

Wireless Data Entry Device for Forward Observers

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ABSTRACT

The Army is developing a replacement for the Handheld Terminal Unit (HTU) as a dismounted Forward Entry Device (FED). The FED allows forward observers (FOs) to submit digital calls for indirect fire support. This project explored the use of open-systems, platform-independent software on commercial off-the-shelf Personal Digital Assistants (PDAs) for this purpose. This paper describes the PDA FED architecture developed as part of this research.

INTRODUCTION

Project Manager Field Artillery Tactical Data Systems (PM FATDS), now PM Intelligence and Effects (PM IE), developed the Handheld Terminal Unit (HTU) as a Forward Entry Device (FED). The HTU (the only implemented FED) allowed dismounted forward observers (FOs) to create and submit digital calls for indirect fire support (e.g., mortars, artillery, bombs from aircraft, etc.). Feedback from Army and Marine Corps units, however, indicated that users found the HTU bulky, heavy, and difficult to use. In response, PM IE contracted the Information Technology and Operations Center (ITOC) and the United States Military Academy to conduct a market survey of available commercial off-the-shelf (COTS) solutions. At the time of the survey (1999-2000) no suitable COTS hardware existed; however, the ITOC recommended that the PM develop open-systems, platform-independent FED software so that when PDA technology provided a viable COTS hardware solution, the software would be ready. The purpose of this project, a continuation of previously reported work [1], was to demonstrate the feasibility of such a platform-independent PDA FED. The eventual goal of this development effort is to make the user interface on the PDA merely a backup system to be used only when the future voice recognitions systems fail.

The proof-of-concept PDA FED developed as part of this research involves a client interface running on a ruggedized PalmOS PDA. The client software is written in a platform-independent, constrained version of Java designed to run on small devices. A Bridge, also written in Java, connects to Army radios via a serial port and to the client via IEEE 802.11b wireless LAN technology. Messaging between the Bridge and the Advanced Field Artillery Tactical Data System (AFATDS) emulator is accomplished using XML messages, another open-system, platform-independent technology. A partially functional proof-of-concept was

successfully completed, demonstrating the efficacy of this platform-independent approach for Army tactical systems.

DESIGN AND IMPLEMENTATION

There were two major design goals as part of this project. The first was to maintain platform independence. The second was to build a user interface that was simple and intuitive. Platform independence is desirable, because it decouples the hardware from the software. It ensures that the Army can purchase the latest hardware without having to rebuild the existing software. This will greatly decrease acquisition time and cost in the future. It also makes it possible for a unit with heterogeneous hardware to use the same software on a variety of different platforms. To accomplish platform independence, a variety of cross platform software tools were used:

- The user interface was written in Java 2 Micro Edition (J2ME) Connected Limited Device Configuration (CLDC) Mobile Information Device Profile (MIDP) [2]. The technology allows code written for J2ME CLDC MIDP to run on a variety of platforms, including cellular phones, two-way pagers, and PalmOS personal digital assistants (PDAs).
- The message system used the Hypertext Transfer Protocol (HTTP). This made the system connectionless, causing some design challenges, but it also ensured that a variety of servlet and CGI technologies could be used at the Bridge module (described below).

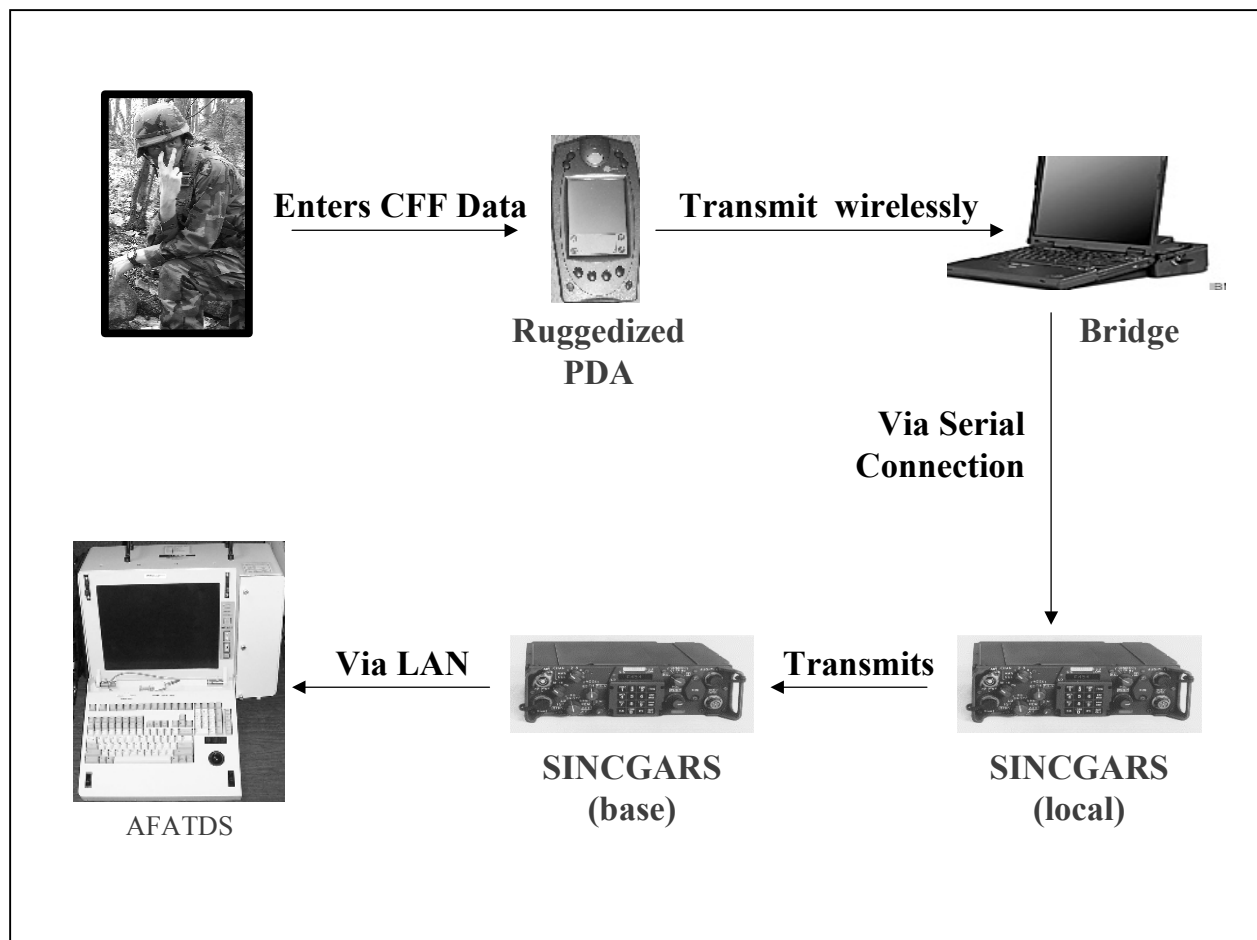


Figure 1: Proof-of-concept architecture.

In this case, Java servlets were used.

- The Java server (on the Bridge) was the Jakarta Tomcat server [3]. Tomcat runs on a variety of platforms and provides a stable platform for serving up Java servlets.
- XML messages formed the messaging protocol. The design of the XML messaging scheme, completing the proof-of-concept architecture, is a separate research project.

The second goal, an intuitive interface, was made very difficult by the choice of J2ME CLDC MIDP as the programming environment on the PDA. Because MIDP must cater to the “lowest common denominator” hardware, it does not provide a rich set of GUI widgets or layout options [4]. This imposed a constraint on interface design that was not easily overcome.

The overall architecture of the PDA FED is shown in Figure 1. The Field Artillery (FA) Forward Observer (FO) will input data into a ruggedized PDA. When the FO hits the send button, the call for fire is submitted to the Bridge via an HTTP Get message sent to the Tomcat Java server. The Java servlet is launched to answer the query, and it reads the message sent in the Get message. This message is in a proprietary format that consists of the various data fields concatenated together. Communication between the PDA and the Bridge is done, in this prototype system, using IEEE 802.11b peer-to-peer, wireless networking.

For this proof-of-concept system, Bluetooth [5] was also considered as a candidate wireless technology. When this project began, however, Bluetooth was still developmental and full support for Bluetooth in J2ME CLDC MIDP was not available. Since this time, Bluetooth standards and products have progressed significantly and may be the correct technology for this application in a fielded system.

The servlet launched by the Tomcat server on the Bridge to process the HTTP Get message parses the incoming message and reformats it as an XML message to send to the Single Channel Ground Air Radio System (SINCGARS) radio [6]. A call for fire XML schema was developed for the XML messages. In addition to transforming the message, the Bridge servlet also logs the message for future recall. In future versions of the prototype system, coordinate conversions will also occur during this transformation; all methods of call for fire (e.g., grid, shift from a known point, polar, laser polar, etc. [7]) will be converted into a simple grid fire mission at the Bridge. The Bridge hardware consists of a laptop computer, which was not ruggedized, but would need to be for a fielded system. The Bridge then sends the XML version of the call for fire to the SINCGARS radio via the serial interface on the laptop.

The SINCGARS passes the message to a second SINCGARS radio. In a fielded system, this second SINCGARS radio would connect into a tactical Army communications system, possibly a LAN within a brigade tactical operations center (TOC). Within the TOC, the message would eventually be delivered to an Advanced Field Artillery Tactical Data System (AFATDS) computer. The real AFATDS does not yet understand the XML messages prepared by the prototype PDA FED, so an AFATDS emulator that could receive, process, and understand the XML versions of the messages was built. For purposes of this prototype, the AFATDS emulator, which was written in Java and could run on any computer with a serial connection, only needed to perform three actions:

- Format and display the XML messages in a human readable form,
- Allow the user to accept or deny calls for fire and send the appropriate response back to the PDA FED, and
- Allow the user to send text messages to the PDA FED.

The purpose of the AFATDS emulator was merely to test that the PDA FED and the Bridge were functioning properly. No AFATDS functionality was required or implemented.

RESULTS

The project prototype has been completed as a proof-of-concept. Handspring Visors were used as the data entry device during development; however, it was also tested on a Symbol SPT 1734 ruggedized PalmOS device with built-in IEEE 802.11b NIC. A notebook computer was used as the Bridge machine, linking the PDA via IEEE 802.11b wireless NICs, to the SINCGARS radios. The AFATDS emulator runs on a desktop personal computer connected to a SINCGARS radio, which enables it to receive communications from the Bridge.

The prototype system uses all open system, cross platform software technologies. The response time from the user interface is acceptable; although, the interface itself needs to be enhanced to make it more usable. Despite the seemingly complex architecture (driven by the open system, cross platform requirement) the system proved to be robust and error free. Message passing and conversion to and from XML works well. This system also demonstrates the use of XML as a messaging protocol in a proof-of-concept system. This project showed that open system, platform-independent software technologies can be used in Army tactical systems.

FUTURE WORK

As mentioned previously, the user interface for the PDA FED prototype needs to be made more user friendly. Without resorting to low-level graphics, which would hurt the platform independence of the software, it is very difficult to create more sophisticated GUIs in J2ME CLDC MIDP. The PDA Profile (PDAP) is in Java Community Process review, and it is due to be released in the summer of 2003 [8]. The PDA profile promises to support more GUI widgets, and programs written in J2ME CLDC PDAP promise to run on PalmOS, RIM Blackberry, and PocketPC. This will provide a truly platform-independent PDA programming language.

Envisioned as part of the conversion from the PDA-Bridge messages to XML messages is the conversion of all fire missions to grid missions. In addition, all coordinates will be converted into a single type, probably geocentric coordinates using the WGS84 datum. Military maps use the Military Grid Reference System (MGRS). Some command and control systems use MGRS, and some use LatLong. The XML schema allows the specification of default values. By specifying the default as WGS84 and converting to WGS84 whenever possible, the creation, transmission, and processing of these messages will be made easier.

A few issues remain with regard to the passing information through the SINCGARS radio. The Bridge sends data packets in an asynchronous manner to the SINCGARS radio, yet the SINCGARS expects data in synchronous fashion. The means of converting asynchronous data into synchronous data is the placement of a Tactical Communications Interface Module (TCIM) between the computer and the SINCGARS radio. A TCIM is also needed between the SINCGARS radio and the LAN on which the AFATDS emulator operates.

The use of wireless communications, particularly those that make use of commercial protocols, raises a number of security concerns. Research is ongoing on the detection and interception ranges of the signals emitted by this system, and alternative technologies are being explored. In addition, there are physical security issues raised by the likely, eventual capture of data entry devices deployed so close to the enemy. A number of biometric and software technologies are being explored to ensure that an enemy cannot use captured devices to disrupt friendly command and control.

The eventual goal of this development effort is to make the user interface on the PDA merely a backup system. The vision is for the user to speak the call for fire information into a microphone and have this information understood by a speech recognition system that fills in the appropriate blocks on the call for fire request. The FOs current location would be provided

automatically by a Global Positioning System radio [9]. The FO could then “paint” a target with a laser. Knowing the FOs location and the direction and distance to the target, a very accurate, very fast call for fire can be created. With the PDA, GPS, speech recognition system, and laser designator all wirelessly networked, the PDA could remain in the FOs breast pocket unless one of the other input systems fails.

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BIOS

Lieutenant Colonel John R. “Buck” Surdu was commissioned a lieutenant of Infantry in 1985 and is now serving as an Army Acquisition Corps automator. His infantry assignments include 82d Airborne Division; 3d Battalion, 325th Infantry (Airborne), Vicenza, Italy; 2d Battalion, 11th Infantry, Ft. Benning, GA; 1st Battalion, 507th Infantry (Airborne); 1st Brigade, 2d Infantry Division, Republic of Korea; Army Research Laboratory; and Department of Electrical Engineering and Computer Science, United States Military Academy, West Point, New York. He earned his B.S. in Computer Science from West Point in 1985, M.B.A. from Columbus State University in 1990, M.S. in Computer Science from Florida State University in 1995, and Ph.D. in Computer Science from Texas A&M University in 2000. His research interests involve the use of simulations and artificial intelligence in decision support.

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