



# Comparing the performances of HP, Dell and Lenovo notebook PCs featuring integrated broadband connectivity

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## Executive summary

Metrico Wireless, a leading national provider of wireless device performance products and services, conducted a series of tests on an HP Compaq nc6400 Notebook PC and two competitive models, all featuring integrated wireless broadband capability. The objective of this testing was to compare data throughputs for the key broadband access technologies, High Speed Downlink Packet Access (HSDPA) and EVolution Data Optimized (EVDO). In addition, the throughputs of integrated and discrete broadband solutions were compared.

With HSDPA, the download task data throughput of an HP Compaq nc6400 Notebook PC was at least 24% higher than the throughputs of the Dell Latitude D620 and Lenovo ThinkPad T60, whether tested in stationary or mobile environments. With EVDO, the download data throughputs of the HP Compaq nc6400 Notebook PC and Dell Latitude D620 were at least 106% higher than the throughput of the Lenovo ThinkPad T60. Over the course of the testing, upload throughputs were comparable.

An analysis of task rate distributions within mobile environments revealed that the HP Compaq nc6400 Notebook PC achieved the highest download rates (750 Kbps or more) four times as often as the Dell Latitude D620 and Lenovo ThinkPad T60 notebooks. Furthermore, 40% of HP Compaq nc6400 Notebook PC data packets achieved throughput rates of 850 Kbps or more; Dell Latitude D620 and Lenovo ThinkPad T60 were not able to achieve data rates of 850 KHz or more.

Integrated HSDPA and EVDO broadband solutions out-performed the Sierra Wireless AirCard 860 PC Card and Sierra Wireless Audiovox 5740 Data Card, respectively, in download data throughput.



## Testing

Metrico Wireless tested six comparably-configured notebooks, each featuring integrated HSDPA or EVDO technology. The following models were tested:

- HP Compaq nc6400 Notebook PC
- Dell Latitude D620
- Lenovo ThinkPad T60

In addition, the HP Compaq nc6400 Notebook PC was tested with wireless PCMCIA cards featuring HSDPA or EVDO technology.

## Test cases

Testing was performed in Seattle, WA utilizing the Cingular 3G HSDPA and Verizon Wireless EVDO networks, with the following test cases:

- Stationary testing  
Transactions were conducted from three stationary test locations, representing high, medium and low signal strength respectively. Tested systems were configured for automatic network selection.
- Drive testing  
Transactions were conducted along two test routes.  
The first route demonstrated excellent-to-fair signal strength; tested systems were configured for automatic network selection. The second route demonstrated medium-to-poor signal strength.

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### Notes:

Variances in throughput measurements can occur whenever testing is conducted using a publicly available WAN network. In addition, different payload sizes and test application software may produce slightly different absolute results. However, close attention was paid to the test conditions, payloads and application software such that the conditions between the tests were consistent, ensuring reliable comparative data

.The drive routes were selected such that HSDPA or EVDO connectivity was always available

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In general, data transactions consisted of 4 MB FTP downloads and 1 MB FTP uploads.

Multiple tests of each configuration were carried out between 9:00 am and 6:00 pm. This approach ensured time-of-day diversity to minimize any effects from normal network usage.



### **Tested configurations**

Table 1 outlines the key components of the HP Compaq nc6400 Notebook PC, Dell Latitude D620 and Lenovo ThinkPad T60 tested by Metrico Wireless.

Table 1. Configurations of tested systems

Component	nc6400	D620	T60
Processor	Intel Core 2 Duo T5600, 1.83 GHz	Core 2 Duo T5600, 1.83 GHz	Core 2 Duo T5600, 1.83 GHz
RAM	1 GB	1 GB	1 GB
Operating system	Microsoft Windows XP Professional, Service Pack 2	Windows XP Professional, Service Pack 2	Windows XP Professional, Service Pack 2
Integrated EVDO	HP ev2200 1xEV-DO Broadband Wireless Modem 6/23/2006, 2.0.6.0	Dell Wireless 5700 Mobile Broadband (CDMA EVDO) Minicard Modem, Novatel 03/08/06, 2.0.2.7	Sierra Wireless 1xEV-DO Network Adapter, 08/05/05, 1.5.1.0
Integrated HSDPA	Sierra Wireless AirCard HSDPA Modem, 7/12/2006, 2.0.0.23	Dell Wireless 5500 Mobile Broadband (3G HSDPA) Minicard modem, 03/08/06, 2.0.2.7	Sierra Wireless MC8765 Minicard, 04/03/06, 1.5.1.5
External HSDPA PC card	Sierra Wireless AirCard 860 PC Card	[Not tested]	[Not tested]
External EVDO PC card	Sierra Wireless Audiovox 5740 Data Card	[Not tested]	[Not tested]

Prior to testing, each system was updated using the vendor's online software update services.

## Test results

This section provides sample test results that demonstrate the average data throughputs achieved by the integrated HSDPA and EVDO broadband solutions. Download data rate distributions are shown for the drive testing with integrated HSDPA solutions.

In addition, sample results are provided for the comparison of integrated and discrete broadband solutions.

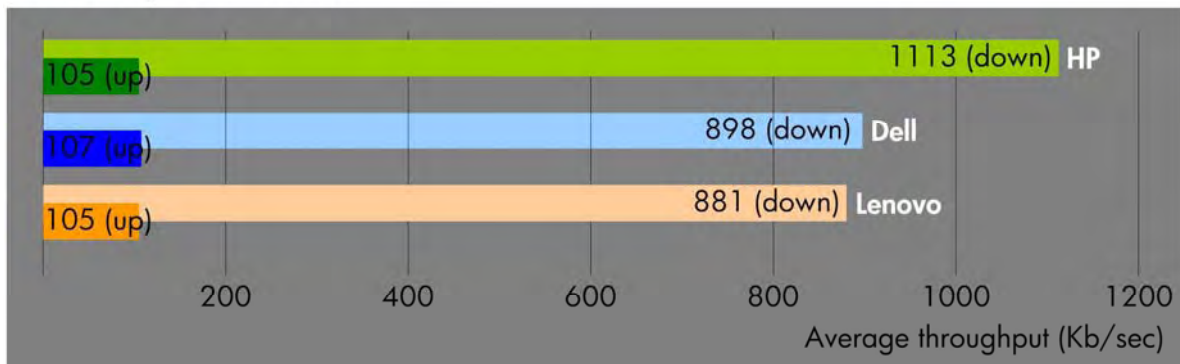
For more detailed results, refer to [Appendix A](#).

### **HSDPA connectivity**

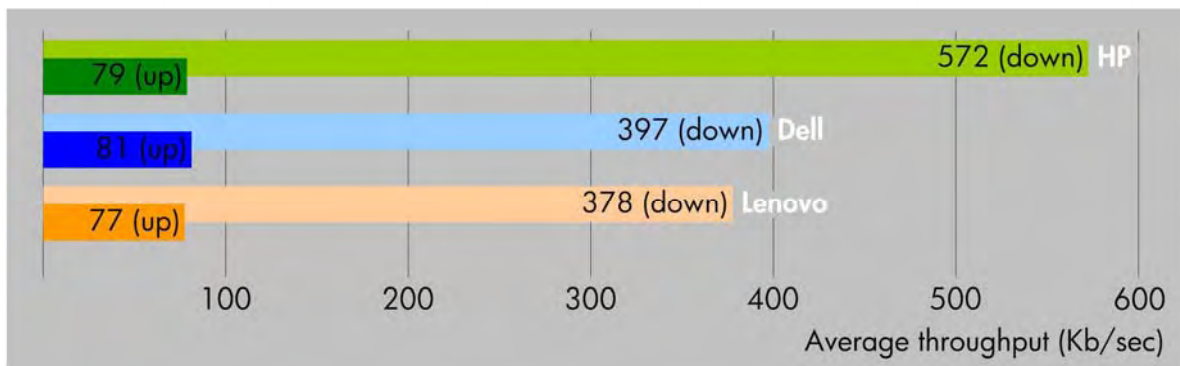
Figure 1 illustrates the average throughput with HSDPA connectivity. Download (down) and upload (up) metrics are provided.

Figure 1. With HSDPA connectivity, download throughput for the HP notebook was superior to those of the similarly-configured Dell and Lenovo notebook models

#### Stationary test – HSDPA



#### Drive test – HSDPA





With HSDPA, the average download task throughput of the HP Compaq nc6400 Notebook PC was at least 24% higher than the throughputs of the Dell Latitude D620 and Lenovo ThinkPad T60, whether tested in stationary or mobile environments.

Upload throughputs were comparable.

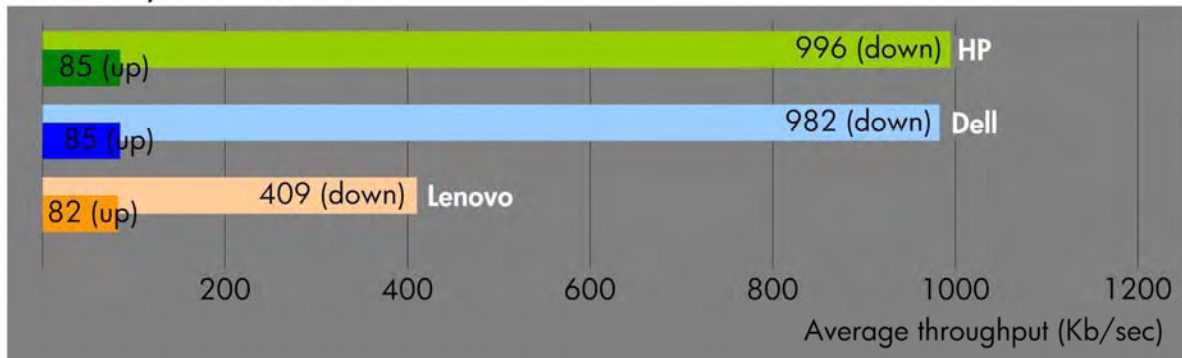
The download throughput for each notebook was faster in stationary tests than in drive tests.

### **EVDO connectivity**

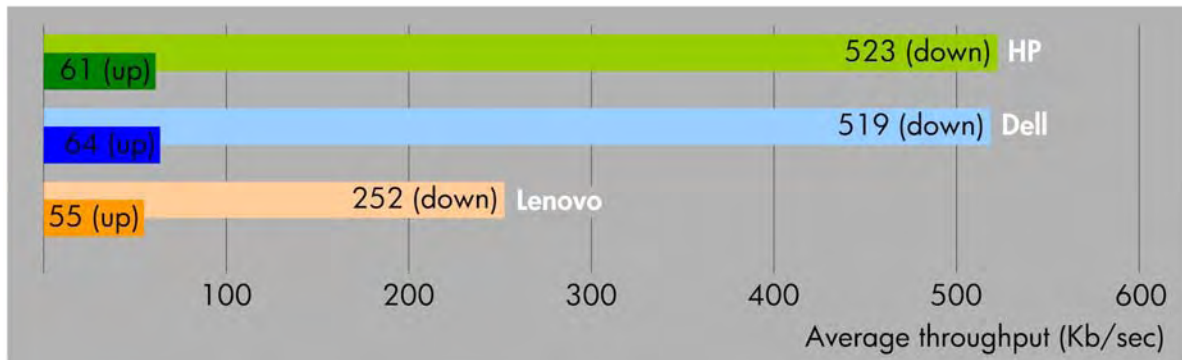
Figure 2 illustrates the average throughput with EVDO connectivity. Download (down) and upload (up) metrics are provided.

Figure 2. With EVDO connectivity, download throughputs for the HP and Dell notebooks were superior to that of the similarly-configured Lenovo product

#### Stationary test – EVDO



#### Drive test – EVDO



With EVDO, the download data throughputs of the HP Compaq nc6400 Notebook PC and Dell Latitude D620 were at least 106% higher than the throughput of the Lenovo ThinkPad T60, whether tested in a stationary or mobile environment.

Upload throughputs were comparable.

The download throughput for each notebook was faster in stationary tests than in drive tests.

### Task data rate distributions

Figure 3 shows the distribution of task download data rates for HSDPA in mobile environments that fell within each particular set of throughput ranges. For example, the HP Compaq nc6400 Notebook PC was able to maintain a minimum of 550kbps and maximum of 1200kbps during the mobile environment drive testing.

Figure 3. The HP Compaq nc6400 Notebook PC was able to achieve and maintain higher data rates for longer periods of time

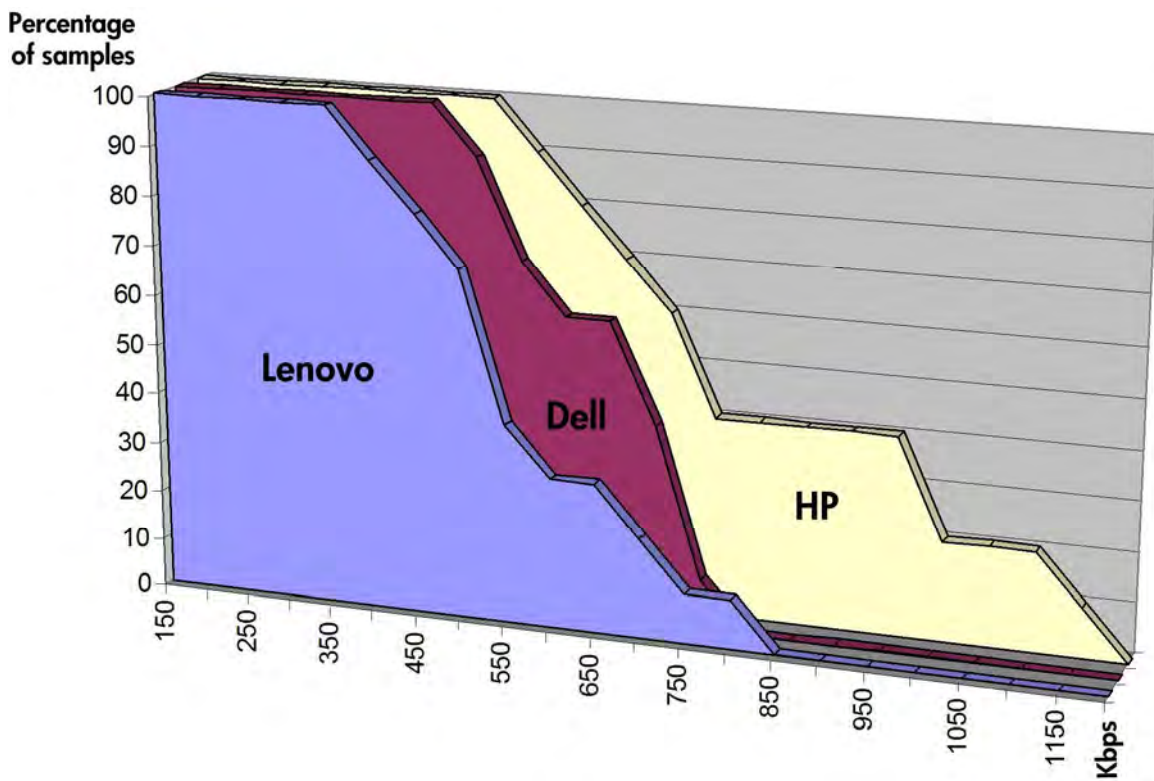
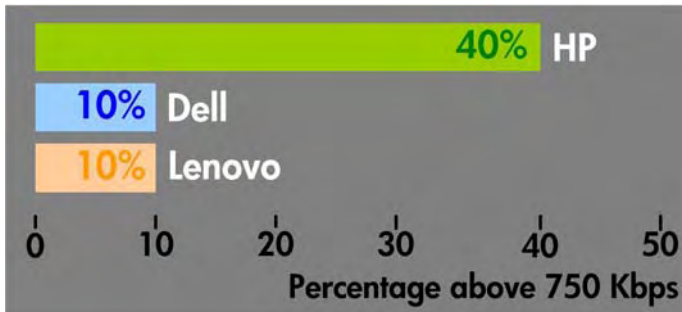


Figure 3 shows that 40% of the HP Compaq nc6400 Notebook PC achieved task throughput data rates of 750 Kbps or more; Dell Latitude D620 and Lenovo ThinkPad T60 achieved 750kbps task throughput data rates only 10% of the time.

Figure 4 summarizes the test results shown in Figure 3, comparing the achieved task throughput data rates above 750 Kbps.

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Figure 4. The HP Compaq nc6400 Notebook PC consistently out-performed the Dell Latitude D620 and Lenovo ThinkPad T60



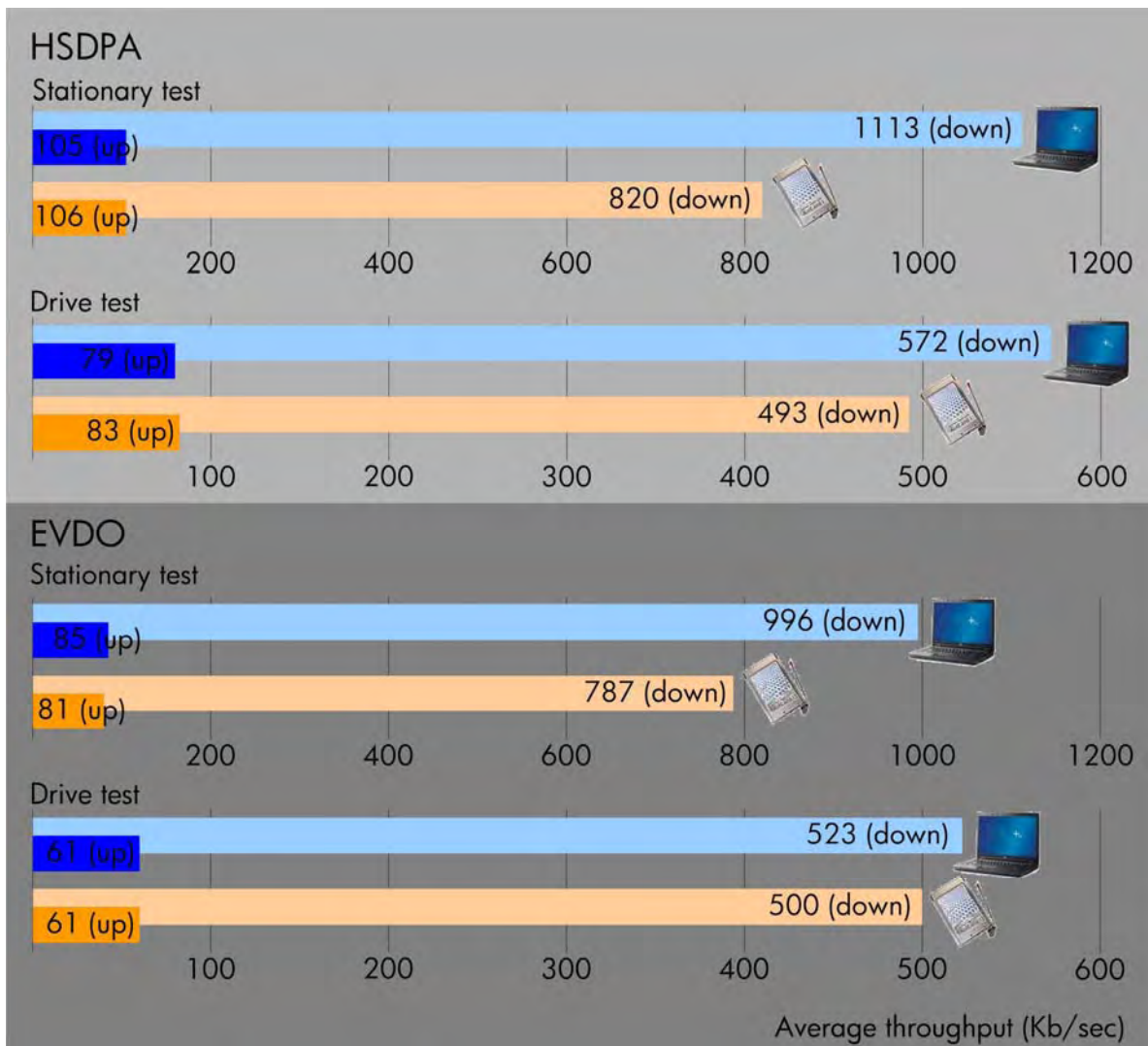
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Furthermore, 40% of the HP Compaq nc6400 Notebook PC was able to achieve task throughput data rates of 850 Kbps or more; Dell Latitude D620 and Lenovo ThinkPad T60 packet were not able to achieve task throughput data rates of 850kbps or more.

### ***Integrated versus PC Card broadband comparison***

Figure 5 compares the performance of HP Compaq nc6400 Notebook PCs equipped with integrated and PC Card broadband solutions. Download (down) and upload (up) metrics are provided.

Figure 5. The average download task throughputs of the integrated broadband solutions were superior to those of the broadband PCMCIA cards



The integrated HSDPA and EVDO broadband solutions out-performed the Sierra Wireless AirCard 860 PC Card and Sierra Wireless Audiovox 5740 Data Card, respectively, in download data throughput.



## Data Throughput Comparison of Notebook PCs

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The integrated solutions delivered an average download task throughput advantage of at least 26% in the stationary tests, and at least 4% in the drive tests.

Upload throughputs were comparable.



## Appendix A – Detailed test results

This appendix provides the following test results:

- Integrated solutions – HSDPA  
Drive testing and stationary testing
- Integrated solutions – EVDO  
Drive testing and stationary testing
- Data rate distribution – HSDPA  
Drive testing
- Integrated versus PCMCIA solution comparison – HSDPA  
Drive testing and stationary testing
- Integrated versus PCMCIA solution comparison – EVDO  
Drive testing and stationary testing



## Integrated solutions – HSDPA

Table 2. Drive testing

Metric	Download			Upload		
	nc6400	D620	T60	nc6400	D620	T60
Throughput (Kb/sec)						
Average	572	397	378	79	81	77
Standard deviation	283	237	210	18	19	17
Minimum	129	53	107	44	51	53
Maximum	1182	752	824	105	109	102
Attempts						
Successful	29	26	26	32	26	26
Total	32	26	27	32	26	26
Success rate	91%	100%	96%	100%	100%	100%

Table 3. Stationary testing

Metric	Download			Upload		
	nc6400	D620	T60	nc6400	D620	T60
Throughput (Kb/sec)						
Average	1113	898	881	105	107	105
Standard deviation	164	234	97	4	6	5
Minimum	825	491	627	84	87	87
Maximum	1362	1241	1128	108	112	107
Attempts						
Successful	30	30	30	30	30	30
Total	30	30	30	30	30	30
Success rate	100%	100%	100%	100%	100%	100%



## Integrated solutions – EVDO

Table 4. Drive testing

Metric	Download			Upload		
	nc6400	D620	T60	nc6400	D620	T60
Throughput (Kb/sec)						
Average	523	519	252	61	64	55
Standard deviation	222	255	126	18	16	23
Minimum	189	179	39	26	26	12
Maximum	989	1133	454	85	85	86
Attempts						
Successful	26	25	24	26	25	23
Total	26	25	24	26	25	23
Success rate	100%	100%	100%	100%	100%	100%

Table 5. Stationary testing

Metric	Download			Upload		
	nc6400	D620	T60	nc6400	D620	T60
Throughput (Kb/sec)						
Average	996	982	409	85	85	82
Standard deviation	406	370	89	3	2	6
Minimum	380	448	158	75	80	65
Maximum	1569	1513	486	90	88	89
Attempts						
Successful	30	30	30	30	30	30
Total	30	30	30	30	30	30
Success rate	100%	100%	100%	100%	100%	100%



### Data rate distribution

Table 6. Percentages of tasks throughput achieving a particular data rates within a mobile environment.

Tested system	Throughput (Kbps)												
	150	200	250	300	350	400	450	500	550	600	650	700	750
nc6400	100%	100%	100%	100%	100%	100%	100%	100%	90%	80%	70%	60%	40%
D620	100%	100%	100%	100%	100%	100%	100%	90%	70%	60%	60%	40%	10%
T60	100%	100%	100%	100%	100%	90%	80%	70%	40%	30%	30%	20%	10%

Tested system	Throughput (Kbps)								
	800	850	900	950	1000	1050	1100	1150	1200
nc6400	40%	40%	40%	40%	20%	20%	20%	10%	0%
D620	0%	0%	0%	0%	0%	0%	0%	0%	0%
T60	10%	0%	0%	0%	0%	0%	0%	0%	0%



### ***Integrated versus PCMCIA solution comparison – HSDPA***

Table 7. Drive testing

Metric	Download		Upload	
	Integrated	PCMCIA	Integrated	PCMCIA
Throughput (Kb/sec)				
Average	572	493	79	83
Standard deviation	283	217	18	18
Minimum	129	181	44	49
Maximum	1182	881	105	107
Attempts				
Successful	32	22	32	25
Total	32	26	32	26
Success rate	100%	85%	100%	96%

Table 8. Stationary testing

Metric	Download		Upload	
	Integrated	PCMCIA	Integrated	PCMCIA
Throughput (Kb/sec)				
Average	1113	820	105	106
Standard deviation	164	173	4	2
Minimum	825	453	84	102
Maximum	1362	1127	108	110
Attempts				
Successful	30	30	30	30
Total	30	30	30	30
Success rate	100%	100%	100%	100%



***Integrated versus PCMCIA solution comparison – EVDO***

Table 9. Drive testing

Metric	Download		Upload	
	Integrated	PCMCIA	Integrated	PCMCIA
Throughput (Kb/sec)				
Average	523	500	61	61
Standard deviation	222	318	18	20
Minimum	189	127	26	22
Maximum	989	1155	85	83
Attempts				
Successful	26	21	26	21
Total	26	21	26	21
Success rate	100%	100%	100%	100%

Table 10. Stationary testing

Metric	Download		Upload	
	Integrated	PCMCIA	Integrated	PCMCIA
Throughput (Kb/sec)				
Average	996	787	85	81
Standard deviation	406	355	3	5
Minimum	380	286	75	56
Maximum	1569	1414	90	85
Attempts				
Successful	30	30	30	30
Total	30	30	30	30
Success rate	100%	100%	100%	100%