

# SNEWS Operational Mode 5.0

Effective:

This document provides specifications for the instance of the class defined in the SNEWS Operational Mode Template document.

## 1 Participating Experiments

The participating experiments for this mode are:

- Super-K,
- LVD,
- IceCube,
- Borexino,
- KamLAND.

Note that SNO+, HALO and *NoνA* members remain active members of the SNEWS working group in anticipation of future participation. Also note:

- Borexino and LVD count as being at the same laboratory for the purpose of the coincidence conditions defined in section 7.
- SK and KamLAND similarly count as being at the same laboratory.

## 2 Privacy Agreement

The SNEWS inter-experiment privacy agreement can be found at <https://snews.bnl.gov/wg/privacy/>.

## 3 Client Computer Management

Criteria of the privacy agreement (section 2) regarding access to SNEWS-related accounts on the client computer should be strictly observed. In addition, the following are recommended:

- Outside the main domain of the client computer, TCP/IP access to the client machine should be restricted.
- Login to the client computer should be permitted only to SNEWS subgroup members.
- The TCP/IP address of the client computer should be known only to SNEWS subgroup members.

## 4 Server Computer Management

There is one coincidence server machine located at Brookhaven National Laboratory, and the BNL SNEWS sysadmins are Eric McAlvin and Brett Viren. The BNL server is now a virtual machine, allowing for fast failover in case of hardware issues. There is an additional backup server (also virtualized) located at INFN, Sezione di Bologna, and the INFNBO sysadmin is Andrea Paolucci. The BNL server is the main server, and to the extent possible will operate at all times. The INFNBO server will be kept running in parallel with the BNL server, but will normally have alert output disabled; its alert output will be enabled only in the case of BNL network communications failure. Both servers will normally accept datagrams from all client machines.

The details of the server management, which address all security and maintenance issues for both machines, can be found in the Memorandum of Understanding at [http://snews.bnl.gov/wg/server\\_management/](http://snews.bnl.gov/wg/server_management/).

## 5 Client-Server Communications

- Each participating experiment may generate and send to a server different types of alarm datagrams. Each datagram will normally be sent to both the primary BNL server and the INFNBO backup server. The alarm datagrams include a packet type, and a level flag. The packet type can be PING, ALARM, or RETRACTION. The level flag can be TEST, GOOD, POSSIBLE, RETRACTED or CONFIRMED. Datagrams having packet field values which do not belong to any of these categories are discarded by the server.

### Packet Types

- PING: Ping packets are used for test purposes only and cause nothing more than a message printed to the coincidence server log.
- ALARM: Alarm packets contain information about individual experiment alarms; what the server does with them depends on the level flag.
- RETRACTION: Retraction packets contain information about previously sent alarms to be retracted from the server's alarm queues.

### Level Flags

- TEST: This flag indicates a datagram packet intended for test use as well as for any high-rate test mode. The alarm level is set to *0*.
  - POSSIBLE : This flag indicates an alarm generated during scheduled operations (i.e. maintenance, calibration, tests, etc.) or other known anomalous conditions. It is up to each experiment to set this flag inside the packet when appropriate. The alarm level is set to *1*.
  - GOOD: This flag indicates an alarm generated during normal detection conditions. The alarm level is set to *2*.
  - RETRACTED: This flag is set for retraction packets (note that this information is redundant – all packets of RETRACTION type will be retracted regardless of level flag). The alarm level is set to *-1*.
  - CONFIRMED: This flag indicates an alarm that has been confirmed as good. The alarm level is set to *3*.
- The details of the SNEWS datagram structure should not be propagated beyond the SNEWS subgroup.
  - The client datagrams employ TCP protocol and are encrypted using OpenSSL. The server process listens for connections on a specified port, and when a client initiates a connection, it employs several layers of checks to validate the origin of the datagram:
    1. The server process employs a `tcp_wrappers` `hosts_access` call to check the IP of the client machine against the lists in `hosts.allow/deny`. These lists allow only the IP addresses of the client machines of the involved experiments to submit packets.
    2. The client and server exchange certificates which have been verified by the SNEWS Certificate Authority, and reject connections if the check fails.
    3. There is an additional check of specific client machine IP addresses against a list of allowed addresses before data is exchanged.

## 6 SNEWS Shift

SNEWS shifts will be coordinated by Kate Scholberg, and will be run on a week by week basis. SNEWS shifters must be subgroup members. The shifter must have cellular communications capability, and have quick access to a computer during the 24 hour period of his or her shift.

## 6.1 Shift Alert Responsibilities

Upon receipt of any coincidence message, either SILVER or GOLD, the shifter must immediately log on to the server computer to check that SNEWS code is running correctly, according to logs. If everything is in order, he or she must follow the alert procedures outlined in sections 8.3-8.4. If something seems to be wrong, the shiftworker must contact the relevant people.

## 6.2 Shift Maintenance and Monitoring Responsibilities

The shifter has in addition some daily monitoring responsibilities. The online shift checklist is available at

<https://snews.bnl.gov/wg/shift/>. Twice per 24 hour period (morning and evening), the shifter must check the following:

- The gcserver process is running normally on both the BNL server and INFNBO backup server machines.
- The server log output seems normal on both the BNL server and INFNBO backup server machines.
- Ping connections from the shifter's client machine to both the BNL server and INFNBO backup server machines work.
- The shifter's cellular communications capability is active, batteries charged, etc.

The shifter must make an entry in the online logbook and record any anomalous conditions, and, as appropriate, notify the rest of the subgroup of any problems. If any particular experiment has an unusually high rate of alarms, the shifter should notify that experiment's subgroup member.

If the shifter finds that the network connection to the primary server is unavailable, he or she must notify the relevant sysadmins, and initiate the failover procedure to the backup server.

## 7 Coincidence Definition

The general coincidence definition implemented in the coincidence code may generate either of two types of alert: GOLD or SILVER. An INDIVIDUAL alert may also be generated from a single experiment.

A GOLD alert is generated if *all* of following conditions (1 through 4) are met:

1. There is a 2 or more -fold coincidence within 10 seconds, involving at least two different experiments. (The time window refers to the maximum separation of any of the alarms in the coincidence.)
2. At least two of the experiments involved are at different laboratories.

3. Two or more of the alarms in the coincidence are flagged as GOOD. It is the responsibility of each participant experiment to flag the alarm sent to the SNEWS server(s) appropriately. The specific criteria for a GOOD/POSSIBLE/TEST/CONFIRMED alarms are locally defined by each experiment according to the guidelines in section 5.

4. For at least two of the experiments involved in the coincidence, the rate of GOOD alarms for several past time intervals  $\{T_i\} = \{10 \text{ minutes}, 1 \text{ hour}, 10 \text{ hours}, 1 \text{ day}, 3 \text{ days}, 1 \text{ week}, 1 \text{ month}\}$  preceding the first alarm of the coincidence candidate, must be consistent with the  $\lambda_{\max} = 1/10$  days requirement (in other words, the observed rate must have a reasonably high Poisson probability).<sup>1</sup> We define the precise condition as follows: if an experiment sent  $\{n_i\}$  alarms in each of the last intervals  $\{T_i\}$  before the first event of the coincidence, then the Poisson probabilities  $\mathcal{P}_i$  for  $n_i$  or more alarms in  $T_i$ ,

$$\mathcal{P}_i = \sum_{n=n_i}^{\infty} (\lambda_{\max} T_i)^n e^{-\lambda_{\max} T_i} / n!,$$

for each interval  $T_i$ , must each be greater than  $\mathcal{P}_{thr} = 0.4\%$ .<sup>2</sup> This corresponds to the condition that each  $\{n_i\}$  must be less than  $\{1, 2, 2, 3, 3, 5, 9\}$  for the preceding intervals  $\{T_i\}$  for an alarm to be GOLD.

When the first criterion is satisfied, but at least one of the other criteria is not satisfied, the generated alert is flagged as SILVER. In this case the alert has to be checked by the individual experiment collaborations before any public announcement. No alert will be sent to the community by SNEWS until (and if) there is an upgrade to GOLD.

A GOLD alert may also be generated if condition 1 is satisfied and at least one alarm in the coincidence is CONFIRMED, regardless of whether the other conditions are satisfied. This case allows an override of past high rate history demotion, or other dubious conditions, for a human-checked alert.

An INDIVIDUAL alert is generated if a single experiment sends an CONFIRMED alarm.

## 8 Alert Procedure

### 8.1 The Alert Message

For both SILVER or GOLD coincidence cases, a message containing the following information will be automatically sent by the server to the SNEWS subgroup members:

- all detectors involved in the coincidence,

<sup>1</sup>These time intervals represent real time, not live time, since full live time information will not be available to the coincidence server.

<sup>2</sup>The threshold probability is chosen to avoid excessive accidental demotion of good coincidences: see New J. Phys. **6**, 114 (2004) [astro-ph/0406214].

- the types of alarms (GOOD, POSSIBLE, CONFIRMED) for each experiment involved in the coincidence,
- UTC time of each alarm in the coincidence, and
- if available, information about the burst: duration (seconds), number of signal events, right ascension and declination (degrees) of the inferred supernova direction, and error on the direction (degrees), for the alarms in the coincidence. If this information is not available, default values of zero are given, and 360 degrees for the direction error. Note that this extra information need not be sent even if available; it is sent at the discretion of the experiment's collaboration.

The information may also be posted to a restricted SNEWS subgroup page for SILVER, and a public page for GOLD.

For an INDIVIDUAL alert, the same information as above is sent for the single CONFIRMED level experiment.

An example of the alert message follows, for which extra information is available for one out of the three experiments in the coincidence; the other experiments have default values.

Date: Wed, 17 Mar 2010 09:46:24 -0500  
 From: SN Alert <snalert@bnlboom1.bnl.gov>  
 To: an.observer@mydomain.com  
 Subject: Gold Coincidence Alert

-----  
 \*\*\* SNEWS ALERT \*\*\*

Coincidence rating: GOLD  
 Alarms in the coincidence:  
 Experiment: 1 Super-K  
 Level: GOOD  
 Time: Mar 16 2010 16:04:04.55000000  
 Duration: 0.00  
 No. of signal events: 0.00  
 Right Ascension: 23.00  
 Declination: -82.00  
 Error: 10.00

-----  
 Experiment: 5 LVD  
 Level: GOOD  
 Time: Mar 16 2010 16:04:05.02300000  
 Duration: 0.00  
 No. of signal events: 0.00  
 Right Ascension: 0.00  
 Declination: 0.00  
 Error: 360.00

```
-----  
Experiment: 7 Borexino  
Level: GOOD  
Time: Mar 16 2010 16:04:05.10300000  
Duration: 0.00  
No. of signal events: 0.00  
Right Ascension: 0.00  
Declination: 0.00  
Error: 360.00  
-----
```

For information, see web page <http://snews.bnl.gov/>

Note that the server process searches the past day's worth of its alarms in memory.

## 8.2 GOLD Procedure

For a GOLD alert, the alert message is sent directly to the **snews-alert** mailing list, which includes addresses of all who have signed up to received it. This includes astronomers, and the Sky & Telescope AstroAlert list.

In addition, a separate email is sent directly to members of the subgroup, as well as several members of the community requiring prompt alerts to enable data storage: LIGO, Antares.

### 8.2.1 Experiment Gold Procedures

- Super-K: see web page for contact list
- LVD: see web page for contact list
- IceCube: see web page for contact list
- Borexino: see web page for contact list
- KamLAND: see web page for contact list

#### Demoting from GOLD:

Although we hope to avoid ever being in the situation where retraction of a GOLD alert is necessary, any experiment may reflag from GOOD (or POSSIBLE) to RETRACTED its own alarm after data checking. The server will then automatically reevaluate and reissue the alert based on alarms in the past day of its memory: the result may be still GOLD, demotion to SILVER, or no alert at all. For the latter case, the SNEWS subgroup is notified, and a RETRACTED alert will be issued to the same mailing list as for GOLD and posted on the public web page.

### 8.3 SILVER Procedure

For a SILVER alert, no automated alert message to the community is generated by the coincidence server. Email is sent to experimental contacts and subgroup members only. The procedure indicated by each experiment should be followed by the SNEWS shiftworker.

#### 8.3.1 Experiment Silver Procedures

- Super-K: see web page for contact list
- LVD: see web page for contact list
- IceCube: see web page for contact list
- Borexino: see web page for contact list
- KamLAND: see web page for contact list

#### Upgrading from SILVER to GOLD

A SILVER alert may be upgraded to GOLD if the requirements are confirmed in a second step. Any individual experiment is expected to resend its alarm datagram if the flag can be changed from POSSIBLE to CONFIRMED. All subgroup members must be then informed by e-mail. If the GOLD conditions are consequently fulfilled after the new alarm dispatch, the GOLD procedure will automatically operate. Note that the server process searches for coincidences in the past day's worth of alarms in memory.

### 8.4 INDIVIDUAL Procedure

The INDIVIDUAL procedure is identical to the GOLD one.

### 8.5 SNEWS Data Exchange

All server-client information exchanged during a supposed SN alert will be saved in the server log file. This information is available to subgroup members at any time, and later to the experiment collaborations by agreement of the SNEWS Advisory Board.

### 8.6 Summary

Figure 1 summarizes the sequence of events and GOLD vs. SILVER decisions.



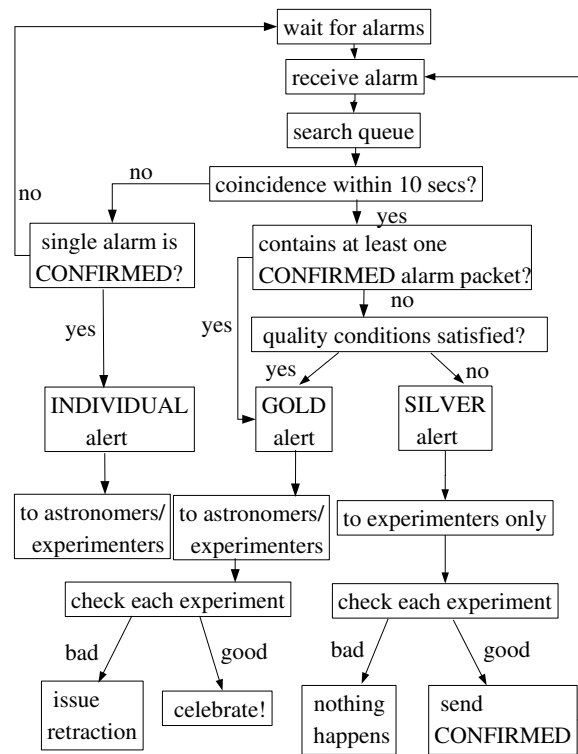


Figure 1: Flowchart summarizing the sequence of events and decisions that determine whether an alert is GOLD, SILVER (or INDIVIDUAL).

## 9 Communication to the Scientific Community

### 9.1 Alert Mailing List Management

To allow the confirmation of a SNEWS alert as really coming from SNEWS, any alerts will be public key signed using the SNEWS key. This key has the ID# 0x68DF93F7, and is available on the network of public PGP key servers such as <http://pgp.mit.edu/>

People receiving any alert should verify that this signature was used to sign the alert message, to satisfy themselves that the alert is really coming from the SNEWS collaboration and is not being maliciously or accidentally spoofed. Exactly how to do this is a function of the individual user's email client. Since many people do not use such features on a day to day basis, anyone wishing to be able to verify SNEWS alerts should set up their client in advance. Instructions for doing so can be found on the SNEWS web site for many popular email clients.

Email to the list of alert subscribers will be limited to real alerts and quarterly test messages. These test messages will be clearly labeled as a mailing list test, to remind the subscribers that they are subscribed and to ensure mailing list functionality.

People wishing to subscribe or unsubscribe from the alert mailing list can do so automatically using the GNU mailman software linked from the SNEWS website. The subscriber list is held in complete confidentiality, only available to the SNEWS core group and not used for any purpose other than alerts and periodic tests. (Advisory board members may request the list.)

For the GOLD and INDIVIDUAL cases, the same information and updates will go to the public SNEWS URL. For the SILVER case, the message goes out only to the SILVER list.

### 9.2 Individual Experiment Alerts

The INDIVIDUAL alert mode is intended to allow individual experiments to make use of SNEWS alert infrastructure; it is not required. There is no restriction on individual experiments making any independent announcement based on individual observation in the case of absence of a SNEWS alert, SILVER or GOLD, or preceding or following any SNEWS alert message. Any individual experiment may publicly announce a supposed supernova signal following a dispatched SILVER alert which has not yet been upgraded to GOLD, or a GOLD alert. In these cases the information that a previous alert from the SNEWS server has been received should be cited.

## 10 Changelog

### Version 5.0

- Add KamLAND.

- Add note that KamLAND and SK count as being at the same laboratory.
- Update BNL sysadmin personnel.
- Update backup server description (now virtual machines).
- Minor clarification of description of high-rate suppression criterion.
- Alert criteria not adjusted to conditions for five experiments running (2/5 coincidence). Mean alarm rate of 1/10 days is still acceptable; Poisson probability threshold for automatic rate suppression of 0.4% makes only small change in undesirable alarm demotion, so is not changed.
- Update alert information.

#### **Version 4.0**

- Add Borexino.
- Add note that Borexino and LVD count as being at the same laboratory.
- Change AMANDA to IceCube.
- Update sample alert message for new experiments.
- Alert criteria adjusted back to version 3.0 conditions (2/4 coincidence), for four experiments running: mean alarm rate is changed from 1/week to 1/10 days; Poisson probability threshold for automatic rate suppression is changed from 0.5% to 0.4%.
- Add note on availability of subscriber list.

#### **Version 3.1**

- SNO is now off; gold alert criteria adjusted for 2/3 coincidence: mean alarm rate is changed from 1/10 days to 1/week; Poisson probability threshold for automatic rate suppression is changed from 0.4% to 0.5%.
- Describe new backup server, and criteria for failover in Section 4.
- Add backup server check responsibilities to shift section.
- Update links to privacy and server management web pages.

#### **Version 3.0**

- Allow for INDIVIDUAL alert for a single CONFIRMED level alarm. Change flowchart accordingly.
- Send GOLD coincidence if a single CONFIRMED is included, regardless of other condition (previously at least one GOOD and one CONFIRMED was required).

- Change nomenclature: OVERRIDE  $\rightarrow$  CONFIRMED.

#### **Version 2.1**

- Specify additional optional allowed fields in the alarm (duration, number of signal events, direction.)

#### **Version 2.0**

- Add AMANDA/IceCube.
- Update web links.
- Small quantitative changes to criteria to accommodate the fact that it's now a 2/4 coincidence: mean alarm rate is changed from 1/week to 1/10 days; Poisson probability threshold for automatic rate suppression is changed from 0.5% to 0.4%.

#### **Version 1.0**

- First version, for SK/SNO/LVD.