Abstract—The prototype National Emergency Deployment System (NEDS) is an application that provides a fast and efficient means of planning timely responses to emergencies and a centralized system that maintains a high state of readiness in case of an emergency. The prototype NEDS system has been fielded at one site and had been used in response to several incidents. This paper describes the software capabilities and the open-source development and then discusses the modified development approach that led to a successful software development process.

Index Terms—emergency services, open source, DHS, scheduling, data management, software development.

1. INTRODUCTION

The National Urban Search and Rescue Response System responds to natural or man-made disasters, terrorist events, or any other type of incident where local jurisdictions are overwhelmed are require assistance. The National Emergency Deployment System (NEDS) was developed in order to expedite the rostering of personnel for deployment. The first “real test” of the NEDS system came with Hurricane Katrina. Attempting to capture the availability of personnel had been a daunting tasking in the past. However, personnel were able to login to a website and indicate their availability for deployment. This provided a rapid snapshot of personnel within approximately 30 seconds. This allowed team management to concentrate on rostering the team in acceptable amount of time for the mission.

The prototype National Emergency Deployment System (NEDS) is an application that achieves the primary goal of responding to emergencies in a timely and efficient manner. The software capabilities are discussed in Section 2, while the development strategies that resulted in a successful project are in Section 3, with the conclusions in Section 4.

2. SOFTWARE CAPABILITIES

Since the initial development of the NEDS system, there have been multiple improvements to the system. The Whiteboard application allows management to assemble the roster and specific FEMA forms. The Family Support Network (FSN) is able to retrieve a list of deployed personnel and their emergency contact information. The Availability Website rapidly provides information on deployable personnel, and the Barcode Scanner assists in quickly updating personnel status.

A. The Whiteboard

The Whiteboard is a standalone application that is connected to the main database. It offers a drag-and-drop functionality that allows Managers and Administrators to organize and put together a deployment team. They can also create, edit, save and print organizational charts, as needed.

The original method of arranging a team is shown in Figure 1, where the commander places people by hand on a customized board. This functionality was replicated in the NEDS system with several improvements, shown in Figure 2.

The first improvement is the automatic loading of the available personnel and their status. This alleviates the need for sorting the names by hand. Personnel details are available on demand. Personnel can be sorted by their specialty in order to simplify the team building process. The software GUI is shown in Figures 2 and 3.

Figure 1. The old method of forming teams on a board.

Figure 2. The whiteboard shows the available team members, and they can be dragged and dropped into the necessary positions. This is a FEMA type I chart.
Figure 3. The NEDS software also supports FEMA type III charts. The names that have been placed become lighter but are still shown in the roster. The names have been abbreviated to just one letter for privacy.

Figure 4. The NEDS software allows sorting of the roster of available personnel by primary skill, secondary skill, and status. The displayed roster can also be filtered to show only personnel of particular status, allowing the team to be built with only deployable personnel. Names have been reduced to just a letter for this example.

Figure 5. The NEDS software allows filtering to show only personnel of particular status, allowing the team to be built with only deployable and on-scene personnel. Names have been removed from this image.
A populated digital USAR/FEMA form can be generated from the NEDS software and printed. The names in this case are some of the students who helped with this project.

The available personnel can be displayed or hidden based on their status. The filters can be seen in Figure 4, and the application of filters can be seen in Figure 5. Thus a team can be built with deployable and on-scene personnel, and personnel in medical or checked in can be added if necessary. The whiteboard automatically syncs with the database every thirty seconds, but the syncing can also be executed on-demand.

A digital version of the USAR/FEMA form is incorporated in NEDS and is shown in Figure 6. The various controls on the digital form are shown in Figure 7. This form is populated from a completed Type I or III chart and is easily printable. It contains information on the personal, check-in times, departure point, disciplines and other useful information.

The data stored within the NEDS system can also be exported in standard text or Excel format for additional analysis.

The main page of the NEDS availability website can be modified from the default appearance. The administrator can add external links and images as well as other modifications possible through HTML code. This example has been personalized for Maryland Task Force One.

B. The Availability Website

The main page is shown in Figure 8, and is personalizable for any particular team. The Availability Website allows all team members to log in from any computer with an Internet connection, and indicate which dates they are available for.
responding to emergencies, as well as view and update their personal information. This availability management software is designed so that in an emergency no time is wasted calling in someone who is not going to be available, and that calls are made to updated phone numbers or pagers. The software also manages emergency contacts. The full use of the availability website can be seen in Figure 9.

Figure 9. The menu bar for the NEDS Availability Website demonstrates the uses of NEDS. For regular users, the website serves as an online record system of their availability. It allows them to enter / edit / view the days they are available for deployment. For managers, the website allows them to view roster pages of those users that have marked themselves as available. For family support network users, the website allows them to view emergency contact information for members.

Figure 10. The NEDS availability website allows users to update their information. This shifts the workload off of the managers, but managers and administrators can still edit information for other users as in this case. This allows administrators or managers to update information for members who are not computer literate.

Personnel manage their own information through the availability website as can be seen in Figure 10. The interface is designed to be simple and easy to use. Of course, managers and administrators can still edit information for them. This also simplifies the collection and maintenance of emergency contact information and daily availability information.

The availability information can be entered into the calendar interface which was chosen for ease of use and familiarity as shown in Figure 11. The default condition is unavailable so that administrators would not be deceived into thinking more people were available than there were. There are several toggles to simplify the data entry, including changing availability for entire weeks or months with one click. By making the interface familiar and quick, we hoped personnel would make the easy changes online instead of calling them in and having someone else record them. In reality, transitions to new software are always difficult and the utilization was not 100%, but administrators did have a reduced workload and an easy interface for entering data.

Figure 11. The NEDS availability website allows users to update their availability information in a calendar view. Marking days green means available, while the default is unavailable. Entire weeks and months can be toggled to speed up the process.

Figure 12. The NEDS availability website allows managers to view their rosters and sort by skills.

The personnel have taken control over their own information with the availability website, which saves time and increases accuracy. Administrators can still quickly upload information if some users are reluctant to use the system. There are also management tools built into the software to help managers make sure that they are ready for an emergency.

Managers and Administrators can view rosters, create, edit and remove users. They can keep track of their personnel roster and determine where more training is needed, as shown in Figure 12. They can sort their roster by secondary as well as primary skill and availability. They can also sort by last name, by first name, and even by username in order to find the right people. They can also click on the person to edit their information quickly.
Figure 13. The NEDS availability website allows managers to the available people over a variable range of days. This allows them to make sure they have the personnel with the necessary skills available in case of an emergency. The available members can be filtered or sorted based on their skills. The members can also be sorted by their status, their availability for the time range, and even their name. The member list can also be exported.

Figure 14. NEDS produces lists of emergency contacts for the personnel who are deploying. The information here is test data.

The primary goal of the availability website is making the available personnel clear to managers. This helps avoid the situation where there are not enough people to field for an emergency. Managers can also view, edit, and print the availability of all MDTF1 team members, as well as their emergency contact information. They can also view the total availability of the team, as shown in Figure 13. They can focus on particular skills through the filters, making sure that they have enough of each skill for the time ranges. This also helps in an emergency that might be extended because managers can quickly determine who will be available for a longer emergency. In this way, the availability website simplifies the first step of responding to an emergency by determining for the manager who will be available for the emergency response and providing their contact info.

Figure 15. NEDS produces a badge report of who has checked in without their badge for the emergency. The information here is abbreviated.

For deployments, it is nice to be able to easily produce and print a list of emergency contacts for personnel. This is easily done with the availability website as shown in Figure 14. A hardcopy with improved print formatting is also available.

NEDS also has the ability to keep track of personnel status by their badges, but if they do not have their badges with them managers can rectify the situation by looking them up in the badge report shown in Figure 15. If they do not have their badge, the NEDS software can still handle their data.
The Users can change the status of members through the Status Monitoring page. If the user would like to change a member’s current status, they can click on the single left (LEFT) or single right (RIGHT) arrow next to the user’s name which will move them into the next category, in the respective direction. If the user wants to send someone immediately from medical to deployable, they can simply click on the multiple right arrows (RIGHT). The user can change multiple member statuses at once by checking the boxes next to the members and then selecting the desired status from the drop down box. Clicking on the blue usernames of the members will bring up part of that user’s contact information so there is no need to go to an entirely separate page. Next to each name is also an Edit icon (EDIT) which when clicked, leads the user to the Edit Info Page of the specified user.

Figure 17. The NEDS barcode scanner reads a badge and then the status can be updated through the buttons. In offline mode the last update time and date is shown. If there is no badge, a pulldown menu can be used to update the personnel.

C. The Barcode Scanner

The Barcode Scanner has access to the same database as the Availability Website and Whiteboard over a wireless connection. Whenever team members arrive on scene in response to an emergency, the Administrator can scan their barcode IDs, and changes each team member’s status (medical, deployable, non-deployable, etc) to reflect where he/she is in the deployment process. An image of the barcode user interface is shown in Figure 17. Whenever the Barcode Scanner is not connected to the Internet (i.e. Offline Mode), any information entered is stored locally. As soon as Internet connection is available, all changes will be updated in the database.

The barcode scanner may not be available, so the system is redundant in that the status of individuals can be updated via the website as well using the user interface shown in Figure 16. Systems that must be used in an emergency setting must have multiple paths to success to prevent a single point of failure from derailing the project.

3. DEVELOPMENT, DEPLOYMENT, AND TESTING

The prototype NEDS system has been fielded at one site and had been used in response to several incidents with gradually improving levels of success. Additional field testing is ongoing because the deployment environment at natural disasters is highly varied and challenging.

The development of the NEDS software was done in an incremental or spiral manner over a series of years. The initial whiteboard requirements grew to include the availability website and the barcode scanner as add-ons once the initial technology was acceptable. The software also heavily leveraged available open-source tools in order to reduce costs and improve reliability. The incremental development and testing also allowed requirements to be refined and improved. Documenting the requirements and code with UML as shown in Figures 18 and 19 should simplify the conversion of the prototype into a full-scale system.
The prototype was built as part of a continuing software engineering project at the University of Maryland, College Park. The main goal of the prototype is to help determine the overall requirements for the project as well as assess any technically challenging aspects to the project. Many of the challenging aspects of the project were resolved through the use of the prototype, both on the client side and the development side.

Risk management is particularly important in software development projects due to the inherent uncertainties that most software projects face. Project management has to anticipate risks, understand their impact on the project, and take steps to avoid them. Previous studies have identified several risk items [12, 13, 14, 15, 16, 17, 18, 19], and several risk-reduction strategies have been proposed [17, 20, 21], but this work took a different approach. By treating each turn of the spiral development process as a separate contract with a separate development team and separate independent testing, the risk of contracting to a poor performer was mitigated because that turn (consisting of three months of development) could be restored to a previous version. Independent testing also ensured that the quality was known and that new bugs or problems would be identified.

The development process was significantly different from traditional government software contracts. Typically there is a waterfall model of development with a large delivery at the contract completion date. We break this one massive, long-term, and risky contract up into multiple consecutive short- term contracts. Change to the requirements can occur after the prototype is delivered and evaluated, preventing difficult and costly negotiations with the contractor. The adjusted requirements are then passed onto the next contractor, along with the current prototype.

The new contractor is asked to demonstrate and evaluate the previous prototype as well as develop new capabilities and components. This can be compared with the independent testing that was performed earlier to help build confidence in the testing. This guarantees that the software from the previous deliverable can be installed and rebuilt, and this can be used as a test and potentially a performance measure for the deliverable of the previous development team. This also improves the probability that the contractor will build upon the previous code base instead of rebuilding the entire project. The risk with rebuilding the entire code base is that the quality of the code could go down. Under this scheme, multiple teams have had to modify the code and thus multiple annotations and clarifications will be incorporated into the code base. By having multiple teams work with the same code, the documentation of the code will have to be of high quality. This guarantees a higher level of maintainability for the project as a whole and will make future improvements and changes both simpler and less costly.

By utilizing multiple different contractors with short-term deliverables, the project is also more responsive to technical change. In this case, one of the many technical changes that occurred during the lifetime of the product development was the increased availability of barcode scanners with integrated wireless networking capability. The transition to an improved hardware system was easily incorporated into the project by adding it to the next development cycle.

An additional benefit to contracting multiple independent
development cycles is the availability of early prototypes for use and for testing. The utility of the software could be determined immediately, and new requirements can be developed. The whiteboard was the first development, and its creation spurred the development of the availability website to feed into it as well as the barcode scanner to automate the data collection. The whiteboard prototype was already in use and exposing defects before the availability website was in development. The prototypes had been tested on-site for almost the life of the development process, making the finding and fixing of defects part of the development cycle, and not part of the maintenance.

4. CONCLUSIONS AND FUTURE WORK

The NEDS National Emergency Deployment System developed customized software for the Department of Homeland Security emergency responders based on open-source projects and custom code. The software handles data management through an availability website, deployment through the whiteboard, and data collection through the barcode scanner. The components are loosely coupled and the code quality is kept high through the use of a modified contracting and development scheme. This software is currently in use as a prototype and has been utilized with increasing levels of success on several FEMA incidents from 2002 to 2009.

Some additional functionality that would enhance the system would be exportability of the deployment roster into business type applications such as Excel or Word, customizable deployment charts, and email capability.

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REFERENCES


