Wireless Data Entry Device for Forward Observers

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The U.S. Army is developing a replacement for the Handheld Terminal Unit to allow forward observers to submit digital calls for indirect fire support. This project explored using open-systems platform-independent software on commercial off-the-shelf personal digital assistants (PDAs) for this purpose. This article describes the PDA software architecture developed as part of this research.

The purpose of this project was to develop a proof-of-concept Handheld Terminal Unit (HTU) to allow dismounted forward observers (FOs) to create and submit digital calls for indirect fire support (e.g., mortars, artillery, bombs from aircraft, etc.). Feedback from U.S. Army and Marine Corps units, however, indicated that users found the HTU bulky, heavy, and difficult to use. In response, the project manager (PM), Intelligence and Effects contracted the Information Technology and Operations Center (ITOC) and the U. S. Military Academy to conduct a market survey of available commercial off-the-shelf (COTS) solutions to these complaints.

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 software so that when personal digital assistant (PDA) technology provided a viable COTS hardware solution, the software would be ready. The purpose
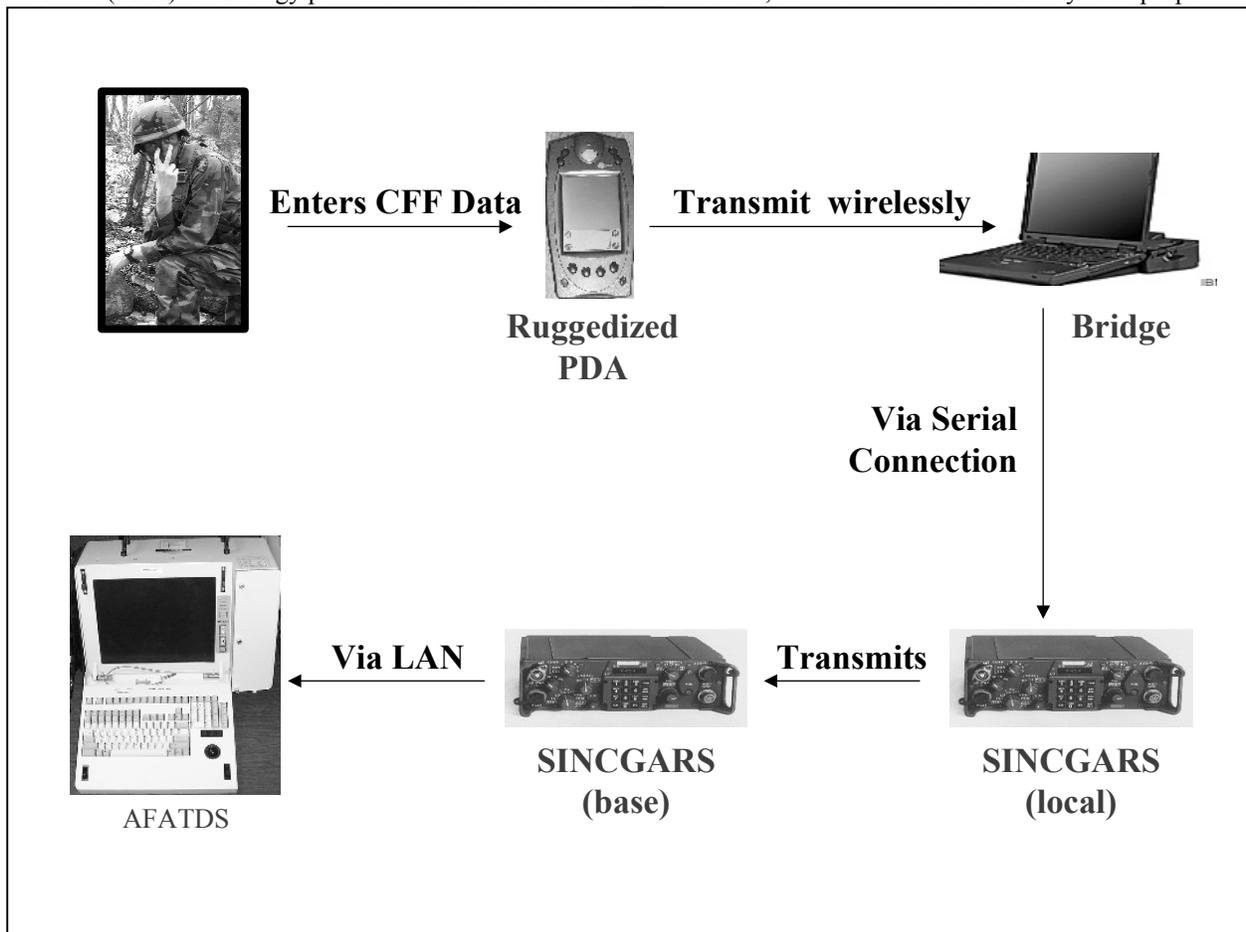

Figure 1: *Proof-of-Concept Architecture*

- 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). 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 PDA programming environment. Because MIDP must cater to the *lowest common denominator* hardware, it does not provide a rich set of graphical user interface (GUI) widgets or layout options [4]. This imposed a constraint on interface design that was not easily overcome.

The overall architecture of the PDA system is shown in Figure 1. The Field Artillery 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 then sends the XML version of the call for fire to the SINCGARS radio via the serial interface on the laptop. The Bridge hardware consists of a laptop computer, which was not ruggedized, but would need to be for a fielded system.

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 AFATDS computer. The real AFATDS does not yet understand the XML messages prepared by the prototype PDA system, 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.
- Allow the user to send text messages to the PDA.

The purpose of the AFATDS emulator was merely to test that the PDA software 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 could be used in Army tactical systems.

Future Work

As mentioned previously, the user interface for the PDA 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 promises to run on PalmOS, RIM Blackberry, and PocketPC. This will provide a truly platform-independent PDA programming language.

The conversion of all fire missions to grid missions is envisioned as part of the conversion from the PDA Bridge messages to XML messages. 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 regarding 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. To convert asynchronous data into synchronous data a Tactical Communications Interface Module (TCIM) is placed 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.

Using 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 then this information is 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 GPS 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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