Gridless Wireless Network
Product Description

Team name:
Off the Grid

Team members:
Ian Schneier
Linda Palacios
Weikang Zhang
Xucheng You
Jingwen Luo
Alec Motazedi

Project Sponsor:

Prof. Alan Mickelson

User Problem

We are addressing the issue of a network failure in the case of natural disasters. During these disasters existing communication networks are often among the first pieces of critical infrastructure to fail, leaving individuals disconnected. In these events, wireless fidelity (Wi-Fi) networks and other forms of communication are obsolete; making it difficult for rescue teams and those affected to communicate. This absence of communication increases the mortality rate, of which we would like to limit. The solution shall be explained later in the description.

Overall Product Solution

Our goal is to provide wireless communication during the aftermath of major disasters such as earthquakes, hurricanes, and tsunamis. Individuals will be better suited to communicate with each other, receive directions for nearby shelters, and facilitate fast response for rescue.

The Gridless Wireless Network (G.W.N) will operate in the ISM (Industrial Scientific Medical) band at 2.4 GHz. This band will be utilized because it is designated by the United Nations for wireless communication without any licenses. G.W.N will use a TI microcontroller, CC3200SF, that has built-in Wi-Fi module and follows 802.11b protocol. The system will have two features Wi-Fi and Ethernet (wire-connection). The controller will work with the Ethernet controller IC made by Microchip (using 802.3 protocol). The transmit power is up to 18 dBm, and receiver sensitivity is down to -96 dBm which satisfies product’s requirements. Our self designed modulation circuit would process the digital signal output and transform it into a 2.4 GHz Sine-wave that will be ready for transmission. In addition, there are several chips in our solution, such as linear regulators (ZLDO1117), amplifiers (output up to 30 dBm), and active filters.

G.W.N will incorporate two antennas, one Mono-directional antenna for long range functionality and one Omni-directional antenna for short range functionality. G.W.N device will have two modes, base mode and bridge mode. In base mode, device will emit from the Mono-directional antenna, and in bridge mode it will use the Omni-directional antenna to communicate among user devices and other G.W.N nodes. Mode switching will be handled by software but a mechanical switch will be available for manual operation.

When a user’s device connects to a G.W.N node, a pop up form will appear. This will be the only functionality of the network, pushing and popping users once the pop up form has been completed. The form will consist of questions that will either prompt the user to move to the nearest shelter or send a distress signal for rescue teams to provide relief. The durability of structure and network connection reliability will allow rescue workers and affected victims to communicate clearly, thus saving more people, more effectively.

In order to correctly map users' devices and each G.W.N node, the device will request the user's devices last known location. This will allow the device to determine the point of contact of each user which may be sent to the rescue teams on-call. Using this data, G.W.N may also triangulate its own location, allowing the base station to map out the location of the device. This would allow the device to be recovered by its last known location if it were to die or become nonfunctional.

The device's housing will have two strict requirements. It will be hermetically sealed (waterproof) and able to be released from high altitudes. Waterproofing the device will allow it to function in areas that have/will experience flooding. The device will also be shock-resistant in order to protect the inner components from damage as it drops from high altitudes. Each GWN system will weigh under 10 lbs for enhanced mobility.

It will be powered by rechargeable batteries and have built in internal power management systems to extend its battery life to at least 72 hours. After calculation and part selection, it will be a 300 Wh battery with the size of 7''x7''x3'' and 6.7 lbs of weight. The linear regulators will stage the 12V down to 5V and 3.3V. The total power output of the system should be under 1W because of the civil transmission power limit. Comparing with the power consumption of signal transmission, all other power consumed on board should be negligible.

Benefitting Group

Disaster victims could rely on this network to access basic resources like maps and local messaging in order to find someone near for help or gather as a team to save themselves. In addition, local authorities could also use the network system to perform search and rescue operations by seeing what devices are connected to the Off-the grid network, reducing the time it takes for rescue teams to find victims by searching their locations through the network, which could result in saving more lives in the aftermath of a disaster.

What Makes Us Different

Our product is a low-cost kit based on a permanent Wi-Fi Long Distance (WiLD) testbed previously designed and made by Professor Alan Mickelson and team, located at the University of Colorado at Boulder. We miniaturized the technology in order to differentiate the product from others that already exist. This will enable the device to be portable and quick to deploy in a disaster area. G.W.N will be able to communicate with other kits of its kind in order to build a stronger mesh network and improve coverage as well as throughput. Additionally, G.W.N will locate the user's device in the network, in order to track and rescue them in the event that they are trapped under a collapsed structure or in another perilous situation. Even during the earthquake or flooding, the network can connect community members and responders, which will make the search and rescue mission more efficient. With the improved network coverage created by the device users can access their needed information and other services via the Off-the-Grid wireless network.