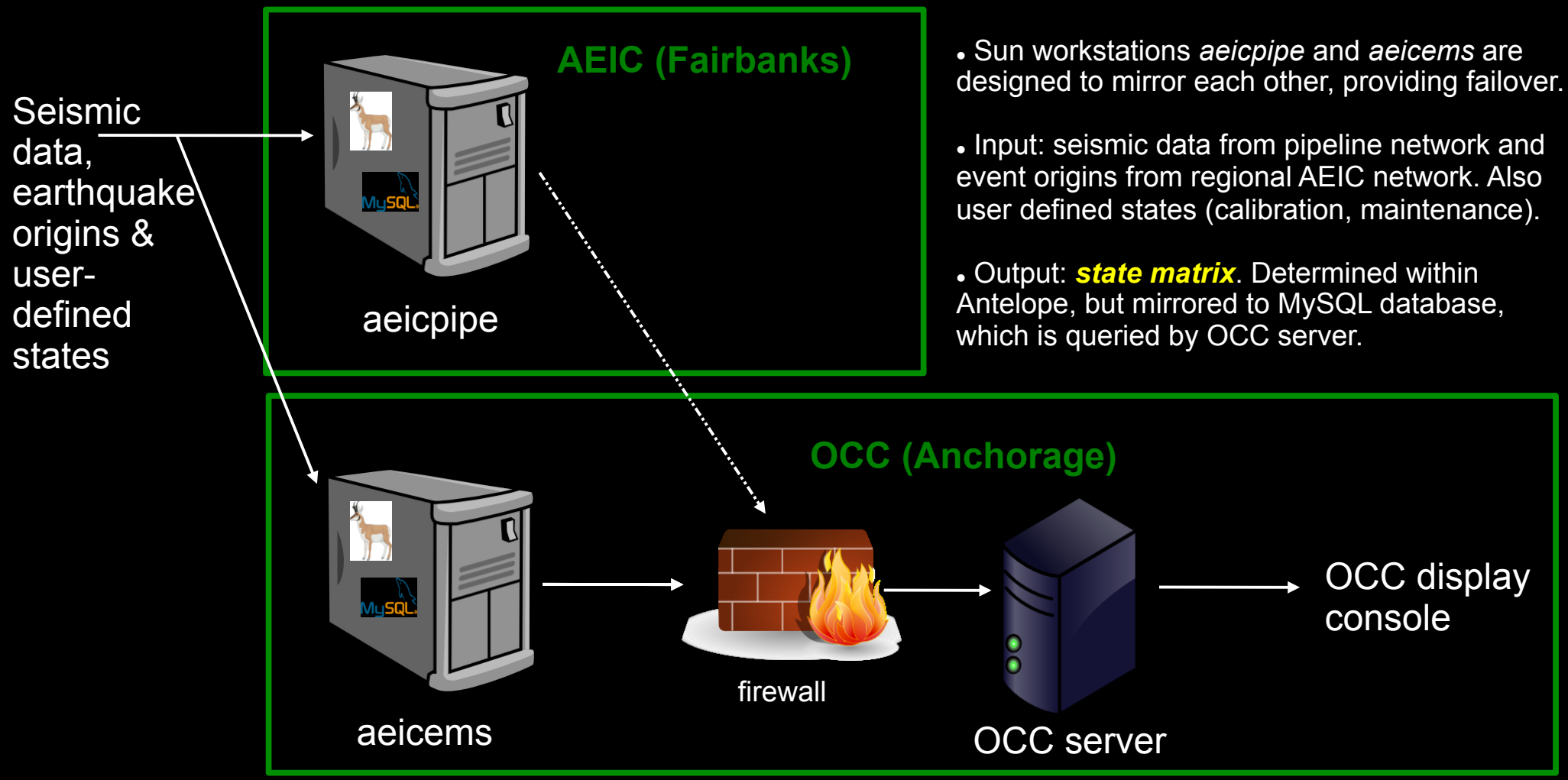


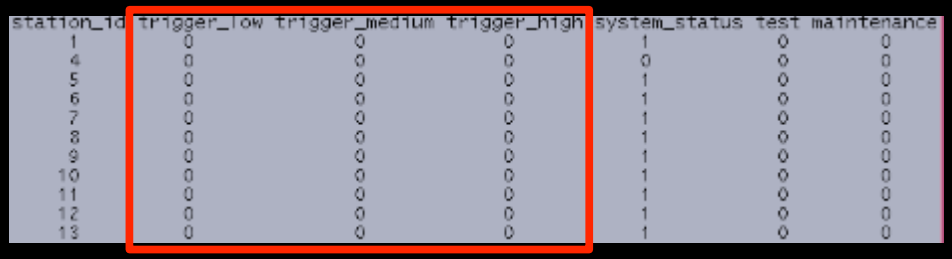
- Sun workstations *aeicpipe* and *aeicems* are designed to mirror each other, providing failover.
- Input: seismic data from pipeline network and event origins from regional AEIC network. Also user defined states (calibration, maintenance).
- Output: ***state matrix***. Determined within Antelope, but mirrored to MySQL database, which is queried by OCC server.

State Matrix

- Off/on states (marked by 0 or 1) for each pipeline station
- Has an alarm been declared at the station?
- Is the station operating?
- Is it being calibrated?
- Is it down for maintenance?
- Has an event just occurred?

station_id	trigger_low	trigger_medium	trigger_high	system_status	test	maintenance
1	0	0	0	1	0	0
4	0	0	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	1	0	0
7	0	0	0	1	0	0
8	0	0	0	1	0	0
9	0	0	0	1	0	0
10	0	0	0	1	0	0
11	0	0	0	1	0	0
12	0	0	0	1	0	0
13	0	0	0	1	0	0

Threshold alarm



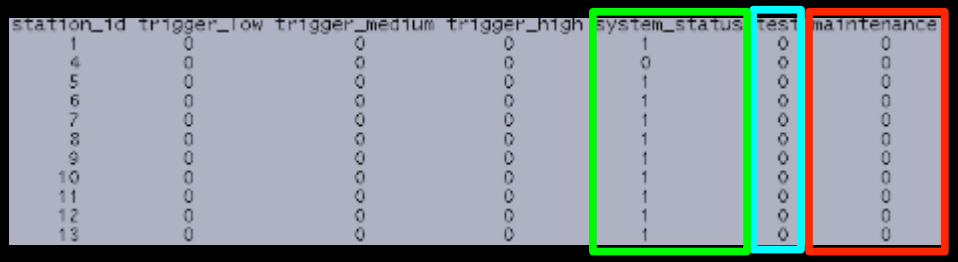
station_id	trigger_low	trigger_medium	trigger_high	system_status	test	maintenance
1	0	0	0	1	0	0
4	0	0	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	1	0	0
7	0	0	0	1	0	0
8	0	0	0	1	0	0
9	0	0	0	1	0	0
10	0	0	0	1	0	0
11	0	0	0	1	0	0
12	0	0	0	1	0	0
13	0	0	0	1	0	0

These bits are changed to 1 if there is a low, medium or high threshold alarm declared

- Thresholds (and other settings) for each station can be configured different (identical presently).
- Seismic data filtered from 0.01 to 4 Hz.
- Compares a 2 minute average with threshold settings. If exceeded an alarm is declared.
- Alarm stays active for at least 1 minute. Seismic signal may increase during this time, activating higher alarm states (medium, high).

THRESHOLD SETTING	% normal gravity	m / s^2
trigger_low	8%	0.785
trigger_medium	15%	1.47
trigger_high	200%	19.6

State Matrix continued...



station_id	trigger_low	trigger_medium	trigger_high	system_status	test	maintenance
1	0	0	0	1	0	0
4	0	0	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	1	0	0
7	0	0	0	1	0	0
8	0	0	0	1	0	0
9	0	0	0	1	0	0
10	0	0	0	1	0	0
11	0	0	0	1	0	0
12	0	0	0	1	0	0
13	0	0	0	1	0	0

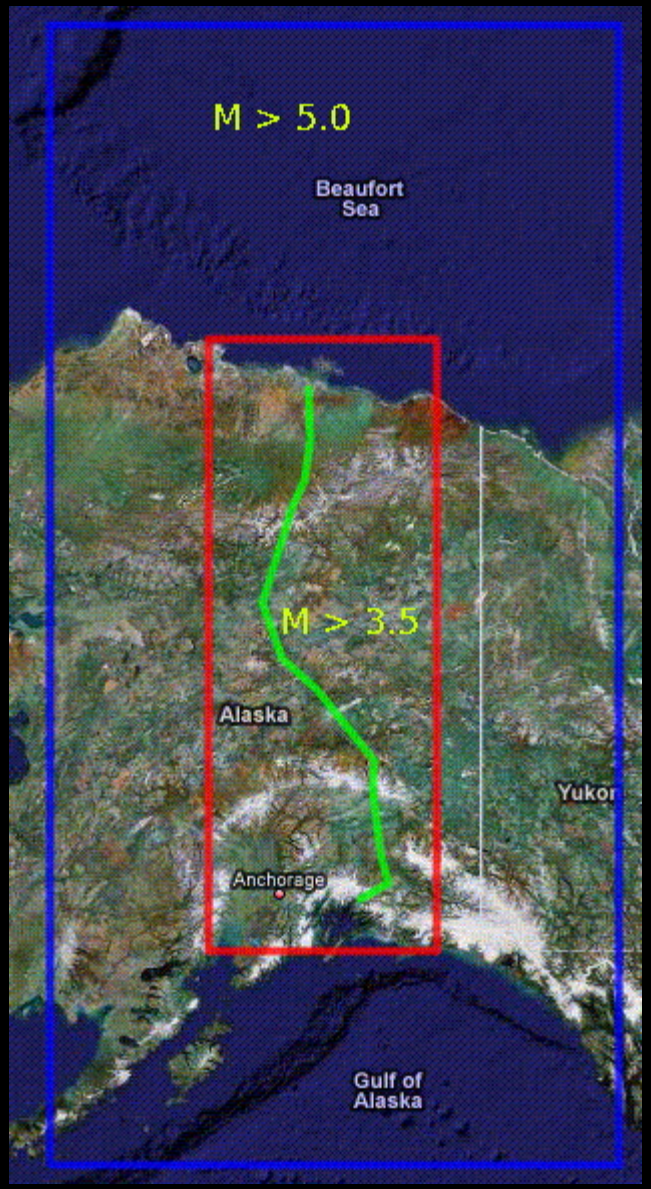
System status: Is station operational?

Test — Is station currently being calibrated? (twice a month)

Maintenance — Is station in need of maintenance (e.g. are diagnostics being run?)

There is also an event bit in the MySQL database, set whenever an earthquake above a certain magnitude occurs within range of the pipeline corridor. This is explained in the next slide...

Earthquake Event Notification

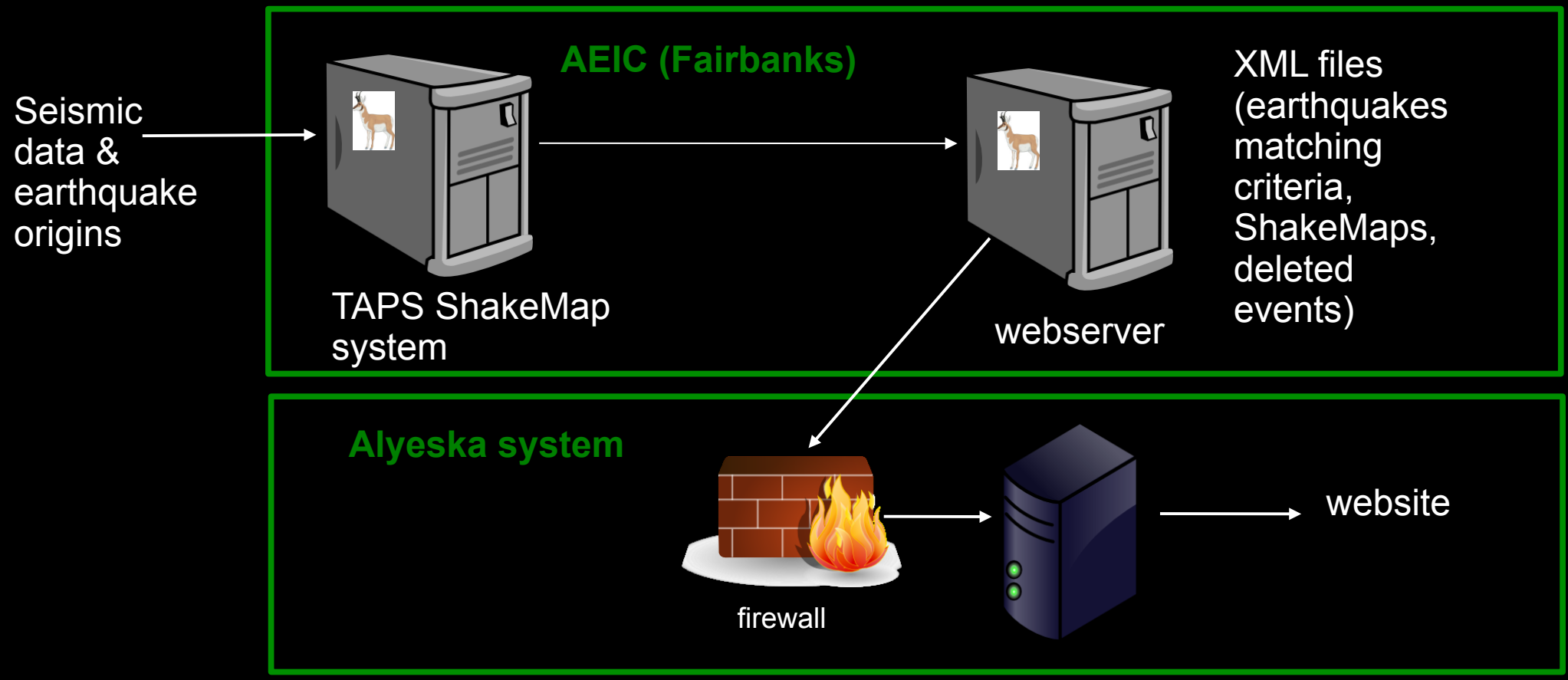


AEIC typically detects about 50 earthquakes each day in Alaska, but most are too small or too far from the pipeline to be of concern.

Earthquakes greater than magnitude 5 in the blue box, and greater than magnitude 3.5 in the red box, are broadcast to the OCC (via the event bit) and Doug Nyman (via XML files).

They also trigger ShakeMaps, providing there are at least 10 arrivals, and intensity (MMI) >= 2 at the epicenter.

Spectral calculations are also made for earthquakes M > 3.8.



Here is the XML describing one earthquake event.

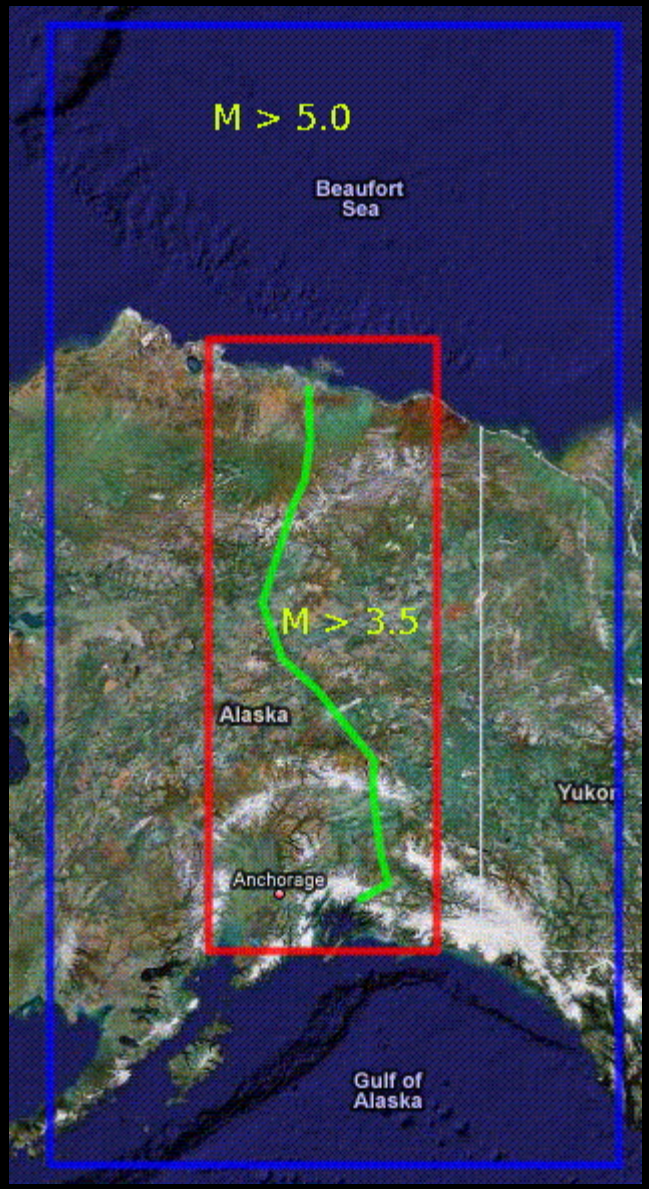
This can change. AEIC automatically computes better origins (and magnitudes) as more data become available – as seismic waves propagate across a 400 station network.

Analysts review solutions and may even delete events if they are false (rare, but can happen).

As new origin solutions become available, ShakeMaps are recomputed.

```
<event>
   <event_id>Tsaina_se</event_id>
   <origin_time>05/22/2008  18:08:00.000</origin_time>
   <latitude>61.2670</latitude>
   <longitude>-145.6800</longitude>
   <magnitude>7.1</magnitude>
   <shakemap>y</shakemap>
   <arrivals>10</arrivals>
   <review>y</review>
   <timestamp>5/22/2008  18:08:00.000</timestamp>
</event>
```

The Fuzzy Boundary Problem



Because event origins are automatically “improved” as more data become available, an event that initially satisfies the criteria may:

- Move out of the red or blue boundary
- Be reassigned a magnitude that no longer qualifies.

AEIC can either “cancel” the event (remove it from the XML file, cancel the event bit, and remove it from the ShakeMap system). Or it can continue to track an event which no longer qualifies. Currently we do the latter.

Spectral calculations are only made for earthquakes greater than magnitude 3.8. So if a magnitude 3.9 event is reassigned magnitude 3.7, the spectral calculations will disappear.

TAPS ShakeMap & XML systems

- Tested extensively with Alyeska system in coordination with Jimmy De La Garza & Doug Nyman
- Suite of 10 simulated earthquake origins used, 19 step sequence
- Test script can be re-run at anytime
- Conditions tested:

1. New qualifying event
2. New preferred origin that qualifies
3. New ShakeMap
4. Manually modified ShakeMap
5. New preferred origin that does not qualify
6. Manually cancelled event

Origin No.	Origin Name	Mag.	Depth	Latitude	Longitude	
1	Denali 1	7.3	4.2	63.5141	-147.4529	
2	Coldfoot 1	4.2	10	67.2230	-149.8090	
3	Prince William Sound 1	4.1	10	61.0170	-147.6480	
4	Tsaina 1	6.7	10	61.2670	-145.6800	
5	Denali 2	7.4	5.2	63.5131	-147.4539	
6	Salcha 1	4.2	10	64.6100	-147.1200	
7	Tsaina 2	6.8	11	61.2680	-145.6810	
8	Tsaina 3	6.9	11	61.2670	-125.6820	
9	Prince William Sound 2	4.2	10	61.0160	-147.6470	
10	Denali 3	7.5	5.2	63.5161	-147.4549	