



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY**

Name(s) Roy C. Gross	Project Number J1007
Project Title An Emergency Communication Mesh Network for Civilians: Lessons from Puerto Rico	
Objectives/Goals Motivated by the communication failure in Puerto Rico, I designed a low-cost, portable, person-to-person, communication network called WAEF-EL. The goal is to let civilians communicate with one another using their smartphones without relying on cell or Wi-Fi signals, or external power. It was designed to be self-contained, easy to use, rugged, and cost less than fifty dollars.	
Abstract Methods/Materials I designed a prototype on a breadboard, using an Arduino Uno, a small VHF radio, and an Android App that I wrote to control the unit. Once this was working, I built two mobile units using the smaller Arduino Nano, self-contained power systems, and prototyping boards. I placed them in waterproof cases. Debugging the units was difficult, requiring many experiments and tools, like voltmeters, oscilloscopes, and audio wave analysis software.	
Results Test 1: Unit-to-Unit Field Test. One unit was stationary, while the other was in a car which drove around the neighborhood. I tracked communication between the units and analyzed the resulting GPS data. Test 2: Mesh-Network test. I created a simple Y-shaped mesh network shape, using the two WAEF-EL units I made, plus two additional radios which could only receive the data. I successfully propagated a message through the network. Test 3: Satellite Communication. I located an APRS satellite using free software, aimed an antenna at the satellite, and sent a message from a WAEF-EL unit. It was received by the satellite and retransmitted back to Earth. An amateur radio operator 800km away received the message and posted it online to confirm the contact. Test 4: Battery Life. I modified one unit to auto-transmit a message every ten minutes. I built a voltage logger and tracked the system voltage. It performed reliably for 18 hours until the battery voltage fell too low and the radio stopped transmitting.	
Conclusions/Discussion Inspired by the events in Puerto Rico, I designed and built a low-cost emergency communication system. My system allows people to use their existing cell phones to communicate with each other when all other systems are down. The final design requires no external power. It is rugged, waterproof, and costs about fifty dollars. I demonstrated unit-to-unit communication, LEO satellite communication, and propagation across a mesh network.	
Summary Statement Motivated by the communication failure in Puerto Rico, I designed a low-cost, portable, person-to-person, communication system.	
Help Received The author of a programming library gave me advice on how to properly use the library.	