MONTSERRAT VOLCANO OBSERVATORY

GOVERNMENT OF MONTSERRAT

Review of MVO Seismic Monitoring, August 2000

(prepared for consideration by the Independent Monitoring Panel)

Glenn Thompson

MVO Open File Report 00/02

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EXECUTIVE SUMMARY

What is MVO's mission? Is it to do the most basic monitoring? Or are we here to provide a really effective monitoring programme? It is the latter I believe we should be aiming at, while there are still people living on Montserrat, because they need an MVO that can help them understand what is happening to their island so they can feel safe, rather than an MVO that tells them the number of earthquakes each week.

At present we are in danger of not even being able to do the most basic monitoring, because we do not have an effective network maintenance programme and our acquisition systems are malfunctioning and need upgrading. And with activity at levels similar to early 1997, this is a dangerous combination and needs to be addressed quickly.

The next step would be to add systems that aid monitoring. For example, it would be useful to have a digital network RSAM system, since the analog network RSAM saturates easily. Then it would be useful to have a rockfall location system, which would be a great aid to hazard assessment and safety in the field. Our present systems do not allow us to implement such ideas because the digital network system has no real-time capability and the Sun processing power is weak, and also because we do not have calibration data for either network.

Alarm response could also be much more effective, by having seismic data available on the web. This would enable us to get out warnings to NOAA 20 minutes earlier than at present, which significantly reduces the chances of aircraft encountering ash.

And many of these ideas would be much more effective if digital network and analog network data were available on the same analysis system (particularly anything involving event location). This which would also lead to great improvements in efficiency, saving money on staff.

Another very serious issue are the shortage of radios and the unreliability of the radio repeaters – these are essential to the safety of people working in the exclusion zone.

Problems with the network, including maintenance, calibration, and assessment of spares have not been addressed, and I don't feel confident that the present MVO staff can take care of these things. This is the reason for proposing that MVO appoint a Field Seismologist. It makes no sense to quibble about the salary of one staff member when that person is so important to MVO's mission and his salary so small in comparison to the MVO budget.

Problems with the acquisition systems are already being addressed, and though problems with the VME were first noted in 1996, a replacement for the VME still seems a long way off, and this is only component of the programme of upgrades planned. Until these upgrades are made, maintenance of the acquisition systems is likely to be major problem.

So to enable these upgrades to happen more quickly I have suggested that MVO appoint a second seismologist, for a period of 6-12 months. Decisions still need to be made about whether EarthWorm or Soufriere will be part of MVO's future, although if the current plan to replace the VME with SA24 fails, we will be forced to adopt one of these systems.

None of the suggestions made in this document are made because of a desire to turn MVO into a research establishment. They are made because our seismic monitoring system is deteriorating, albeit slowly, and this directly affects the safety of everyone on the island.

1 SEISMIC NETWORKS

1.1 Network configurations, August 2000

MVO presently has two independent seismic networks. The digital network [Fig. 1] consists of 8 stations: Long Ground (MBLG), Windy Hill (MBWH), St. George's Hill (MBGH), Roache's Yard (MBRY), South Soufriere Hill's (MBSS), Broderick's Yard (MBBY), Garibaldi Hill (MBGB) and Mango Hill (MBMH). The analog seismic network [Fig. 2] consists of 6 stations: Long Ground (MLGT), Windy Hill (MWHT), St. George's Hill (MGHT), Roache's Yard (MRYT), Lee's Yard (MLYT) and Jack Boy Hill (MJHT). Although there are a total of 14 stations, 4 of these sites are shared, so there is a total of only 10 seismic sites.

In addition to the seismic stations, there are repeater stations. Signals from 6 stations are repeated at Centre Hills (MWHT, MBWH, MGHT, MBGH, MLYT, MBBY). Signals from 3 stations are repeated at Silver Hills (MBSS, MBRY, MBLG). The signal from MLGT is repeated at MJHT and that from MBSS is repeated a second time at MBRY. In total there are 12 unique sites.

1.2 Immediate problems

Recurring power problems at the Center Hills repeater site have interrupted signals from up to 6 seismic stations, reducing the total number of stations from 14 to just 8. This site can only be reached by helicopter, and landing is difficult. Maintaining this site is a serious problem.

MBLG has been down since the collapse on March 20, 2000. Ash has made it impossible to land there, and walking across the pyroclastic fan from the airport is too risky, since further collapses could occur at any time. Fortunately, the loss of MBLG does not significantly impact seismic monitoring.

Activity in the Belham River Valley (BRV) is perhaps the main threat to people in the safe zone. Although MLYT and MGHZ pick up mudflows in the BRV quite well, a seismic station deployed specifically for this task would help. DFID Montserrat have earmarked $30000 US funding for a BRV warning system, equipped with a seismometer, an acoustic flow meter, traffic lights & gate, to be installed at the time MVO moves to Flemings.

MVO’s ability to monitor deep earthquakes (> 5 km) or events within a few kilometers offshore of Montserrat is poor. Such activity is rare, but could be significant.

1.3 Recommendations

Install a wind generator at the Centre Hills repeater site. Wind generators have been successfully installed at the South Soufriere and Spring Estate GPS sites, and have been found to be much more effective than solar panels at maintaining power. These can be bought off the shelf in Antigua for around $1000 US. However, the wind at this site is not particularly strong.

Attempts will continue to be made to get into Long Ground during or immediately after heavy rainfall (which should reduce the airborne ash). Attempts to walk to the site will have to wait until after a major collapse.

Suggest to DFID that they immediately provide funding for purchase and installation of a new analog network site close to the BRV. The other components of the BRV warning system are not so urgent.

Ask SRU if they would allow us to receive data from one SRU station on each of Antigua and St. Kitts. Make a similar request to Guadeloupe Observatory for data from one of their stations. (SRU receive data from MVO stations MJHT, MGHZ and MRYT; Guadeloupe Observatory also receive MGHZ). Funding for the extra telemetry equipment and installation visits would have to be acquired.

1.4 The move to Flemings

With the move Fleming's, alterations to the seismic networks will be necessary in order to simplify the telemetry and minimise the dependence on the helicopter. Event classification and location will also be improved by moving some of the seismic stations. Figures 3 and 4 show the digital and analog networks as they would like if all the proposed changes are implemented.

These changes will be made at the time MVO moves to Fleming’s:

- MBMH (Mango Hill) will be moved to Silver Hills (next to the repeater), which will be quieter and require 1 less repeat.
- A new repeater site will be installed at Garibaldi Hill. This new site will be accessible by road and should have AC power by then (January 2001 according to Monlec).
- The Center Hills repeater site will be eliminated. 5 of the 6 stations currently repeated at Centre Hills can probably reach Fleming's without a repeat (MBBY is the exception: it will be repeated at Garibaldi Hill).

The following changes will also be considered:

- Move MBSS to South Soufriere Peak, to simplify the telemetry and bisect the 120^o gap between Roache's Yard and Broderick's Yard. A viable site has not yet been identified, and may not exist.

- MJHT could be moved to Harris*, ideally close to the permanent GPS site. This should be excellent for detecting rockfall activity on the northern slopes. Harris is preferred to Hermitage for safety reasons

- A close station would help to constrain the depths of hybrid earthquakes and thereby answer some important scientific questions. The proposal is to move MRYT to Galways Mountain*. This would be too dangerous at present, but may be viable at some point within the next 2 years.

2 DIGITAL NETWORK DATA ACQUISITION

2.1 The digital network acquisition system

The digital network acquisition system [Fig. 5] consists of a 24-bit Interpolating Line Interface (ILI) and an OS9-based VME computer running the Seislog acquisition software. Event files and continuous data are then transferred using ftp to a Sun workstation and archived to DAT by the VME_COLLECT software, developed at BGS. Analysis of event files is performed manually on the Sun using Seisan.

The system was designed for regional earthquake monitoring and is virtually identical to a system used for that purpose in Hong Kong. It lacks some important features for volcano monitoring such as an alarm system or real-time display of data. The event classification software is excellent but there are no tools for more detailed data analysis, although some have been added by MVO.

2.2 Current problems

The VME computer/OS9 operating system have several problems:

- It is not Y2K compliant. BGS applied Y2K patches in December 1999.

- It is rather slow (50 MHz?), and during times of high activity, it crashes fatally.

- The VME has become increasingly more difficult to reboot. On one occasion this took more than 24 hours.

* MVO would consult SRU before re-deploying MJHT, MRYT or MGHZ since they currently receive data from these stations.

- An increasing number of event files are corrupted, which crash the VME_COLLECT software.

- There is no local support available for OS9 or the VME, which makes troubleshooting difficult.

These problems have led to serious data loss. Between January 1 and August 15, 2000, the average data loss per day was 3.9 hours.

In November 1999 and January 2000, BGS made unsuccessful attempts to replace the VME with a QNX-based PC, but later found this PC had been damaged in transit. Work continued on the QNX, but ran into problems with the QNX-ILI interface. BGS are now planning to replace the VME with a PC running SA24, a system developed by Earth Data Ltd which interfaces with the ILI (also supplied by Earth Data Ltd.). BGS will also write a program to convert SA24 format files into Seislog format, so this unit can be a drop-in replacement for the VME.

BGS have ordered the SA24 system, but they do not expect delivery until December 2000 at the earliest. Testing will follow, and installation in Montserrat is unlikely before January 2001. MVO has grave concerns about the prospect of maintaining the VME for another 6 months.

Other problems:

The two DAT drives used for archiving digital network data are beyond their expected lifetime. Write errors frequently occur, which leads to an accumulation of data on the Sun computer, which quickly overflows and leads to data loss. New DAT drives and larger hard drives are required to overcome these problems.

The slow speed of the Sun computer (~100 MHz) makes event classification slow, and makes it difficult to set up systems for automated analysis of continuous data.

The Sun workstation is also difficult to support since it does not use PC hardware. There is also no local Unix support.

2.3 Recommendations

More resources should be devoted to finding a suitable replacement for the VME, and bringing the timeframe of its replacement forward. MVO is very optimistic about the SA24 system that BGS Edinburgh are investigating. Brian Baptie has suggested that I visit BGS Edinburgh in late October 2000 to appraise the SA24 system, subject to BGS funding.

BGS have already ordered a Linux PC to replace the ailing Sun workstation. This will be easier to support since it uses standard PC components, has a large amount of disk space

(18 GB) and CPU power (two 600 MHz processors). Although Windows would have been easier to support than Linux, software development on a Windows platform is much more difficult. BGS have also allocated money to purchase a DAT drive for the Linux PC ($1000 US). MVO plans to install Seisan on the Linux PC, and adapt the VME_COLLECT software so that the Sun workstation and its two DAT drives can eventually be phased out. This is likely to require several weeks of dedicated work.

Figure 6 summarises how the digital network data system would look after these changes.

3 ANALOG NETWORK DATA ACQUISITION

3.1 The analog network acquisition system (PC-SEIS)

The analog network system [Fig. 7] was installed by VDAP in July 1995 and consists of a digitiser box and three PCs for acquisition (PC-SEIS), real-time monitoring (RSAM) and analysis (BRAINS). The RSAM system includes an alarm system which is vital to MVO operations. The system is well-designed for volcano monitoring, and requires little maintenance work, but also has many limitations. Although PC-SEIS strictly refers only to the software running on the acquisition computer, the entire system is usually referred to as PC-SEIS.

3.2 Current problems

The PC-SEIS system runs under DOS and is not compatible with modern PC hardware, which makes maintenance and networking difficult. The problems with the analog network system are small by comparison to those of the digital network system, but these problems will increase and MVO would like to replace PC-SEIS with a more modern system.

The analysis software (BUDSPICK and BOB) is also rather poor, but this is dealt with in the ‘Data analysis’ section below.

3.3 Possible replacements for PC-SEIS

VDAP recognizes the problems with PC-SEIS and are developing the EarthWorm system as a direct replacement. EarthWorm runs on the latest PC hardware under Windows NT, which would allow easy integration with MVO’s NT network. Improved RSAM and SSAM modules are included. Updates to the alarm system and analysis software have not been made yet. A very useful new feature is a module which can display the last 5 hours of data over the web. New digitizers and two new NT workstations would have to be purchased for around $15000 US. Installation and training would be extra. Software free.

IceWorm was developed by the Alaska Earthquake Information Centre and is used by the Alaska Volcano Observatory (AVO). It includes EarthWorm, but interfaces it with Antelope, which has impressive databasing and analysis software package. IceWorm is probably the best data acquisition and analysis system available. However, it is very complex and I fear it might be difficult to maintain, based on my experience at AVO. It is also very expensive. The Antelope software would cost $30000 US plus an additional licence fee each year. Hardware costs would be as for EarthWorm, about $15000 US, plus installation and training.

ViSeis is a commercial product written by John Rogers who co-wrote PC-SEIS. I appraised this system in December 1999 when it was still under development and wasn't particularly impressed, but it should probably be re-appraised now. Total costs would be competitive with EarthWorm.

Soufriere is SRU's acquisition system. I am planning to appraise this system shortly, subject to BGS funding a visit to SRU.

3.4 Recommendations

EarthWorm is already used widely for regional earthquake monitoring throughout the US, and during the last year it has been installed by VDAP at a few volcano observatories in Central and South America. The system is designed with a modular structure and end-users are encouraged to contribute new modules, and so the system will continue to improve. I believe this is the system we should go for, but first Soufriere should be appraised and ViSeis re-appraised.

4 DATA ANALYSIS

4.1 Routine analysis

Event classification on the digital network system is performed using Seisan, and on the analog network system using BUDSPICK. Seisan is superior since it allows the Seismic Data Analyst to compute a spectrum which is often useful for correctly identifying event type. However, the event location software on the analog network system, HYPO71, seems to be better than HYPOCENTER, bundled with Seisan.

4.2 Current problems

Events are analysed completely independently on both the analog network and the digital network system. This is very inefficient, leading to an average of about 3 extra man hours of work each day. Many other advantages could be accrued by combining data from both networks into a single analysis system: event classification and location would improve, since there would be 14 rather than 8 or 6 stations available. There would also only be one system to maintain and support, and all data would be archived in the same format, making further study easier.

Data analysis software at MVO is poor, and neither the analog network or digital network systems has a well designed database. Until early this year, event counts were the only data from the digital network system that were used for monitoring. The lack of good analysis software makes data analysis unnecessarily time consuming, difficult and tedious, and consequently undermines the quality of the scientific advice that MVO can provide.

4.3 Combining data from both networks

There are several ways in which data from both networks could be combined, but none is trivial, not least because the digital network uses a sampling rate of 75 Hz, whereas PC-SEIS (and EarthWorm) assume a sampling rate of 100 Hz. This is BGS' proposed solution [Fig. 8]:

Feed the analog data from the analog network into an A2D card to sample the data at 75 Hz (to match the digital network sampling rate), and then into a new PC running Seislog. These data would still go into PC-SEIS too, since Seislog does not have the RSAM or alarm systems.

Write an association algorithm to combine the analog network Seislog event files with the digital network Seislog event files.

Analyse these data with Seisan, as is done now for the digital network data. This analysis would be done on the Linux PC that is on order to replace the ailing Sun workstation.

This solution is tempting because the good parts of PC-SEIS (the RSAM and alarm systems) are kept and the poor parts (BUDSPICK, BOB) replaced by the superior analysis tools of Seisan. If PC-SEIS were replaced by EarthWorm this solution would still work, only even better since EarthWorm offers much improved real-time monitoring tools.

This solution assumes that BGS' plan to replace the VME with a PC running SA24 is successful, and is not significantly delayed. An alternative proposal [Fig. 9] may be to use Guralp's *Scream!* software to acquire data from the digital network. An interface between *Scream!* and EarthWorm already exists, and real-time monitoring would be greatly improved since data from both networks would be monitored by the RSAM, SSAM and alarm modules. This would eliminate the ILI and VME. Seisan would also be eliminated, so it might be best to wait until EarthWorm offered an upgrade to BUDSPICK.

4.4 Development of improved analysis tools

Matlab GUIs are presently being developed for plotting digital network event counts, energy and hypocentral data, and continuous seismic amplitude. A tool for plotting digital network RSAM data is being developed using Java. Eventually it is hoped that these tools will also incorporate hypocentral and RSAM data from the analog network system. The key will be to design a suitable database for storing all these data.

Matlab tools will also be created for analyzing Seisan event and rbuffer (continuous data) files. These will allow spectrograms, reduced displacement and digital helicorder data to be plotted.

Finally it would be a great boost to have better real-time monitoring tools. Real-time spectrograms, reduced displacement and digital helicorder plots could be developed using Java and made to auto-update (scroll). These are particularly useful for monitoring tremor and swarms. It would be best to develop these tools using Java, since the applications could be modified to run as applets over the web (see the Remote Monitoring section below).

5 REMOTE MONITORING AND ALARM RESPONSE

5.1 MVO alarm response

The RSAM alarm system is connected to a modem and alerts the Duty Scientist (a position which rotates weekly between the overseas scientists) to significant increases in seismicity. It is common for 30 such alarms to be sent each week [Fig. 10]. Most of these alarms are received while the Duty Scientist is at home, a 20 minute drive from MVO, and the normal response is to check visually for ash above 8000 feet. Only if two or more alarms go off in within a 20 minute period is it normal for the Duty Scientist to drive to MVO to check the seismicity.

5.2 Current problems

Checking for ash can be very challenging against a dark cloudy sky obscured by buildings and trees, but it is unreasonable to expect the Duty Scientist to drive up to the MVO 4 times in one night. Moreover, during the 20 minutes it takes to reach MVO, jet airliners will have traveled about 200 miles, considerably increasing the risk of encountering as ash cloud. There is a clear need for a system whereby seismicity can be quickly and easily be assessed from home, without any need to drive to MVO.

5.3 Solutions

There are two solutions which will require 24 hour web access. These systems would not only assist with alarm response, but also be of great interest to overseas scientists and schools:

- DrumCam: MVO has installed a video camera over one of the drum recorders, and hopes to put this image live on the web. (A VolcanoCam has also been installed, looking from Jack Boy Hill, and this will also appear on the web).
- Digital data on the Web: The Alaska Volcano Observatory have near-real-time spectrogram, reduced displacement and filtered helicorder plots on the web for 15 volcanoes. The height of an ash cloud is proportional to the reduced displacement.

Presently MVO does not have the infrastructure to develop such a system, but within a few months this may be possible.

- It has also been suggested that the image from DrumCam (and possibly VolcanoCam) might appear on local access TV, which would be much more convenient than logging on with a PC. Other alternatives are:

- Scanner Seismograms: The real-time FM seismic signals received by a scanner could be fed into a PC (if a suitable interface were adapted) and plotted (perhaps using some music software).

- HomeDrum: An extra drum recorder could be acquired and set up at the Seismologist’s home. It difficult to see how this could work in practice since it would require the Seismologist to respond to every alarm.

6 REGIONAL AGENCIES

It is important for MVO to contribute to regional monitoring so long as this does not interfere with its ability to monitor the Soufriere Hills Volcano. The two regional agencies are MIDAS and SRU. While there has been little interest from MIDAS, the history between SRU and MVO is long and complex. We would like to rebuild these relations.

6.1 Sharing real time data

Presently SRU receive real time data from three MVO short-period stations (MJHT, MGHZ and MRYT). MVO receives no data from SRU. It would be very helpful to receive real-time telemetred data from one station on each of St. Kitts and Antigua (and from Guadeloupe though this has nothing to do with SRU) and patch these data into our analog network acquisition system. This would help for distinguishing between volcanic and regional earthquakes, and improve our ability to locate events outside our network.

6.2 Sharing archived data

MVO archives Seisan event files from the digital network system onto DAT tapes and sends these to SRU on at irregular intervals. The Seisan format is inconvenient for SRU, and John Shepherd recently suggested that MVO convert Seisan event files to SEED format and automatically place them on an IRIS data server. MVO does not presently have the necessary infrastructure to do this (our digital network system is not even integrated with the local area network, let alone the internet) but this may be a possibility within the next 12 months. SRU would also put their event data on the IRIS data server, though this is unlikely to benefit MVO.

6.3 Acquisition systems

There is no *a priori* reason why SRU and MVO should use the same acquisition systems, since programs can be written to convert data from one format to another. John Shepherd (Head of SRU) acknowledged this in a recent email:

Dear Glenn

I am not sure that we can make any progress on Souf without discussing things face to face. David Beckles is still in Barbados and I am pretty sure that I can get him here if you come here.

Lloyd is at CVO working with the VDAP team at the moment and has spoken about EARTHWORM. It is a good system and is probably best for your mix of digital and analogue stations… The souf system is the only system which will multi-task freely - apart from big mainframe-based systems of course. Actually I don't think it is essential for us both to use the same system, although it would be handy of course. In the very long run of course we will replace your system with our system anyway when we re-assume responsibility for MVO. When that will happen I have no idea. After I have retired probably…

Cheers, John

However, Soufriere may be a viable alternative to EarthWorm, and an effort should be made to appraise Soufriere before MVO commits to another system. Installation of Soufriere would likely strengthen relations between SRU and MVO.

7 NEW STAFF

7.1 Temporary Seismologist

The many problems with our acquisition and analysis systems have been covered in some detail elsewhere in this document. Many of these problems have existed for a long time (VME problems were first noted in 1996) but little has been done about them. Systems have continued to deteriorate, and throughout this time the lack of good analysis software has made it difficult to 'stay on top' of the seismicity. These problems need to be addressed.

During the last 7 months I have found little time to analyse data, with the bulk of my time necessarily devoted to maintenance of the digital network acquisition system and development of new analysis software. Maintenance is likely to remain high for at least another 6 months (until the VME is replaced) and completely upgrading the acquisition and analysis systems is likely to take 12 months. I do not feel confident that I can carry out his work *and* analyse the seismic data is sufficient detail simultaneously. I am therefore recommending that MVO appoint a second seismologist, for a minimum of 6 months, preferably 12 months. The need is particularly acute given the ongoing relatively high level of volcanic activity. Such an appointment would hardly be unprecedented, since during similarly active periods in 1996 there were often two or more seismologists at MVO.

7.2 Field Seismologist

The condition of equipment in the field is a cause for great concern. Presently 4 of the 8 digital network stations are down, three of them because of recurring power problems at the Centre Hills repeater site, and one of them (Long Ground) has been down for over 5 months. Guy cables have broken off antenna, and solar panels are not fastened securely – these could be lost in hurricane season. Padlocks at some stations have seized. Most serious of all, our radio communications in the field are often garbled, presumably because of problems at the repeater stations. Many sites are difficult to land at because there is no regular 'debushing' campaign. After his recent visit, Brian Baptie was so alarmed that he is now recommending to BGS that two preventative maintenance trips be made by BGS Staff each year, since as he puts it 'experience suggests that [the field equipment] cannot be adequately maintained locally'. Preventative maintenance is an alien concept at MVO.

I believe the problem is that MVO's Senior Electronics Technician has too many responsibilities. I would suggest that MVO appoint an experienced Field Seismologist to maintain the seismic networks and field equipment and train local staff. Ideally this person would also support (perhaps even develop) the seismic data acquisition systems, which would then preclude the need for a temporary second seismologist as discussed in the previous section.

8 NEW EQUIPMENT

8.1 The digital network

Discussions with staff at MVO suggest a worrying shortfall in the level of spares for the broadband network. In a crisis situation such as volcanic monitoring we would recommend a level of spare equipment of around 50% of the operational requirements. This would allow rapid substitution of hardware in the event of equipment failure. We also stress that the specialised nature of the equipment means that replacements are not available off the shelf. The companies with whom orders must be placed typically require 3-4 months before equipment can be shipped. This highlights the need for equipment to be readily available on island in adequate amounts.

Currently there are 4 broadband Guralp CMG-40T seismometers and 4 Integra LA-100 seismometers deployed in the field. There are 4 spare LA-100 seismometers, which seems adequate, but two further broadband instruments are required. More worryingly, there are no spare digitizers. At least three, preferably four should be purchased as soon as possible.

Telemetry requirements for the eight operational stations amount to a total of 15 radio transmitter/receiver pairs deployed. These are vulnerable elements of the system and there are only 5 pairs on the shelf. It is not known whether they are in working order. In any case, a total of 8 pairs are required as spares; that means 3 new pairs.

The level of spare equipment of the more mundane items, such as solar panels, regulators, lightning protectors, cabling, batteries and battery chargers, essential for any installation, is inadequate. Other items like antennae and other cabling may need replacement.

Immediate costs:

Item	Quantity	cost per item (£)	Cost (£)
Guralp seismometer	2	4000	8000
Earth Data digitizer	4	2500	10000
Earth Data radio pairs	3	1800	5400
Field station hardware	7	2000	14000
Equipment repairs			10000
Total cost			47400

Field station hardware includes antennae, multiplexers, solar panels, regulators, lightening protectors, cabling, connectors, batteries and battery chargers.

8.2 The analog network

Dave Williams is compiling an inventory of the analog network equipment and will recommend new purchases. All stations are presently working though some routine site maintenance is necessary.

8.3 Digital network data acquisition and analysis

As already indicated, the VME will be replaced as soon as possible with a PC running EarthData's SA24 system. This will require a new PC (already included in the QNX budget), SA24 software & ILI interface card ($1000 US). BGS is ordering the equipment and will configure and test the system, and come to MVO to install it.

A Linux PC to replace the Sun workstation is on order. BGS have allocated approximately $1000 US for a replacement DAT24 drive, although two of these will be needed.

8.4 Analog network data acquisition and analysis

MVO needs to make a decision whether to replace PC-SEIS with EarthWorm. Two NT workstations and other hardware would cost ~$15000 US. Installation and training costs would be extra.

BGS plans to acquire a new A2D card ($800 US) and feed signals from PC-SEIS (or EarthWorm) into a new PC running Seislog ($3000 US). This way it will be possible to combine data from both networks on the Linux PC, and analyse them using Seisan.

9 POINTS FOR THE MVO REVIEW PANEL TO CONSIDER

- Is there sufficient justification to appoint a temporary Seismologist?
- Is there sufficient justification to appoint a Field Seismologist?
- Do the Panel agree that the MVO Seismologist should visit SRU, to appraise the Soufriere acquisition system?
- If Soufriere is found to be unsuitable, would the Panel recommend MVO to replace PC-SEIS with EarthWorm, or do this only if the SA24 replacement for the VME fails?

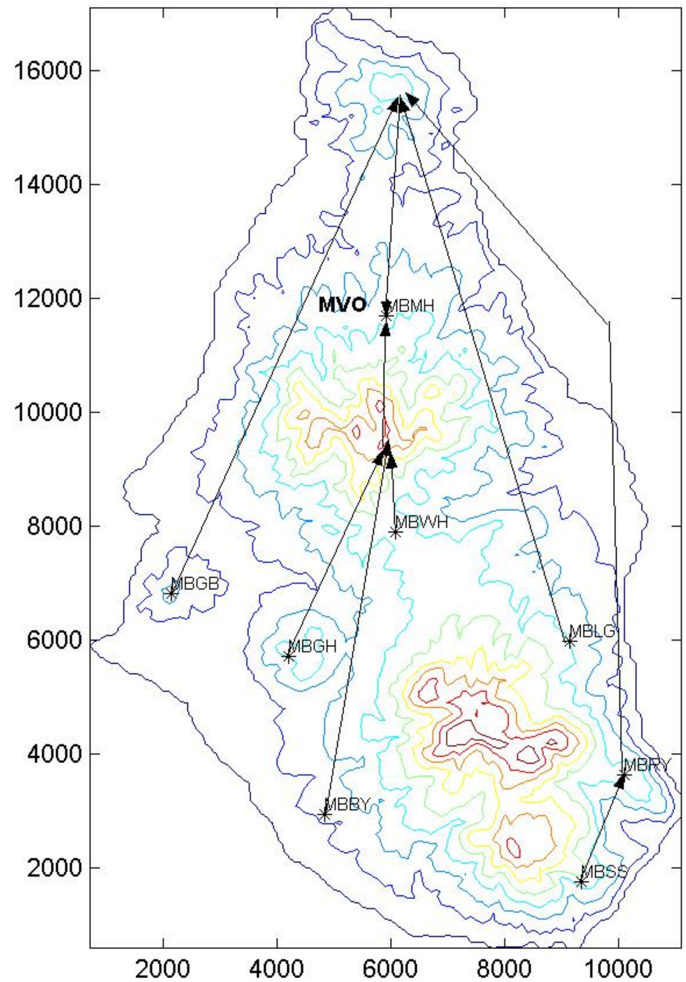

Figure 1: The digital seismic network, August 2000. The Centre Hills repeater site is a weak link.

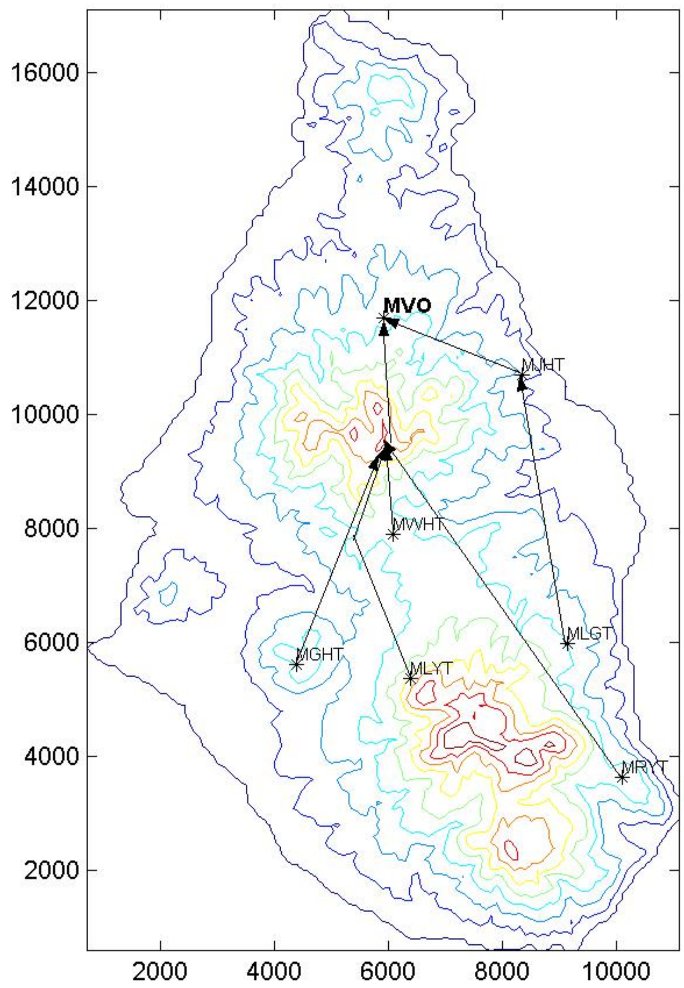

Figure 2: The analog network, August 2000. The Centre Hills repeater site is a weak link.

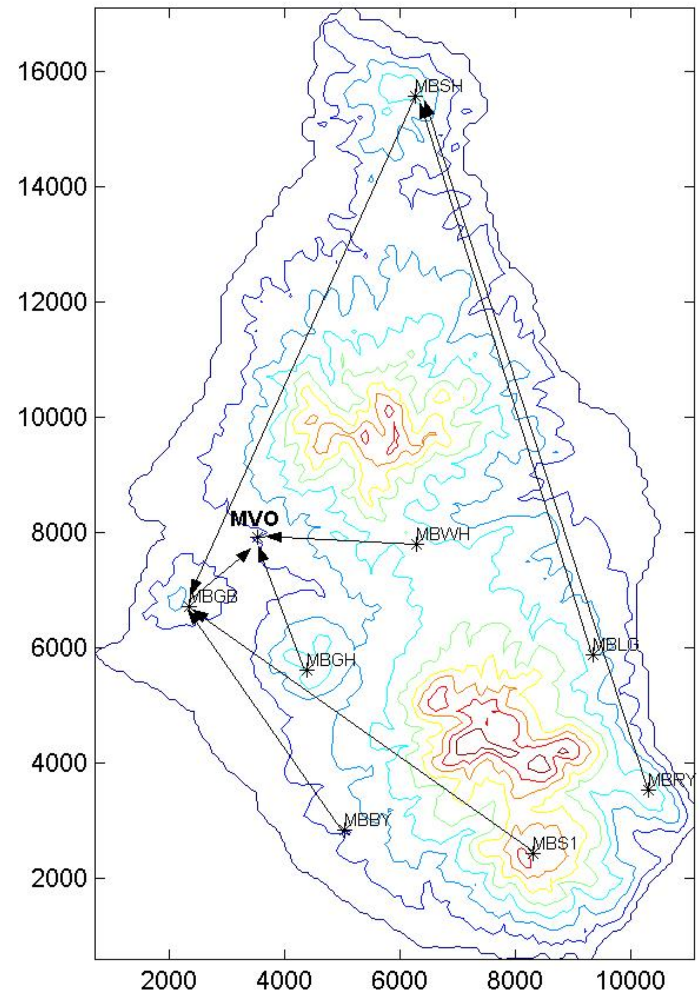

Figure 3: The digital seismic network as it is envisaged when MVO moves to Flemings. The Centre Hills repeater site is eliminated in favour of Garibaldi Hill. MBMH has moved to MBSH (Silver Hills). MBSS has moved to MBS1 (South Soufriere Peak).

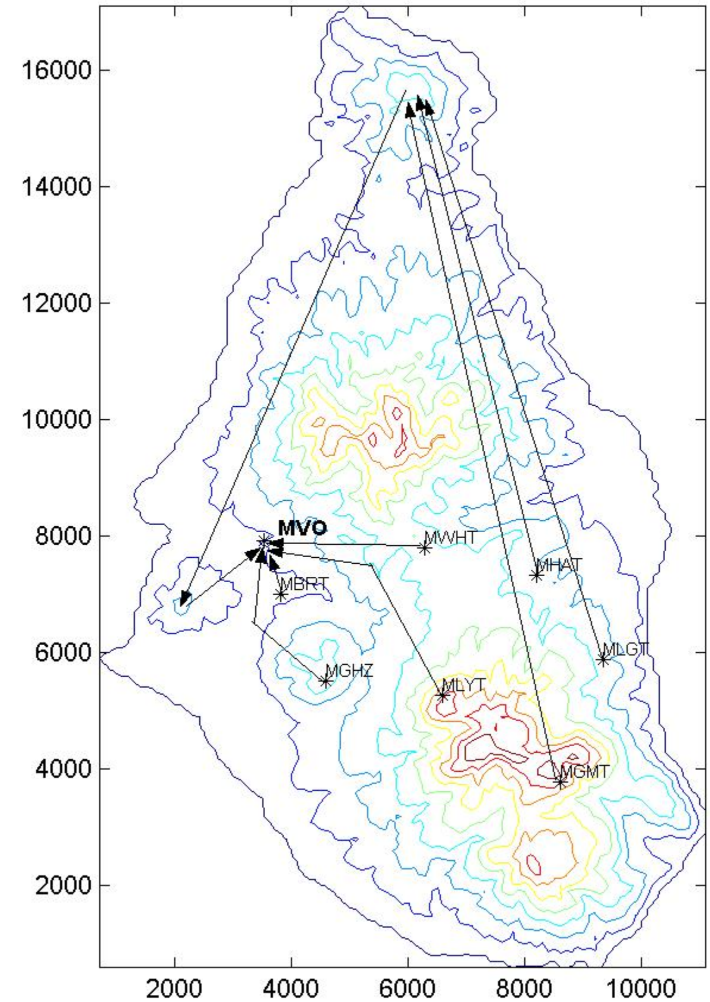

Figure 4: The analog network as it is envisaged when MVO moves to Flemings. The Centre Hills repeater site is eliminated in favour of Garibaldi Hill. MJHT has moved to MHAT (Harris) and MRYT to MGMT (Galways Mountain). MBRT is part of the Belham River Warning System.

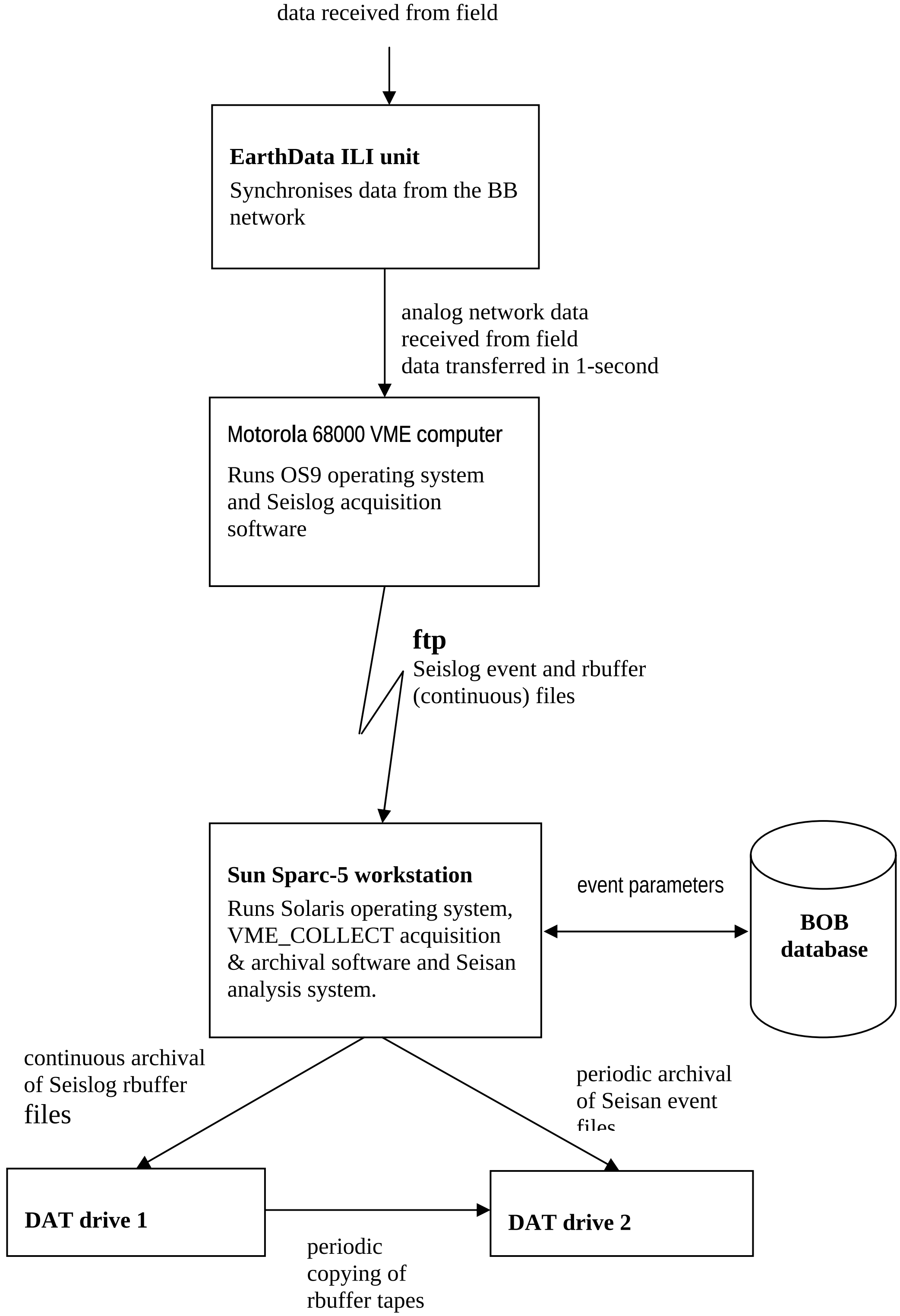

Figure 5: The digital network acquisition system, August 2000. There are major problems with the VME, and additional problems with the Sun workstation and 2 DAT drives.

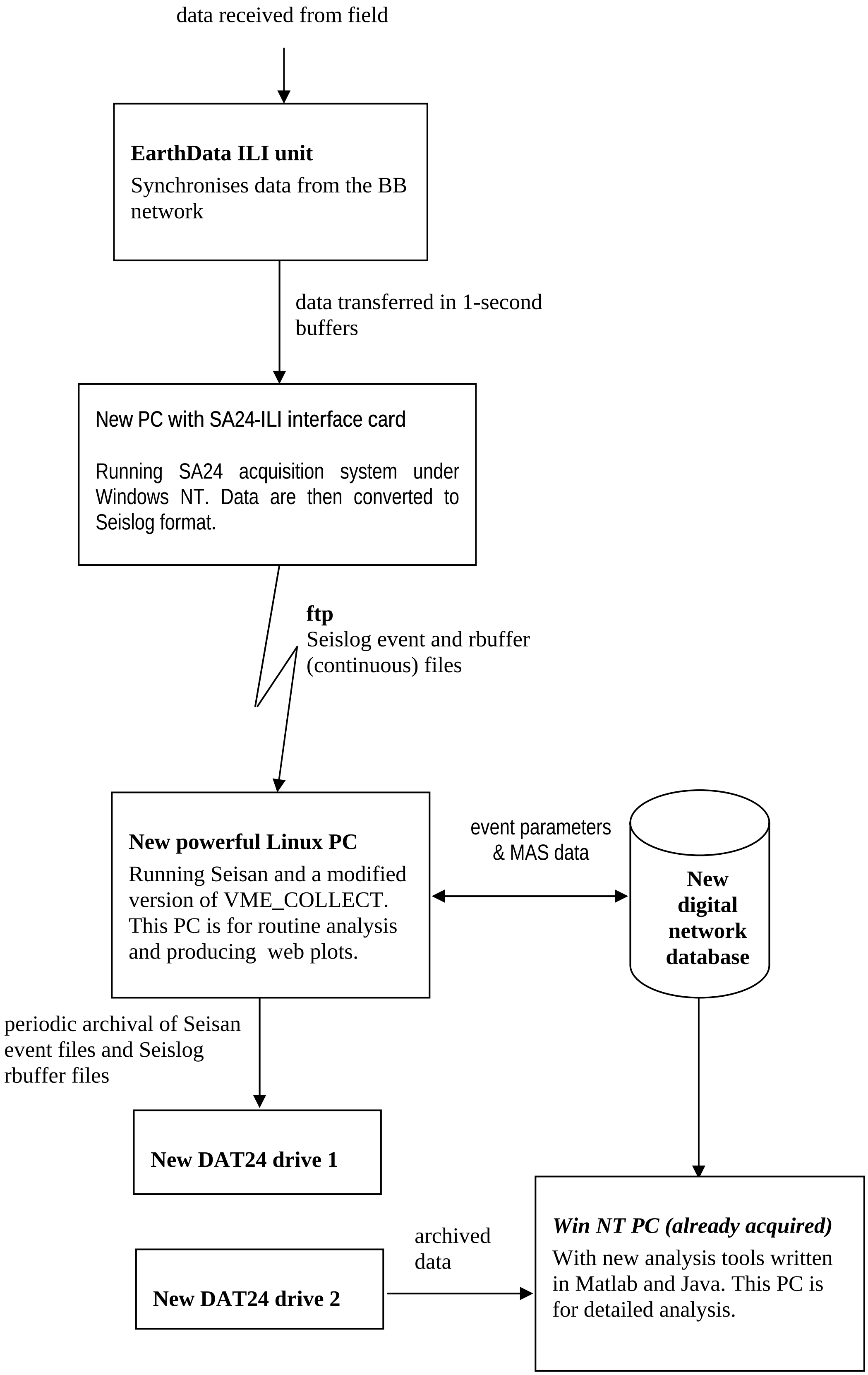
data received from field
EarthData ILI unit
Synchronises data from the BB network
data transferred in 1-second buffers
New PC with SA24-ILI interface card
Running SA24 acquisition system under Windows NT. Data are then converted to Seislog format.
ftp
Seislog event and rbuffer (continuous) files
New powerful Linux PC
Running Seisan and a modified version of VME_COLLECT. This PC is for routine analysis and producing web plots.
event parameters & MAS data
New digital network database
periodic archival of Seisan event files and Seislog rbuffer files
New DAT24 drive 1
New DAT24 drive 2
archived data
Win NT PC (already acquired)
With new analysis tools written in Matlab and Java. This PC is for detailed analysis.

Figure 6: The proposed digital network acquisition system. The SA24 PC has replaced the VME, and a powerful Linux workstation has replaced the Sun workstation, and 2 new DAT24 drives have replaced the present DAT4 drives. Also shown is a new digital network database which needs to be designed and will be the basis for new analysis tools on a recently acquired NT workstation.

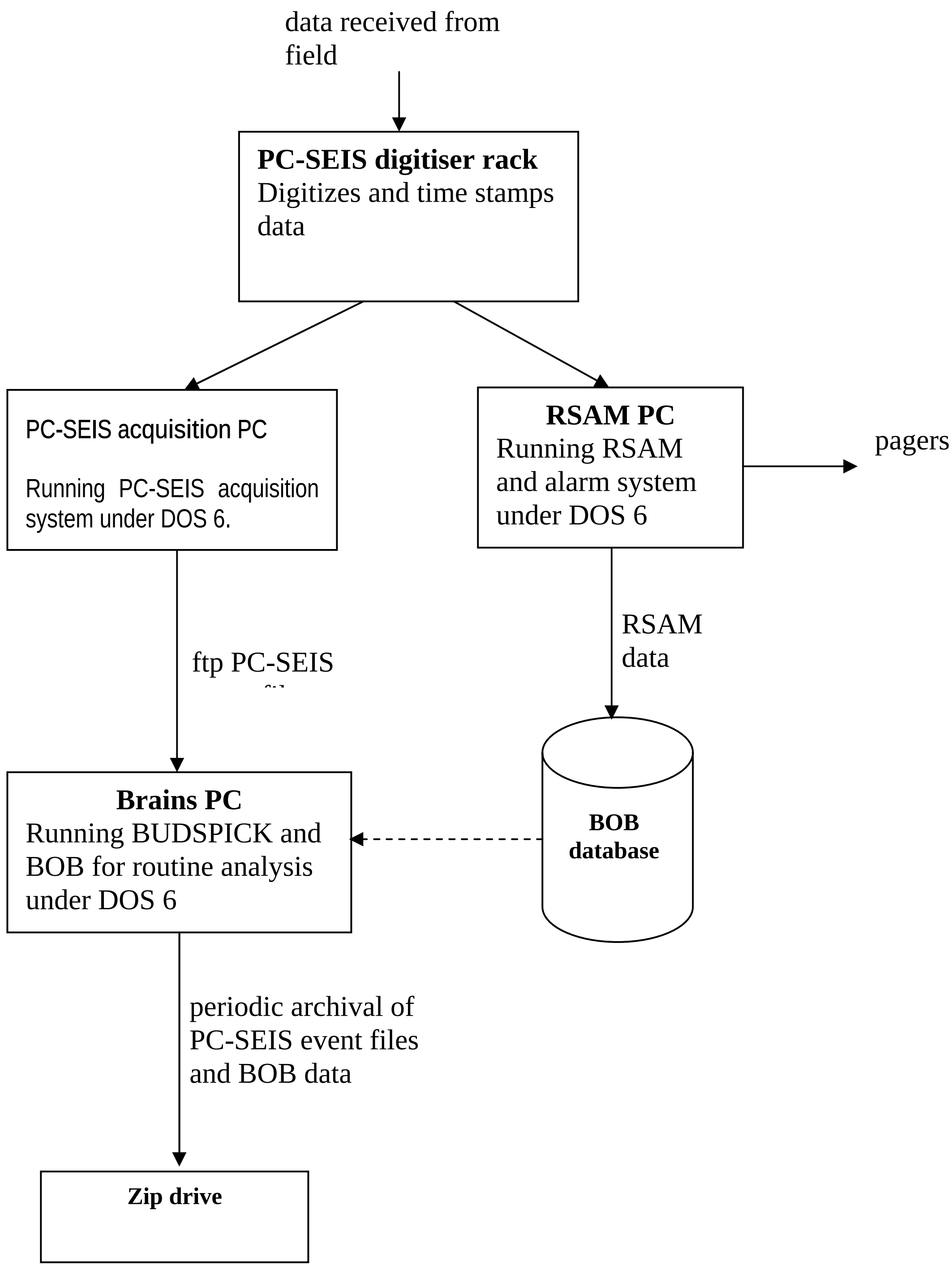

Figure 7: The analog network acquisition system, August 2000. Not shown is the TILT/PORKY computer which acquires data from non-seismic field instrumentation.

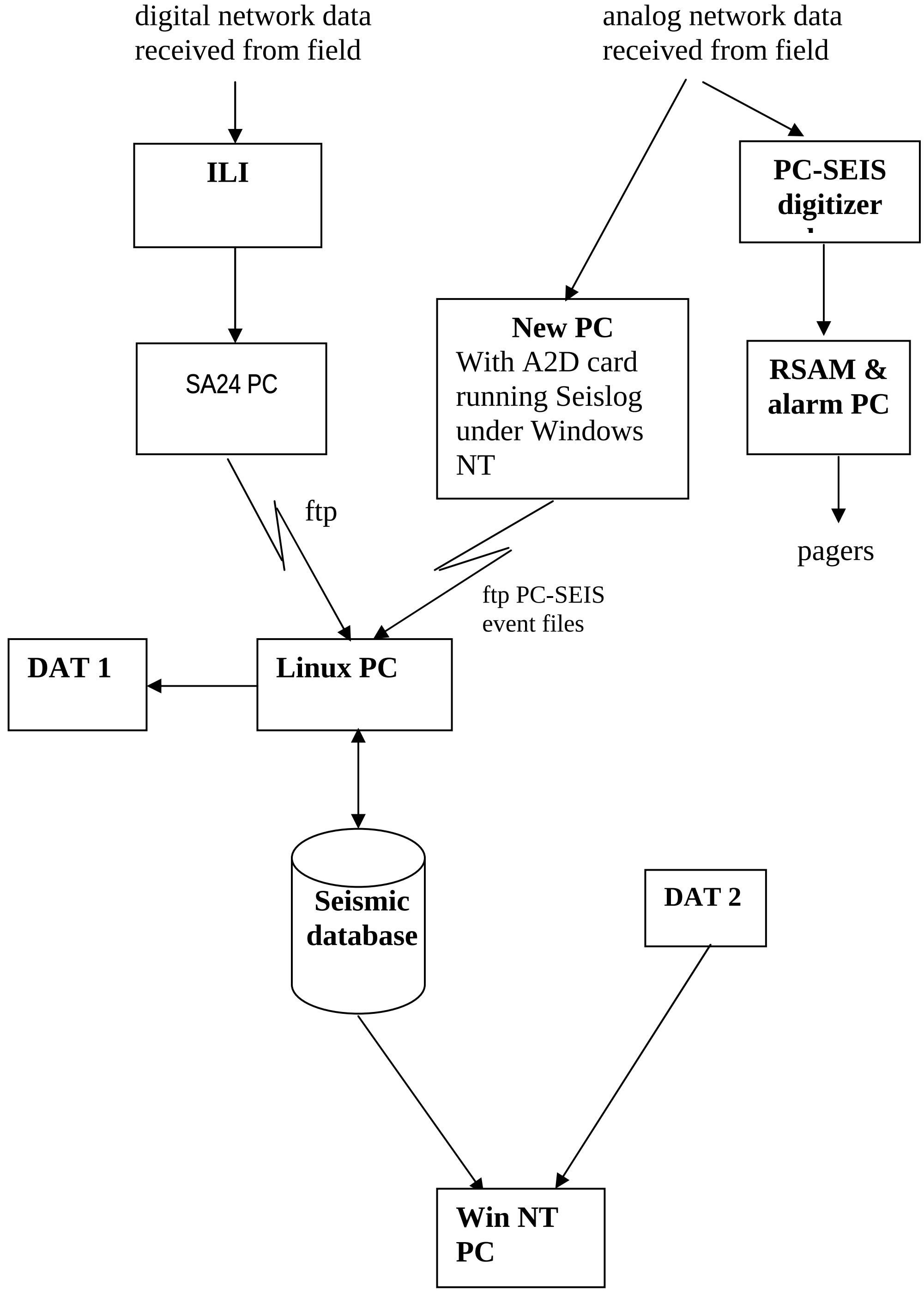

Figure 8: The BGS proposal for combining data from both networks: This relies on the VME being replaced by the SA24 system. Analog data from the field would be sent into a new PC with an A2D card sampling at 75 Hz (to match the broadband system). This PC would run Seislog under Windows NT. Seislog files from both networks would then be combined on the Linux workstation.

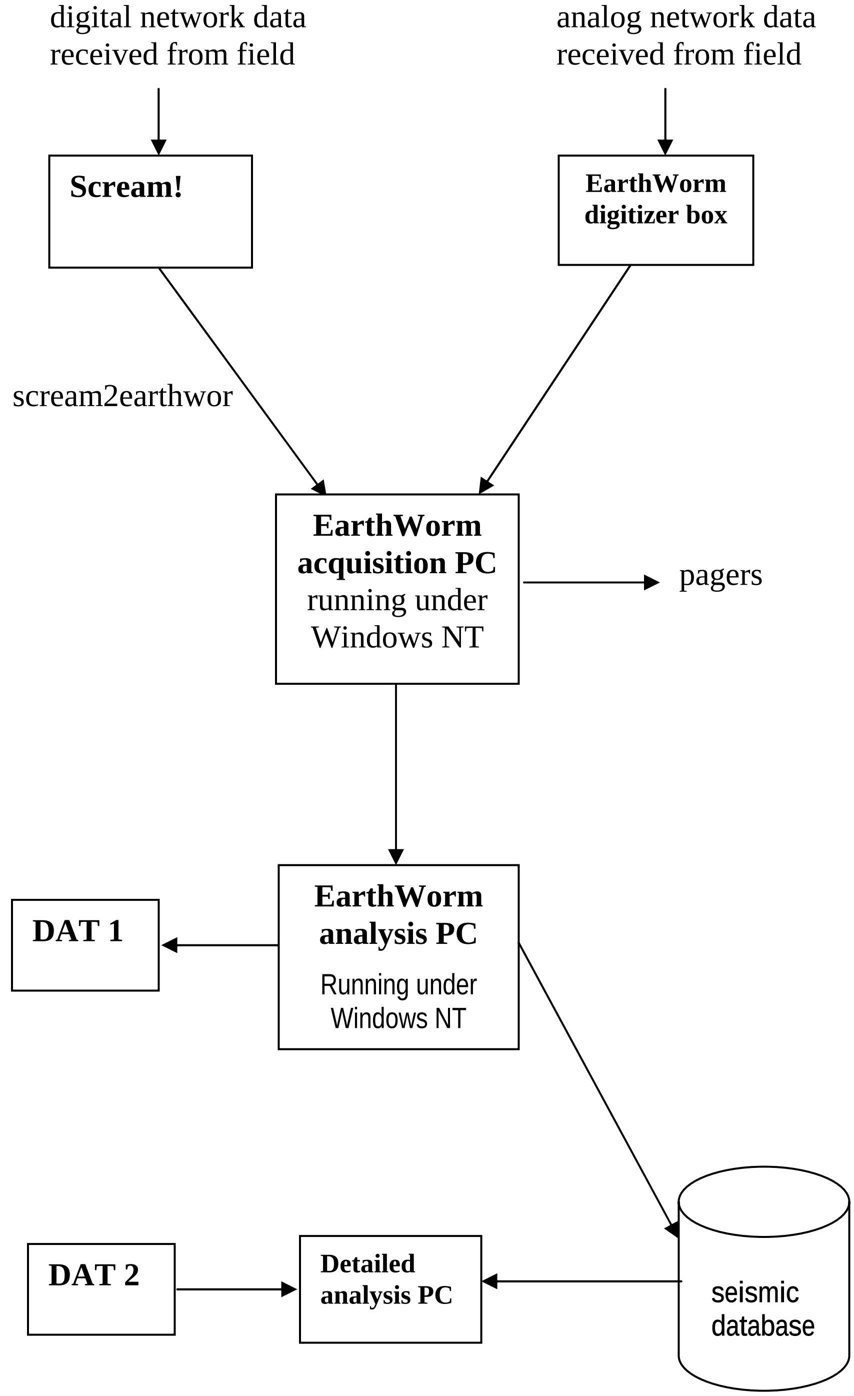

Figure 9: Alternative proposal for combining data from both networks: Data from both networks are acquired using EarthWorm. This eliminates the need to combine data further downstream. EarthWorm also has better real-time monitoring tools.

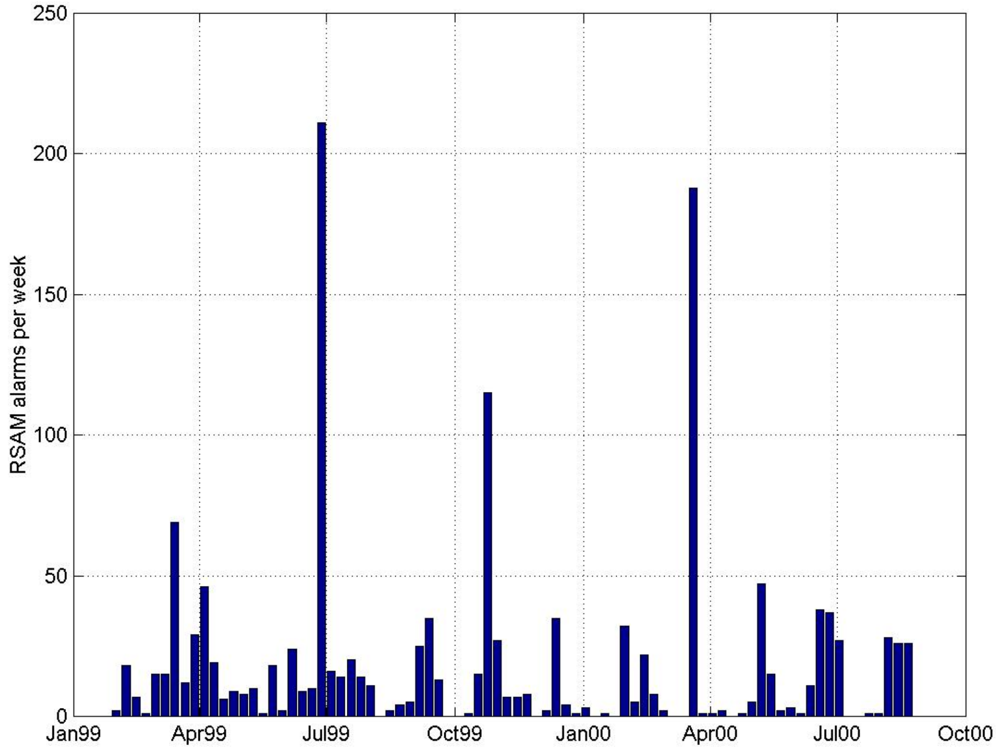

Figure 10: Number of alarms per week for the period January 1999 to August 2000. The maximum number of alarms per week has been artificially kept around 30 by periodically decreasing the sensitivity of the alarm system.