TTY Forum Test Results Summary

Technology: TDMA / GSM / Analog

Contribution Date: 98.11.04

Contribution Number: 98.11.04.14

Contributing Company: Ericsson

Summary: This contribution outlines the testing done using GSM, DAMPS, and Analog technologies. The contribution outlines the test setup and execution as well as the results of the tests. A summary of the test results can be found on page 9 of the contribution.

The connection was a modified acoustic handset, and 2.5mm connector between the mobile and the TTY device.

TDMA Results NGT – 3.61%
GSM Results NGT – 2.23%
Analog Results - <1%

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TTY/TDD Compatibility Measurements (Preliminary Results)

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November 3, 1998

TOPICS

- TTY / DIGITAL WIRELESS COMPATIBILITY
- SYSTEM TEST SETUP
- TEST RESULTS
  - ANALOG
  - DIGITAL
  - GSM
- CONCLUSIONS

TTY / Digital Wireless Compatibility Issues

- <u>TTY Compatibility Issues</u>:
- Industry Standard for TTY devices
- Modulation using FSK Baudot 45.45
- Interface to digital wireless
- Performance tolerance

- <u>Digital Wireless Compatibility Issues</u>:
- Digital wireless optimized for voice
- Vocoder distorts sinusoids in FSK signaling
- Channel conditions
- Noise and Interruptions

TTY / Digital Wireless
System Test Set Up

- Conditions: Controlled Lab environment, stationary test
- Technology Tested: AMPS, DAMPS, DAMPS1900, GSM 1900
- Test Script: 1) Lober & Walsh Ver 1.1 Copyright 1998
  4000 + random characters
- Scored: PCER=number of missed and replaced character
  TCER= Baudot code character shifting
- Connection: Modified acoustic handset, and
  2.5mm connector between mobile and TTY device
- Network: AMPS 800MHz: Commercial Network
  DAMPS 800MHz: Internal Basestation linked to PBX
  DAMPS 1900MHz: Internal Basestation linked to PBX
  GSM 1900MHz: Commercial Network

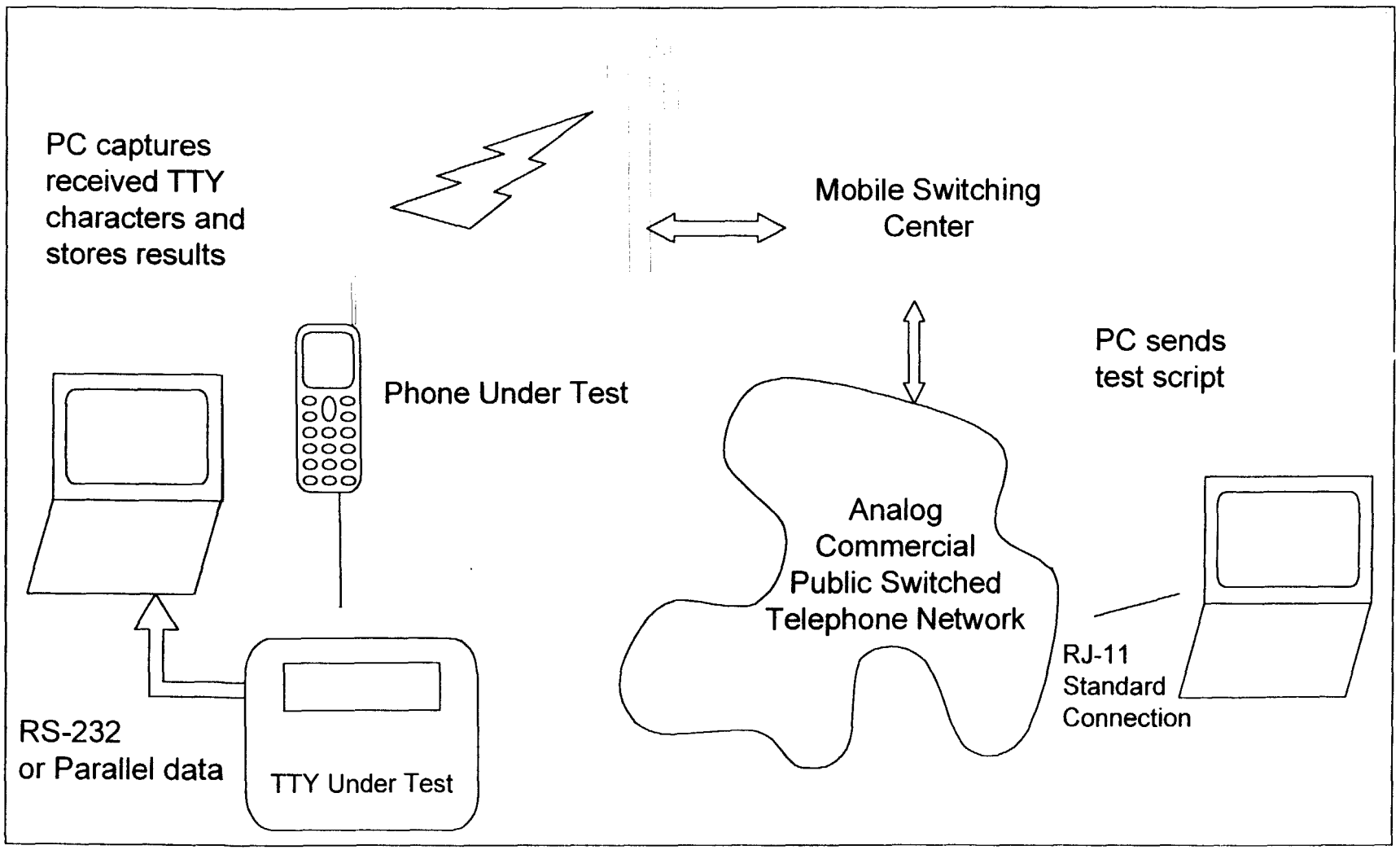
TTY / Digital Wireless
Test Data and Results
AMPS:

Using test script from L&W version 1.1 Copyright 1998
Device Tested: AF778

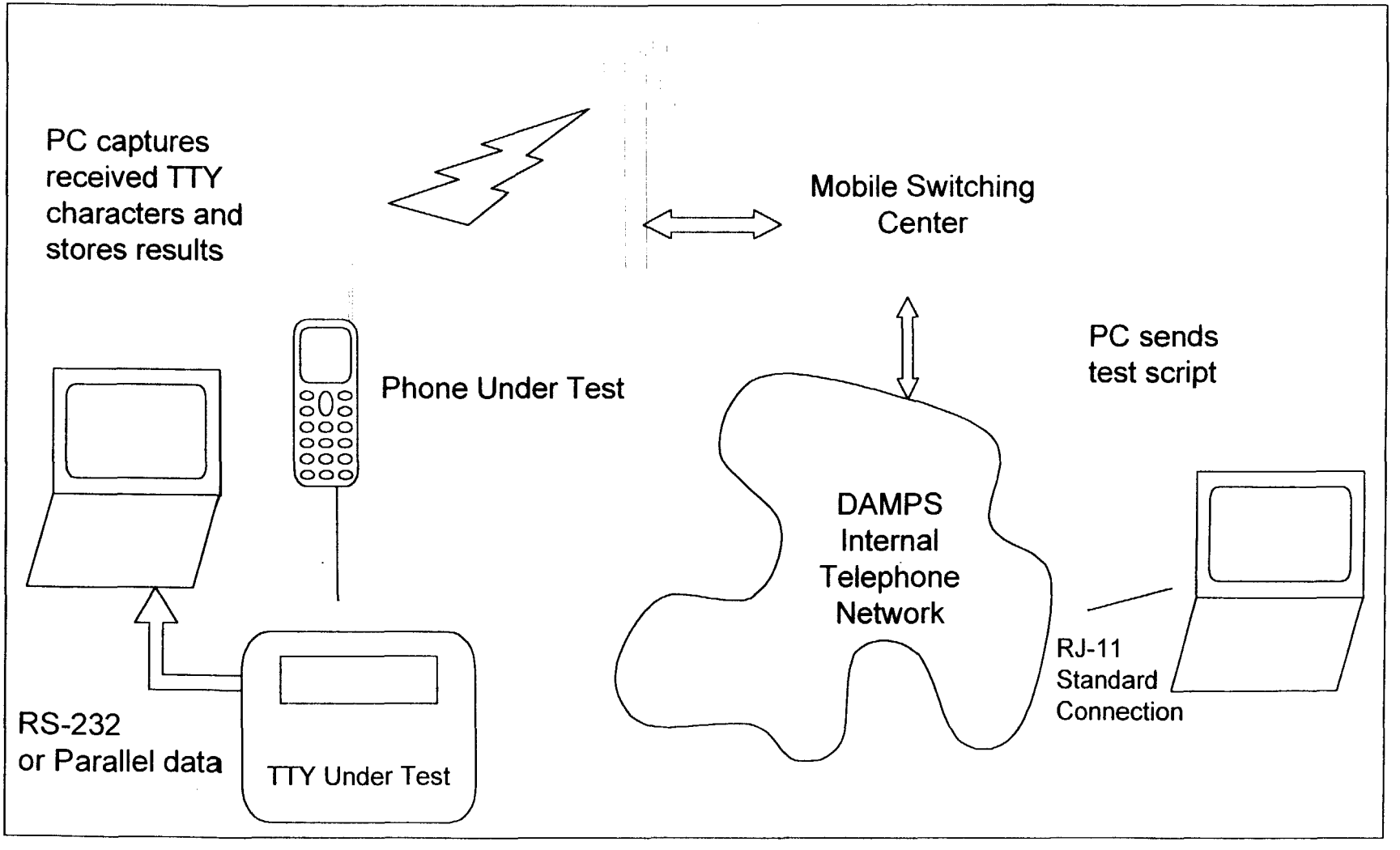
- *Uplink:*
- Percent Error (PCER) = 0.26
- Total = 4216, Correct 4205, Added = 0, Missed = 3, Changed = 8
- Percent Error (TCER) = 0.08
- Total = 6225, Correct 6220, Added = 0, Missed = 4, Changed = 1

- *Downlink:*
- Percent Error (PCER) = 0.02
- Total = 4216, Correct 4215, Added = 1, Missed = 0, Changed = 1
- Percent Error (TCER) = 0.02
- Total = 6228, Correct 6227, Added = 1, Missed = 0, Changed = 1

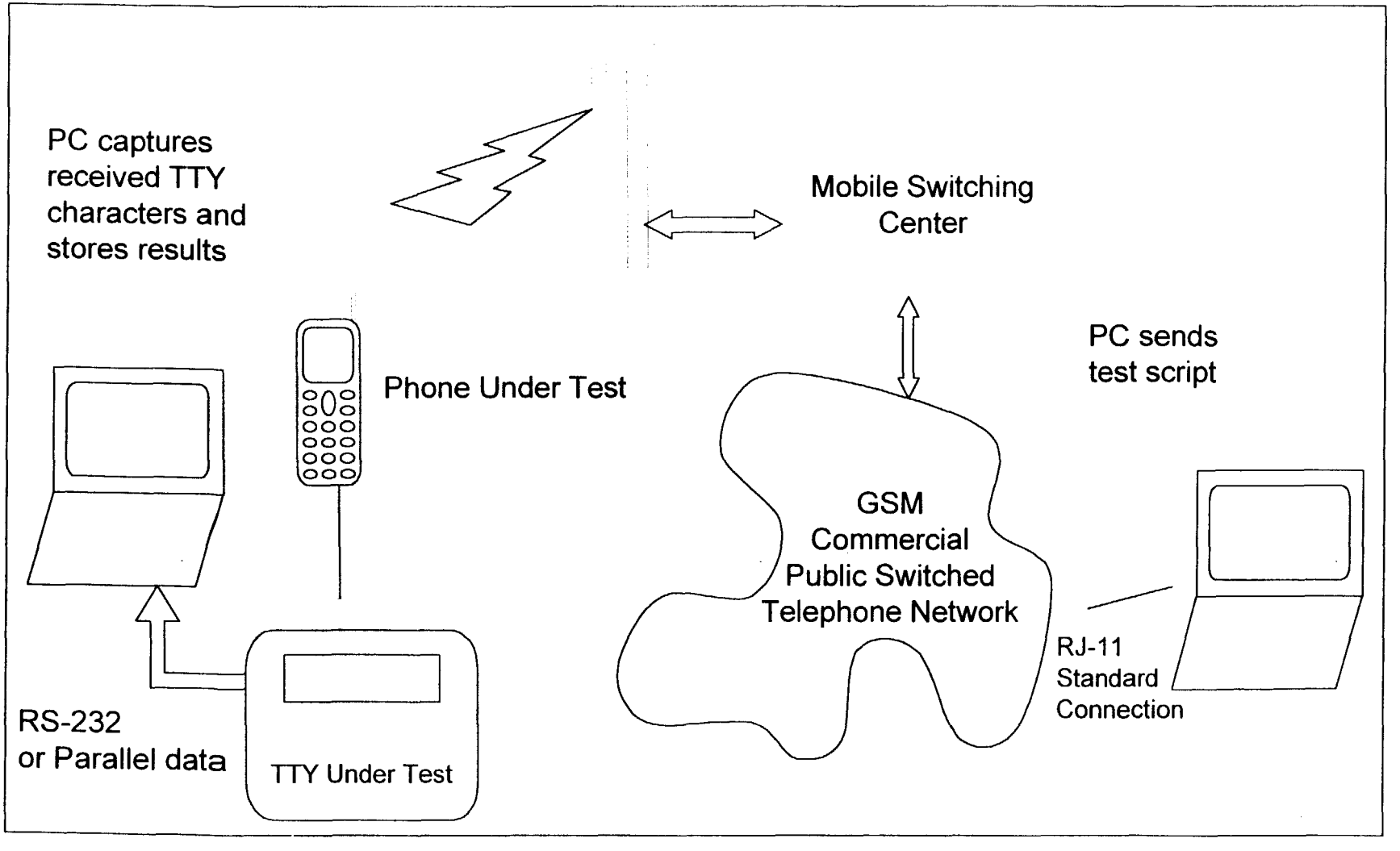
AMPS Mobile Termination Configuration



DAMPS Mobile Termination Configuration



GSM Mobile Termination Configuration



Test Results

No.	Link	Technology	TTY	Phone	Rate	Envir	Set	Test	Technology	Vocoder	TCER	PCER
1	Uplink	AMPS	Ultratec	AF778	3/4	Lab	AC	Static	IS-19		0.00%	0.04%
2	Downlink	AMPS	Ultratec	AF778	3/4	Lab	AC	Static	IS-19		0.00%	0.00%
3	Uplink	AMPS	Ultratec	AF778	3/4	Lab	DC	Static	IS-19		0.00%	0.04%
4	Downlink	AMPS	Ultratec	AF778	3/4	Lab	DC	Static	IS-19		0.00%	0.00%
5	Uplink	AMPS	Mobility	AF778	3/4	Lab	DC	Static	IS-19		0.08%	0.26%
6	Downlink	AMPS	Mobility	AF778	3/4	Lab	DC	Static	IS-19		0.02%	0.02%
7	Uplink	GSM1900	Mobility	CF688	3/4	Lab	DC	Static	IS-136	ACELP	0.78%	1.47%
8	Downlink	GSM1900	Mobility	CF688	3/4	Lab	DC	Static	IS-136	ACELP	1.13%	2.23%
9	Uplink	TDMA 800	Mobility	KF688	3/4	Lab	DC	Static	IS-136	VSELP	2.01%	3.61%
10	Downlink	TDMA 800	Mobility	KF688	3/4	Lab	DC	Static	IS-136	VSELP	0.19%	0.50%
11	Uplink	TDMA 1900	Mobility	KF688	3/4	Lab	DC	Static	IS-136	ACELP	1.33%	2.70%
12	Downlink	TDMA 1900	Mobility	KF688	3/4	Lab	DC	Static	IS-136	ACELP	0.29%	0.50%

TTY / Digital Wireless
Test Data and Results
GSM 1900 EFR:

Using test script from L&W version 1.1 Copyright 1998
Device Tested: CF688

- *Uplink:*
- Percent Error (PCER) = 1.47
- Total = 4216, Correct 4154, Added = 48, Missed = 26, Changed = 36
- Percent Error (TCER) = 0.78
- Total = 6193, Correct 6145, Added = 51, Missed = 39, Changed = 9

- *Downlink:*
- Percent Error (PCER) = 2.23
- Total = 4216, Correct 4122, Added = 3, Missed = 30, Changed = 64
- Percent Error (TCER) = 1.13
- Total = 6171, Correct 6101, Added = 9, Missed = 47, Changed = 23

TTY / Digital Wireless
Test Data and Results
DAMPS 800 VCELP

Using test script from L&W version 1.1 Copyright 1998

Device Tested: KF688

- *Uplink:*
- **Percent Error (PCER) = 3.61**
- **Total = 4216, Correct 4064, Added = 80, Missed = 38, Changed = 114**
- **Percent Error (TCER) = 2.01**
- **Total = 6157, Correct 6033, Added = 83, Missed = 64, Changed = 60**

- ***Downlink:***
- **Percent Error (PCER) = 0.50**
- **Total = 4216, Correct 4195, Added = 0, Missed = 1, Changed = 20**
- **Percent Error (TCER) = 0.19**
- Total = 6216, Correct 6204, Added = 0, Missed = 9, Changed = 3

TTY / Digital Wireless
Test Data and Results
DAMPS 1900 ACELP

Using test script from L&W version 1.1 Copyright 1998

Device Tested: KF688

- *Uplink:*
- Percent Error (PCER) = 3.96
- Total = 4216, Correct 4049, Added = 5, Missed = 37, Changed = 130
- Percent Error (TCER) = 2.00
- Total = 6154, Correct 6031, Added = 10, Missed = 70, Changed = 53
- (A second pass for this configuration yielded PCER = 2.70, and TCER = 1.33)

- *Downlink:*
- Percent Error (PCER) = 0.50
- Total = 4216, Correct 4195, Added = 0, Missed = 3, Changed = 18
- Percent Error (TCER) = 0.29
- Total = 6212, Correct 6194, Added = 0, Missed = 13, Changed = 5

TTY / Digital Wireless
Supporting Facts

- Digital vocoders distort sine waves in FSK signaling
- Digital vocoders are optimized for voice transmission
- Transmission rate effects the CER
- Digital technology today can only be transmitted with errors
  - Muting, fading, noise bursts, Co-channel and Adjacent Channel Interference, or frame losses will increase CER (*everyday issues in the field*)
- TTY devices do not handle high amplitude peaks from digital vocoder

TTY / Digital Wireless
Conclusion

- Direct vs acoustic connection for the mobile to TTY provides some improvement to CER in the Lab environment.
- Analog transmission provides the best CER rate
- Very little difference between "strong" signals and "weak" signals
- Lab environments optimize CER, with clean Channel conditions
- Actual Field testing will introduce factors unable to reproduce

TTY Forum Test Results Summary

Technology: iDEN

Contribution Date: 99.01.26

Contribution Number: 99.01.26.08

Contributing Company: Motorola

Summary: This contribution reports the results of Motorola's iDEN testing. The testing was done in both lab and field environments.

The signal strengths used for test were:

- Strong Signal
  -55 +/- 3dBm (Stationary Test)
  -47 to –72 dBm (Driving Test)
- Moderate Signal
  -75 +/- 5 dBm (Stationary Test)
  -55 to –82 dBm (Driving Test)
- Weak Signal
  -95 +/- 5 dBm (Stationary Test)
  -72 to –102 dBm (Driving Test)

For connectivity to the mobile handset device, Motorola crafted a custom cable with a RJ-45 connection to the TTY device and a 2.5mm jack connection to the phone.

The results of the tests are outlined on page 9 of the contribution. They show a TCER no greater then 4.18%.

TTY/99.01.. 08

MOTOROLA

iDEN Subscriber Division

TTY/TDD FORUM-9

iDEN™

Introduction

In order to characterize TTY performance over iDEN (a TDMA based cellular system) Digital voice channels, the iDEN Subscriber Division conducted a series of live-network laboratory and field tests using the Motorola i600 digital mobile unit with the Lober & Walsh Engineering, Inc. CPT Mobility TTY and the Ultratec InteleModem devices.

Physical Configurations

- **Laboratory Enviroment (controlled)**
  Stationary Testing

- **Field Enviroment (real world)**
  Stationary Testing
  Driving Testing

RF Signal Strengths

- **Strong Signal**
  -55 +/- 3 dBm (Stationary Testing)
  -47 to -72 dBm (Driving Testing)
- **Moderate Signal**
  -75 +/- 5 dBm (Stationary Testing)
  -55 to -82 dBm (Driving Testing)
- **Weak Signal**
  -95 +/- 5 dBm (Stationary Testing)
  -72 to -102 dBm (Driving Testing)

Test Equipment

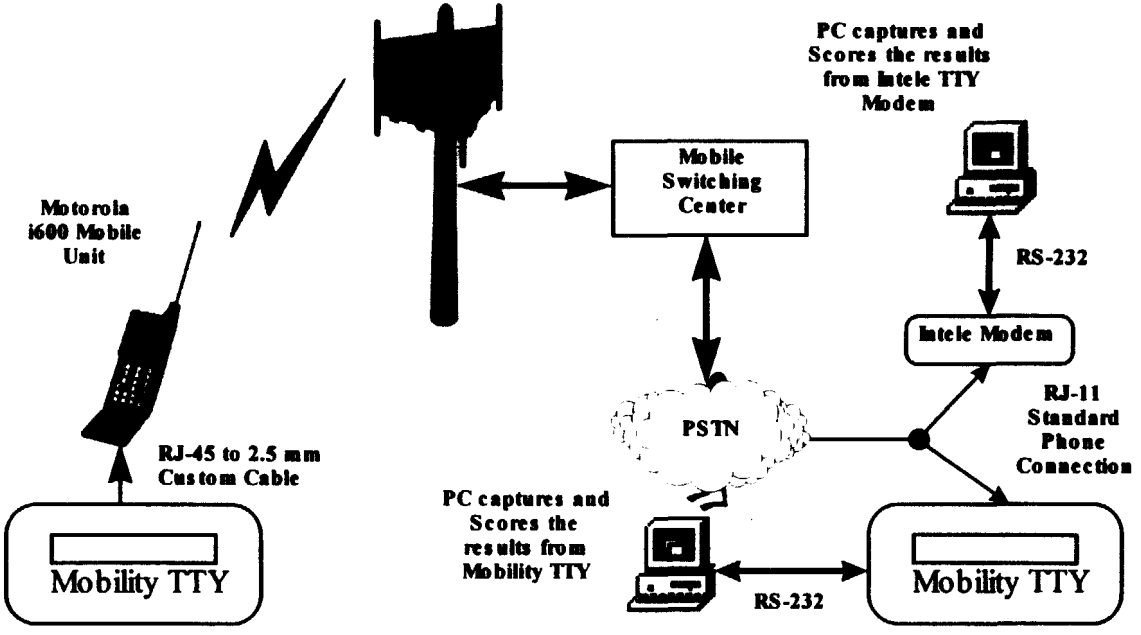
- **TTY Device**
  CPT, LLC Mobility TTY (2)
  UltraTec InteleModem

- **Digital Cellular Device**
  Motorola i600 Mobile Unit

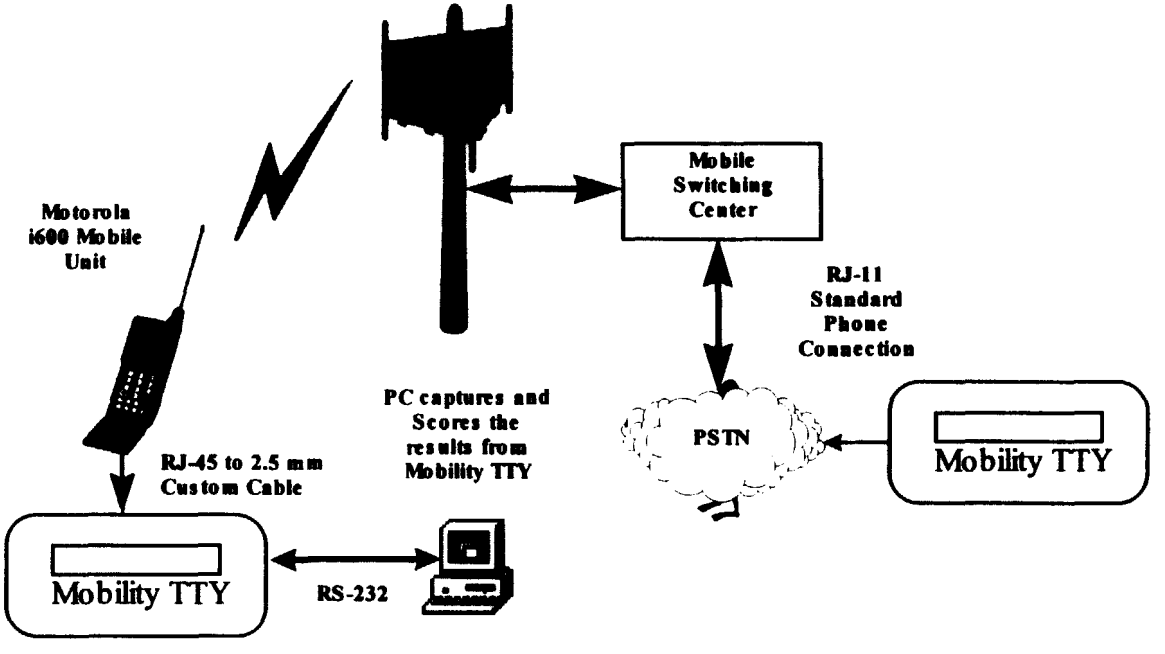
Test Setup

- Mobile to Land
- Land to Mobile

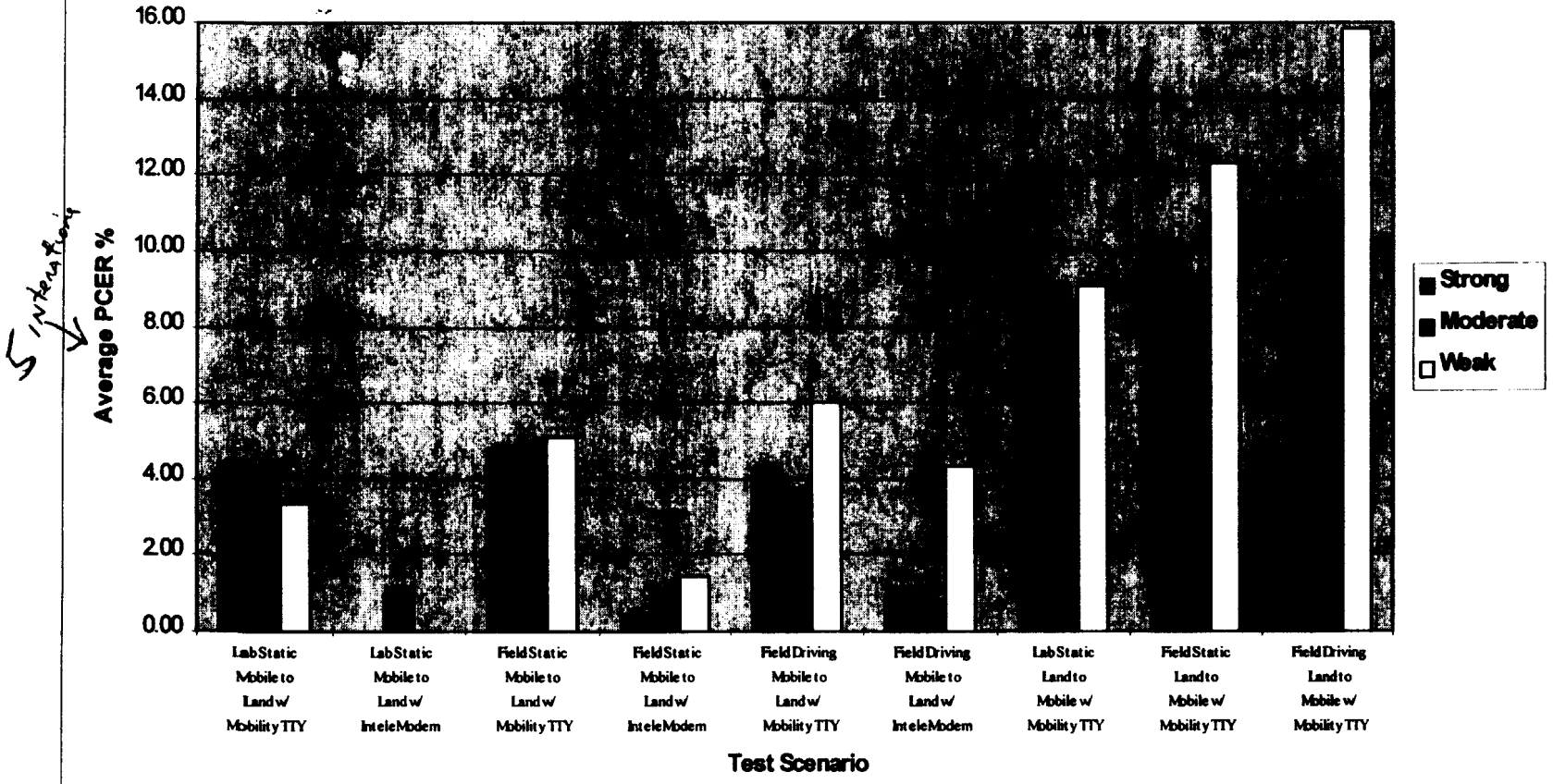
Mobile to Land



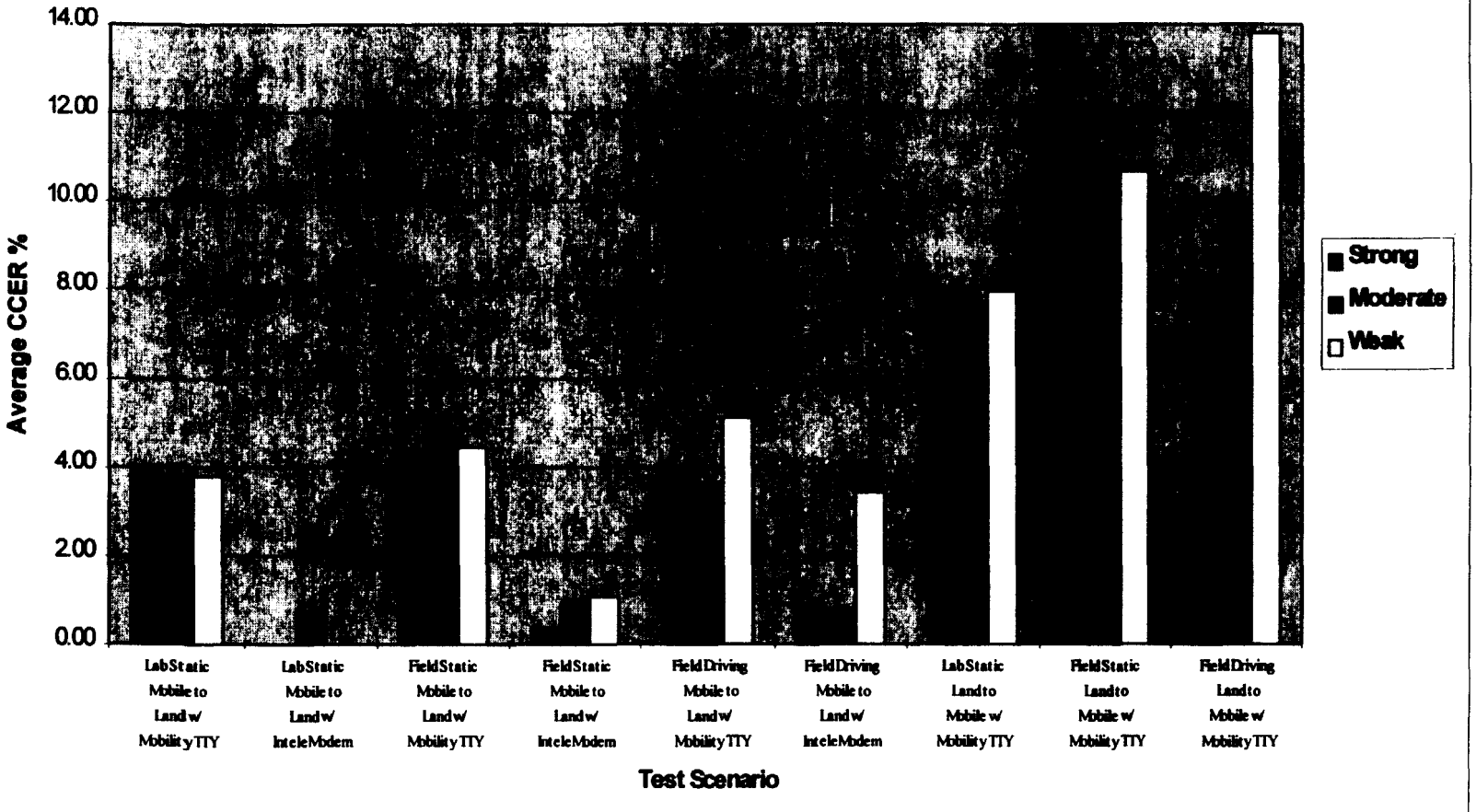
Land to Mobile



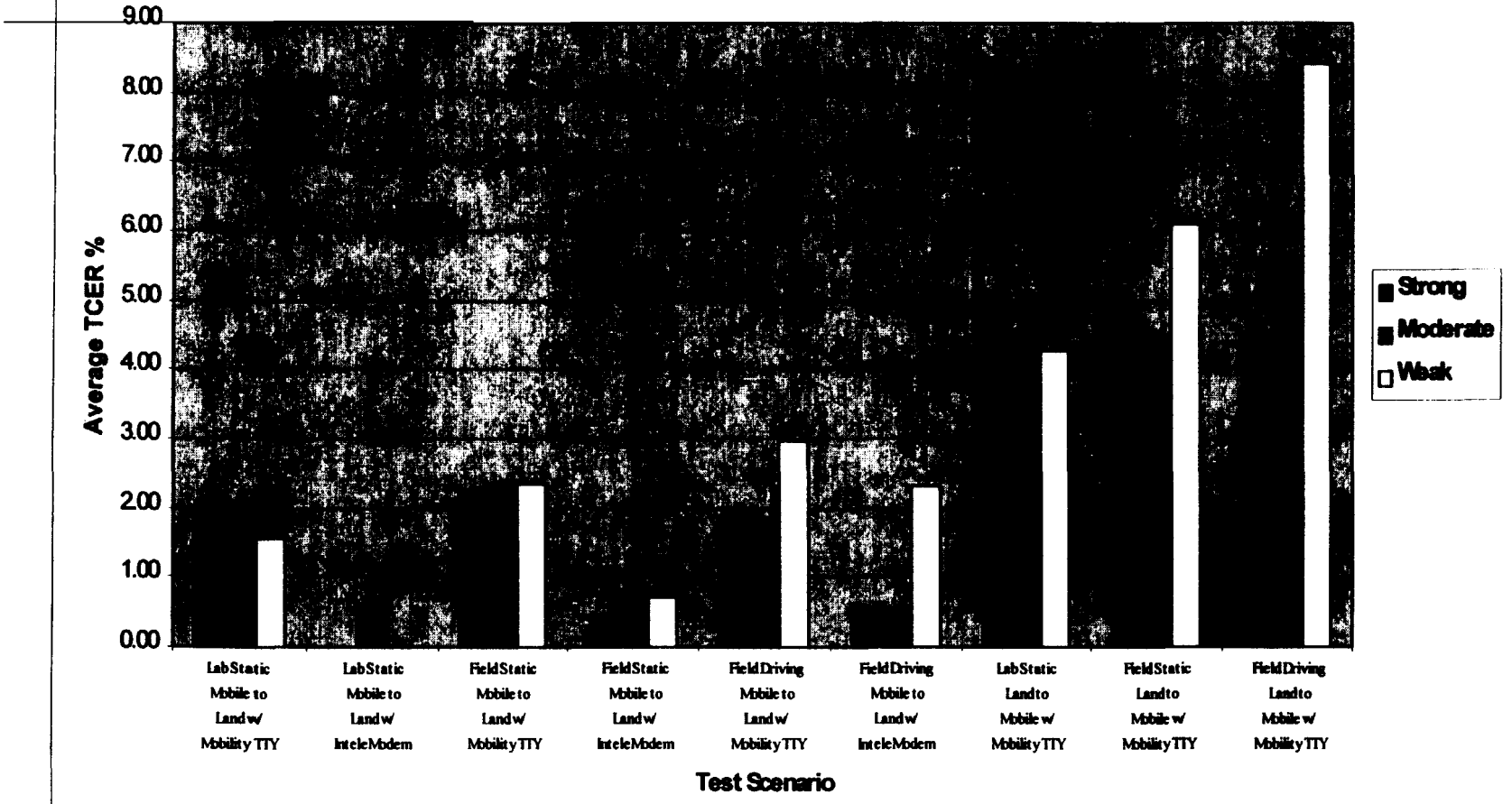
Printable Character Error Rate



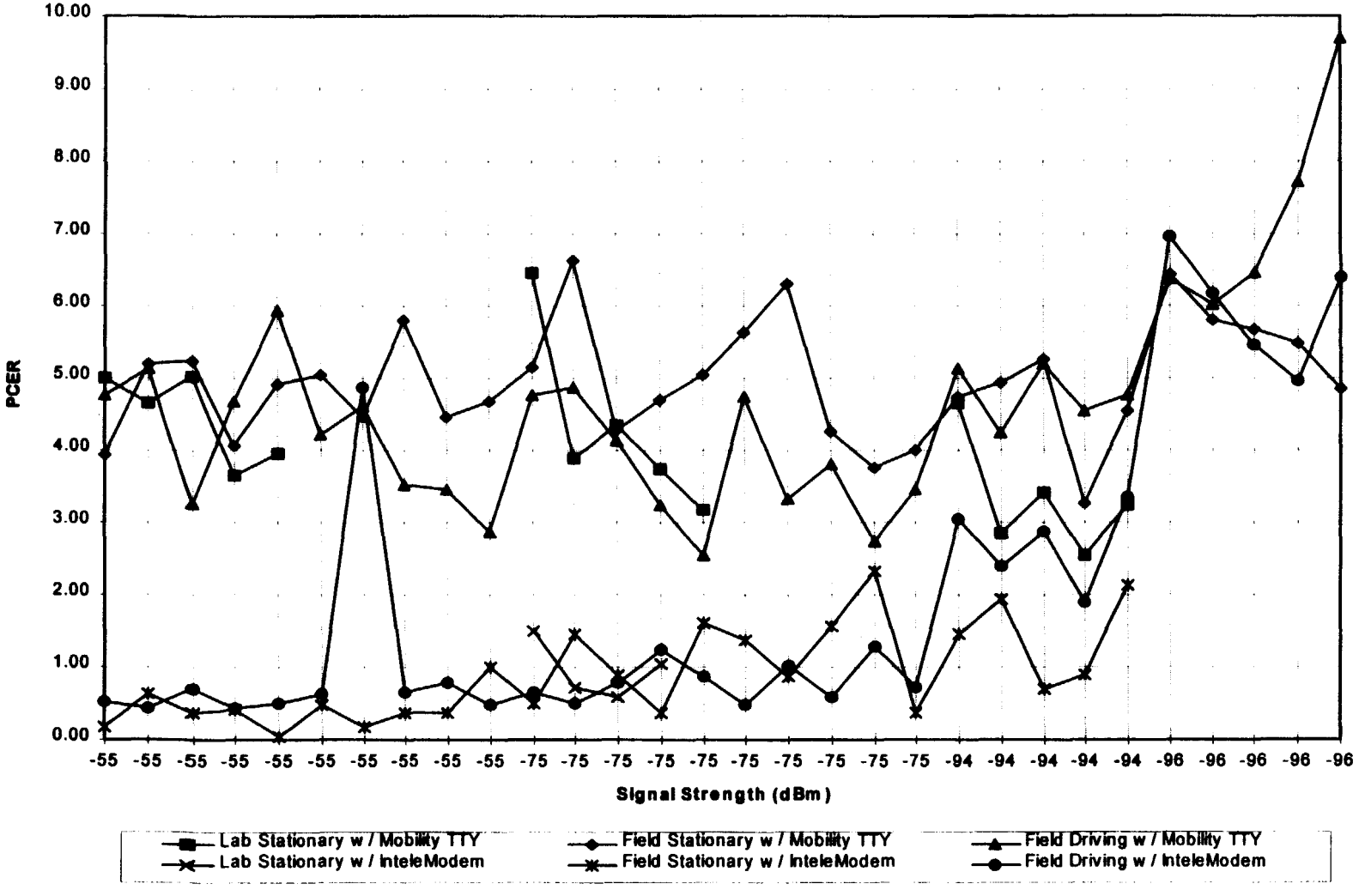
Consumer Character Error Rate



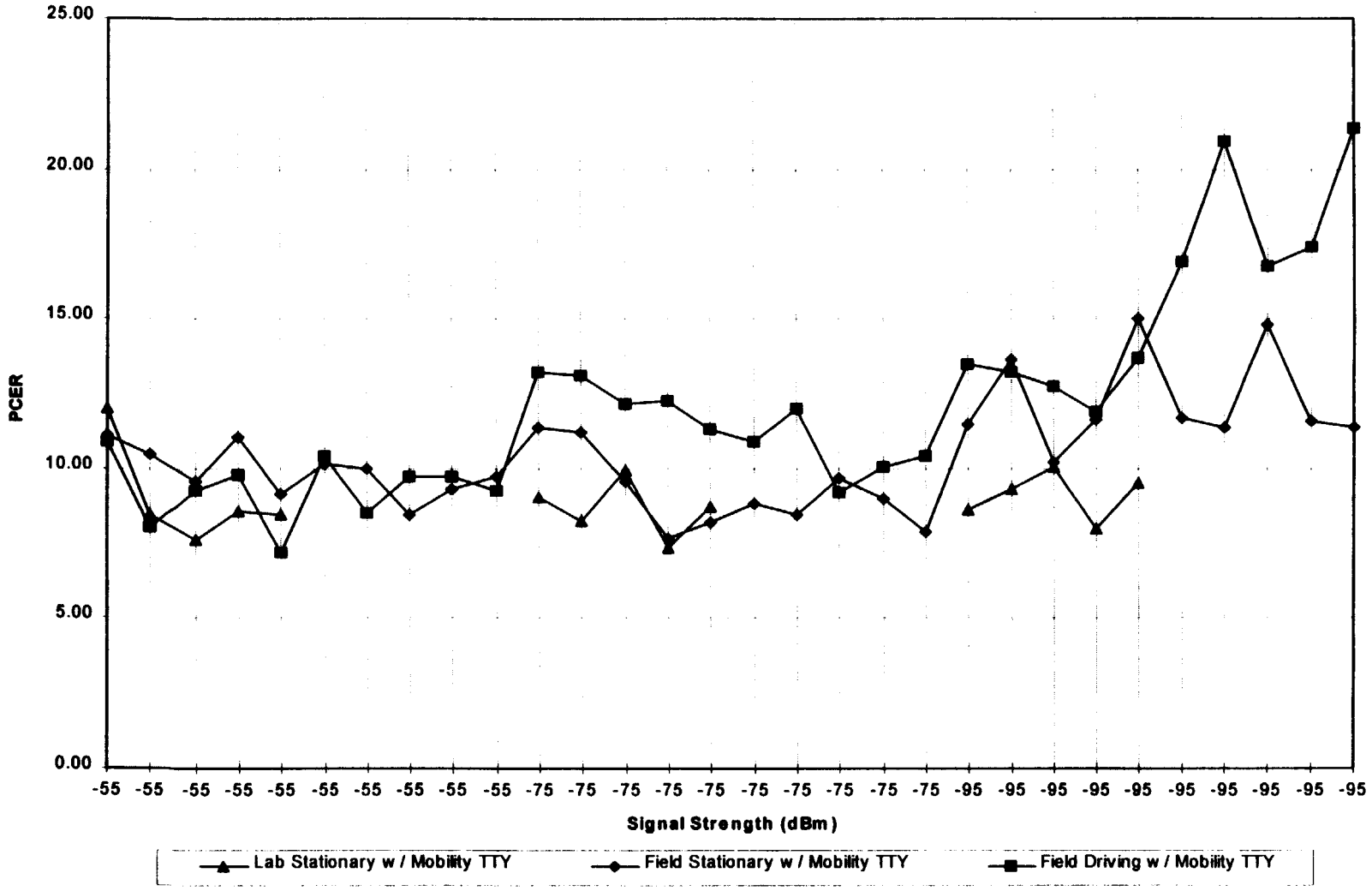
Total Character Error Rate



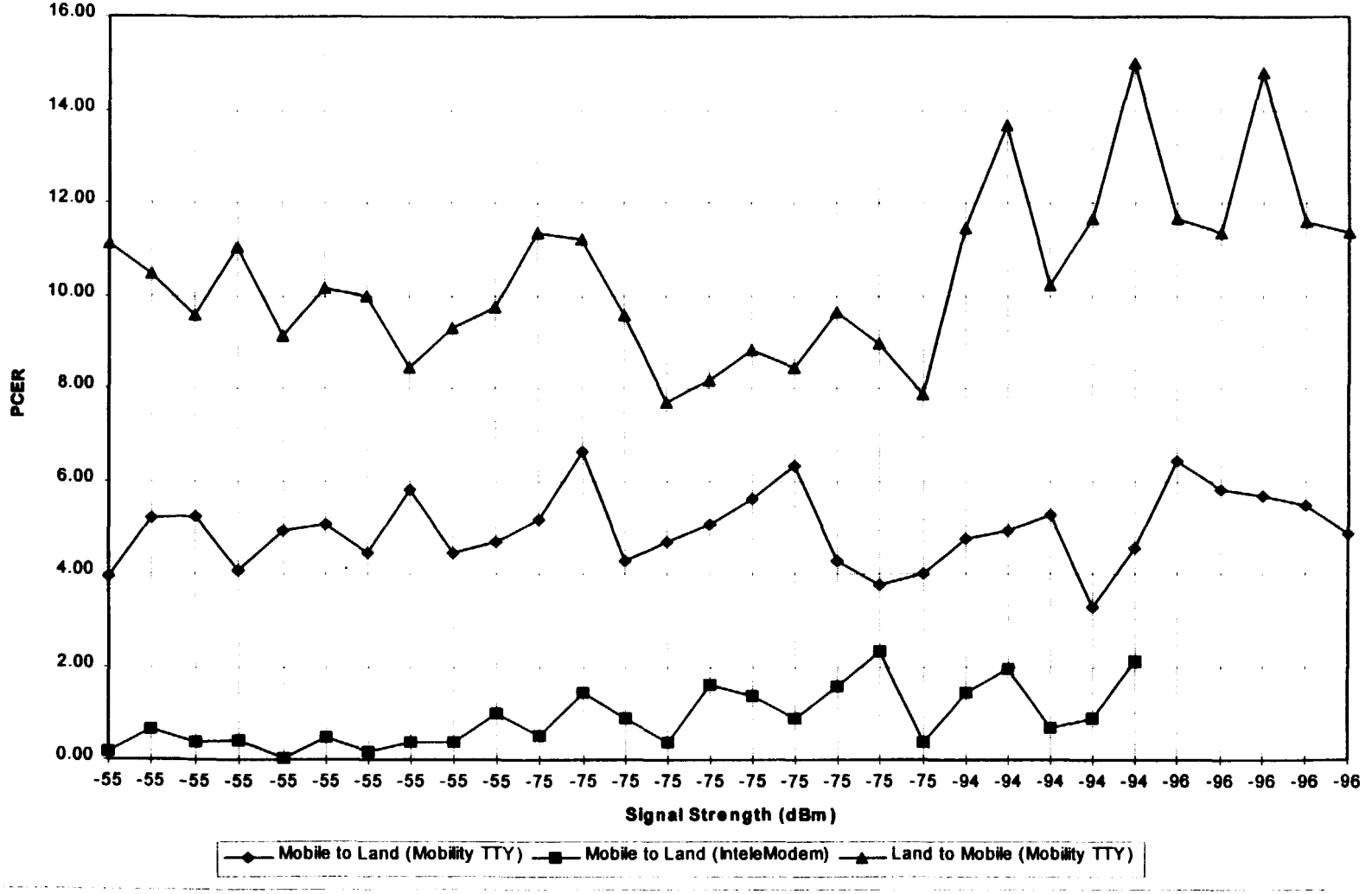
Mobile to Land Testing



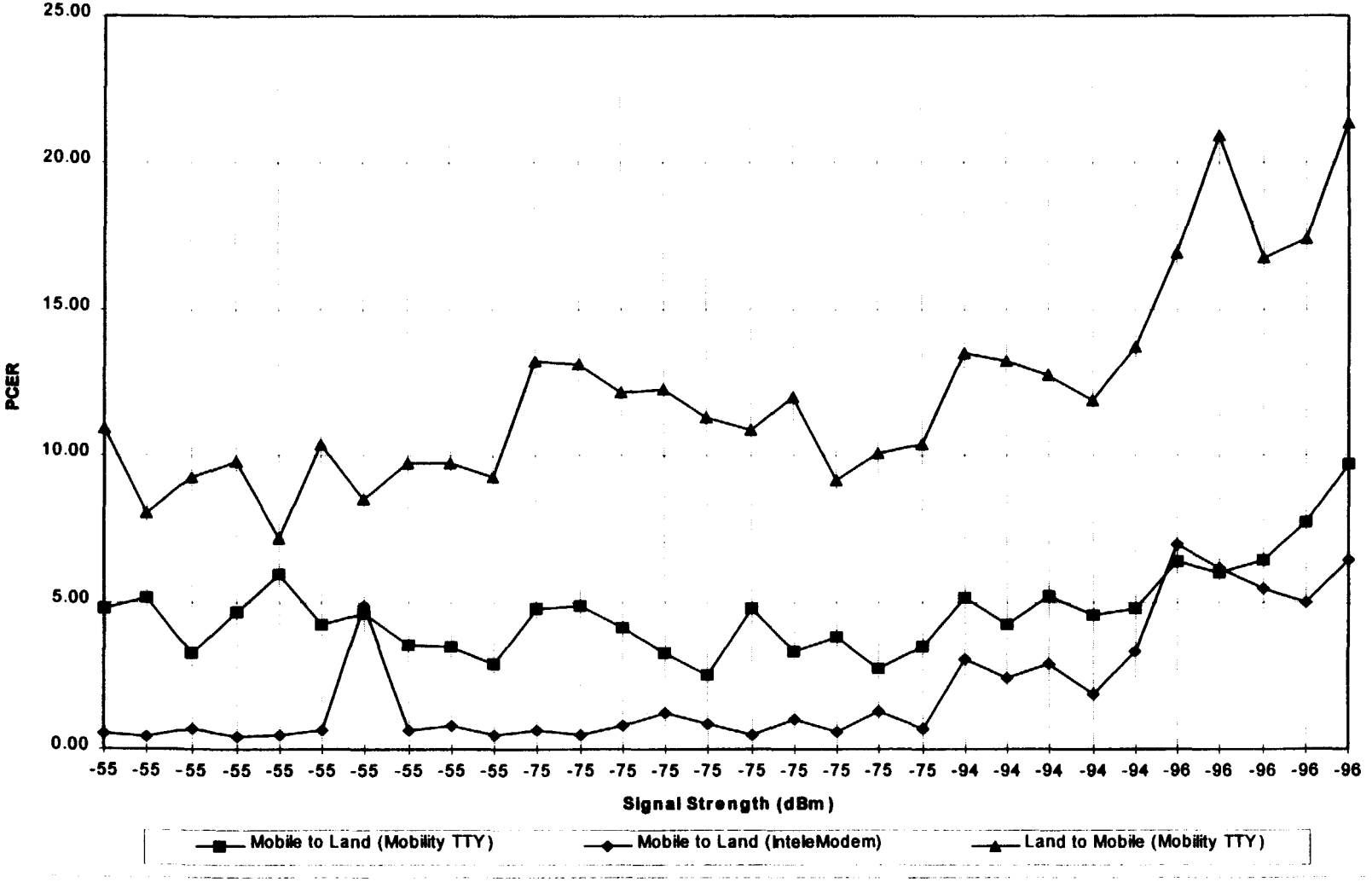
Land to Mobile Testing



Field Stationary Testing



Field Driving Testing



Summary

- **Laboratory**

  Mobility TTY - Stationary
  PCER = 6.48%
  CCER = 5.7%
  TCER = 3.1%

- **Field**

  Mobility TTY - Stationary
  PCER = 7.7%
  CCER = 6.75%
  TCER = 3.7%
  Mobility TTY - Driving
  PCER = 8.43%
  CCER = 7.33%
  TCER = 4.18%

- **Laboratory**

  InteleModem - Stationary
  PCER = 0.96%
  CCER = 0.74%
  TCER = 0.64%

- **Field**

  InteleModem - Stationary
  PCER = 0.90%
  CCER = 0.69%
  TCER = 0.49%
  InteleModem - Driving
  PCER = 2.05%
  CCER = 1.61%
  TCER = 1.11%

Conclusion

- **Better results were observed with the InteleModem**
- ***Mobile to Land* testing yield better results than *Land to Mobile* testing**
- **No substational differences between the results from the Laboratoty and Field testing**
- **Performance while driving is slighty worst than while stationary at higher RSSI levels**

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TTY Over Digital Testing

No.	Date	Filename-No.	TTY	Phone	Rate	Format	Vocoder	Type	Test	RSSI (dBm)	PCER (%)	Total	Correct	Added	Missed	Changed
101	11-Jan	DynamicMtoL-101	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	4.77	4216	4015	9	51	150
102	11-Jan	DynamicMtoL-102	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	4.86	4216	4011	8	46	159
103	11-Jan	DynamicMtoL-103	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	4.13	4216	4042	11	34	140
104	11-Jan	DynamicMtoL-104	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	3.25	4216	4079	4	31	106
105	11-Jan	DynamicMtoL-105	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	2.54	4216	4109	6	21	86
106	11-Jan	DynamicMtoL-106	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	4.74	4216	4016	8	42	158
107	11-Jan	DynamicMtoL-107	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	3.32	4216	4076	9	24	116
108	11-Jan	DynamicMtoL-108	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	3.80	4216	4056	6	38	122
109	11-Jan	DynamicMtoL-109	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	2.73	4216	4101	4	27	88
110	11-Jan	DynamicMtoL-110	CPT	i600	Full	iDEN	VSELP	Field	Mobile to Land	From -55 to -81	3.46	4216	4070	7	32	114
121	15-Jan	DynamicLtoM-121	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	10.91	4216	3756	14	109	351
122	15-Jan	DynamicLtoM-122	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	8.02	4216	3878	8	95	243
123	15-Jan	DynamicLtoM-123	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	9.27	4216	3825	18	95	296
124	15-Jan	DynamicLtoM-124	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	9.77	4216	3804	12	75	337
125	15-Jan	DynamicLtoM-125	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	7.19	4216	3913	8	83	220
126	20-Jan	DynamicLtoM-126	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	10.41	4216	3777	16	112	327
127	20-Jan	DynamicLtoM-127	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	8.49	4216	3858	14	85	273
128	20-Jan	DynamicLtoM-128	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	9.75	4216	3805	28	94	317
129	20-Jan	DynamicLtoM-129	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	9.72	4216	3806	16	98	312

130	20-Jan	DynamicLtoM-130	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From -47 to -72	9.25	4216	3826	21	104	286
[redacted]																
141	19-Jan	DynamicLtoM-141	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	13.50	4216	3647	19	156	413
142	19-Jan	DynamicLtoM-142	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	13.21	4216	3659	23	145	412
143	19-Jan	DynamicLtoM-143	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	12.74	4216	3679	20	149	388
144	19-Jan	DynamicLtoM-144	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	11.91	4216	3714	22	160	342
145	19-Jan	DynamicLtoM-145	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	13.69	4216	3639	25	173	404
146	19-Jan	DynamicLtoM-146	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	16.89	4216	3504	41	223	489
147	19-Jan	DynamicLtoM-147	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	20.94	4216	3333	44	257	626
148	19-Jan	DynamicLtoM-148	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	16.75	4216	3510	36	225	481
149	19-Jan	DynamicLtoM-149	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	17.41	4216	3482	39	223	511
150	19-Jan	DynamicLtoM-150	CPT	i600	Full	iDEN	VSELP	Field	Land to Mobile	From 83 to -99	21.37	4216	3315	38	267	634

CCER (%)	Total	Correct	Added	Missed	Changed	TCER (%)	Total	Correct	Added	Missed	Changed
[redacted]											
4.17	6140	5884	15	105	151	2.21	6140	6004	15	105	31
4.23	6120	5861	14	99	160	2.37	6120	5975	14	99	46
3.69	6126	5900	18	86	140	2.02	6126	6002	18	86	38
2.71	6163	5996	11	61	106	1.46	6163	6073	11	61	29
2.20	6168	6032	10	49	87	1.28	6168	6089	10	49	30
3.81	6138	5904	18	83	151	1.97	6138	6017	18	83	38
2.94	6157	5976	15	63	118	1.59	6157	6059	15	63	35
3.34	6143	5938	10	83	122	1.84	6143	6030	10	83	30
2.37	6170	6024	7	58	88	1.26	6170	6092	7	58	20
2.99	6160	5976	12	69	115	1.54	6160	6065	12	69	26
[redacted]											
9.47	5988	5421	38	213	354	5.08	5988	5684	38	213	91
7.09	6061	5631	16	187	243	4.06	6061	5815	16	187	59
8.17	6019	5527	40	195	297	4.52	6019	5747	40	195	77
8.60	6035	5516	28	180	339	4.23	6035	5780	28	180	75
6.45	6079	5687	15	171	221	3.75	6079	5851	15	171	57
9.08	6036	5488	26	221	327	5.09	6036	5729	26	221	86
7.53	6044	5589	27	181	274	4.22	6044	5789	27	181	74
8.49	5998	5489	47	190	319	4.68	5998	5717	47	190	91
8.57	6030	5513	31	202	315	4.83	6030	5739	31	202	89

7.97	6022	5542	39	191	289	4.32	6022	5762	39	191	69
[redacted]											
11.83	5936	5234	39	288	414	7.11	5936	5514	39	288	134
11.65	5933	5242	44	277	414	6.78	5933	5531	44	277	125
11.15	5965	5300	39	276	389	6.64	5965	5569	39	276	120
10.28	5982	5367	36	271	344	6.03	5982	5621	36	271	90
11.84	5953	5248	48	301	404	7.22	5953	5523	48	301	129
14.59	5859	5004	68	367	488	8.99	5859	5332	68	367	160
18.64	5768	4693	74	442	633	11.62	5768	5098	74	442	228
14.27	5867	5030	67	350	487	9.12	5867	5332	67	350	185
14.94	5877	4999	64	366	512	9.27	5877	5332	64	366	179
18.93	5816	4715	74	458	643	11.49	5816	5148	74	458	210