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Direction Finding Application

for the

WZRDnet™ Wireless Mesh Network

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1 ABSTRACT

This white paper describes a Direction Finding Application developed for the WZRDnet low-power wireless ad-hoc mesh network in order to increase the network's utility as a situational awareness tool. The Application shows users their GPS position and a graphical image of their direction of travel. It allows saving of position coordinates for storage, transmission and analysis. The Application also provides users with direction toward a specified target whose coordinates are preset manually or received dynamically over the air. The Direction Finding Application uses the user's handset's color LCD display to depict a simple compass-like image showing direction of travel in degrees, distance to target and position. The Application is extremely useful in cases where dispersed dismounted soldiers have to be directed towards a specific assembly point. In these cases, the leader of the deployment sets the assembly point manually or via the embedded GPS receiver and sends its coordinates as a broadcast message to all users. Since the Application is dynamic, a leader can update the target location at any time and all users' handsets are automatically revised with the new information.

The Direction Finding Application relies on the embedded GPS receiver inside the WZRDnet handset as well as on the network's capability to transmit broadcast text messages. WZRDnet's secure voice, text and data messages hop from one handset to another without the need for an established infrastructure (i.e., no cell towers or satellites required). WZRDnet handsets have a range of 2 km per hop and 32 hops per message meaning soldiers can be located a significant distance from the assembly point and still find the target.

2 INTRODUCTION

A need has been identified, specifically by members of the US Armed Forces, for incorporating direction finding capabilities into the operation of the WZRDnet wireless ad-hoc mesh network. This requirement is of great importance especially when dismounted soldiers find themselves separated from their unit and far from their assembly point. For example when during parachute jumps changing wind patterns force soldiers to land several kilometers away from the drop zone. Once on the ground these soldiers must find their assembly point with little or no recognizable landmarks.

In response to the need, TELEGRID Technologies, Inc. (TELEGRID), the developer and producer of the WZRDnet low-power wireless ad-hoc mesh network developed the Direction Finding Application described herein. This development as well as the development of other applications for WZRDnet was straightforward due to the software-based design and the structured hardware architecture which allow simple addition of user-defined applications to the network. The Direction Finding Application utilizes the inherent capabilities of the embedded GPS receiver and the text messaging capability of WZRDnet to provide all users with the basic elements of situational awareness.

TELEGRID developed the Direction Finding Application after first defining three critically important Key Performance Parameters (KPPs). The first KPP is that the application will be self-contained and not require users to have any additional equipment to achieve direction finding. External equipment, including maps and landmarks are not always available and reliable in every Area of Operation (AOO). Maps are sensitive in nature and this may preclude their use by every user where they can be lost or stolen. As for landmarks, certain AOOs (e.g., desert, jungle) lack useable landmarks which may become an obstacle to proper orientation. The second KPP is that the application allow assembly point location to be updated dynamically over-the-air so that a leader can update target information at any time for all users. The third KPP is that the application will be simple to use and intuitive such that the user will not require extensive training.

When these key requirements are added to the key requirements already satisfied by the WZRDnet network such as low-power, portability, Low Probability of Intercept (LPI) and Low Probability of Detection (LPD), the result is a powerful tool for providing basic situational awareness capabilities to the user.

3 WZRDnet BACKGROUND

WZRDnet is a low-power wireless ad-hoc mesh network developed by TELEGRID to provide secure voice, text and data connectivity in an austere environment. WZRDnet does not require any infrastructure (i.e., no cell towers or satellites required) and is therefore an ideal solution for dismounted soldiers.

WZRDnet's mesh architecture is based on low-power/ low-weight portable handsets. As opposed to other mesh networks, which rely on large fixed access points with central routing tables, WZRDnet routes messages through the handsets themselves. Each handset maintains and updates its own routing information thereby removing the need for access points and the possibility of a single point of failure. Normally routing communications through handsets rather than access points requires a large amount of processing and transmission which can quickly drain a handset's battery. WZRDnet overcomes this challenge by employing the low-power IEEE 802.15.4 standard in combination with a hardware architecture which is focused on SWAP (Size, Weight and Power). As a result, WZRDnet handsets can operate for up to 38 hours between battery charges (at 5% talk, 5% receive and 90% standby – an industry standard), which compares favorably to commercial two-way radios that operate for 8-10 hours assuming the same duty cycle.

WZRDnet handsets have a range of 2km per hop with up to 32 hops per message creating a sizeable network over a considerable area. The network can overcome line-of-sight issues by allowing calls to hop around obstructions. This ensures that soldiers receive messages no matter where they are. While all soldiers receive the message, the 2km per hop range ensures that only soldiers in close vicinity receive sensitive information thus promoting LPI/ LPD. This advantage is presented in Figure 3.1 which compares broadcasting target coordinates using WZRDnet to using standard VHF/UHF radio transmissions near an assembly point (target).

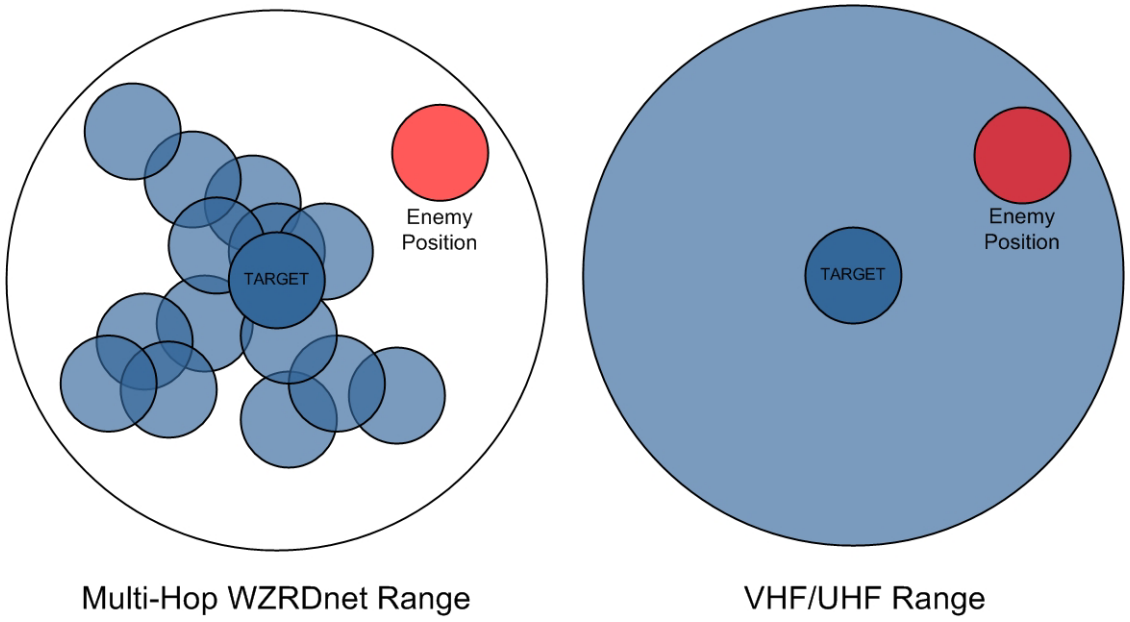

Figure 3.1 WZRDnet LPI/LPD Advantage

4 THE DIRECTION FINDING APPLICATION

The WZRDnet Direction Finding Application includes several capabilities ranging from calculating and displaying the user's current position, to calculating and displaying the user's direction of motion, to calculating and displaying direction and distance to a target point. The Application can be found in the GPS submenu on the handset's Main Menu screen. Note that the design of the WZRDnet handset limits the menu depth in order to make applications easier to find and to shorten training times. The following paragraphs provide a description of the capabilities of this application.

4.1 Acquiring User Position

This capability displays the user's precise GPS location as Longitude and Latitude coordinates. As the user moves, these numbers change to display the new position. These coordinates can also be saved along with a description for future transmission and analysis. An example of the display is shown in Figure 4.1.

Figure 4.1 Acquiring User Position

4.2 Acquiring User Direction

This capability displays the user's direction of motion relative to Global North at the top of a NSEW compass background. The user's direction is calculated using the two most recent GPS position readings. As the user moves these reading are automatically updated providing the current heading. An example of the display is shown in Figure 4.2.

Figure 4.2 Acquiring User Direction

4.3 Acquiring Direction to Target

This capability directs the user to a targeted assembly point. The direction to the target is presented on the handset's display as a **RED** dot on the outer ring of the NSEW compass background. In addition, the angle that the user is moving relative to Global North is depicted at the top of a NSEW compass background (see Acquiring User Direction above). In order to reach the target the user must walk in the direction which places the **RED** dot in the top center of the screen. The distance to the target is displayed on the bottom of the screen. By displaying the position and direction on a color display a user is able to better visualize their location. This creates a simple-to-follow set of instructions which cuts training time.

The Application is based on comparing the user's current position to target coordinates received via a broadcast message from the deployment leader. The user's current position is continuously updating while the target's location is set until a new broadcast message is received. Note that target broadcast messages include the target's unique ID in order to ensure that the correct target is being addressed. The target position can also be set manually by the deployment leader or by the user. The Application allows the user to save their current GPS position and use it later as a target (e.g., finding their way back to base). An example of the user's display is shown in Figure 4.3.

Figure 4.2 Acquiring Direction to Target

5 WZRDnet Command Center

The WZRDnet Command Center is a user friendly, Java based application that allows communications between a central operator and all handsets. The Command Center software provides a list of all available users and allows bi-directional communication with each. The Command Center supports force tracking of all WZRDnet devices in the network. PLI can be sent periodically by all handsets or can be requested on demand by the operator for any or all handsets. Received PLI is plotted on a 3D map that is powered by NASA and USGS satellite imagery as well as topographic data. The 3D map provides a graphical presentation of the entire network and allows the operator to control the map's view (e.g. zoom, pan, etc.). Historical PLI is stored in order to track a user's movement and provide the route traveled to their current location. The Command Center can be used to track equipment as well as personnel (e.g. vehicles, cargo, etc.).

The WZRDnet Command Center software embraces the principle of a self-contained network, on which the WZRDnet system was built. It is able to operate as an independent entity or as part of a larger Wide Area Network (WAN). When an operation calls for a local, rapidly deployable force tracking system the Command Center software can be loaded onto any laptop or tablet and operated locally. When an operation calls for a remote centralized tracking system, individual location information can be sent to a central Command Center through the WZRDnet Gateway.

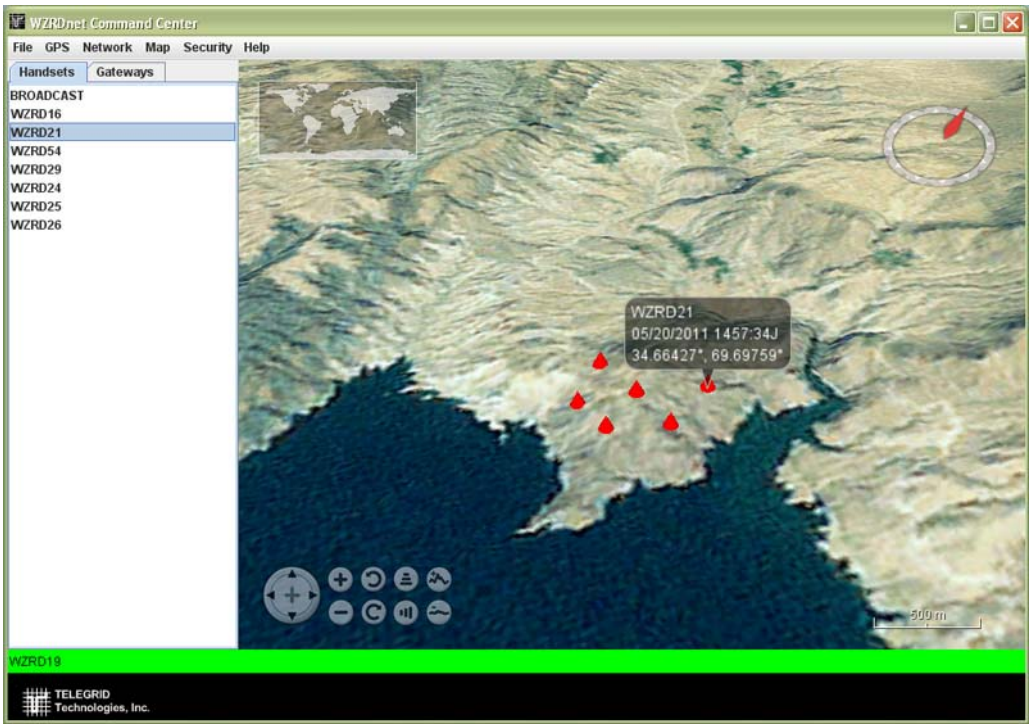

Figure 5.1 WZRDnet Command Center

6 SUMMARY

The WZRDnet Direction Finding Application provides a real-time view of the user's position and direction of motion as well as direction to and distance from an assembly point or drop zone. This application does not require any previous knowledge of an AOO or any external equipment beyond the WZRDnet handset thus making it an ideal solution for rapid deployment. To further aid deployment flexibility the target location can be preset or updated dynamically over the WZRDnet low-power wireless mesh network. The graphical depiction of location and direction provides a simple and easy to learn platform for basic situational awareness.

To learn more about the WZRDnet Direction Finding Application or request information regarding other applications for the WZRDnet low-power wireless mesh network please email sales@telegrid.com.