Geophysical Research Abstracts
Vol. 13, EGU2011-9466-1, 2011
EGU General Assembly 2011

A New Instrumental Approach to Earthquake Early Warning

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Over the last decade digital data telemetry has led to vast improvements in the quality of the data collected by seismic networks and has substantially increased the reliability of such networks. Nowadays full waveform data with sampling rates of several hundred sps are routinely transmitted, received and processed in quasi real-time without major glitches. However, the ever growing number of Earthquake Early Warning (EEW) systems places completely new demands on seismic networks. In those systems time is of the essence and every second counts, as it can make the difference between a successful warning and a disaster. Here we present a new approach to data processing, which is capable of reducing the time it takes for mission critical parameters to reach an EEW processing and alarm center.

Currently, most digitizers used in the remote stations of seismic networks are capable to sample the incoming analog waveform data at one or more sampling rates. Depending on the communications protocol, the digital data are then bundled into packets. Once a packet is "full", the digitizer will send it to the receiver, in most cases an acquisition computer in the data center. From there the data are transferred to processing computers, where the parameters critical for EEW are computed. These parameters include, but are not limited to, peak ground acceleration (PGA), peak ground velocity (PGV), spectral intensity (SI) as well as estimates of the amplitudes and periods of the wave train necessary to predict the magnitude of an event. Depending on the structure of the packets governed by the telemetry protocol, the design of the telemetry network, the way incoming data are handled within a data center and the algorithms used to calculate the EEW parameters, it can take up to tens of seconds between the first detection of an earthquake and the availability of these parameters to decision makers.

To substantially reduce this time we have developed a new way to calculate the EEW parameters, by making full use of the processing capabilities of the digital signal processors (DSP) within our Guralp DM-24 family of digitizers. As much of their capacity is idle during routine digitization, we have reprogrammed and augmented them such, that a string of EEW parameters is continuously calculated directly at the remote location. We have also made provisions, that user defined code can be remotely programmed onto the DSP in order to optimize the calculation of the parameters needed for a specific EEW system. As soon as a threshold of ground movement is triggered, these parameters are immediately transmitted to the data center via a priority telemetry protocol, without the need for bundling them into large packets. At the data center, these values can be immediately used in displays and also to trigger a preset level of alarms.

This novel concept has already been realized in several EEW systems. We will present data from various applications.