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Competitive Network Benchmarking

Denver, CO Data Report

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Prepared for:

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Executive Summary

EnVision Wireless was contracted by Carrier A to conduct a competitive analysis of commercial wireless network performance in the Denver, CO market in November and December of 2007. This report represents the data measurement results of that survey.

EnVision uses the Agilent E6474A measurement system in the execution of these benchmarking surveys. This equipment allows for an accurate, repeatable network evaluation from a perspective that duplicates the discriminating opinion of the subscriber. Results collected in this method are independent of technology and are useful for comparison at the local, regional and national levels.

The following parameters were measured and compared for the Carrier A, Carrier B, Carrier C and Carrier D data networks:

Table 1:
Parameters Measured

Parameter	CDMA 1x	CDMA EVDO	UMTS
Call Events	•	•	•
Accessibility, Retainability and Composite Scores	•	•	•
Forward RLP Throughput	•	•	
Reverse RLP Throughput	•	•	
Application Throughput (Session)	•	•	•
Application Throughput (Instantaneous)	•	•	•
Mobile RX Power	•	•	•
Aggregate Ec/Io	•	•	•
Retransmitted Frames	•		
Access Latency	•	•	•
Serving SINR		•	
Requested DRC Rate		•	
ARQ Effective Receive Rate		•	
Active Set Pilots/Active Pilot Count	•	•	•
SCH Data Rate (Forward and Reverse)	•		

The following table summarizes the overall average results of the survey. For detailed results, please refer to the next section of this report.

Table 2:
Overall
Network
Performance

Carrier	Access Attempts (#)	Access Failures (#)	Dropped Calls (#)	Accessibility (%)	Retainability (%)	Composite Score (%)	RX Power (dBm)	Aggregate Ec/Io (dB)	Active Set Pilots (#)
Carrier A	4244	5	391	99.88	90.48	95.18	-67.59	-2.11	2.21
Carrier B	1230	6	164	99.46	85.02	92.24	-65.42	-6.79	1.14
Carrier C	430	0	32	100.00	91.60	95.80	-68.27	-6.30	1.23
Carrier D	1605	109	174	92.56	87.17	89.86	-78.31	-6.07	1.37

A detailed comparison of the data rates (DRC, ARQ, RLP and Application) measured during the survey is shown in Table 3.

Table 3:
Rate
Comparison
Table

	DRC Rate (kbps)	38.4	76.8	153.6	307.2	614.4	1228.8	2457.6	Weighted Average
Carrier A	DRC (%)	3.87	6.12	5.74	23.90	15.25	34.66	10.45	N/A
	ARQ (Kbps)	155.44	167.27	212.81	366.16	557.96	915.48	1534.64	698.37
	ARQ (%)	2.95	5.63	5.21	23.43	15.59	36.12	11.06	N/A
	RLP (Kbps)	94.93	114.48	153.80	243.97	316.44	394.72	488.27	320.18
	RLP (%)	3.37	5.47	5.15	23.38	15.61	35.54	11.49	N/A
	App (Kbps)	32.39	49.99	70.87	125.54	162.73	203.86	258.60	160.90
	App (%)	3.87	6.12	5.74	23.90	15.25	34.66	10.45	N/A
Carrier B	DRC (%)	5.08	15.10	7.78	30.83	12.13	21.11	7.97	N/A
	ARQ (Kbps)	114.29	149.86	199.43	352.97	561.90	873.40	1526.86	534.39
	ARQ (%)	4.54	14.86	7.79	30.49	12.65	21.47	8.20	N/A
	RLP (Kbps)	88.20	154.80	177.20	243.93	279.24	329.62	362.21	252.56
	RLP (%)	4.59	14.42	7.23	30.19	13.08	22.18	8.31	N/A
	App (Kbps)	35.30	68.69	82.80	116.17	140.41	166.85	175.12	120.63
	App (%)	5.08	15.10	7.78	30.83	12.13	21.11	7.97	N/A
Carrier C	DRC (%)	1.54	3.40	3.90	21.55	15.95	38.15	15.49	N/A
	ARQ (Kbps)	92.51	123.04	187.84	333.05	535.28	878.29	1582.15	738.74
	ARQ (%)	1.55	2.98	4.06	23.09	15.94	37.64	14.74	N/A
	RLP (Kbps)	60.02	133.84	159.50	216.69	270.09	279.02	317.61	258.41
	RLP (%)	1.70	2.94	3.62	20.70	15.95	39.48	15.61	N/A
	App (Kbps)	27.55	47.80	77.11	105.89	137.42	139.20	142.51	125.00
	App (%)	1.54	3.40	3.90	21.56	15.96	38.16	15.49	N/A

Detailed Data Results

This section provides the graphical results of the data performance survey. Composite statistical graphs are provided for the following metrics:

- ▶ Requested DRC Rate
- ▶ Forward RLP Throughput
- ▶ RX Power
- ▶ Session Mean Application Throughput
- ▶ Instantaneous Application Throughput
- ▶ Active Pilot Count
- ▶ Access Latency
- ▶ SINR
- ▶ RX Power vs. Forward RLP Throughput
- ▶ SINR vs. Forward RLP Throughput
- ▶ SINR vs. AT Requested DRC Rate

Figure 1:
Requested DRC Rate PDF

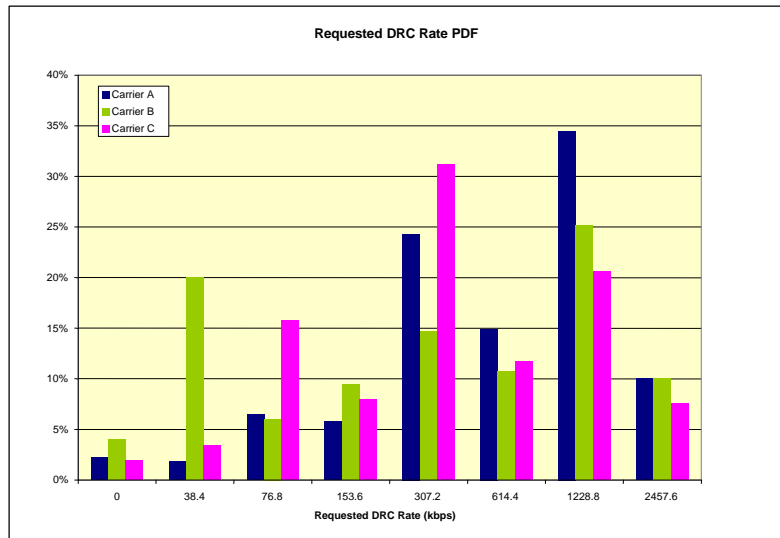


Figure 2:
Requested DRC Rate CDF

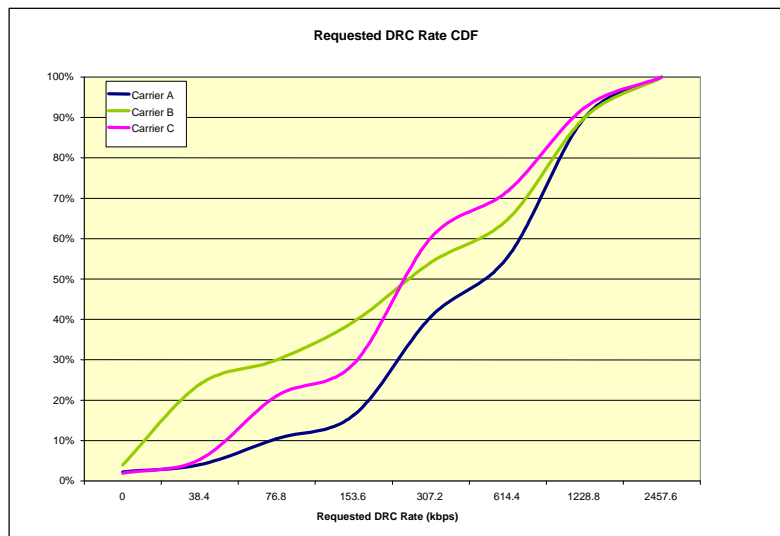


Figure 3:
 Forward RLP
 Throughput
 PDF

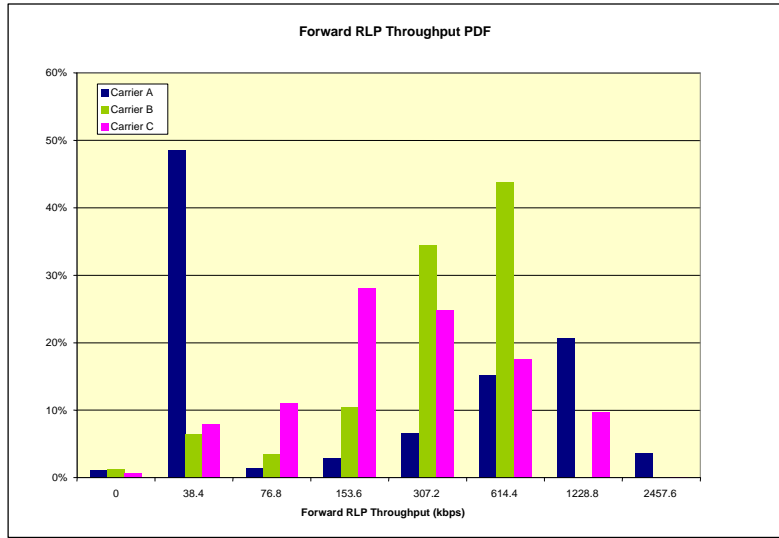


Figure 4:
 Forward RLP
 Throughput
 CDF

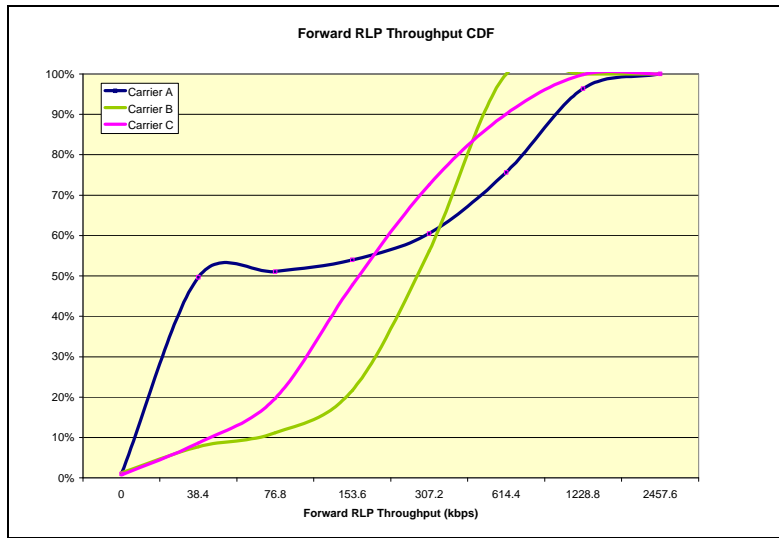


Figure 5:
 Mobile RX
 Power PDF

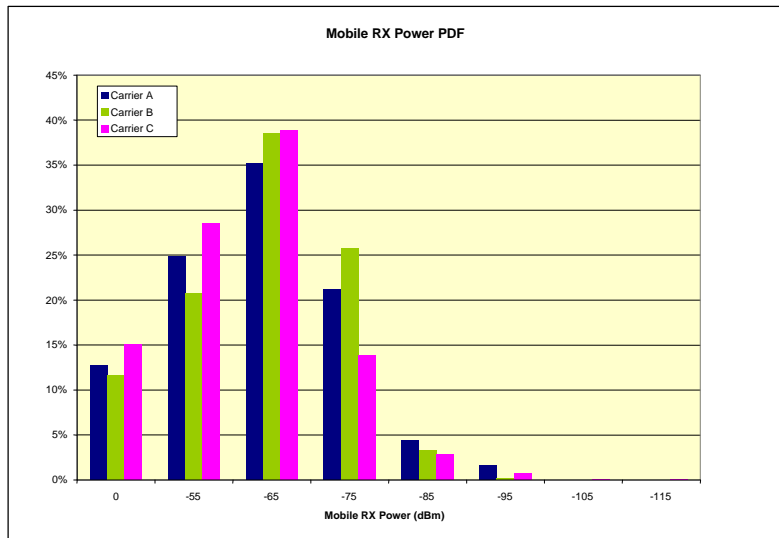


Figure 6:
Mobile RX
Power CDF

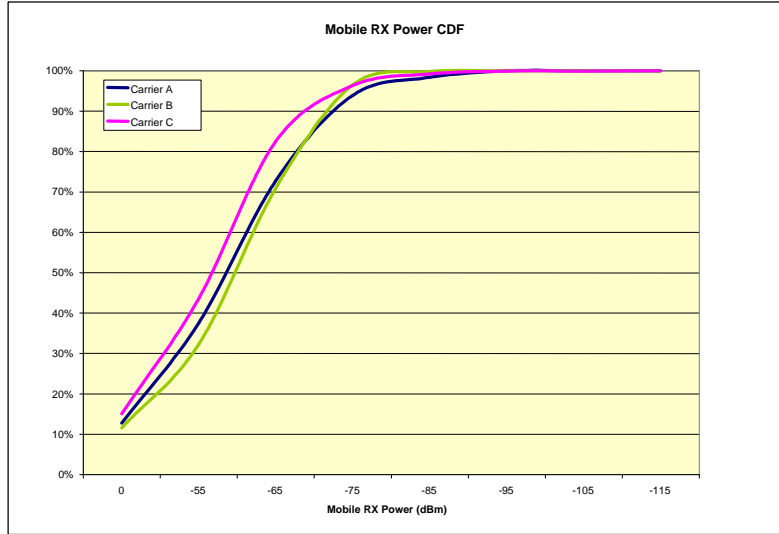


Figure 7:
Session
Mean
Application
Throughput
PDF

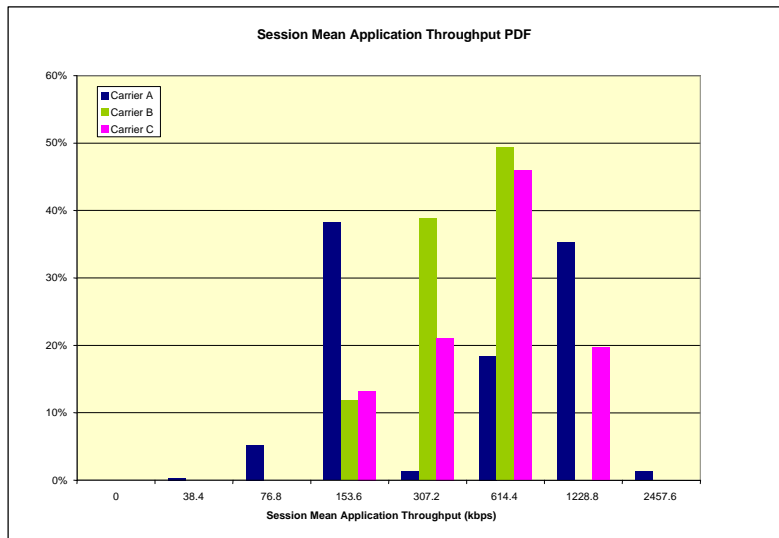


Figure 8:
Session
Mean
Application
Throughput
CDF

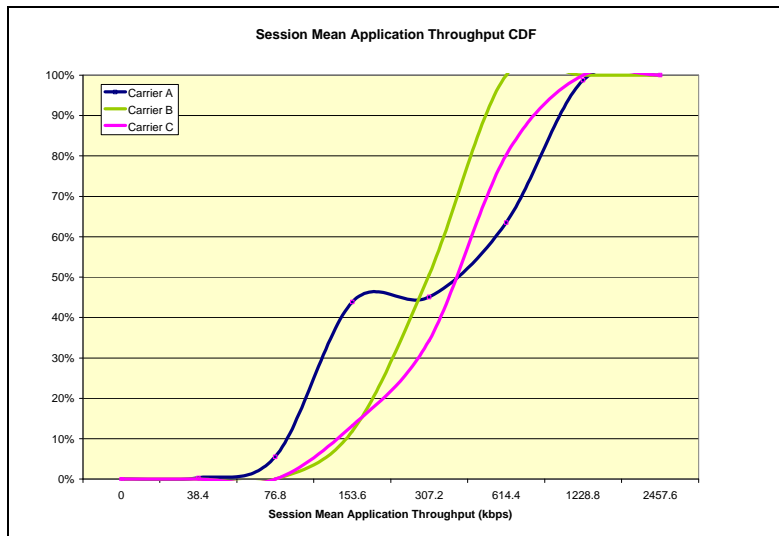


Figure 9:
Instantaneous
Application
Throughput
PDF

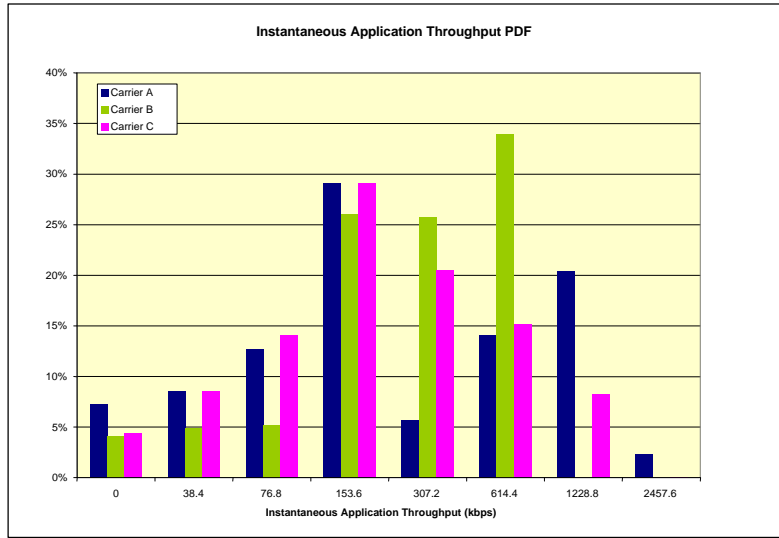


Figure 10:
Instantaneous
Application
Throughput
CDF

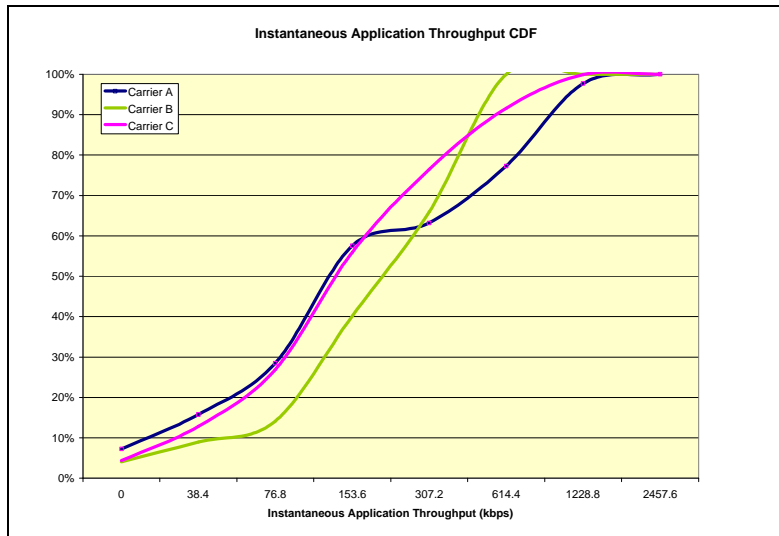


Figure 11:
Active Pilot
Count PDF

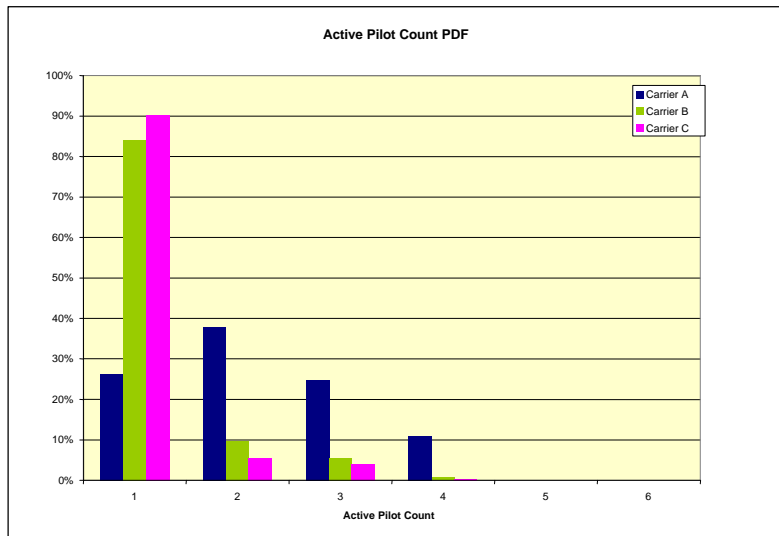


Figure 12:
 Active Pilot
 Count CDF

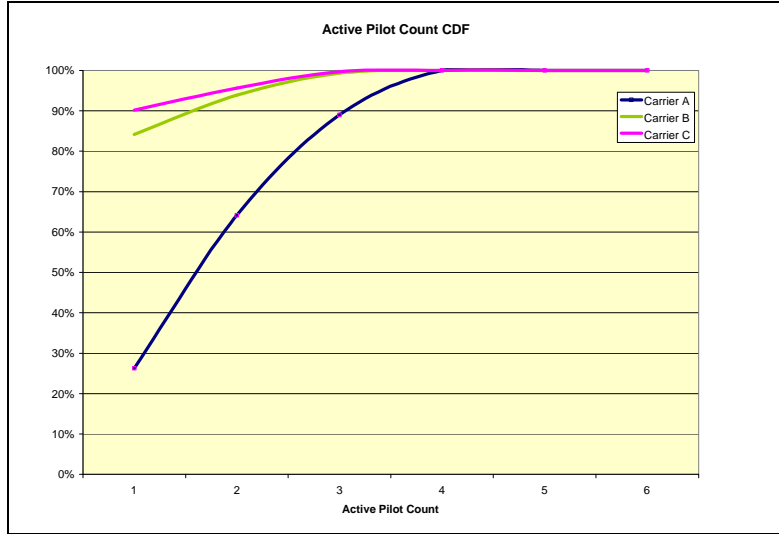


Figure 13:
 Access
 Latency PDF

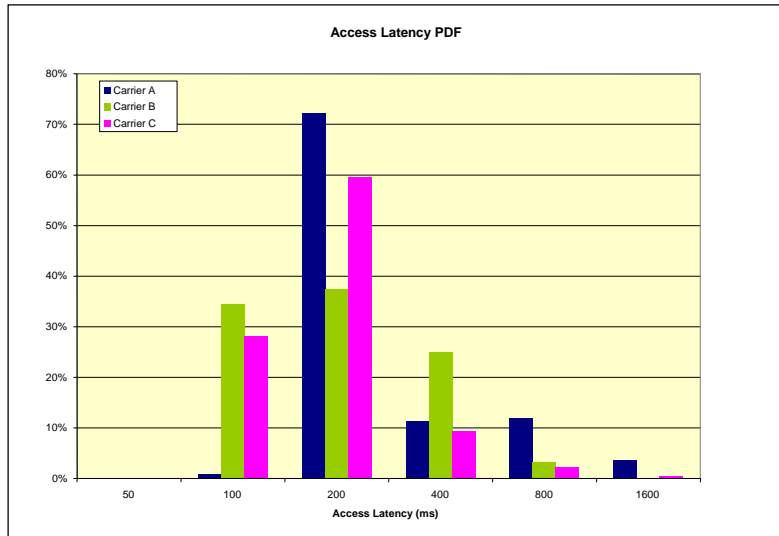


Figure 14:
 Access
 Latency CDF

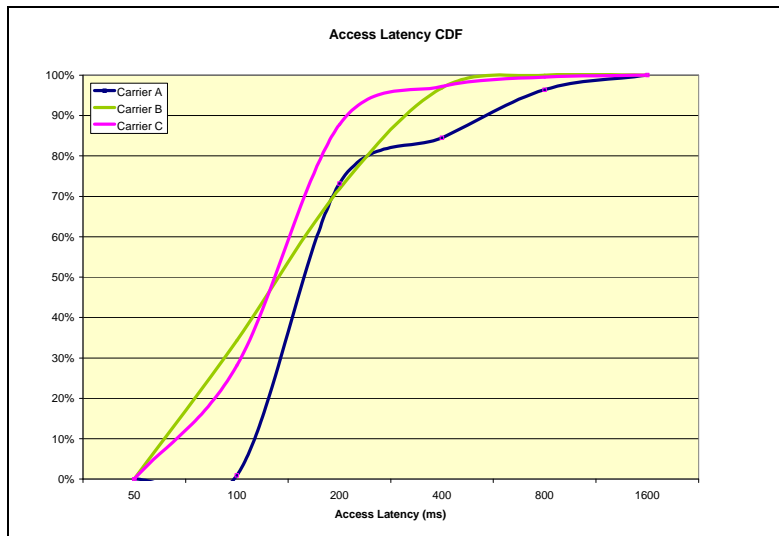


Figure 15:
Forward RLP
Throughput
vs. Mobile
RX Power

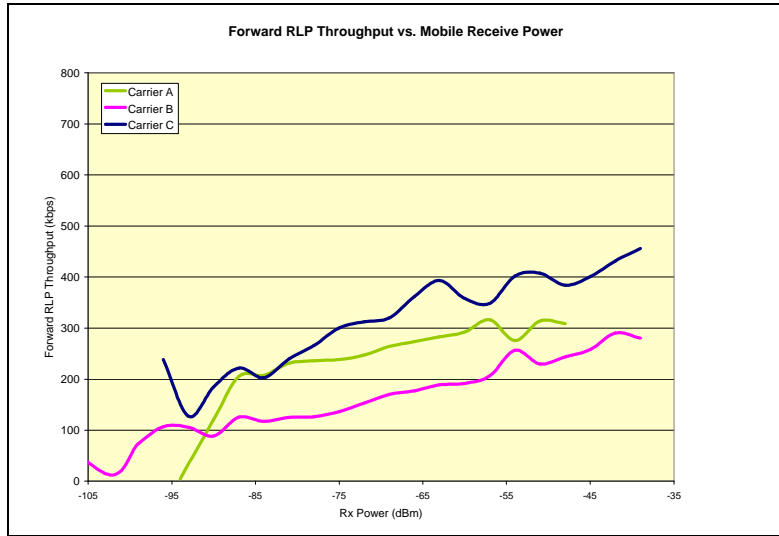


Figure 16:
Forward RLP
Throughput
vs. SINR

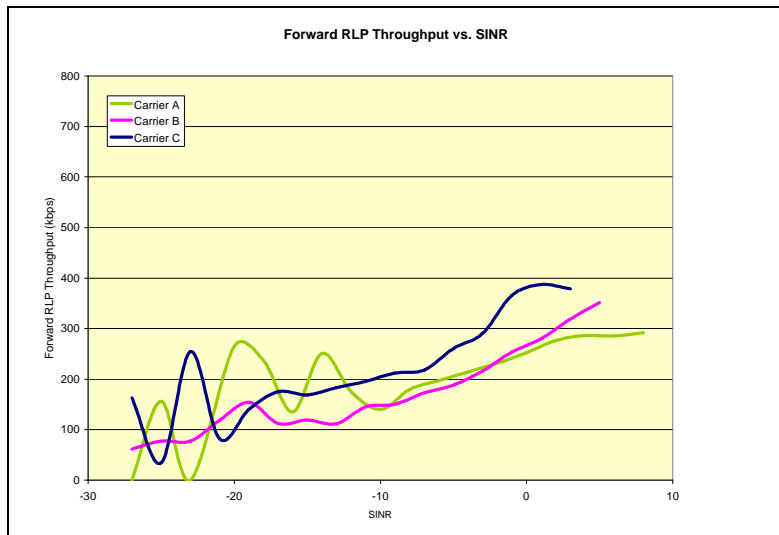
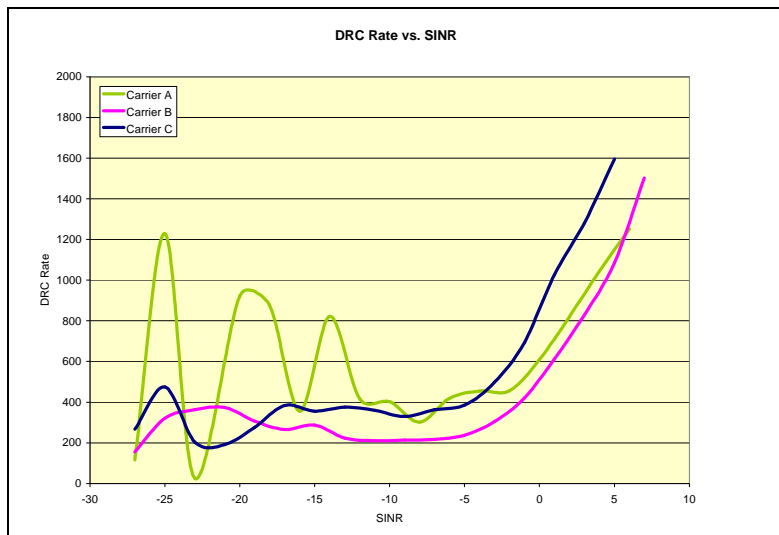


Figure 17:
Requested
DRC Rate vs.
SINR



Benchmarking Methodology

This section provides a summary of the project parameters used during the project.

Table 4:
Project
Parameters

Project Parameter	Value
Networks surveyed	Carrier A Carrier B Carrier C Carrier D
Handsets used	Carrier A - Kyocera KPC650 Carrier B - LG Musiq Carrier C - Kyocera KPC650 Carrier D - Samsung A707
Software used	Agilent E6474A (Nitro) Version 9.3 Qualitest Gladiator Version 3.0 Microsoft MapPoint Microsoft Excel Microsoft Word
Miles surveyed	Approximately 2000
Drive route selection methodology	Provided by Carrier A
Data collection window	12:00 p.m. - 9:00 p.m. daily
FTP profile	FTP Download - 10MB Wait FTP Upload - 1MB Disconnect Note: Only downloads are performed for competitive carriers.
Location of FTP server	Carrier A - provided by Carrier A All others - EVWI FTP site
Drive test vehicle	Standard mini-van
Dates of survey	November 29, to December 20 2007

Appendix

The following geographic plots are attached to this report.

Denver, CO (Data)
Drive Route
Call Failures - All Networks
Carrier A Call Events
Carrier A Data Mode
Carrier A Forward RLP Throughput (kbps)
Carrier A Requested DRC Rate (kbps)
Carrier A ARQ Effective Receive Rate (kbps)
Carrier A Instantaneous Application Throughput (kbps)
Carrier A Mobile RX Power (dBm)
Carrier A Active Pilot Count
Carrier A Aggregate Ec/Io (dB)
Carrier B Call Events
Carrier B Data Mode
Carrier B Forward RLP Throughput (kbps)
Carrier B Requested DRC Rate (kbps)
Carrier B ARQ Effective Receive Rate (kbps)
Carrier B Instantaneous Application Throughput (kbps)
Carrier B Mobile RX Power (dBm)
Carrier B Active Pilot Count
Carrier B Aggregate Ec/Io (dB)
Carrier C Call Events
Carrier C Data Mode
Carrier C Forward RLP Throughput (kbps)
Carrier C Requested DRC Rate (kbps)
Carrier C ARQ Effective Receive Rate (kbps)
Carrier C Instantaneous Application Throughput (kbps)
Carrier C Mobile RX Power (dBm)
Carrier C Active Pilot Count
Carrier C Aggregate Ec/Io (dB)
Carrier D Call Events
Carrier D Instantaneous Application Throughput (kbps)
Carrier D Mobile RX Power (dBm)
Carrier D Aggregate Ec/Io (dB)