

The 2nd International Workshop on Earthquake Early Warning
April 22, 2009. At Kyoto University Uji Campus.

Development and Operation of Early Earthquake Warning System for Radio Broadcasting

Hiroshi Asahara[1], Hideaki Matsumoto[1], Kenji Kamiya[2], Osamu Sakurai[3], Katsuhiro Kato[4], Hisato Nagasaka[5] and Fumio Inuzuka[6]

[1] Advanced Simulation Technology of Mechanics Co., Ltd.,
[2] Tokai Radio Broadcasting Co., Ltd., [3] FM Aichi Broadcasting Co., Ltd.,
[4] Mie FM Broadcasting Co., Ltd., [5] ZIP-FM Inc., [6] Aichi International Broadcasting Co., Ltd.

1. Introduction

We developed an Earthquake Early Warning (EEW) auto-broadcasting system for AM/FM radio stations to quickly announce to the public that strong tremors are coming, and started the operation in September 2008.

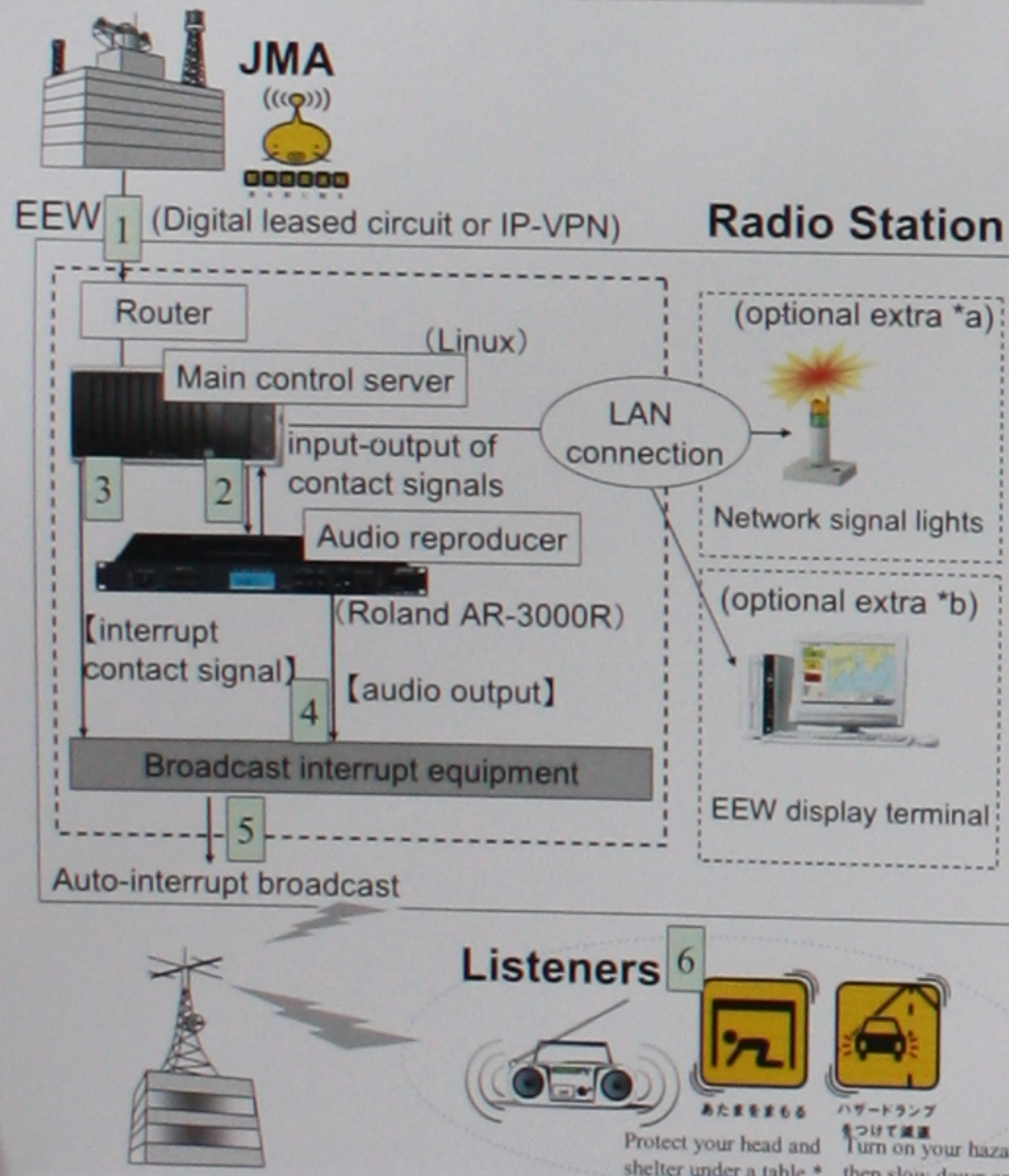
→ 5 radio stations in which the developed systems are installed and historical earthquakes.



Features of the system

- (1) An EEW message is automatically broadcasted (requiring no manual operation), interfering the broadcast of current program even if in the middle of a commercial. → 2. System Configuration
- (2) The auto-interrupt broadcast is performed only when the coverage area of the radio stations is expected to be the threshold intensity or greater. → 3. Judgment of Interrupt-Broadcasting
- (3) The broadcast message is dynamically generated including the epicenter location and the expected area names of strong shaking. The messages using multiple languages are possible. → 4. Broadcast Message
- (4) The reliability for the system is emphasized as well as multiple functions. → 2. System Configuration

2. System Configuration

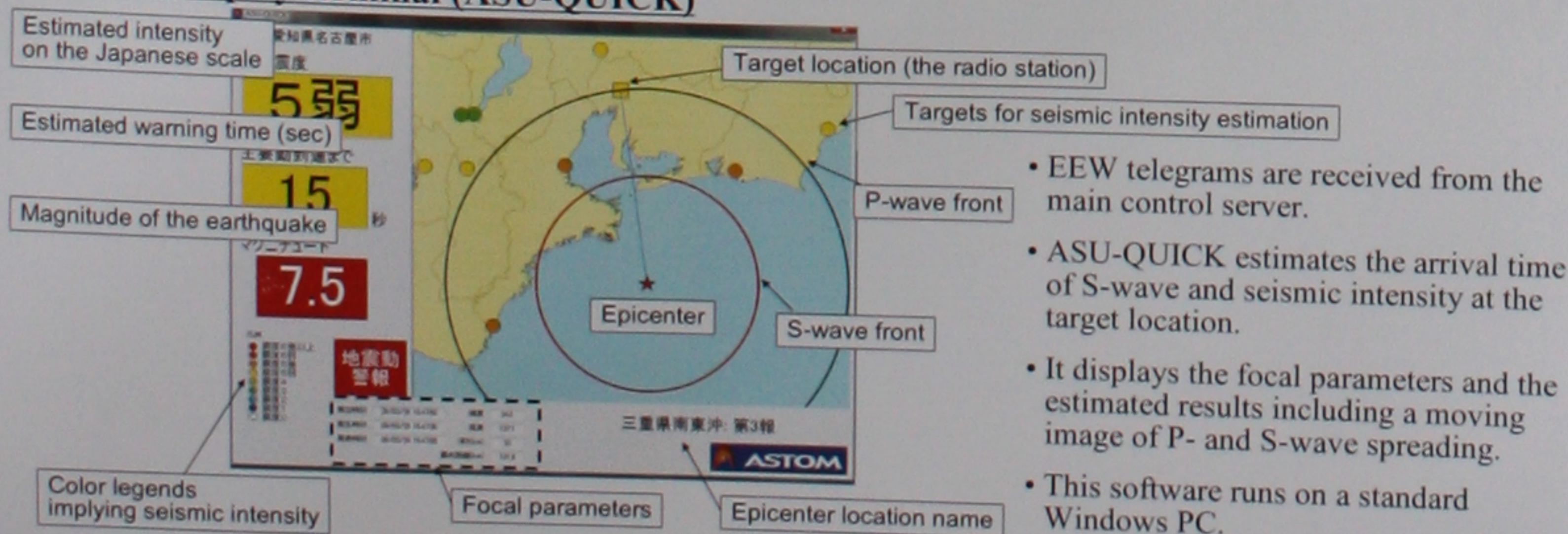


- 1) The main control server receives EEW telegrams from JMA servers. The server judges whether interrupt-broadcast should be performed or not. The telegrams are also transferred to the EEW display terminal.
- 2) The server controls the audio reproducer. The audio reproducer has short segments of broadcast sentences, and plays the phrases in sequence ordered by the command using 13 contact signals from the server.
- 3) The server simultaneously outputs "interrupt contact signal" to the broadcast interrupt equipment.
- 4) The equipment receives both the contact signal from the server and the audio output from the reproducer.
- 5) The equipment interrupts the current program to bring the EEW message.
- 6) Listeners who hear the EEW act quickly to protect themselves.

*a) Network signal lights

- Up to 5 network signal lights are available via LAN connection.
- Lights inform the execution of EEW interrupt-broadcasting and system failure detections.

*b) EEW display terminal (ASU-QUICK)



- EEW telegrams are received from the main control server.
- ASU-QUICK estimates the arrival time of S-wave and seismic intensity at the target location.
- It displays the focal parameters and the estimated results including a moving image of P- and S-wave spreading.
- This software runs on a standard Windows PC.

Tokai Radio Broadcasting extends self-produced interfaces.



Signal Interface counts up the number of test outputs from the sever, when time tone telegrams are received from JMA on the hour every hour.



Operation Box shows the interrupt-broadcasting status. When an operator pushes the right red button, EEW broadcast is forced to be stopped and switched to a special program of the earthquake.

3. Judgment of Interrupt-Broadcasting

EEW broadcast via TV and radio in Japan

NHK (the public television and radio organization)

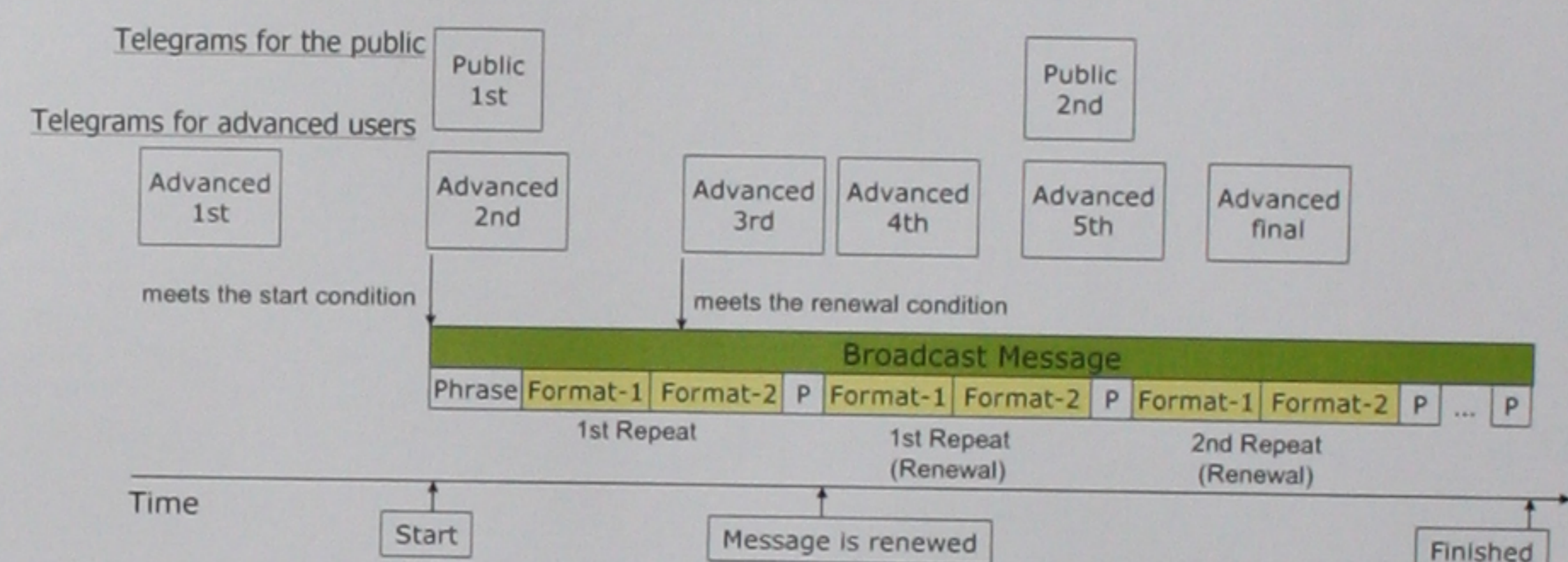
- NHK is obliged to broadcast EEW by law.
- NHK broadcasts every EEW warning on TV and radio throughout the nation.

Commercial TV and radio stations

- Not all stations have started the EEW broadcasting.
- The broadcasting is performed only when the intensity in the coverage area is expected to be the threshold intensity or greater.
- Radio stations have their own thresholds. (The stations in Tokai area commonly set the threshold to intensity 5 upper.)

Judgment Conditions

Telegrams for the public implies that the information is "the warning" and the warning areas. Telegrams for advanced users also contains the estimated intensity of the regions.



Broadcast Start Conditions

- Telegrams for the public are issued.
- At least one of the coverage area meets the threshold.

Renewal Conditions

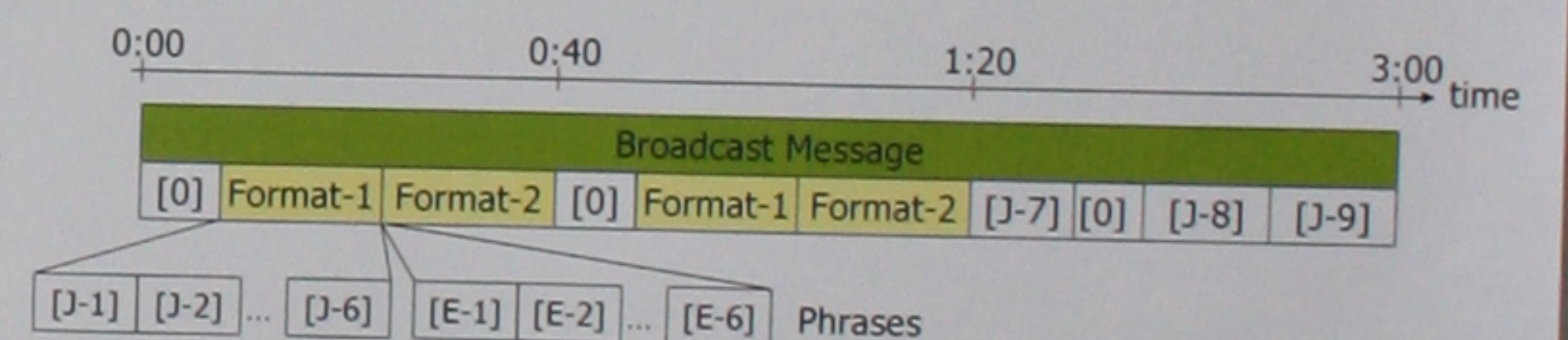
- The areas where meet the threshold become widespread by the renewal telegrams for advanced users.
- During the interrupt-broadcasting, another EEW about another earthquake is issued and it meets the start conditions.

4. Broadcast Message

EEW broadcasting message used in Aichi International Broadcasting (RADIO-i) is introduced. RADIO-i offers information services to foreigners in Tokai area.

Structure of Broadcast Message

Alarm sound is firstly played for attention-calling. Then the alert messages are repeated two times both in Japanese and English.



Definition of Phrases and Formats

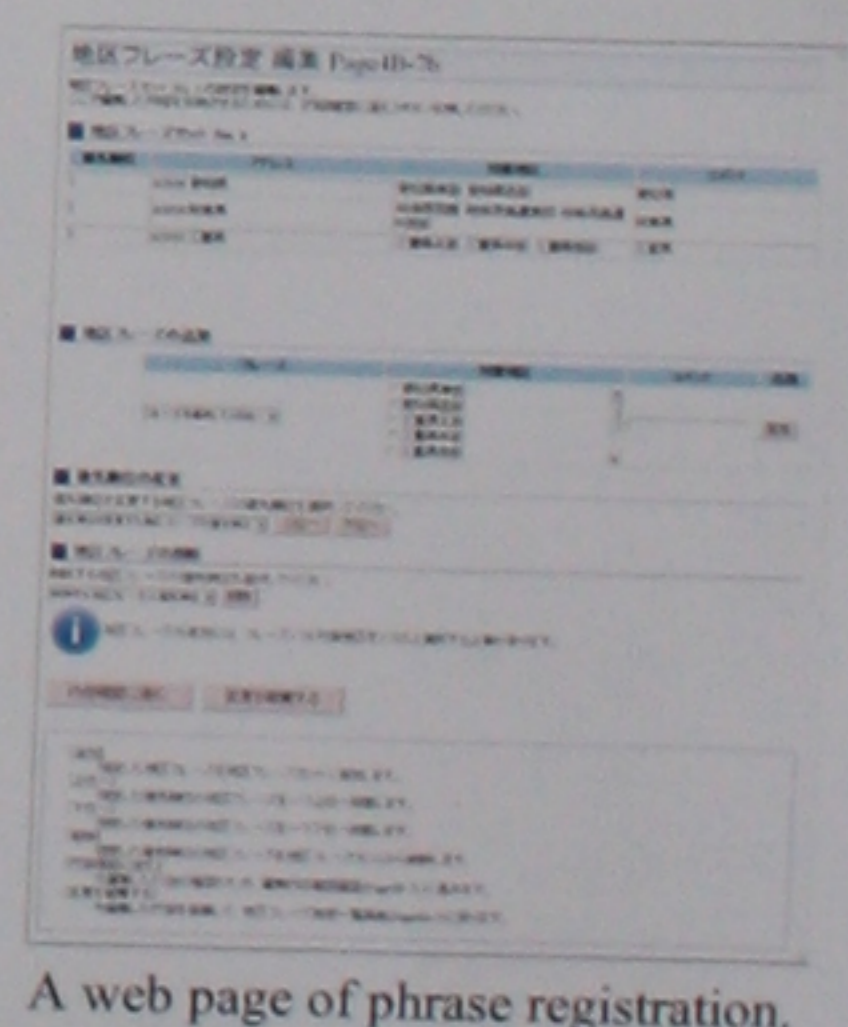
- [0] (EEW sound composed by NHK: Japan Broadcasting Corporation)
- [J-7] 緊急地震速報です。(This was an emergency earthquake warning.)
- [J-8] 激しく揺れている地域では、...(While strong shaking, protect your head and shelter under a table...)
- [J-9] 揺れが収まったら、火の始末をしてください。...(After shaking, turn off the gas in the kitchen...)
- Format-1 (Japanese message)
 - [J-1] 緊急地震速報です。
 - [J-2] (震央地名)で、
 - [J-3] 地震が発生しました。
 - [J-4] 強い揺れに注意してください。
 - [J-5] あわてず身の安全を確保してください。
 - [J-6] ドライバーは安全を確認してゆっくり減速して下さい。
- Format-2 (English message: Meaning is the same as Format-1.)
 - [E-1] This is an emergency earthquake warning.
 - [E-2] An earthquake has just occurred
 - [E-3] (epicenter location name).
 - [E-4] Please be aware that strong tremors may occur at any minute.
 - [E-5] Please remain calm and evacuate immediately to a safe place.
 - [E-6] Drivers should slow down and stop their vehicles safely on the side of the road.

- The message is structurally defined in advance, using phrases and formats. The message is generated joining up to 2,000 segments recorded in the compact flash memory card.

- The epicenter location and the area names of strong shaking expected can be inserted by analyzing EEW telegrams.

- This system can adapt to the cases that the regions where strong tremors are expected become widespread by the renewal of the EEW, and that another EEW about another earthquake which occurs nearly simultaneously is issued during the interrupt-broadcasting.

- Operators in radio stations can define their alert messages via Web pages of the main control server.



A web page of phrase registration.

5. Summary

- Our system is developed considering the system generality for other ordinary radio stations to introduce without change.
- Many kinds of I/O signals make it possible that engineers of each radio station extend self-produced interfaces to adapt the system to their circumstances.
- EEW broadcasting is a rare event. Therefore, usual condition monitoring is also a very important function for the long term operation. Our system checks its I/O control functions using time tone telegrams received from JMA servers on the hour every hour.