ANAR: A NEW INSIGHT INTO EARLY WARNING SYSTEM FOR DECLINING THE DELAY

Ali RIAHI
M.Sc. of Geophysics, Earthquake Research Center, Ferdowsi University of Mashhad, Mashhad, Iran
A.Riahi.seismo@gmail.com

Mahdi NAVAZANDEH
M.Sc. Student in Software Engineering, Ferdowsi University of Mashhad; Anar Web Developer Company, Mashhad, Iran
M.Navazandeh@gmail.com

Majid SEDARATY
Software Engineer, Earthquake Research Center, Ferdowsi University of Mashhad; Anar Web Developer Company, Mashhad, Iran
Majid.Sedaraty@gmail.com

Keywords: Earthquake Early Warning System, Network Management, Minimize the Delay, Noisy Station, Modified Filterpicker Algorithm

Earthquakes, annually, have made up an undeniable portion of death toll in the globe. Nowadays, Earthquake Early Warning systems (EEWs) have an utmost important impact on natural disaster risk management and to alleviate fatalities and destructions. Most regions in Iran are prone to earthquakes. Therefore, occuring of large events in a crowded areas are highly expected in every decade.

High-risk zones in Iran are thus extremely required to be equipped with EEWS. For this purpose, our team has designed and implemented a sophisticated early warning and seismic network management system (Anar) since 2 years ago. The system has the capability to alert the hazard of the quake just occurred, quickly and manage the seismic network, online and automatically.

The EEW system involves both software and hardware ingredients. While some present seismological early earthquake detection algorithms are customized for a particular region, the one provided by Anar is duly general and independent of software and geographical region.

The hardware component of EEW system must be specially designed for reduced-delayed warning and early-event alarming. There are several issues which may postpone in EEWs, such as: delay of sensor, delay of digitizer, packing and sending by protocol, transfer distance between station and centre, receiving and unpacking by protocol, processing and the effects of some network instruments like router, switcher, operator system and etc. Our Anar system is provided with several features to minimize the associated delays as far as possible. The scalability is utilized in the design of communication protocol between components which permits one to incorporate unlimited number of stations to a network without process slowing. In addition, the design of this system provides distributive property, which leads to some highlighted characteristics such as distribution of volume processing and great security. To distribute the process, we devise a black box which provides opportunity to shift the software process from central server to a personal computer located at the station. All these properties may efficiently decrease unwelcome delays. Our experience for NJFI station of Earthquake Research Centre (EQRC) network of Ferdowsi university of Mashhad, Iran reveals that just a 0.308-milliseconds postpone is developed in the Anar EEW system, which is far less than the standard maximum acceptable delay of 100 milliseconds. Anar includes several components and uses them to process the received data. The chart of these components is revealed in Figure 1.

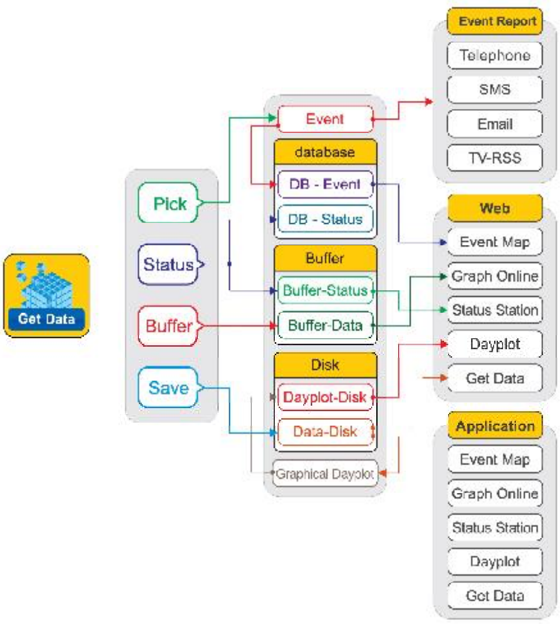

Figure 1. Several components of Anar in the different steps of the data process

In addition, an efficient early warning system must incorporate several further attributes to be operable. Here, we prepare the system in a flexible and stable manner, such that the buffer and back up parts provide adequate protection for cases when connection between components of the system is broken. In addition, Anar system is effectively energy-efficient, portable and can be run on any personal computer or even Field-Programmable Gate Arrays (FPGA), Graphics Processing Units (GPU) and Cells. On the other hand, most EEWs are unable to support network management satisfactorily and most of them require a technician to install and run it. Therefore, we have made a serious attempt to design a user friendly interface.

The EEW systems are usually based on event-detection by P waves and must alarm the location, magnitude and any essential information before the arrival of S waves (as the most destructive waves). A significant part of the detection step is to pick the P phase accurately, while the system analyses the real time arrived records sample by sample. Although Anar's hardware is algorithm-independent, we commence to improve the seismological methods for any EEWs. For this purpose, the FilterPicker algorithm of Lomax et al, 2012 is modified; it was presented by Riahi et al, 2014. It is a common practice to have a noisy station in the network. The FilterPicker may not pick the phases accurately for noisy stations, leading to wrong picking which might undesirably affect the locating process. Our modified Filterpicker rises the probability of success for right picking in noisy stations by incorporation of some further formulas to the based algorithm which provides identification of the P phase arrive time more obviously. Though the processing steps of the modified method are doubled and the test is shown that Anar can analyse 50000 sample per 1 millisecond, whereas it is run on a personal computer with Intel core i5-2430M (2.40 GHz×4) CPU and 4 GB physical installed RAM; the system is operated by Kernel Linux 3.2.0-4-amd64 with Gnome 3.4.2 and release 7.4 (wheezy) 64-bit. In the next step of our project, we will focus on further seismological methods to improve software and programing components.

REFERENCES

Lomax A, Satriano C and Vassallo M (2012) Automatic picker developments and optimization: FilterPicker—a robust, broadband picker for real-time seismic monitoring and earthquake early warning, *Seismological Research Letters*, 83: 531-540

Riahi A, Navazandeh M and Sedaraty M (2014) Automatic P-Wave Detection in Very Noisy Stations, *Proceedings of 16th Iranian Geophysical Conference*, Tehran University, Iran, No. 2382