

Wireless SAS® Applications for the iPAQ™ using SAS/IntrNet®

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Abstract

Personal digital assistants (PDAs) and SAS software can provide mobile, real-time data access. It is no longer acceptable for analysis and delivery to be completed in days or weeks but rather, seconds. Just as cell phones transformed telecommunications, wireless PDAs will revolutionize data access. Integrating SAS with wireless devices can yield remote, powerful, data entry, retrieval, and analysis. We discuss a method for creating wireless iPAQ applications using SAS/IntrNet software components and the considerations encountered when moving traditional SAS applications into PDAs.

Introduction

Expectations on what technology can and should do for users are constantly rising. In the recent past, research consisted of libraries, card catalogues and manual searches. Today's Internet search engines process billions of Web pages and deliver results within a fraction of a second. SAS software solutions must collect and deliver faster, more accurate, and now mobile information. Wireless technology can extend the power of SAS onto PDAs. We investigated an architecture to harness it through experimentation and analysis.

Wireless data technologies have the potential of adding enormous capabilities to its users, but only if the technologies are properly used. There are significant limitations in current wireless technologies that if not addressed during design planning, may lessen the advantages over wired methods.

Our methodology uses readily available software and hardware components. Our SAS applications are developed and run using the Application Dispatcher component of SAS/IntrNet software. We discuss the system architecture for wireless SAS analysis and application development strategies.

Wireless and iPAQ Overview

There is a large spectrum of wireless technologies to choose from, each with its own strengths and weaknesses. We used the most prominent wireless LAN protocol, IEEE® 802.11b, due to its robustness in operating with existing wired ethernet systems, its range of features, and its cost. It is currently the standard for wireless ethernet networking. The IEEE 802.11b, which is commonly referred to as wireless ethernet or WiFi, operates in the unlicensed 2.4ghz frequency spectrum. A single wireless hub, or access point, can offer 11Mbps shared bandwidth with users. It has a range of 100m, but can be limited by walls and building materials. Limitations are its low bandwidth, vulnerable hardware security layers, and possible interference from cordless phones and electronics.

Currently, the Compaq® iPAQ handheld is one of the newest handheld devices running the Microsoft® Pocket PC operating system. Although the iPAQ uses a Windows® branded platform, the device cannot use software and drivers from other Windows platforms. It offers Pocket PC versions of many Microsoft Office suite products including Internet Explorer (IE).

In addition, the iPAQ has hardware expansion sleeves for CompactFlash™ (CF) and PCMCIA (PC) cards. PC cards have been an industry standard for laptop computers for several years. CF is a newer standard which is much smaller and usually consumes less power. Many CF cards are currently on the market, including ones for wireless and wired networking. A cradle is included with the iPAQ for PC connectivity and synchronization. Included with the iPAQ is a cradle for PC connectivity and synchronization. We chose the iPAQ due to its flexibility, power, and emergence as a corporate standard.

Handheld Connectivity

Although the iPAQ is one of the most powerful PDAs currently on the market, it is not powerful enough to run significant computations independently. In our model, SAS program requests are sent to the server by the iPAQ through the Internet and the Application Dispatcher. The server then processes the request and sends results back to the iPAQ. With a seamless design, users have the power of a load-balanced server in a handheld. There are significant tradeoffs between cost, features, mobility, and development complexity as one determines how to connect a handheld to the server. Rather than creating specific applications, we investigated probable connectivity scenarios of the iPAQ and SAS.

Connected versus Disconnected

An important design criterion is whether real-time connectivity is required. Some definitions of "wireless" connectivity mandate real-time processing. System architecture is greatly simplified if the iPAQ is always connected, but in this model, the hardware and infrastructure cost may be high. A disconnected, but synchronized model is more complex from a software design standpoint, but has virtually unlimited mobility. The framework we discuss allows for both connected and disconnected systems. Transition between the two is possible using connection management software, such as AvantGo®.

AvantGo

AvantGo coordinates data transfer between the iPAQ and the server in both connected and disconnected modes. AvantGo is available as an add-on to Pocket IE and as a separate client. AvantGo channels are synchronized when the iPAQ is connected. Applications developed with AvantGo can be seamlessly portable over all the connection scenarios. An alternative to AvantGo is Mobile Favorites, a feature included with Pocket IE. It allows users to designate Websites to be automatically stored on the iPAQ for offline viewing. However, it cannot store data entered by the user and content is managed on an individual PC.

Wireless Phone

A cell phone with data services can give an iPAQ the capability of dialing in to Internet service providers, which then could route data through the Internet to internal servers. Without a layer of security, external parties can intercept data. Current US wireless services do not offer data capabilities past 14.4kbps.

Most implementations require computers to interface the cell phone as a modem with the modem interface emulated by the service carrier. Most carrier plans have per minute service charges and many have additional costs for wireless data access. Although slow and expensive, the wireless infrastructure is established and would offer the largest geographic service range.

Wireless Networking

Wireless networking would be ideal from the user's standpoint, but has challenges in implementation. In this method, the iPAQ connects to an access point and data is routed to the server. Physical range is limited to the amount of access points installed and they must be installed into a wired network anywhere that wireless access is required. As more access points are installed, security and data integrity issues must be addressed to maintain a viable system. The available bandwidth per user is usually less than that of desktops making high-bandwidth applications, such as streaming video, less feasible. In addition, there are no industry standards for load balancing with multiple access points in the same service range. If the support infrastructure exists for wireless networking, SAS requests for reports can be dynamically submitted and generated yielding fast, mobile results.

Wired Networking

If room-to-room mobility is all that is necessary, wired networking may be a good option. Wired networking on the iPAQ uses the same infrastructure and components as existing ethernet systems. All that is necessary is a CF or PC networking card, the appropriate expansion jacket, and an available wired network jack. Once connected, the iPAQ will have access to most network resources that a PC would. Current networking cards offer 10/100Mbps bandwidth and many office environments have network jacks readily available.

Cradled Operation

In the majority of cases, disconnected syncing in the cradle is the only viable solution due to the requirements of the other methods. Without connection management software, the SAS functionality of the iPAQ will only be available when tethered to a PC. Once connected, the iPAQ uses the PC as a proxy server to access network resources. Microsoft ActiveSync® software handles syncing between the two and many third party vendors have used it in product synchronization development.

Methodology

Our objective was to find a flexible architecture that would allow SAS data analysis capabilities to be used wirelessly on the iPAQ. We developed the architecture in a test SAS/IntrNet environment for the iPAQ. The hardware and software components used are listed in Table 1.

Cradled Operation

It took less than two hours to take the iPAQ out of the box, install the software and run Application Dispatcher applications using the cradle. Demos from the SAS Website showed data entry, reporting, and analysis. With SAS/IntrNet previously installed, we only needed to start the server, run IE on the iPAQ, and type in the address of the server.

Despite a fast startup on the test environment, we quickly encountered drawbacks of cradled operation. The small screen

and the fact that the IE on the iPAQ is taller than it is wide (portrait) made running many existing applications difficult.

Table 1

Hardware	MSRP
iPAQ Model 3670	\$650
iPAQ Model 3850	\$650
iPAQ Cradle (included with iPAQ)	N/A
iPAQ CF Expansion Pack	\$100
Socket® Low Power Ethernet Card™	\$100
Universal AutoSync Cable	\$25
Compaq Wireless PC WL110 card	\$100
Samsung® SCH-8500 wireless phone (Sprint® PCS service carrier)	Variable
Wireless web connection kit	Variable
Wireless web connection kit	\$60
Software	
SAS Software Release 8.2	Licensed
SAS/IntrNet	Licensed
Apache Web Server	Open Source

Costs are estimated

Users must be careful when entering data into the iPAQ while cradled since the vertical design is not always stable with input pressure. This situation can be remedied by using an AutoSync cable. This allows users to lay the iPAQ flat on a desk and still connect the device to the PC without the cradle. For the most part, running SAS in the cradle posed few challenges.

Wireless Phone

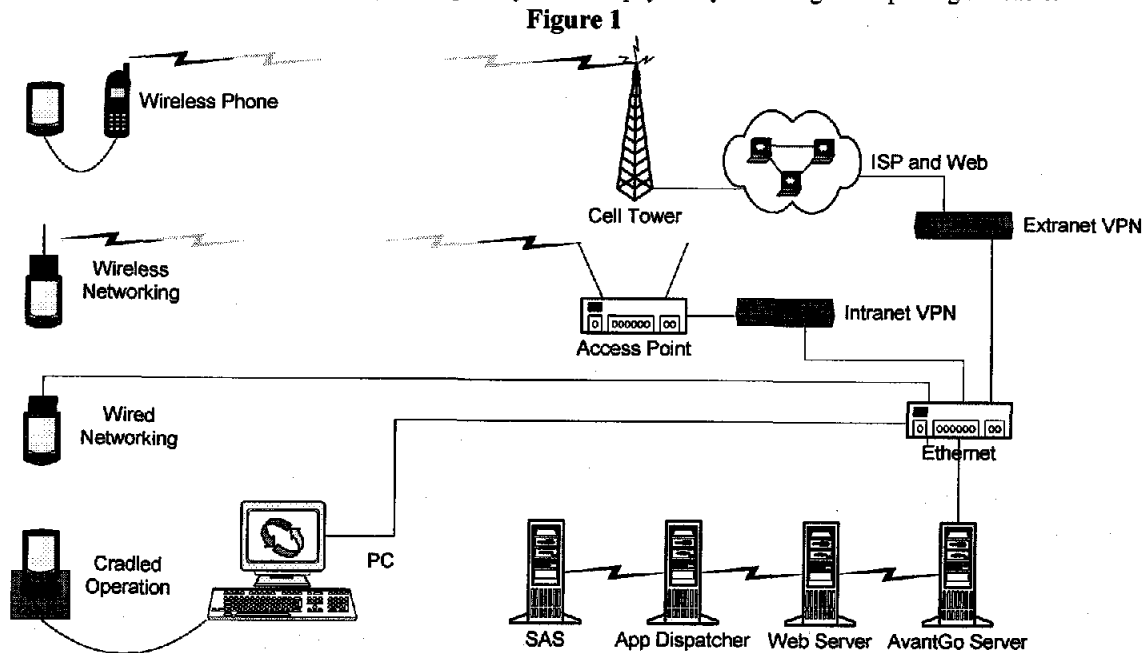
A wireless phone with data services has the capability to run Application Dispatcher applications, however, there is little information available about using a cell phone with a PDA. Most cell phones have different requirements for data connectivity. In addition, specific software for the iPAQ is usually necessary and few support options are available. After several hours of investigation, we were able to configure the cell phone as a data modem. Once set up, the iPAQ dialed and connected to an ISP and after authentication, the iPAQ had Internet connectivity. Despite the slow connection (14.4kbps), we could run Application Dispatcher applications. In this wireless test, we were not in sync mode, but rather always connected.

Cell phone modem emulation offers only a limited Hayes compatible command set and as a result, unusual dialing schemes are difficult at best. Pauses, secondary dial tones, or other special dialing options may not be supported with all phones and carriers. Although newer "air modem" expansion cards will give much better cellular phone integration in PDAs, cell phones with wireless data connectivity are much more abundant.

Wired Networking

With the networking equipment setup, it was a relatively simple matter to plug the cable into a spare port in the hub and log in. Both synced and non-synced wired networking with IE worked well and the performance was the best of all of the configurations. We feel that this is a good configuration for Application Dispatcher application development. It simulates wireless networking without the initial cost and security considerations of running wireless networking to an access point. With the exception of wireless security issues, it is possible to simulate much of the wireless platform.

For example, developers can simulate wireless signal dropout by physically removing and replacing the cable.



Architecture

Figure 1 shows the four connection schemes discussed and the system architecture used for delivering SAS analysis on the iPAQ. Each method is interchangeable and independent, however, implementing each has different requirements. Virtual Private Networking (VPN) systems, deployed in many corporations, are used for both wireless phone and wireless networking systems for an additional layer of security. These can consist of encryption, firewalls, authentication, and other security systems.

The software framework we used is a multi-tiered system. Each level is a separate component; however, the aggregate can deliver SAS data analysis wirelessly. In the following diagram, the user and the separate software components are listed with descriptions of all data transactions (Figure 2). The data flow, initiated by the user and completed when information is delivered, is described and proceeds in accordance with the arrows.

Application Development

Wireless applications for the iPAQ require developers to be efficient both in design and development. All handhelds are limited in display space, battery life, and processing power. These are some of the many considerations which need to be addressed when designing applications for the iPAQ.

SAS/IntrNet

As a member of the SAS product family, SAS/IntrNet includes Application Dispatcher and easily integrates with base SAS. Development with SAS/IntrNet software is flexible, but requires some knowledge of SAS and Web application development. Since wireless iPAQ applications run Application Dispatcher software just like PCs and browsers, the same infrastructure and support system can be used when extending its capabilities.

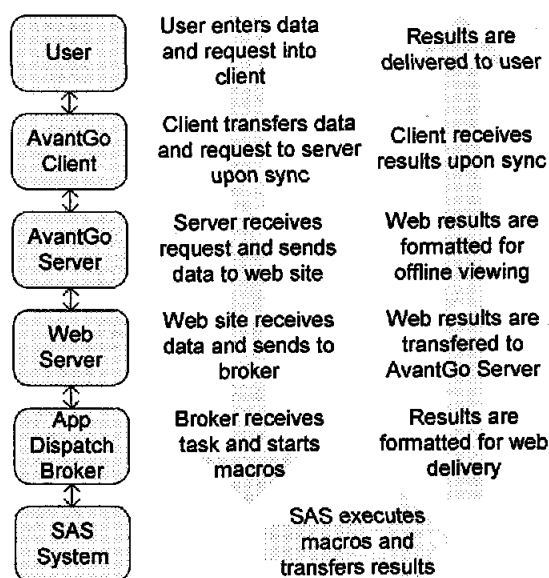
AvantGo

AvantGo is a system that incorporates many different elements of Web connectivity. An important aspect for Web

developers is that the Web applications are not directly visited by the actual users, but instead by the AvantGo server. Web sites, set up as AvantGo Channels, are visited and cached by the AvantGo server. AvantGo will visit sites each time a user synchronizes with a PC unless otherwise configured. Other Channel settings include setting link depths, which are the depth of links that AvantGo will visit and save.

AvantGo applications are developed very similarly to traditional Web applications. Internet cookies allow for the user customization of content and are stored on the AvantGo server. To customize a channel, Web applications read the user's cookie, and displays different content or links depending on the cookie data.

Figure 2



If a user has entered data into HTML forms while disconnected, AvantGo saves the data for later synchronization. A feature and consideration with AvantGo development is that the clients employ a different set of JavaScript functions than PC browsers. Some functions available for PCs, will not work on AvantGo. Likewise, the AvantGo JavaScript engine has functions that can assist with user interfaces and development, but do not operate on PC browsers. Developers can use the HTTP User Agent variable to determine the type of user that is actually visiting the Web page. Using the variable and cookies, developers can create content that is tailored to the specific device and user. Once all transactions are completed, the results are then archived and stored for offline viewing with the iPAQ AvantGo client.

AppDev Studio™

SAS AppDev Studio (ADS) is a suite of tools that allow developers to seamlessly integrate SAS with other technologies. Included in ADS is a single user version of SAS/IntrNet which includes Application Dispatcher. On a stand-alone PC, a developer can experiment with SAS/IntrNet software with a development environment that exploits many of the newer Web technologies. With the current release of ADS 2.X, there are no tools specifically for the iPAQ. However, with Web browsing and Java application support on the iPAQ, wireless SAS applications are more of a matter of software design and capabilities, rather than limitations of the software development environment.

User Interface

Once an iPAQ has access to servers, it will need specialized Web applications to deliver SAS content. One of the largest challenges in developing applications for PDAs is the physical viewing size of the user interface. With a limited amount of space, applications must be carefully tailored to the device. Graphics and animation, though flashy, can become bottlenecks with limited bandwidth. In addition, keyboards usually are not present on PDAs so all data entry must be conducted with a stylus. From a usability perspective, traditional applications on PCs ported directly over may not perform well on PDAs.

Future Directions

Today's PDAs may be quickly eclipsed by tomorrow's technologies. Like any new technology, end user expectations and needs will drive development of more sophisticated solutions. Depending upon the requirements and objectives, other methods may be more ideal for wireless SAS applications. Several other growing and emerging technologies can offer SAS solutions.

XML

Touted by some as the next ASCII, Extensible Markup Language (XML) may offer more flexible system integration. A full discussion of XML development is beyond the scope of this paper. Structured similarly to HTML, XML consists of a tagged format. Unlike HTML, XML does not necessarily carry formatting information, only data. The separation of data and delivery allows for common interfaces, and better data integrity. The use of stylesheets and schemas allows the same XML data to be displayed on different devices. XML with formatting can be processed either at the server level or the device level. Although computationally intensive, the iPAQ's IE browser is able to process XML documents. Wireless Application Protocol (WAP), which is structurally similar to XML, is not as cross-platform compatible due to a lack of a single standard for cell phones, the largest users. Perhaps more importantly, XML is becoming an industry standard for not only wireless, but classic Web applications as well. There are a number of SAS products, including base SAS that have XML capabilities. This is definitely an area to further explore.

Devices

Currently, manufacturers are developing many devices and expansions to blur the lines of cell phones and PDAs. Hybrid devices, offering easy phone usage with PDA functionality are already on the market. Manufacturers are also developing "air modem" plug-in cards and services for PDAs that eliminate the need for using the separate cell phone. It is expected by year-end 2002, there will be additional iPAQ connection options that will make connecting to a cell phone more than likely obsolete. The drawback is that one would have to purchase device specific hardware and pay a monthly wireless access fee.

Many vendors are developing tablet PCs and demonstrating them at technology tradeshow. These PCs are the size of a small laptop, sometimes containing many of the same components, but with a large stylus input screen. These devices have emerged in response to a growing demand for PDA simplicity with laptop processing power. Several manufacturers are developing thin-client versions where the majority of processing is conducted on a separate PC. Both the tablet and the PC would be connected to operate wirelessly in tandem thereby offering superior processing power with the dimensions of a clipboard.

Wireless Technologies

IEEE 802.11a may become an emerging technology for wireless networking, however, it is not in mainstream use due to its cost and complexity. It offers much faster access, 54Mbps, and better security methods. In many situations, 802.11b offers all the capabilities necessary, which would not warrant the use of 802.11a. Although similar, the technologies are incompatible. As markets for both technologies develop and differentiate, more support and working knowledge of 802.11a will become available.

Wireless Wide Area Networks (WWANs) may offer wider capabilities in the future. Already a widely used technology in Japan, WWANs offer networking capabilities through the cellular phone infrastructure. The success of these systems in Japan is due largely to the consumer market and the cellular providers, which are vastly different than the US. Current WWAN systems do not offer any direct Internet capabilities and applications would need to be designed specifically per system. US cellular carriers are planning on deploying more WWAN services, however, it will be some time before a cross-carrier and cross-platform system is implemented.

Native Device Development

In some instances, Web-derived technologies will not offer the capabilities necessary for specific wireless SAS applications. Most device manufacturers offer software development kits to create applications, which run directly on the device. Included with many are device emulators for PCs that allow developers to test applications without the device. Development, training, and support costs are usually high due to the highly specialized nature of these applications.

Summary

The general consensus in the computer industry is that wireless technologies and PDAs will change the way we use computers. Technology and consumer demand will dictate the degree and the speed of change. With the technologies available today, many applications, never imagined before, are only a development cycle away.

The term "wireless" can be an ambiguous term for SAS/IntrNet software applications. From an application design standpoint, developers must first determine whether the system must be always connected, sometimes connected by synchronization, or a combination. Each scenario has its advantages and disadvantages.

When always connected, applications are the simplest to develop and can parallel most traditional Web applications. However, applications designed for only that connection are least flexible when embracing different scenarios. The disconnected and synchronized scenario is the most flexible since it can operate with constant connections, but has a more complex architecture. The major challenge to wireless SAS applications is the determination of those requirements and compromises with technology limitations. This architecture allows for the greatest flexibility across the different scenarios discussed.

As wireless products are still an emerging technology, design and development are very important when developing wireless SAS applications for the iPAQ. Rather than solve a specific business problem, we used an approach that tested common scenarios, which could later be applied to specific solutions. It is very important to consider the following:

- "Wireless" is loosely defined and requirements should specifically detail expectations.
- Synchronization software, although adding greatly to complexity, can extend a framework to disconnected connections.
- An iPAQ running a browser has little need for WAP since XML may be the future technology of choice to transfer and receive data.

- Many SAS tools exist which can aid wireless applications development.
- User interfaces for PDAs are a major challenge and must be addressed.
- There are major security considerations especially when deploying in a wireless environment.
- Although the iPAQ and wireless technologies have room for refinement, they have many applicable business solutions.
- Technology will continue to shape the future of what is possible.

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