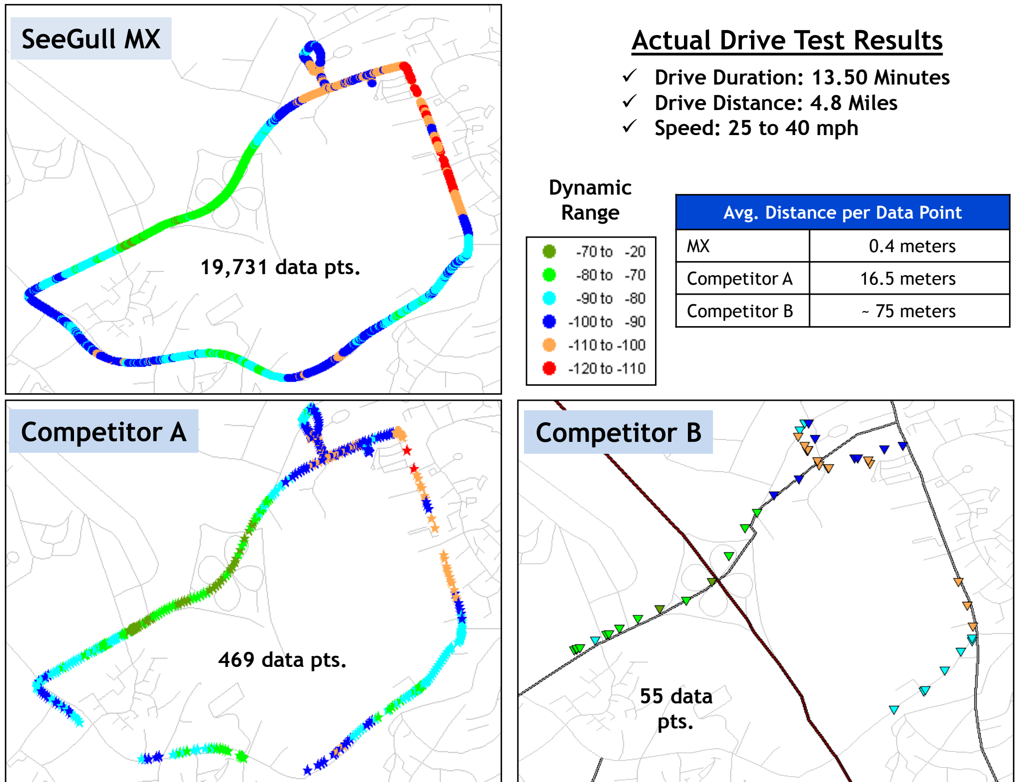


Figure 4: 10 meter binning of data from ***Figure 3****. The blue line bins all 113 data points collected by the PCTEL SeeGull MX, while the red line bins only the 17 data points shown in the red line in* ***Figure 3****.*

Data Density in High-Stress Scanning Situation

Raw scanning speed is not the only aspect of scanning receiver performance that can affect data density. Some scanners may have difficulty decoding signals in high-stress environments such as cell edges, areas with many neighboring cell sites, or areas with high levels of out-of-system interference. In these situations, certain scanner capabilities such as dynamic range and signal acquisition may also affect data density. **Figure 5** shows the results of a single drive test including the PCTEL SeeGull MX and two competitor scanners. Competitor data density for the sector shown is greatly reduced in certain areas of the drive, creating large holes in the data as well as a low overall data density.



Avg. Distance per Data Point	
MX	0.4 meters
Competitor A	16.5 meters
Competitor B	~ 75 meters

Figure 5: Competitive drive test results of PCTEL SeeGull MX compared to two competitors, Feb. 2011.

Conclusion

High-density data is crucial for accurate network characterization, but most scanning receivers are not designed for high data density when drive testing multi-technology networks. Inferior scanning receivers may report one data point per second or less for each technology on a network, leaving measurements vulnerable to effects such as fast fading, even when data is binned. PCTEL's SeeGull MX solves the multi-technology data density problem with high-performance concurrent scanning, producing superior data density in multi-technology lab and field tests. The MX gives operators the information they need to control costs while building, maintaining, and optimizing today's increasingly complex cellular networks.