G2-080142
Agenda Item 5.3.7

ETWS Primary Notification

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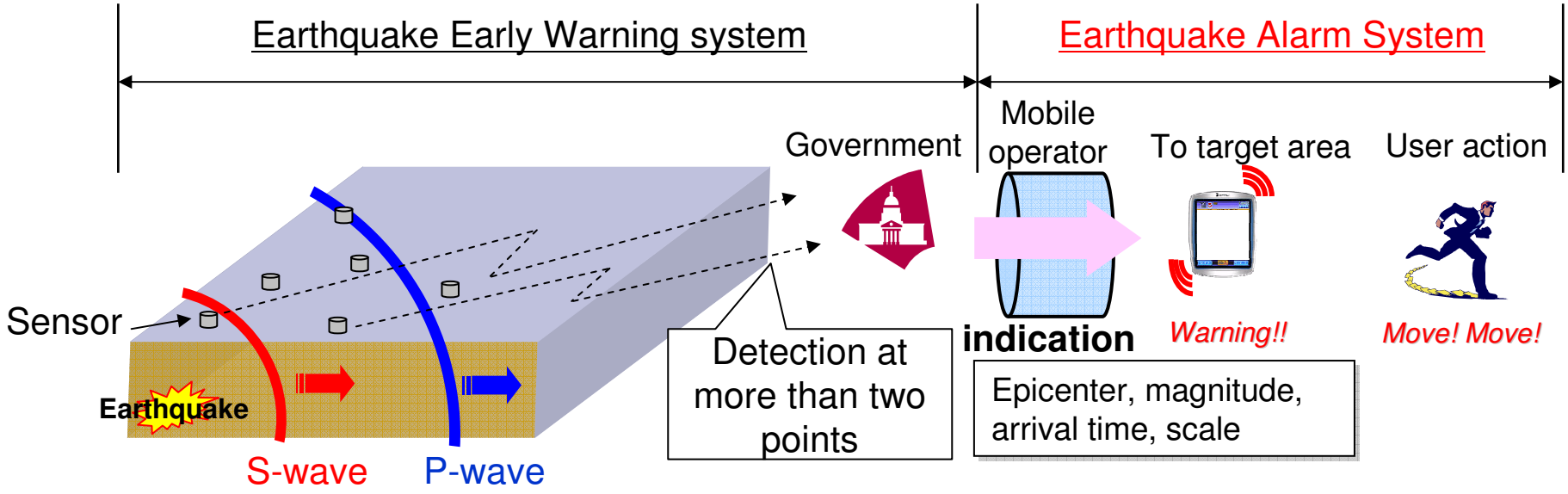
Contribution Overview

- ETWS requirements were derived from the description in TS 22.968 Annex B

- This contribution gives a short summary of TS 22.968 Annex B
  - How the Primary Notification duration was derived
  - and the amount of information to convey in the Primary Notification

Earthquakes Overview

- Two types of waves are produced when an earthquake happens
  - Primary wave (P-wave)
  - Secondary wave (S-wave)
- Existing early warning system in Japan relies on the detection of the P-wave
- Once detected, the earthquake alarm system is triggered, notifying the impacted areas well before the S-wave arrives



Derivation of the 4 seconds ETWS primary notification requirement

- P-Wave: little destructive force, travels at 7 km/sec
- S-Wave: major destructive force, travels at 4 km/sec
- Distance from epicentre to the area nearest to the epicentre in disaster areas can range from 10-50 km
- => arrival time interval at the area between Primary wave and Secondary wave is about 3-17 seconds
- It takes 5 seconds for the earthquake detection system to send Earthquake Early Warning information to a mobile operator
- It takes 2-3 seconds for users to take safety measures

Therefore, it is ideal to shorten the PWS delivery time to the order of seconds, not minutes

Derivation of the 4 seconds requirement (cont..)

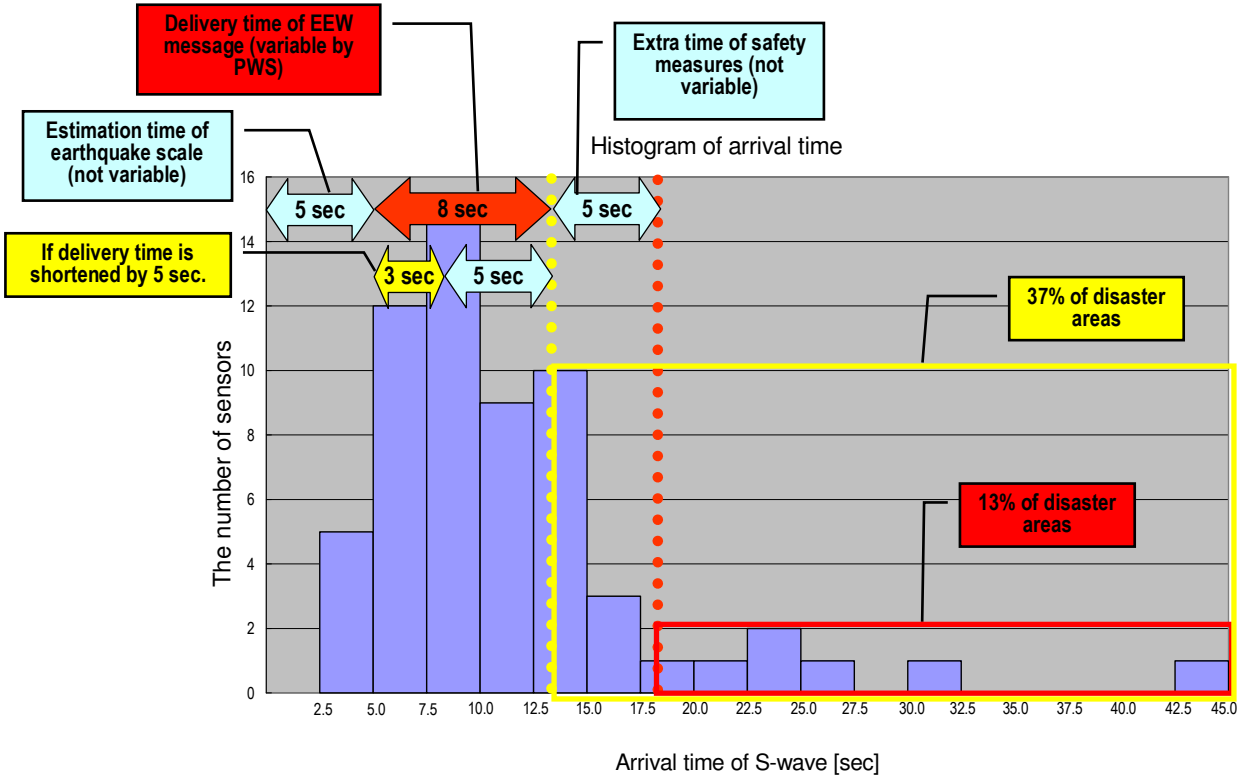
- Based on example scenario in Japan
- 2004 Chuetsu earthquake because it is the most recent inland earthquake
- Depth of epicentre is 13km
- Calculate a propagation distance of S-wave between the epicentre and a sensor: D

$$D = \sqrt{(\text{distance between sensor and epicentre})^2 + (\text{depth of epicentre})^2}$$

- Propagation speed of S-wave: V = 3.5 km/s [1]
- Calculate arrival time of S-wave: T

$$T = D / V$$

- Draw a histogram, and then compare arrival time S-wave with delivery time of EEW message (see next slide)



- Figure shows arrival time of S-wave measured at each earthquake sensor in the 2004 Chuetsu earthquake
- If the EEW is delivered within, say, 8 secs (red arrow), the figure indicates that
  - the EEW message is only delivered to ~37% of disaster areas before the S-wave arrives
  - including time to take safety measures, then a 8 secs EEW delivery time will be useful to only ~13% of the disaster area
- If the delivery time is shortened by 5 secs to 3 secs, notification can be delivered to 74% of the disaster areas, but only effective to ~37% of disaster areas when including time to take safety measures

Note: statistics of past earthquakes indicate that the average time for the EEW system to detect the earthquake scale and issue a warning was 5 seconds

Justification for the amount of information needed for earthquake notification

- It is sufficient to transfer a few bits of data to have handsets ringing, buzz, or display a short text prepared in a handset
  - e.g. "Earthquake Warning! Do safety measures!"
- There is very little time to read the text for users to quickly execute safety measures (e.g. extinguishing gas stoves, opening doors, hiding under the table, moving to a safer place), before the arrival of the destructive Secondary wave
- After an earthquake happens, it would be effective to deliver more data such as map for navigation to safe area or emergency facility where users can get important information, food, or essentials for life

Our Summary

- On the 4 seconds requirement to deliver the Primary Notification
  - How this requirement was derived shows that the notification cannot fundamentally guarantee to reach 100% of the disaster area
  - Therefore, the service is based on “best effort”
  - It is more important to deliver the primary notification in the shortest time possible (in the order of seconds)
- On the amount of information needed to deliver warning message to users
  - Some countries do not have regular earthquake drills like Japan
  - Telecom infrastructure may be damaged as a result of a earthquake so delivering the secondary notification may not be possible

Reference

[1] H. Yamanaka, et al., "Estimation of local site effects in the Ojiya city using aftershock records of the 2004 Chuetsu earthquake and micro tremors", (http://www.eri.u-tokyo.ac.jp/hirata/chuetsu/kakenHoukoku/5.2yamanaka.doc)

[2] TS 22.968 Annex B: Japan - Public Warning System (PWS) Use Cases Earthquake and Tsunami warning