



Handheld Computing

Col. Kenneth L. Alford, Ph.D.
U.S. Army

Handheld computers, especially personal digital assistants (PDAs), are increasingly being used throughout the Department of Defense. This article highlights some of the ways that PDAs are used today and are envisioned for the future. It outlines some of the considerations involved in a PDA procurement, discusses four tools for developing PDA resource materials – programming tools, hypertext markup language- and eXtensible markup language-based tools, text tools, and calendar tools – outlines some of the benefits and challenges associated with using PDAs, and shares several lessons learned.

Computing power continues to increase in capacity and decrease in cost and size. Today's low-cost handheld computers and personal digital assistants (PDAs) allow computing resources to be almost ubiquitous. This article illustrates how handheld computing is changing the way some Department of Defense (DoD) organizations *do business* and discusses how you may take advantage of the capabilities that are available through this technology.

Example Handheld Programs

PDAs, which are defined in DoD Directive 8100.2 as “a generic term for a class of small, easily carried electronic devices used to store and retrieve information” [2], were at one time viewed as little more than novelties. Yet, with approximately 20 million PDAs shipped last year, business and government groups continue to find new ways to use them.

Here are some of the many ways that PDA technology is currently being used within the DoD:

- The Pocket-Sized Forward Entry Device (PFED) is a ruggedized PDA designed for forward observers, artillery fire direction, and target acquisition missions. With built-in laser range-finding and global positioning system (GPS) hardware, PFED users can issue a call-for-fire request in less than 10 seconds – compared to 45 seconds or more when using other systems [3].
- Security guards at Wright-Patterson Air Force Base use PDAs at the gates and on patrols. Prior to receiving PDAs, guards were provided thick binders containing daily event lists with guest and sponsor contact information. Only three of the 10 gates on base received a binder each day. Visitors who arrived at one of the other seven gates had to wait for someone to confirm if they were allowed on base. Now each guard has a

copy of the complete daily list. Using their PDAs, guards can also provide visitors with maps and directions to their destination on base [4].

- The Commanders Digital Assistant is a ruggedized PDA that is being fielded to combat troops; it has already seen field use with the 82nd Airborne in

“... I sat down with a group of Marines in California who had just returned from the Iraq war. At one point in our conversation, I asked the Marines in the room to raise their hands if they had either a cellular telephone or a PDA. Every hand went up.”

—Vice Adm. Herbert A. Browne,
U.S. Navy (Ret.) [1]

Iraq. It integrates dismounted troops into the *Blue Force Tracking* system, enables commanders to distribute orders, and provides several additional capabilities [5, 6].

- The Coast Guard uses PDAs to help automate the task of inspecting fishing vessels. Based on answers to 16 questions, the PDA generates a customized checklist of safety requirements for firefighting, lifesaving, and bridge equipment appropriate to each vessel. As boarding officers click on each

requirement, the PDA displays detailed specifications. Officers then check off whether items are found to be satisfactory or are in violation of federal law. Instead of laboring to determine whether the law requires a particular type of life rafts, an inflatable buoyant apparatus, life float, or nothing at all, boarding officers, with PDAs in hand, now spend their energy on, for example, inspecting life rafts to ensure that they are properly set up to release should a ship sink [7].

- In 2004, the Marine Corps awarded a \$2.9 million contract to purchase rugged PDAs (RPDAs) designed to increase tactical awareness. This follows a previous \$12 million award that supplied RPDAs to several branches of the U.S. military. These devices offer navigation, tactical digital messaging, remote radio control, GPS, wireless local area network (LAN) and Bluetooth capabilities [8].
- All West Point cadets purchase a PDA. Students and faculty members use PDAs to store schedules, class assignments, reference documents, and other instructional materials. PDAs have also been incorporated into some senior engineering design projects.
- Army medical units in Iraq use PDAs to collect patient information.
- Los Alamos National Laboratory's researchers have developed a PDA radiation detector [4].

There are many other programs and projects throughout the DoD that could also be listed. Many service members even receive a PDA as part of their unit's standard issue.

Benefits

As the previous examples illustrate, there are many ways to effectively incorporate PDAs into the workplace and many reasons for doing so. PDAs offer a variety of

advantages over other automated solutions. For example, given the right work environment, PDAs can do the following:

- Increase worker productivity.
- Improve customer support.
- Reduce time spent searching for information.
- Allow users to take computing power and large amounts of information to places where they could not previously go.
- Increase accuracy.
- Save lives.

This is because PDAs are versatile, portable, inexpensive, and easy to use.

Retired Vice Adm. Herbert A. Browne recently noted the following:

Virtually all of the lessons learned from Operation Iraqi Freedom include comments about the speed of the forces' advance exceeding the speed with which line-of-sight communications could keep up. Command and control (C2) of our forces was challenged by this rapid mobility, and wireless technology is viewed as the most likely solution to getting collected information and C2 down to the tactical, *trigger-pulling* level. [1]

PDAs can offer solutions to some of those challenges.

Concerns

Like other forms of automation, introducing PDAs into the work environment comes with a potential downside as well. Here are some of the concerns associated with using PDAs:

- PDAs have limited data input capabilities, especially for typing-intensive work.
- There are additional maintenance and cost requirements.
- Non-ruggedized PDAs can be easily broken.
- PDAs may introduce additional training costs in both time and dollars.
- It is difficult for many users to separate business and personal use of PDAs.
- There are numerous security concerns.

Security

PDAs can introduce multiple security challenges. Due to their small size, for example, PDAs have an increased risk of loss or theft. PDAs that wirelessly connect to government networks create additional obvious security concerns.

On April 14, 2004, Deputy Secretary of Defense Paul Wolfowitz signed Defense Department Directive 8100.2

“Use of Commercial Wireless Devices, Services, and Technologies in the Department of Defense (DoD) Global Information Grid (GIG)” [2]. The directive’s guidelines apply to all commercial wireless devices (including PDAs). It establishes “policy and assigns responsibilities for the use of commercial wireless devices, services, and technologies in the DoD GIG.”

Hardware Considerations

The use of business and government (*enterprise*) PDAs has been on the rise for the past several years. The Gartner Group’s research estimates that more than 4 million enterprise PDAs were in service during 2004, and they estimate that number will rise to 6 million by 2008. At the same time, the total cost of ownership (TCO) per year of a business PDA has dropped 28 percent – from almost \$2,700 in 1999 to \$1,946 in 2004 [9]. (These figures are based on a two-year amortization rate.)

**“The Commanders
Digital Assistant is a
ruggedized PDA that
is being fielded to
combat troops; it has
already seen field use
with the 82nd
Airborne in Iraq.”**

The popularity of PDAs has resulted in a wide variety of devices being offered in the marketplace. Government users considering PDA purchases have several decisions they must make regarding the device they will use. Decisions must be made regarding the processor, operating system, wireless technologies, screen characteristics, battery life, expansion memory, input options, and durability (business versus ruggedized models), among other questions.

Processor

Most PDA processors are made by Intel, Samsung, or Texas Instruments; PDA processor speeds currently range from 16MHz to over 500MHz.

Operating System

Most PDAs run on one of the following

operating systems:

1. **Palm OS** (the latest version is Palm OS Cobalt, previously known as Palm OS 6).
2. **Windows Mobile** (which comes in three profiles: Pocket PCs, Pocket PC Phone Edition, and Windows Mobile for Smartphones).
3. **Symbian OS** (the leading operating system for Smartphones).
4. **RIM** (used in Blackberry devices).

Wireless Technologies

An increasing number of PDAs are being sold with one or more of these wireless technologies [10]:

1. **Bluetooth.** This is an industry specification for wireless communications that uses short-range radio technology. Bluetooth version 1.2 throughput is typically in the 400-500 kilobytes per second (Kbps) range. Bluetooth does not have any native support for Internet Protocol (IP) that means it does not currently support tactical computer processor (TCP)/IP or wireless LAN applications very well. It is better suited for connecting PDAs, cell phones, and PCs during short intervals. Bluetooth certification means that an individual product has been tested for compliance with the Bluetooth specification; it does not guarantee that it will be compatible with other Bluetooth-enabled products.
2. **802.11/ Wireless LAN (WLAN).** On an 802.11 WLAN, most PDAs adhere to the 802.11b specification that provides 11 megabytes per second (Mbps) transmission rates and throughput in the 4-6 Mbps range.
3. **Global System for Mobile communications (GSM), General Packet Radio Service (GPRS), and GSM Evolution.** The GSM is a European digital cellular phone standard. GSM 1900, the North American version of GSM, generally provides throughput in the 56 Kbps (or less) range. GPRS is an overlay to GSM networks; the maximum speed is theoretically 171.2 Kbps, but actual user experience is usually limited to 56 Kbps or less. GSM Evolution is a radio interface technology for mobile services; while data throughput rates of approximately 384 Kbps are theoretically possible, users more frequently report throughput closer to 64 Kbps.
4. **Code-Division Multiple Access (CDMA).** This is a spread-spectrum digital cellular technology. It was first used during World War II and became

commercially available in 1995. The latest CDMA standard provides voice and data rates up to 2 Mbps.

Screen Characteristics

The screen size, resolution, backlighting capability, and color should all be considered during any purchase evaluation.

Battery Life

Battery life is an important element in determining which PDA to purchase. Nearly all PDAs today offer rechargeable batteries. The two main battery types are lithium ion and lithium polymer. Most PDAs offer a rechargeable lithium ion battery.

As would be expected, actual battery life depends on a wide variety of factors: screen size, resolution, use of backlighting, data intensity of applications, etc.

Expansion Memory

While PDAs have generally offered a relatively small amount of memory (in the 8-64 megabytes range), new models are offering 256 megabytes with forecasts and expectations for more. Data-intensive PDA applications often require additional memory, and most PDAs offer at least one external expansion slot for additional memory. Several memory card expansion options are available [9]:

1. **Secure Digital (SD)** cards are small and are used in PDAs, digital video camcorders, digital cameras, audio players and mobile phones. Cards are currently available to store up to 1 gigabyte.
2. **Secure Digital Input/Output (SDIO)** provides improved multimedia and device management. SDIO cards generally support PDA peripherals (such as GPS receivers, Wi-Fi, digital cameras, and Bluetooth).
3. **Multimedia Memory Cards (MMC)** expansion slots are supported by many PDAs and are available in storage sizes up to 1 gigabyte.
4. **Compact Flash (CF)**, at one time, was the most popular PDA expansion card format. Some PDAs allow users to add up to 6 gigabytes of expansion memory.
5. **Memory Stick**. This is a proprietary format (from Sony). Memory sticks currently have a storage capacity up to 2 gigabytes.

Input Options

In addition to standard PDA touch-screen data entry (either through point-and-touch or PDA graffiti recognition software), many PDAs offer small built-in or

attachable QWERTY (standard) keyboards. At least one company has developed an exciting prototype technology:

... that lets users of PDAs and similar mobile devices put data into their handheld systems simply by typing on an image of a standard-size keyboard projected onto a desktop or other surface. The *electronic perception* technology captures the user's finger motions via emitted light photons that form 3-D real-time images that are then processed and translated into keystrokes. [12]

Durability

Ruggedized PDAs (also known as industrial handhelds) must meet additional specifications. For example, they must be

“Every decade has some word associated with it. In the '80s, it was the PC. In the '90s, it was the Internet. For the rest of this decade, the key word is going to be convergence.”

—Steve Case, AOL Time Warner, Chairman of the Board [11]

able to survive significant drops (from one meter or greater) onto a concrete floor, water tests, heat and cold tests, and tolerance for electromagnetic shock. Ruggedized handhelds generally cost between 50 percent and 200 percent more than business PDAs.

The Gartner Group estimates that the TCO in 2004 of a ruggedized PDA was \$2,002 per year (almost the same as the \$1,946 TCO for a business PDA) [9]. These figures are based on a three-year product life, but many ruggedized users keep their PDAs longer than three years, which lowers the ruggedized TCO cost. Because they are designed to withstand rougher treatment, ruggedized PDAs tend to have a longer useful life than business PDAs.

Convergence

Digital convergence – defined here as the

coming together of two or more technologies – is rapidly occurring in the field of handheld computing. In many cases, PDAs and cellular phones have merged and are sold in a single device known as a Smartphone. In the third quarter of 2004, Smartphone shipments exceeded those of PDAs (3.96 million to 2.86 million units) [13].

New devices, new capabilities, and new technology will continue to appear. The DoD should embrace and incorporate, whenever possible, the new opportunities that these advances will provide.

Developing PDA Tools

PDAs are increasingly being used throughout the DoD, and this is especially true at many educational and training locations. For example, at the U.S. Military Academy, PDAs are becoming an effective instrument in an instructor's toolkit.

There are several no-cost, low-cost, and commercial products available to increase the functionality and usability of personal digital assistants in work and training settings. There are four basic ways that PDA resource materials can be developed: (1) programming tools, (2) hypertext markup language (HTML)- and eXtensible markup language (XML)-based tools, (3) text tools, and (4) calendar tools.

Programming Tools

Several software development environments exist for creating applications for personal digital assistants. Introductory information can be found online at numerous Web sites¹. Java – whether in the form of Kilobyte Virtual Machine (KVM), Kawt (an implementation of the Abstract Window Toolkit for the KVM), J9 (IBM's virtual machine that is supported by Visual Age Micro Edition), or any number of other flavors – is currently one of the most popular languages for programming handheld applications. C, C++, versions of Basic and Visual Basic, Compact Application Solution Language (CASL), Pascal, Forth, Scheme, Smalltalk, and several other proprietary scripting tools are also available [14].

Application development is appropriate when existing PDA software resources cannot adequately satisfy existing requirements. At West Point, for example, plebes (freshmen) must be able to recite the number of days that remain until each football game, spring leave, graduation, and other notable cadet activities. Faculty in the Department of Electrical Engineering and Computer

Science created a small PDA program called *The Days* that automates and simplifies this daily ritual for freshmen students.

HTML- and XML-Based Tools

HTML and XML files can be easily formatted to be viewed on a PDA. There are numerous ways this capability can be used to support teaching and other military training. For example, instructors at West Point have formatted all of the following into HTML and/or XML pages to be read on PDAs: course syllabus and guidelines, course schedules, reading assignments, project and other course assignment files, supplemental reading assignments, class handouts, review information for exams, self-administered non-graded quizzes, Web pages, Web sites, other HTML documents, and student projects. In other work environments, it may be appropriate to place copies of regulations, field manuals, directives, maps, and directions on PDAs.

Two of the most popular programs for transforming Web-ready pages into PDA documents are Plucker², a freeware program, and AvantGo³, a commercial product. Plucker software, for example, allows users to easily create and update PDA-readable versions of a single Web page, multiple Web pages, or entire Web sites. Users can configure graphic quality and size, timing of file updates, depth of search, and numerous other options.

Text Tools

As an alternative to formatting text into an HTML or XML formatted document, there are several text-based tools, each with its own unique file format that can be used to develop PDA-readable documents.

There are several no-cost and low-cost alternatives available for developing PDA documents. One of the quickest and easiest ways to send text and small documents to many PDAs is to use the *Memo Pad* feature found in Microsoft Outlook and several PDA synchronization programs. Using Memo Pad is a very basic solution, but it does have the advantage that students can modify original text they receive. Memo notes are useful when students are asked to modify and return a document or assignment.

To obtain increased document functionality, instructors can turn to freeware or commercial software products, such as PalmReader⁴ or Adobe Acrobat⁵. PalmReader provides all of the software and instructions necessary to create finished PDA-readable documents with text

and limited graphics. Copies of the reader software are available for the Windows, Macintosh, Palm OS, and Windows Mobile operating systems. An advantage of using PalmReader or Adobe Acrobat is that the same document can be read on platforms with all four supported operating systems. PalmReader uses a unique tag-based description language that supports text styles, links, graphics, sidebars, footnotes, bookmarking, notes, and other features.

PalmReader, Adobe Acrobat, and a variety of similar programs can be used to create functional and extremely useful documents and electronic books for handheld computers.

Calendar Tools

The ability of handheld computers to hot synch with personal information management software, calendar software, and

“It is important to realize that the next generation of federal workers will not remember a time when computers and connected environments did not exist.”

other information located on personal computers makes calendar and schedule applications a natural target for course-work development.

Faculty and students at the U.S. Military Academy use Course Hour Appointment for Outlook Scheduler (CHAOS) – a Microsoft Visual Basic program for entering lesson dates, titles, and assignment information into their personal and handheld computers. CHAOS-generated files are loaded into the Microsoft Outlook calendar and then synchronized with the calendar program on student and faculty PDAs. Faculty and students at the U.S. Military Academy have used this method to create and distribute calendars and schedules for student clubs, student project teams, and a variety of other groups.

Lessons Learned

Instructors at the U.S. Military Academy have been creating PDA instructional

content for several years. Here are some of the lessons they have learned in developing applications and resources for PDAs:

- Be aware of size constraints. PDA storage capacity is rapidly improving, but it is still a constrained development environment.
- Use graphics sparingly and ensure that they have been optimized.
- Double-check everything, especially links and graphics, *before* you distribute PDA programs and products.
- Whenever possible, provide non-handheld alternatives for resources you develop for PDAs.
- Recognize different PDA operating systems, screen resolutions, and color capability. Reference to specific colors in images, for example, is meaningless for users who have a 16-grayscale PDA screen.
- Eliminate screen scrolling on PDAs whenever possible; it is tedious and time-consuming.
- Limit the number of PDA file-reading programs you require users to load on their PDA. PalmReader, Plucker, and Adobe Acrobat, for example, are all excellent programs, but requiring users to load all of them in order to read a wide variety of materials could require an unreasonable amount of valuable PDA memory space.
- Concentrate first and foremost on usability. The best content available can be rendered almost useless by a poor presentation.

Future Handheld Programs

Numerous DoD handheld computing applications are currently being developed. Here is a glimpse of some of the applications that we should see in the future:

- The Protect America system is being designed to give military commanders and force protection personnel from U.S. Customs, the Secret Service, the U.S. Coast Guard, the Transportation Security Administration, the Federal Bureau of Investigation, and others a common information-sharing tool [15].
- The Seismic Landmine Detection System would send seismic waves through a minefield, slightly moving the earth and items buried beneath. A radar sensor, connected to a PDA, will measure ground displacement to locate plastic anti-personnel or anti-tank mines [16].
- Technologies are being developed that will enable computers and PDAs

“to accept gestures, motions, speech, and facial expressions as data input methods ... designed to facilitate silent troop communication during combat” [11].

- PDAs are being tested to serve nuclear, biological, and chemical detection roles in future conflicts. Many other exciting applications will be delivered, as well.

Conclusion

A great deal is being written about the large personnel turnover that the federal government will experience during the next decade as the existing workforce retires in substantial numbers. It is important to realize that the next generation of federal workers will not remember a time when computers and connected environments did not exist. A recent report from the Gartner Group estimates (with an 80 percent probability rating) the following by 2007:

Seventy percent of all levels of Western governments will double the turnover of new employees due to worker dissatisfaction with the technology infrastructure. ... The generation that is about to enter the government workforce thinks differently. They use cellular phones and instant messaging as a matter of course. Facts are available in seconds from online resources. Projects are done in teams. High school and college campuses have wireless access in common areas. Dormitory rooms have broadband access. In the meantime, governments treat IT [information technology] as overhead, and consider Internet access too easy to abuse and instant messaging a time waster. However, the incoming workforce expects to be able to work *anywhere, anytime*. It is accustomed to receiving information in seconds, not in quarterly reports. It will not work in an environment that cannot support these requirements. Economic situations or a sense of responsibility may draw workers to government jobs, but unless the technology environment changes the next generation of workers will not perform well and will be highly dissatisfied. As a result, government agencies will lose access to this pool of talent. [17]

Defense personnel should be able to use the best tools available to complete

their mission. In many instances, the best tool available will be a handheld computing device such as a PDA. Security concerns regarding the use of PDAs can and must be resolved. ♦

References

1. Browne, Herbert A. “Wireless Technologies Are the New Information Revolution.” Signal Dec. 2003 <www.afcea.org/signal/articles/anmviewer.asp?a=46>.
2. Department of Defense. “DoD Directive 8100.2: Use of Commercial Wireless Devices, Services, and Technologies in the Department of Defense (DoD) Global Information Grid (GIG).” Washington: DoD, 14 Apr. 2004. <www.dtic.mil/whs/directives/corres/html/81002.htm>.
3. “Pocket Sized Forward Entry Device (PFED).” Defense Update 2005: Issue 1 <www.defense-update.com/products/p/pfed.htm>.
4. Lilie, Cheryl. “Personal Assistants Aid Security.” Signal. Feb. 2004. <www.afcea.org/signal/articles/anmviewer.asp?a=10>.
5. “Land Warrior System.” Defense Update. <www.defense-update.com/features/du-4-04/land-warrior-2.htm>.
6. “Survival of the Fittest,” Jane’s Defense Weekly 21 May 2003: 25-28.
7. Rossett, Allison, and Erica Mohr. “Performance Support Tools. The U.S. Coast Guard Uses PSTs ...” Business and Management Practices, 58.2 (Feb. 2004): 34.
8. “Marines to Receive Rugged PDAs.” Defense Daily International 4.9 (12 Mar. 2004):1.
9. Redmon, P. “Total Cost of Ownership Is Down for Business PDAs.” Gartner Research Note COM-22-1757 21 Apr. 2004.
10. Troni, Federica, and Roberta Cozza. “Personal Digital Assistants: Overview.” Gartner Technology Overview DPRO-90774. 29 Mar. 2004.
11. Bloch, Marcus. “Convergence: Fusion or Fantasy?” Gartner Report Jan. 2002.
12. Vijayan, Jaikumar. “User Interfaces.” Computerworld 38.32 (Aug. 2004): 28.
13. Gartner Group. “3Q04 Smartphone Shipments Overtake PDAs.” Gartner Dataquest Alert 22 Dec. 2004.
14. Jones, N. “Choosing a Pocket Programming Language,” Gartner Research Note DF-16-1282 11 June 2002.
15. Kellogg Jr., Joseph K., and Mark Powell. “Protecting America With

Information Technology.” Signal June 2003. <www.afcea.org/signal/articles/anmviewer.asp?a=207>.

16. Lilie, Cheryl. “Land Mine Detector Makes Waves.” Signal July 2004. <www.afcea.org/signal/articles/anmviewer.asp?a=222>.
17. Baum, C., et al. “Predicts 2005: Government Ramps Up IT.” Gartner Commentary 1 Nov. 2004.

Notes

1. See <www.onjava.com/pub/-a/onjava/2001/03/15/java_palm.html>, for example.
2. The Plucker software home page (which contains programs, instructions, samples, and source code) is <www.plkr.org/index.plkr>.
3. AvantGo, a commercial software product that is often bundled with other PDA-provided software, is available at <www.avantgo.com>.
4. PalmReader software is available at <www.palmdigitalmedia.com/-product/reader/browse/free>.
5. Adobe Acrobat software for the PDA is available at <www.adobe.com>.

About the Author



Col. Kenneth L. Alford, Ph.D., is a professor at the Industrial College of the Armed Forces at the National Defense University in Washington, D.C. He has served 26 years in the U.S. Army as a personnel, automation, and acquisition officer in a wide variety of duty assignments, including his previous position as an associate professor in the Department of Electrical Engineering and Computer Science at the United States Military Academy, West Point, N.Y. He has a doctorate in computer science from George Mason University, master’s degrees from the University of Illinois at Urbana-Champaign and the University of Southern California, and a bachelor’s degree from Brigham Young University.

National Defense University
408 4th AVE
Fort Lesley J McNair
Washington, DC 20319
Phone: (202) 685-4325
Fax: (202) 685-4175
DSN: 325-4325
E-mail: alfordk@ndu.edu