## Number of Mobile Device Consumers

We estimate that the number of worldwide consumers that will own a wireless mobile device in 2005 to be about 1.3 billion. To arrive at our estimate we start with people living in urban areas that are over the age of fifteen. We limit the population to urban dwellers since the wireless infrastructure is unlikely to be built out in many rural areas in all but high-income countries by 2005. We then estimate the penetration rate, the percentage of consumers within this group that would be likely to buy a mobile device (see table below). We arrive at 1.3 billion potential worldwide consumers, or 20% of the world's population in 2005.

**Penetration rate.** World Bank segments the world's population into four groups according to the GNP per capita of a country: low, lower-middle, upper-middle and high income. Low income includes those people living in countries with GNP per capita of $755 or less; lower-middle income $756 – 2,995; upper-middle income $2,996 – 9,265; high income $9,266 or more. For point of reference, U.S. GNP per capita was $30,600 in 1999 while income per capita (excluding taxes and non-cash compensation) was about $20,000.

- For high-income countries we assume an 85% penetration rate. In the United States 15% of households have incomes less than $15,000 per year, which makes mobile devices with monthly subscription fees largely out of reach. In other high-income countries, the percentage of households with incomes less than $15,000 per year is generally higher.
- For upper-middle income countries we assume a slightly lower penetration rate, 80%. Many of these countries will skip the build out of landline infrastructure in favor of wireless, which should help mobile device penetration.
- For low income and lower-middle income countries, which include China and India (which represent about one-third of the world's population), we assume that the number of mobile device consumers will be about double the number of telephone mainlines these countries had in 1999. Our estimate is about equal to the number of mainlines these countries would have in 2005 if mainlines continued growing at the same pace of the past few years.

**Potential Mobile Device Consumers**

| **Millions** | **Population, 2005E** | **Urban population over age 15, 2005E** | **Penetration Rate of Urban Pop. over age 15, 2005E** | **Mobile Device Consumers, 2005E** |
|---|---|---|---|---|
| Low income | 2,718 | 496 | 40% | 198 |
| Lower middle income | 2,228 | 669 | 55% | 368 |
| Upper middle income | 622 | 338 | 80% | 271 |
| High income | 923 | 581 | 85% | 494 |
| **World** | 6,490 | 2,084 | 64% | **1,331** |

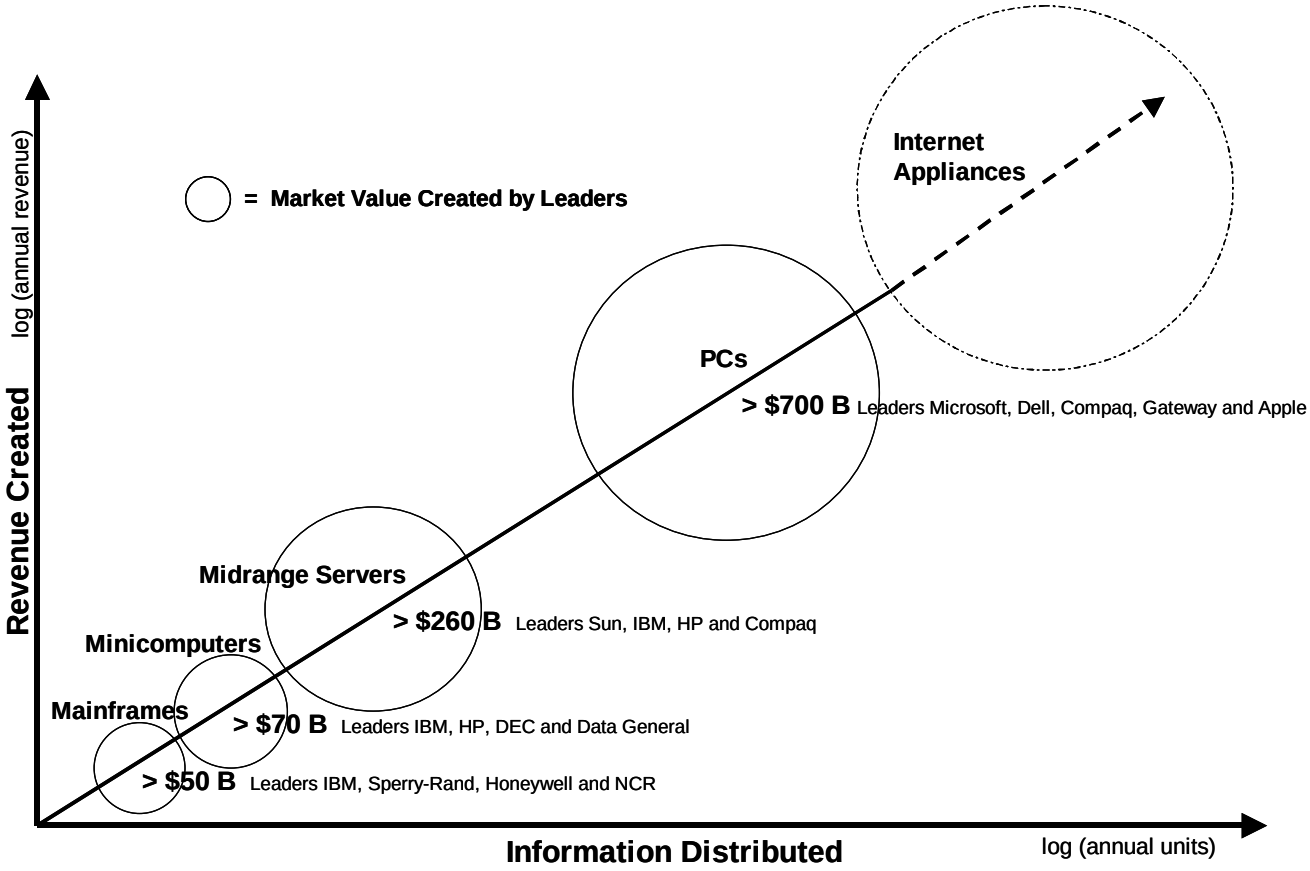
Source: Wit SoundView and U.S. Census Bureau

***The Next Evolution of Computing***

Handheld computers are part of the next stage in the evolution of computing platforms, Internet appliances. Internet appliances follow the PC and the midrange server (client/server architecture), the mini computer and the mainframe.

With each stage of computing since the advent of the mainframe in the 1960s, the number of users, revenue and wealth created has been successively greater. This has occurred against a backdrop of increasing distribution of information.

**Evolution of Computing Hardware and the Market Value Created**




Source: Wit SoundView, Company Reports, Fact Set and *The Computer Industry: The First Half Century*

**New stage, more wealth.** The jump in wealth created from the mainframe and mini computer stages to the client-server stage (PCs and midrange servers) was enormous. The leaders of the mini computer stage – IBM, Data General, DEC and HP – created market value of about $70 billion by selling mini computers. PC leaders Microsoft, Apple, Compaq, Dell and Gateway created market value in excess of $700 billion – 10x greater than the mini computer stage. If we add in the market cap created by midrange server leaders Sun, IBM and HP that figure is close to one trillion dollars.

Part of this increase in market cap can be attributed to the 3x increase of the market P/E during this time. Even without the increase in market P/E, however, the market cap increase from one stage to the next was over threefold.

It is no coincidence that this huge increase in wealth occurred as networking took hold, which massively increased the velocity and distribution of information and therefore the value of the PC.

It is too early to call if Internet appliance leaders will create greater market value than their PC predecessors. However, trends are taking shape in the industry, particularly with handheld computers, that are similar to what happened in the PC market years ago.

Prices of handheld computers are an order of magnitude less than the PC, just as prices of PCs were an order of magnitude less than minicomputers. We believe the lower prices will enable handhelds to eventually reach substantially more users than the PC. Wireless networking of handheld computers should also begin to hit an inflection point in the next few years as next generation wireless packet-based networks arrive. These networks should increase the value of handheld computers and the number of users, as was the case when networking of PCs took hold in the late 1980s.

**One billion+ Internet appliances annually.** Annual unit shipments have increased by orders of magnitude with each successive stage in the evolution of computing platforms, while unit prices have declined roughly by a factor of ten with each stage (please see table below). We expect 135 million PCs to ship this year at a little over $1,000 each. Connecting the dots would suggest at least one billion annual shipments of Internet appliances at around $100 each when the appliance stage is closer to maturity. Annual shipments in excess of one billion seem achievable including mobile phones with Internet access, Internet game consoles and set-top boxes.

Indeed, Sun Microsystems' Chief Technology Officer Greg Papadopoulos expects $10^{10}$ (tens of billions) of consumer appliances to be connected to the network during the next decade or so. This would logically require annual shipment rates of Internet appliances to exceed one billion per year.

**Opportunity for new industry leaders.** Few vendors have successfully transitioned from being the leader in one stage of computing to being the leader in the next (please see table below). This appears to be the case again in Internet appliances, where Palm has a clearly established lead over PC vendors that have entered the space. In addition, there have been few vendors that have garnered over 80% operating platform share of a large unit market, as Palm has, that have lost the lead.

**Evolution of Computing**

| Computing Hardware Platform | Mainframes | Minicomputers | Midrange Servers | PCs | Internet Appliances |
|---|---|---|---|---|---|
| Computing architecture | Centralized master/slave | Closed | Client server | | Internet |
| Information distributed / number of users | Lowest | Low | Mid | High | Highest |
| Year Introduced | 1964 | 1967 | 1970s | 1977 | 1996 |
| Leaders (top four in order of market share) | IBM, Sperry-Rand, NCR and Honeywell | IBM, Data General, DEC and HP | IBM, SUNW HP and CPQ | Microsoft, Compaq, Dell, and Gateway | Handheld Leaders: Palm, Handspring and RIM<br>Key Challengers: Microsoft, Compaq, Sony and Nokia |
| Market Value Created (leaders) | $50 B | $70 B | $260 B | $700 B | …. |
| Industry revenue (peak annual revenue to date) | Billions | Tens of Billions | Tens of Billions | Hundreds of Billions | …. |
| Prices | Millions | Hundreds of thousands | Hundreds of thousands | Thousands | |
| Industry Units (peak annual to date) | Thousands | Hundreds of thousands | Hundreds of thousands | Hundreds of millions | …. |

Source: Wit SoundView, Company Reports, Fact Set and *The Computer Industry: The First Half Century*

***Market***

**PIM applications are driving growth today.** Applications drive growth and attract new users in the computing industry. For the handheld computing industry, personal information management (PIM) applications have been the primary growth driver to date. That is, consumers are buying Handspring and Palm devices primarily to manage their contacts and schedules.

**We see three applications that will drive growth for the industry going forward.**

- **Wireless data.** Today the wireless user experience on wireless voice handsets and handheld computers is poor and user adoption has been slow as a result. Looking forward, the arrival of 2.5G wireless technologies will bring persistent, higher speed connections that will enable handheld vendors to develop more compelling wireless data applications. Handheld computing vendors are in a strong position to incorporate wireless data applications -- their roots are in data. The displays, processors and operating systems of handhelds are data-centric.
- **Wireless voice.** Voice is the most widely used mobile application with over 600 million wireless voice subscribers today. Handheld computing vendors are tapping into this opportunity by adding voice as a feature of their devices. A narrow slice of this market would drive huge incremental units for the industry.
- **Multimedia and entertainment.** Handheld computing vendors are in a strong position to add multimedia capabilities given the robust nature of the handheld computing platform (i.e. fast processor, high memory content and robust operating system). Initial multimedia capabilities include music and games. Video is unlikely to see significant adoption for several years.

**How big is the opportunity?** We believe that the number of handheld computer users will someday exceed the number of PC users, which number about 240 million today. First, handheld computers are about one fifth the price of PCs. Second, upcoming applications such as wireless data, voice and multimedia should increase the handheld value proposition significantly. Third, we believe that multiple users compared to consumer PCs will share fewer handheld computers.

We believe that people with PCs at both home and work are strong candidates for handheld computers. Assuming that every person that has a PC at home also has one at work, the number of unique PC users today is about 240 million worldwide. Handheld computing users of 240 million would support annual shipments of 80 million units at a three-year replacement cycle, or ten times our forecast for unit shipments in 2000. With the rapid pace of change of device and wireless network technology, handheld replacement cycles could be significantly shorter than three years and instead be closer to the eighteen month cycle for wireless handsets.

**PC Forecast**

| *Millions of units* | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|
| Consumer PC shipments | 35 | 46 | 54 | 62 | 72 |
| Consumer PC installed base | 113 | 142 | 177 | 217 | 261 |
| | | | | | |
| Professional PC shipments | 83 | 90 | 103 | 118 | 133 |
| Professional PC installed base | 215 | 243 | 276 | 311 | 354 |

Source: Wit SoundView, Dataquest

As handheld vendors add wireless radios to their products – Bluetooth, GPRS, or other radios – the available market will increasingly expand to include wireless phone subscribers.

**Wireless Phone Forecast**

| *Millions of units* | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|
| Wireless Phone Shipments | 284 | 420 | 565 | 705 | 852 |
| Wireless Phone Subscribers | 475 | 659 | 818 | 957 | 1,075 |

Source: Wit SoundView and Dataquest

Handheld computing unit growth will accelerate from 70% in 1999 to 156% in 2000 according to our estimates. Given the huge potential customer base and upcoming compelling applications, we believe industry growth will continue at a very rapid pace for the next several years.

**Wit SoundView Handheld Computing Forecast**

| *Millions of units* | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| Handheld Unit Shipments | 3.2 | 8.2 | 15.7 | 26.0 | 41.0 | |
| Y/Y Growth | | 156% | 91% | 66% | 58% | |

Source: Wit SoundView

**The majority of handhelds shipped in 2003 will likely have wireless functionality.** Top industry leaders Palm and Handspring believe that the majority of the devices they sell will have wireless functionality by 2003. Wireless functionality will be incorporated either through the addition of a Bluetooth radio or a WAN radio (e.g. GSM or CDMA).

Bluetooth is a short-range radio frequency technology that enables wireless networking of devices. Because of its short range and ability to connect to a range of personal devices, Bluetooth enables what is often called a personal area network (PAN). The cost of a Bluetooth chipset today is $25-30. Gartner Group believes that this cost will decline to $3-5 by 2004. Importantly, Bluetooth radios consume little power relative to WAN radios, which is important for battery life. Gartner Group believes that 95% of all mobile computing devices and 60% of digital handsets will be Bluetooth enabled by 2004.

***Convergence or Divergence?***

The tendency of devices to diverge, not converge, suggests that competition between mobile phone vendors and handheld vendors may be less than many investors expect.

To be clear, we are not saying that handheld computing devices will not have integrated wireless voice or Internet access capabilities. Some surely will. But the majority of handheld computers we believe will not.

**Devices tend to diverge not converge.** We believe the same will be true of most mobile phones and handheld computers for at least the next two years. All-in-one devices tend to have limited success as consumers value simplicity, reliability, low cost, small and lightweight form factors, flexibility, battery life and protection from obsolescence. It has proven very difficult for vendors to optimize for these factors in an all-in-one device. Low cost is particularly important for consumer markets. However, for the foreseeable future an all-in-one device will likely cost several hundred dollars more than a separate mobile phone and handheld computer.

**The empirical data is already proving the thesis.** The most popular cell phones are the lightest and smallest ones. The most popular handheld computer – by a huge margin – is the smallest and lightest one, the Palm V. All-in-one devices so far have failed to reach a high unit volumes (e.g. Qualcomm PDQ).

**History says divergence, not convergence is the rule.** The all-in-one TV-VCR never made it past niche market status. This is the same with the calculator wristwatch. Radios, computers, TVs, CD players, phones and calculators are all device that diverged. Radio was just radio. Now there is AM radio and FM radio. There are car radios, headset radios, clock radios, cable radios and portable radios. We started with a mainframe computer. Now we have desktops, laptops, ultraportables, handhelds, midrange servers, server appliances and more.

***Next Generation Wireless Networks and Services for Handhelds***

**Packet networks should be a catalyst for growth.** Today, few handheld computers are wirelessly tied to the Internet. That will likely begin to change in 2001 with the arrival of several wireless devices from Handspring, Palm and RIM, GPRS handsets from mobile phone vendors and the commercial rollout of 2.5G technologies, such as general packet radio service (GPRS) and 1xRTT.

GPRS will turn today's circuit switched GSM networks into packet switched wireless networks. 1xRTT will do the same for CDMA networks. In a packet network, all data is digital and broken into packets, which are routed and reassembled at the destination. This means that the data generated by a voice phone call is treated the same way as the data in a Web page request or a wireless email message.

GPRS and other 2.5G technologies will enable always-on connections and faster speeds. This should improve the wireless experience and provide a catalyst for sales for leading wireless handheld vendors. GPRS is capable of theoretical data speeds of 114Kbps, although the realized speeds will more typically be similar to dial-up PC modems (56Kbps or less).

Wireless networking of handheld computers will enable more compelling applications. These applications should increase the value proposition of handhelds, thereby attracting more users and catalyzing handheld sales. More users attract more application developers and applications, which attract more users and increase the value of the network, and so on – the familiar network effect. Palm, Handspring and RIM shares should benefit from this network effect.