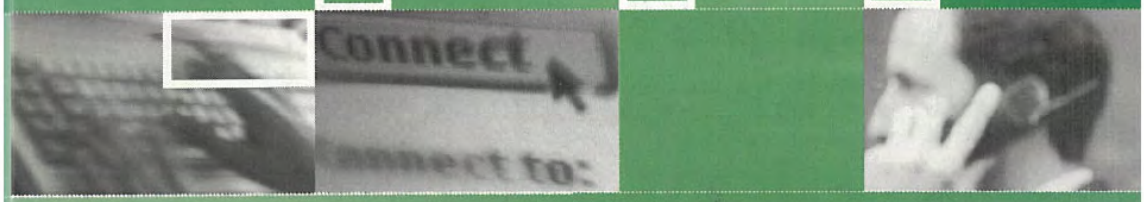
Uwe Hansmann
Lothar Merk
Martin S. Nicklous
Thomas Stober



Pervasive Computing Handbook

Forewords by Philippe Kahn and Nick Shelness

Springer

Uwe Hansmann Lothar Merk
Martin S. Nicklous Thomas Stober

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and Nick Shelness

With 183 Figures

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Uwe Hansmann
Lothar Merk
Martin S. Nicklous
Thomas Stober

IBM Deutschland Entwicklung GmbH
Pervasive Computing
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Foreword 1

Our future is pervasive.

We were not meant to be chained to our computers in our Dilbert cubicles. Having millions of white-collar workers commute to work every day to sit for eight hours chained to their computer is something right out of a Kafka novel.

Before the cell phone, I can remember sitting at my desk waiting for calls to be returned. If I was traveling I made sure that I was all setup to place calls from public phone booths.

Today, I can't imagine having to look for a telephone booth! I can be reached on my tri-band digital cell phone anywhere in the world instantly. I also have a PDA that I carry everywhere. My PDA instantly synchronizes with my desktop computer, which in turn connects to a larger network of computers and web portals. The world is my neighborhood.

Soon digital devices will be working together hand in hand thanks to technologies such as Bluetooth. This includes devices such as Cell phones, Digital Cameras, PDAs, and desktop computers. The Wireless Internet is the catalyst for the convergence of digital communications, computing, and rich media. This is a mega trend that we call "Pervasive Computing".

What "Pervasive Computing" means to each and every one of us is the ability to take our own worlds of personal and business information with us wherever we go. Now we can always be in touch with our families, affinity groups, and co-workers.

The vision for "Pervasive Computing" encompasses universal and integrated instant person to person or person to business visual communications. This is a complete new media that will revolutionize the way we communicate. One good example is an instant wireless digital camera that can share photographs instantly with the rest of the world through the wireless Internet: point, shoot, and share... instantly. A picture is worth a 1,000 words!

As technologists we are delivering this vision through careful adherence to open industry standards such as JPEG 2000 and

SyncML. Together with the worldwide build-up of a global infrastructure for the Wireless Internet these are the key ingredients to make our vision a reality.

The technology components necessary to deliver on this global vision are advanced and complex. However, they deliver an elegant and functional end-to-end solution. And as we know well, a world connected and synchronized is a world perfected.

Because of its universal appeal, the industry growth that will be generated by Pervasive Computing will be astounding.

"Pervasive Computing" is global and universal and focused on simplifying our daily lives. A very good thing!

Philippe Kahn
Chairman of the Board, LightSurf Technologies, Inc.
August 2000

Foreword 2

Those of us old enough to have grey or missing hairs have lived through the aftermath of a number of major technological developments. These developments have resulted in the widespread deployment of, for example, black and white televisions, color televisions, VCRs, camcorders, quartz watches, mobile telephones, personal computers, and the Internet. In some of these cases (black and white television, VCRs, mobile telephones, personal computers, and the Internet), these technological developments have had a profound sociological impact. They have changed the way that people live their lives. In other cases (color television, camcorders, and quartz watches) they have been replacement technologies that have significantly improved the quality of an experience, but have had little or a less profound sociological impact.

We now stand on the verge of yet another major technological development – the embedding of inexpensive digital processing, storage, and communication capabilities into a vast range of devices both existing and new. These devices will span the gamut from home appliances (refrigerators, washing machines, stoves, etc.) to buildings (windows, doors, heating and air conditioning, etc.), vehicles (cars, busses, trucks, trains, airplanes, etc.), and new forms of personal electronic accessory (electronic organizers, electronic shopping lists, electronic books, web capable cell phones, etc.). What is not yet clear is how these capabilities will be exploited, if and how these devices will communicate with each other in practice, and what, if any, sociological impact their availability will have.

There are a number of preconditions that are necessary for the widespread deployment of devices that exploit new technological capabilities.

1. They have to deliver an easily perceived value, at a low enough price, to convince a significant number of individuals to part with their hard-earned cash.
2. They have to fit seamlessly into a widely deployed infrastructure.
3. They have to be sufficiently easy to use.

Without an easily perceived value, nothing will happen, but price is also a key element of any deployment equation. From the moment of their introduction, a huge number of people could see the value of owning, carrying, and using a cell phone. They didn't rush out and buy one because the initial prices of purchase and use were high, and could only be justified for high value calls. If one views cell phone deployment rates, especially in Europe, then there have been three pricing developments that have had a huge impact on deployment levels. a) The real cost of handsets came down, but perhaps even more important, most of the real cost of a handset was amortized by service providers over future subscription and call charges. This allowed handsets to be sold for an artificially low price, and often be given away for free. b) During evenings and on weekends, cellular call tariffs were priced significantly below residential wireline telephone tariffs. This made a cell phone a significantly cheaper alternative to a residential wireline telephone, especially for households which were away during the day. c) Handsets that employ prepaid smart cards (SIMs) were introduced. These allowed cellular users to both budget and cap their call charges on a call by call basis, and for parents to totally eliminate bill shock when providing their children with cell phones. Each of these pricing developments has had a profound effect on the willingness of very large populations to own, carry, and use cellular telephones. In the UK alone, the introduction of prepaid smart card cell phones turned an additional 1/4 of the entire population into cell phone users in little more than a year.

Once purchased, devices must have widespread access to a widely deployed infrastructure. This in practice requires at least national, if not the universal, adoption and deployment of de-jure or de-facto standards. If different television sets had been required to view different broadcast channels, deployment would almost certainly have been stalled. Attempts to employ a different parallel infrastructure, even if better, are also usually doomed to failure. Sony's Betamax VCR format is a well known example of this. Without near total coverage in the areas a user wishes to traverse, a cellular telephone becomes largely useless. It is just such a widely deployed infrastructure that has given GSM cellular telephones their extremely wide appeal. I personally carry a tri-band GSM2 cell phone that has worked in every continent I have traversed in the last year including large parts of the North America, Europe, Australia, and Asia. Perhaps the greatest testimony to the importance of a widely deployed and common infrastructure is the World Wide Web. Hypertext linking and packet switching are both thirty year old technologies. What gave the Web its growth power was the ability to use almost

any browser on almost any computer to access an entire and mushrooming world of content and services.

Finally, devices based on new technologies have to be sufficiently easy to use. Note, I didn't say easy to use. The number of deployed VCRs that display a flashing time of 00:00 are testimony to this, but if the main things that a user wishes to do are too difficult they will just give up, and tell their friends and neighbors not to waste their money trying.

So where do devices that embed digital processing, storage, and communication capabilities stand with respect to these three criteria? The simple answer is that it is too soon to know. There have been some extremely successful pilots and even full scale deployments in relatively narrow spaces such as electronic shopping assistants and web capable cell phones, but these are hard to project from.

We know that in Japan, NTT DoCoMo are deploying more than one million new I-mode (web capable) cell phones a month, but projecting from Japan, a country in which there are only 3 million PC–based web users, almost all of them office based, to other geographies that already have large numbers of home–based PC web users, is extremely dangerous. Similarly, projecting from Japan's success in employing a pure Web (HTML 3.2 and HTTP 1.1 over a cellular bearer rather than TCP/IP) infrastructure to future European success in deploying an alternative WAP (non-HTML and non-HTTP) infrastructure is, I think, premature.

So what is the role of this book? It is twofold. It is to peer into the future by presenting a number of potential road maps, and it is to describe the technologies and infrastructures that will be required to pave the way. Some of these technologies and infrastructures are available at a suitable price now, some will be available at a suitable price soon, while others are still missing in action.

Like the early days of automatic teller machines (ATMs), early pervasive computing pilots and deployments are already having a significant bottom line impact for early adopters (see NTT DoCoMo above). With the passage of time the deployment of pervasive computing devices and infrastructures, as with ATMs, may well simply become a cost of doing business that delivers minimal bottom line advantage. For this reason, the time is now right for businesses to determine whether they wish to take the risks and garner the potential rewards of being early adopters. This book is a useful tool in coming to an informed decision.

Nick Shelness
Chief Technical Officer, Lotus Development Corporation
August 2000

Table of Contents

Preface 1

About This Book 2
The Audience of This Book 3
No Need to Read the Whole Book 4

About the Authors 9

Acknowledgements 10

1 What Pervasive Computing Is All About 11

1.1 Times Are Changing 11

1.2 Decentralization Continues 14

1.3 Applied Pervasive Computing 16

1.4 Pervasive Computing Principles 18
1.4.1 Decentralization 19
1.4.2 Diversification 19
1.4.3 Connectivity 22
1.4.4 Simplicity 23

1.5 Pervasive Information Technology 24

Part I.
Devices 27

2 Information Access Devices 31

2.1 Handheld Computers 31

2.1.1 Palm OS-Based Devices 31
2.1.2 Windows CE-Based Handheld Computers 35

2.2 Sub-Notebooks 41
2.2.1 Windows CE-Based Sub-Notebooks 41
2.2.2 EPOC-Based Sub-Notebooks 42

2.3 Phones 43
2.3.1 Cellular Phones 43
2.3.2 Data Transmission Capabilities 44
2.3.3 Smart Phones 46
2.3.4 Screenphones 48

2.4 Further Readings 49

3 Smart Identification 53

3.1 Smart Cards 53
3.1.1 What Is a Smart Card? 53
3.1.2 Smart Card Hardware 55
3.1.3 Smart Card Software 58
3.1.4 Communication Between the On-Card and Off-Card Parts 59

3.2 Smart Labels 62
3.2.1 Example Applications 65

3.3 Further Readings 67

4 Embedded Controls 71

4.1 Smart Sensors and Actuators 71

4.2 Smart Appliances 77
4.2.1 The Smart Clock 77
4.2.2 Heating, Ventilation, and Air Conditioning 78
4.2.3 White Goods Appliances 79

4.3 Appliances and Home Networking 83
4.3.1 Residential Gateway 84
4.3.2 Cellular Communication 85
4.3.3 Service Provider and Residential Gateway 87

4.4 Automotive Computing 87
4.4.1 Intelligent Controls, Sensors, and Actuators 87

4.4.2 On-Board Computing Systems 89
4.4.3 In-Vehicle networks 95

4.5 Further Readings 102

5 Entertainment Systems 105

5.1 Television Systems 105
5.1.1 New Applications 105
5.1.2 Analog and Digital Broadcasting 107
5.1.3 Set-Top Boxes 108
5.1.4 New Players in the Entertainment Business 109

5.2 Game consoles 110
5.2.1 Sega Dreamcast 111
5.2.2 Sony Playstation 2 113
5.2.3 Nintendo Dolphin 115
5.2.4 Microsoft X-Box 116

5.3 Further Readings 117

Part II.
Software 119

6 Java 121

6.1 Language Characteristics 122

6.2 Java Class Libraries 123

6.3 Java Editions 125

6.4 PersonalJava and EmbeddedJava 128

6.5 Development Tools for Java 129

6.6 Further Readings 131

7 Operating Systems 133

7.1 Windows CE 133
7.1.1 Operating System Configurations 134
7.1.2 Memory Management 135
7.1.3 Processes, Threads, and Interrupts 138

7.1.4 User Interface 139
7.1.5 Communication and Networking 141
7.1.6 Peripherals and Device Drivers 142
7.1.7 Platform-Builder – Creating a Custom OS 143
7.1.8 Developing Applications 145

7.2 Palm OS 146
7.2.1 Memory Management 147
7.2.2 Events 150
7.2.3 User Interface 150
7.2.4 Communication and Networking 151
7.2.5 Conduits 154
7.2.6 Developing Applications 155

7.3 Symbian EPOC 157
7.3.1 Operating System Architecture 158
7.3.2 Application Architecture 159
7.3.3 Developing Applications 159
7.3.4 A Sample Application 161

7.4 Java Card 162
7.4.1 Java Card Framework 163
7.4.2 Lifetime of On-Card Applets and Objects 164
7.4.3 Developing a Card Applet 165
7.4.4 A Sample Applet 167

7.5 Windows for Smart Cards 169
7.5.1 File System and Access Control 169
7.5.2 Applets and Windows for Smart Cards API 171
7.5.3 Off-Card Application 173
7.5.4 Solution Manager 174
7.5.5 A Sample Card Applet 175

7.6 Further Readings 177

8 Middleware Components 181

8.1 Programming Consumer Devices 181
8.1.1 JavaPhone API 181
8.1.2 JavaTV API 183
8.1.3 WebTV 186

8.2 Smart Card Programming 188

8.2.1 OpenCard Framework 188
8.2.2 PC/SC 192

8.3 Messaging Components 195
8.3.1 MQ Everyplace 195

8.4 Database Components 199
8.4.1 DB2 Everywhere 199

8.5 Further Readings 200

9 Security 203

9.1 The Importance of Security 203

9.2 Cryptographic Patterns and Methods 204
9.2.1 Symmetric Cryptographic Algorithms 204
9.2.2 Asymmetric Cryptographic Algorithms 208
9.2.3 How Secure Is an Algorithm? 211

9.3 Cryptographic Tools 212
9.3.1 Hash 212
9.3.2 Message Authentication Code (MAC) 212
9.3.3 Digital Signature 212
9.3.4 Certificate 214

9.4 Secure Socket Layer (SSL) 214

9.5 Further Readings 215

Part III.
Connecting the World 217

10 Internet Protocols and Formats 219

10.1 Hypertext Transfer Protocol (HTTP) 219

10.2 Hypertext Markup Language (HTML) 221

10.3 Extensible Markup Language (XML) 222

10.4 Further Readings 226

11 WAP 227

11.1 The WAP Architecture 227

11.2 Wireless Application Environment 230
11.2.1 Wireless Markup Language 233
11.2.2 WAP Binary XML Content Format 237
11.2.3 WMLScript 238

11.3 Further Readings 241

12 Connectivity 243

12.1 Wireless Wide Area Networks 243
12.1.1 Cellular Basics 243
12.1.2 Major Digital Cellular Systems 255
12.1.3 Advanced Cellular Radio Standards 263

12.2 Short Range Wireless Communication 276
12.2.1 DECT 277
12.2.2 Bluetooth 279
12.2.3 IrDA 288

12.3 Home Networks 292

12.4 Further Readings 301

13 Service Discovery 303

13.1 Universal Plug and Play 304

13.2 Jini 306

13.3 Salutation 307

13.4 Further Readings 308

Part IV.
Back-End Server Infrastructure 311

14 Gateways 315

14.1 Connectivity Gateway 316
14.1.1 Palm Webclipping Proxy Server 316
14.1.2 WAP Gateway 317

14.2 Wireless Gateway 319

14.3 Transcoding 320
14.3.1 InfoPyramid Framework 322
14.3.2 ProxiNet Transcoding Gateway 323

14.4 Residential Gateway 323

14.5 Further Readings 324

15 Web Application Servers 327

15.1 Architecture and Components 327
15.1.1 Java Servlets 328
15.1.2 Enterprise Java Beans 332

15.2 WebSphere Application Server 335

15.3 WebSphere Everyplace Suite 336

15.4 Oracle Portal-to-Go 337

15.5 Further Readings 338

16 Device Management 341

16.1 Tasks of Device Management Systems 341

16.2 Tivoli Device Support Infrastructure 342

16.3 User Profiles and Directory Services 344

16.4 Further Readings 346

17 Synchronization 347

17.1 What Synchronization Is All About 347

17.2 The Challenges of Synchronizing Data 348

17.3 Industry Data Synchronization Standards 349
17.3.1 Infrared Mobile Communications (IrMC) 349
17.3.2 Mobile Application Link (MAL) 350
17.3.3 SyncML 350

17.4 Today's Synchronization Solutions 353

17.5 Further Readings 353

Part V.
New Services 355

18 Portals and Access Services 357

18.1 Internet Portals 357

18.2 Wireless Portal 358

18.3 Broadcasting Portal 360

18.4 Further Readings 361

19 Home Services 363

19.1 The System View 363

19.2 Communication Services 364

19.3 Home Automation 365

19.4 Energy Services 366

19.5 Security Services 367

19.6 Remote Home Healthcare Services 368

19.7 Further Readings 368

20 Travel and Business Services 371

20.1 Travel Services 371
20.1.1 On the Ground 373
20.1.2 ... And in the Air 374

20.2 Business Services 375
20.2.1 Field Support 376

20.3 Further Readings 377

21 Consumer Services 379

21.1 Interactive Advertisement 379

21.2 Loyalty 380

21.3 Shopping 380
21.4 Payment Services 382
21.5 Further Readings 383

Part VI.
Appendices 385

A Bibliography 387

B Glossary 391

C Index 399

2 Information Access Devices

2.1 Handheld Computers

Handheld computers comprise the largest group of Internet connectable pervasive devices. They are small, lightweight, and fit into pockets. A stylus is used to tap on a touch screen to activate applications or enter data. Currently two major operating systems are applied on handheld devices: Palm OS and Windows CE.

2.1.1 Palm OS-Based Devices

Palm OS was developed by Palm Computing, a subsidiary of 3COM. It is the best-known and most popular operating system for handheld devices, having a market share of about 70 percent. Palm OS based devices are manufactured by Palm or other companies, like Symbol, IBM, and Handspring, which licensed the operating system and sell devices on their own.

Some Palm OS devices

The renown Palm III models were launched in 1998. They included infrared communication, version 3.0 of Palm OS and 2 MB of memory. The newer Palm IIIx has 4 MB of memory and an improved display. The heart of the Palm IIIx is a Motorola Dragonball EZ processor, which is more power efficient and opens the way for the use of less expensive memory upgrades. The Palm IIIc is the first Palm OS based device with a color display. It was released in 2000. Besides having generous 8 MB of memory, the Palm IIIc runs Palm OS version 3.5, which is the latest update of the operating system.

The high-end Palm device for professional users is the Palm V. It is a very thin device in a brushed aluminum housing and features 8 MB of memory and a rechargeable lithium-ion battery (Figure 2.1).

These Palm devices can be plugged into a cradle, which connects them to the serial port of a PC. An external modem is also available, allowing them to access a network directly through a phone line.

Figure 2.1: Visor and Palm V

Photos courtesy of Handspring Inc. and Palm Computing, Inc.

The Palm VII device has been designed to have Internet access without any additional hardware and software. The device is turned on whenever the user flips up the antenna. Currently, the Palm VII is only available in the US where users can send and receive wireless emails and lookup special web pages with this Palm device.

A cellular phone and a Palm within one device – that is the concept of Qualcomm's pdQ Smart Phone. It is a full-functional Palm with additional mailing and Internet access capabilities. Symbol's SPT 1500 and 1700 devices are specialized versions of the Palm III. The SPT 1500 has a built in laser-beam reader, and the SPT 1700 can transmit the scanned data using a wireless transmission module.

The last Palm OS device we want to mention here is Handspring's Visor which was developed by the team around Jeff Hawkins, who left 3COM in 1998 to found his own company. The Visor is based on Palm OS 3.0 (Figure 2.1). The advantages of the Visor concept are the very good performance, the improved date and address book applications, the USB interface and – maybe most important – the possibility to plug additional peripherals into a hardware interface called *Springboard*. Some of the planned add-ons are a wireless modem, a Bluetooth module, a MP3 player, and a GPS device.

Palm applications

The most important native applications of Palm OS based devices are the Address Book, the Date Book, the To Do List, the Memo Pad, and the Mail application (Figures 2.2 and 2.3).

- The Address Book displays a master list of addresses sorted by last name and displaying the principal phone numbers.
- The Date Book is used to display and edit appointments in a daily, weekly or monthly view.
- At the time the Memo Pad application is started, it first shows an index consisting of the first lines of the memos. If you tap on a list element, the complete memo is displayed.
- With the Mail application users can read downloaded emails or generate new emails offline.

Many other applications are available as freeware, shareware or commercial products from various third-party providers. Among them are fax software, calculators, alarm clocks, drawing applications, games, travel guides, and many, many more.

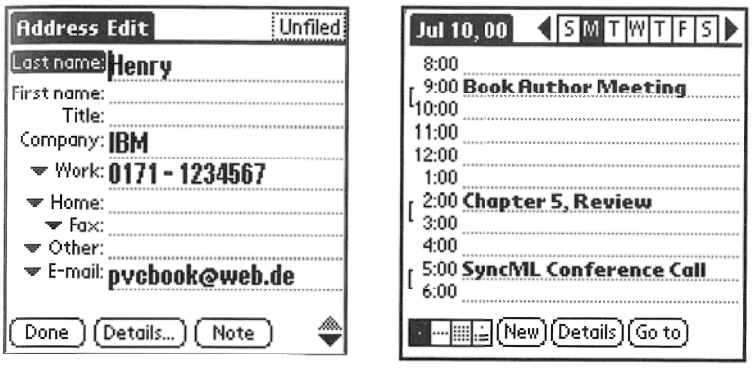


Figure 2.2: Address and Date Book

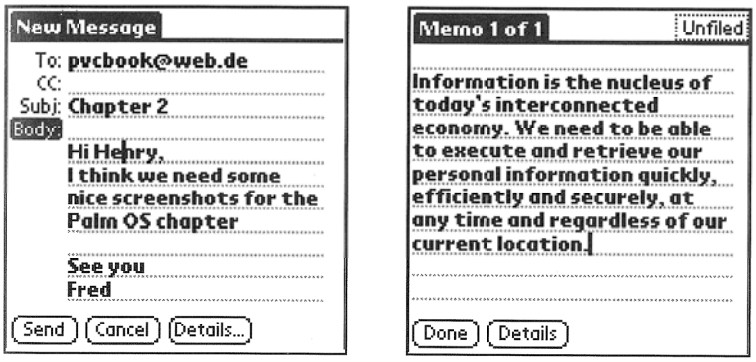


Figure 2.3: Mail and Memo Application

Text entry

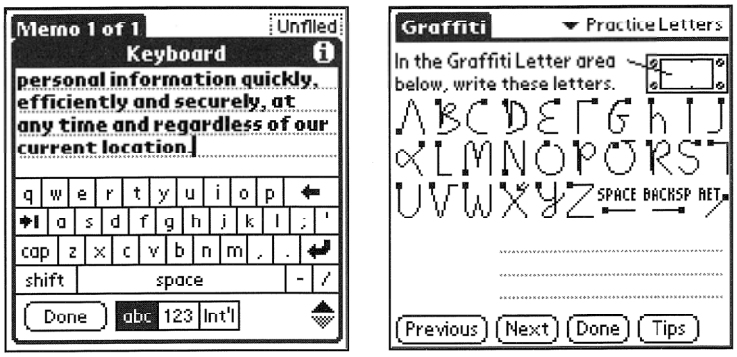
Text can be entered with taps on a small keyboard and displayed on the screen. Alternatively, glyphs can be drawn in a dedicated area below the screen. Glyphs are simplified characters, which can easily be interpreted by a simple handwriting recognition software called Graffiti (Figure 2.4). Graffiti input eliminates the complexity of

different writing styles. Almost every letter can be formed by a single stroke.

HotSync

The synchronization mechanism between a Palm OS based device and a desktop PC is HotSync. The changes made since the last HotSync are automatically updated on the Palm device and the desktop PC. If corresponding records are changed on the PC and the Palm OS device, HotSync will detect a version conflict.

Figure 2.4: Graffiti and Keyboard



Infrared port

The infrared port offers a convenient possibility to exchange data between different devices. Business cards, calendar entries, and entire applications can be "beamed" from one Palm to another without the detour over HotSync and a PC. The infrared port can also be used to communicate with a cellular phone instead of an attached modem to connect wirelessly to a network.

Internet access

The Palm allows to access Internet sites either through an Internet connected PC or directly by going online via modem. There are several Web browsers available. Similar to the capabilities of a PC based Web browser, the Palm Web browsers are able to cache Web sides. This feature is extremely important, since a Palm device usually doesn't have a permanent Internet connection. There are several providers for delivering Internet content, especially for handheld devices. One access point for synchronizing content is AvantGo:

- Internet content can be downloaded by the AvantGo software installed on a PC. AvantGo offers selected Web sites related to manifold topics, which are referred to as *channels*. Users can subscribe individually to particular channels of interest and receive updated content with every HotSync. The information is stored in HTML, thus also graphics, tables, and different fonts can be displayed. The Web pages are compressed before they are transmitted to the Palm OS device.

- Since version 2.0 of AvantGo was introduced, it is also possible to use AvantGo as an online Web browser. A proxy server at AvantGo.com modifies the Web pages in a way that they can be displayed on Palm devices.

Similar to the Web access, there are two ways of working with emails – via a desktop PIM application or directly via mail server.

- Choosing the PC way means that sending and receiving emails takes places on the PC. The email is synchronized between the Palm device and the PC whenever a HotSync with the email program takes place. An email written on a Palm has to be delivered to the PC mail application before it is sent to the mail server in a second step.
- For direct Internet access the Palm uses a modem connection and an email server running the standard POP3/SMTP protocols.

2.1.2 Windows CE-Based Handheld Computers

Windows CE is the second major operating system for handheld computers, taking almost the remaining rest of the market share. Windows CE has been developed by Microsoft and is applied by manufacturers like Casio, HP, and Compaq.

Windows CE versus Palm OS

Comparing Palm OS and Windows CE devices is somehow pretty philosophic: Microsoft wants to extend today's Personal Computer platform to mobile computers. Users should be able to do the same things in the same way on any computer alike device – as far as such is possible under the given constraints of form factors and reduced processing power. Windows CE provides the same consistent look and feel, both on the common PC and on the smaller handheld. For instance Word and Excel will welcome you on Windows CE and the mailing tool is an Outlook derivative, of course. From the Microsoft perspective, a handheld is nothing else than a miniaturized PC! This philosophy is reflected by terms as PocketPC, Palmheld PC, and Handheld PC.

Palm propagates PC companions instead. They are different and complementary to PCs. Since the usage scenarios are different, the applications and their usage must be different too. Palm OS user interfaces are pretty straight-forward to use and are optimized for quick mobile information access – even in a crowded subway.

In fact, the opinions about these different approaches are split: Some get started more easily with Windows CE because of the familiar user interface and because they have similar applications on their handheld, as they have on their PC. Others dislike the more circumstantial usage of Windows CE. There are more windows, more controls, and more taps required than a Palm III needs for the same operation.

High-end Windows CE hardware

Compared to the competing Palm OS, Windows CE requires plenty of memory and processing power making devices much more expensive. The Casio E-115 (Figure 2.5) for example takes a minimum of 16 MB of RAM and has a 133 MHz processor embedded. Palm devices instead are shipped with up to 8 MB RAM and include a cheap 20 MHz processor, which keeps them easily affordable for a broad audience.

Figure 2.5: E-115 PocketPC from Casio

Photo courtesy of Casio

Personal Information Management

While Palm concentrates on state-of-the-art mobile information management, Windows CE devices are technological wonderboxes, generously equipped with fancy hardware features: They usually have a color display with a good resolution, enabling multimedia applications such as computer games. There is a built-in microphone for a voice recording facility and a MP3 player. A stereo output is pro-

vided to plug in a headset. USB and infrared support ensure connectivity with peripherals and other devices. A CompactFlash card slot can be used to attach memory cards for additional storage capacity or one of a wide variety of the other special-purpose cards such as a digital camera card, or a modem card. All these add-ons make Windows CE devices extremely versatile and justify the high price for those, who can take advantage out of them.

Delivered with Windows CE are the typical Personal Information Management (PIM) applications (Figure 2.6). Data can be entered with a displayed keyboard, which is operated with the stylus. Handwritten notes can be drawn on the touch screen and stored within graphic files or interpreted by a recognition software. Memos can also be recorded using the built-in microphone.

Active Sync

ActiveSync is the synchronization software, which Windows CE applications use for keeping the mobile data consistent and up-to-date with databases on the user's corresponding PC. This way, information like address book or calendar entries can be maintained both on the mobile device and on the workplace PC. ActiveSync supports communication through USB, infrared, and serial port, as well as via Ethernet LAN. ActiveSync cannot synchronize between two devices or between client and server directly.

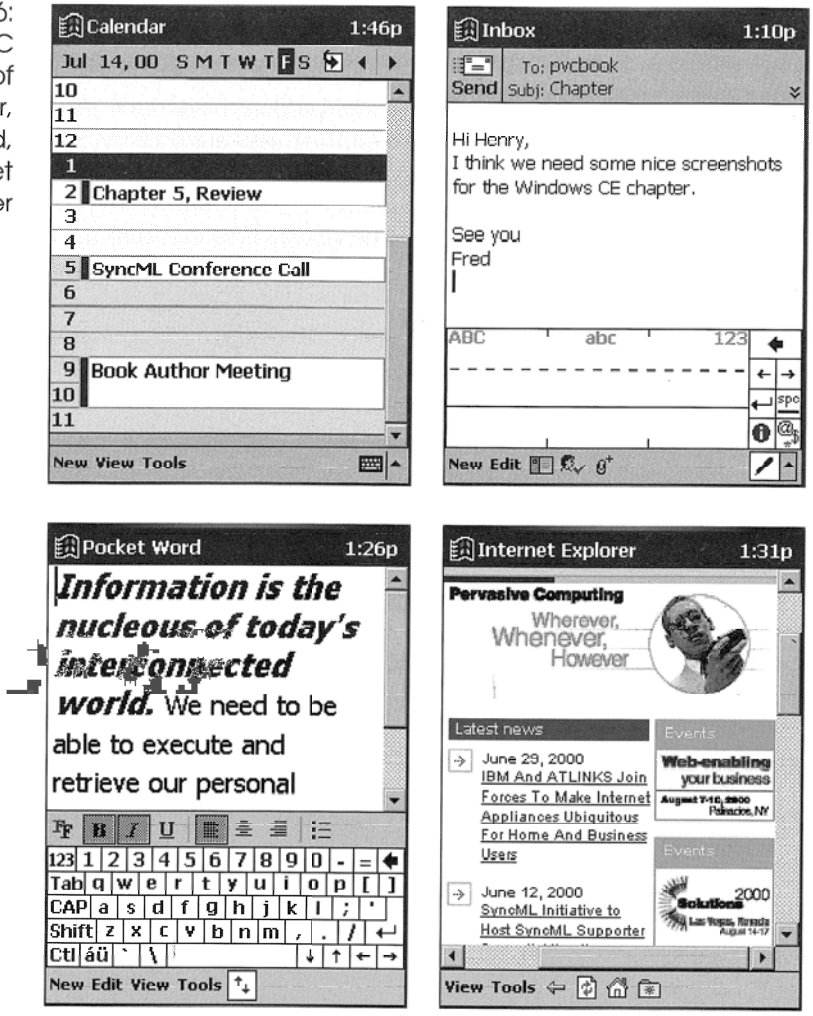
ActiveSync comprises a Service Manager and multiple Service Providers. The Service Provider is the synchronization engine, establishing the connection, tracking changes, and resolving data conflicts. Service Providers are plug-ins contributed by application providers. They implement all application specific tasks, such as user interfaces or retrieving and storing changed data.

PocketPC

Most of today's Windows CE devices in the field run a customized version of Windows CE 2.11, which is tailored for handheld computers. That version is referred to as "Palmheld PC". Products are the Casio Cassiopeia E10x, Compaq Aero 1500, and HP Jornada 420. With the new Windows CE 3.0, the "Palmheld PC" was renamed to "PocketPC". This version is used for the HP Jornada 540, the Compaq iPaq H3630, and the Cassiopeia E-115. For version 3.0 Microsoft's developers have redesigned the user interface entirely, improving especially the clarity of the application layouts. Fancy stuff, like 3D look of buttons has been removed. The icons and windows remind a bit of the good old Windows 3.1.

The performance of version 3.0 has been doubled, and the operating system itself is much more stable than in recent versions. Among the features of 3.0 is a new handwriting recognition. Glyphs, script or print characters, written on the touch screen can be interpreted by that new software.

Figure 2.6: PocketPC Version of Calendar, Mail, Word, and Internet Explorer



PocketPC Office suite

The PIM applications of 2.11 have been updated and renamed to Pocket Outlook. Part of Windows CE are pocket versions of Microsoft Word and Excel. Up to now, these tools had only been shipped with larger sub-notebooks versions of CE. Word and Excel will help viewing attachments (if there is any chance to download them onto the device). MS Money and a street mapping program are nice complimentary utilities.

Internet Explorer

The Pocket Internet Explorer is definitely one of the highlights of version 3.0. It supports online and offline browsing, ActiveX and JavaScript. While the predecessor Mobile Channel Viewer could only browse dedicated web sites, the Pocket Internet Explorer is free to surf anywhere in the net. A "shrink to fit" mechanism is an ap-

proach to deal with the smaller screen size: Web content is zoomed down, until it fits into the window.

Multimedia access

A electronic book application and a media player reflect the aim of Microsoft to emphasize on content delivery complementary to providing just base technology like operating systems.
The Microsoft Media Player can download an individual music library from major record companies onto a handheld device. The Windows Media format compresses two hours of music into 64 MB. That is about half as much as MP3 needs. Access management prevents copyright violations using cryptographic mechanisms.

Microsoft Reader is an electronic book software delivering books to Windows CE based devices. Well readable fonts, a built-in dictionary, and a large collection of book titles are the benefits for the user. The goody for the publisher is a corresponding copy-protection system preventing illegal reproduction.

While handheld computers are today mostly used by business people keeping track of their appointments, there will soon be a significant shift towards private and entertainment usage. Especially new multimedia computer games will target the PocketPC platform in close future.

Table 2.1: Comparing Handheld Computers and Sub-Notebooks

Device Class	Palm	Pocket PC	Handheld PC	EPOC PDA
Products	Palm IIIx/ IIIc/V/VII (Palm), Visor (Hand-spring), Workpad (IBM)	Jornada 540 (HP), E-115 (Casio), iPaq H3630 (Compaq)	Aero 8000 (Compaq), Jornada 820 (HP), MobilePro 880 (NEC)	Serie 5mx pro/ Revo (Psion), MC218 (Ericsson)
Operating System	Palm OS	Windows CE 3.0	Windows CE 2.11	EPOC
Size	8 x 12 x 2 cm	13 x 7.8 x 1.6 cm	25 x 20 x 3 cm	17 x 9 x 2 cm
Weight	140 – 160 g	255 g	1 – 1.3 kg	200 – 350 g
Data Entry	Stylus	Stylus	Keyboard	Keyboard
Display Type	monochrome or 256 colors touch screen	65000 colors touch screen	65000 colors touch screen	monochrome touch screen
Display Size	7.8 cm	21 – 25 cm	21 – 25 cm	12 – 14 cm
Display Resolution	160 x 160 pixels	320 x 240 pixels	800 x 600 pixels	480 x 160 pixels
RAM	2 – 8 MB	16 MB	16 MB	8 – 32 MB
Battery charge	> 10 hours	8 hours	4 – 10 hours	> 10 hours
Peripherals	Serial, Infrared, Springboard (Visor only)	Serial, USB, Infrared, Compact Fl., Voice rec., Audio speaker,	Serial, USB, Infrared, PC Card, Compact Fl., ext. display	Serial Port, Infrared, Compact-Flash
Applications	PIM, HotSync, Graffiti	PIM, ActiveSync, Handwriting recognition, Internet Explorer, Office Suite, Media player	PIM, ActiveSync, Handwriting recognition, Internet Explorer, Office Suite	PIM, Internet Browser, Database, Spreadsheet, WAP (MC218 only)

2.2 Sub-Notebooks

Something between handheld and laptop

In terms of size, weight, processing power, and functionality, sub-notebooks or clamshells are somewhere in between a handheld device and a regular notebook. Most of a handheld computer's characteristics are valid for sub-notebooks too. But they have more memory, more CPU power and they provide a reasonable screen as well. Additionally, they have a small keyboard, making data entry much easier – a significant advantage, in case a lot of text has to be typed in. Although sub-notebooks won't fit into pockets anymore, they are still highly portable and a bit lighter than full-sized notebooks. The main differences to regular notebooks are that the sub-notebooks have much less computing power, cost less and that they are intended for mobile usage. Like handhelds, they have instant-power on, avoiding to boot an operating system first before usage. Their battery capacity exceeds the usage time of notebooks. Nevertheless, floppy and CD ROM drives are uncommon for sub-notebooks. And hard disks are rare.

But being less convenient to carry around than a handheld and having less functionality than notebooks, makes the sub-notebook class not very popular for a broad audience.

Targeting mobile sales forces

Probably the largest group of users are mobile sales forces. Sales representatives need to fill out contracts, orders, or lead sheets directly at the point of sale. They must have immediate access to all relevant data, such as customer profiles, order status or product catalogues. Sub-notebooks are very well suited for these kind of tasks: The keyboard allows quick data entry and the display is large enough for product presentations. There is enough storage for local data repositories allowing to work offline while on travel and to synchronize only periodically with the company's back-end systems.

Most sub-notebooks run either the EPOC 32 operating system or Windows CE. Table 2.1 compares devices of the sub-notebook class with handheld computers described in the previous section of this chapter.

2.2.1 Windows CE-Based Sub-Notebooks

Major device manufacturers for Windows CE sub-notebooks are HP (Jornada 820) and Compaq (Aero 8000) – both are using version 2.11 of that operating system. Version 3.0 is not yet available for that class of devices. In Microsoft terminology, the Windows CE

version 2.11 configuration for sub-notebooks is called "Handheld PC (H/PC)" or "Handheld PC Professional (H/PC Pro)". This might be a bit confusing with the terms "PocketPC" or "Palmheld PC" applied for handheld computers.

Along with handheld PC devices comes a complete set of miniaturized Microsoft office tools and the Internet Explorer. Windows CE handhelds feature a PC Card slot for various peripherals like wireless communication adapter, modems, and many more.

2.2.2 EPOC-Based Sub-Notebooks

EPOC is a versatile operating system designed for usage in various mobile devices. Beside sub-notebooks, it is also applied for phones. EPOC has been developed by the Symbian consortium, founded by Ericsson, Motorola, Nokia, and Psion. EPOC based sub-notebooks are available as MC218 from Ericsson, Oregon Scientific's OsariS, and Psion's 5mx Pro (Figure 2.7), Series 7, and revo. All of them are based on the current version of EPOC, EPOC Release 5, except for the OsariS, which still uses EPOC Release 4.

Figure 2.7: Psion 5mx Sub-Notebook Device

Photo courtesy of Psion

Remarkable is, that the EPOC operating system is very stable and users only experience crashes every few years. These devices contain a rich set of applications for mobile workers. Besides the PIM applications, they feature a word processor, a spreadsheet application, a web browser which supports Java applets, a communication suite with email, fax and SMS, as well as an application to backup and synchronize the device with a PC.

Data entered on an EPOC device can be exported to PC documents and imported in applications like Lotus SmartSuite, Word-

Perfect or Microsoft Word. There is plenty of additional third-party software available for EPOC devices. Maps, databases, dictionaries, tools for internet, email, fax and SMS, financial calculators, and accounting applications, just to name a few of them.

2.3 Phones

Modern phones create a high demand for new pervasive technologies. They have evolved from a simple person-to-person voice interface to powerful network clients. Fancy computing features like tiny hard disks and voice recognition are condensed into a tiny shell dissolving the demarcation to handheld organizers. Today, address books, calendar, memos, and games are state of the art applications, which are no longer restricted to high-end phones.

But it is more than just surfing the net with a screenphone or playing Tetris on a cellular phone, while waiting for a train: address books and calendar entries on the device are synchronized with a Personal Computer. On the other side, data from server databases, like Enterprise Resource Planning (ERP) systems can be accessed, making phones valuable e-Business components.

2.3.1 Cellular Phones

An incredible diversity

The diversity of cellular phones is incredible; their functionality too: the endless list of features gets longer every day. There are manifold games, fancy form factors, built-in FM radio, and even PIM functionality. The operating systems used in cellular phones are quite manifold too. Mostly proprietary systems like RTOS from Siemens or GEOS from Geoworks are used. Others like EPOC are applied by several companies.

Entering text

One issue, cellular phones without a reasonable keyboard have to cope with, is how to enter text easily: Voice recognition is one sumptuous way. Instead of picking one of the miniaturized keys, commands and data can be spoken to the device. Stored phone numbers are dialed with one shout.

Predictive text input is another way to leverage data entry. T9, which stands for "Text on 9 keys", has been adopted by numerous phone manufacturers. The user types in arbitrary texts with the 9 keys of the numeric keypad of a phone. Only one keystroke per character is needed instead of the annoying multi-tap text entry. Since each numeric key stands for three or four letters, a software decodes

the sequence of pressed keys. Within a linguistic database possible word variations are checked until the text is no longer ambiguous. There are databases in more than a dozen languages available.

The communication bearer between a mobile phone and the telecommunication network differs strongly from country to country:

GSM

Global System for Mobile Communication (GSM) is the accepted de facto standard for mobile wireless communication. A dense net of GSM base stations has been established by numerous telecommunication providers throughout more than 100 countries. Each station feeds the digital signals from cellular phones within its reach into the worldwide telephone network. The standard ensures interoperability from a technical point of view. Roaming agreements allow to use the phone in networks operated by other providers. This approach is strongly decentralized: all information required for user identification and authentication as well encryption of the communication is stored on a smart card, which is plugged into every phone. The so called Subscriber Identity Module (SIM) functions as a secure token.

There are several frequencies used for GSM: 900, 1800, and 1900 MHz. Triple Band phones support all frequencies, giving travelling users more flexibility.

CDMA and TDMA

In North America and parts of Asia wireless communication providers operate networks based on several other digital standards. Among these, Code Division Multiple Access (CDMA) is today's most common one. It also allows a secure communication using an encoding key, which is sent along with the voice data. Time Division Multiple Access (TDMA) is a competing standard, which works similar to CDMA, but has an improved bandwidth.

2.3.2 Data Transmission Capabilities

Accessing the Internet

Besides the pure voice communication, there are several ways for transmitting and accessing data through a wireless network. Data communication is used to transfer information between devices or between a device and an IT network, like the Internet. Especially the connection to the Internet gives mobile users access to a standard resource for information.

- Paging is one way of sending data to a recipient. Only a notification and a callback number is delivered.
- GSM data is a part of the GSM communication, which can be used for data or fax transmission.

- Short Message Service (SMS) allows up to 160 characters to be transmitted within one message from and to a GSM phone.
- Wireless Application Protocol (WAP) is a cross-industry standard used to deliver specially formatted content from a web server to phones and other wireless devices with a limited screen. A WAP browser within a device enables Internet interaction for retrieving flight schedules, weather forecasts, driving directions, brokerage services, or making hotel reservations (Figure 2.8). All these applications are definitely a promising opportunity especially for mobile users.

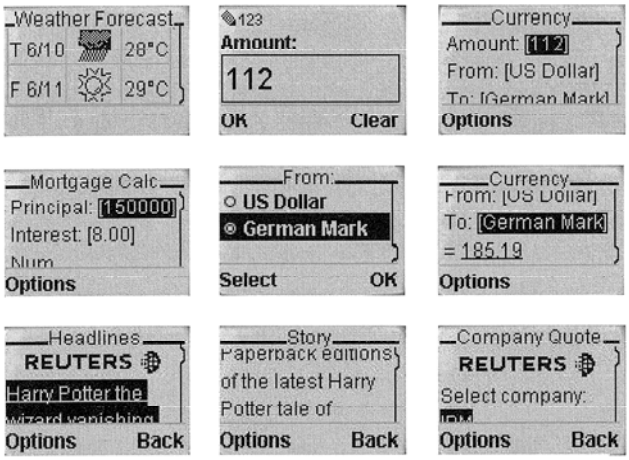


Figure 2.8 : Some WAP Applications

Multimedia messaging

Data transmission using a mobile phone is becoming more and more important – the emerging WAP applications make this evident. But WAP is only the very beginning of new data based communication technologies. Beyond SMS, Picture Messaging allows to send text and graphics. Multimedia Message Service adds digital imaging capabilities. Mobile Multimedia supports entire new content types, such as animations or video clips.

GPRS and UTMS

The most important obstacle for this evolution is the speed of the data transmission itself: GSM Data currently allows only 9,6 kilobits per second, which is the bottleneck for wireless information retrieval. From the year 2000 on, a new enhancement to GSM, called General Packet Radio Service (GPRS) is available. This packet-oriented standard will increase the bandwidth of mobile data communication up to 115 kbps. That will already be more than the speed of today's ISDN wired telecommunication nets. But GPRS will only be an intermediate solution. In 2003 the Universal Mobile Telecommunications System (UMTS) will be introduced as a worldwide common

standard for wireless communication. UMTS will allow 100 kbps to 2 Mbps for data transmission! Phones based on these enhanced communication standards are often referred as third generation phones (3G).

But communication aspects of phones are not limited to the pure telecommunication:

Infrared

Mobile phones usually have an infrared port to exchange data locally with another device. For example in order to "beam" an address book entry to someone else's phone or to interface with a calendar on a PC. Or a simple handheld computer could use an infrared connection to a mobile phone to establish a wireless connection for accessing some server.

Bluetooth

Bluetooth is a convenient approach to let multiple devices collaborate wireless with each other within a short distance of a few meters. While infrared is a one-to-one communication, Bluetooth establishes a local wireless radio frequency network. Phones, handhelds, and personal computer can communicate with peripherals, like headsets or hard disks. A typical scenario could be a handheld, connecting via Bluetooth to a phone, which dials up to a network. Using a Bluetooth connection, the downloaded data can be sent to a standalone memory card.

2.3.3 Smart Phones

Smart phones combine a mobile phone with a handheld organizer into an all-in one communication system.

Nokia Communicator

One example is the Nokia Communicator 9110. The device can be unfolded to access a small keyboard inside. The Communicator is based on the GEOS operating system and features an Intel embedded 386 class processor with 24 MHz. 4 MB of RAM are occupied by the operating system and the included applications. 2 MB is free for user data and another 2 MB is used for program execution. The monochrome display has a good resolution of 640 x 200 pixels. The communicator is based on dual band GSM wireless communication and provides fax, email, short messaging, Internet access, and Personal Information Management (PIM) applications. While PC connectivity via Infrared and serial port is a common feature, telnet and a VT100 emulation are an additional way of accessing data on servers of interest.

Ericsson R380

Another smart phone is the Ericsson R380 (Figure 2.9). The PDA functionality is similar to the Nokia. The key pad can be unfolded to access the touch screen hidden behind. With 360 x 120

pixels that screen has a reasonable resolution. Dual band GSM, modem, and infrared port ensure connectivity, for example to synchronize with a PC. The R380 is WAP enabled and based on the versatile EPOC operating system.

Figure 2.9: Ericsson Phone R380

Photo courtesy of Ericsson

The near future smart phones of all manufacturers will take advantage of high-speed wireless communication networks like GPRS and UMTS. Besides the phone and organizer functionality, these devices will be able to exchange video and audio streams as self-evident as today's SMS (Figure 2.10).

Figure 2.10: Nokia Design Study of a Multimedia Smart Phone

Photo courtesy of Nokia

For instance Ericsson's future Communicator platform is a high-end device with a handheld computer look-and-feel (Figure 2.11). This EPOC device will support the three GSM frequencies 900, 1800, and 1900 as well as the new GPRS communication for high speed data transmission and Bluetooth. GPS is another feature Ericsson plans to include to their Communicator.

The MultiMobile is a smart phone prototype, developed by Siemens and Casio. It is based on a Cassiopeia PDA and runs the PocketPC version of Windows CE. Besides WAP and SMS, the MultiMobile can play MPEG-4 video files as well as MP3 audio files. This device can even be used for mobile video conferencing.

Figure 2.11: Ericsson Communicator platform

Photo courtesy of Ericsson

2.3.4 Screenphones

Screenphones are the convergence of a phone and an Internet terminal. They have a reasonable screen, an optional keyboard and are dedicated to two single tasks: phoning and accessing Internet content and applications.

Figure 2.12: A Screenphone by Ericsson

Photo courtesy of Ericsson

The main goal of screenphones is to offer simple and convenient usage. They provide a one-click connection to the net targeting especially non-technical users who would hesitate to install a PC on their own. The integrated browsers are capable of displaying multimedia web sites and usually can execute Java applications. Screenphones can be used for simple information retrieval, for executing e-commerce web applications, emailing, etc.

The device is delivered pre-installed and ready to be plugged into the telephone line. The connection to the Internet is established through an dial-up access provider. Mostly screenphones require an ISDN high-bandwidth connection, some use cable modems or even wireless connections. Usually a smart card reader is built-in, allowing secure financial transactions like home banking or e-commerce payments. Figure 2.12 shows a screenphone from Ericsson.

2.4 Further Readings

AvantGo

http://www.avantgo. com/frontdoor/index.html

Information about the AvantGo portfolio on different operating systems.

Ericsson

http://mobile.ericsson.com

The homepage of Ericsson's mobile phone activities.

Ericsson Mobile Phone R320

This white paper [ERI00] describes the features and functionality of the R320 smart phone from Ericsson. It includes the WAP configuration and a detailed glossary with mobile telephony related terms.

Handspring

http://www.handspring.com

Handspring shows the Visor Palm OS devices and some interesting add-on hard- and software.

Motorola

http://commerce.motorola.com/consumer

Motorola's consumer products.

Multimedia Messaging

http://www.nokia.com/press/background/index.html

A white paper from Nokia [NOK00] describing how SMS evolves to mobile multimedia.

Nokia

http://www.nokia.com

The homepage of Nokia.

Palm Central

http://www.palmcentral.com

Plenty of software to download for Palm OS devices.

Palm Computing

http://www.palm.com

Information and downloads for Palm OS computing devices.

PalmZone

http://www.palmzone.com

Online Magazine covering Palm OS related topics.

ProxiNet

http://www.proxinet.com

The place where users can subscribe to the ProxiNet transcoding services for Palm.

Psion

http://www.psion.com

Psion provides the largest variety of EPOC powered devices. Their web site provides information about Psion devices, support, and free downloads of various utilities.

Review and Forecast of the Worldwide Information Appliance Market

http://www.idc.com

An IDC [IDC00] market analysis and forecast about the usage of Internet connected devices, such as PDAs, games, TV, and screenphones.

Symbol

http://www.symbol.com/products/mobile_computers/mobile_computers.html

Symbol's mobile devices with laser beam scanning capabilities.

WAP Development

http://www.forum.nokia.com/wap_developer

Information about WAP development based on Nokia WAP phones.

Windows CE PocketPC

http://www.microsoft.com/pocketpc

The starting point when searching for Pocket PC information.

Windows CE Mobile Devices

http://www.microsoft.com/mobile

An overview of Windows CE devices. This site includes reviews, features, and comparisons of handheld and PocketPC devices. There are also developer and enterprise resources.

Qualcomm

http://www.qualcomm.com

The homepage of Qualcomm includes technology and products for wireless communications.

ZDNet

http://hotfiles.zdnet.com

Shareware and freeware for Palm OS and Windows CE.

14 Gateways

Pervasive Computing is dominated by a variety of non-IP network protocols, which are either proprietary or specific to a particular industry. As soon as devices want to access the Internet or other computer networks a protocol conversion is required. This task is done by a *connectivity gateway*. Gateways are the point of entry into a server network. They isolate the individual communication channels and their specific requirements from the rest of the back-end systems. Gateways, like a WAP Gateway or a Palm Webclipping Proxy Server convert TCP/IP to protocols optimized for wireless data transmission.

Besides protocol conversion, content can also be adjusted for specific classes of devices. Using appropriate *transcoding gateways*, a web application server can deliver content in various formats to different types of clients. The ProxiWare Server is one example for this type of gateway, which will be covered later in this chapter.

Gateways can either be part of the back-end system or they can belong to an user's personal setup. The first possibility could be a gateway which is installed by a service provider offering wireless access to his customers.

The second possibility covers workstations or other systems taking the role of a gateway between devices and the Internet. Local gateways can act as a focal point for personal application management and integration of manifold subordinated devices. One example is the classical PC to which a handheld companion connects. Another example is a *residential gateway* acting as a local interface between appliances connected to an in-home network and the external network, like the Internet. The residential gateway can dispatch external services entering a home network to the connected devices. Or it can route wireless appliances within an office to a high bandwidth Internet line.

14.1 Connectivity Gateway

This section covers three examples of connectivity gateways: the Palm Webclipping Proxy Server, a WAP gateway, and the SecureWay Wireless Gateway.

14.1.1 Palm Webclipping Proxy Server

The developers of the Palm VII handheld computer decided not to use regular web browsing for wireless Internet access: Initially the Internet was not designed for small devices. To achieve a better performance they introduced web clipping. Instead of using a generic Internet browser, web clipping needs a corresponding standalone client application for *each* particular web site. This application implements the required browsing capability and has to be downloaded and stored locally on the device first. It holds the hard coded request forms for each query to the corresponding web page. Web site developers need to develop and deploy such a query component complementary to the regular HTML files. Web clipping uses HTML version 3.2 with some extensions and limitations. For example, there are special tags to identify a device. Applets, Java Script, frames, and cookies are not supported. Only simple queries and no complex hyperlinks to other web clipping sites are possible. The HTML files are converted into a binary format, which can be rendered on the Palm VII device. That technology minimizes storage requirements and the amount of data transferred. The benefits are lower transaction costs and longer battery life.

Palm.Net Data Center

All Palm VII communication goes through a proprietary connectivity gateway, the Palm Webclipping Proxy Server. That proxy server is part of the Palm.Net data center, which provides wireless Internet access to Palm VII users (Figure 14.1).

The communication between a Palm device and the gateway is based on the UDP protocol, which allows one packet to be sent as a request to the server and multiple packets to be replied. The data is compressed and encrypted to be optimized for wireless transmission with low bandwidth and latency. When a Palm VII sends an UDP query to Palm.Net, the gateway translates that query to a standard Internet request and forwards it to the corresponding web server. The server returns a response, which can be displayed on the Palm VII browser.

Frequency agility, network authentication, and the Certicom elliptic curve cryptographic algorithm are used to establish a secure connection between the Palm VII and the Palm.Net Data Center. The connection from the Palm.Net data center to an Internet server can be protected with SSL using a 40 or 128 bit key. The Palm.Net Data Center itself is protected by firewalls.

Mobitex Wireless Network

Bearer for the Palm VII wireless communication is Bell South's Mobitex Network. It only operates within the US and uses the 900 MHz frequency. Every Palm VII device has a built in radio frequency transceiver with an unique Mobitex access number. A direct line to Palm.Net Data center is configured.

One obstacle of the applied communication technology is that the radio frequency bearer allows only about 8 kilobytes per second for data transmission. This limits the amount of information, which can be exchanged in a reasonable response time. About 50 bytes for the query and 500 bytes for the response are the recommended sizing.

Although the Palm VII device only accesses the Mobitex network from Bell South, the architecture is basically open for devices based on other network technologies and providers.

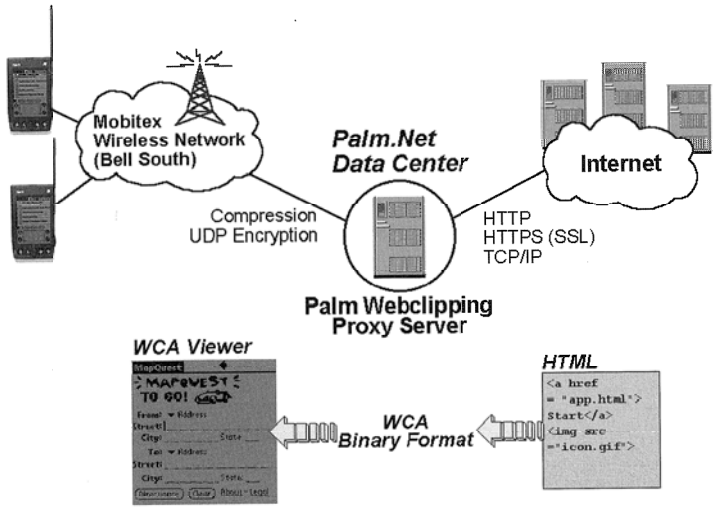


Figure 14.1: The Palm.Net Data Center

14.1.2 WAP Gateway

In order to connect WAP phones to the Internet the standard HTTP Internet protocol used by web servers must be converted into WAP's Wireless Session Protocol (WSP). As described in Chapter

11, this task is done by a WAP gateway. Additionally the content, which must be provide in the Wireless Markup Language (WML) format is translated into a binary content representation (WBXML) to optimize transmission.

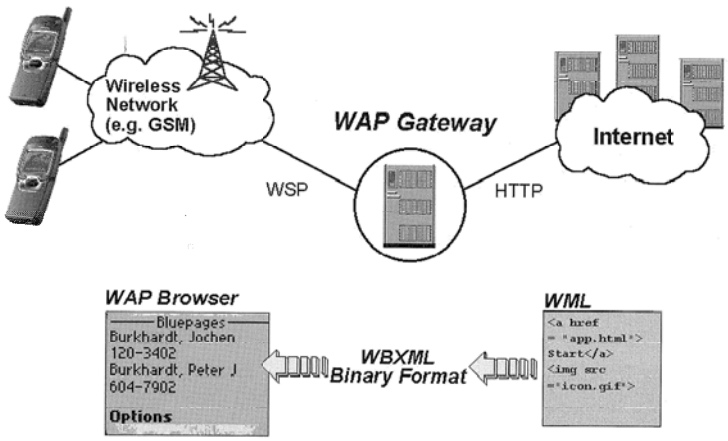
Besides content and protocol transformation, the server initiated client notification needs to be supported, which was introduced with WAP 1.2. This "push"-mechanism is a bit circumstantial, since normal HTTP servers can only respond to requests received from clients. The initiator of a push acts as a HTTP client of the WAP Gateway, which takes the role of a Web server, referred to as Push Proxy Gateway (PPG). The PPG forwards the push notification to the WAP client over WSP. Each push message consists of two components: the content to be pushed to the WAP client and a control entity, which holds information, like the message expiration date.

Since WAP is an open standard and independent from a specific telecommunication network any gateway should work with any WAP compliant phone.

Nokia WAP Server

Among the available commercial gateway products is *Nokia's WAP Server*. Connections from WAP clients to the gateway can base on the bearers Short Message Text (SMS) and Circuit Switched Data (CSD). It is possible to implement other protocols than HTTP on the server side, for instance, when legacy systems need to be supported. An application programming interface (API) enables a service provider to develop particular stand-alone applications, like servlets, directly on top of the gateway. Additional back-end server systems can be omitted this way.

Figure 14.2: WAP Gateway



14.2 Wireless Gateway

Gateway

The *IBM SecureWay Wireless Gateway* tunnels the IP protocol through a diverse set of wireless and wireline networks. Applications on client systems can communicate with enterprise networks based on TCP/IP, although this protocol is actually not supported by the communication bearer. Any application developed for the standard TCP/IP interface, will run on top of SecureWay Wireless without modifications.

Client

The *SecureWay Wireless Client* is the counterpart of the gateway and must be installed on the user's client system. A user interface allows to initiate the communication to the gateway. The mobile user can select the network type, which meets best his current needs, without making any changes to the installed applications.

In order to setup the network transparent to the application, different network characteristics are encapsulated by SecureWay Wireless. On the client side, all network specific details are hidden beneath the common TCP/IP interface layer. SecureWay Wireless works like an additional network device driver. It intercepts the TCP/IP communication and routes the data traffic over the chosen non-IP networks. Inside the gateway, Mobile Network Interfaces (MNI) expose the access to a particular network type.

The list of supported network protocols include:

- Public and private Packet networks (CDPD, DataTAC, GPRS, and Mobitex).
- Analog and digital cellular networks (GSM, CDMA, TDMA, and AMPS).
- Satellite networks (Norcom).
- Wireline (Cable modem, DSL, PSTN, ISDN, and Dial-up ISP).
- LAN connections (Ethernet, Token Ring, and wireless LAN).

Efficient

Besides the simple IP-based communication between client and gateway, SecureWay Wireless optimizes the network traffic using data compression mechanisms. Increasing efficiency is extremely important for low speed wireless networks. The benefits of less data traffic are better response times and often lower network fees. Additionally, an idle connection can be disconnected automatically and will resume as soon as communication continues. The user will not notice that interrupt (short-hold mode).

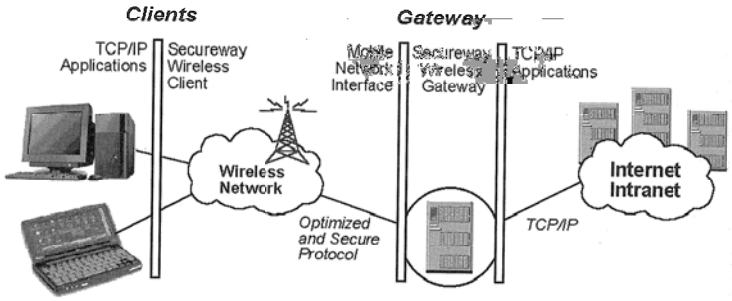
Secure

For reliable data privacy, all data transmitted through public networks from the client device to the gateway can be encrypted with RSA. Two way client/gateway authentication mechanisms prevent unwanted access.

Besides gateway and client, IBM provides *the SecureWay Wireless Gatekeeper*. This tool enables system administrators to configure multiple wireless and dial-up network, and define users, resources, and access rights. LDAP is used to store user profiles and network management data.

WebExpress is an enhancement for HTTP communication through SecureWay Wireless. WebExpress features HTTP header reduction, as well as HTML data stream compression and content caching.

Figure 14.3: SecureWay Wireless Gateway



14.3 Transcoding

Transcoding is a content adaptation technology, which tailors information for a specific device by transforming its format and representation. Multimedia data as it can be found on Web pages, is filtered, converted, and reformatted, until it matches the capabilities of the displaying device.

Why transcoding?

The purpose is obvious: When providers deliver content to various pervasive clients, they need to accommodate device specific constraints such as limited memory, slow data transmission, and small screens. Transcoding automatically translates content into different representations for each class of receiving client systems. This simplifies authoring, deployment, and maintenance dramatically! An arbitrary multimedia web page can be provided to Internet TVs, handhelds, and WAP phones without change. It is even possible to adapt content from legacy systems into a standardized Internet rep-

resentation, or transcode Web pages to the proprietary format of a specific client device.

Besides adapting content according to particular device capabilities, another aspect of transcoding gains importance: information is personalized for a particular user, depending on his preferences and organizational policies. For instance, content of interest can be transcoded into individual user interface styles or a preferred language.

Transcoding Proxy

Transcoding is typically done by a gateway or proxy, which intercepts the data exchange between the content server providing multimedia data and the client rendering the received information (Figure 14.4). The transcoding proxy analyses the content and identifies the included media objects. In order to determine graphical navigation buttons, images, and related textual content, the semantics of each object is examined. According to defined preferences, appropriate methods for content manipulation are invoked. Preferences can be device capabilities, user profiles, communication bandwidth, and others. They indicate what kind of information has to be transcoded in which way.

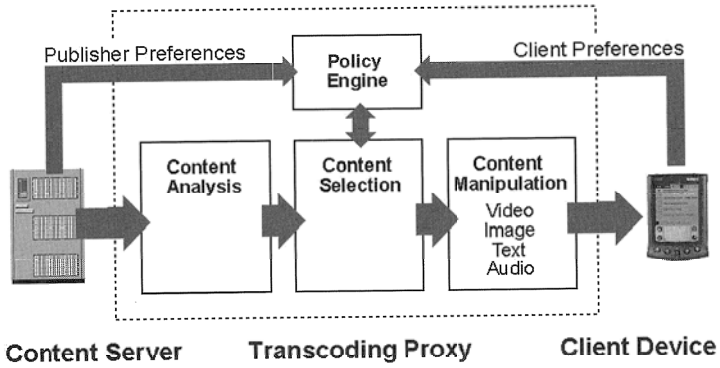


Figure 14.4: Internet Content Transcoder

Modality and fidelity

This content adaptation comprises two dimensions:

- *Modality:*
  Multimedia includes video clips, images, text and audio data in manifold formats. Since not all of these modalities are suitable for all devices, transcoding translates data according to the targeted devices needs.
- *Fidelity:*
  Reducing the fidelity of information is another approach to reach even small devices with multimedia information. Compressing and filtering are techniques applied in this context.

Content manipulation methods

The following list shows several common methods for content manipulation:

- Conversion of images to hyperlinks, allowing the user to retrieve them separately only when explicitly needed.
- Compression and reduction of scale and color level of images.
- Substitution and removal of images.
- Conversion from one image format to another.
- Translation of XML documents according to a given style sheet.
- Video skimming.
- Video-to-image conversion.
- Text-to-speech conversion and speech recognition.
- Text summarization from detailed text to headlines.
- Text reformatting from tables to simple lists.
- Language translation.

14.3.1 InfoPyramid Framework

An implementation of transcoding technology is the IBM InfoPyramid Framework. This framework allows to manage media objects with different modalities and fidelities. Media objects can be either stored in different representations or be created on-the-fly in order to meet the capabilities of a requesting device.

Media objects correspond to cells in an "*InfoPyramid*" (Figure 14.5). Within the pyramid, the fidelity of information representation decreases from bottom to top. The lower cells refer to detailed information, such as high-resolution images or comprehensive texts. The upper cells correspond to strongly compacted information, such as simplified images or summarized text. When moving horizontally within the pyramid, the modality changes. For instance text-to-speech conversion changes a text based representation to audio.

Transcoders

The framework includes methods to manipulate media objects. These are referred to as *transcoders* and are distinguished between *translators* and *summarizers*. Translators convert modality, while summarizers change fidelity. The framework is extensible and allows to add new transcoders using a provided developer toolkit. It is also possible to define additional modalities, such as different languages of text.

The framework has been implemented as a stand-alone proxy server as well as a servlet. The proxy server intercepts HTTP requests

and responses between the user and any selected Web server. The servlet version runs directly on a particular Web application server.

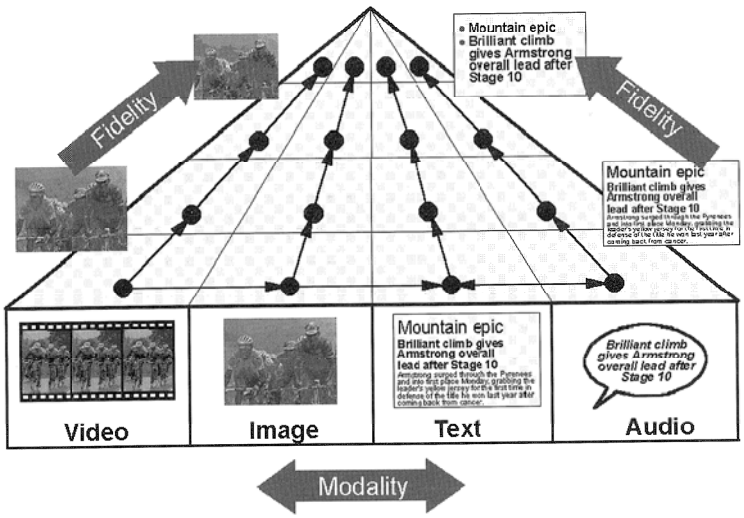


Figure 14.5: IBM's InfoPyramid

14.3.2 ProxiNet Transcoding Gateway

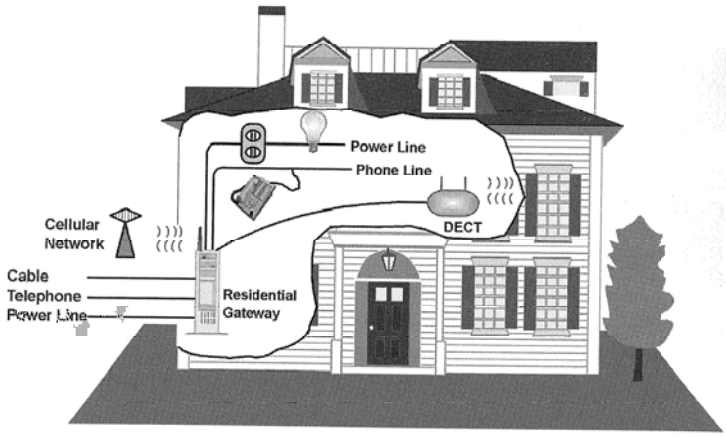
ProxiNet's transcoding technology is based on the *ProxiWeb* browser for client devices and the *ProxiWare* gateway. Any selected web site is retrieved, transformed, and delivered in a very compact representation to the client's ProxiWeb browser. ProxiWeb is an ultra-thin browser for Palm OS and comprises only about 120 kilobytes. When the device is connected to an Internet provider, the browser gives immediate Web access. Downloaded sites are kept within a cache and can be viewed offline at a later time again.

14.4 Residential Gateway

The residential gateway is a computer that acts as a central bridge between the outside world and the networked devices in the home. Figure 14.6 shows a residential gateway with several connectivity options in a home. There are two major aspects to the residential gateway.

On one hand, the residential gateway integrates "traditional" communication media – telephone and cable TV – into the home audio-visual system. Through a caller ID function such a system could, for example, announce a caller's identity through the home audio system. The resident could then decide whether or not to get out of his Jacuzzi to pick up the phone.

Figure 14.6: Home Networks



On the other hand, work is carried out to define the gateway as a bridge between the home and the Internet. Valid services should be able to access the home systems. For example, the refrigerator repair center should be able to access the appliance in the home for diagnostic purposes. However, unauthorized access must be blocked – it must not be possible for unauthorized persons to determine information about the residents.

14.5 Further Readings

IBM Transcoding Solution

http://www.research.ibm.com/networked_data_systems/transcoding

This site includes documents and publications related to transcoding. An online demonstration transcodes arbitrary web pages, which can be selected by entering their URL.

IBM Networked Home

http://www.ibm.com/pvc/nethome

This web page includes a scenario of a networked home environment.

Information Delivery Infrastructure in the Mobile, Wireless Age

http://www.proxinet.com/technology

This white paper covers the ProxiNet transcoding approach as well as a generic analysis of different technologies to deliver content to small devices [FOX99].

Nokia WAP Gateway

http://www.nokia.com/corporate/wap/wap_server1_1.html

The technical features of the Nokia WAP gateway can be accessed through this link.

Palm VII Wireless Internet Access

http://www.palm.com/pr/palmvii/7whitepaper.pdf

This white paper explains Palm's approach to provide wireless network access through the Palm.Net gateway [PALMVII].

Panja Home Systems

http://www.panja.com

This site features a photo tour through a networked home installation.

Point Clark

http://www.pointclark.net

A commercial provider for residential gateway software and services.

ProxiNet

http://www.proxinet.com

The place where users can subscribe to the ProxiNet transcoding services for Palm devices.

Residential Area Highway Project

http://hoegaarden.ec.ele.tue.nl

This page includes interesting links to standardization activities, documents, and projects related to in-house networks and residential gateways.

SecureWay Wireless

http://www.ibm.com/software/network/mobile

Information about IBM's SecureWay Wireless product.

Uwe Hansmann

Lothar Merk

Martin S. Nicklous

Thomas Stober

Pervasive Computing Handbook

This book is a guide for the world of Pervasive Computing. It describes a new class of computing devices which are becoming omnipresent in everday life. They make information access and processing easily available for everyone from anywhere at any time. Mobility, wireless connectivity, diversity, and ease-of-use are the magic keywords of Pervasive Computing. Devices include handheld computers, mobile phones, interactive television, smart cards, household appliances as well as intelligent automotive equipment. The book covers these front-end devices as well as their operating systems and the back-end infrastructure which integrates these pervasive components into a seamless IT world. A strong emphasis is placed on the underlying technologies and relevant standards for building pervasive solutions. These fundamental topics include commonly used terms such as XML, WAP, UMTS, GPRS, Bluetooth, Jini, transcoding, and cryptography, to mention just a few. Besides a comprehensive state-of-the-art description of the Pervasive Computing technology itself, this book gives an overview of today's real-life applications and accompanying service offerings. M-Commerce, e-Business, networked home, travel, and finance are exciting examples of applied Pervasive Computing.

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"Very good coverage of Pervasive Computing – ranging from the device level up to the server. They cover the range with authority and state-of-the-art knowledge." Peter Thompson, Senior Software Engineer, Starfish Software

"This book is the first I have seen on the topic of Pervasive Computing. This is a great reference for anyone wanting to understand the impact of this important field on their business." Frank Dawson, Consulting Engineer/Senior Technical Staff Member, Lotus Development Corporation

"This book is a comprehensive survey covering many of today's hottest technologies. If you need to understand the components involved in building Pervasive Computing solutions, start here." Noel Poore, Head of Software Technology, Psion Computers plc

"Pervasive computing is the extension of applications and services to a variety of devices, including mobile phones, PDAs (personal digital assistants), vehicles, home appliances, kiosks, and medical and security devices. It provides immediate access to information and transactions, offering great convenience to mobile users of these services. The companies that embrace these technologies today will gain a competitive advantage over those who wait to see how the market develops." Jonathan L. Prial, Director of Marketing and Strategy, IBM Pervasive Computing Division