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TMT Wireless Equipment

14 January 2009

# Mobile Operating System

## Anarchy in the OS



Deutsche Bank



### FITT Research

#### Fundamental, Industry, Thematic, Thought-Leading

Deutsche Bank's Company Research Product Committee has deemed this work F.I.T.T. for our clients seeking differentiated ideas. Here, our wireless technology team looks at trends in the mobile operating system, which is emerging as a key battleground in the future of the mobile ecosystem.

**Fundamental: Phones are getting more powerful and need an OS**

**Industry: There are three leading OS vendors, with another four contenders**

**Thematic: The operating system with the best third-party software wins**

**Thought-leading: The game remains wide open**

**Investment options limited, but expect them to grow significantly**



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# Mobile Operating Systems

## Anarchy in the OS

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Deutsche Bank's Company Research Product Committee has deemed this work F.I.T.T. for our clients seeking differentiated ideas. Here, our wireless technology team looks at trends in the mobile operating system, which is emerging as a key battleground in the future of the mobile ecosystem.

### Fundamental: Phones are getting more powerful and need an OS

The computing power of the average cell phone is increasing rapidly; many smartphones are approaching laptop-like processing capabilities. As phones become more complicated, they are offering greater functions. Simple operating systems are no longer able to manage this much complexity. Hardware vendors cannot or will not develop their own OS, opening the door to new OS vendors

### Industry: There are three leading OS vendors, with another four contenders

Symbian, various flavors of Linux, and Microsoft Windows Mobile still have the most robust OS platforms, as well as the largest installed base. Four others – Apple, Google Android, Palm and RIM – have viable offerings, but each has its own strategic flaw. We could even see phones become 'net-top' devices in which sophisticated browsers handle many OS functions. There is no clear winner today.

### Thematic: The operating system with the best third-party software wins

History has shown that the OS with the largest pool of applications enjoys a virtuous cycle and can quickly consolidate share. The mobile OS that can attract the largest pool of third-party developers has the potential to dominate the field. Carriers may be able to skew this process slightly, but the returns to scale in the OS industry are considerable.

### Thought-leading: The game remains wide open

Consumers are just beginning to realize the full capabilities of their phones. This education process will be slow, but leaves the door wide open to change. The advent of mobile data into daily life is an event horizon, beyond which any OS vendor could come out ahead. The current incumbents are not guaranteed continued dominance as buying patterns shift.

### Investment options limited, but expect them to grow significantly

This remains a difficult space in which to invest. Most mobile OS offerings are very small pieces of very large companies. We think Nokia/Symbian has taken the right approach, and no one should underestimate their capacity for massive transformation. Google and Apple have both generated significant media attention, but their commercial success remains an ongoing development. RIM seems to be distracted, but has an interesting approach to the problem. Palm's effort remains a question mark pending the arrival of its new OS. Despite this, the stakes are high as smartphones move into the netbook and low-end laptop arena, and the mobile OS addressable market grows strongly in coming years.

### FITT Research

Companies featured			
<b>Motorola (MOT.N),USD4.50</b> <b>Buy</b>			
	2007A	2008E	2009E
EPS (USD)	-0.02	-0.26	-0.31
P/E (x)	-	-	-
EV/EBITDA (x)	103.1	26.2	8.3
<b>Palm Inc (PALM.OQ),USD5.91</b> <b>Hold</b>			
	2008A	2009E	2010E
EPS (USD)	-1.05	-5.57	0.28
P/E (x)	-	-	21.2
EV/EBITDA (x)	-	-	8.3
<b>Research In Motion (RIMM.OQ),USD46.45</b> <b>Sell</b>			
	2008A	2009E	2010E
EPS (USD)	2.26	3.18	3.35
P/E (x)	35.6	14.6	13.9
EV/EBITDA (x)	22.3	8.0	7.7
<b>Brightpoint (CELL.OQ),USD4.90</b> <b>Buy</b>			
	2007A	2008E	2009E
EPS (USD)	0.75	0.13	0.40
P/E (x)	17.9	39.0	12.4
EV/EBITDA (x)	13.0	3.7	2.6
<b>Qualcomm (QCOM.OQ),USD34.86</b> <b>Buy</b>			
	2008A	2009E	2010E
EPS (USD)	1.90	1.40	1.87
P/E (x)	23.2	24.9	18.7
EV/EBITDA (x)	9.3	8.8	6.3

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We would like to thank our Evalueserve colleagues Tarun Mittal and Siya Sunder

# Executive summary

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## Investment thesis

Cell phones are becoming more complex. And as they become more complex, they need better software systems to make them usable. With smartphones approaching the processing power of laptop computers, the need for a robust operating system (OS) grows. Smartphones are evolving into replacements for low-cost laptops and netbooks start running on smartphone OS.

Smartphone vendors are also finding it increasingly difficult to differentiate their products with hardware alone. Form factor has become table stakes, easily replicated by competitors. In the future, software will become the most important factor that distinguishes one vendor's product from another. Vendors without solid OS platforms will face commoditization.

We identify seven vendors of mobile operating systems. The three largest, by installed base, are Symbian, Linux and Microsoft's Windows Mobile. Four others that have offerings that merit attention, but are not quite there yet in terms of features or installed base, are Apple's iPhone, Google's Android variant of Linux, Palm's new Web OS, and RIM's Blackberry. The advent of the mobile operating system will require consumers to change their habits. This could take some time, but it is also an event horizon. As consumers adopt new usage patterns, all of these vendors will have a shot at taking a leading role. However, each of them has at least one flaw that prohibits their success from being a foregone conclusion.

Twenty years ago, the personal computer market faced similar chaos in OS offerings. In that market, one vendor built a slightly larger user base, which attracted more third-party software developers, which in turn attracted more users. This led to a cycle resulting in one vendor capturing the lion's share of the market. We think a similar process will take place for the mobile OS, with the market quickly winnowing down to a smaller number of vendors.

There will, however, be a few differences. Carriers will have an impact on this process, which will likely result in different leaders in different geographies. The mobile OS will also likely incorporate features never considered part of the computer OS, including some role in application distribution, a billing mechanism and the ability to provide OS updates remotely. There is also a school of thought that holds that the smartphone will not need a full-featured OS, but instead make do with some form of sophisticated web browser, shifting the focus of the contest but not the highly fragmented landscape.

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## Valuation

For public market investors, this remains a nascent opportunity. The investable options are few today, but the ultimate impact will be important to web usage someday. We are not providing specific investment recommendations in this report, as most of the OS offerings are small pieces of very large companies. In general, we value these companies using a discounted cash flow analysis, a comparison with public comparable companies or a comparison with recently completed acquisitions or other corporate transactions.

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## Risks

The chief risk to the development of the mobile OS market is the high degree of technological change. We have identified key trends among existing market participants, but the field is evolving rapidly, which could lead to new entrants or obviate the need for mobile operating systems entirely. The pace of adoption will also likely be driven by consumer demand and other macroeconomic variables.

# Anarchy in the OS

## ***The mobile OS is coming to the fore***

The last six months have been eventful with respect to smartphones – the launch of the iPhone, the G1, new Blackberrys, Nokia’s acquisition and open sourcing of Symbian and most recently Palm’s new Web OS. We thought this would be a good time to collect our thoughts on the mobile operating system (OS). We think some trends are becoming clear and merit a more comprehensive look.

## ***OS sit between users and hardware***

Let’s start from the beginning. An operating system is an intermediary between a user and some form of hardware. For many years, this hardware was always a computer, but now includes mobile phones (and soon TVs). In fact, the list of hardware that needs an intermediary for its users is growing longer, and the distinctions between categories blurrier.

## ***Complex devices need a robust OS...***

Cell phones used to be simple. They made phone calls. Users did not need an intermediary; they just needed a key pad and a two-line monochrome screen so they could read the number they were dialing. Nokia was probably the first company to realize that phones could offer a little more. It started adding features like ring tones, address books, and the ever-entertaining snake game. That simple realization quickly took Nokia to 30+% market share in one of the fastest growing electronics segments.

Still, adding a little functionality did not require much computing power or complexity in the operating system. Most phones can exist with less processing power than 1980’s arcade games. Regardless, silicon prices kept falling and it became easier to put significant horsepower into small form factors. Adding power alone, however, does nothing to make the phone more usable or profitable. So, vendors have started adding more features. These have added complexity to the devices and that complexity has, in turn, driven the need for some kind of intermediary to help the users navigate their phones.

## ***...And cell phones are becoming increasingly complex***

There is a chicken-and-egg problem here. Consumers have shown an interest in buying complex devices. However, they want these devices to be useful or even productive, and they have not responded well when complex devices offer little utility. Simply put, mobile phones have gotten as complex as small computers and they need a good OS to run them. In fact, another trend we have seen is the growth of netbooks or low-cost laptops, many of which are being built to run on OS originally intended for smartphones.

At the same time, cellphone vendors have found that every hardware feature they add is quickly copied by all their competitors. Our core thesis is that very soon hardware will become largely commoditized. For vendors to actually differentiate their products they will need to have software that is better than or at least different from their rivals.

## ***Success in software will determine success in hardware***

Since success in cell phones is increasingly driven by success in software, and software depends on the OS, we think the OS could be a crucial battleground for competitive strength in smartphones and eventually all cell phones.

## **A quick look at the history of the OS**

### ***In the PC OS, more users brought more developers, which brought in more users***

A simple way to understand the mobile operating system playing field is to compare it to the development of the OS in the personal computer space. In that market, during the 1980s, there was a real war for the OS. For a long time, there were multiple platforms – remember the Commodore and the Radio Shack Color Computer? Eventually one OS, Windows, attracted a slightly larger user base. This attracted a slightly larger group of developers

creating useful software for Windows. This in turn attracted more users, and a virtuous (or vicious, depending on your viewpoint) cycle brought Windows into universal acceptance. Software determined the winning OS. We simplify here, but the cycle exists.

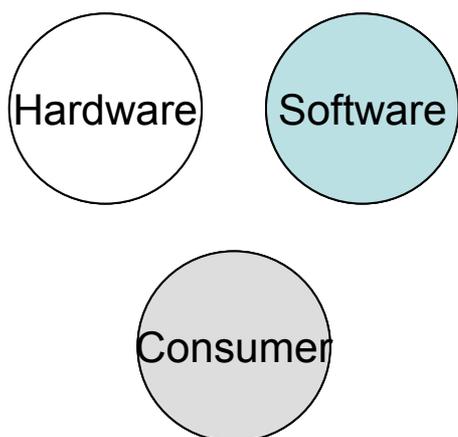
***The deepest market attracts the most investors***

If there are any financial readers still tuned in at this point, we can think of the OS as similar to a financial market. Traders want to be in the market with the greatest number of other investors, since this gives the best liquidity and a host of other benefits. Eventually, the deepest market attracts the most investors.

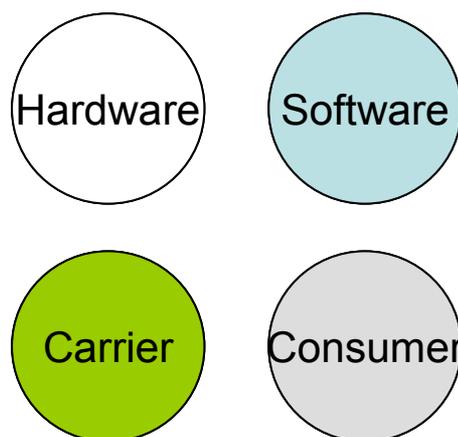
***Software developers do not want to work on too many platforms***

This cycle works because it allows a form of standardization. Software developers do not want to have to create everything from scratch, nor can they afford to customize their offering for every possible hardware combination on the market. By defining features common across a range of hardware, the OS maker greatly improves the economics of software development. Similarly, developers cannot afford to build versions for every OS, so they want to only go with the most popular platforms, where they feel they can sell the most.

**Figure 1: OS decision makers for the PC**



**Figure 2: OS decision makers for mobile**



Source: Deutsche Bank

***Building an OS is incredibly expensive***

For operating systems, there is the potential for real returns to scale. But building an OS is expensive and needs to be maintained at significant cost. Developers want features to be added regularly, and often the OS builder has no means for charging for such updates.

***The mobile OS market is still very fragmented***

In many ways, the mobile OS market resembles the PC OS market of twenty years ago. It is highly fragmented, with countless software and hardware platforms on the market. This scares away consumers, and leaves mobile software to the geeks and the specialists (no comment as to which group we belong). For most wireless subscribers, cell phone software is not interesting or useful. Yet.

***The current state of the market penalizes developers***

Third party software developers face the biggest bottlenecks in this OS ecosystem. If they want to develop applications for a mobile phone, they have to first decide which phones to reach. For the PC, this is a much simpler decision – Windows first, and maybe a Linux or Mac version somewhere down the road. In mobiles, there are dozens of platforms to choose from, with multiple implementations of OS, run-time environments, Java profiles and configurations. This is an expensive way to build software. For instance, mobile gaming vendors tell us regularly that they spend 50% of their R&D budget on porting software to different versions of phones. Porting is not technically challenging, but it is time- and labor-intensive. Clearly, this is an industry that needs some rationalization.

It's reasonable to hope for a similar path in mobile OS as we saw in the PC OS. Many big companies are working on this premise. Several companies are working hard to make their

OS the industry leader and reap the ensuing economies of scale. Others are actively working to fend off this process to avoid falling under the thumb of one major OS vendor.

***But the mobile OS may develop in a very different manner than the PC OS***

In fact, we have reason to believe that the mobile OS market may evolve differently from the PC OS. That reason is the carriers. In the PC world, most users buy their own computers, but in the mobile world, the carriers still have a huge role in determining which device you use. In many markets, carriers still buy the majority of phones. Even in heavily pre-paid markets with no subsidies, the carriers are still the largest buyers and distributors of phones. Carriers in many markets are also showing an increasing interest in subsidizing the price of phones to lock in subscribers. All of this gives the operators a strong hand in determining which features, including operating systems, phones offer.

***Carriers will play a far larger role in determining the OS***

Further, unlike PCs, the value of a phone without a network is pretty close to zero (as demonstrated by the rapid decline in PDA sales). Smartphones need to tie the OS to the network. Many carriers make this difficult, or at least do not make it less difficult.

The hard truth is that the carriers are happy with OS fragmentation. Sort of. Many of the features of the operating system cut uncomfortably close to the carriers' interests. Many carriers with whom we have spoken are afraid of being overrun by Microsoft, and, increasingly, Google. And in Europe, the carriers have longstanding tensions with Nokia.

We think the industry may have to live with OS fragmentation for some time longer, and all industry participants need to be careful. The current situation is not tenable. Mobile software has to improve or we risk seeing the collapse of mobile data. Fortunately, there are other alternatives, and we do not think this doomsday scenario is likely, merely possible.

***Mobiles are changing the definition of an OS***

Finally, there is the potential for the nature of the OS to change. We could see a world in which the low-level functions of the OS remain fragmented, and higher level applications reside on the network. Phones would become browsers. This is the network appliance idea that rears its head every few years. This approach has a lot of advantages, since it requires far less work for the software developers, but it also raises its own set of bottlenecks.

## Smartphone estimates

In analyzing the market recently, we realized segment growth has outstripped our original estimates. Consequently, we are now raising our estimates for global smartphone shipments in 2008. Much of this growth is the result of rapidly falling prices for smartphones, which have driven them into the mainstream. Working against this positive trend for smartphones is overall macro growth.

**Figure 3: DB smartphone market estimate**

Smartphone (units '000)	2003	2004	2005	2006	2007	2008E	2009E	2010E	2011E
Western Europe	4,700	5,229	18,450	25,124	33,748	44,387	40,745	54,117	59,471
Eastern Europe	636	1,224	1,429	2,326	4,425	15,185	14,164	19,817	24,234
Asia	1,291	6,739	10,623	21,696	54,039	78,742	90,248	120,344	148,302
North America	1,357	4,303	6,546	9,229	22,382	35,811	35,997	45,761	52,176
Latin America (Ex. Brazil)	264	313	431	554	1,265	3,305	2,714	4,758	5,927
Brazil	165	205	215	281	687	1,169	1,702	2,543	3,528
Africa & Middle East	401	409	585	1,192	2,416	5,589	6,440	11,335	15,745
<b>Total Unit Shipments</b>	<b>8,813</b>	<b>18,423</b>	<b>38,280</b>	<b>60,402</b>	<b>118,962</b>	<b>184,189</b>	<b>192,009</b>	<b>258,675</b>	<b>309,383</b>
As % of global handsets	2%	3%	4%	6%	10%	15%	18%	22%	24%
y/y growth	26%	109%	108%	58%	97%	55%	4%	35%	20%

Source: Deutsche Bank, Informa and company data

## Moving Beyond Cell Phones

**The distinction between a smartphone and a computer has blurred**

In this report we have focus largely on mobile phones. We typically think of smartphones as resembling a cell phone – something that fits in the hand. However, the computing power of these devices has advanced to the point that they can support many of the functions we typically associate with ‘computers’. We would argue that the distinction between a smartphone and a computer is about to be erased.

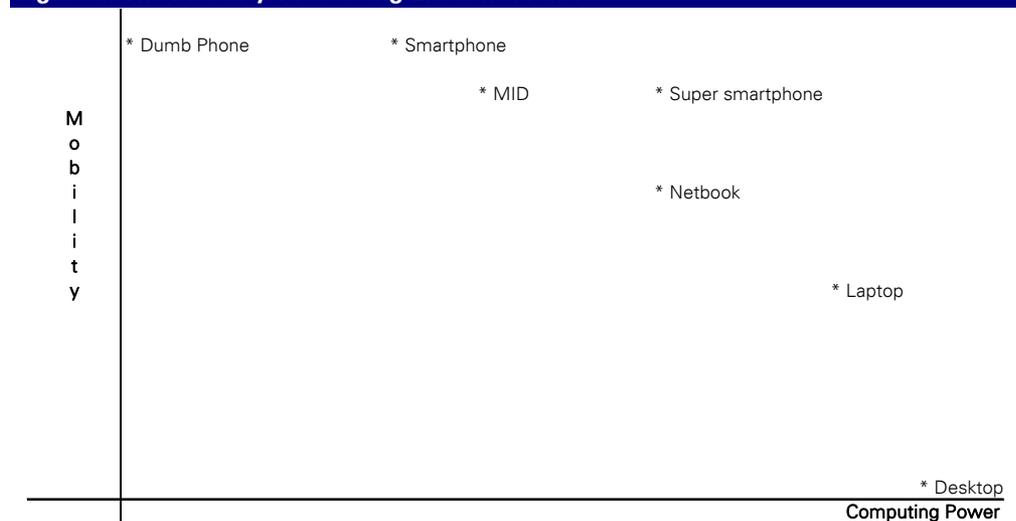
**There is a spectrum of devices trading processing power and computing**

Instead the computing universe will now be a spectrum from low-powered “dumb” phones at one end and desktop computers at the others. In between is a range of netbooks, low-cost laptops, MIDs and whole new categories of devices. Below is our very simplified graphical depiction of the space. When examined this way, we found a frontier curve, showing the rough trade-off between computing power and mobility. In coming years, advances in silicon such as Qualcomm’s Snapdragon and increasingly powerful applications processors from the likes of Texas Instruments will push this frontier further out. In this graph, we identify something as a “Super Smartphone”, that is our terminology for a device that does not really exist yet, but we expect to see them soon. As smartphones reach mainstream prices, we expect to see new entries in the high end of the market. This will likely be smartphones with processing power greater than the average laptop.

**All of these will need an OS**

All of this is relevant to our discussion of operating systems, because just as the distinction between a cell phone and a computer blurs, so will the distinctions in operating systems. All of these devices will need operating systems, and there are suddenly many more options available to hardware makers.

**Figure 4: The Mobility/Processing Efficient Frontier**



**Mobile OS can replace desktop OS for many**

We have recently seen a number of product demonstrations showing low-cost laptops and netbooks running Windows Mobile and increasingly Android. For those who do intensive graphics processing or data entry on their computers, such OS are insufficient. For the vast majority of consumer usage, however, a device that can browse the web and send/receive e-mail a mobile OS is perfectly sufficient.

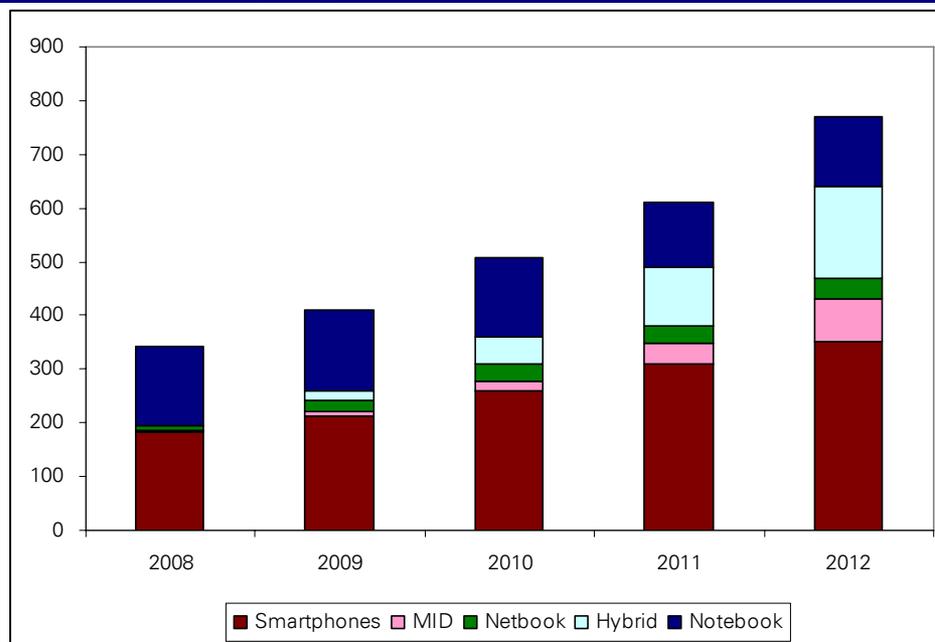
**The browser is changing the nature of the OS**

We expect to a broadening diversity of devices. Some will be powerful enough to run a full-fledged version of Microsoft or a Linux variant. Others are likely to be nothing more than browsers-in-a-box, capable of surfing the web but not running any other native applications. For instance, Qualcomm has recently been showcasing its prototype ‘Kayak’ or mobile computing device. There has been much speculation in the press about what OS these

devices will use. We think there are many possibilities, but a light-weight device like this could easily run on little more than BREW. Another example, Google is doing a lot of work on building a better browser. They are investing heavily in making browsers capable of a far wider range of features. Most browsers today can execute simple ‘applications’ using JavaScript or Flash. With its Chrome Browser and Google Gears, Google is trying to enhance the application complexity of which a browser is capable. With that as a starting point, it’s not hard to see the company extending those capabilities to a mobile browser. At the point, the browser essentially becomes the operating system.

Depending on how you count all these devices, the addressable market for mobile operating systems could triple between now and 2012. Our smartphone estimate only doubles during that period, but if you add in the move to netbooks and as these eat into laptops, the markets starts to appear much larger for mobile operating systems.

**Figure 5: Growth in computing devices (m units)**



Source: Deutsche Bank, ARM Holdings, Gartner, ABI

## OS overview

**Smartphone pricing has fallen to mainstream price levels**

Typically, we equate the mobile OS market with the smartphone market. You cannot have a smartphone without an operating system. However, the market for smartphones has grown dramatically in the last 18 months and prices have plummeted. This has blurred the definition of a smartphone. For instance, many of the iPhone clones that Samsung and LG now produce (Instinct, Dare, etc) have incredible features, a solid user interface and a hefty price tag, but we would not consider them true smartphones. On the other hand, the G1 and the iPhone are both available for subsidized prices below \$200. Further up the spectrum, we are starting to see smartphones which resemble laptops. These netbooks or Mobile Internet Devices (MIDs) run on smartphone silicon with embedded baseband modems and use mobile operating systems rather than desktop versions.

**The definition of a smartphone has become blurry**

We have struggled over the years to find a good definition of a smartphone. The closest we have come so far is a phone that replicates a computer as a flexible data device –with a common operating system capable of being altered by the user, or at least by numerous third-party software vendors.

**Smartphones can change their instruction sets**

The distinction is admittedly blurry, but we think a key differentiating factor is the ability of a smartphone to change its instruction set. The highly featured phones are closed loops and cannot really be altered once they leave the factory floor in Gumi or Shenzhen. To qualify in our view as a true OS, the system also has to have enough openness to allow outsider developers to provide applications for it. Platforms such as Java (in certain flavors) or BREW provide a framework for adding applications to phones, but typically lack many of the low-level functions of a complete OS. Similarly, there are countless proprietary low-level systems for managing hardware, but these lack the higher level user interface features.

Without meaning to antagonize any computer science majors out there, we think there are three features that qualify a system as a cell phone OS:

- Management of low-level machine features, including the telephone especially
- A user interface
- Enough interfaces (APIs) to allow third-party developers to build software for that OS

By our count, there are three true mobile phone operating systems and four others that come close, but are currently lacking in some way.

**Figure 6: Summary OS analysis**

	<b>Strength</b>	<b>Weakness</b>
<b>Symbian</b>	<ul style="list-style-type: none"> <li>* Largest installed base by far</li> <li>* Years of experience</li> </ul>	<ul style="list-style-type: none"> <li>* Poor developer relations</li> <li>* Geographic balance</li> <li>* Reliant on Nokia, model in transition</li> </ul>
<b>Windows Mobile</b>	<ul style="list-style-type: none"> <li>* Windows installed base</li> <li>* Windows developer community</li> <li>* PC synchronization</li> </ul>	<ul style="list-style-type: none"> <li>* Consumer unfriendly</li> <li>* Execution delays</li> <li>* Carrier perception</li> </ul>
<b>Limo/Lisp</b>	<ul style="list-style-type: none"> <li>* Low-cost</li> <li>* Strong support in Asia</li> <li>* Open source</li> </ul>	<ul style="list-style-type: none"> <li>* Fragmented</li> <li>* Losing momentum to Android</li> </ul>
<b>Android</b>	<ul style="list-style-type: none"> <li>* Low-cost</li> <li>* Generating developer enthusiasm</li> </ul>	<ul style="list-style-type: none"> <li>* One more flavor of Linux</li> <li>* Reliant on Google's 'charity'</li> </ul>
<b>Apple</b>	<ul style="list-style-type: none"> <li>* Consumer mindshare</li> <li>* Growing developer interest</li> <li>* Apple ease of use</li> </ul>	<ul style="list-style-type: none"> <li>* Tied to one hardware platform</li> <li>* Still too reliant on computer connection</li> </ul>
<b>RIM</b>	<ul style="list-style-type: none"> <li>* Installed base</li> <li>* Loyalty of enterprise IT departments</li> <li>* Web-centric approach opens developer community</li> </ul>	<ul style="list-style-type: none"> <li>* Lack of focus on OS</li> <li>* Significant platform change needed</li> <li>* Tied to one hardware platform</li> </ul>
<b>Palm</b>	<ul style="list-style-type: none"> <li>* Brand loyalty</li> <li>* Understands ease of use</li> <li>* Web-centric approach opens developer community</li> </ul>	<ul style="list-style-type: none"> <li>* Tied to one hardware platform</li> <li>* New OS is still work in progress</li> <li>* No media sync with desktop</li> </ul>

Source: Deutsche Bank

## Competitive landscape

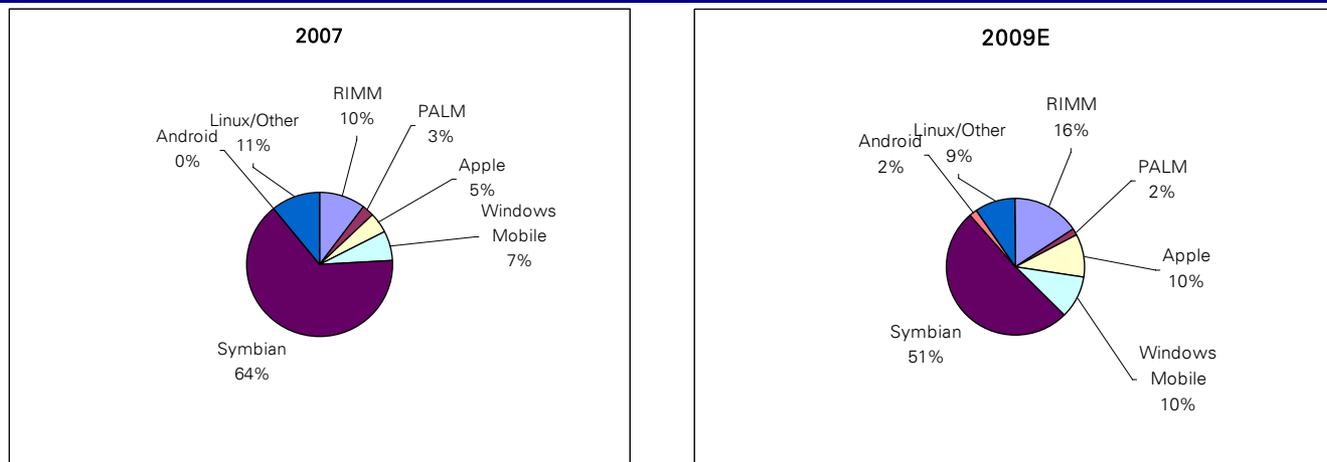
**By installed base, Symbian, Linux and WinMo lead today**

The big three are Symbian, Linux (in all its various splendor) and Windows, in order of installed base. These three all currently ship tens of millions of units a year and offer robust operating systems, each with a developer community that is building third-party applications.

**There are four other aspirants**

After this, RIM, Palm, Apple, and Google's Android (again in order of installed base) all offer operating systems of some sort. In Figure 4, we detail our view of each of these seven.

**Figure 7: Smartphone OS market share, then and later**



Source: Deutsche Bank and company data

**The vast majority of cell phones lack a true OS**

In addition to these, each handset vendor uses a huge array of proprietary solutions, which vary not only between vendors, but within each vendor as well. It's tempting to ignore these because this market is so fragmented, but it's worth remembering that 80+% of phones in use today fall into this category. With time, this segment may shrink, but for the time being, it is too big to ignore.

**Figure 8: Mobile operating system overview**

Vendor	Kernel	Handset vendors	2006 market share	2009E market share	Available devices	Approx cost per license	Developer community	2008E cumul. shipments
Symbian	Symbian	Nokia, Samsung, LG, Motorola, SE, Fujitsu, Sharp, Mitsubishi, etc	67%	57%	159	\$10	Hundreds or thousands	292
Windows Mobile	Proprietary	Motorola, SE, Samsung, LG, HTC and more	5%	8%	<100	\$15-\$20	Millions	27
Android	Linux	HTC	0%	1%	1	"\$0"	Hundreds or thousands	1
Limo/Lisp	Linux	Motorola, Samsung, LG, and more	17%	12%	<100	\$0	Thousands	65
Apple	Proprietary	Apple	0%	7%	1	NA	Thousands	19
RIM	Proprietary	RIM	8%	13%	5	NA	Hundreds or thousands	24
Palm WebOS	WebOS: Linux Legacy: Palm/Windows	Palm	3%	2%	WebOS: 1 Legacy: 3	NA	WebOS: Millions Legacy: Hundreds	12

Source: Deutsche Bank and company data

Another way to gauge the support of the operating system is to look at which handset vendors are building phones on that OS. In this regard, Symbian and Windows Mobile are again leading vendors. In Figure 7, we do our best to aggregate vendor support by platform.

**Figure 9: OS support by handset vendor**

	RIM	Palm	Apple	Windows Mobile	Symbian	Linux	Android
Apple			X				
Chinese Vendors						X	X
HTC				X		X	X
Japanese Vendors					X	X	
LG				X	X		
Motorola				X	Discontinued	Discontinued	X
Nokia					X		
Palm		X					
RIM	X						
Samsung				X	X		X
Sony Ericsson				X	X		
Total	1	1	1	5	5	3	4

Source: Deutsche Bank. Note: Samsung is reportedly working on an Android phone, but has not officially launched anything.

**Another crucial element is the support baseband vendors provide to a given OS**

Another crucial element will be the support baseband vendors provide to a given operating system. In the PC world, the Microsoft-Intel partnership played a major role in standardizing the operating system, allowing software developers to gain scale. In the mobile world, chip support for operating systems will similarly play a major role. In Figure 8, we again see that Symbian has the lead, which makes sense given the amount of time it has been in the market. Figure 8 only looks at baseband support, and application processors should also figure into this calculation. Whether baseband of the applications processor support plays the determining role in choosing an OS remains an important topic for a separate report. For the purpose of this study, we think it's safe to conclude that the picture would look similar to the baseband results.

**Figure 10: OS support by baseband**

	RIM	Palm	Apple	Windows Mobile	Symbian	Linux	Android
Qualcomm	X	X		X	X*	X	X
TI					X	X	X*
Infineon			X		X		
ST Micro					X		
Freescale				X	X	X	
Ericsson Mobile Platforms					X		
Broadcom					X*		
Marvell	X			X*			
Total	2	1	1	3	7	3	2

Source: Deutsche Bank. Items denoted with \* denote project we believe are underway, but which have not yet been announced or commercialized. These items are counted towards totals.

## The latest in OS fashions

**The mobile OS has many new features**

So far, we have looked at the OS through the historical prism of how operating systems developed for the PC. Since the great OS wars of the 80's, the role of the OS has continued to evolve. Most of these changes have gone largely unnoticed by users who have come to expect periodic updates from Microsoft and Apple. These improvements could have shifted share a decade or two ago, but today lack the drama that might give them more attention. Nonetheless, the coming fight for the mobile OS has accelerated some of these trends. We are starting to see new features from the PC world applied to the mobile, as well as new features becoming important to the mobile OS, which were never even considered part of the PC OS.

**This will include many features not seen in PC OS**

In addition to a good user interface, efficient memory management, developer tools and multitasking, we think there are three new elements of an OS that need to be included in mobile OS offerings – Remote updates, Application distribution, and Billing mechanism.

**Mobile OS will need simple updating mechanisms**

One of the interesting features of the iPhone is its ability to provide **over-the-air (OTA) software updates**. This is an emerging feature in the PC OS realm, but has proven crucial in the mobile world. Again, Apple has shown the rest of the industry what needs to be done. Previously, there was no mechanism for distributing software patches to consumers. This was a particular problem for early versions of Windows Mobile, version x.0. Both Apple and

Microsoft encountered early battery-life issues when their OS went live. Apple was able to push out the latest version of its software on short notice, quickly quieting an uproar. Microsoft, on the other hand, has had to rely on consumers getting patches from their carriers, or worse, from the handset OEMs themselves. RIM has been able to rely on enterprise IT managers.

**Apple has added application discovery to the role of the OS**

Until Apple came along with the App Store, no one really understood how awful **Application Distribution** was. Everyone complained that the existing methods were unwieldy, but no one managed to come up with anything quite as simple and useful as the App Store. Most carriers had their own portal with varying degrees of search possible. The App Store’s success, in our view, was based not only on the ability to search for applications based on a variety of metrics, but also on its pre-arranged search criteria. The App Store features a “What’s Hot” list, as well as separate lists for Paid and Free applications. Since the App Store launch, other OS vendors have been racing to roll out their answers: for instance, Google launched its Android Marketplace and RIM announced its Blackberry Application Storefront. Blog reports also indicate that Microsoft may be working on something similar.

**Apple has been very successful because of its billing relationship**

A crucial element of this distribution is the **Billing Mechanism**. Previously, content could only be purchased by working through the carriers’ portals or by entering a credit card into the phone; neither is an ideal solution. Apple had a pre-existing billing relationship with many consumers through its iTunes Music Store. This is an important asset, but only goes so far, since consumers can only sign up for an account by using a computer, not through the iPhone itself. This billing relationship will be difficult for others to replicate. Google has announced it will work through Amazon for the Marketplace, while RIM has indicated it will work with PayPal. These are good short-term solutions, but will also likely require some form of registration through a PC. It also remains to be seen whether working through third-parties is sustainable, or whether these platforms risk being torn up by conflicting strategic interests.

**New features could put OS vendors in conflict with carriers**

The difficulty with all these new features, however, is that they introduce an element of conflict with the carriers. In particular, the distribution and billing mechanism remain contentious. Apple has been able to persuade the carriers to go along with its App Store largely through the strength of its brand. And even in this case, Apple had to disable OTA music downloads (except via Wi-Fi). We think the other application stores will struggle with this issue. Carriers still largely think they can generate revenue from the sale of downloads. If they had a sincere interest in moving away from this model, they could first increase the revenue share with third-party developers, which remain heavily skewed to the carriers at around 50%-60% for the carriers, versus an Apple/developer revenue split of 20/80, 30/70 for RIM and 30/70 for Android (in this last case, the 30% goes to the carrier, not Google).

**Figure 11: New features by OS vendor**

Vendor	Application Store	Revenue share		Billing Mechanism	OTA Updates
		OS	Developer		
Symbian	No		NA	NA	No
Windows Mobile	In development		TBD	TBD	No
Android	Android Marketplace	30% (to carrier)	70%	Amazon	Yes
Limo/Lisp	No		NA	NA	NA
Apple	App Store	30%	70%	iTunes	Yes
RIM	Blackberry Storefront	20%	80%	PayPal	No
Palm	App Catalog		TBD	Amazon	Yes (?)

Source: Deutsche Bank

# Mobile OS vendors

## Symbian

***Symbian remains by far the largest OS vendor***

With all of the buzz the iPhone has generated lately, it is easy to forget that Symbian is by far the largest mobile operating system in the world. Symbian shipped 77 million units last year, and has an installed base of probably hundreds of millions of users.

***It has the advantage of over a decade of experience***

Arguably, Symbian is the most evolved OS out there. It has been working on this for a long time. In our opinion, this experience gives Symbian one of the deepest technology platforms of the big seven – if for no other reason than it had more time for trial and error, and has gotten more feedback on actual working phones than any other OS vendor on the market. This makes a big difference, especially in that crucial but hard-to-measure factor – time to market.

***Nokia acquisition clouds the future***

However, Symbian's future remains cloudy. The company has long been tied to Nokia, and Nokia's acquisition of the company two months ago is only an admission of the obvious.

***Geographic range is limited***

Symbian also suffers from a tight geographic range. Outside of Nokia phones, the OS has only gained traction in Japan. Nokia is not a real contender in that market and so Symbian has never been seen as a competitive threat by the handset vendors. Elsewhere, Symbian's share of the OS market has geographically tracked that of Nokia's share of the handset market. So, in the US, Symbian is a tiny presence. In Europe, on the other hand, Nokia's dominance has forced other handset vendors to adopt Symbian to cater to consumer preference. This includes phones from Sony Ericsson, Samsung and Motorola. In many markets, we think Symbian's strength is derived almost entirely from its inclusion on high-end Nokia devices. Many consumers, we believe, choose Nokia smartphones because they are a status symbol, the most expensive Nokia devices. They do not pick these phones because they are smart, and the OS is an unnoticed feature.

***Many consumers buy Symbian phones because they are the most expensive Nokia phones available***

We think Symbian has two key vulnerabilities. The first is the oncoming change in consumer habits. Consumers globally are just waking up to the possibilities offered by their smartphones. As consumer habits change, they could easily move to new platforms, even in entrenched markets. We could imagine a world in which people buy a Nokia phone and some other brand for their data device. Of course, this cuts both ways. In the US, consumers are still in the early stages of adopting smartphones. As long as they are learning new habits, they could easily learn to make a habit of Symbian.

***Developers do not love Symbian***

This leads to Symbian's second problem. Its development community is weak and unconnected to broader changes in data usage. The clearest symptom of this is the poor synchronization with the PC.

***The age of the Symbian kernel and development tools are the chief concerns***

Above, we noted that Symbian has a solid technology platform. We imagine many developers stopped reading at that point out of frustration, because Symbian is also using an older kernel. Many developers with whom we have spoken feel that the core kernel elements of Symbian are dated and has not kept up to date with the many changes in OS trends. This is important for developers who have voiced complaints about development tools and support from Symbian.

Symbian's relationship with the Silicon Valley development community is not close. This is important if the future of operating systems depends on the applications ecosystem. Symbian is much closer to the handset vendors than to developers, and it needs to overcome this soon to stay relevant.

***Nokia to make Symbian open-source, someday*****Nokia to 'open' Symbian**

This all leads to the latest developments at Symbian. Nokia has announced its plans to acquire the 49% of Symbian that it does not already own, and to then make the OS open-source. Of all the events that have shaken the OS landscape over the past three months, we think this is the most important and misunderstood.

***Nokia's moves lower its licensing costs and hones its R&D focus***

Nokia's move sparked a great deal of head-scratching. Nearly everyone with whom we spoke in the industry (outside the two companies involved) was searching for Nokia's 'hidden agenda'. We have spoken with people at both Nokia and Symbian, and think Nokia had several reasons for making this move:

- Cost-savings. Nokia paid the equivalent of roughly eight quarters worth of royalty payments. Since it will take at least that long before Symbian becomes fully open-sourced (and free), the move is probably accretive for Nokia over the long-term. Nokia is essentially internalizing Symbian's R&D costs, much of which it would have footed the bill for anyway.
- Nokia now has control over the pieces of Symbian it most desires, including the user interface. It will also externalize the costs of maintaining the OS. As an open-source project, other companies who want to participate will now have to pay more for their share through an investment in the open-sourced OS. This also frees up Nokia to invest more in the higher layers of mobile software, including the UI and the applications suite.
- A sincere interest in expanding Symbian's user base.

The last point is probably the most contentious, but we think it has some validity. Nokia is aware of Symbian's reputation as a Nokia-centric system. If it can get others engaged in building the OS, it may enhance the third-party development community's interest in Symbian. In part, this move is a direct response to Android, which has done just that.

***Making Symbian open-source will take many years***

We think all of this could make Symbian an even more formidable contender. However, it could also take many years to play out. Our contacts continue to warn us that opening some of Symbian's low level functions fully could take much longer than anticipated.

**Conflicting interests?**

Nokia also has many moving parts that could create an internal conflict of interest. In addition to Symbian, Nokia recently acquired open-source Linux developer Trolltech. It is still a little unclear why they need two operating systems in-house.

***Nokia is building its own applications ecosystem***

Nokia has been on a roll in recent years, acquiring a wide range of other software companies (see M&A section at the end of this report for more on this topic). It is bundling these into its Ovi offering. At one level, this makes a lot of sense. Recognizing that it is increasingly difficult to differentiate its products through hardware alone, it has made the smart move to try to differentiate itself with software. At another level, it is essentially looking to transform itself into a software company. This kind of transition would be difficult or impossible for most companies. Nokia, however, could pull it off; after all, the company used to make rubber boots and paper products.

***Nokia's Ovi will be competing with the developers that Symbian needs***

Another difficulty is that Nokia is putting itself in a position to compete with itself. While Nokia will not 'own' an open-source Symbian, developers will likely view Symbian as a Nokia platform. Meanwhile, Nokia is seeking to develop its own range of software products. This puts the company in direct competition with the developers that Symbian needs to win over to remain a viable platform. Nokia's Ovi software suite has become a large ecosystem of applications, this threatens to crowd out several categories of development. They have been weeding this down recently, but it remains unclear if they have left enough room for other developers.

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## Windows Mobile

### ***2008 was not a great year for Windows Mobile***

Last year was not a good year for Windows Mobile. While it did gain share, delays in launching the version 6.1 update likely caused it to miss its FY08 target of 20 million devices shipped. Still, it remains a formidable power in the industry.

### ***Overshadowed by RIM and Apple, WinMo still has a much larger installed base***

Although market share estimates do not show it, WinMo probably has one of the larger installed bases. It does not reveal its geographic breakdown, but by our estimates, it is strongest in the US and Asia, and weaker in Europe. In the US, it is overshadowed by RIM and Apple, but it has been selling for a long time, giving it a reasonable installed base on mobile. In Asia, ex-Japan, it has quite possibly the second largest installed base among smartphone users after Symbian.

### ***Windows Mobile benefits from ties to the PC***

One of its biggest advantages is obviously its ties to the PC and its long-standing relationship with many equipment manufacturers. Windows Mobile is very similar to PC Windows in terms of appearance and the user interface. In theory, it also offers a high degree of synchronization with PC applications and data. Windows developers can also use many of the same tools to develop for both PC and mobile platforms. The applications may not be the same, but at least there is a high degree of familiarity for the million-plus members of the Windows development community. Versions of Windows Mobile are also used in a variety of consumer electronics devices beyond smartphones.

### ***WinMo is still a work in progress***

Beyond this, WinMo has some serious issues with which to contend. First, similar to Symbian, we think many users who own WinMo smartphones do not really make use of all the features of the platform. They buy Windows-based smartphones because they tend to be high-end devices or have features such as full QWERTY keyboards that users want. In practice, synchronizing data on one of these devices with the PC can be a painful process, especially for consumers without the benefit of a corporate IT department.

### ***Carriers are a little wary of Microsoft***

Windows also scares the carriers. Wireless operators, already wary of becoming 'fat pipes,' do not want to let Microsoft gain too much access to their subscribers. Many carriers want to control the look-and-feel of their devices, and would have to lose some of that control with a Windows UI.

Windows Mobile also suffers from being part of a larger platform. Much of the functionality of WinMo is overkill, in our opinion, offering more functionality than most users want. A good analogy here is another Microsoft product – Word. Few users of MS Word make use of all the features the program offers. On a PC, however, sacrificing an extra GB of memory for those unnecessary features is barely noticeable, but the smartphone has little memory to spare. Microsoft is aware of this, but believes that with time the phones will grow in power, increasing the OS's addressable market.

### ***WinMo also has to fit into the larger Windows strategy***

The flip side of its close ties to the PC Windows is that it has to make certain trade-offs for the "Platform" of Microsoft's broader strategy. For example, in our recent discussion with the Microsoft Mobile team, the group went out of its way to extol the benefits of Microsoft Silverlight. This is the company's multimedia framework for the web, and the company's competitive offering to Adobe's Flash. For an independent OS, the Flash vs. Silverlight debate is a sideshow. Eventually, it may matter in the world of mobiles, but is not currently a priority for carriers, users or developers. Nonetheless, WinMo will have to plan for Silverlight in future releases. This loyalty is not always reciprocated, as evidenced by MSN's recent announcements with Nokia around closer ties to MSN Live and other Microsoft services.

We think Microsoft faces two tiers of issues going forward. The first is execution. It needs to keep the improvements coming with new versions. We think it can deliver on this front. We trust that Microsoft can manage huge software projects, albeit with a few speed bumps. The

unit has recently changed management. We think this could mean a delay in the release of WinMo 7. This is not bad news, as the OS could use a good, high-level rethinking.

***Still highly regarded by  
enterprise IT teams***

Our bigger concern is over the long-term future of the company's OS. Our chief criticism of the OS is that it remains too enterprise-focused. It is still unfriendly for most consumers across a range of areas, and complicated to install and manage. Users have to rely on IT departments to manage configuration and upgrades. For consumers, this means a trip to the carriers, who have little interest in serving in this role. Despite the large developer base, there is no easy way to load content onto WinMo devices, as opposed to Apple's App Store. The blogosphere thinks that Microsoft is working on its "Sky Market", but this only solves part of the problem. Even enterprise users do not make full use of the power of their WinMo devices. E-mail synchronization should be straightforward for enterprises with Exchange mail servers, yet we know of only a few organizations that make use of such functions on a large scale.

Being part of the larger Microsoft organization does have benefits for the mobile OS. For instance, the company is now heavily focused on implementing their vision of 'cloud computing', the synchronization of data and software across multiple methods of accessing it. Mobile devices are an important piece of this world. Our sense is that Microsoft is deeply committed to being a force in the mobile space as part of that strategy. They also have a lot of services that work well with mobile formats, such as MSN Live and messaging. These do not need to be tied into the OS, but we imagine they will work well when coupled together. We also think the company has many under-the-radar projects which could yet to come play and keep Microsoft at the forefront. For instance, in 2007 they acquired the messaging platform company Danger. They have not made many public comments on the future of Danger, but it's easy to see it becoming a more compelling part of the WinMo experience.

All in all, we think Microsoft has time to work out its focus and improve the user experiences on its devices. However, it does not have unlimited time, and risks being confined to the enterprise market.

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## **Linux**

Linux is the most difficult OS to analyze. Its open-source nature drives its appeal, but has also meant a great deal of fragmentation.

***Linux is 'free'***

Linux has the benefit of ostensibly being free. There is no cost to license it, and no royalty payments. As with all things, however, there is no free lunch. Linux comes at a cost. Handset vendors that seek to use it need to devote significant resources to developing it. Despite this, the OS still holds significant appeal. It has received the best reception in Japan, a market several years ahead of the rest of the world in the adoption of high-powered phones. It has also generated significant interest for vendors selling in China.

***Open sourcing has led to  
fragmentation***

The chief drawback of Linux is its open-source nature. This gives all users the right to alter the source code at will, so long as they publish their changes. This has allowed the OS to fragment, with different handset vendors using different versions, sometimes several each. Motorola has had at least three different Linux platforms and now appears to be working on its fourth. This factor directly counters the scaling benefits of having a common OS, discouraging developers.

As in the PC world, there are companies that exist by selling 'free' software. In the mobile world, Trolltech and Access both had viable business building ready-to-wear Linux platforms for handset makers. There are also several industry bodies that have been seeking to standardize the Linux process, including the LiMo Foundation and LiSP.

The Linux world has been completely shaken by the introduction of Google's Android platform. Android is Google's version of Linux for mobiles. Its introduction essentially wrecked Trolltech's business model and drove it into the arms of Nokia. Access is still standing because of its strength in Japan, but will have a difficult time moving beyond that core market. Even the mobile Linux industry bodies merged.

***Android seems likely to become the Linux standard bearer***

We think Linux will remain fragmented. Android could change that by becoming the de facto Linux standard ex-Japan, but for reasons we detail in the Android section below, we think this is unlikely. Instead, we think Linux will remain a fragmented arena. With time, we expect it to maintain or gain a little share, especially in Asia, but we do not think Linux will be the answer to developers' needs.

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## **The contenders**

Below, we walk through other significant operating systems, each of which has both merits and meaningful flaws.

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## **Will Apple rule the mobile world?**

***Apple has shown consumers what smartphones can do***

The short answer is no, it will not. But there are more reasons to fear Apple than there were a few months ago.

***Apple has leapfrogged into the lead of mobile applications***

Since the 3G iPhone was launched four months ago, the media has focused on the new device's hardware – the 3G data rates, GPS and the touch screen. Less clearly understood is how Apple has stolen a march on the mobile content front, taking a giant leap ahead of other mobile operating systems, and even ahead of the carriers. Our favorite feature on the new iPhone is the App Store. This is the software extension of Apple's iTunes music store, a place where users can go to buy software for their iPhones.

***The iPhone has introduced new ideas to the market***

Today, most wireless subscribers in the US and Europe can download new applications for their phones, but none (or very few) bother to do so. It's cumbersome, bordering on painful. Apple has made buying content for a mobile phone fun.

***The App Store gives developers a way to reach consumers***

The App Store has a few big advantages from the developer's point of view. First, it greatly facilitates user discovery. Consumers can find new applications with a decent search tool in iTunes. It's a single page with several useful features, which work on both the phone and on the Web. Second, and probably most important, is that Apple already has a billing relationship with consumers through iTunes. Billing remains a thorny issue. Apple's success with the App Store is built on the company getting the carriers to agree to let subscribers use Apple's, not the carriers', billing platform. We think this will be difficult for others to replicate. For developers, this greatly eases payment, and lets them focus on building software rather than trying to create some complicated business model.

***Apple knows how to make things easy for consumers***

One thing Apple does better is customer service. We recently visited an Apple store to return an item. The check-out line was very long that day; there were two visiting Europeans at the head of the line trying to buy large numbers of iPhones. However, Apple store employees have remote terminals that let them move about the line, helping out customers with simple purchases. Using our receipt, they were even able to process our return without scanning our credit card again. They e-mailed the receipt to us. Five minutes in line and we were done. It's the easiest retail experience in the US, because Apple realizes that people who have pleasant memories of their experience in the Apple store will likely come back to buy more. That's why the Apple Store on Fifth Avenue in New York is a tourist destination. By contrast, the AT&T store experience is so unpleasant that we do not want to ever go back there again to buy anything, including the new iPhone.

***Few others have grasped  
Apple's appeal***

We bring this up because we think that despite all the years of Apple's success, few of their competitors really understand its causes. This is important for mobile content because Apple will make it as easy to install new software on an iPhone as it is to download a track to your iPod or return that iMac you do not really need.

Our core thesis about smart phones is that success will not depend on form factor or features, but on software. Phones with the best software will prove more popular with consumers. This will result either in share gains or better pricing or both for the companies with the best solutions. Apple is far down this path. So is Nokia. Motorola is far behind. (See Digits #3, October 2007). It seems like Samsung and LG are not even looking in this direction.

For consumer ease of use, Apple is way ahead of its competitors.

***The App Store skews  
developers' decisions***

With finite resources, software developers have to carefully choose which platforms to develop for. Choosing Apple is risky. iPhone units will likely remain small this year relative to other platforms – 13 million in CY08, according to our Apple analyst Chris Whitmore, versus cumulative several hundred million Nokia Series 60 devices. On the other hand, there is reason to believe that the attach rates of applications will be much higher on the iPhone. Moreover, revenue share with Apple is much friendlier than similar agreements with the carriers. Apple is asking for 30% of revenues, and the carriers usually take 60% or more. Apple's take is not trivial, but it does facilitate the cumbersome task of delivering to consumers.

***Despite Apple's advantages, the game is far from over***

These reasons are compelling enough to cause concern that Apple may be able to build a huge pool of developers around its platform, which would drain the pool for others. However, despite this momentum working in Apple's favor, we see several reasons why the market will never become 100% Apple.

***Apple is strongest in the US***

First, Apple remains largely a US phenomenon. Despite its success signing up carriers outside the US at a healthy clip, Apple faces a far more difficult task overseas. The Apple brand carries far less weight outside the US, albeit its progress on this front.

***Carriers may resist the App  
Store and iTunes***

Second, the Apple App Store, which we view as the company's secret weapon, will meet a great deal of carrier resistance. Until now, most downloads of mobile content were done through the carriers. The App Store operates at the expense of the carrier. Somehow, Apple has been able to persuade AT&T that this was a good deal for the company. We think other carriers will be less receptive, especially over time.

***iPhone is still reliant on a  
home computer***

Another important issue for Apple in gaining traction overseas is its ties to the computer. The App Store and iTunes music store work on the phone adequately on a standalone basis, but they are really designed to be used in conjunction with a computer, whether it be Mac or PC. We believe that most of the world's population will never use a computer and most of their data needs will be satisfied by the mobile phone alone. If that phone needs a computer to work to its full capability, then that phone's market will be somewhat limited. This is true not only of emerging markets, but of several large European markets as well.

In short, Apple could be a real threat in the mobile content market. It has a platform that puts to shame many of the incumbent handset players. Over time, however, its business model has several structural barriers that could prevent it from becoming truly dominant or even a serious rival to some of the incumbent vendors. To be clear, Apple can still make a lot of money selling the iPhone, but we do not think it will ever displace Nokia in market share.

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## Google's Android

### ***Android has shown developers what smartphones can do***

If the Apple iPhone has driven consumer interest in mobile phones as data devices, then Google's Android has done the same thing in sparking interest among developers. We think Google's reputation for smart coding has drawn the focus of the Silicon Valley developer community in a way that no platform has so far. Unfortunately, this may not be enough to build a viable long-term platform.

Currently, the first Android-based phone, the HTC G1, had recently begun to ship to T-Mobile customers (see the Appendix for our first impressions of the G1). Our colleague KC Kao in Taiwan thinks the G1 will be shipped close to a million units in 2008. This is a respectable number for a new device. With time, we think other handset makers will launch Android devices. Motorola has announced that Android will be one of only three OS platforms with which it will work (WinMo and its proprietary P2K are the other two). So far, Samsung and LG have both shown varying signs of interest.

### ***Android depends on Google's 'charity'***

Unfortunately, except for Motorola and HTC, all of Google's Open Handset Alliance/Android partners are demonstrating ambivalent commitments. At heart, the trouble with Android is its business model. One contact at Android actually told us, "Google's business model for Android is not a priority," meaning it does not expect to make money with Android. Apparently, it does not even plan to directly monetize it. Google is investing significantly in the OS, then giving it away for free. Its goal is to drive consumer usage of the mobile web. Once on the web, presumably these users will use the Google search engine just as they do on the PC web. Pardon our skepticism, but giving away something to drive 'eyeballs' is a 1999 business model'. We think there are a few flaws in this plan: for instance mobile web users may not use Google, or ignore the ads, reducing CPMs. In our test drive of the G1, we found that the Google searches we ran generated great results, but did not display any ads.

### ***Developing an OS is expensive***

Developing an OS is expensive, and is a marked departure from their core search expertise. Even Google's resources are finite. Our DB colleague Jeetil Patel has noted that Google has been managing expenses recently as we enter tough economic times. Android's resource constraints became apparent this summer. Developers began complaining in public online forums that they were not getting the support from Google they needed to build applications. There was a sense that the company had chosen to focus its engineering support resources on getting HTC and the G1 ready to go, and that its second priority was helping the fifty finalists of its application contest. This left little for everyone else, as demonstrated by the delays in releasing a full software development kit (SDK). Since then the grumbling has subsided, but the development community remains a bit wary.

### ***Google could have taken other paths***

On the one hand, we are in awe of Google's ambition. Android is a bold move, which could truly alter the landscape in Google's favor. Google may also see strategic imperatives in going this route. It cannot risk being shut out of mobile web platforms, and may have felt that it has few friends in the mobile world. This could also be part of its plan to build a broad-based software stack. On the other hand, we think there were other actions Google could take to promote the growth of mobile web usage. For example, we think it should have catalogued device profiles for every cell phone on the market. Cataloguing disparate information strikes us as being Google's core competency. This could have gone a long way towards facilitating others' development efforts. They could have also dedicated the resources to growing Google Gears for Mobile or building a mobile version of their Chrome Browser. Maybe these are in the works.

### ***Android is Linux-based and could become just one more Linux variant***

The big risk is that Android becomes just one more flavor of mobile Linux. To an extent, this is already happening. For Android to succeed, it will need to become the standard bearer of mobile Linux, and Google will have to act as ringmaster for the three-ring goat circus that emerges in most technical standard-setting bodies. Android's greatest strength is its ties to

Google, which is trying to position itself as an 'honest broker' between carriers, consumers and content providers. At the same time, the ties to Google also work against Android. Many developers we spoke with in the Linux community are wary of any one corporation gaining too much influence over the open-source process.

There is a real concern that the development community may not see Google as an honest broker. In the section on Linux we note that the entry of Google into the OS space has put pressure on many business models. We think the open source community is wary of having a big corporate entity try to set terms for the whole community. Android has to walk a fine tightrope to balance all these conflicting interests.

***Carrier interest in Android remains lukewarm***

The carriers are another big concern. Other than T-Mobile, we know of only one carrier who has signed an agreement to participate in the Open Handset Alliance (OHA), the Android advocacy forum. That carrier is China Mobile, who does not seem to be in a hurry to launch an Android phone. Moreover, our contacts tell us that its agreement with Google has ample opt-outs. Lots of other carriers put out press releases to announce their participation in the OHA, but as far as we know, none have signed a contract. We think they are eager to see lower prices for handsets, but are ambivalent about letting Google get in between them and their customers.

***Consumers are still largely unaware of Android***

Despite all the press attention on the G1 launch, we think consumer interest remains modest in Android, at best. Few consumers care about operating systems, and most are not even aware of their existence. They will buy the G1 and other Android phones if the form factor and the price are right. We think this is a big blind spot for Google. Our contacts have told us that the G1 is based on an old platform, and that this is the same device Android demonstrated two years ago when it first began the serious work on commercialization. A lot has changed in the smartphone world over the last two years. From our tests, we think the G1 has lots of appeal for the technically-inclined, but we think it is lacking in consumer appeal. Admittedly, this is not Google's problem, the handset OEMs will ultimately be responsible for designing and marketing their smartphones.

***Google has to balance its own resources and the demands of handset makers***

Ultimately, however, the handset makers interest in Android will come down to the costs associated with using Android. While there is no licensing fee for each Android device, that does not mean they using Android is free. Hardware makers will still have to spend resources on integrating Android into their devices. This has emerged as a point of conflict between the vendors and Google. The other OS vendors invest significantly in supporting their handset partners. Google who generates no revenue from Android, does not offer the same level of support. For the most part, they seem to be letting the OEMs find their own way. The hardware makers see this as an added expense, reducing Android's appeal. Further, the more that Google lets its partners do their own work, the greater the risk that Android fragments. Motorola will want to differentiate its smartphone software from HTC's. In doing so, they may tweak their version of Android to the point that not all third-party software will be compatible with both versions. The phone vendors will want to tweak the open-source OS to differentiate their phones. This is a natural inclination, but risks eliminating the benefits of having a standard platform.

Someone will have to ensure that applications written for the G1 will work on Motorola devices and all the other Android phones that may come out. That role will obviously fall to Google, but the process will require an ongoing investment. This leaves the Android team stuck between its shareholders and declining global ad spending on the one side and the hardware makers and the developer community on the other, clamoring for more support.

**Conclusion**

Despite all this, Android looks to be in good shape at the moment. We expect to see at least a dozen new Android devices this year from HTC, Lenovo, Motorola and possibly others.

Google needs to prove its OS is stable and as easy to deploy as many hope. If they can nail down a few issues such as the application distribution and get a few more carriers signed up then they have the potential to become a truly disruptive force in the industry. Google has the ability to not only secure a foothold for Android in mobile phones, but to move up the curve as well. We are seeing an increasing number of laptop-like devices running Android. So Google could potentially use Android as a platform for greatly increasing its footprint across laptop computing as well.

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## Palm

### ***Legacy PalmOS was again***

Prior to last week, not much needed to be said about Palm's OS. Their legacy Palm OS cannot handle such basic functions as multi-threaded processing, which means it cannot do simultaneous voice and data connections, and so cannot handle WCDMA.

### ***With WebOS, Palm has gone from worst to first***

However, that has all changed with the launch of their new Web OS platform. Palm has gone from arguably the weakest OS to the best. From what little we know of it as of this publication date it seems to be a solid offering.

### ***Palm has learned from others***

Given limited access to the new device, the industry has focused on their new user interface which is quite appealing. Palm's roots lie in designing highly intuitive UIs and the WebOS is no disappointment. Easy, single touch access to much of the device's functionality along with multi-touch support. As the most recent entrant to mobile OS, the new system clearly has learned from the recent advances made by Google and Apple.

### ***Pervasive multi-tasking and cut and paste –***

Under the hood the system seems to be very promising as well. We obviously appreciate the fact that it has cut and paste capabilities, which are oddly lacking in the iPhone. More seriously, WebOS can handle multithreaded processing. In demos, we saw that the device could run one application (say the music player) and simultaneously load multiple web pages. We also appreciate the phone's ability to trade between applications without exiting and re-entering them in turn.

### ***Palm's web-based approach, opens development to a large community***

Most intriguing, however, is their approach to third-party development. WebOS is truly web-centric, and programming applications for Palm will now only require a knowledge of web design tools such as HTML, CSS and JavaScript. This throws open the doors to the widest possible development community – the millions of web designers out there. It will also have limited ability to store data, and thus maintain state without network connections, through the use of HTML 5 capabilities. Apple tried a similar approach when it first launched the original, 2G iPhone. This largely proved disappointing because the browser did not really give developers access to most of the phone's functions. Palm, on the other hand, seems to have built the whole phone around this concept and thus integrates the browser capabilities into most of the phone's functions. This means that third party applications should be able to call on the contacts directory or the map or the music player.

### ***Tying the OS to one hardware platform limits share***

So from what we have seen, we like the OS, but we still see a few problems. First, the OS will run only on Palm hardware (presumably we are not going back to the days of Palm Source). This will cap the ultimate size of the market for the device, just as it caps the iPhone's eventual size.

### ***Palm needs better desktop synchronization***

While a minor point, we also think the lack of synchronization for desktop media content is a mistake. Palm could easily have given Apple a run for the iPod money by supplying an easy-to-use music synchronization client. Instead, it looks like users will have to resort to drag and drop for putting their music onto a Palm device. Perhaps this will not matter as users increasingly get their music from web sources such as Pandora.

**Many details remain unclear** As of this date, we still lack a lot of detail on the WebOS. For instance, it is unclear whether the device can support OTA updates. We suspect it can, but have no definite word on that.

**How will App Catalog provide billing?** Another big question remains their distribution of third-party content. Palm has announced that they will have their equivalent of the App Store, tentatively called App Catalog. No word yet on revenue sharing, degree of their control or billing mechanism. They did announce that music will be available for download (over Wi-Fi, not cellular) via Amazon's mp3 store. This is the same move Android has made.

**Web-based OS may be weak gaming platforms** In general, web-based architectures trade simplicity for a reduction in capabilities. We think Palm has done a lot to minimize that reduction, but some loss is inevitable. One trade-off will likely come in the form of graphics capabilities. Applications which require intensive graphics support (i.e. gaming) will probably overtax the capabilities of the rendering engine. After the WebOS announcement, the blogosphere seemed to think that ultimately Palm would open up the platform to a binary run-time environment and allow for native applications. This remains to be seen.

**We are generally positive, but still have many questions** We have many other questions as well. When will they announce support for UMTS? How will developers react to the OS? How will the emerging web-centric OS develop? Will web-based applications developed for Palm actually work on RIM's equivalent web-based platform? They should, but we think a lot of work still has to take place in the web design community. It took the better part of a decade before tools like CSS earned widespread adoption. We expect a similar process in the mobile community as web designers go through the trial and error process of determining which design methods work best for mobile devices.

So while we are generally positive on Palm's new OS, we will need to see more before we can assess its ultimate prospects

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## Research in Motion

**RIM has a large installed base, but their interest in the OS is unclear** We name RIM at the end of this list for alphabetical reasons, but of the four second-tier contenders, it has the largest installed base by far, probably larger than the other four combined. The trouble with its OS, and its long-term prospects, is that it does not necessarily feel it is in the OS business.

**Developer interest in RIM remains limited** On occasion, RIM presents itself as providing a platform for development, but has never claimed to be an operating system provider. We know that it is working hard to build up its development community and grow the "Blackberry ecosystem". It has just held its first developer conference, and announced an application marketplace similar to Apple's App Store, as well as rolled out new development tools.

**Waterloo is a long way from Silicon Valley** Its difficulty, however, is that Waterloo, Canada is very far from Silicon Valley. RIM's efforts to reach out to the software world seem to be a low priority in practice, if not intent.

**Blackberry is largely a closed system** We think part of the problem is that the Blackberry has always been designed as a closed system. This helped win the support of corporate IT departments concerned about security. Opening the platform will take a lot of work, and likely many years. Our contacts tell us the proprietary RIM OS lacks many of the sophisticated features that the others offer, including its video management, database queries, memory management and many other features.

**There are few native apps available for Blackberry** In general, we think the range of applications being developed for the Blackberry remains limited to low-end entertainment (e.g., casual games) and highly customized for specific enterprises (e.g., employee directories).

***RIM is looking to build a better browser***

Instead of aiming to be an OS provider, however, RIM could be taking a slightly different approach. Buried amidst their multiple press releases last year, RIM announced that it was working on a version of Google Gears for Mobile. This is an intriguing alternative to the problem. Instead of building on OS, they are taking the chance that the browser and not the OS becomes the key software platform for phones. We explore this possibility further on in this report. For such a browser to be successful it would need to maintain functionality even in places without a network connection (tunnels, airplanes, our living room). Embedding this capability into a browser is the goal of Google Gears. If this works, RIM could redraw the mobile OS landscape.

Ultimately, this is a very similar approach to what Palm has done with WebOS. The big advantage of this approach is that it throws open the mobile development doors to the largest developer pool out there – web designers. Building web pages can be far simpler than building native applications and would give RIM a big leg up against vendors with far larger developer communities already in place. However, it is important to remember that Gears is in early days even in PC environments. Getting it to work on mobile will take several years.

This radical approach and RIM's growing installed base merit its inclusion as a serious contender in this business. The Blackberry remains one of the few smartphones that are bought largely for their data properties, as opposed to being just another pretty device. With the right effort, RIM could remain a force.

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**Everything else*****The vast majority of devices today do not need an OS***

Beyond these seven, there is a vast sea of companies in the 'other' category. We do not expect this to change any time soon. The vast majority of devices do not need a sophisticated operating system, nor can they support one. This does not mean that mobile data will only be confined to the smartphones. Quite the opposite.

The biggest growth areas for mobile phone sales over the next two years (maybe the only growth areas) will be low-end handsets sold into emerging markets. Here the advent of SMS, a feature which many phones still lack, is likely to have a profound impact on data networking. Through low-speed 2G connections, billions of people will gain access in some form to the Internet.

***Developing for these phones is challenging***

This will make life harder for developers, but by no means does it shut off the market. In China, for example, there is a robust market selling applications to consumers through a variety of channels, from carrier portals to street-side vendors. However, this market will likely remain fragmented. Much, but not all, of this development will focus on simple Java programs. This means that this software market will remain fragmented. Consumers will have to navigate the maze of compatibility, and developers will have to continue to pick and choose the number of devices to which they port their software.

We think there are three platforms that will play an important role in this market for the foreseeable future. None of them constitute a full-fledged operating system, as we would see on a smartphone, but they all have a large installed base and low cost to implement. These are the Mediatek, BREW and Java OS. This is a varied bunch, and there are many others, but these are the three with by far the biggest installed base.

***Mediatek, a chip vendor, supplies a limited OS with its basebands***

**Mediatek** is actually a chip supplier. It has emerged as one of the leading vendors of low-cost 2G basebands for many of the low-cost handsets sold in the emerging markets, especially China. Its low-cost chip platform has thrived in large part because it has offered its customers a simple, proprietary OS along with the chips. This appeals to low-margin handset vendors who lack the capacity to design their own OS. The top five handset vendors have

been able to cobble together enough of their own proprietary systems because they have the scale to devote some resources to software. So far, none of the other low-cost chip vendors have offered anything comparable. We know some companies are working on a solution for other chip platforms, but Mediatek's remains the de-facto leading OS in this market, by far. Few developers build applications for this OS, and we do not think that will change any time soon.

***Java is widely deployed, but too fragmented***

For the most part, software development on low-end phones focuses on simple **Java** applications. We tend to lump Java in with the Linux operating system, discussed above, but its widespread penetration merits attention. The overwhelming majority of applications developed for mobile phones today are Java applications. However, we think this platform will struggle to scale. Java profiles vary from phone to phone. For example, Nokia, which has among the most organized Java implementations, uses at least three different Java profiles for its phones. This means that developing software for Java can be very costly, with separate porting or even development required to support each class of device. This has resulted in a highly fragmented marketplace with ample confusion about which applications work on which phones. So far, this problem has been solved at the retail level. Consumers access this software either through downloads from carrier platforms or side-loaded from some off-portal vendor, often a vendor with a physical presence. We think developers will increasingly shun this effort as too costly as more robust operating systems emerge on the market.

***Qualcomm's BREW has fared better than many expected***

Qualcomm has sought to address this problem through its **BREW** platform. The Binary Runtime Environment for Wireless (or BREW) is not really an OS. It is often described as a development or execution framework that seeks to fill some of the gaps around existing low-end, proprietary systems. BREW provides content discovery, over-the-air downloads and billing mechanisms, and offers programming hooks into low-layer telephony features. We include it here because it is available on essentially all phones with Qualcomm basebands. In addition, it could some day emerge as an aid to the more robust OS offerings, supplying them with features they do not already possess. From what we can see, Qualcomm does not seem to have any intention of moving upstream and morphing BREW into an OS competitor. Instead, we think it will focus on working with existing OS vendors to bring better software to phones. The one exception to this is in the emerging area of mobile computing devices or mobile Internet devices. This is the category of network-enabled devices that have more processing power than most phones, but less than the average laptop. Some people believe the BREW could be used to support such devices in lieu of a stand-alone OS. This is an area of intense development, so we expect a lot of change to happen here. For the next year or two, however, we do not expect this to be a significant volume.

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## **Do we really need an OS?**

***Smartphones could exist using only a browser***

There is another possibility. We may not need an operating system at all. Another alternative is that all mobile applications remain web-based, so that a phone would only need a browser. There is an ongoing debate within the industry about the merits of running applications in a native OS environment or running them over the web. Palm, and apparently RIM have take a web-centric approach, while the others all seem to be going native, for now.

This debate is actually the extension of an even older argument from the PC world. Companies like Oracle and Sun long ago predicted that computers would become thinner and thinner clients, with most of the computing power residing on the network. This never took place, as the price of computing power fell far faster than the price of connectivity. However, the mobile phone lends itself to a renewal of that line of thinking. After all, a smartphone is a very low cost computer, which specializes in network connectivity. The smartphone could be the grail long sought by the proponents of the network-centric model.

***Developing a browser is far easier than building an entire OS***

There are definite advantages to this approach. For handset vendors, developing a browser is much cheaper than developing an operating system. Alternatively, it is much less threatening to license a third-party browser than it is to license a whole operating system. Handset vendors or carriers could keep control of the core of their devices' functions, and still have access to a range of third-party applications.

Another major advantage would be that it could throw open the doors to the widest possible pool of developers. Generally speaking, designing a web page or web application is far simpler than building a native application. If the goal of every OS vendor is to build the biggest possible development community, a purely web-based solution would outnumber all the other installed developer bases out there. This seems to be a major reason that Palm and RIM are both moving down this path.

A variant of this approach is to see the development of widgets. In this case, a widget is a very light-weight application that pulls data off the net, a very special-purpose browser. This approach has a lot of appeal as well. It opens up the field to third-party developers a little more.

***Web-centric devices will not have the same functions***

Of course, the web-centric approach has numerous drawbacks. First, it will likely severely limit the functions available to third-party developers. In particular, it would make it very difficult for applications to control the phone. If it were badly implemented, this would mean that applications would lose their data or run poorly when interrupted by an incoming phone call. For example, many advertisers would be interested in one-click calling for users who see a mobile ad that appeals to them. It is unclear if web-based applications could adequately perform these functions. Apple tried a web-based approach as a short-term stop gap until its full SDK and programming environment were ready when the 3G iPhone launched. This proved largely unpopular among developers. It also seems that web-based OS's will lack the complete graphics capabilities of native environments. This could be important for games, an area of immense development on the iPhone.

***Web-based applications have met with mixed results***

Web-based applications have met with mixed results in the PC world. For the enterprise, multi-tenant, Software as a Service (SaaS) applications are clearly a hit, as evidenced by companies like salesforce.com. However, this model only goes so far. Though first-order SaaS vendors have been successful with their applications, we think results remain unclear for their second-order business of selling a platform (App Exchange in Salesforce's case). On the consumer side, the results are clearly not as good. For example, Google's iGoogle customized home page would seem to lend itself well to the web-based mobile model. But even on iGoogle, the widgets available are uninspiring: they are useful but not worth paying for.

***Web-based applications need web connections which are not always available***

Another big concern is that browser-based approaches need network connections to work all the time. This is clearly a non-starter in mobile environments. If users find that their applications do not work when they are out of coverage zones, they will not use those applications and the device becomes a paperweight. JavaScript can bridge some of this gap, but as we note above it lacks functionality and power. One potential solution to this is the development of platforms such as Google Gears. Gears is an add-on to PC browsers which let the browser access much of the hardware's computing power. This is essentially an added layer of abstraction between the browser and the OS. As noted above, RIM is working with Google to make such a browser available on a mobile environment, but we think it could be several years before this is truly commercial.

**Mobile browsers*****Mobile browsers merit their own report***

Shifting the argument to a web-based model just moves the battle from the OS to the browser, where there is at least as much fragmentation. Mobile browsers are a topic which merit their own report. There is a great deal of innovation taking place on this front. Right

now, the focus of mobile browser development is on basic usage issues. Mobile browsers for many years have been WAP-based, text-only systems. This has worked well for simple websites, but requires extra design work from web developers and often require their own WAP server.

***The advent of HTML browsers has greatly improved mobile browsing***

Increasingly, the focus has turned to HTML browsers. These have the advantage of running on the same web pages as the PC. Browser makers have recently focused on making those web pages readable on mobile form factors. The typical model involves some zoom-in/zoom-out mechanism. With time, some of these features can be more readily addressed by web developers as web tools improve to make mobile rendering and mobile style sheets more common.

***Apple has raised the bar, but there are many other interesting options***

Beyond basic usability, however, there are a lot of interesting developments being considered for mobile web browsing. Privately-held Skyfire, for instance, has introduced a highly-scalable browser that caches much of a website's content, which doles out web pages to network devices in more efficiently. This can greatly speed up the time it takes to load a web page, which is crucial in mobile networks that do not offer download speeds comparable to what users expect from the PC-based web.

Once again, Apple has set the bar for consumer expectations in this field. Other mobile browsers will be compared to Safari, justly or not. This will likely require support for multi-touch touch-screens and some form of synchronization with desktop bookmarks, among many other features.

Browsers still have many hurdles to overcome. Add-in features are proving particularly challenging. For instance, much has been made of the lack of Adobe Flash support for the iPhone. And while developing for a mobile browser is simpler than developing for an operating system, developer relations will matter greatly here as well. Web page developers will have to test the rendering of the web pages across multiple browsers. Supporting Safari, Firefox and multiple iterations of Microsoft's Internet Explorer is cumbersome enough. We think web designers will balk at providing full support of all the mobile browsers. The fact that many mobile browsers are being built around the Webkit rendering engine helps matters, but does not completely solve the problem.

Mobile browsing is an interesting field in its own right, and an area where we expect considerable innovation in coming years. That aside, it does not answer all the needs of coming generations of smartphones and will likely be just one more piece of the puzzle.

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## **Conclusion**

In coming years, we think the mobile content space will change considerably. Consumers will go through an education process as they learn to do more with their phones. These changes in habits are rare events and can prove highly unpredictable. Given the scale of the changes about to take place, anything can still happen. We think none of the current smartphone vendors has a lock on the market. The three 'largest' vendors need to adapt quickly to changes in the marketplace. The next four contenders all possess great potential, which is offset with flaws unique to each.

We still believe that software, especially third-party software, will be a crucial determinant. The OS that attracts the deepest, most sustainable developer base will have a big advantage over the competition.

Applications alone, however, will not be the final determinant. The carriers are likely to maintain a role in this process. Fearful of being relegated to 'dumb bit pipes', they will do

their best to pick a winner. This may result in some compromises among vendors, but it could also result in stagnation, with developers caught in a no-man's land.

We also expect fragmentation to remain an issue for some time. Success in the mobile market, however, will not necessarily be identical to success in PC OS. It's highly possible that the OS remains fragmented geographically, with each continent picking one or two champions. Other variations are possible as well.

Ultimately, we think mobile data will become a huge market and the OS will play a large role in shaping its trajectory.

# Fragmentation

***There will be more than one mobile OS***

Despite the strong pressure for developers to unify around one or two standard OS platforms, we think there are equal pressures that will keep things more fragmented in the mobile environment than what we have seen in the PC world. There are three factors that we think cause cracks to appear in the model. The first is the strength of the carrier in determining purchasing patterns. The second is that the sheer size of the market means that there are far more situations in which people can and will use their mobiles, and this creates some very specialized needs. Third, the very nature of some of the technology involved opens the door for fragmentation.

***Carriers will have a role***

**Geography**

As opposed to the PC world, another decision maker is involved in the purchase decision between the end-user and the hardware vendor. Carriers have found many ways to interject themselves into the mental calculus involved in buying a smartphone. These run the gamut from requiring network certification for devices, as in the US, to their role as the largest distribution channel in almost every market.

***Some carriers want to maintain control...***

Some carriers, particularly in the US, want to determine exactly which smartphones their customers can use. They restrict access of other devices to their networks. While many carriers have proclaimed a newfound 'openness,' even these initiatives come with strings attached. The carriers seek to shape their subscribers' experience of mobile devices and find ways to share in the economics of mobile data. This model is under threat in most places. Even in the US, the iPhone offers little revenue sharing for AT&T beyond the initial data and voice subscriptions.

***...even those who do not will still have major buying power***

By contrast, in most other markets, particularly GSM networks, the carriers have little direct control over what software consumers have on their phone. In Europe and most of the rest of the world, consumers freely switch between devices. In these countries, carriers do not try as hard to restrict operating systems. However, they still play a sizable role in shifting end-user purchases. In many of these markets, carriers are still among the largest distributors of cell phones. They are often able to purchase phones at volume discount prices.

***We think the market will fragment geographically***

Ultimately, we think this has caused the mobile operating system market to fragment along geographic lines. Consumers on different continents will likely eventually see one or two OSs leading the pack. In the US and much of the Americas, we expect to see a lot of Apple and Windows Mobile. In Europe, Symbian and an as yet undetermined competitor will be strongest. Japan and Korea seem likely to continue down their own separate paths for some time. China, India and much of emerging Asia are still up for grabs, but we think these would be good markets for Android or other Linux variants, with the potential for Microsoft or even Symbian to become stronger forces. We think much of the rest of the world – South America, Africa, the Middle East – will follow a path similar to Europe, given the leading market share Nokia enjoys there today.

Much of this remains a work in progress. Another common theme we have found is that the change in consumer habits opens the door to all kinds of potential outcomes. But over the next two to three years, we expect to see consumer buying patterns solidify in many regions.

***Usage patterns will also fragment the OS market***

**Vertical silos**

Another reason we expect to see multiple OS platforms is the distinct silos in which we use mobile devices. The most obvious example is RIM. Many people have a Blackberry given to them by their employer, and a separate mobile phone for personal use. We expect such usage patterns to cause fragmentation among vertical silos.

We still expect personal use by consumers to remain the largest category. Much of our discussion in the rest of this report implicitly assumes strong consumer demand. Enterprise usage, however, could cause a much wider range of platform fragmentation. Many enterprises, or at least industries, are large enough to be able to support an operating system or at least a range of highly customized devices.

***Enterprise requirements  
open the door for other  
solutions***

The key to understanding enterprise demand is the different set of requirements these purchasers bring to the table. Enterprise IT managers have concerns around security, data synchronization and over-the-air (OTA) control of remote devices. These are interesting features and turn out to be relatively difficult to accomplish. The lack of most of these features in many operating systems has given RIM the opportunity to build a solid foundation among enterprise clients, for instance.

Developers of enterprise applications also have different incentives. Typically, there is a higher degree of customization. Large enterprises often have the resources to choose customized software, or at least niche products. This reduces the need for developers to work on a single platform. If they have to do custom work anyway, there is less reason to use an off-the-shelf OS.

We think all of this will help to maintain a few niche markets for different mobile OS offerings. Over time, one of the biggest beneficiaries of this could be Microsoft. It can build on its extensive deployments in international enterprise networks. RIM is the leading vendor now in this space, but from what we have heard about its roadmap, its future beyond corporate e-mail still needs a lot of development.

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## **No future-proofing**

One of the greatest difficulties in preparing this report has been keeping up with the rapid changes. Originally written after the 3G iPhone launch, we had to delay the report for the launch of Nokia's new smartphones, the open-sourcing of Symbian, the roll out of the new Blackberry's and finally the launch of Palm's WebOS. We expect many further changes in the year ahead.

# Appendices

# Appendix A: M&A history updated

In October 2007 we published a comparison of the M&A history of Motorola and Nokia. In that article we found that over the previous five years, both companies had been active in making acquisitions, each completing about 35 deals. However, the nature of the acquired companies differed greatly. Nokia had largely acquired software companies, while Motorola had largely acquired hardware companies. We thought this made it clear where each company's priority lay. When narrowed it further, we found that of the software companies Motorola had acquired, only a small number were *mobile* software companies, the bulk were actually enterprise or set-top box related software plays. In fact, when we added Google's M&A history into the mix it turned out the Google had acquired almost as many mobile software companies as Motorola has.

We have updated this analysis to the end of 2008 and found that little has changed, although about a dozen companies were acquired by each of the corporates.

**Figure 12: M&A history summary, deals announced, by sector**

	Total	Hardware	Software	Mobile software
Google	44	1	38	5
Motorola	43	26	17	6
Nokia	31	9	22	12

Source: Deutsche Bank

We think this analysis is relevant to the discussion of mobile OS and software as the past acquisitions have become increasingly important in laying each company's strategy going forward. Below we reprint the deals.

In hindsight, its interesting to see how these acquisitions have fared within each company. For instance, 18 months ago, it was not entirely clear what Google was planning to do with its July 2005 acquisition of a secretive company with no known revenue stream or products named Android. Or Motorola's November 2006 purchase of Good Systems. While this company initially foundered within the bowels of Motorola, it has now emerged as the kernel of their hopes for building viable software. We can also trace the foundations of Nokia's Ovi platform in their acquisitions of enpocket for advertising, gate5 for navigation, Intellisync then Oz for messaging and most recently Symbian. We also want to highlight their acquisition of Trolltech. As noted in this report, Trolltech had originally provided a mobile Linux platform. It is unclear if Nokia will ever launch a Linux phone. Instead it seems that that they are using Trolltech to supply development tools for the company in an attempt to improve developer relations.

**Figure 13: Google's announced acquisitions 2003 - 2008**

<b>Date Announced</b>	<b>Target</b>
02/15/03	Pyra Labs
04/23/03	Applied Semantics Inc
09/30/03	Kaltix Corp
10/24/03	Sprinks
07/13/04	Picasa Inc
10/27/04	Keyhole Corp
03/28/05	Urchin Software Corp
05/11/05	Dodgeball.com
06/01/05	Shopping.com Ltd
07/19/05	Akwan
07/31/05	Android Inc
09/15/05	Transformic Inc
12/20/05	America Online Inc
01/16/06	dMarc Broadcasting Inc
03/09/06	Upstartle LLC
03/15/06	@Last Software
08/15/06	Neven Vision Inc
10/09/06	YouTube Inc
10/30/06	JotSpot Inc
12/18/06	Endoxon AG-European Mapping
01/04/07	Shenzhen Xunlei Networking
01/20/07	Adscape Media Inc
04/13/07	DoubleClick Inc
04/18/07	Tonic Systems Inc
05/01/07	Marratech AB
05/30/07	GreenBorder Technologies Inc
06/01/07	Panoramio
06/02/07	FeedBurner Inc
06/06/07	PeakStream
06/19/07	Zenter
07/02/07	GrandCentral Communications
07/09/07	Postini Inc
07/24/07	ImageAmerica
08/21/07	Tianya.cn
09/27/07	Zingku-Cert Asts
07/18/08	Zao Begun
09/12/08	Tatter & Co
07/02/07	GrandCentral Communications
08/21/07	Tianya.cn
07/24/07	ImageAmerica
07/09/07	Postini Inc
09/27/07	Zingku-Cert Asts
10/10/07	Jaiku Ltd

Source: Deutsche Bank, Capital IQ and Deal logic

**Figure 14: Motorola M&A Activity 2003-2008**

<b>Date Announced</b>	<b>Target</b>	<b>Hardware/Software</b>
5/20/2003	Cadence Design Sys-Tech Assets	Hardware
2/21/2001	Blue Wave Systems Inc	Hardware
7/25/2006	Broadbus Technologies Inc	Hardware
5/18/2004	DVN(Holdings)Ltd	Hardware
5/17/2007	Modulus Video Inc	Hardware
11/13/2006	Netopia Inc	Hardware
6/25/2002	Next Level Communications Inc	Hardware
4/18/2006	Orthogon Systems	Hardware
5/19/2003	Paceline Systems Corp	Hardware
3/30/2004	Quantum Bridge Commun Inc	Hardware
7/30/2001	Riverdelta Networks Inc	Hardware
4/23/2007	Terayon Communication Sys Inc	Hardware
11/10/2003	XtremeSpectrum Inc	Hardware
02/25/08	Hangzhou Image Silicon	Hardware
02/25/08	Zhejiang Dahua Digital Tech Co	Hardware
7/30/2003	Covigo Inc	Hardware
6/16/2004	Force Computers Inc	Hardware
7/5/2006	NextNet Wireless Inc	Hardware
9/18/2006	Symbol Technologies, Inc. (NYSE:SBL)	Hardware
11/20/2001	Synchronous Communications Inc	Hardware
4/15/2003	Winphoria Networks Inc	Hardware
6/18/2004	Appeal Telecom Co Ltd	Hardware
5/2/2006	BenQ Corp-Development Center	Hardware
6/29/2005	Sendo Ltd-R&D,Singapore	Hardware
11/05/07	Vertex Standard Co Ltd	Hardware
3/31/2005	Mobility Electronics Inc. (NasdaqNM:MOBE)	Hardware
7/10/2007	Leapstone Systems Inc	Middleware
1/17/2006	Kreatel Communications AB	Software
12/21/2006	Tut Systems Inc	Software
1/18/2005	Ucentric Systems	Software
9/25/2006	Vertasent LLC	Software
07/10/07	Leapstone Systems Inc	Software
11/16/2004	MeshNetworks Inc	Software
2/3/2003	NetPlane Systems Inc	Software
12/22/2005	Wireless Valley Communications, Inc.	Software
07/28/08	AirDefense Inc	Software
11/10/2006	Good Technology Inc	Software
9/16/2002	4thPass Inc	Software
9/9/2005	Melco Mobile Communication Europe, R&D Team and Research Center	Software
6/1/2006	TTP Communications PLC	Software
10/15/07	UIQ Technology AB	Software
01/08/08	Soundbuzz Pte Ltd	Software

Source: Deutsche Bank, Capital IQ and Deal logic

**Figure 15: Selected Nokia M&A transactions, 2003-2008, by sector**

<b>Date Announced</b>	<b>Target</b>	<b>Hardware/Software</b>
7/25/2001	Amber Networks	Hardware
6/19/2006	Siemens AG-Carrier Related	Hardware
11/3/2003	Tahoe Networks	Hardware
08/29/08	DASAN TPS Inc	Hardware
2/14/2006	Sanyo-Certain Mobile Phone Ops	Hardware
5/3/2007	TPL-Moore Microprocessor	Hardware
09/07/07	Vivento Technical Svcs GmbH	Hardware
10/25/07	Atrica Inc	Hardware
01/02/08	Apertio Ltd	Hardware
6/5/2006	LCC International Inc-US	Software
4/22/2003	Eizel Technologies Inc	Software
9/17/2007	Enpocket	Software
8/31/2006	gate5 AG	Software
11/16/2005	Intellisync Corp	Software
1/12/2001	InterTrust Technologies Corp	Software
8/7/2006	Loudeye Corp	Software
9/8/2004	Metrowerks Corp-Dvlp Tools	Software
10/1/2007	Navteq	Software
11/9/2003	Psion PLC	Software
8/19/2003	Sega.com Inc-Online Games Op	Software
2/8/2004	Symbian Ltd	Software
7/23/2007	Twango Inc	Software
9/25/2001	VoiceAge Corp	Software
07/23/07	Twango Inc	Software
09/17/07	Enpocket	Software
10/01/07	NAVTEQ Corp	Software
12/04/07	Avvenu	Software
01/28/08	TrollTech ASA	Software
06/23/08	plazes AG	Software
06/24/08	Symbian Ltd	Software
09/30/08	OZ Communications Inc	Software

*Source: Deutsche Bank, Capital IQ and Deal logic*

# Appendix B: Android first impressions

We purchased the G1 on 22 October 2008, the first day it was available, from a local T-Mobile store. There was no line, and it had ample stock. This was the opposite of our experience waiting six hours to buy the 3G iPhone.

That was not the only difference with the iPhone. The G1, made by HTC, is not a pretty device. It's bulky and decidedly not as 'sexy' as the iPhone. Our industry checks told us that the G1 is the same form factor Android has been using to demo its products for the last two years. Much has changed in cell phone form factors over that period (or any two-year period in this industry). So we were initially unimpressed by the device.

This began to change as we started using the device. First, the G1 is noticeably faster than the iPhone. We did several side-by-side downloads, primarily of YouTube videos, and found the G1 faster. There are several possible reasons for this. First, the G1 is one of the few 3G devices T-Mobile sells. They only launched their HSDPA network a few months ago, so the network is far less crowded than AT&T's, where most of their phones for sale are 3G capable. T-Mobile also has better coverage in San Francisco than AT&T, due to that company's acquisition-related divestiture of numerous cell sites in California. The G1 also uses a Qualcomm 7200 baseband, which is more time-tested than the Infineon solution in the iPhone. So while we take time trials with a grain of salt, the important takeaway from this experience is that the G1 is at least comparable to other 3G devices. As with the iPhone, we found the processor was good enough, but would have been better with more processing power.

On the user interface (UI), we found that we actually preferred the Android to the iPhone. The phone has five buttons (excluding the slide-out QWERTY keyboard) and track ball, to the iPhone's single button. The touch screen interface also has a few more capabilities. Drag and drop of icons is more fluid. There are more options at each screen. The device is also less application-centric. For instance, it's easier to get the dial-pad and the phone features. A drawback of the iPhone, in our opinion, is that it's a phone second and a data device first. The G1 is more balanced. The drawback of all these extra buttons and features is that it takes a little longer to learn. The UI also has its flaws. For instance, the red hang-up button puts the phone to sleep. This is useful, but unintuitive.

As for the phone's other features, we found voice quality and battery life comparable to other 3G phones. The G1's QWERTY keyboard makes for a clunky form factor, but reminded us how much we wish the iPhone had one. Typing is much easier, making web searching and using applications in turn much easier.

The G1 does have one serious drawback. Consistent with the thesis of this report, the third-party applications are lacking. We have had the device for two weeks now and found that there are few applications we are excited to download and use. Data we have seen on the blogosphere indicate that downloads for the G1 are about one-third of iPhone downloads at launch. The Android SDK has been on the market long enough that there is not a sizable difference in the amount of time developers have had to prepare for the two. It's also telling that there are no paid applications. This makes sense, since there is no easy payment mechanism. By contrast, the iPhone App Store had some very compelling applications from day one, and improved quickly in the first few weeks.

All in all, we think the Android has the technical merits to be competitive. This in itself is an important accomplishment. Now the question will turn to the 'social' issues around the phone building the brand and the developer ecosystem.

# Appendix 1

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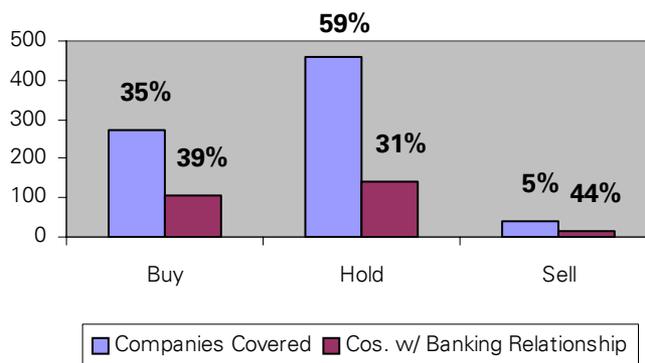
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