

# Alert map generation and distribution within the context of the Self-Organising Seismic Early Warning Information Network

The SOSEWIN design group,  
SAFER and EDIM Projects

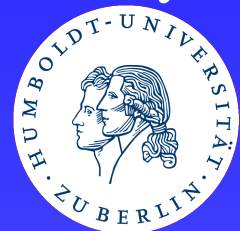
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# What is an "Alert map"?

- Term "Alert maps" first used by Wurman et al. (2007).
- Display of **predicted peak ground motion**, over a given area, using USGS ShakeMap "style" figures.
- Predictions based on earliest observations from the first triggered stations, and empirical attenuation relations. ElarmS, Allen & Kanamori (2003).
- Updated at regular intervals as more stations trigger and with longer time series available.
- Centralised processing.
- Alert maps converge towards shake maps.

# Other alert maps

Alert maps are also planned to be incorporated into alarm schemes by the IMO (Icelandic Meteorological Office) as part of the SAFER project.

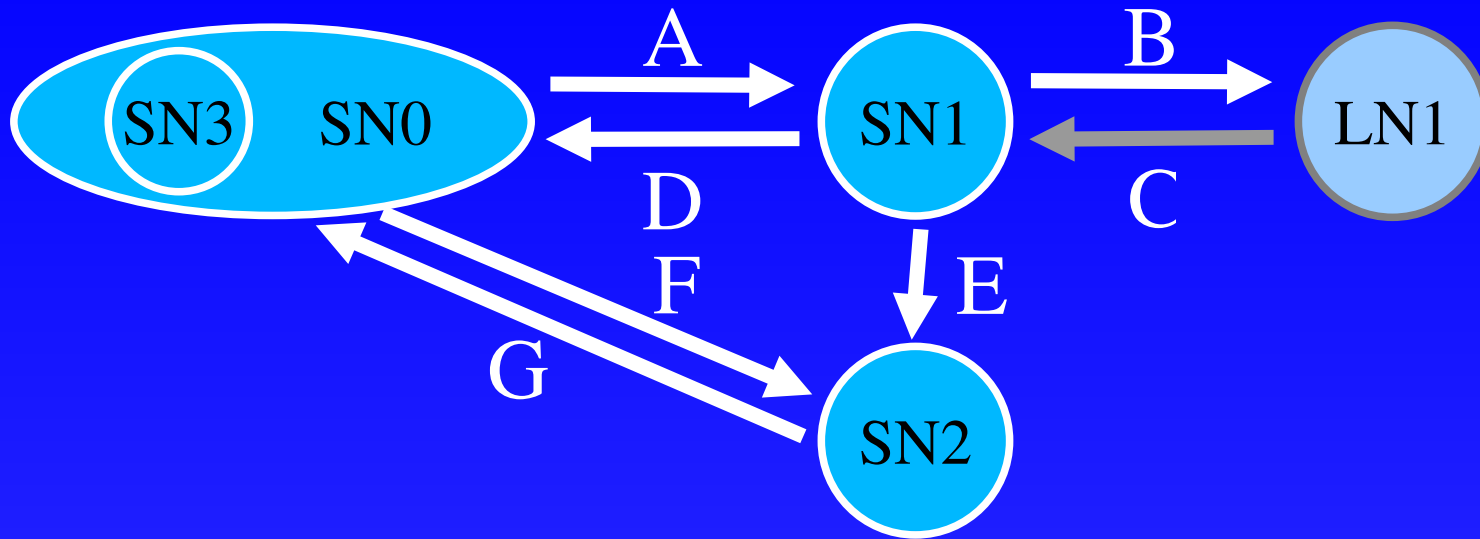
- Again, use of a centralised processing centre and empirical relations.
- "Alert maps" will show relative times for station alerts on real to near-real time web-based maps.

# Alert maps and SOSEWIN

Within the context of the SOSEWIN, alert maps are (will be) equivalent to an alert, and are characterised by

- Again, **predicted peak ground motion** based on the use of the earliest part of the signal i.e. P-wave arrival and updated as more information is available.
- Which "ground motion parameters" are to be used is still under discussion. Currently, we will determine
  - \* Cumulative absolute velocity
  - \* Predominant period
  - \* Arias intensity
  - \* Peak Ground Motion
- *Most importantly, will follow a decentralised approach.*

# Alert protocol - Sensing Nodes



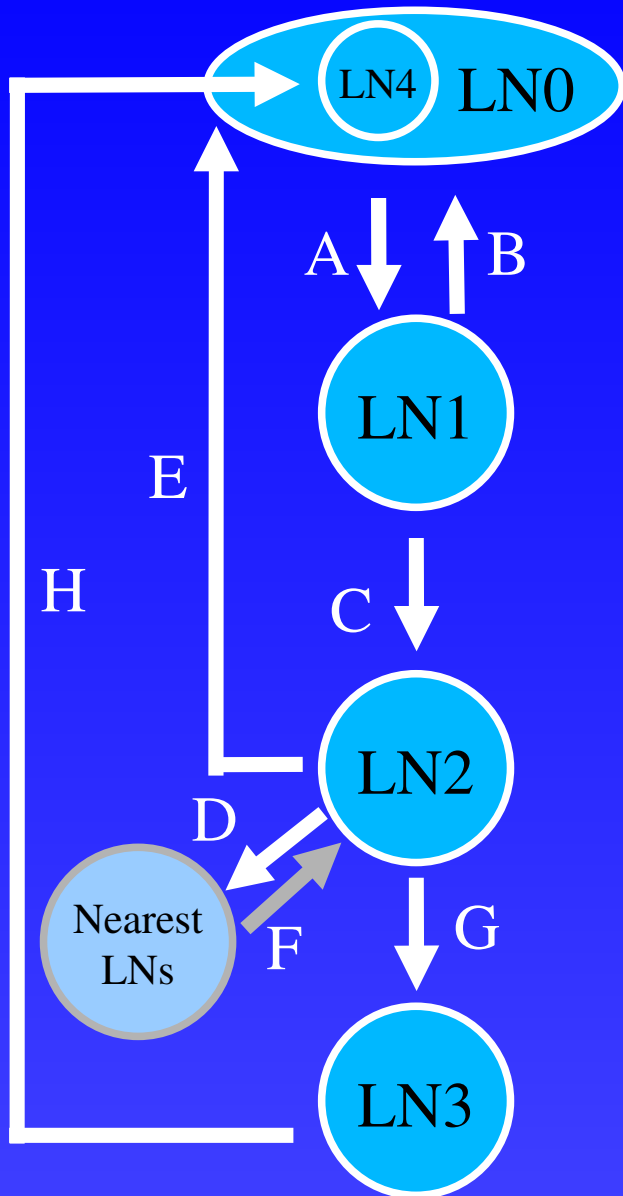
**SN0 Monitoring:** Each SN does its own processing and communicates with its LN.

**SN1 Detection:** The SN or LN is triggered (A) and informs its LN (B). If too few SNs trigger, the LN informs it (C) to return to monitoring (D).

**SN2 Characterisation:** The event is confirmed (E) or its LN tells it that one has occurred (F).

**SN3 Disaster management:** The event has ended (G) and a report describing is produced, including shake map files.

# Alert protocol - Leading Nodes



**LN0 Monitoring:** Communicates with its SNs and neighbouring LNs. The network can be reconfigured in this state.

**LN1 Sensor alarm:** A SN has been triggered (A). If too few SNs trigger, the LN returns to LN0 (B) and informs its SN to return to SN0.

**LN2 Group alarm:** LN informs its neighbouring LN (D). These LN are then in LN1.

**LN3 System alarm:** When 2 or more neighbour LNs confirm the event (F), i.e. also in LN2, a network-wide alert is issued (G).

**THESE ARE THE ALERT MAPS!!!**

**LN4 Disaster management:** When the event is over, the "all clear" is given (H). Checks the state of the network, if necessary, invokes reorganisation.

# How are system alerts/alert maps issued?

Because of the decentralised nature of SOSEWIN, each LN will need to know

- Location and state of all other LNs (possible with OLSR protocol).
- Local empirical relations.
- The initial P-wave/peak ground motion relations.
- Alerts are reissued as more data is available (time series and stations). Would include refining the location of the event.

The alert/alert map message will include

- Some measure of the size of the event.
- Some measure of the location.

**Question:** Should a LN determine for "specific" LNs their potential danger, then prioritizes communicating to them, OR, let each LN determine by itself if it is in danger.

# Incorporating 'alert maps' into SOSEWIN

(1) **Seismological:** Deciding which characterisation parameter(s) to use, and how to extract information from the initial P-waves (several seconds) and relate this to peak ground motion.

Local/regional attenuation relations, some of which we have (e.g. being developed within SAFER).

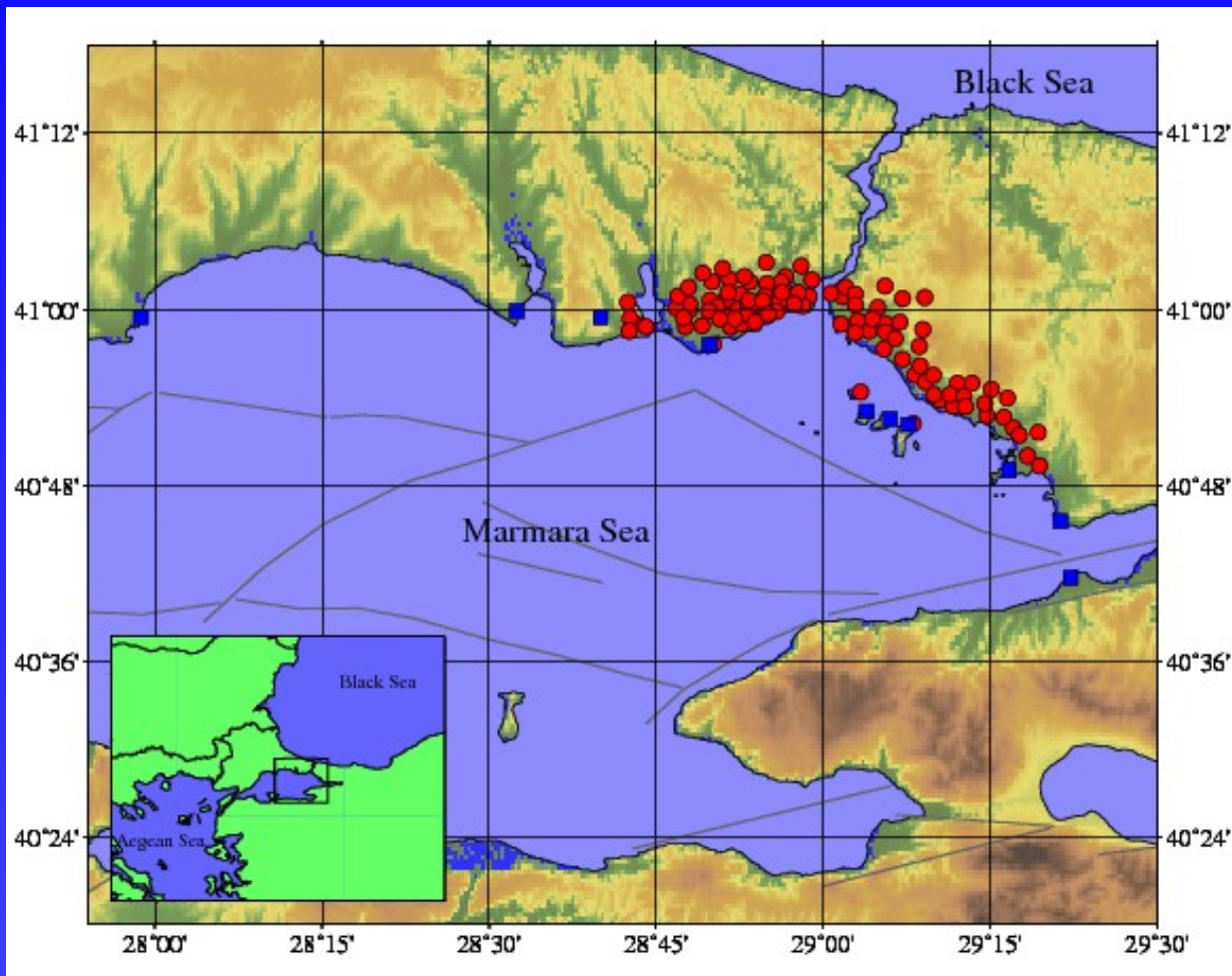
(2) **Informatics:** Deciding on which communications and routing protocols to use, and what information to send between nodes.

Is a function of

- Communications rate
- Data package size sent
- Targeted warning or network flooding

# Primary test area: Istanbul

Istanbul a test city for the SAFER and EDIM projects.  
Istanbul Earthquake Rapid Response and Early Warning System  
(IERREWS)



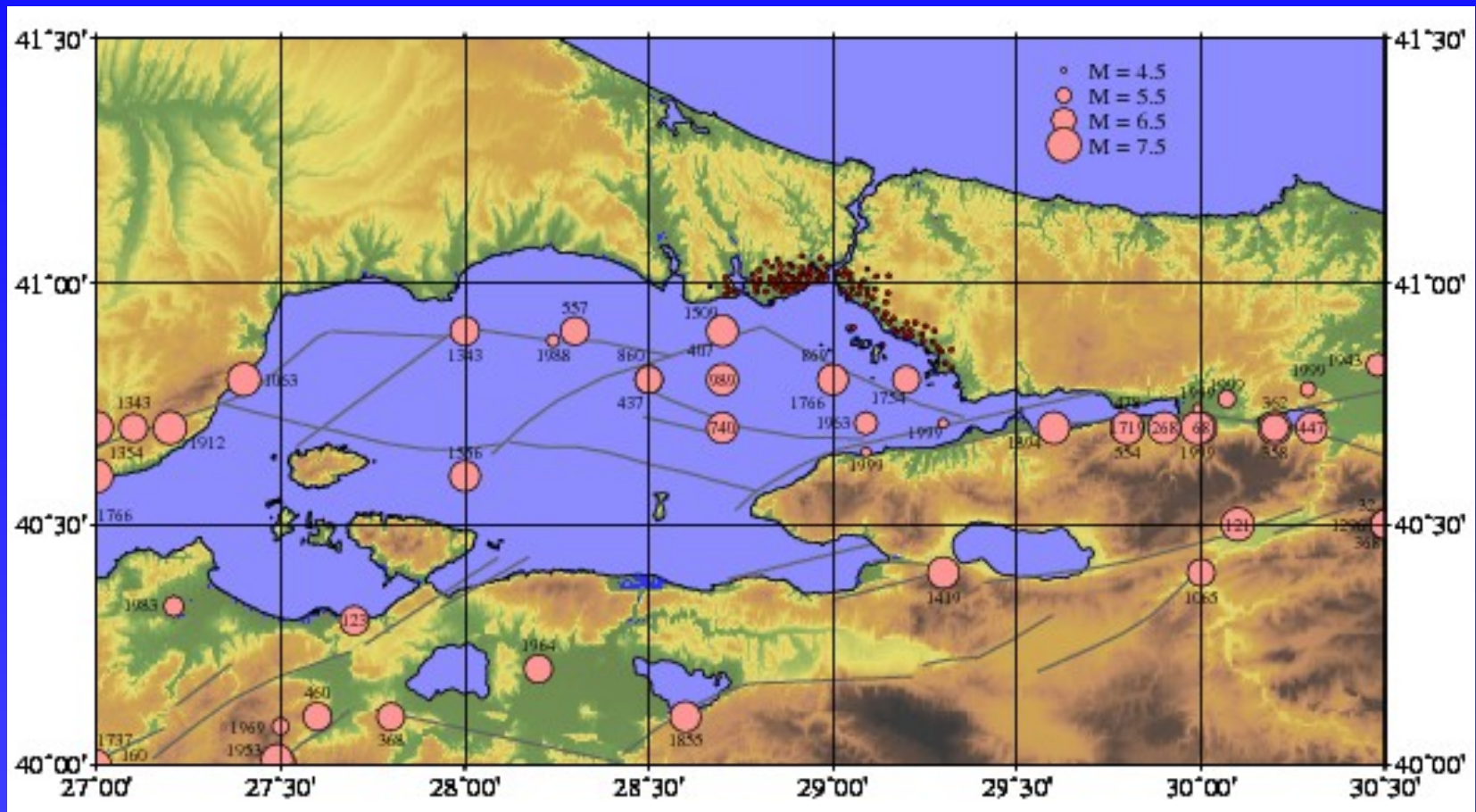
● Rapid Response (100)

□ Early Warning (10)

Grey lines faults  
(Ambraseys, 2002)

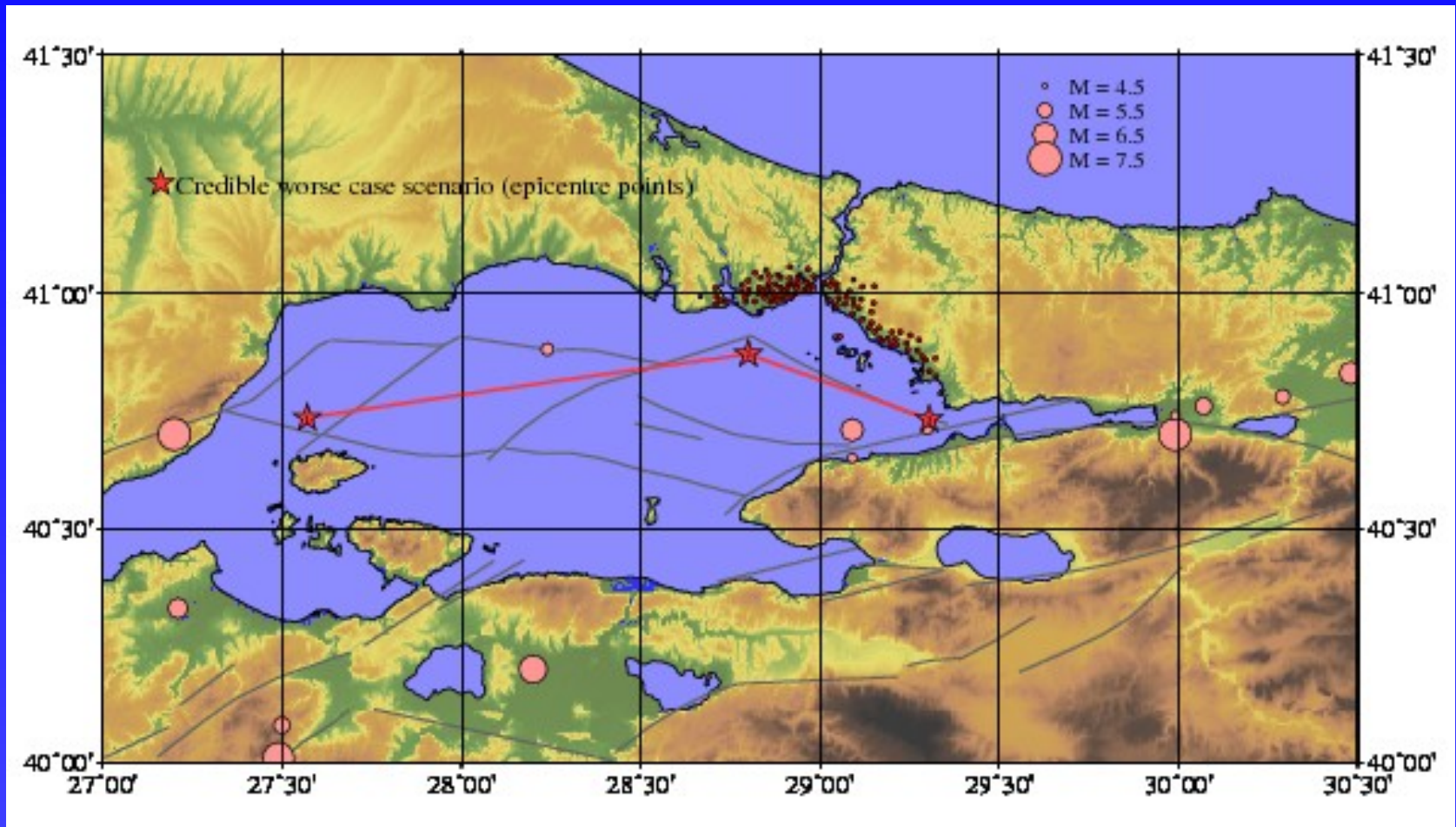
# Marmara Sea seismicity

Events for the past ca. 2000 years, suggest there is a large event "overdue" for the area closest to Istanbul.  
(Ambraseys, 2002, Sengor et al., 2005)



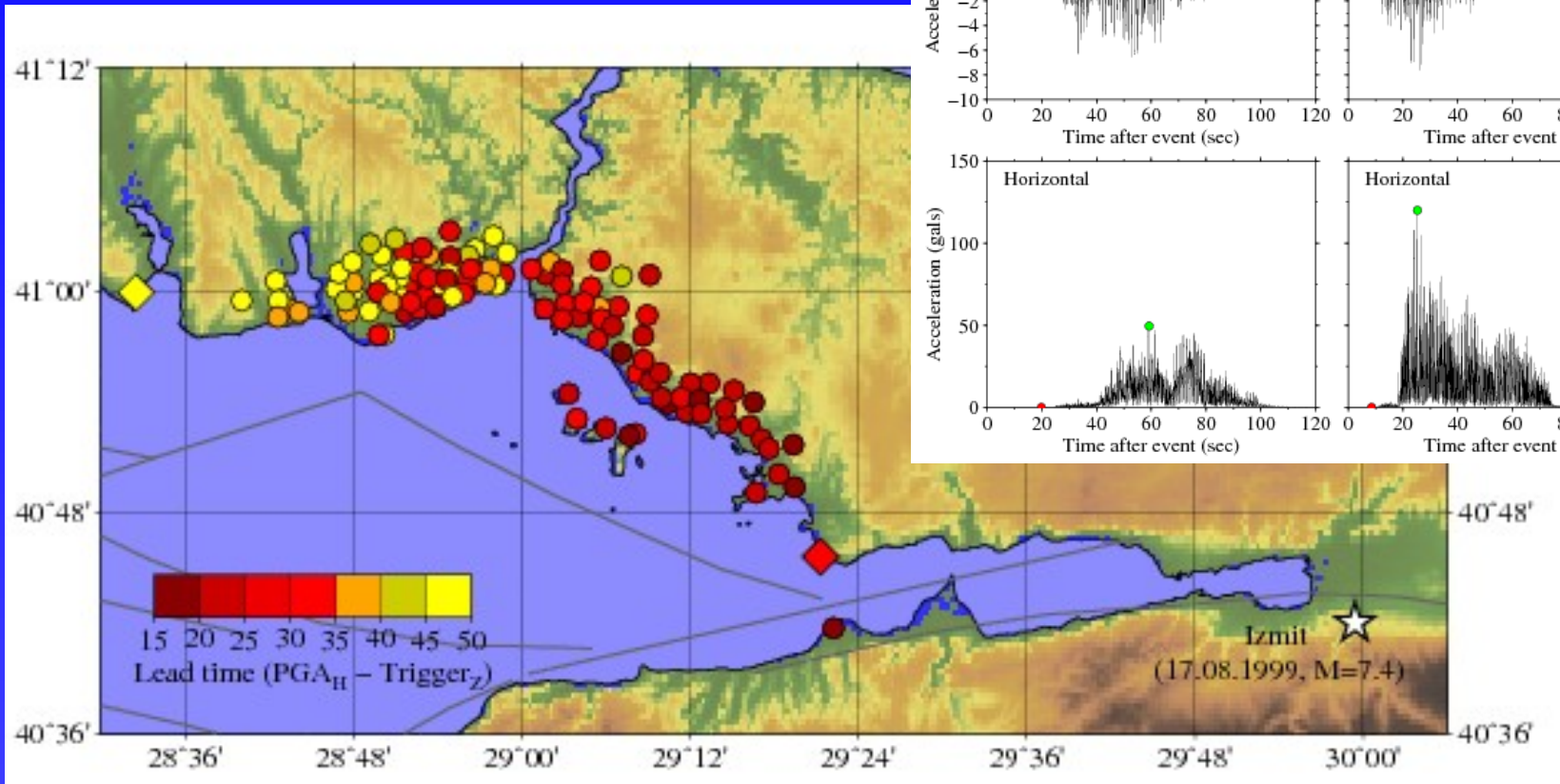
# Synthetic seismograms

As well as real data, synthetic seismograms (Wang, 1999) are used, using as examples events over the past century and the credible worse case scenario (Erdik et al., 2003; Pulido et al., 2004).



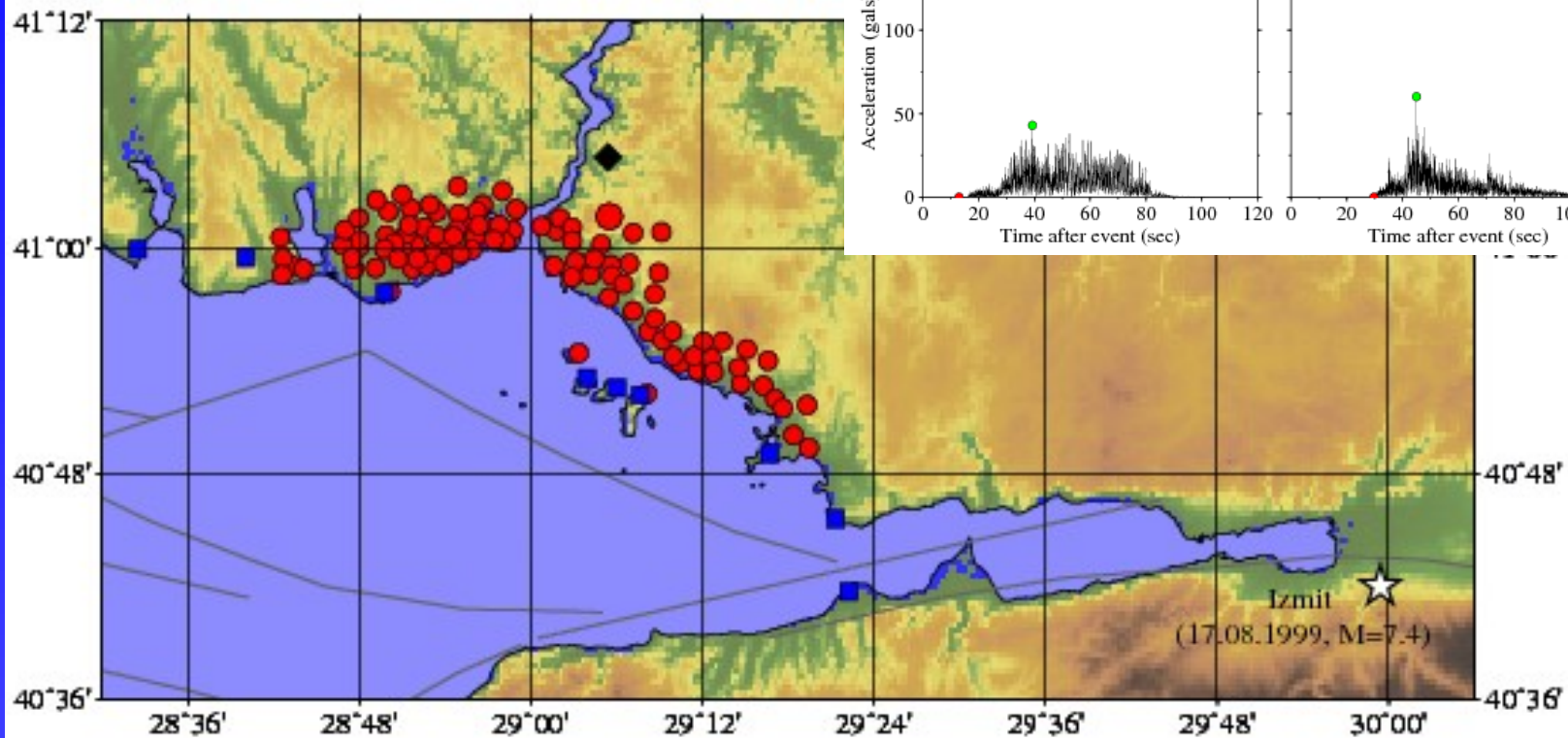
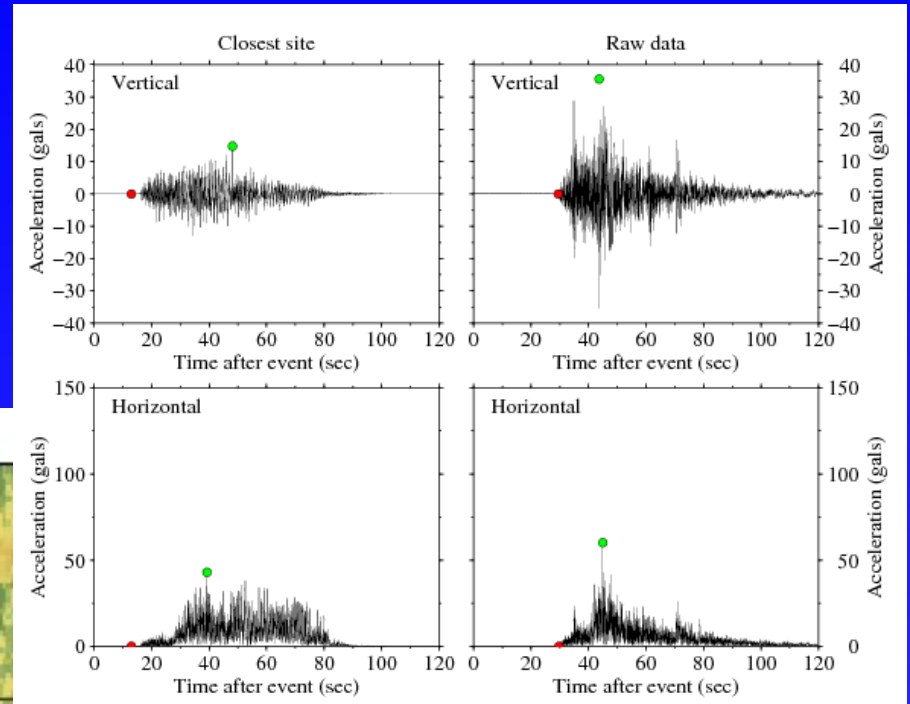
# Example: Izmit, 17.08.1999 event

Illustrative results for the  
Izmit 1999 event.



# Comparing synthetic and real data

Raw data from black diamond.  
Closest site larger circle.



# Inferring peak ground motion from earliest signal

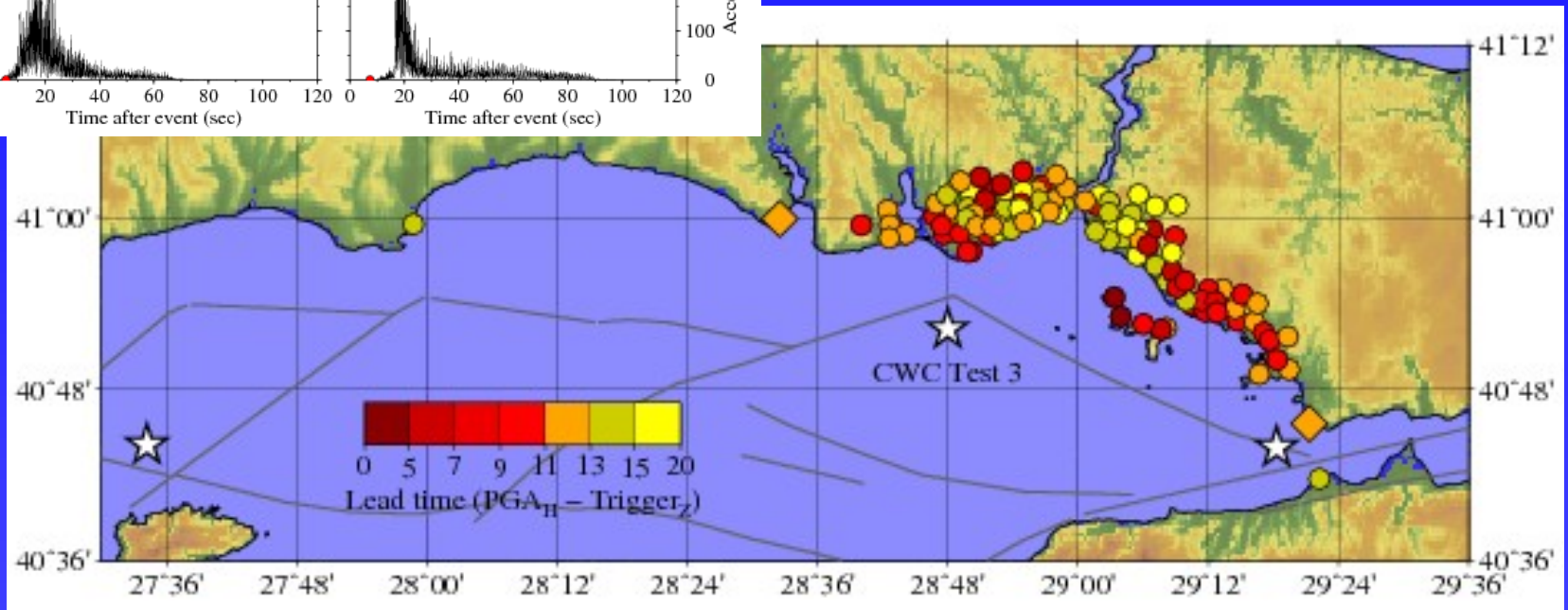
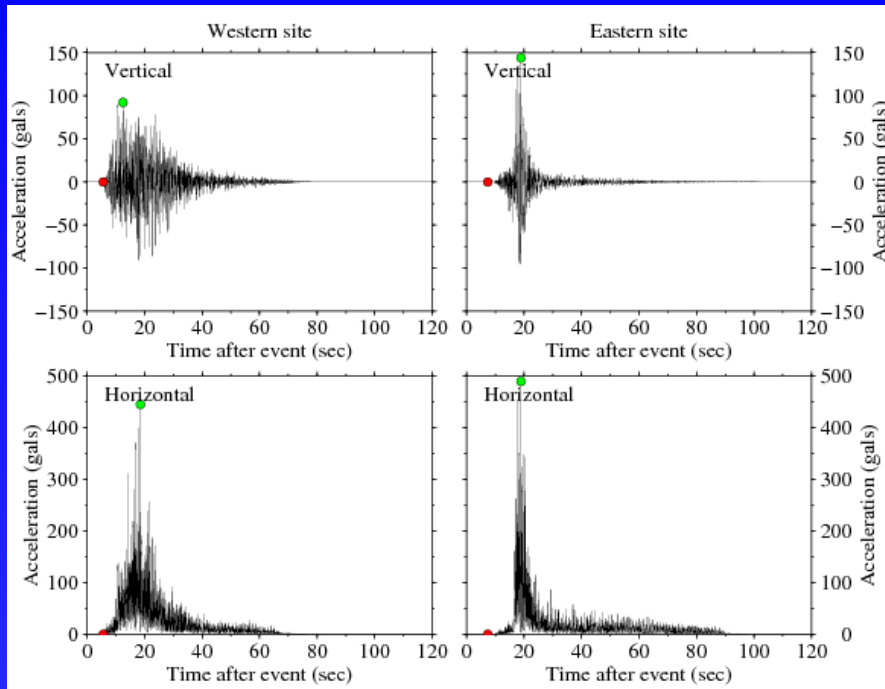
ESSENTIAL that this is rapid, and simple, as a limitation, a part from time, is the "low cost" cpu units in each sensor.

One method to be tested is the peak  $PGA_{p\text{-wave}}$  of the first few seconds, and relate this to the  $PGA_{s\text{-wave}}$ .

Need to estimate also the event's location, or at the very least, the general direction.

# Example: Credible Worst Case Scenario 3

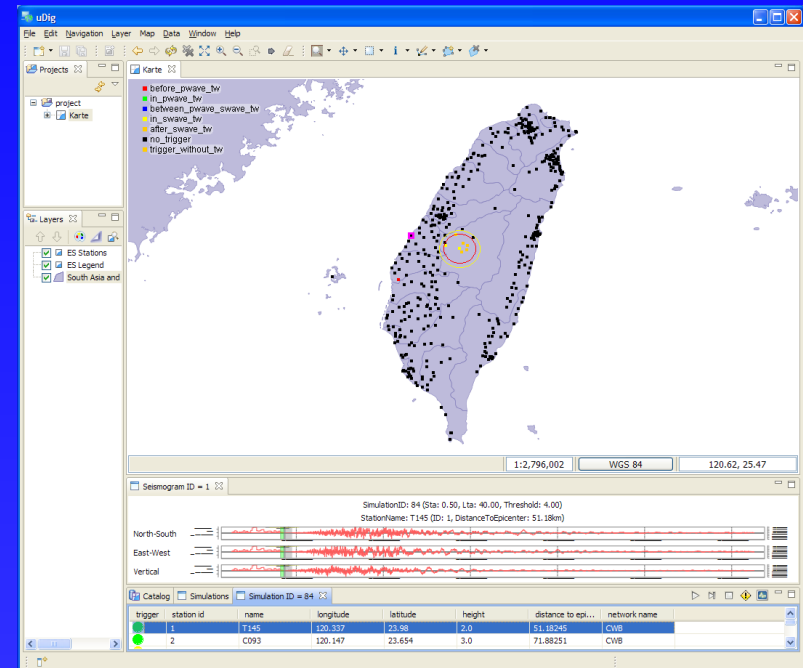
Illustrative results for a credible worst case scenario (M=7.4)



# SOSEWIN Network optimisation simulator

Being developed by Humboldt University of Berlin for SAFER and EDIM.

- Incorporates topography.
- Displays simulation results.
- Support for deployment.
  - ◆ Node hardware.
    - Placing nodes.
    - Health status.
  - ◆ Node software.
    - Updating processing codes.
- Monitoring of the installed SOSEWIN.



# Concluding statements

With the establishment of the test SOSEWIN in Istanbul, and the soon installation of the alert protocols, more detailed tests under realistic situations will be under way.

Future steps are divided between

- The "informatics" part (i.e. testing and implementing the best routing protocols).
- The "seismological" aspects (attenuation relations, characterisation parameters).

# Concluding statements

Some of the activities that need to be undertaken are

- Incorporating realistic "processing/transmission delay times" into the network simulator.
- Testing "alerting options", e.g. flooding, preferential alerts.
- Use of available real data to determine appropriate characterisation relations for real-time processing (e.g. predominant period, earliest PGAp versus PGAs).
- Use of the synthetic seismograms to further test these relations, and to infer others.
- Decide how to consider site effects. Initially, site amplification factors will be included as part of a node's installation.