

Application of Earthquake Early Warning System in Schools and Experience of the 2008 Iwate-Miyagi Nairiku Earthquake

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The Earthquake Early Warning System (EWS) based on the nation wide earthquake observation networks in Japan can be applied for earthquake damage mitigation in various fields. As chief of a project team, the first author has contributed to develop an application of EWS for disaster prevention in schools.

The authors have developed the EWS for school and have performed the demonstration tests. Fig.1 shows the diagram of the EWS installed at an elementary school in Sendai and the system extended for other three elementary schools and one junior high school. The information about the magnitude and the hypocenter is sent via satellite or IP-net from the Japan Metrological Agency (JMA), based on the nation wide JMA-NIED earthquake network systems. The information is transferred to the receiver computer at the teacher's room. The computer estimates the countdown to the S-wave arrival and the expected seismic JMA intensity. Based on this information, the broadcasting system issues a warning voice to all the area of the school. Voice/image warning information is transmitted to a TV receiver at each classroom. The automatic connection from the receiver to the broadcasting system is controlled by an ON/OFF switch. Usually, on school days the switch is set to ON and on weekends to OFF.

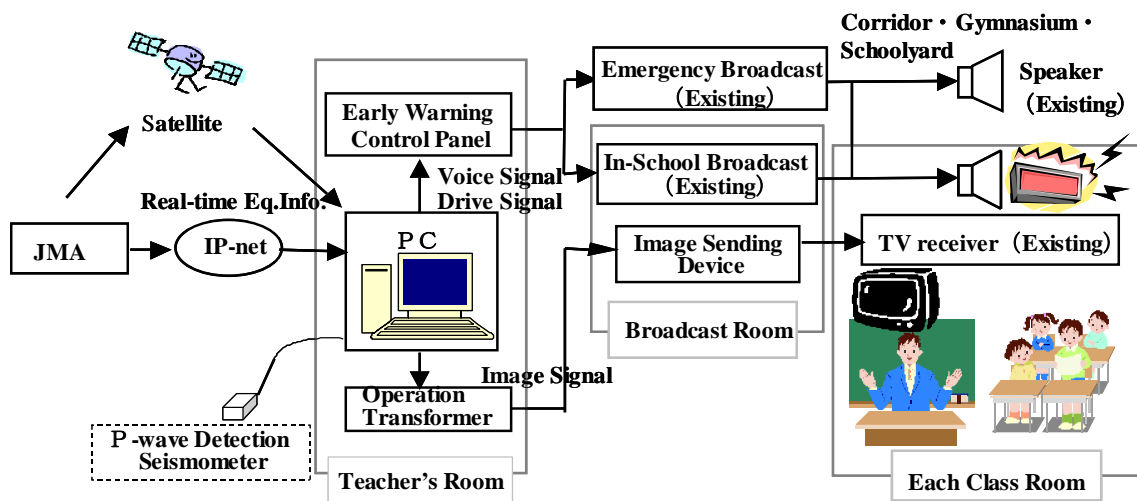


Fig. 1 Diagram of the Earthquake Early Warning System in Schools

The EEWS in schools has three functions: 1) Evacuation mode, 2) Training mode and 3) Education mode. The evacuation mode secures the safety of pupils and teachers to persuade the evacuation when the expected intensity becomes more than a specified intensity e.g. JMA IV, issues a warning via speakers and shows a warning image on screens.

The authors have also performed the demonstration test using the School in Wide Area Network in Miyagi prefecture (Miyagi-SWAN), Japan. Fig.2 shows the developed system using the schools' WAN, which leads to totally cheaper communication fee for transmission of the real-time earthquake information to schools' group. The authors have suggested that efficient use of the existing network and the broadcasting system is important in spread of the EEWS. It is noted that Tohoku University installed EEWS using the University's LAN (TAINS) in the fiscal year, 2008 and now the warning alarm is transmitted to the existing broadcasting systems of the 5 campuses of the university.

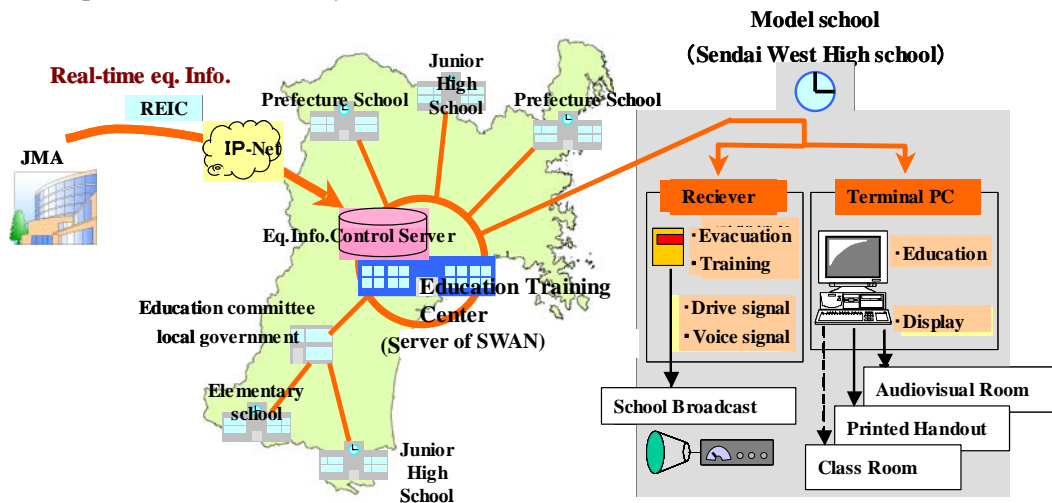


Fig.2 Schematic figure of earthquake early warning system in schools using Miyagi-SWAN

The EEWSs in schools in Miyagi prefecture experienced a real earthquake, the June 14, 2008 Iwate-Miyagi Nairiku earthquake (M7.2). For this earthquake, JMA issued the real-time earthquake information improving source parameters (magnitude and hypocenter) 10 times as observation points increased. It is noted that the estimated magnitude was 5.7 initially in the 1st information, and improved to 6.1 in the 2nd, 6.2 in the 3rd, and 7.0 in the 10th information. The EEWS in schools are set to connect to in-school broadcasting if the predicted seismic JMA intensity exceeds a preset intensity, and if a switch is set to 'ON'. If the switch is set to 'OFF', warnings are not broadcasted. The source parameters issued the 3rd time, are used to connect to the in-school broadcasting system at 5 schools. Figure 3 shows the available time before the arrival of S-waves together with the predicted seismic intensity based on the tentative magnitude estimated by the determined source parameters issued the 3rd time. The soil

amplification factors are set differently at each school.

The earthquake occurred at 8:43 in the morning of Saturday, not a school day. As usual the broadcasting connection of the receiver of the real-time earthquake information was set to 'OFF' during the weekend at 4 elementary schools, but at Shiroishi Junior High School, the broadcasting connection was ON because about 100 students were at school attending a regional athletic meeting. They could actually do the drilled evacuation actions, e.g. duck under the desk, cover their head and hold the legs of the desks based on the warning announce issued 21s before S-wave arrival. It was a nice coincidence that an evacuation drill was performed 3 days before the earthquake occurrence. This was reported by some media (TVs and Newspapers) as a successful example of EEWS in schools (refer to Frig.4). The real time earthquake information was also received at other 4 schools before S-wave arrival. The available times were 3 sec at Furukawa 3rd E.S in Furukawa, 9 sec at Kama E.S in Ishinomaki, 11 sec at Tsurugaya E.S in Sendai and 13 sec at Nagamachi E.S in Sendai.

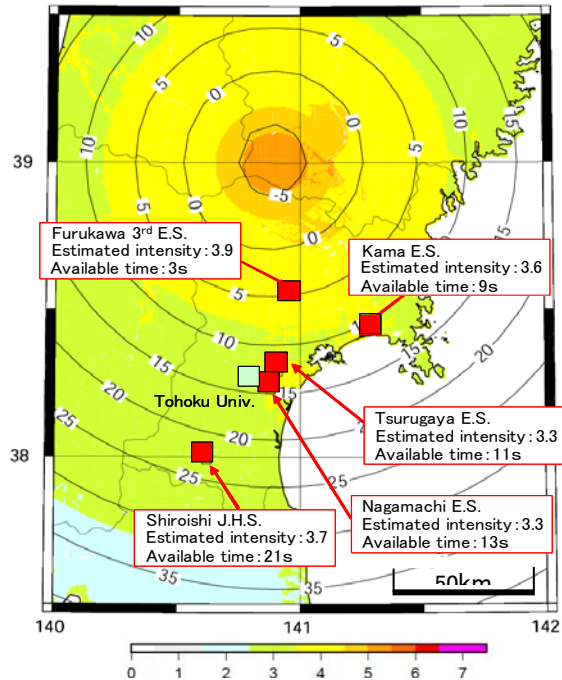


Fig.3 Available time and the estimated seismic JMA intensity at 5 schools for the 3rd issued source information from JMA

The EEW 21s before S-wave arrival

About 100 students could actually do the drilled evacuation actions

生徒100人無事避難

緊急地震速報 21秒前に受信

Effectiveness of broadcasting was realized

after Yomiuri Shinbun on June 22, 2008

Fig.4 Successful example of EEWS in school the 2008 Iwate-Miyagi Nairiku earthquake