Antelope and Earthquake Early Warning

Lessons from USArray and the ANZA Seismic Network

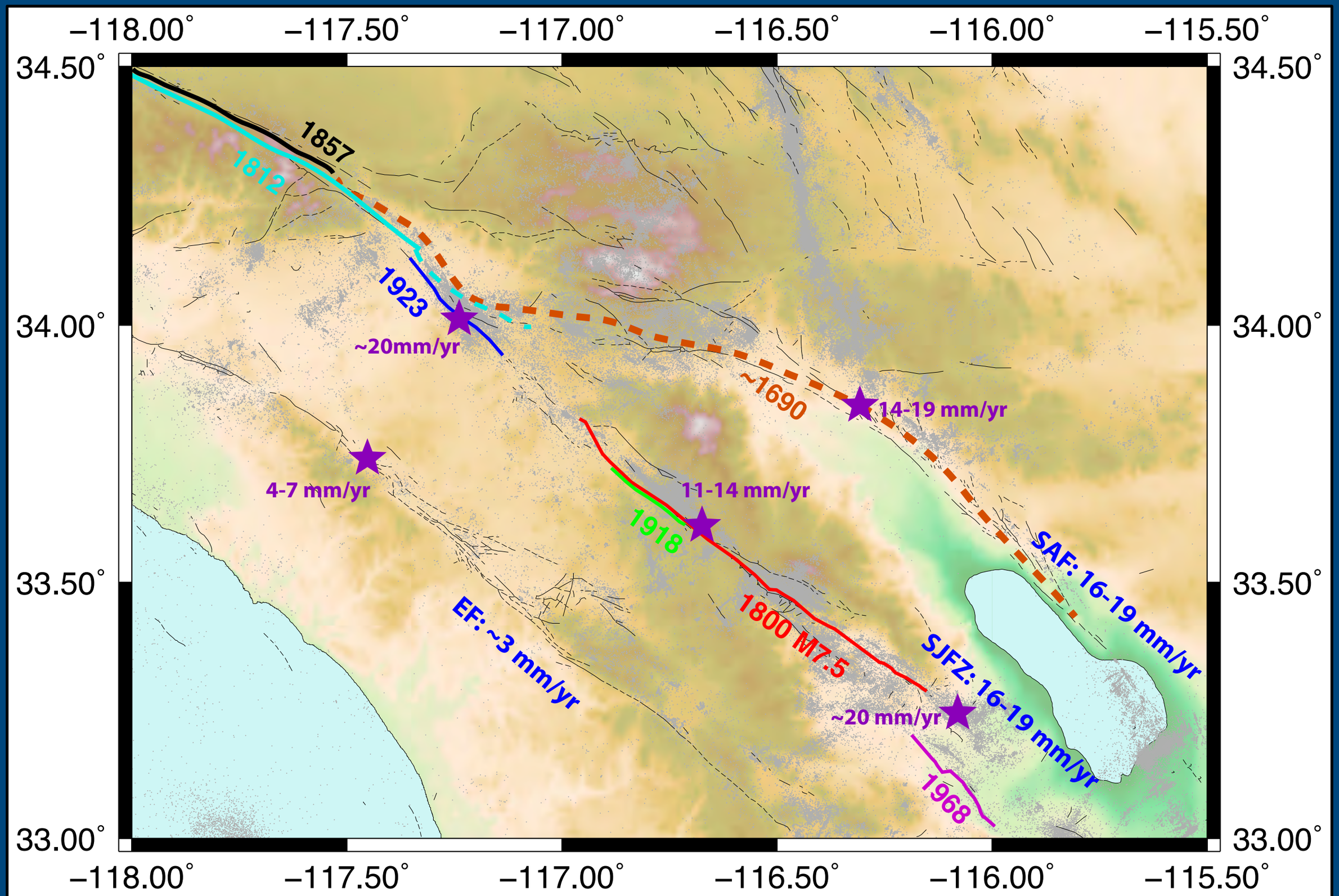
Frank Vernon

University of California, San Diego

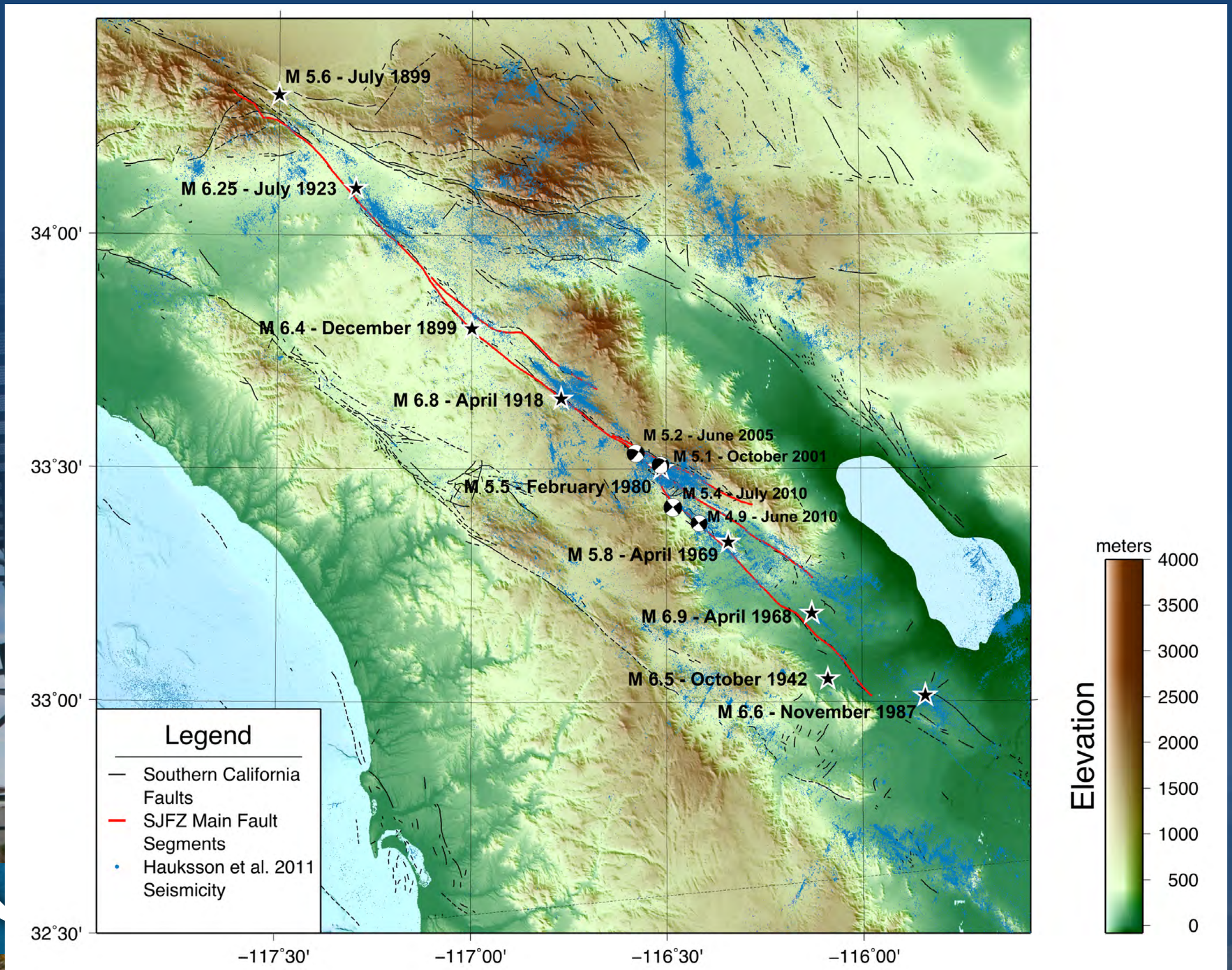
Antelope User Group Meeting

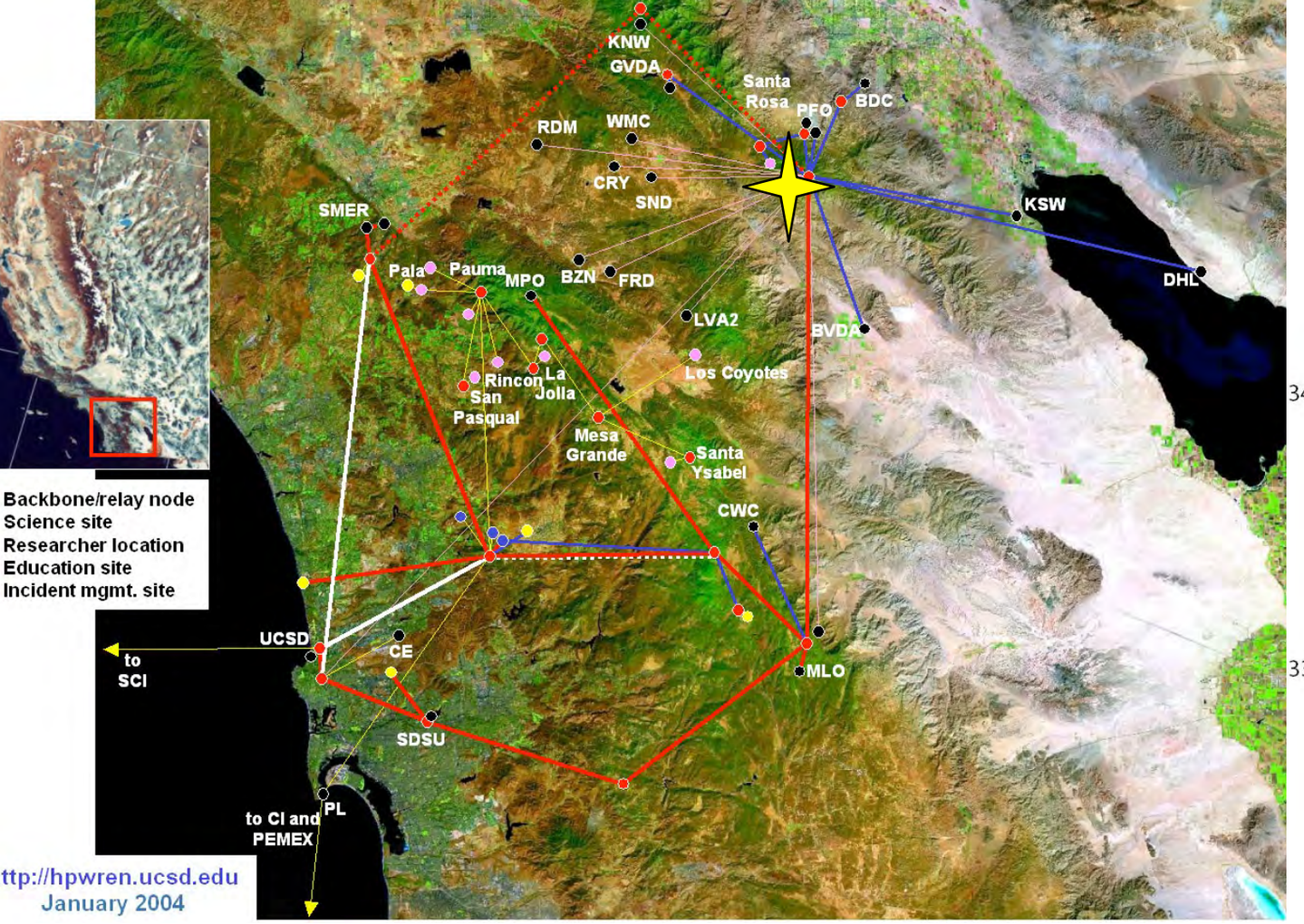
15 January 2015

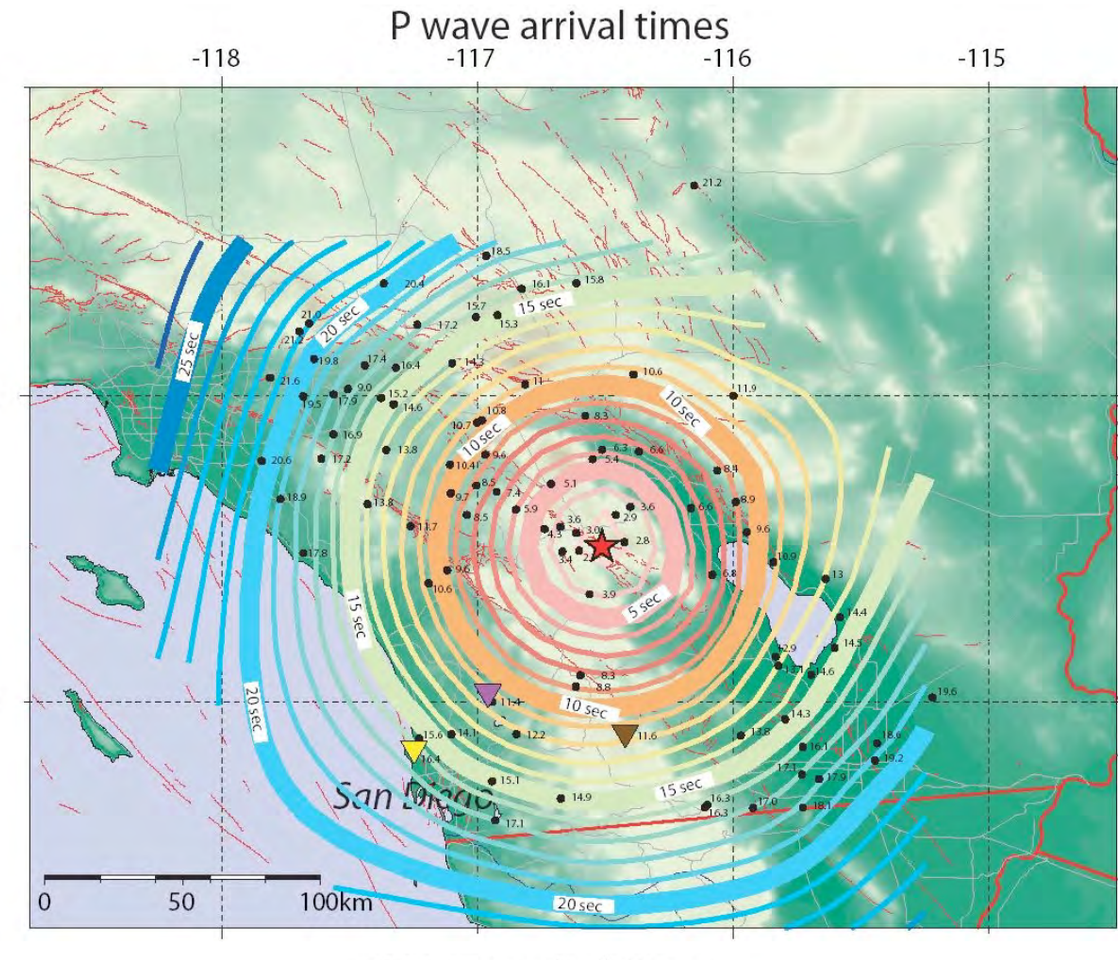
Southern California Major Ruptures

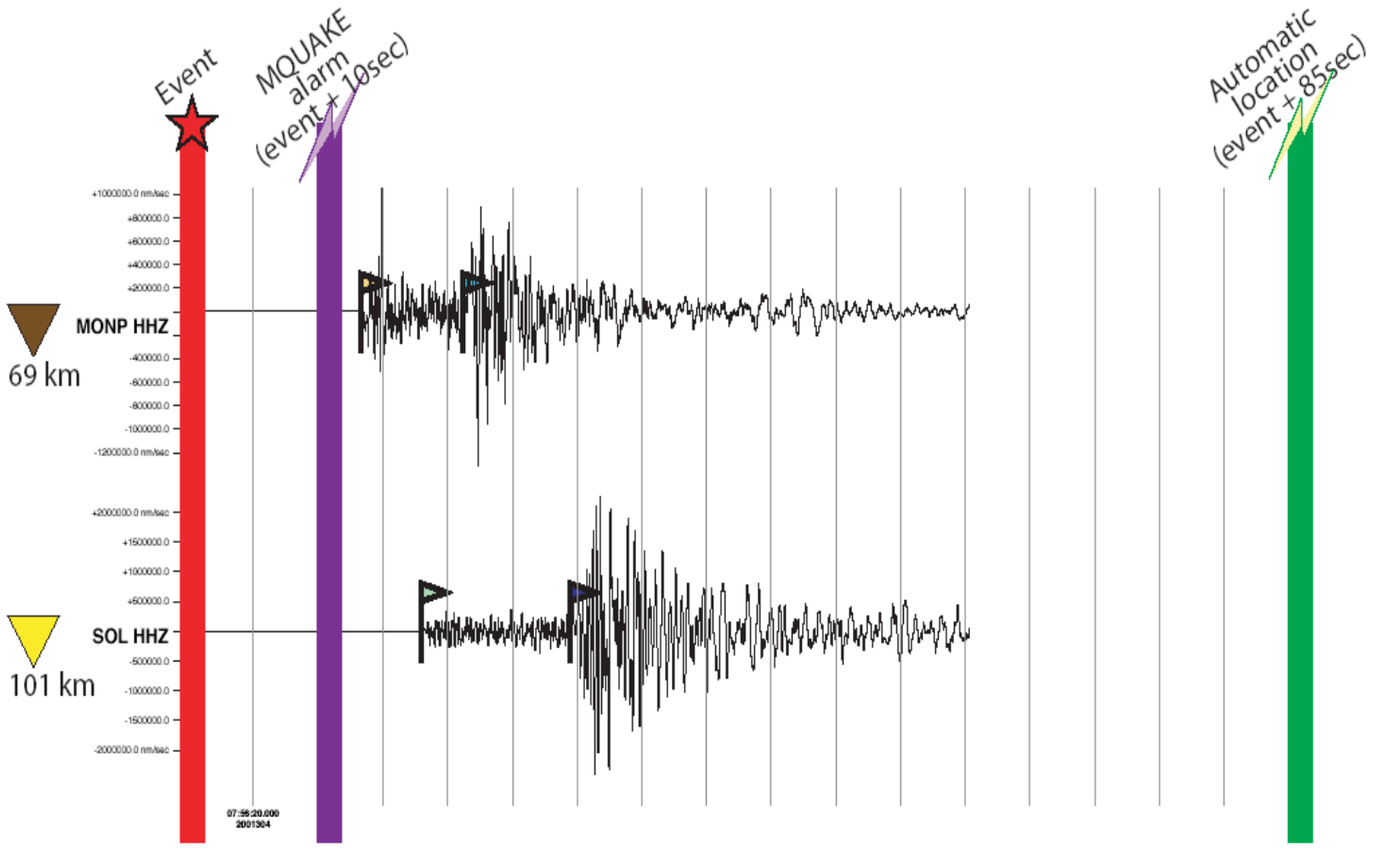


San Jacinto Fault Zone




KNW
GVDA
Santa Rosa
PFO
BDC
RDM
WMC
CRY
SND
KSW
SMER
DHL
Pala
Pauma
MPO
BZN
FRD
LVA2
BVDA
Rincon
La Jolla
San Pasqual
Los Coyotes
Mesa Grande
Santa Ysabel
CWC
UCSD
to SCI
CE
MLO
SDSU
PL
to CI and PEMEX
Backbone/relay node
Science site
Researcher location
Education site
Incident mgmt. site
ttp://hpwren.ucsd.edu
January 2004

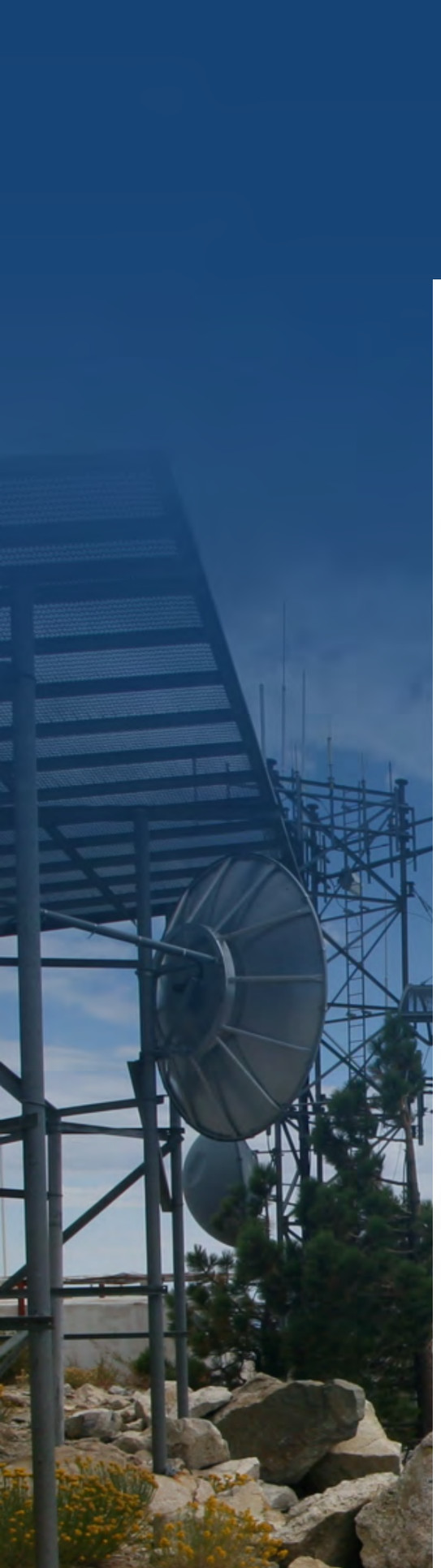

P wave arrival times
-118
-117
-116
-115
34
33
25 sec
20 sec
15 sec
10 sec
5 sec
0
50
100km
S wave arrival times
30 sec
25 sec
20 sec
15 sec
10 sec

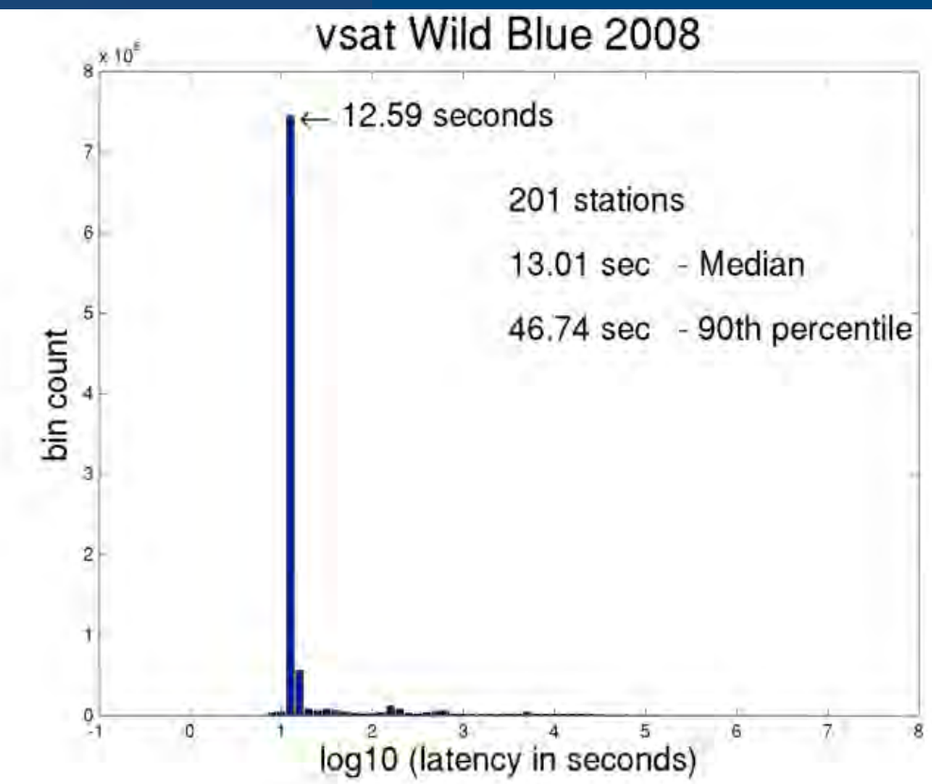

Event
MQUAKE alarm (event + 10sec)
Automatic location (event + 85sec)
MONP HHZ
69 km
SOL HHZ
101 km

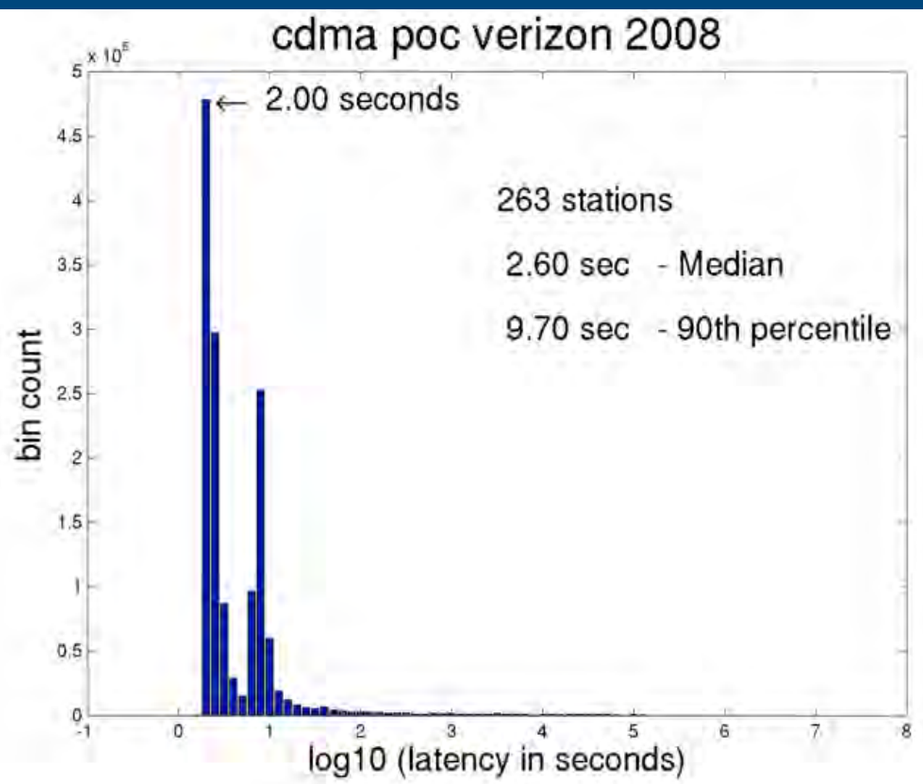
Earthquake Early Warning Dataloggers

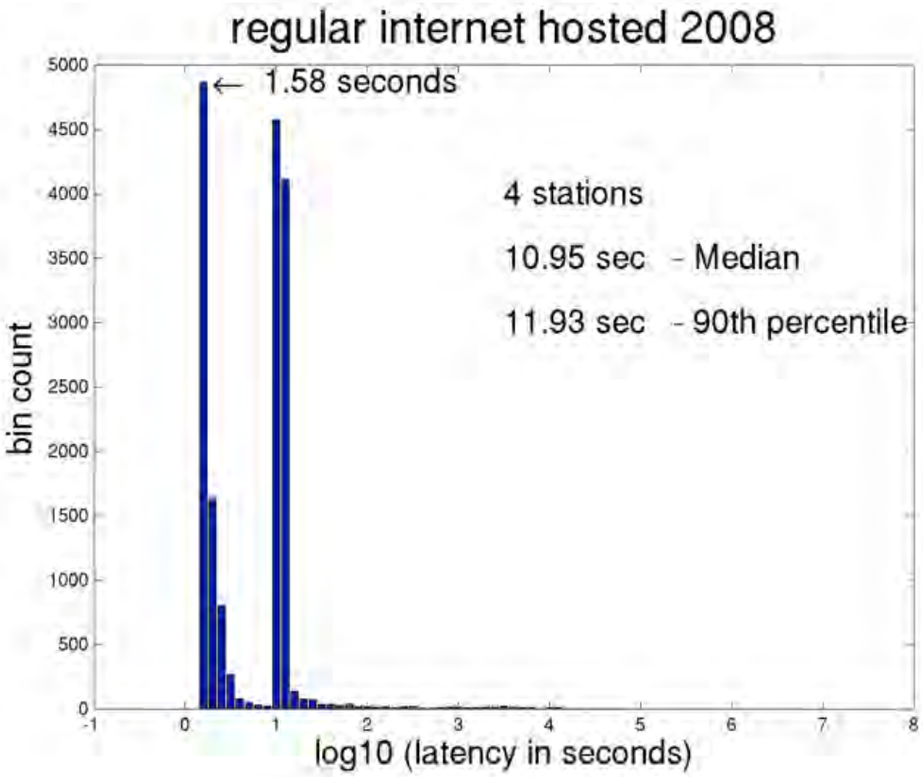
- Q330, KMI, Reftek
  - Fixed time packets
  - 1 sec packet contains all channels
    - *Multiplexed packets*
  - ~2 sec latency (USArray, ANZA)
- Guralp
  - 512 Bytes (Compressed)
  - 1 Channel/packet
  - ~2 secs per packet for EH and HH
  - 5-85 sec latency (Neptune Canada)

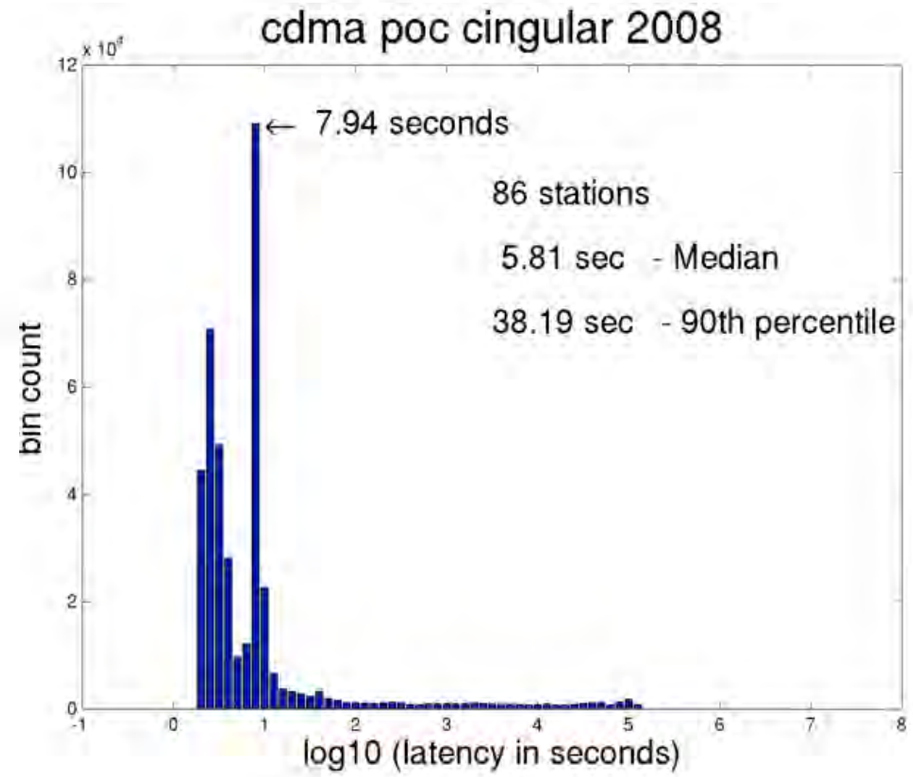
Earthquake Early Warning - Telemetry (Median Latency)



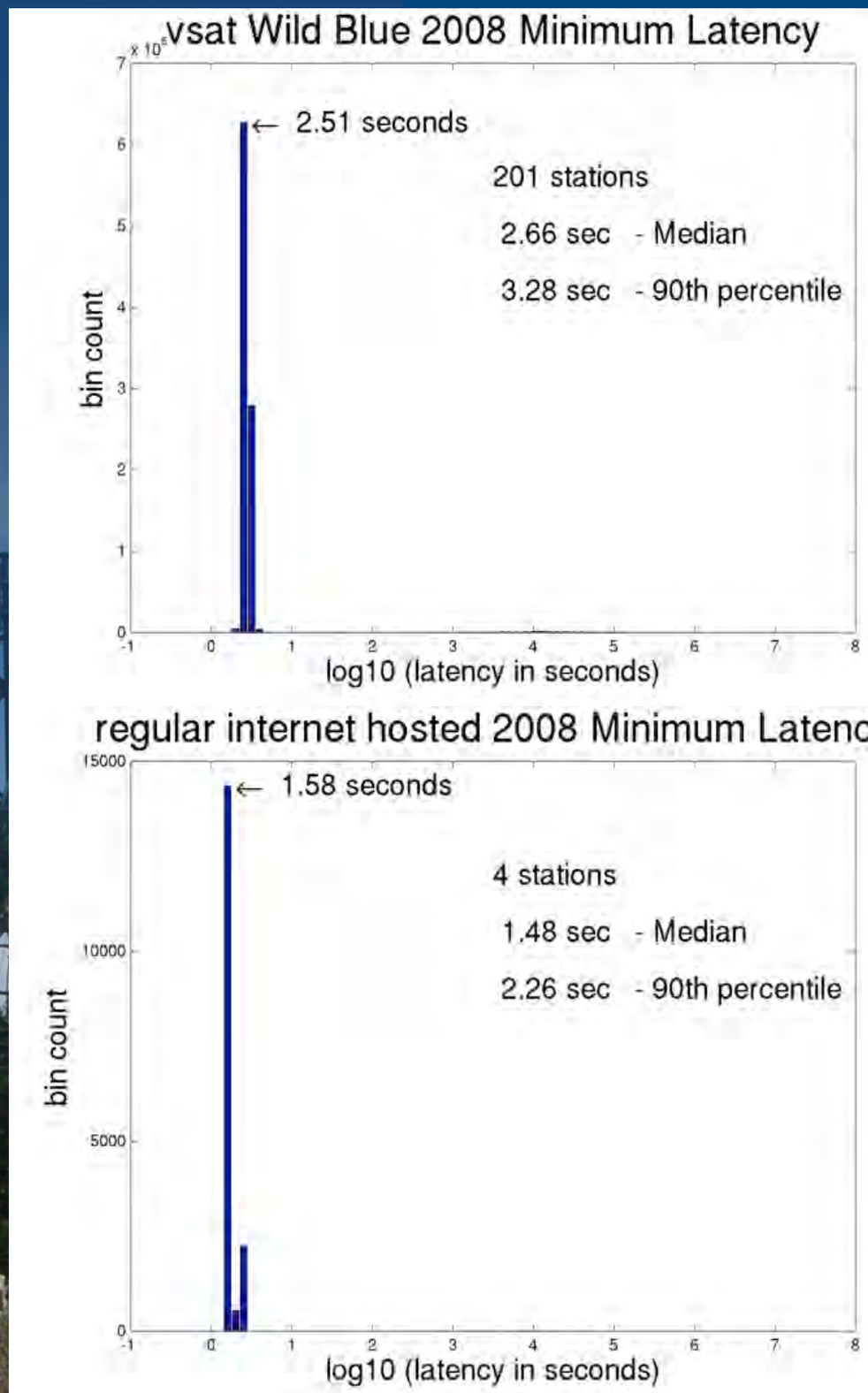


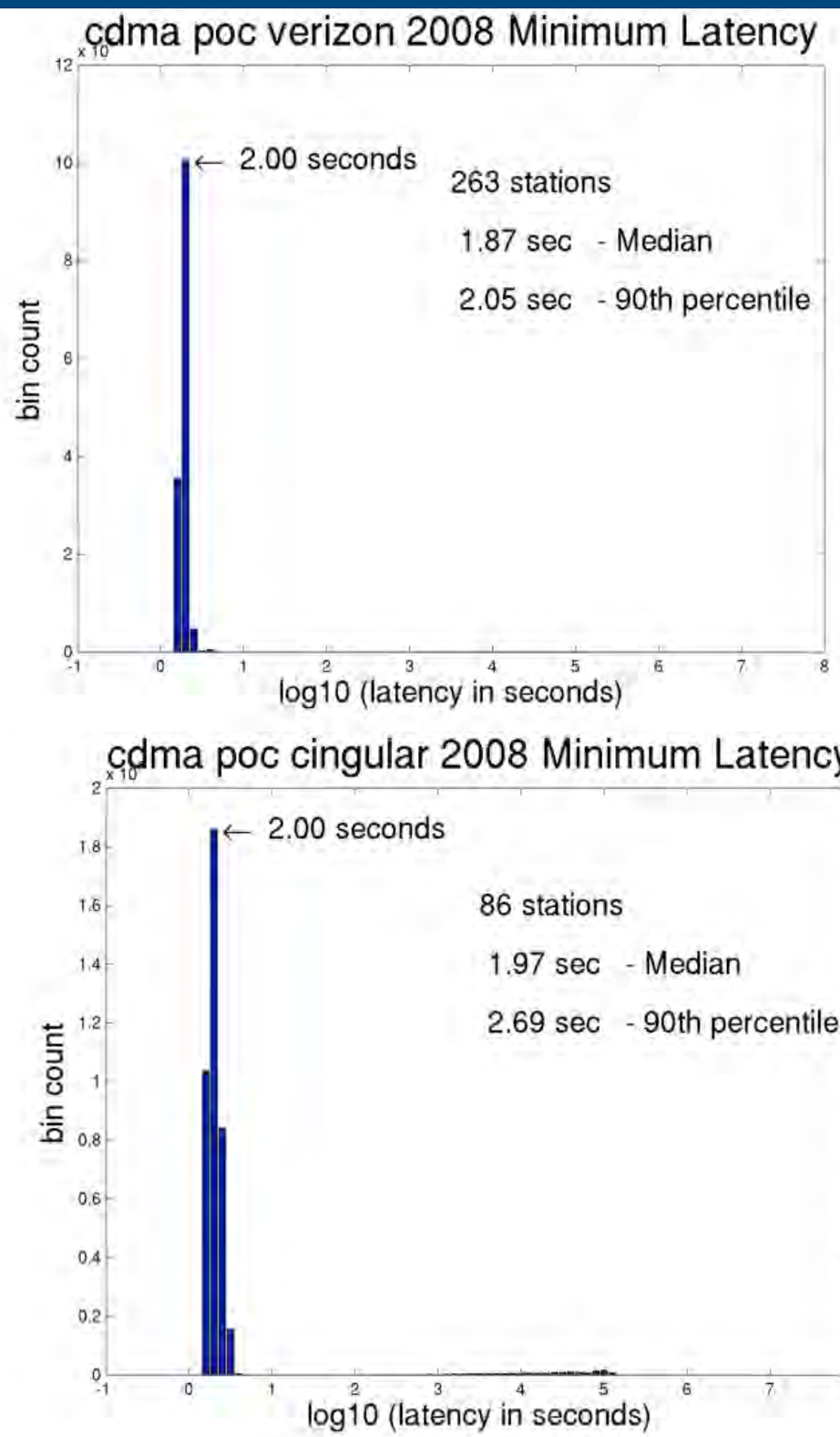






Earthquake Early Warning - Telemetry (Min Latency)





Earthquake Early Warning - Processing

- Network Triggers
  - Location
    - *Need minimum number of stations*
      - 10 stations for reliable
      - 4 stations as minimum
    - *~ 6 seconds minimum for ANZA*
  - Magnitudes
    - *Need minimum number of stations*
      - 10 stations for reliable
      - 4 stations as minimum
    - *Need S waves*
    - *~ 8 seconds minimum for ANZA*
- Station triggers
  - PGA/PGV
    - *Made on individual stations*
    - *Need S wave data*
    - *Dependent on hypocentral distance*

Earthquake Early Warning - Essential Elements

- Quality of data
  - Information Quality
    - *Calibrated waveforms*
    - *Accurate automatic parametric data*
    - *Accurate metadata*
  - Clock Quality
    - *Location error*
    - *Earthquake warning accuracy*
- Availability of data
  - Completeness
    - *No gaps in data*
    - *Streaming realtime data available in time order*
  - Latency
    - *Data acquisition characteristics*
    - *Telemetry formats*
    - *Telemetry propagation speeds*
    - *Processing characteristics*
- Station distribution
  - Need stations near seismic source regions
  - Need inter-station spacing appropriate for Earthquake Early Warning requirements
- Information dissemination
  - Technologies
  - Timely delivery
  - End user requirements