

BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Joined United Services Group in 1996. I am currently the Leader of software Development for United Services Group. I have eight years experience in the electric utility industry serving as developer, project manager, and software engineer. During this time I have had the opportunity to consult with numerous companies including Great River Energy (Minnesota's second largest electric utility based on generating capacity) and many of its 28 cooperative members along with cooperatives and municipal utilities in neighboring states. I have directed the software product development and consulting in the areas of asset management and field data collection for the past four years.

Past Experience

From 1991 to 1996 I worked as a Range Specialist for a state military installation located in Minnesota. I was responsible for the programming of automated firing ranges. This consisted of developing firing plans, alternatives and consulting with end users to ensure realistic combat scenarios for small arms and tank firing.

Educational Information

AAS – Central Lakes College
AA – North Hennepin Community College
Law for Legal Specialist Certification

Professional Memberships

User Affiliate Membership amfm international/GITA since 1997
Institute of Electrical and Electronics Engineers (IEEE)

GOING MOBILE: AN ELECTRIC UTILITY SOFTWARE DEVELOPER'S PERSPECTIVE

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ABSTRACT

In today's economy companies aiming to increase productivity while reducing costs may need to consider new data-gathering and business processes, just to stay competitive. Mobile computing is becoming more prevalent in the normal day-to-day tasks of the average workforce employee but, is it being utilized to its fullest extent? With new software and mobile device vendors emerging at a seemingly exponential rate, are you prepared to make a knowledgeable selection or just an impulse buy based on today's trade magazine highlights? Will leveraging your existing tools and software accomplish the same goals without the business risk? This paper will express the presenter's opinion based on experiences gained during the development, testing and usage of several mobile applications for the electric utility industry and answer the above questions. The presenter will highlight the selection of devices based on industry standards, software choices and customized solutions for mobile data entry. Comparisons between non-ruggedized and ruggedized units will be evaluated and conclusions based on return on investment will be discussed. Considerable time will be spent discussing problems encountered with and work around solutions for mobile data collection in an outdoor environment along with implemented process changes for efficiency.

INTRODUCTION

The mobile device industry is on an ever-growing pace. With greater technology comes more and more companies adding their devices and solutions to help the rest of the world get more advanced. In a study by International Data Corporation (IDC), Personal Digital Assistant(PDA) sales will go from 9.4 million to a predicted 13.7 here in 2004. In the same study, notebook computers will go from 26 million to 49 million, handheld PCs from 1 million to 1.8 million and Smart Phones will make a staggering 172.6% increase by going from .5 million to 27.6 million. They predict the overall, mobile/wireless device, increase to be 25.6% or from 39 million to an estimated 97 million.

BUSINESS CASE

With the talk of deregulation looming over their heads, electric utilities have started looking into the implementation of mobile devices and solutions to try to get a competitive edge over their would be competitors. One problem is that there are so many different solutions available, choosing one can become a very difficult task.

Before any decisions are made on which mobile solution to go with, some research has to be done to gather information on what is needed to perform a job correctly. You must also have communication with the end users. They are the ones who do the job on a

regular basis and can be a great source of information about not only what could help process improvement but also environmental factors. After you gather the information on who is using it and where it is being used, you can then start to look at basic functions you want it to perform as well as which functions will have the greatest impact on the business. A list of priorities made here will help in deciding which solution is best.

Like any other business decision, purchasing a mobile solution can only be completed if it can be justified. A well informed decision must be made as to how much you want to spend on a device and how much are you expecting this device to save you in time and money. In other words you need to figure out how much return you want on your investment. But you have to be careful when trying to compute the ROI. Many people underestimate the total cost of the device by not taking into account costs for software, support, development, evaluation, training, application management and implementation.

An important aspect of the overall success of your new mobile solution is end user buy-in. To help control end user buy-in, communication with the end user is a must and it needs to start early in the process to let users get comfortable with the idea as well as give them a chance to learn about the solution before they have it. Because they are going to be the ones using the devices, their input in the beginning will help in the decision of which solution to purchase. It is also a good idea to have the devices ready and tested before the end user gets to the field and find out it doesn't work the way it is supposed to. This with proper training will help the implementation of the mobile solution be successful.

MOBILE DEVICES: FORM FACTORS/ HANDHELD/ TABLET/ VOICE RECOGNITION

Mobile devices are designed with a number of styles and combinations of technology according to the form factor users require. Depending on the application, the device may need to be very durable to extreme environments and on the other hand the device may be required to process data rapidly. To adapt to the number of possible solutions there are a wide variety of mobile devices available today. Just to name a few are: PDA, hybrid-cell phone (cell phone, digital camera, email, etc.), barcode scanner and GPS (Global Positioning Systems).

Mobile devices are very useful for users that are on the move. The tablet PC combines the power of a notebook PC with the convenience of pen and paper. Handwritten notes may be taken with Windows Journal. The screen can be utilized like a palm with a digital pen. Docking the tablet allows a keyboard, mouse and monitor to be utilized in a vehicle or on a desk. You may view email on the tablet screen while writing a document on the monitor. Some tablets come as a clam shell design with a keyboard inside. Much like the PDAs, the tablet has wireless support. You can access email and network(s) once connected. Lastly, you can send ink email to anyone. The handwritten email can be received by any user.

The outlook for voice recognition (IBM Via Voice or ScanSoft Dragon NaturallySpeaking) is very good. "Speech will become the primary interface, especially in mobile computing," said Intel VP Howard Bubb. Voice recognition allows users more freedom to do things other than focus on a device. The user can dial-up to a network,

enter data into a database or execute a command all while in the confines of a car. Voice recognition has gotten a lot better and can work well in a controlled environment. The downside is using voice recognition outdoors, in a factory situation or anywhere there is lots of background noise. The extra "white noise" makes it almost impossible to use voice recognition in these conditions.

Reliability in extreme environments is a major concern. Many models are available that are capable of operating in a wide temperature range, dust, moisture, rugged handling and even electromagnetic field (EMF) interference. Specialized outdoor readable displays are a necessity.

When you think about it, the tools you use to do your work should work when you do. If you are required to perform your duties in temperatures that are of an extreme nature, you should be able to count on your equipment to work. In temperature tests we conducted we actually placed devices in a freezer overnight to test their ability to work under extremes. One of the devices was of a "ruggedized" type and another was an off the shelf model not designed for extreme environments. When we took them out of the freezer we powered them up to see what would happen. Both machines recovered from the freeze but at different rates. The ruggedized machine did come "back to life" first and was ready for use in a reasonably expected time frame. The non-ruggedized machine took almost twice as long. Of course we could not physically test every model on the market but for our needs a valuable lesson was learned with this initial temperature test. In Minnesota, we are usually more concerned about our equipment working in extreme cold conditions so we did not do any high temperature evaluations.

One interesting problem that we ran into involved the EMF that was in Substations. On devices where the cases were slimmer (the housing thickness) we found that we occasionally lost memory on flash rom cards and sometimes the entire system was "zapped" clean. There was no predictable point at which data was lost from the device and this did not seem to be a problem with the thicker plastic (or other material) cases found in rugged devices.

When attempting to determine the level of ruggedness your device will require, you'll need to consider where it will be used (indoors, outdoors); temperature extremes; degree of impact; and exposure to vibration, water humidity, sand, dust and altitude.

At the time of this paper there is no independent body that has established ruggedized standards. Without a true standard of rating in the market for rugged devices you sometimes play a guessing game as far as classification of devices. There are only a handful of classifications for ruggedized devices the most popular are:

MIL-STD-810F: Military Standard or MIL spec as it is often called originates from a U.S. Air Force document on test methods for aerospace and ground equipment that was used in the early 1960's. The specification provides many tests to determine how much punishment equipment can handle. Usually vendors who do test to full MIL spec will market it as such and are eager to express it, they will be easy to identify.

Ingress Protection (IP44): Ingress is defined as the act of entering or the power of liberty of entrance or access.

The first digit refers to protection from solid objects penetrating the device's housing on a scale of 0 to 6

- 0 - No protection (Sometimes X)
- 1 - Protected against solid objects up to 50mm²
- 2 - Protected against solid objects up to 12mm²
- 3 - Protected against solid objects up to 2.5mm²
- 4 - Protected against solid objects up to 1mm²
- 5 - Protected against dust, limited ingress (no harmful deposit)
- 6 - Totally protected against dust

The second digit relates to protection from liquids on a scale from 0 to 8

- 0 - No protection (Sometimes X)
- 1 - Protection against vertically falling drops of water like condensation
- 2 - Protection against direct sprays of water up to 15 degrees from vertical
- 3 - Protection against direct sprays of water up to 60 degrees from vertical
- 4 - Protection against water sprayed from all directions - limited ingress permitted
- 5 - Protected against low pressure jets of water from all directions - limited ingress permitted
- 6 - Protected against low pressure jets of water - limited ingress permitted
- 7 - Protected against the effect of immersion between 15cm and 1m
- 8 - Protected against long periods of immersion under pressure

National Electrical Manufacturers Association (NEMA 250)

The NEMA 250 specification describes a variety of different enclosures and how they hold up against environmental impact and is further defined at www.nema.org.

There are also some market terms that are used to identify "classes of ruggedness".

- Semi-rugged:
 - Used by the traveling worker whose device sees some road work
 - No serious drops, moisture or other abuse
 - Overcomes the obstacle of vibration and targets the vehicle-mounted solution.
- Fully-rugged
 - Front Line use
 - Typically a five foot drop to concrete and sealed against dust and rain to IP44 standards
 - Direct impacts, sand, rain and temperature extremes
- Ultra-rugged
 - Typically equivalent to IP64 – IP66 standards or greater
 - Often times these are the trade show exhibits that have running water over the device.

Some other considerations for the choice of rugged devices:

- Often heavier than standard devices
- Processor speeds take a small step down
- Form factor
- Roughly 25-35 percent more expensive than the non-rugged device

- Failure rate is about five percent annually compared to the 30 to 50 percent annual failure rate of non-ruggedized devices used in a rugged environment. If you are replacing that many mobile devices you lose the reason you installed the system in the first place – efficiency.
- All-day runtime and less battery drain is a priority over lightning-fast computing.

These classifications and considerations can help you make a more informed decision based on your specific need and what your budget can handle.

There is always a price to pay when it comes to performance. In the following there are few technologies new in recent years described that may shed some insight to possible uses to increase performance. A number of devices have been selected based on price and durability and are described below. The following new mobile technologies could be incorporated into valuable uses both in the office and in the field.

Bluetooth technology enables short-range wireless connections between desktop and notebook computers, PDA's, mobile phones, camera phones, printers, digital cameras, keyboards and even a computer mouse as long as the other device has Bluetooth technology. Bluetooth wireless technology uses a globally available frequency band (2.4GHz) for worldwide compatibility. In a nutshell, Bluetooth technology unplugs your digital peripherals and makes cable clutter a thing of the past and do it wirelessly, within a 30-foot range. Obvious advantages are that a user can port data from anywhere and deposit it quickly and easily.

Wi-Fi is short for wireless fidelity. This is another name for IEEE 802.11b. Products certified as Wi-Fi by WECA (Wireless Ethernet Compatibility Alliance) are interoperable with each other even if they are from different manufacturers. A user with a Wi-Fi product can use any brand of Access Point with any other brand of client hardware that is built to the Wi-Fi standard. In short, people are setting up free internet access with Wi-Fi cards in their PC's. There are limitations because it is over radio waves. There needs to be repeater stations and users need to be within a quarter mile of a location. The San Francisco Bay area already has a blanket covering their area ([link](#)). This may be useful for collecting data in the field and transmitting it back to the vehicle.

TracVision A5, a new ultra-low profile, phased-array antenna delivers live satellite television to in-vehicle video screens. Passengers will have access to more than 300 channels of video. The TracVision A5 package includes the antenna, mounting hardware, in-vehicle 12V receiver and the remote control. Once internet is incorporated into the device the user will be completely mobile and as functional as being at a desk.

Electronic Paper: Printed paper has high resolution, inexpensive and flexible. It's also recyclable. However, there is one thing you still can't do with paper. Once it's printed, that is it-- you can't make any changes. Several research facilities have developed a new type of electronic paper that reproduces the best features of traditional paper in an electronic format, but also adds rewritability. Electronic paper is made from a thin layer of plastic, but the key to this technology is tiny two-toned particles contained in separate oil-filled compartments. By applying a voltage pattern consisting of electrical charges, the particles rotate and create images or text. A different voltage pattern erases old images and creates new ones. Xerox's Palo Alto Research Center(PARC), calls its

electronic paper display technology gyricon. Gyricon uses a "wand" device to essentially serve as the printer by providing an electrical charge for the display sheet. Simply draw or wave the wand over the gyricon sheet and the image appears. This technology would be a viable option when a large view of a schematic in the field is necessary.

The costs of mobile devices vary as much as by what they are used for. The following describes the costs of a few at the time of the writing.

PDA

Palm Zire Handheld Organizer - \$79.99

Hybrid Phone/PDA - Handspring: Treo 600 - \$600 w/o cell service (editor's choice)

HP: iPAQ Pocket PC (Model h5555) - \$650 - Personal Entertainment Organizer(PEO) - Sony: CLIE PEO (Model: PEG-NX80V) - \$550.00

Tablet PC

Element Computers: Helium 2100 - \$999

Toshiba: M200 - \$2899

Notebook

Dell: Inspiron 1100 - \$699

Sony: Powerbook 17 inch G4 - \$2699-\$3012

GPS

Delorme: EarthMate - \$130-\$320 (laptop-Bluetooth w/ PDA/laptop)

Trimble: Pro XRS - \$11,000.00

Vehicle Satellite

KVH Industries, Inc.: TracVision A5 - \$2.995

SOFTWARE

No mobile solution is complete without software. Most mobile devices come with some software, but it is usually eye candy items that will not be helpful out in the field. Software solutions have to be acquired to make the device valuable. There are a couple of ways you can get your software. One option is that you can buy your software off-the-shelf. One of the benefits of off-the-shelf software is that it is available to use when you decide to purchase it. Some sources say that if a software product gives you at least 75% of your requirements, you should strongly look into purchasing that product without customization. There is virtually no time lag between the time of purchase and when you install it. The big drawback of utilizing purchased software is that there are features that are either there that you will never use or there are features that you want but are not available with it. Again, if you can get at least 75% of your requirements with off-the-shelf software, it deserves some very strong consideration.

If the off-the-shelf software meets less than 75% of your requirements, with some careful planning and requirements gathering, you should investigate writing the software yourself or pursue a developer who will write it for you. Customized software gives you the ability to choose exactly what features you want a certain program to have. This does come at a cost though. First, the price of the application has a tendency to be higher than that of off-the-shelf software because you are paying for the complete cost of the software instead of dispersing it to everyone. Second, the time you decide to use customized software and the time you get to implement it is usually never close

together. It takes time to program, test and implement for the specific features you want. When you are considering development by a third party you should be very sure you know exactly what you want.

DATA DELIVERY/TRANSFER

On top of all the choices you have to make about what type of device to get, you have to also decide how you want it to interact with your current network. There are many ways to move data to and from your mobile device. Do you want to go wireless? What type of data transfer do you want to use? These are just a couple of things to think about in deciding which solution is best for you.

Wireless

Wireless data transfer is one of the options available for moving your data from handheld devices to the corporate network. Wireless devices use radio transmissions through the airwaves to communicate with other wireless devices and adapters.

Infrared is one form of wireless data transfer that has been around for a long time. It is an invisible band of radiation at the lower end of the electromagnetic spectrum. Infrared transmission requires an unobstructed line of sight between transmitter and receiver. It is not only used for transmission between computer devices as it is the same technology as a TV or stereo remote control.

Wi-Fi, described earlier, has a broader range than infrared and does not require direct line of sight. A Wi-Fi device can talk or exchange data with any other Wi-Fi device in the area.

The use of cellular phones has become a popular way of accessing the internet while away from the office. This access has enabled the use of uploading or downloading data while performing field work without having to make extra trips to the office for the information.

Docking

Before there was wireless, everything was connected via some sort of a cable. This option is still available and because it is "old" technology, it is usually cheaper than wireless. But even here there are several methods in which you could use to connect to your mobile device. Laptops, for instance, can be "docked" in a docking station which allows the user to use it as if it were a regular PC. Cradles are used to connect PDA's to a PC or server while at the same time giving it power to recharge. Single cables can be used to connect via the serial port or an USB port.

Types of Transfer

The ability of different devices to communicate with each other, whether they are the same type or different, is done through Electronic Data Interchange(EDI). Third parties provide EDI services that enable organizations with different equipment to connect.

Extensible Markup Language (XML), is a language that was designed especially for Web documents. It uses a similar tag structure as HTML, the internet language, but where HTML defines how elements are displayed, XML defines what those elements contain. XML allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations. By providing a common method for identifying data, XML is a dominant format for EDI.

All computers and computer devices use binary language to accept and send information. Binary is a series of pulses with different voltages creating a series of the digits 0 and 1 to create all of its information. This string of data can flow through any medium and be accepted by electronic circuits that process these binary numbers.

Some files that you may need could be in a different format than that of the software application you are using. Importing allows you to read a file in a format that is not known to the application in use. Exporting lets you save a copy of a document, database or image into a file format required by a different application.

With the need to stay competitive in the business atmosphere, real-time access is needed to help free up time and resources. Real time is a level of computer responsiveness that the user can sense is fast enough to be considered instantaneous. Real-time information is information on demand.

SOME PRACTICAL ELECTRIC UTILITY EXAMPLES OF MOBILE DEVICES ARE:

Staking or Construction Line Design: This software is developed for making a mock-up of a power line site previous to construction, editing an existing map for pole/pole part replacements, or editing for damaged items that have been/need to be replaced. A worker goes into the field with their mobile device loaded with this type of software and draws a map of the area with the GUI making note of trees, fences, roads, homes, bodies of water. Then the required poles are placed on the drawing with GPS coordinates stored in the software. Each pole may be selected and parts may be added/removed to the pole through the interface (ex: oil circuit recloser or a guy). After all the data is collected/removed and the design is complete the user may come back to office and sync up to their PC and dump the data for the GIS department. Later the poles can be constructed/alterd as specified. The program keeps the entire inventory localized in one system to manage the lines inventory, maintenance, assets and GIS maps.

Asset Management/Inventory Management is software that is used to collect data in the field and in the warehouse with the use of mobile devices. The data will be dumped into the database and will be utilized for prompting users, for example, to change out an oil circuit recloser that has reached its service life and needs to be replaced, or that a part exists in the warehouse inventory and can be used to replace the obsolete unit, or a cooperative sees over an internet swap site that an oil circuit recloser exists and sends an email to purchase it.

USG collects raw data in the field with a Trimble Pro XRS mobile GPS device and post processes it with Path Finder Office. Path Finder Office verifies the data and corrects

errors in the way points. Once collected the data is dumped into a GIS database to design maps.

LESSONS LEARNED

From a developer standpoint we have found that there are very few software choices out there that accomplish over the desired 75% of the customer goals but, there are some. Spending the time up front looking for these is worth the effort especially if you are willing to change your process rather than change the software. Always, always, always get buy in from the end users and involve them in the whole process not just during the requirements gathering phase and roll out. We have witnessed several clients who have jumped into a major software endeavor only to find too late that the software is not what they expected or does not provide the usability required.

If you are considering a customized application, don't try to "reinvent the wheel". There is a reason why you don't like "brand x" software. Be sure to clearly identify these issues with your software developer or try working with the vendor to identify issues. They may be fixed in the next release of the software.

Always research your investments and understand their usefulness because they have to cover your bottom line.

SUMMARY CONCLUSION

With all of the solutions on the market today and with all the technology on the verge of becoming mainstream, there is a mobile solution out there for everybody. With careful planning, investigating, requirements gathering and good communication, the right solution can be found for your company.