Seismic alarm systems:
1. Detect large events (Ml)
2. Detect swarms (events per hour, delta_t, 'cumulative' magnitude)
3. Detect tremor (RSAM/DR, *SSAM, gliding lines*)
4. Detect problems with automated data acquisition, alarm or archival systems.

RSAM alarm system provides 1 & 3. IceWeb alarm system also provides 3.
Swarm alarm system provides 2.

Swarm alarm system:
- start of swarm
- escalation in swarm
- end of swarm

Generic alarm management system:
- able to handle any type of alarm that we want to send as an email / text message.

Tremor alarm system:
- base on IceWeb alarm system, but convert from MATLAB (not robust) to C or Python.

Diagnostic alarm system:
- ?

Official AVO catalog (Scott's picks)

binsize = 1 day
magnitude threshold = -1.0
5 km radius from summit

Counts
- 129 lp events from 1 Jan – 10 Jun
- 1576 vt events

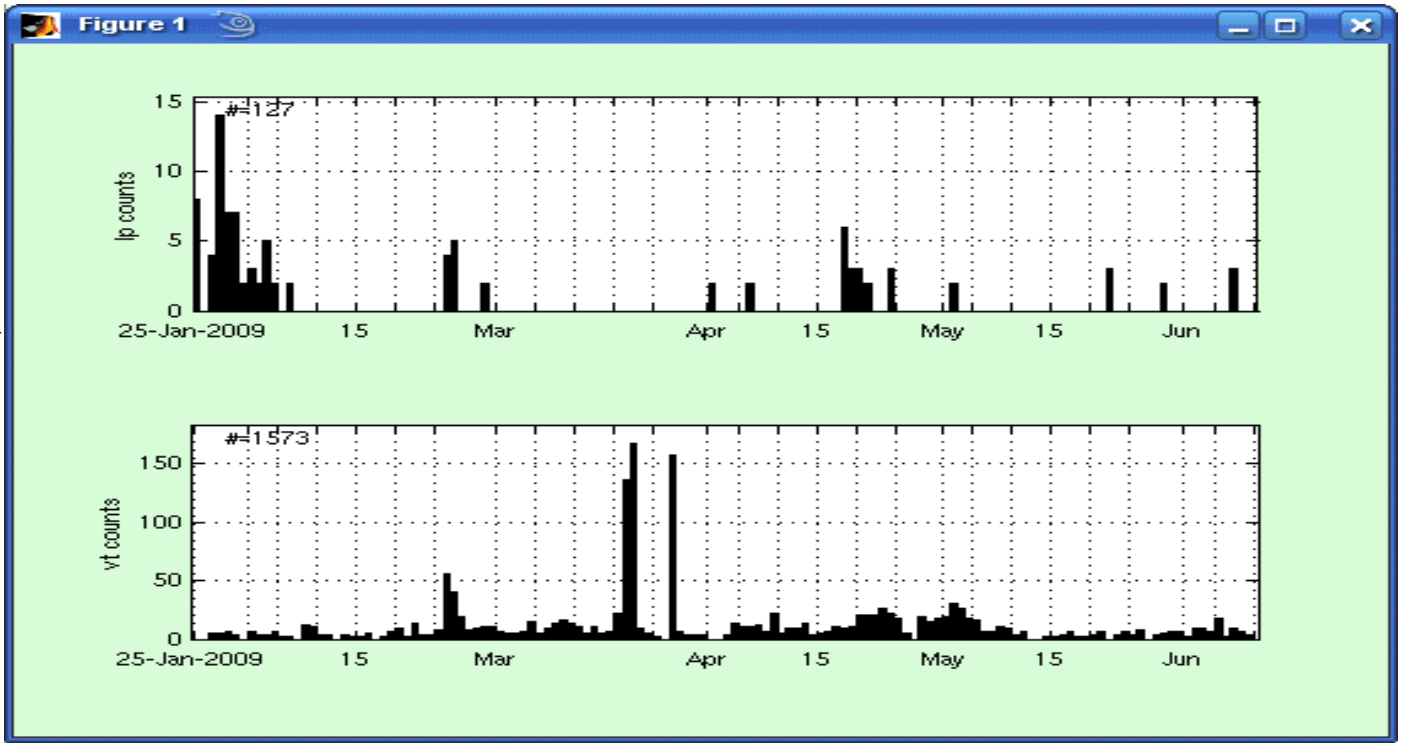
Cumulative (or equivalent) magnitude

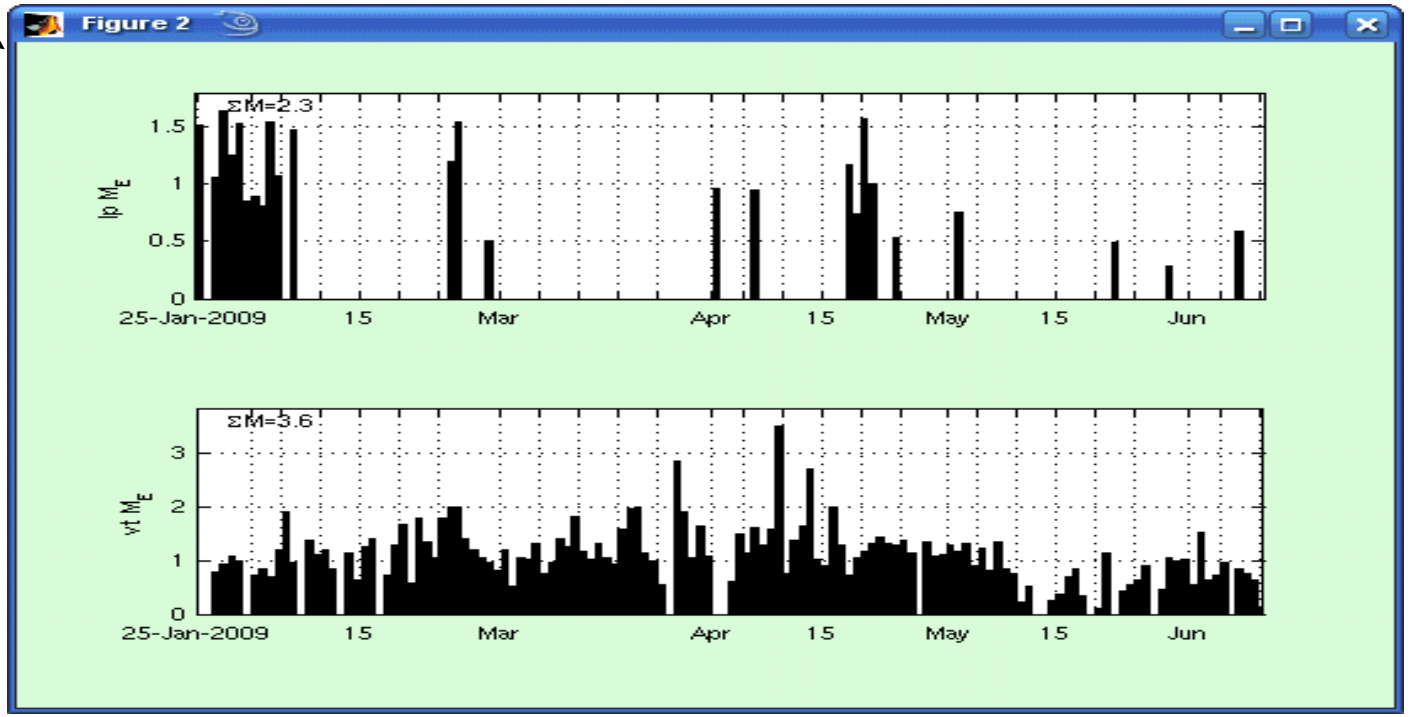
Algorithm:
- convert each magnitude to energy
- add energy
- convert total energy to magnitude

M_{cum} = 2.3 for lp events,
3.6 for vt events

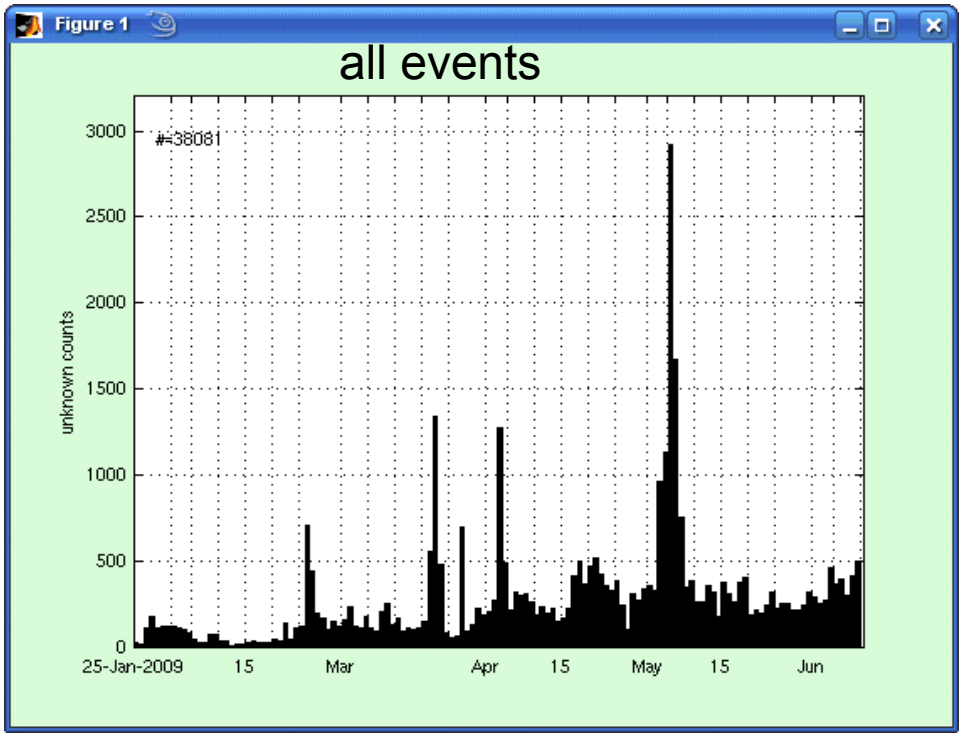
Pros:
- good magnitudes, good locations

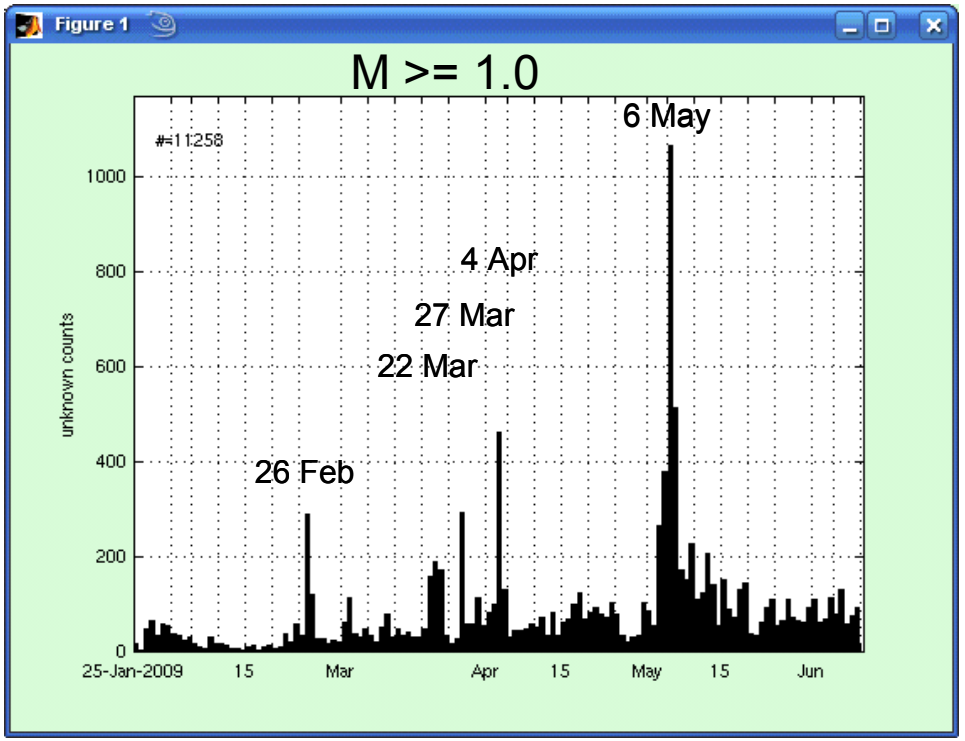
Cons:
- not real-time
- not good for swarms

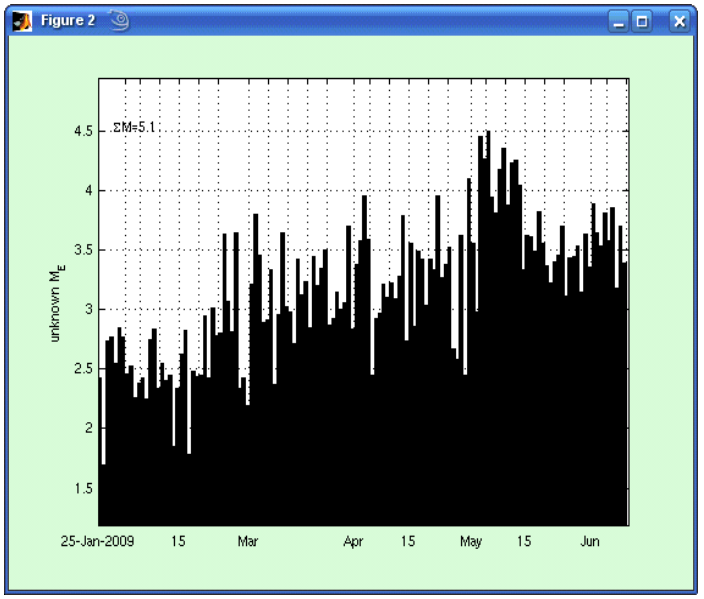


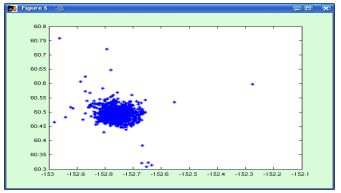


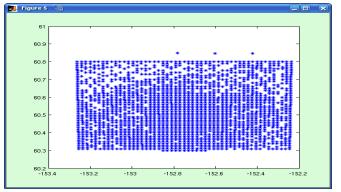
Real-time system (automated hypocenters, magnitudes)











Pros:
- 38081 events, compared to 1700 from AVO catalog (22 times more)
- works well for swarms

Cons:
- locations / magnitudes horrible
- no classifications
- no data prior to 25 January (yet)

Swarm parameters (real-time catalog)

Date	**#**		**#M>1**	**M_{cum}**			
peakEventsPerHour							
26-27 Feb	1267	442		3.7		94	
20-23 Mar	2525	565		3.7		82	
27 Mar	754		318		3.8		131
2-4 Apr		2038	688		4.1		101
3-7 May		7430	2393	4.8		205	

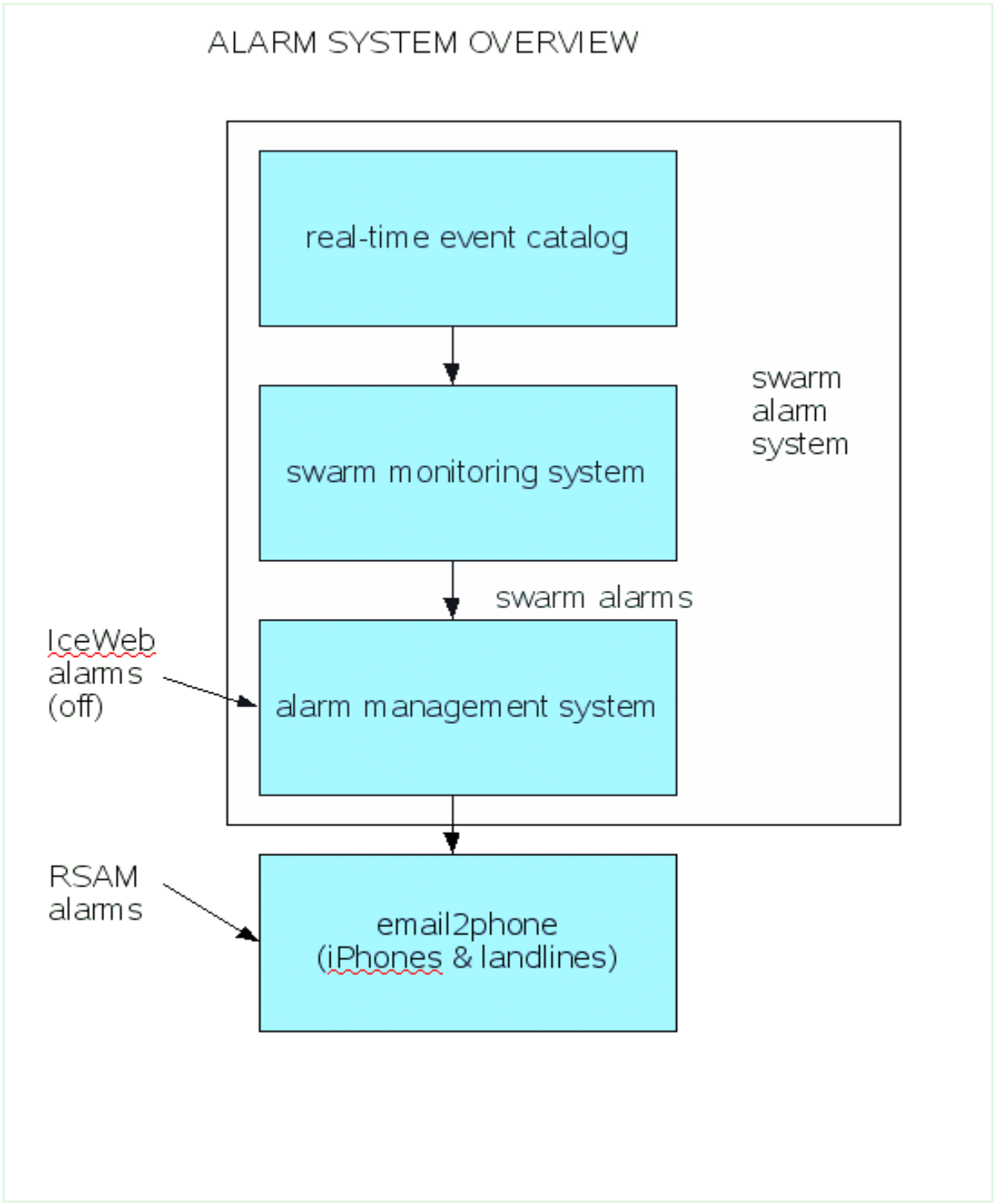
swarm “equivalent” magnitude

Remarks:

- magnitude threshold alters counts, but not energy/M_{cum}
- swarms (small events) not well represented in AVO catalog, real-time catalog better

New tools:

- recompute magnitudes based on locations from AVO catalog / other work
- merge with VolPlot
- temporal/spatial (cylindrical shells?) b-values
- classifications for real-time catalog (frequency-index, neural network, Markov chains?)

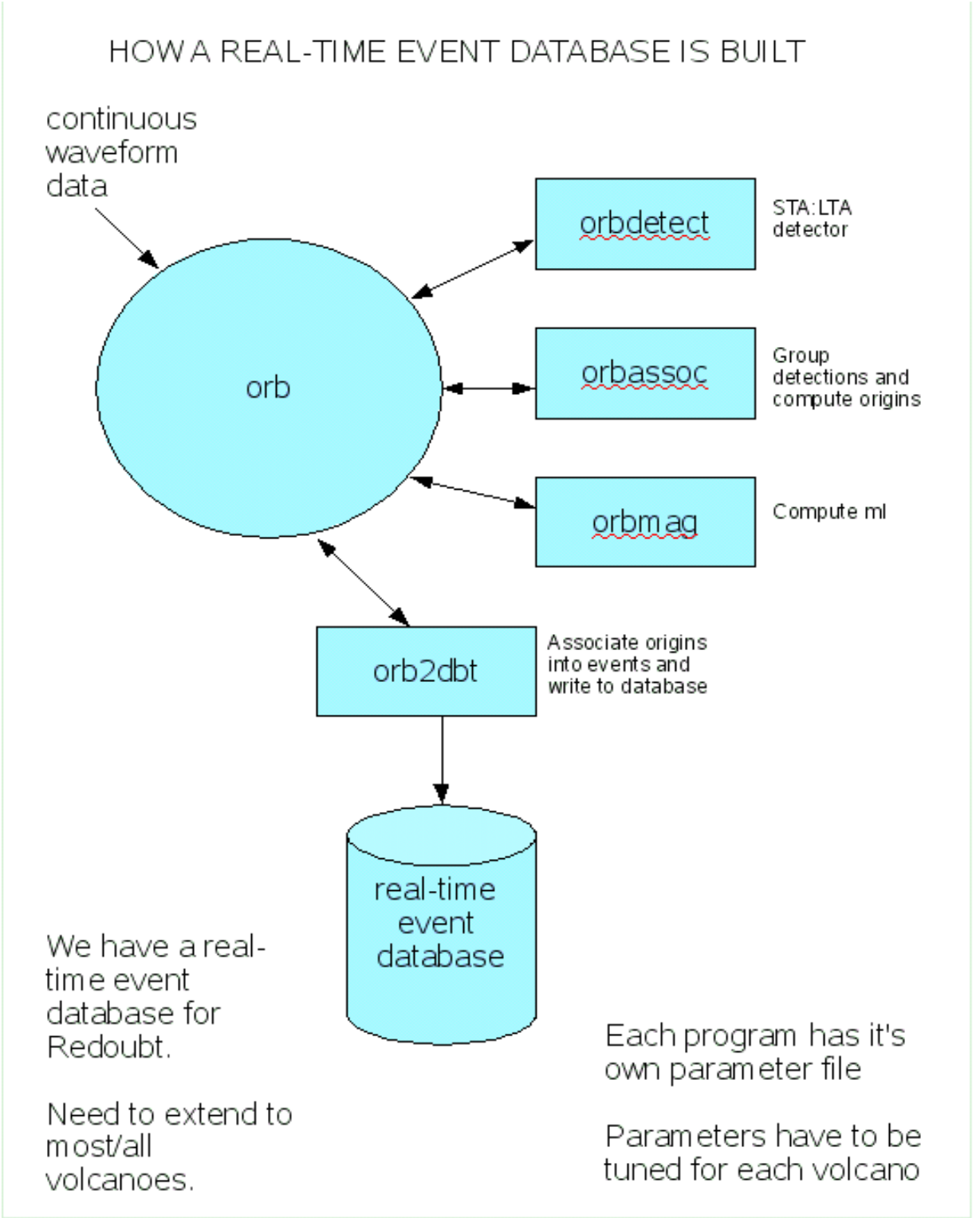

ALARM SYSTEM OVERVIEW
real-time event catalog
swarm monitoring system
swarm alarms
alarm management system
swarm alarm system
IceWeb alarms (off)
RSAM alarms
email2phone (iPhones & landlines)

Redoubt real-time database contains ~25 times more events than analyst reviewed catalog.

Locations are not well constrained, but this should not greatly affect magnitude (at least will not compromise swarm alarms).

Events are unclassified. But we hope (one day) to automatically classify all events.

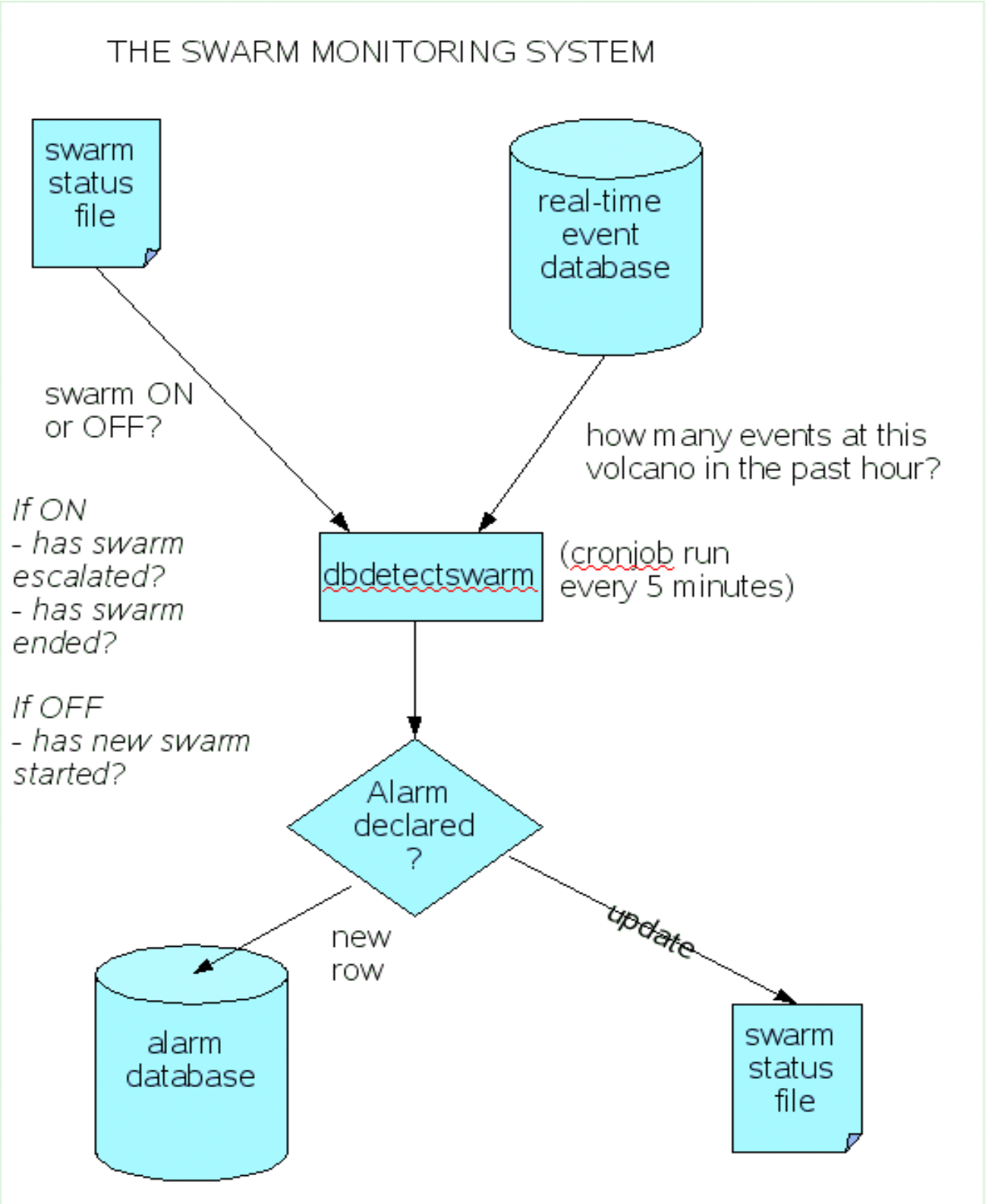
All sorts of additional tools and plots can be based on these databases.



Once we have a real-time event “catalog”, it's trivial to see how many events there have been in the last hour, and what the magnitude of those events was.

So a program is run every 5 minutes to check the real-time event catalog.

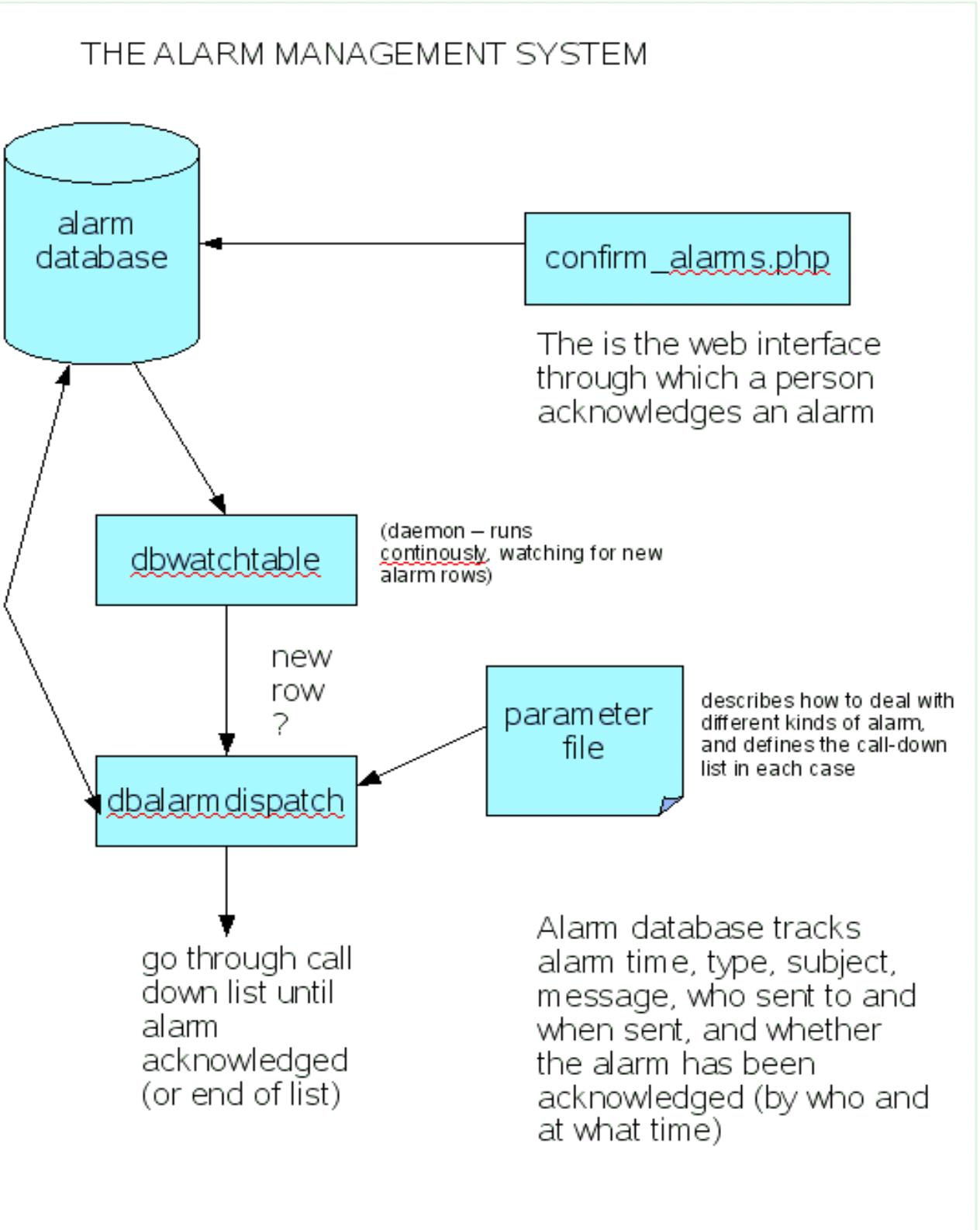
The only other thing we need is to track the swarm status, so we can decide whether to check for a new swarm, or the escalation or end of a previously declared swarm.



A program watches for new rows in the alarm database, and dispatches them via a call-down list defined in a parameter file.

The call-down is stopped if somebody acknowledges the alarm.

This generic alarm management system can handle any kind of alarm (they don't even have to be seismic).



Alarm Acknowledgement Page - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://giseis.alaska.edu/AVO/internal/avoseis/op/confirm_alarms.php?username=glenn&ackkey=345

kml google maps

openSUSE Getting Started Latest Headlines

Alarm Acknowledgement Pa... | Alarm 345

Show Unacknowledged Alarms Only

Showing alarms since 2009/02/22 00:00 UTC from alarms/alarmdb/alarmdb.alarms

Each row in the following table corresponds to a separate alarm that was declared

Acknowledge alarms by clicking on the button in column 1 (Key)

Key	UTC Time	Alarm Class	Algorithm Name	Subject	More Info...	Spectrograms (not IE)
345	2009/07/22 18:40	swarm	swarm_RD	'Swarm Over Redoubt 10:40:00 AKDT'	show	show
345	2009/07/22 00:00	swarm	swarm_RD	'Swarm Continuing Redoubt 16:00:01 AKDT'	show	show
345	2009/07/21 20:55	swarm	swarm_RD	'Swarm Continuing Redoubt 12:55:01 AKDT'	show	show
345	2009/07/21 17:45	swarm	swarm_RD	'Swarm Escalation Redoubt 9:45:01 AKDT'	show	show
345	2009/07/21 16:10	swarm	swarm_RD	'Swarm Continuing Redoubt 8:10:00 AKDT'	show	show
345	2009/07/21 13:00	swarm	swarm_RD	'Swarm Continuing Redoubt 5:00:00 AKDT'	show	show
345	2009/07/21 08:20	swarm	swarm_RD	'New Swarm Redoubt 0:20:00 AKDT'	show	show
343	2009/07/20 07:30	swarm	swarm_RD	'Swarm Over Redoubt 23:30:00 AKDT'	show	show
343	2009/07/20 06:25	swarm	swarm_RD	'New Swarm Redoubt 22:25:00 AKDT'	show	show
341	2009/07/10 03:25	swarm	swarm_RD	'Swarm Over Redoubt 19:25:00 AKDT'	show	show
341	2009/07/10 02:50	swarm	swarm_RD	'New Swarm Redoubt 18:50:00 AKDT'	show	show
339	2009/07/07 06:15	swarm	swarm_RD	'Swarm Over Redoubt 22:15:01 AKDT'	show	show
339	2009/07/07 05:20	swarm	swarm_RD	'New Swarm Redoubt 21:20:00 AKDT'	show	show
337	2009/07/02 02:30	swarm	swarm_RD	'Swarm Over Redoubt 18:30:01 AKDT'	show	show
337	2009/07/02 01:20	swarm	swarm_RD	'New Swarm Redoubt 17:20:00 AKDT'	show	show
335	2009/06/30 04:50	swarm	swarm_RD	'Swarm Over Redoubt 20:50:00 AKDT'	show	show
335	2009/06/30 02:30	swarm	swarm_RD	'New Swarm Redoubt 18:30:00 AKDT'	show	show
333	2009/06/29 06:20	swarm	swarm_RD	'Swarm Over Redoubt 22:20:00 AKDT'	show	show
333	2009/06/29 02:40	swarm	swarm_RD	'New Swarm Redoubt 18:40:01 AKDT'	show	show
329	2009/06/28 06:40	swarm	swarm_RD	'Swarm Over Redoubt 22:40:01 AKDT'	show	show
329	2009/06/28 04:50	swarm	swarm_RD	'Swarm Continuing Redoubt 20:50:00 AKDT'	show	show
329	2009/06/28 01:50	swarm	swarm_RD	'Swarm Escalation Redoubt 17:50:00 AKDT'	show	show
329	2009/06/27 23:35	swarm	swarm_RD	'New Swarm Redoubt 15:35:00 AKDT'	show	show
327	2009/06/17 18:45	swarm	swarm_RD	'Swarm Over Redoubt 10:45:00 AKDT'	show	show
327	2009/06/17 15:50	swarm	swarm_RD	'New Swarm Redoubt 7:50:00 AKDT'	show	show
325	2009/06/11 09:00	swarm	swarm_RD	'Swarm Over Redoubt 1:00:00 AKDT'	show	show

Done

325 2009/06/11 09:00 swarm swarm_RD 'Swarm Over Redoubt 1:00:00 AKDT' show show

Done

Each alarm declared is a separate row here.

Background color:
Green – acknowledged
Red – not acknowledged

Alarm Acknowledgement Page - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://giseis.alaska.edu/AVO/internal/avoseis/op/confirm_alarms.php?username=glenn&ackkey=345

kml google maps

openSUSE Getting Started Latest Headlines

Alarm Acknowledgement Pa... | Alarm 345

23	2009/03/13 16:20	swarm	swarm_RD	'New Swarm Redoubt 8:20:00 AKDT'	show	show
21	2009/03/12 14:55	swarm	swarm_RD	'Swarm Over Redoubt 6:55:00 AKDT'	show	show
21	2009/03/12 13:40	swarm	swarm_RD	'New Swarm Redoubt 5:40:00 AKDT'	show	show
19	2009/03/09 15:00	swarm	swarm_RD	'Swarm Over Redoubt 7:00:00 AKDT'	show	show
19	2009/03/09 14:05	swarm	swarm_RD	'New Swarm Redoubt 6:05:00 AKDT'	show	show
17	2009/03/06 13:00	swarm	swarm_RD	'Swarm Over Redoubt 4:00:00 AKST'	show	show
17	2009/03/06 11:00	swarm	swarm_RD	'New Swarm Redoubt 2:00:00 AKST'	show	show
14	2009/02/27 09:50	swarm	swarm_RD	'Swarm Over Redoubt 0:50:00 AKST'	show	show
14	2009/02/27 08:50	swarm	swarm_RD	'Swarm Escalation Redoubt 23:50:00 AKST'	show	show
14	2009/02/27 06:40	swarm	swarm_RD	'New Swarm Redoubt 21:40:00 AKST'	show	show
11	2009/02/27 05:45	swarm	swarm_RD	'Swarm Over Redoubt 20:45:00 AKST'	show	show
11	2009/02/27 03:40	swarm	swarm_RD	'Swarm Escalation Redoubt 18:40:00 AKST'	show	show
11	2009/02/27 01:05	swarm	swarm_RD	'New Swarm Redoubt 16:05:00 AKST'	show	show
8	2009/02/27 00:00	swarm	swarm_RD	'Swarm Over Redoubt 15:00:00 AKST'	show	show
8	2009/02/26 23:40	swarm	swarm_RD	'Swarm Continuing Redoubt 14:40:00 AKST'	show	show
8	2009/02/26 18:30	swarm	swarm_RD	'New Swarm Redoubt 9:30:00 AKST'	show	show
3	2009/02/26 14:50	swarm	swarm_RD	'Swarm Over Redoubt 5:50:00 AKST'	show	show
3	2009/02/26 14:25	swarm	swarm_RD	'Swarm Continuing Redoubt 5:25:00 AKST'	show	show
3	2009/02/26 11:20	swarm	swarm_RD	'Swarm Continuing Redoubt 2:20:00 AKST'	show	show
3	2009/02/26 08:15	swarm	swarm_RD	'Swarm Escalation Redoubt 23:15:00 AKST'	show	show
3	2009/02/26 07:50	swarm	swarm_RD	'New Swarm Redoubt 22:50:00 AKST'	show	show
1	2009/02/22 12:15	swarm	swarm_RD	'Swarm Over Redoubt 3:15:00 AKST'	show	show
1	2009/02/22 10:45	swarm	swarm_RD	'New Swarm Redoubt 1:45:00 AKST'	show	show

Current parameter file settings

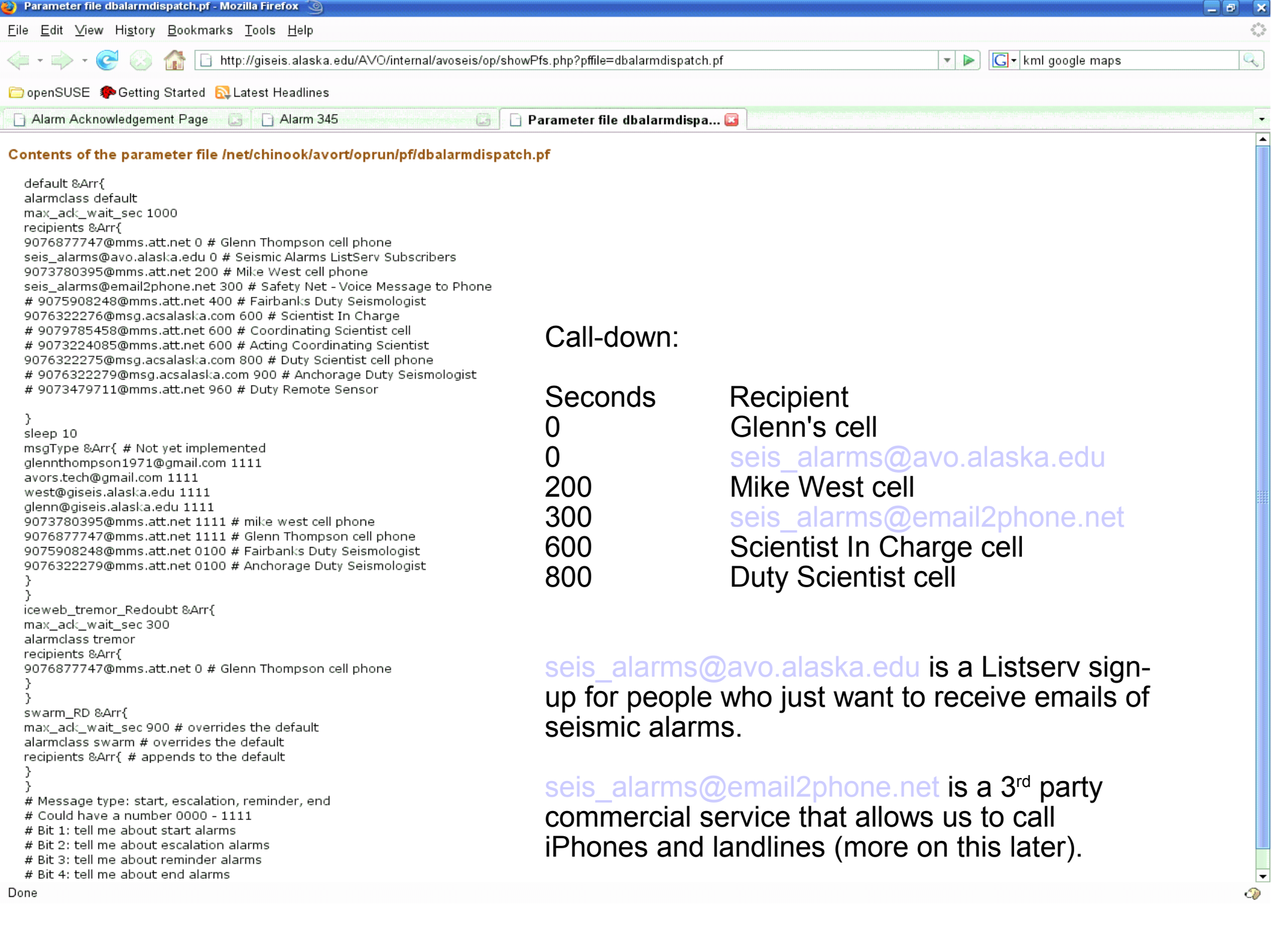
rtexec.pf
orbdetect.pf
orbassoc.pf
dbwatchtable.pf
dbdetectswarm_RD.pf
dbalarmdispatch.pf

Live parameter file settings are here including call-down list

Server processed your request at: 2009/07/22 18:42

Your name glenn will be recorded when you acknowledge alarms

Done


Parameter file dbalarmdispatch.pf - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://giseis.alaska.edu/AVO/internal/avoseis/op/showPfs.php?pffile=dbalarmdispatch.pf
kml google maps
openSUSE Getting Started Latest Headlines
Alarm Acknowledgement Page
Alarm 345
Parameter file dbalarmdispa...
Contents of the parameter file /net/chinook/avort/oprun/pf/dbalarmdispatch.pf
default &Arr{
alarmclass default
max_ack_wait_sec 1000
recipients &Arr{
9076877747@mms.att.net 0 # Glenn Thompson cell phone
seis_alarms@avo.alaska.edu 0 # Seismic Alarms ListServ Subscribers
9073780395@mms.att.net 200 # Mike West cell phone
seis_alarms@email2phone.net 300 # Safety Net - Voice Message to Phone
9075908248@mms.att.net 400 # Fairbanks Duty Seismologist
9076322276@msg.acsalaska.com 600 # Scientist In Charge
9079785458@mms.att.net 600 # Coordinating Scientist cell
9073224085@mms.att.net 600 # Acting Coordinating Scientist
9076322275@msg.acsalaska.com 800 # Duty Scientist cell phone
# 9076322279@msg.acsalaska.com 900 # Anchorage Duty Seismologist
# 9073479711@mms.att.net 960 # Duty Remote Sensor
}
sleep 10
msgType &Arr{ # Not yet implemented
glennthompson1971@gmail.com 1111
avors.tech@gmail.com 1111
west@giseis.alaska.edu 1111
glenn@giseis.alaska.edu 1111
9073780395@mms.att.net 1111 # mike west cell phone
9076877747@mms.att.net 1111 # Glenn Thompson cell phone
9075908248@mms.att.net 0100 # Fairbanks Duty Seismologist
9076322279@mms.att.net 0100 # Anchorage Duty Seismologist
}
}
iceweb_tremor_Redoubt &Arr{
max_ack_wait_sec 300
alarmclass tremor
recipients &Arr{
9076877747@mms.att.net 0 # Glenn Thompson cell phone
}
}
swarm_RD &Arr{
max_ack_wait_sec 900 # overrides the default
alarmclass swarm # overrides the default
recipients &Arr{ # appends to the default
}
}
# Message type: start, escalation, reminder, end
# Could have a number 0000 - 1111
# Bit 1: tell me about start alarms
# Bit 2: tell me about escalation alarms
# Bit 3: tell me about reminder alarms
# Bit 4: tell me about end alarms
Done
Call-down:
Seconds Recipient
0 Glenn's cell
0 seis_alarms@avo.alaska.edu
200 Mike West cell
300 seis_alarms@email2phone.net
600 Scientist In Charge cell
800 Duty Scientist cell
seis_alarms@avo.alaska.edu is a Listserv sign-up for people who just want to receive emails of seismic alarms.
seis_alarms@email2phone.net is a 3rd party commercial service that allows us to call iPhones and landlines (more on this later).

Alarm message

Subject: 'Swarm Over Redoubt 10:40:00 AKDT'

(Reading message from alarms/alarmdb/alarmaudit/message/swarm_RD/2009/07/221840.txt)

From chinook at 2009/07/22 18:40 UTC
Span: 60 minutes
Evts: 13 (13 located)
Mean Rate: 11/hr
Median Rate: 31/hr
Mags: 0.0/1.2/6.0 (of 11)
Cum Ml: 6.0
RSO(12) RED(11) RDJH(10) NCT(8) RDWB(5) DFR(4) RDN(2) REF(2)
End.

Confirm at: http://giseis.alaska.edu/AVO/internal/avoseis/op/confirm_alarms.php

(Read 4 records from alarms/alarmdb/alarmdb.alarmcomm for alarmid=351)

Alarm Calldown

Time (UTC)	Recipient	Delay (s)
2009/07/22 18:40:10	seis_alarms@avo.alaska.edu	9
2009/07/22 18:40:11	9076877747@mms.att.net	10
2009/07/22 18:43:24	9073780395@mms.att.net	203
2009/07/22 18:45:06	seis_alarms@email2phone.net	305

This alarm was acknowledged by glenn at 2009/07/22 21:22:37 UTC

EMAIL2PHONE

Text messages (SMS/MMS) to (regular) cellphones are great.

However:

1. iPhone only allows a barely audible sound when text message arrives – not going to wake anyone. iPhones do have loud/long ringtones – so we want to call them instead of texting them.

2. Cannot send text message to landline. Landlines are a great way to reach people at night because: (a) cellphones may be dead/mislaid/off/out of range, and (b) landlines ring loudly.

We are trying a service called email2phone.net. It turns emails sent to seis_alarms@email2phone.net into voice messages. It can call up to 20 phone numbers, until someone picks up the phone and answers. It costs $10/month.

RSAM alarms are currently going to seis_alarms@email2phone.net.
So are swarm alarms if they have not been answered within 5 minutes.

Alarm messages

RSAM message

From MakushinWorm@usgs.gov

Subject RSAM event Redoubt 07/17/2009 05:47:03

ANC Makushin reports

RSO:EHZ:AV_ data= 20/ 600

REF:EHZ:AV_ data= 39/ 500

RED:EHZ:AV* data= 621/ 200

Swarm alarm message

From: iceweb@giseis.alaska.edu
Subject: New Swarm Redoubt 12:20:00 AKDT

From chinook at 2009/07/22 20:20 UTC
Span: 60 minutes
Evts: 38 (38 located)
Mean Rate: 30/hr
Median Rate: 59/hr
Mags: -0.2/0.6/1.8 (of 30)
Cum Ml: 2.1
RED(35) NCT(29) RSO(29) RDJH(19) DFR(14) RDWB(14) REF(10) RDN(7)
End.

Designed for text message / email. Not well structured for conversion to voice message.

REQUIREMENTS

Alarm systems need to be highly robust:

- Should be run on two different computers, providing failover capability (ideally one in Anchorage, one in Fairbanks)
- Should have an individual, well-maintained UPS, to protect against brown-outs.
- Should auto-reboot following a power outage.
- A diagnostic alarm should monitor all potential points of failure of all mission critical systems.