PNW ShakeAlert

Earthquake Early Warning for the Pacific Northwest

The PNW ShakeAlert Demonstration System

Goals of the PNW ShakeAlert Demonstration

- Overall: prepare the best EEW system for wide distribution and use (~2 years)

- Demonstrate viability and usefulness of ShakeAlert warnings

- Understand users needs and adapt ShakeAlert to meet them

Goals of the PNW ShakeAlert Demonstration

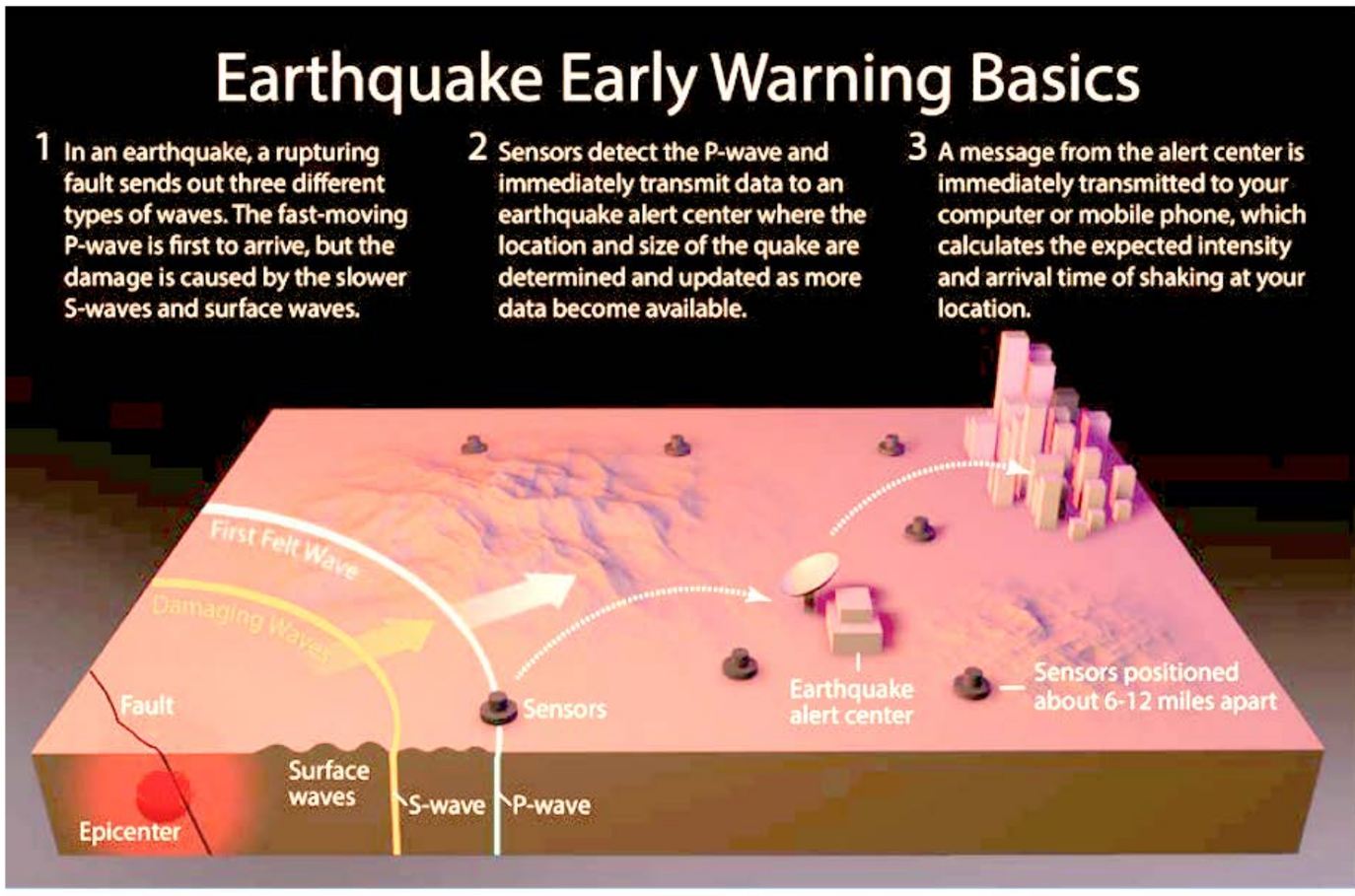
- Identify users (and uses) in your organization.
  - – those for whom EEW will make their job easier
  - – advocates for EEW
- Communicate user experience and ideas to us—we want feedback!
- What will it take to implement EEW in your organization?
  - – who and how? challenges? technical help?
- Each organization develop an “action plan” to implement EEW, with PNSN collaboration.

Definitions…

- **ANSS / PNSN / RSN**
  seismic monitoring network.
- **EEW**
  generic Earthquake Early Warning.
- **ShakeAlert (PNW ShakeAlert)**
  A particular EEW system developed in California. We use a variant here. May use several methods.
- **ElarmS**
  A particular seismic EEW method within ShakeAlert. Processes seismic data and provides warning messages.
- **UserDisplay (PNW UserDisplay)**
  A stand-alone computer application that receives ShakeAlert messages, then calculates and displays (for humans) expected shaking levels and times.

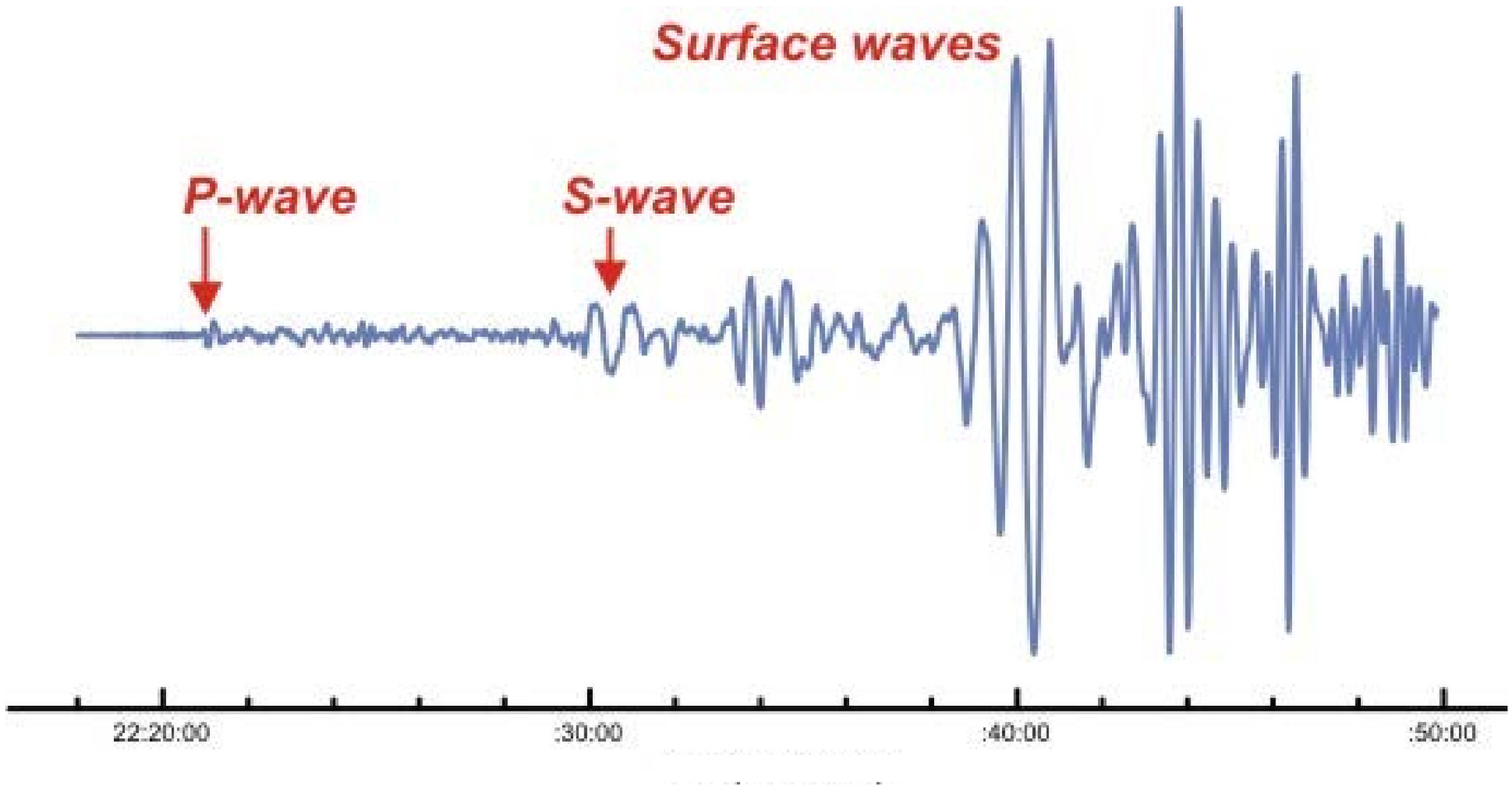
What is Earthquake Early Warning?

- Rapidly detecting and evaluating the strength of an earthquake (within seconds)
- Estimating likely impacts
- Alerting customers before strong shaking hits them
  - There must be time to take defensive action
  - At most this will be several minutes, more commonly less than a minute



How EEW works

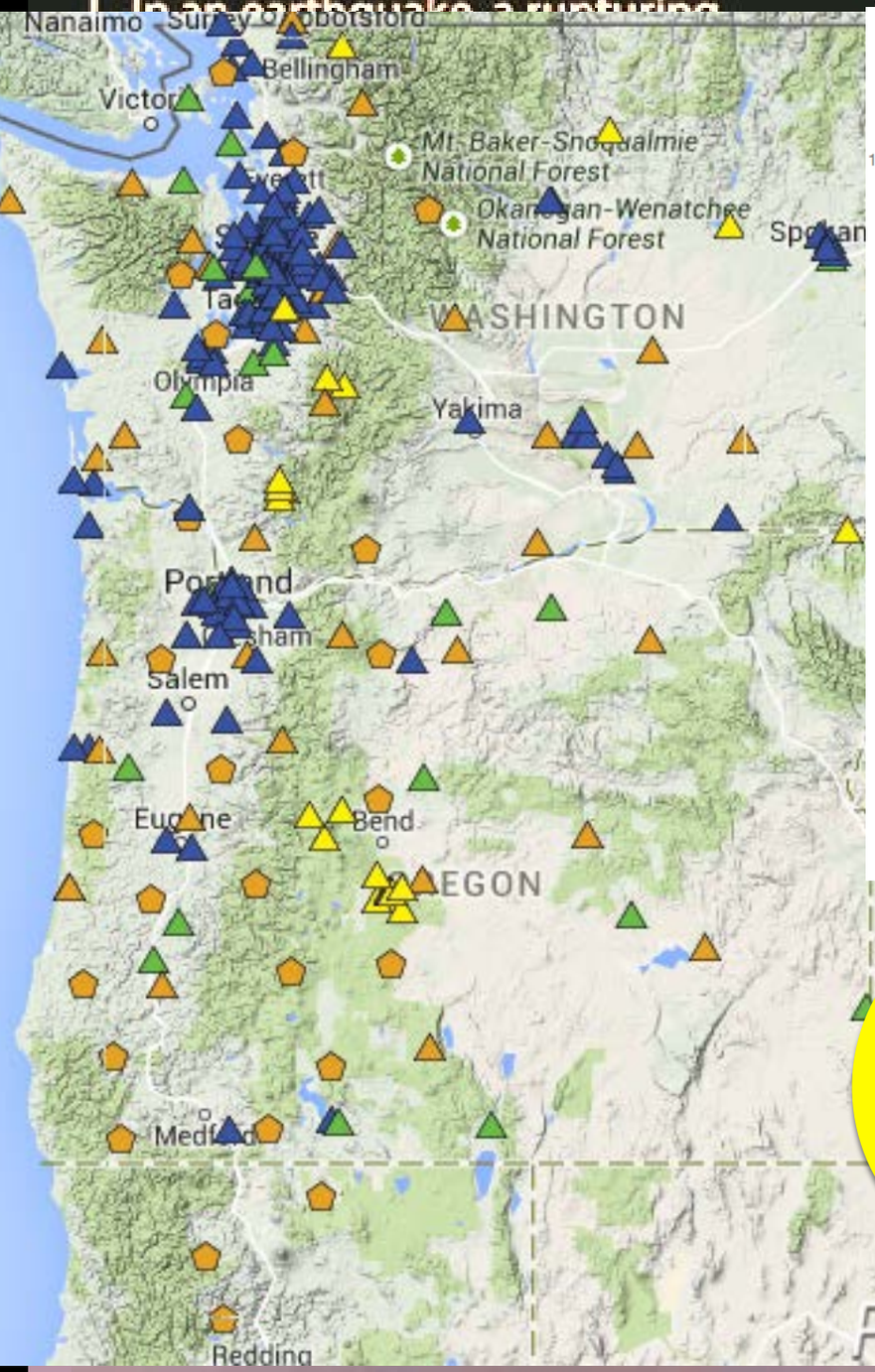
- Damaging seismic waves are slower than smaller “P” wave vibrations.

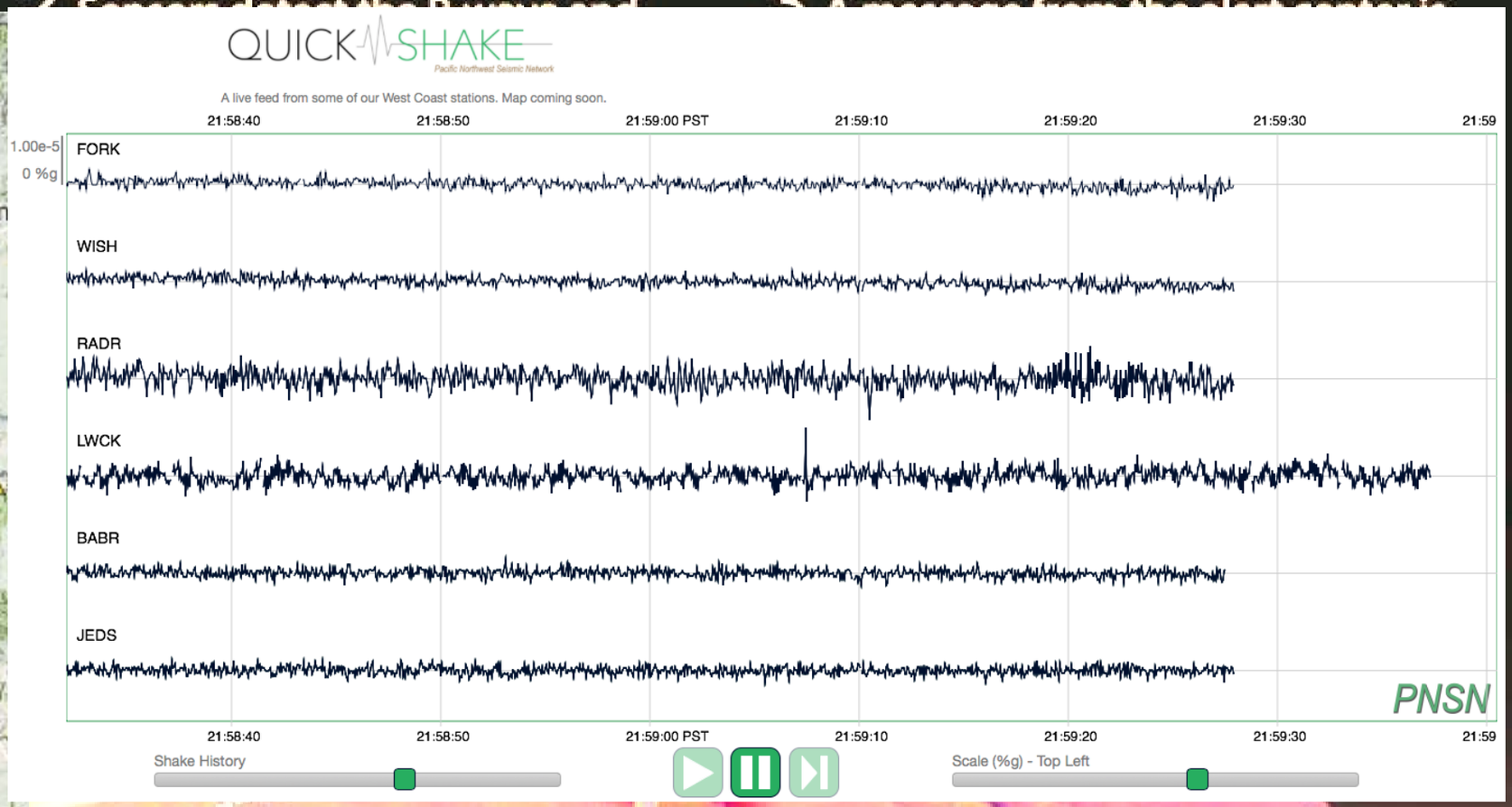


- The amplitude of the early P-wave grows with magnitude of earthquake.

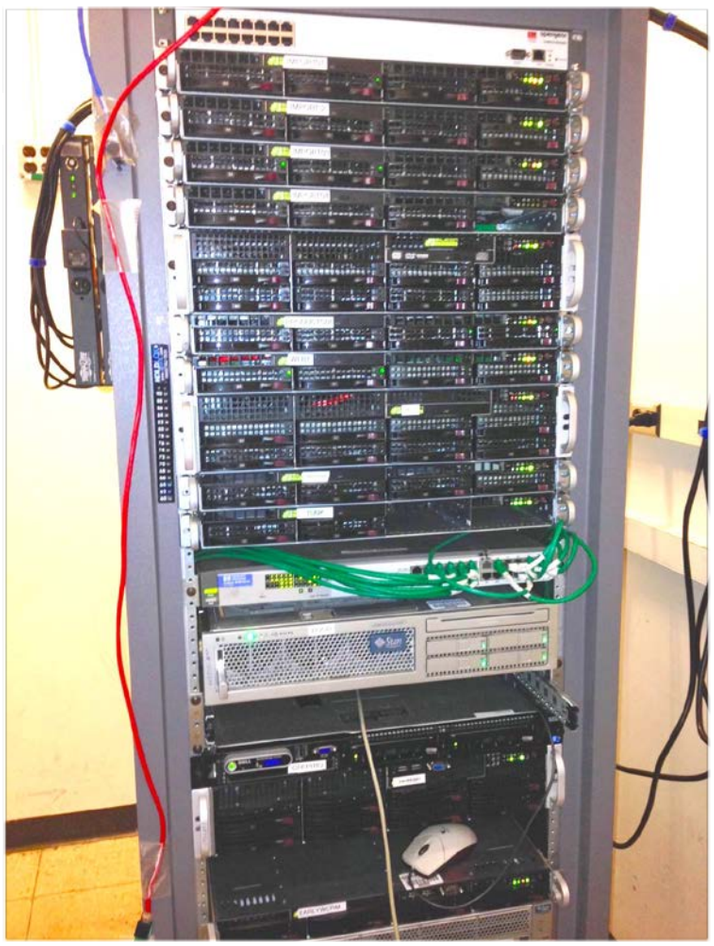
Seismic data in real-time from ~220 stations in PacNW

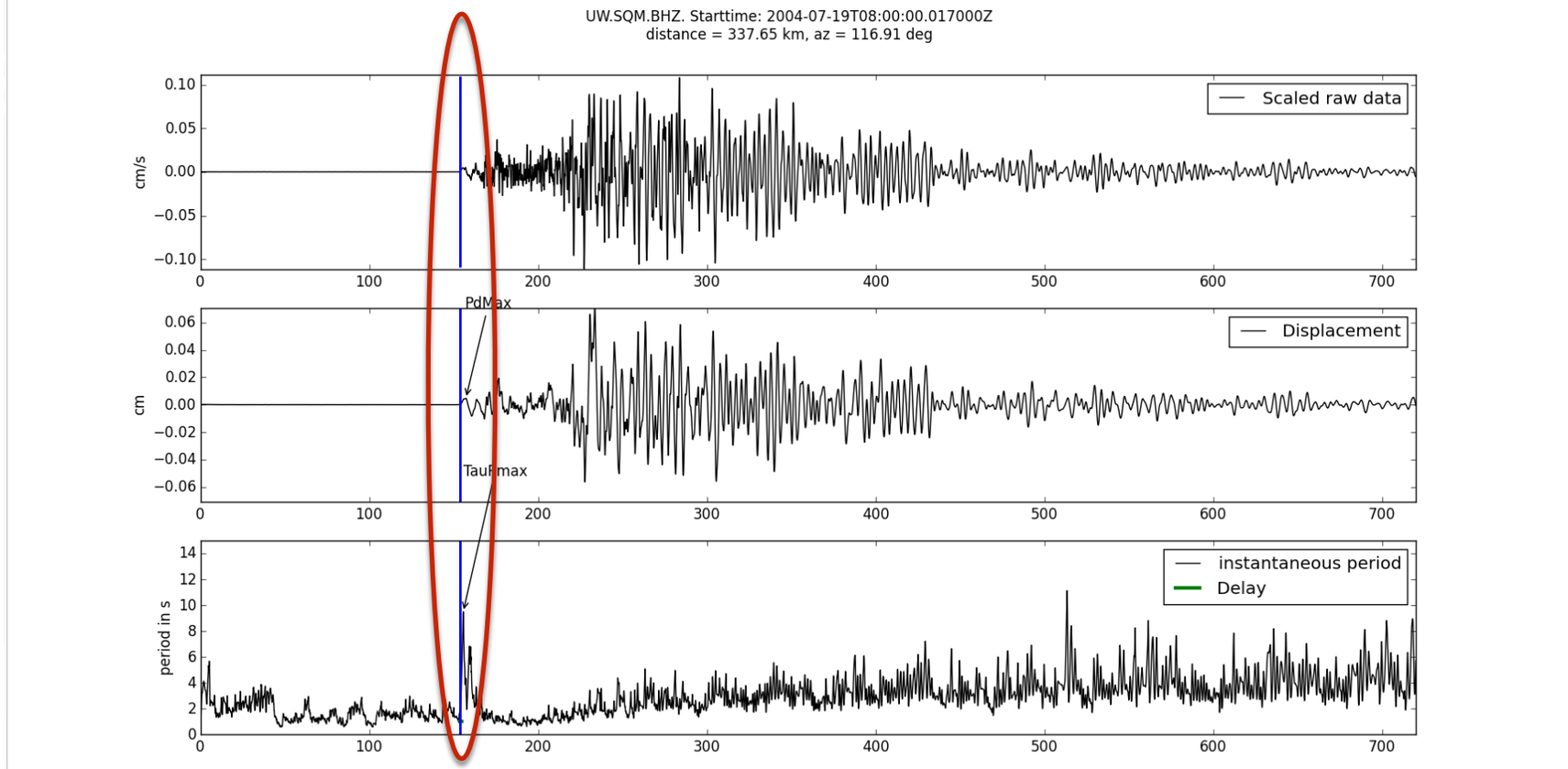
Earthquake Early Warning Basics





ElarmS - based on first 1-4 sec. of P-wave





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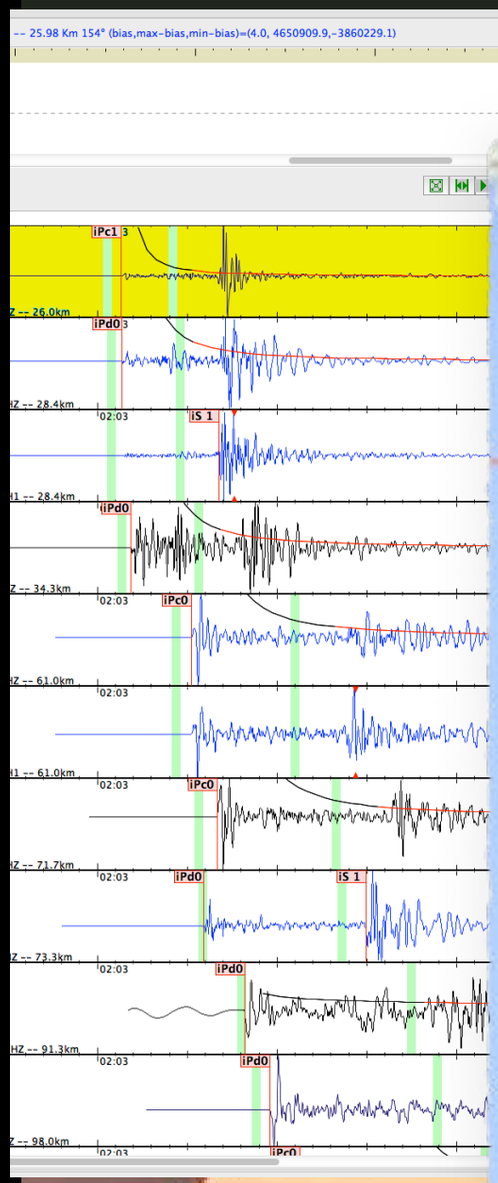
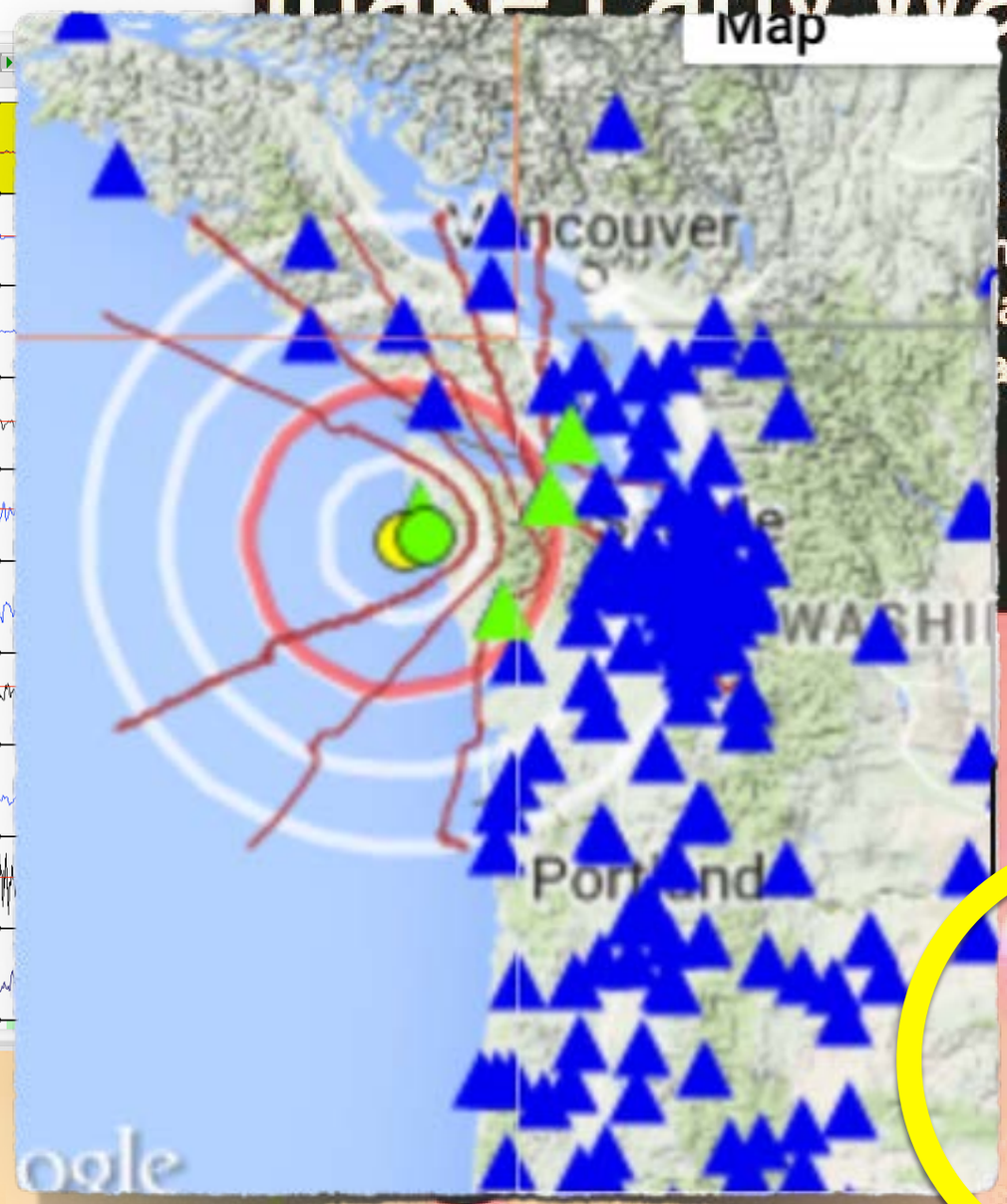
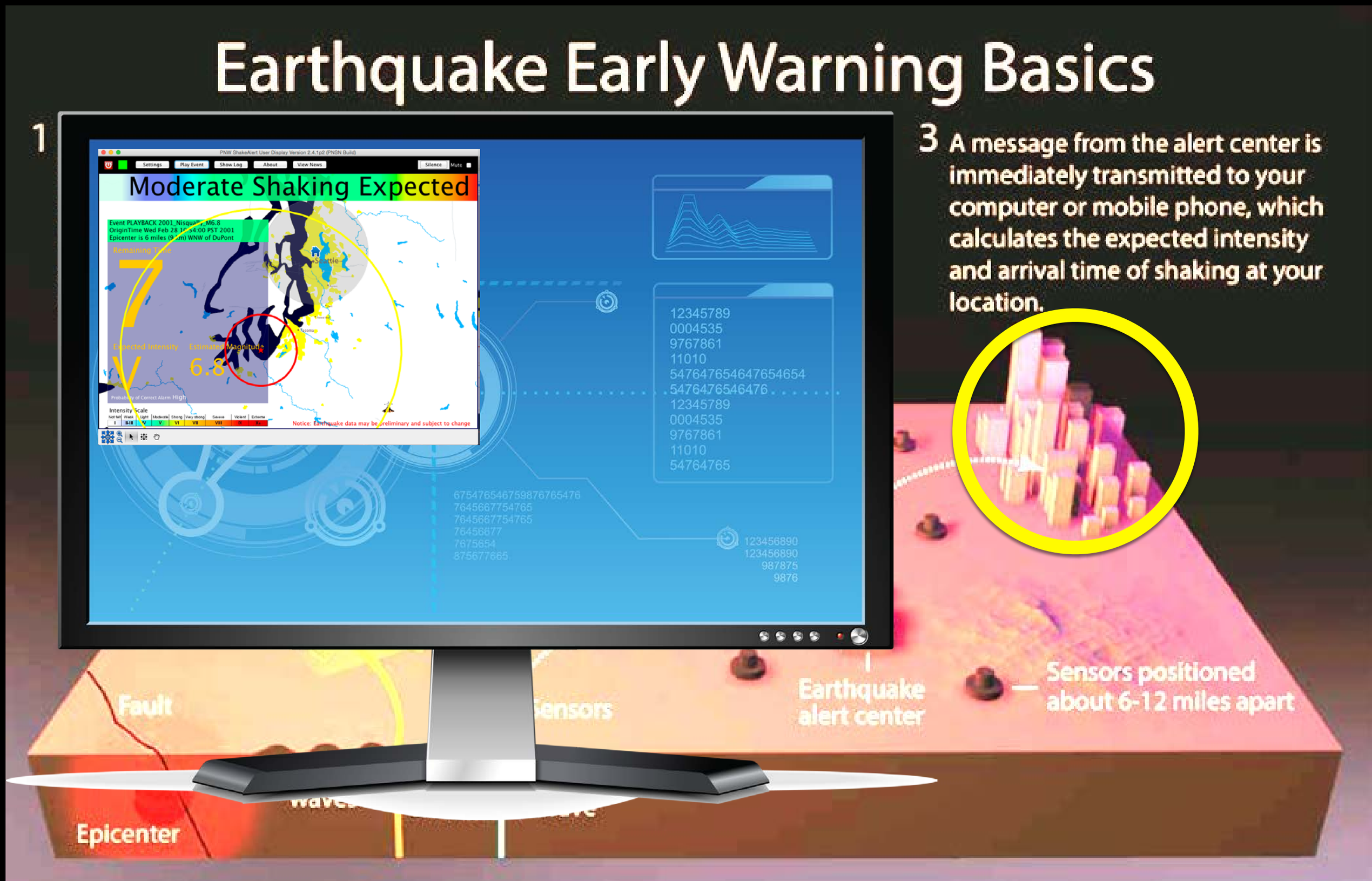




Alerts sent to UserDisplay (Mag, Location, Time)



PNW ShakeAlert User Display Version 2.4.1p2 (PNSN Build)

Settings | Play Event | Show Log | About | View News | Silence | Mute

Moderate Shaking Expected

Event PLAYBACK 2001_Nisqually_M6.8
OriginTime Wed Feb 28 10:54:00 PST 2001
Epicenter is 6 miles (9 km) WNW of DuPont

Remaining Time
7

Expected Intensity
V

Estimated Magnitude
6.8

Probability of Correct Alarm High

Seattle
Renton
Kent
Federal Way
Tacoma

Intensity Scale

Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
I	II-III	IV	V	VI	VII	VIII	IX	X+

Notice: Earthquake data may be preliminary and subject to change

Automated Control

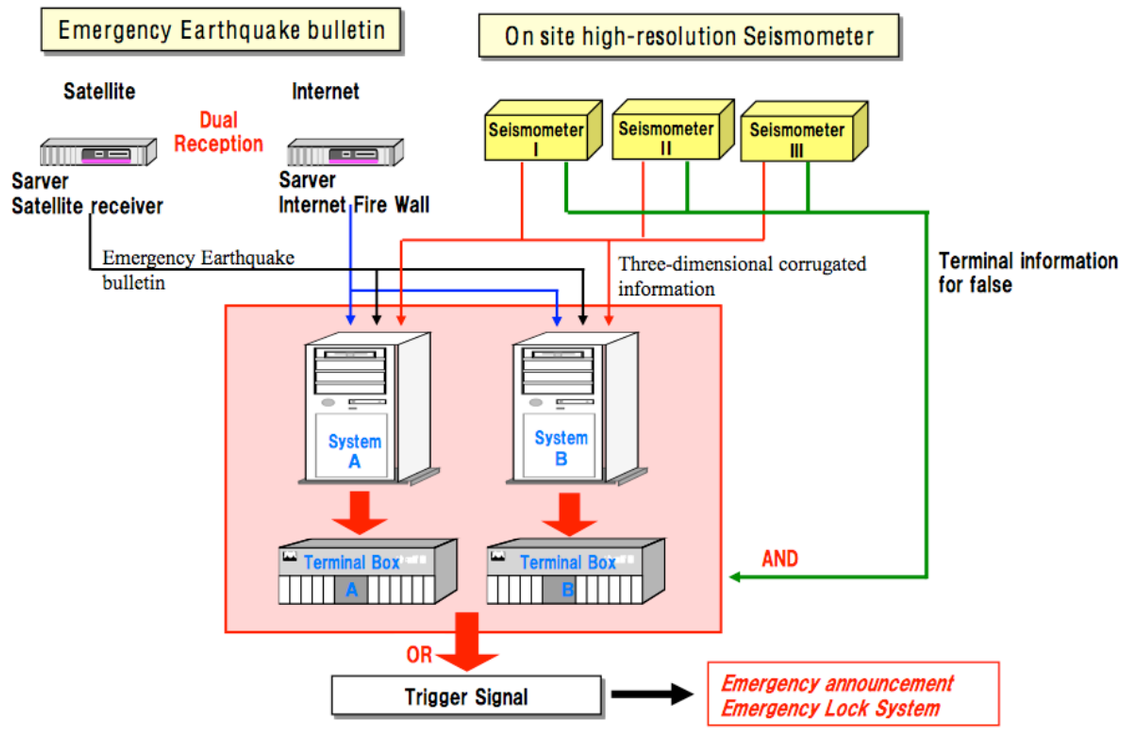
OKI Engineering Co.,Ltd.

chip manufacturer

Miyagi, Japan

2003: Two damaging earthquakes

- $15 million in losses
- fire, equipment damage
- 17 and 13 days loss of productivity

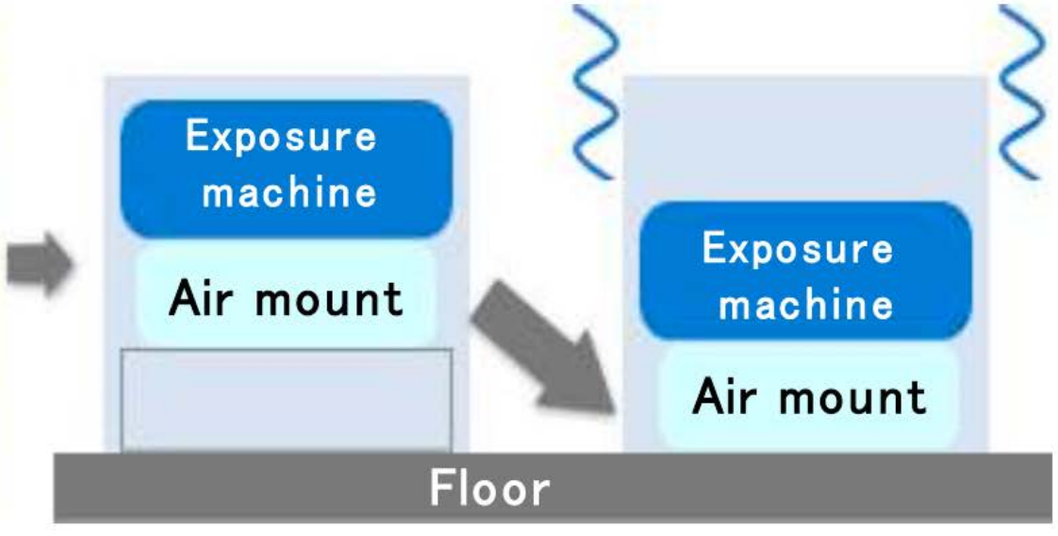


Spent $600K on early warning and shear walls in basement

- Sensitive equipment set down on floor to reduce shaking and damage

Two similar earthquakes

- $200K in losses
- 4.5 and 3.5 days loss of productivity



Automated Control

Bullet trains

At the time of the M9 Tohoku-oki earthquake…

- **24 trains were running in the Tohoku Shinkansen system**
- 9 seismic sensors along the coast, and 44 sensors along the train track
- detected the initial tremor; automatic shutdown of power; activation of the emergency brakes
- **all trains stopped without derailment**
- they did not sustain any damage on bridges and tunnels, and could restore the operation very quickly

- from Asahi

阪神や中越教訓 対策進め復旧へ

東北新幹線

東北新幹線が4月下旬までに全線で復旧の見込みになった。架線の切断や電柱の傾き、高架橋のひび割れなど、被害は大宮（さいたま市）－いわて沼宮内（岩手県岩手町）の区間（路線延長496・2キロ）で計約1200カ所に及んだ。それでも早期復旧にこぎ着けたのは、過去の地震被害を教訓に対策を進めてきたからだ。＝1面参照

1995年の阪神大震災では、山陽新幹線で高架橋や橋柱の鉄筋コンクリートが崩れる「せん断破壊」が発生、8カ所で橋げたが崩落した。全面復旧に81日もかかった。2004年の新潟県中越地震では上越新幹線「とき325号」が脱線し復旧に66日を費やした。

JR東は阪神大震災を教訓に、95年度から新幹線高架橋の柱に鉄板を巻く補強工事を始めた。中越地震を受けて工事のペースを早め、07年度までに対象となる約1万8500本すべてで工事を終えた。今回、せん断破壊は起きず、橋や高架橋、トンネルの崩落もなかった。同社は「早期復旧が可能になったのは、ゼロから作り直さなければならない致命傷がなかったことが大きい」と話す。

人的被害もなかった。11日の地震発生時、東北新幹線は24本が営業運転中だったが、太平洋の海岸沿いに9カ所、さらに沿線44カ所にも設置した地震計が初期微動を検知。自動停電を受けて非常ブレーキが作動し、全列車とも脱線せずに停車した。けが人はなかった。中越地震以後、JR東は地震計を新幹線の沿線で28カ所増設し、非常ブレーキが作動するまでの時間を短縮するシステム改良もした。

中越地震の脱線事故の教訓から、JR東は脱線防止用に車軸に逆L字形の鋼鉄製ガイドを全ての新幹線車両に設置。今回、仙台駅へ向かっていた試運転列車1本が緊急停車時に脱輪したが、このガイドがレールに引っかかり、横転は免れた。

JR東は、管内の復旧工事にかかわる約8千人のうち、約3500人を新幹線の復旧に充てている。担当者は「中越地震の時、新潟の人たちから『新幹線の復旧は被災地に元気をくれる』と言われた。東北新幹線の全線開通を復興の一歩にしたい」と話した。

（宮嶋加菜子）

Communicating the Warning

Japan

earthquake location and hazard

estimated shaking in your area

TV and radio announcements

- 124 of 127 TV stations (98%)
- 41 AM, 35 FM radio (75%)

J-Alert messages

- 226 municipalities receive the warnings
- 102 announce them with public address systems

Cell phones

- 3 companies (Docomo, AU, Softbank)
- 52 million can receive them (47%)

Dedicated providers serve

- power plants
- factories
- schools
- hospitals
- shopping malls

PNW UserDisplay Demo

Miscellaneous Points

- Please don't share UserDisplay too widely
  - Keep track of who has it in your organization
- Consider CISN Display (or our PNSN Webpage) also to gauge UserDisplay performance
- Next UserDisplay release will allow multiple sites
- We'll send occasional "test events"
- Bill Steele will be coordinating feedback
- Computers can't be allowed to go into "sleep" mode
- Size of largest earthquakes (~M8+) likely currently underestimated by ElarmS. New GPS methods will fix.