BDPNN Meeting
29 May 2014
"Present and Future of Earthquake Warning Systems"
Dr Richard Allen, UC-Berkeley

Norine started the meeting with a welcome and introductions of the Board. Of the 22 people in attendance, about 1/3 of them were newcomers to the Network. She mentioned that handouts about all levels of earthquake preparedness were available on the websites.
https://groups.yahoo.com/neo/groups/bdpnn/info in the FILES section

She also reminded people that it is fire season, and, with the drought we are in, everyone needs to ensure 30 feet of safe distance for all vegetation from homes, particularly if you live in the Berkeley Hills. The City of Berkeley has several programs to help people clear the vegetation, so if you are interested, see the City's website:
http://www.ci.berkeley.ca.us/Fire/Home/FP-Vegetation_Management.aspx

Norine also introduced Khin Chin and commended his volunteer group on a great CERT Fair held at the North Berkeley BART parking lot. The Network received 50 new members and 10 requests for preparedness briefings from just this event.

Norine also introduced Bruce Carleton, who is returning to the Network as a Ham Radio representative. Bruce talked briefly about the new radio group for amateur radios called "BeCERTAINN", started by Jeff Lomax, which focuses on ways to optimize ham radio communications in a disaster. Ham radios may be the only way neighborhoods can communicate with local authorities, so if you are thinking about getting your license and a ham radio, you should definitely look into it.
Website: https://groups.yahoo.com/neo/groups/BeCERTAINN/info

Upcoming events include: CERT Radio Training on Tues, June 11, followed by the Network's Radio Practice on Sat, June 14, at Cesar Chavez Park. Also, the Network's next quarterly meeting will be held on July 31, which will be a safety presentation by PG&E.

Then Sandy Miarecki introduced the guest speaker, Dr. Richard Allen, who is a Professor with the Department of Earth and Planetary Science at UC-Berkeley. He is also the Director of the Berkeley Seismological Laboratory. Recently, he has been working on several projects that involve early-warning earthquake detection systems, and today's talk would cover those systems and the plans to make them operational within the near future.

Dr. Allen started with an overview of the growing earthquake threat, reminding us that every second that an earthquake does NOT happen means that additional stress is growing on every fault in the area, and the stored energy is building dangerously. He showed a map of the strain between the Hayward and San Andreas Faults, which are only about 17 miles from each other. Both faults should be moving about 4 centimeters per year on average, and yet we have not experienced a major rupture on either fault in many years. Currently, the USGS estimates the earthquake threat at 63%. This means that there is a 63% chance that a major earthquake will strike this area within the next 30 years. The chance is about evenly divided between the Hayward and the San Andreas. Every year that an earthquake does NOT happen means that the percent risk keeps going up.

There has been an alarming increase in the number of casualties and fatalities from major quakes worldwide, mostly due to several large quakes in the last 10 years (such as Sumatra, Kashmir, Wenchuan, and Haiti). There have been over 650,000 casualties from these quakes because of the intense shaking damage and of course the tsunamis.

In this briefing, Dr. Allen covered 3 main topics: earthquake early warning in California today, improved warning systems for the near future for big quakes, and the possibility of a worldwide warning system involving smart phones. The research that Dr. Allen is involved with has several major collaborators from laboratories, universities, and private industries, with a special thanks to the Gordon and Betty Moore Foundation, which has contributed the bulk of the funding to continue the research.

In Japan in 2011, a huge 9.0 quake hit just off the coast of Japan and caused a massive tsunami that devastated the coastlines of several countries. This quake was the first true test of the earthquake warning system that Japan had initiated after the Kobe quake of 2007. Dr. Allen showed a recording of the actual warning that occurred automatically on TV broadcasts in 2011. The TV program was the Japanese Parliament meeting in Tokyo, which is their version of C-SPAN in the US. The Japanese warning system is completely automated. As soon as the sensors detected a major quake, the warning was sent in many different forms, including TV announcements, text messages, and other means. Even the people in Sendai, the town nearest the epicenter, had about 20 seconds of warning before the major shaking occurred.

The system works by detecting the P wave and triangulating the probable location of the epicenter. The P wave is the fastest part of the earthquake wave that results in one big jolt and not much initial damage. The S waves are the slower parts of the earthquake waves, which are the damaging side-to-side motion that lasts from 30 seconds to 2 minutes, depending upon the magnitude of the quake. The difference between the speed of the P and S waves results in the warning time that can be given to people who live several miles from the quake (since obviously the people who live nearest the epicenter won't have any warning between the P and S waves because both waves will arrive almost simultaneously).

In the case of Japan, the system did a great job of warning the northern 5 prefectures (or counties) nearest the epicenter, but it did not accurately predict the extent of the shaking which extended well past Tokyo. These southern areas did not receive any warning because the computer systems did not believe that the shaking would be a problem further south. So the warning system was a success and a failure at the same time. Undoubtedly, however, the system saved many lives.

Before the 2011 quake, there had been 6 other warnings for quakes of 7.0 or more from 2007-2011. Fortunately, the system does not have a high false alarm rate, and therefore the people of Japan have taken these warnings very seriously and have not been desensitized by getting too many false alarms.

In 2011, California had NO warning system of any kind. After the Japan quake, there was a great deal of interest in these systems worldwide but particularly in California. There was an Earthquake Summit meeting held between UC-Berkeley, USGS, BART, state and local legislators, and many other interested parties. There were 2 outcomes: (1) A long-term goal to have an early warning system all along the Pacific coast, from Washington to Oregon to California, and (2) A short-term goal to develop a prototype early warning system that could be tested and refined for the future.

In addition, a law was passed by the California Senate, in a bill started by Senator Alex Padilla, and signed into law by Governor Jerry Brown in Sep 2013. The law requires that the State Office of Emergency Services develop a comprehensive statewide earthquake early warning system to alert Californians in advance of dangerous shaking. The law passed unanimously, but it contained no financial support whatsoever.

Soon after the Summit, plans for a prototype early warning system were formed. Today, that prototype system is working well, and we are getting close to having a working early warning system for California. One part of that system is called Shake Alert. It is an integrated seismic network in the state of California which includes about 400 seismic stations organized into 3 network hubs. Currently, the system sends out alerts only to scientific members (such as Dr. Allen) and those businesses interested in automated alerts, such as BART. These members have desktop programs and apps that warn of the detection of the P wave and the imminent arrival of the S waves for every quake above a minimum that is set by the user. Dr. Allen showed an example of the recent 3.5 magnitude quake that happened near the 1989 Loma Prieta epicenter. At UC-Berkeley, Dr. Allen received a 25 second warning before the S waves arrived. If the magnitude of the quake would have been much larger, that 25 seconds could have been used to take cover or shut down construction sites, etc. The system also tells the user about how much shaking to expect (mild, moderate, severe). Right now the system can provide up to 60 seconds of warning (such as a major quake near the area of Eureka).

The system requires 2-4 sensors to detect the P wave, and the signals are sent to a central computer system which then calculates the location and magnitude of the quake. Then the alert goes out. All this takes time, of course, so there is a period of time where no warning would be possible for the people nearest the epicenter, as expected. The computer programs (called algorithms) try to determine if the sensors picked up a quake or not, to reduce the number of false alerts.

For example, in the 5.1 magnitude LA quake in March 2014, the warnings were sent out by the Berkeley system to the LA area. This earthquake broke water mains and gas lines and caused some landslides, but it was not a particularly deadly quake. There was a 4-second delay between the actual quake and the warning going out. This is particularly fast when you realize the time was 7 seconds only a few years ago.

Speaking of false alerts, Dr. Allen showed a comparison of the actual quakes to the detected quakes. For all magnitudes greater than 3.0, the San Francisco system had 23 actual quakes, with 22 of them detected and alerted, 1 missed quake, and only 1 false alert (no quake but an alert was sent). For the LA area, they had 17 quakes, with 17 detected, 0 misses, and 2 false alerts. This is an incredible success story for a system that has just gotten started.

Then Dr. Allen talked about "what can you do with 10-20 seconds of warning?" He showed examples of eye surgery, construction sites with large cranes carrying heavy loads, BART trains, airports, and fire stations. All these locations, and more, would receive an automated alert to give them time to sound an alarm and/or shut down operations before the heavy shaking arrived.

(1) Currently, the San Francisco Department of Emergency Management Operations Center (SF DEM OPS) is getting automated alerts from this system. In the future, these alerts would be passed on to the fire stations, and fire crews would be alerted early, and station doors would be opened in advance.

(2) BART was the first to automate the response to these alerts. There are 64 trains with about 1000 people per train during rush hours, and some trains are traveling as fast as 70 mph. BART uses the alerts to automatically send a slow-down signal to all the trains. In 10-20 seconds, the speeds of the trains can be down to almost nothing, thus reducing the chance of a derailment or other serious injury to passengers.

(3) Google is also using this information in the Operations Center, in particular to start the emergency generators in advance of the shaking.

(4) The UC Police Department is using the alerts as a Code Red for early action.

The California warning system uses GPS-based technology developed by Berkeley and mainly situated on the Hayward Fault. The heavily populated areas of the state have very good coverage, but the less populated parts, such as the forested areas in Northern California, do not have good coverage. This is a problem that needs to be solved. The final sensor system will combine many different inputs into the computer programs that decide whether to give out an alert and to which areas.

However, many areas of the world have ZERO coverage, mainly the second-world and third-world countries that can't afford such a system. These countries are typically the ones with the highest fatality counts after large quakes. This is where the idea of using smart phones as miniature sensors has come into play. Each smart phone has an accelerometer and a rough GPS position. If a network of smart phones could be created through the use of the "Cloud", real-time quake information could be gathered from every person that has a smart phone. There are currently 16 million smart phones in California alone, and 1 billion of them worldwide, growing every day. These phones could be the gap-fillers in developing countries. The only parts needed would be the computer network to collect all that information and process it, then the warning system to warn people via smart phone messages that the quake is coming.

The "My Shake" app is in development and testing at UC-Berkeley now. In Fall 2014, the university will expand this prototype system to include 1000 users with smart phones. Deutsche Telecomm has been a major player in the development of this system. Testing of the phones shows that smart phones have their best performance in the critical shaking range that is needed for this type of system. The testing is continuing to separate normal everyday activity (such as jogging, riding a bike, dropping the phone, etc.) from earthquake signals. The testing shows that the computer programs can tell the difference with an amazing 99.8% accuracy. Now, all that is needed are the servers to collect the data and the app for the phones. These are in testing now, with good results and projecting a Fall 2014 roll-out into the next phase of testing.

We live in an interesting time, with science, technology, and public policy all working together and building off each other in a synergistic way to make an early earthquake warning system a reality within the next few years.

Again, a reminder of the next BDPNN meeting scheduled for July 31 at 6:30 pm at the Unitarian Universalist Church meeting hall at Cedar and Bonita. The topic will be a safety demonstration by PG&E.