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Smart Home Concepts: Current Trends

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A. Introduction

In this paper, we discuss some important current developments concerning smart home technologies and their future prospects.

Information Appliances

Information appliances are consumer devices which offer Internet and/or network access without using the traditional operating system interface. That being said, the line dividing information appliances (“IAs”) and traditional PCs is not altogether clear. For instance, a device whose only user interface is a Web browser, but which runs on top of the Linux operating system, is considered an IA because of its simplified interface. However, operating systems, most notably Microsoft Windows, have grown increasingly simple and browser-like themselves. Just ten years ago, remember, the “c-prompt” was a daily fact of life for PC users.

The evolution of Windows has pushed the PC ever closer to our information appliance definition, and seems likely to continue on this path toward usability. Thus, it may be useful to briefly consider some devices currently considered IAs (more discussion of particular devices can be found in Section 2 of this paper). Information appliances include PDAs, palmtops, and set-top boxes. However, as network capabilities are added to more familiar devices, “intelligent” car stereos, VCRs, and refrigerators start to come under the IA heading as well. The IA market is also likely to introduce more new devices, such as personal hand-held scanners and Web tablets, both of which are currently in some stage of development or introduction. In his article “How information appliances are winning over businesses”, Chris Edwards states that “there is no single definition of what an appliance should look like”. This statement in itself could be considered a useful description.

Typically, an information appliance does not have a hard drive, or at least not a big one, and is only required to run smaller applications and use less processor speed than a traditional PC. In exchange for these, the typical IA is more portable, more versatile, and less expensive. In addition, because IA operating systems (OS’s) tend to be simpler than PC standard OS’s, information appliances are generally easier to use. Says Edwards, information appliances “appeal to users more familiar with Sony PlayStations than computers”.

The information appliance can also be considered in terms of function. IA’s are expected to deliver the benefits of the Internet without the potential hassle of a PC. They are expected to be easily networked and intuitive in operation.

Finally, the general term “information appliance” has a number of synonyms. These include “internet appliance”, “net terminal”, and “web appliance”. While the names used seem to be interchangeable, “information appliance” is most prevalent.

Smart Homes

Smart homes, then, are homes which utilize information appliances and a home-based network to connect household appliances to each other and to the outside Internet world. Because of the integral nature of the home-based network into the smart home, the discussion of the smart home should be inclusive of the discussion of the networked home.

There have been several high-profile smart home projects undertaken by private citizens over the last few years. The most well-known of these has been Microsoft founder Bill Gates’ residence on Mercer Island east of Seattle. The home includes art frames which can display different “paintings” on demand, as

well as identification badges which are handed out to guests, which can then tailor the music played in a particular room based on the guest's preferences.

Smart home technologies are also beginning to find their ways into homes *not* owned by the world's richest. However, they do seem to be owned by the employees of technology-savvy companies. Sherman Homes, a smart home builder in the Seattle area, has found that many of its clients use the installed home network to work from home at least one day a week (Kossen).

Beyond mere paintings, smart homes are expected to develop some very useful properties. Among suggested benefits that could be offered by smart homes are improved energy efficiency (and lower electrical bills), improved security, "upgradeable" home appliances, on-demand video programming, and safety mechanisms to allow the elderly to continue living at home. The following section on IA and smart home applications details more of these possibilities.

B. Applications

James Jones, president of Seattle-area Triumph Technologies, a company that specializes in installation of smart home systems, says that the most appealing smart home features are in the area of safety and security (Kossen). This would include features such as smoke detectors, and a single switch that would turn on all lights in the house.

Smart home technology is also foreseen as a way to help the elderly, particularly those suffering from forgetfulness and dementia. The smart home could, for instance, stop a bath from overflowing, locate misplaced eyeglasses or keys, and remind residents about taking medication. At an estimated consumer cost of \$20,000 for such a system (Sandford), installing these smart home technologies would be a less expensive option than placing a senior citizen into residential care.

In another smart home experiment, British cellular network provider Orange is building smart home technology into an existing, older home (Price). Their system uses a Compaq iPaq IA to operate systems, as well as Panja touch-screen wall panels and Hitachi LCD web tablets. The home uses solar panels to provide a third of its power and the company plans to add voice activation to certain parts of the house.

Xanboo Inc. offers a system that uses cameras to monitor the home. Their system lets owners via e-mail, pager, or cell phone in case of any specific "trigger events", such as smoke detection or an unexpected entry into the home.

Examples of IA and Smart Home-related Devices

Some examples of information appliances and other smart home devices include:

- ?? *WebTV*: Perhaps best-known information appliance is also one of the oldest. WebTV allows users to access the Internet without needing a PC by using an existing television as its display. The WebTV is considered the prototypical set-top device: it is a black box that sits on top of the TV and is connected to the Internet via a phone line. It comes with a keyboard to allow user input.
- ?? *StoryBox Connected Frame and Network*: Forwarded by Weave Innovations, in partnership with Kodak and investment firm CMGI, is the "StoryBox Connected Frame and Network". The device is, essentially, a framed LCD panel connected to the Internet. The device has a \$299 price point and an additional monthly service fee. In addition to pictures, the frame can also deliver other Internet content through alliances with MSNBC, E-Online, Sportsline.com, and the Weather Channel.
- ?? *Compaq Clipper*: Compaq's Web and e-mail IA, the Clipper uses the BeIA operating system and no hard drive. While still searching for the optimal operating system, Compaq executives somewhat curiously claim that the product will succeed "precisely because it closely replicates the Web browsing experience people can get on a PC" (Davis). The product will retail for \$200.
- ?? *Maestro Reference Design*: Not an IA itself, Maestro Reference Design, created by Stream Machine, captures, stores, and streams live or pre-recorded digital media through the home network. The device is based on the Linux platform and includes a LAN card, X86 processor, and an MPEG video capture and coding card. The system interacts with PCs or other "spigots" (IAs) connected to televisions. The system runs \$25,000.
- ?? *IA Network Server*: Cobalt Networks has introduced a line of web server information appliances. Costing under \$1,000, the devices run Linux and Apache and include hard drives. The machine is considered an "appliance" because the user never interfaces with the OS or the server interface; instead, all inputs are given through a browser interface.

- ?? *Kerbango*: Kerbango is an “internet radio”. It accesses the Internet to find Web-based music services, which can then be “tuned in” to, as with a radio.
- ?? *Qubit Web Tablet*: Qubit is set to do battle with several well-entrenched on the Web tablet front. The Web tablet is a flat IA intended for e-mail and web surfing. The device has a manufacturing cost of \$550 and is expected to retail for between \$750 and \$1,000, with lower prices available for buyers agreeing to service contracts.
- ?? *Shopping Mate*: Created by Pace in partnership with Phillips and HighPoint Systems, the Shopping Mate is a palm-size handheld device with a barcode scanner that enables in-kitchen shopping. It allows the user to compile a list of groceries by scanning UPC codes, then sends the list directly to the grocer for delivery. The product includes the barcode scanner, product database, touch screen, and Dragonball CPU and is expected to cost the consumer \$200-400.
- ?? *Smart Microwave*: The smart microwave could also be a useful appliance. The microwave could include a barcode scanner that would scan UPCs and, using a networked database, determine how long the enclosed food should be cooked. In addition, the microwave could use the scanner and database to identify “undesirable ingredients”, which could pose an allergy or health hazard.
- ?? *Smart Sprinklers*: The company Emware, which makes interface cards and software for information devices, suggests the introduction of “smart sprinklers”, which can either water or not water the lawn depending on outside temperatures and the humidity in the grass.

Information Appliances and Shopping

Some members of the information appliance industry are looking to improve the prospects for in-home shopping. Farzad Dibachi, president and co-founder of Diba, an IA developer, is not surprised by the failure of so many consumer-oriented e-commerce websites. According to Dibachi, “Building the infrastructure for electronic commerce without equipping consumers with easy-to-use information appliances is like building a shopping mall without an entrance”. To that end, his company has released a line of IA’s designed to bridge this gap, including an in-kitchen recipe finder, an e-mail phone, and an Internet television.

The Networked Community

A developer in the Seattle area, Specialized Homes, has taken the networked home a step further, creating the networked community. The company has created an 18-house development, named “Sundance” in the city of Renton, southeast of Seattle. The development was to be completed in November 2000.

The development offers the following key features:

- ?? Electronic neighborhood watch, which turns the lights on and alerts police via the Internet in case of security breach
- ?? Community television broadcasts of emergency weather information, school-related messages, and offers from local merchants, broadcast via a set-top box
- ?? A “digital town square” – system allows for intranet chat among community households
- ?? Ability to control systems (e.g., furnace, lights) from remote locations via wide area protocol IAs (e.g., cell phones, PDAs).

Specialized’s Bob Nieman says that the services “will enhance the sense of neighborhood” and “instill a sense of community among residents” (Frishberg).

The project, however, has met with skepticism, however. Anthony Townsend of the Taub Urban Research Center at New York University says: “The whole idea behind the Internet and its appeal is that it lets you tap into ‘communities of interest’ that can’t necessarily reach critical mass wherever you’re located”. He comments that web sites that have built their business around the concept of place have not succeeded. “The things a community intranet might help you do would happen anyway in a community of 18 people.”

Despite expert misgivings, however, Specialized says they will use Sundance as a test bed, and draw from their experience to build larger networked communities in the near future.

Household Appliances

Household appliances such as refrigerators, washing machines, and dishwashers, are also earmarked to become information appliances.

For instance, if the refrigerator were connected to the electric company via the Internet, the utility could shut off the refrigerator during peak usage times in order to lessen usage spikes (in fact, in his article “Smarter Homes Are No Dumb Joke”, Robert Poe speculates that electricity and environmental concerns could be a serious driving factor in the proliferation of smart home technology). During peak periods, the utility would send a message to the refrigerator that it should turn off for five minutes. During this period, food inside the refrigerator would not become perceptibly warmer. The economic benefit to the electric company by not having to supply excess power would be enormous, however. Purportedly, then, the electric utility and the consumer would share in both the cost of the networked portion of the refrigerator, as well as in the cost savings realized by the ability to shut off during peak periods. A similar process could be used for in-home lighting or heating.

Several companies are working on various other networked household appliances. Sunbeam, for instance, is working on networked alarm clocks, coffee makers, and electric blankets. Others, including Whirlpool, are developing the refrigerators mentioned above, which will also keep tabs on things such as the expiration dates on milk and whether the ketchup supplies are running low.

Would these kinds of devices have a chance on the open market? Maybe, if they came cheaply enough. According to Vince Vasquez, group business development manager at Sun, “You will be able to go to Sears and buy a network-ready dishwasher or non-networked dishwasher and the cost difference will be \$10” (Merritt). He makes it clear that the household appliance market is aiming at mass-market middle America, and not just tech-savvy millionaires.

IA Usage in the Corporate World

PCWeek’s Aaron Goldberg writes that Information Appliances are a “portal into the user’s personal and corporate data”. In his article “How information appliances are winning over businesses”, Chris Edwards writes that IAs are attractive to corporations because they can go places that traditional PCs cannot, and because they are easier to use than traditional PCs.

Edwards attributes the ease-of-use to IAs’ not relying on the Windows interface. This would be a great advantage for corporate IT organizations trying to restrict costs. Easier tools mean easier support for the company’s MIS department.

C. Key Problems

There are several key problems to the proliferation and advancement of IA technologies, and Smart Home technologies in particular. In Michael Grebb's article, "Battle of the Network Stars", Gary Arlen, President of Arlen Communications, captures the heart of the problem succinctly: "The big barrier to this thing is selling and installing it". A further discussion of some of these problems can be found in the Technical Issues section.

- ?? *Consumers are unaware of the benefits of the networked or smart home.* At this point in time, most home networks are used to connect PCs for tasks such as printing and shared Internet connectivity (McLaughlin). Consumers still do not see the other potential benefits, such as on-demand video, enhanced voice communications, and remote security control. Because of this lack of awareness, the demand for home networking products is still minimal.
- ?? *Running additional wires through homes is costly and a hassle for consumers.* In order to counteract this problem, the industry is developing wireless and other standards which will allow users to interconnect information devices without installation of new wires.
- ?? *Technology is too complex for most household users.* Unlike other home electronics, the technology behind home networking is not intuitive and requires more technological expertise than the average household possesses. With the complex array of products that manufacturers are currently using to take aim at the Smart Home market of the near future, the potential for confusion could become daunting. According to Triumph Technologies' Jones, "Someone will have to gain control of this monster before it gets out of hand, if it hasn't already" (Kossen).
- ?? *Lack of incentive for Internet providers to push networking technology.* Wong suggests that in-home providers of broadband Internet (i.e., cable Internet providers and DSL providers) are currently surviving well enough on the strength of their connectivity service sales and do not need to push additional products. In addition, these communications carriers are too busy building network infrastructures and too swamped with customers demanding their high-speed access to spend time worrying about home networking. According to Parks Associates analyst Kurt Scherf, "When the monthly (broadband) rates fall below \$30, you'll see more service providers bundling home networking services." So far, most in-home broadband service costs \$40 or more per month. Service providers may now be ready to start offering home networking: EarthLink began offering home networking services to its 200,000 U.S. broadband Internet customers this month (April 2001).
- ?? *Potential privacy issues.* Because the networked home would enable information to flow out of the home in ways that households are not accustomed to, privacy could be compromised. Additionally, the new technology behind information appliances and smart homes could introduce new security holes not before encountered. The topic of privacy is addressed in greater depth in the next section.
- ?? *Interface issues.* In smart home test beds, control interfaces have ranged from touch-screen devices to PDAs. Data on the effectiveness of the various interfaces seems scarce.

D. Technical Issues and Additional Problems

In addition to the key problems mentioned in the previous section, there are many other technical challenges and disputes arising in and around the IA and Smart Home industry.

Broadband Access and Networking

One serious technical concern is the need caused by IAs and Smart Homes for widely available broadband Internet access. Another major concern would be wiring the appliances within the home and creating the in-

home network. Having to install Ethernet cables or other wiring throughout the house would be prohibitively costly and would stifle growth within the industry. In her article “Jacking into Home Networking”, Leander Kahney explains that “whatever the technology, a lot of players have adopted the mantra ‘no new wires’”.

According to Yoshida, there have been “no signs of [the industry] consolidating around any particular [broadband] technology yet”. In terms of broadband access and in-home networking, four major technology groups have come to the foreground: cable, phone line, wireless, and electrical line.

Cable companies, which in recent years have become Internet service providers by offering high speed Internet access via the cable jack, are intently interested in the development of the networked home. Chris Boyce, head of strategic business development at Pace Micro Technology says that “all cable operators recognize that they don’t want to be just a fat, dumb pipe”. Instead, cable operators are hoping to increase their role in the future networked economy by offering additional services. By itself, however, cable does not allow for easy networking of devices within the home.

Similarly, phone companies and others have introduced Digital Subscriber Line (DSL) broadband Internet access into homes. Similar to cable, DSL uses existing outlets (phone jacks) in order to stream data into and out of the dwelling. In some areas of the US market, demand has far outstripped supply for DSL service, which has caused the technology to lose potential customers. Phone line technology, however, *does* allow for in-house networking between phone jacks, notably using Anypoint technology. However, the network is limited by the placement of the phone jacks.

While wireless broadband is not presently available, wireless figures to play a major role in the in-house networking, and could become a powerful companion technology to either cable or phone line connectivity. Systems such as Apple’s Airport and Lucent’s Orinoco, both of which are based around the same technology, allow Internet access to be “broadcast” from a small antenna-like device. The antenna device is configured using a PC and is connected to the Internet via an Ethernet port, which connects to either the DSL or cable modem. Currently, the technology is used primarily with laptop computers, which require a PC card in order to send and receive data to and from the antenna.

Electrical line technology allows existing electrical wiring to become an Internet conduit and can turn electrical outlets into network spigots. Because electrical outlets are typically found in every wall in the house, there would likely be enough convenient connection points to accommodate a well-networked home. In addition, the system would mean that anyone who has electricity can not only get on the Internet, but also has the capability to use smart appliances, which can talk to each other and the outside Internet world via the electrical wiring.

ECONergy is one company using existing power lines and a home’s existing electrical system to provide Internet access. The ECONergy system allows for access to the Internet via power lines, in addition to using the home’s electrical system to form the in-home network. The company says that the electrical lines would bring “T1 speed” to the home. Another company, Coactive Networks, uses a “home-networking box” called the “Connector 3000” to accomplish the same thing, turning electrical outlets into networking ports. Additionally, Kahney states that such networks would “likely be installed free or at low

Home Networking Technologies

Summarized from Jennifer Recktenwald’s “Home networks: Connecting more than computers”, Tech Republic, November 10, 1999.

Direct Cable: Connects two computers through serial, parallel, or USB port, inexpensive.

Ethernet: Connects 2-12 computers using hub system and network cards in each device. Driver installation and wiring required, hardware conflicts possible, more expensive.

AC Network: Uses power lines and wiring already within home to connect parallel port to adapter in outlet. Difficult to set up, slow networking, problems with interference from other devices, expensive.

Phone Line: Data shares phone line frequency, requires phone jack everywhere a networked device is located. Also requires special cards and drivers.

Radio Free Network: Uses radio frequency waves to transmit data through walls and doors up to 800 feet, requires network card, can have some interference.

Spread Spectrum Wireless: Fast transfer speeds, limited range.

Bluetooth: Cross device wireless standard created for cell phones and PDAs, can link up to eight devices.

cost” in conjunction with subscription service. A Swedish ISP expects to install the Coactive service into 400,000 homes over the next two years.

Pace Micro Technology intends to take the electrical wire and power line concept a step further by melding them together with wireless and traditional wired connectivity. This combination, which Pace calls the “Gateway Expander”, would purportedly deliver more bandwidth more quickly than competing technologies.

Network Protocols

As with operating systems, there are a number of networking protocols competing for a place in the market. These include HomePNA, Apple’s Firewire (also known as IEEE 1394 and iLink), DVI, USB-to-Ethernet, 802.11b, HomeRF, phone line networking, Sun’s Jini, Universal Plug-and-Play, and Bluetooth. A challenge faced by the OS developers is the apparent need for devices to be able to adapt to any and all of these protocols within the home network.

Because of the desire for developers to not bring any new wiring into the home, however, the most important of these networking protocols is likely to be wireless. Industry experts believe that wireless will work better for customers. According to Mike Wolf, Director of Enterprise and Research Communications at Cahner’s In-Stat Group, “research has shown that wireless is very intuitive to end-users” (“Home Networking Market Surges”).

The greatest competition in the wireless home networking field is between the 802.11b standard, which promises high performance, and the HomeRF standard, which promises lower cost. In terms of performance, 802.11b can currently offer transfer rates of 11 Mbps and is expected to develop capacity for rates up to 50 Mbps. In contrast, HomeRF currently offers transfers of only 2 Mbps and advances beyond 10 Mbps are not foreseen. According to Kevin McLaughlin’s article, “Home Networking’s Tangled Web”, the likely winner will be the 802.11b standard, which, due to its higher performance, is likely to reach economies of scale unavailable to HomeRF and thus, in the end, have a lower price factor.

Operating Systems

Many experts question whether there will ever be a standard operating system for the information appliance platform. According to Edwards, the prospect of a dominant DOS/Windows standard appears doubtful because of the wide variety of approaches the devices are taking, as well as the diverse markets encompassed within the IA sphere.

In place of the dominating standard model, several operating systems are vying for market share. These include less well-known operating systems such as VxWorks, BeOS’s BeIA (formerly known as “Stinger”), and QNX, as well as already accepted PDA OS’s like PalmOS and Windows CE.

Microsoft, in fact, is tailoring its Windows CE to fit in a variety of different products. The operating system is suited for devices where the CPU needs to rapidly execute numerous tasks, and includes a stripped down version of Internet Explorer. While winmag.com predicted in 1998 that, for Windows CE version 3.0 “an explosion by next year is possible”, Windows CE has failed to capture dominant market share.

Java

Sun Microsystems, owner of the Java programming language, has pushed hard for the development of Java-associated operating systems within the IA context. According to Jaison Dolvane and Kumanan Yogaratuam, “Java lets you develop graphical applications and applets without worrying about the details of the hardware”. For this reason, Java capability has found its way into a number of IA-oriented operating systems. In his article “If You Embed It, They Will Come”, Farhad Manjoo takes Sun’s Java-IA strategy a step further, saying that “Sun seems to see the embedded market as Java’s savior”.

The Gartner Group projects a large role for Java in future information appliances. According to their study “Will Mobile Java Kill WAP?”, Gartner says that by 2005, client-side Java applications will either replace or substantially augment functionality provided by today’s wireless application protocol in over 90% of mobile applications using complex user interfaces.

QNX, an operating system intended for more specialized devices, has created an operating system designed around set-top boxes which includes PersonalJava and EmbeddedJava technologies. QNX is aiming for the platform independence that Java can provide. In addition, by using Java, applications can be upgraded “in the field” via download. Also, QNX and Sun say that the operating system can recover from system faults without crashing, which would be a convenient feature for users.

Sun has also positioned Java for use in smart home appliances to help develop “mainstream Java home networks”. According to Rick Merritt, Sun’s vision consists of a “variety of networked consumer electronics products using a host of network types supported by a range of OEMs and service providers – all linked by common Java-based middleware.”

Household appliance manufacturer Sunbeam is working with Sun to bring a number of Java-centric networked appliances to market. These include networked alarm clocks, coffee makers, and electric blankets. In addition, Whirlpool is developing Java-based refrigerator-mounted Web pads and GTE is developing Java-based phone services.

Sun has allied itself with additional formidable firms such as Cisco, which is creating Java-enabled gateways for home use; Sony, which is using Java as part of its HAVi middleware; and Sears, which has agreed to carry Java-based network-ready appliances.

In addition, Sun is an active participant in the IA software standards effort, the Open Services Gateway Initiative (OSGI). The associated companies are seeking ways for various hardware devices and applications to interact. According to Vasquez, “We need to have a standard for the networked home that is open and independent of any one OS”. Sun suggests that its Java Embedded Server, because of its cross-platform nature, would be a vital component in any such standard.

Corporate IT Challenges

Widespread use of information appliances will usher in the need for wireless networks within corporate IT organizations, according to Goldberg. He foresees other associated challenges as well:

- ?? IAs will require a new, unique operating system. As Windows CE does not look prone to dominate the IA market, the new operating system must be able to communicate with the corporate network.
- ?? File and display formats will be problematic. For instance, how will an Excel file from the network display effectively on the miniature screen of a cell phone?
- ?? Problems of physical and data security will likely arise
- ?? “Unapproved” devices, purchased by employees for personal use, may have to be integrated into the corporate IT structure.

Storage Options

One situation confronting the introduction of IAs deals with their storage capacity. As the devices typically do not include hard drives, they are limited to the amount of information they can carry with them.

According to Dolvane and Yagaratuam, workarounds for this problem include:

- ?? Local flash-disk storage, which, while convenient, is typically much more expensive per megabyte of capacity than a conventional hard disk
- ?? Remote disk storage via the network
- ?? Network connection availability.

In addition, IBM is developing a “coin-sized” microdrive, which should be available soon and could be implemented in some smaller IAs.

Privacy Issues

While it seems like a wonderful notion that consumers will save money on their electrical bills by allowing the electric company to turn down the thermostat temporarily, how much is the consumer willing to let a utility know about them? In his article “The Net Effect”, Simon Garfinkel warns of using technology without wisdom, telling of a tea kettle being marketed to the elderly in Japan. This kettle will alert family members whenever the kettle starts to boil, so that they can be aware of the situation in the elderly person’s home and potentially prevent accidental fires. However, since the device’s maker can also see this data, it raises the question of whether too much privacy is being given up in the transaction. Similarly, market data that could be gathered from a networked refrigerator may be more than the consumer comfortably wants WebVan or Albertson’s to know.

Intuitively, it seems there must be a level of intrusiveness in which the average consumer would become “spooked” by the amount of information leaving the house. In this sense, images of Orwellian tele-screens do not seem far removed from the idea of the Web-enabled refrigerator.

In addition, the networked household would, by virtue of its two-way flow, change the nature of the home as it relates to work. As has already been discovered by telecommuters, a well-connected home is

easily intruded upon by the employing company. According to Margaret Quan in *EETimes*, with the introduction of the digital information conduit, the home is no longer a “private haven [or] a place to escape from the world”.

E. Outlook

The market has a tendency to overestimate the short-term impact of a new technology and to underestimate the long-term impact. This axiom seems to hold for the Internet industry, and could well be the case for information appliances and smart homes as well.

According to Michael Slater, founder of Micro Design Resources, the PC remains the tool of choice, even though IA introductions are accelerating. He predicts that it may take a long time for Information Appliances to overtake the market: “even with a growth rate of 100% per year, a product starting off at 100,000 units per year would take 10 years to reach the 100-million-unit level that PC’s passed through [in 1998].”

However, this does not mean that the IA market will not outpace PCs. IDC predicts that the market for IA’s will grow from 11 million units and \$2.4 billion in revenues in 1999 to 89 million units and \$17.8 billion in revenues in 2004. Revenue from home networking is expected to grow even more dramatically, according to a study by Cahners In-Stat Group. According to the study, the industry is expected to grow from \$48 million in 2000 to \$8.8 billion in 2003.

In-home networking is also expected to enjoy significant growth. According to a study by Cahner’s In-Stat Group (“Home Networking Market Surges”), the in-home networking industry was expected to grow 97% in 2000, to \$290 million.

According to IDC Customer Devices Resource Program Manager Kevin Hause, the first services to hit with the customer will likely be incremental and come from cable or satellite companies, since people are used to paying these companies for services and “everybody’s got a TV” (Miles, “Information appliance market”).

IDC’s Hause further states that “There’s going to be a lot of experimentation and a lot of failures as these companies are looking for the appropriate mix of product, services, and price.” He predicts that the most successful business models will subsidize hardware with income from e-commerce, services, or advertising. He goes on to say that the companies that are likely to become the big guns of the IA market will be the same integrated companies that rule today’s Internet economy: AOL, Microsoft, and Yahoo!.

Hause: “The devices that will lead the information appliance market are ones that take advantage of existing infrastructures and usage patterns.”

In his article “Web Appliances: Smarter, Still Dumb”, writer Stephen Manes points out a number of problems with some recently-released IA’s. To Hewlett-Packard’s Audrey device, for instance, he ascribes all the market viability of Microsoft’s failed “Bob” interface overlay. Audrey’s \$499 price tag places it close to the realm of the traditional PC, while he says its 8-inch, passive-matrix, 640x480 display is hard to look at and its mouseless navigation system is difficult (perhaps not coincidentally, HP discontinued Audrey at the end of March). He pans AOL TV, a product manufactured by Phillips, and Gateway’s \$599 connected touch pad for similar reasons (Gateway is also reconsidering its involvement in the IA market). These systems are all, according to Manes, subject to system-crashing errors, which cut down on their promised user-friendliness. He finally posits the question: wouldn’t it be better to buy an inexpensive laptop? Egil Juliussen’s findings (“Information Appliances: Add-on”) corroborate the question: “Web terminals are having trouble competing with low-end PCs and will require another generation of products before they reach market takeoff”.

One of the driving factors behind the growth of Information Appliances is the slowing PC sales market. This, coupled with tightening IT budgets in PC-reliant corporations, has led to many players in the PC market, such as Intel and Microsoft, looking to additional markets. To some extent, it seems that investors approve of the strategy. For instance, Intel’s stock rose 3% on the day their new Pocket Concert Audio Player was announced, versus an overall NASDAQ drop of 7% that same day. However, the optimism for IA’s has not produced the desired results. According to IDC analyst Bryan Ma, only 160,000 web-surfing IAs shipped in 2000, compared to 220,000 projected, a 27-percent shortfall.

According to Massachusetts Institute of Technology finance professor Andrew W. Lo, “Companies like Dell and Hewlett Packard will generate a significant amount of revenue from [devices like] MP3 players” (Fuscaldo). However, as mentioned in the Fuscaldo article, IDC’s Ma believes that entrance by PC manufacturers into the consumer electronics market (via IAs) is merely an attempt to drive consumers back to the PC market.

Home networking has also been slow to catch on. McLaughlin notes that 2001 is the third straight year that home networking has been expected to take off. However, the industry has yet to reach critical mass. A further sign that home networking is not catching on as fast as hoped: both Cisco and 3Com have decided to delay delivery of high-end home appliance gateways and instead are concentrating on more basic networking devices. Still, a study by the Yankee Group concludes that 10 million homes in the U.S. will be networked by 2003.

The home networking industry is hoping to jump-start sales, in part through the creation of the “Internet Home Alliance”, a consortium of companies with serious stakes in the home networking field. These companies include Cisco Systems Inc., Sun Microsystems Inc., CompUSA Inc., Sears Roebuck Inc. and General Motors Corp., each of which donated \$2.5 million to the cause. The Alliance’s goal will be to educate customers on the “Internet lifestyle” and to fund groups that will work to foster cooperation among equipment vendors. In James Niccolai’s article (“Group aims...”), Bill Kenney, president of the Internet Home Alliance, says that “there are a lot of very talented companies out there creating devices and technologies, all of which have the potential to make a real difference in people’s lives, but for the mass market to understand, they need to go somewhere to see it, to touch it.”

On the other side, the information appliance is also opening less expensive avenues for third world countries to increase their citizens’ exposure to the new economy, and thus help energize economies. In Brazil, for instance, the government is underwriting a program to bring a \$300 IA to market. The machine, referred to as the “PopularPC” would have no hard drive and no Windows interface, operating in a KDE-interface Linux environment instead. Combined with Brazil’s relatively affordable going rate of \$18 per month for unlimited internet access, the government hopes to help bridge the digital divide and promote Brazil’s status as Latin America’s technology capital.

Microsoft Venus

While brought about by very different reasons than the Brazil initiative, Microsoft suffered a qualified failure when trying to bring a similar device to market in the People’s Republic of China. Hoping to become entrenched in the world’s most populous country, Microsoft introduced Venus to China in 2000. The device, priced between \$240 and \$360, is powered by Windows CE. According to Microsoft, the device has three main functions: education, entertainment, and Web surfing.

However, the endeavor has been unsuccessful, with even Microsoft executives in Asia publicly saying that the venture has under-performed (Einhorn). Two of the company’s original three distributors have dropped the product, and the remaining distributor is sending most of its product to other Asian countries.

Why the problems? According to one analyst, with PCs in china selling for around \$600, there’s “not much reason to buy Venus”. Other analysts add that there is not enough web content available in China to justify purchasing a Web-based appliance and that, for this reason, the environment is not ready for Venus. But whatever the reason, the case points out some of the initial – and predictable – shortcomings of IA deployment (too-small price advantage over PCs, unavailability of relevant content), as well as one company’s over-eagerness to use consumer IAs as a market vehicle.

WebTV

Another Microsoft property, WebTV has never enjoyed the market penetration its originators had hoped for. While it has made in-roads and has, to some extent, introduced the US market to the concept of the non-PC Internet, the device has yet to reach critical mass, several years after its launch. According to Slater, “I expect the functions of WebTV to be more successful in a different form factor: the wireless Web tablet”. With this idea in mind, wireless Web tablets are being pursued by Microsoft, Intel, and front-line PC manufacturers, as well as by upstart companies such as Qubit, which was mentioned in Section 2.

Market Outlook

Egil Juliussen of eTForecasts (“Information Appliances: Add-on...”) believes that the biggest market for IA devices will be existing devices that add web access to current

Unit Sales		2000	2002	2005
Total IA Sales	USA	10.1M	33.0M	112.9M
	Worldwide	54.6M	259.0M	767.6M
New IA Sales	USA	5.1M	10.6M	25.6M
	Worldwide	10.0M	27.5M	98.2M
New IA Share	USA	50.3%	32.0%	22.7%
	Worldwide	18.3%	10.6%	12.8%
Add-on IA Sales	USA	5.0M	22.4M	87.3M
	Worldwide	44.6M	231.5M	666.4M
Add-on IA Share	USA	49.7%	68.0%	77.3%
	Worldwide	81.7%	89.4%	87.2%

Source: eTForecasts, “Information Appliances: Add-on Devices Will

functionality, such as cell phones, set-top boxes, VCR's and video game consoles. He says that piggybacking information appliance technologies to these widely-used devices will grow the IA market at a high rate, while the introduction of new types of devices will require several years to reach critical mass.

Writes Juliussen, "The reason that add-on web appliances will have such spectacular growth is that cost issues, customer familiarity, and infrastructure favor this approach."

Impact of IAs on Current Internet

In another research paper, "Information Appliances are Segmenting the Internet", eTForecasts contends that the particular demands of information appliance devices will segment Web content. For instance, cellular Web content demands are very different from the rest of the PC-based Internet, in no small part because of the variation in screen size. In addition, entertainment-related IAs will also create demand for different content than is currently available. Thus, eTForecasts breaks Internet content down into three categories: PC's, Entertainment, and Wireless. Their research suggests that by 2005, there will be more worldwide Internet users accessing the Web via wireless devices and entertainment devices than there will be people accessing the Web through PCs.

In addition to the three categories mentioned above, the introduction of Smart Home household appliances will likely further segment Internet content. The current Internet does not seem to have enough relevant content to satisfy the needs of the networked kitchen, if such kitchens were to become popular on a mass market scale.

IA Business Model

Many companies introducing information appliances have said they plan on following the cell phone business model in order to get their devices onto the market. Under this model, devices are sold below cost when customers, in return, agree to long-term service contracts. Qubit's web tablet, for instance, could cost as little as \$400 (\$150 below cost) in return for the customer agreeing to an Internet service contract. Compaq is likewise exploring the cell phone model for its Clipper device.

Whether the cell phone model will work is also debatable. Internet service providers and computer manufacturers have attempted a similar ploy by offering \$400 rebates on new computers in return for three-year service agreements with the ISP. Data on the success of these ventures has been difficult to obtain, however the momentum behind the idea seems to be waning and, at any rate, has a long way to go before it becomes the dominant business model for the PC retail market.

Impact on PC Market

As alluded to in Section 1, the differentiation between IAs and traditional PCs becomes more blurry with each new operating system iteration. Ignoring this phenomenon, however, it seems likely that the widespread adoption of IAs will have a serious impact on the PC industry. Michael Slater states that IA's represent a serious threat to PC growth as IA's go beyond merely augmenting PC productivity, assuming also many of their functions. He further asserts that Internet-enabled game consoles, a concept pioneered by Sega's Dreamcast and continued with recent or as-yet unreleased devices such as Sony's PlayStation 2, Nintendo Dolphin, and Microsoft's Xbox, will cross the line to become entertainment computers. As such, he says, they "could make a Trojan horse attack on the PC" as the game consoles add new features (e.g., a keyboard, additional storage capacity) once introduced into the home.

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