Remote MINOS Shift

Brett Viren

January 5, 2011

Abstract

The MINOS detectors and the NuMI beam are now very stable and well understood. In order to conserve funds and effort it is now time to consider taking remote MINOS shifts. Indeed, most aspects of current shift taking are already remote. This document proposes a *strawman* policy governing remote MINOS shifts, describes the technicalities of how to set up a remote shift station. The policy and setup have been followed at Brookhaven National Lab to perform two test remote shifts and four actual remote shifts.

Contents

1 Introduction

Taking a remote MINOS shift (RMS) allows the collaboration to conserve funds and effort over what is needed to travel to Fermilab or Soudan. In the case of an emergency shift opening it can ease the burden on those local to Fermilab as it broadens the pool of individuals that can fill the opening at the last minute.

These benefits can be achieved in a manner that does not degrade the quality of the data. Most aspects of all MINOS shifts have been remote in the sense that a shifter rarely, if ever, is in physical contact with the detectors and essentially all shift duties are done through networked computer applications. Despite that, in this document the term "remote" will indicate a shift station that is not at Fermilab nor Soudan but which is mostly functionally equivalent. Shifts at Fermilab or Soudan are termed "local".

This document provides technical guidance on how to set up an RMS station. It also provides *strawman* policy statements written in the judgement of the author and which can be used by the MINOS collaboration as a starting point for forming a policy based on consensus. The policy is largely captured in the following three sections on scope, establishment and hand–off. The policy and RMS station setup have been successfully followed and tested at BNL of the course of two test shifts and four actual shifts.

2 Scope of Remote Shift

When taking remote shifts some duties will be different or missing compared to taking a local shift. Specifically:

- No key management for going into the Near Detector hall can be performed. This duty is already shared with Minerva and will be delegated to them during periods of remote shift taking or will otherwise not be performed.
- ACNET beam plots will not be made. This choice is made by weighing the technical challenge against their importance and the ease of which experts can call them up for themselves.

- Additional requirements on communication with the other shift takers bracketing the remote shift.
- Perform initiation and finalization chores specific to the remote site.

3 Establishing a New Remote Shift Station

Any institution that is interested in establishing an RMS station should meet some requirements: The members of the institution must:

- Have adequate technical resources to configure and support the station.
- Successfully complete two (uncounted) test shifts by two different people, concurrent with a local shift. At least one test should be done by an individual not directly involved in setting up the technical aspects (ie, "non expert"). These tests need not be full length but all relevant checklists should be performed and both shift hand–offs between bracketing local shifts should be simulated (MCR/Minerva need not be informed about such test). An informal report of any issues found during the test shifts should be given to the run coordinators and other interested parties.
- Be committed to making the station available for collaborators from outside the hosting institution to use for their own remote shift taking.

4 Local/Remote Shift Hand–Off

The remote shift should overlap with bracketing shifts. At the time of writing, these are assumed to be taken locally and that the remote shift coincides with a local Minerva shift. The two collaborations must work on this procedure going forward. Until that is in place, the protocol for local-remote hand–off is:

1. Remote MINOS shifter calls local MINOS shifter before the end of the local shift.
2. Any pertinent information regarding current status should be discussed.
3. They assure that the remote shift's contact information is prominently displayed in the Fermilab control room.
4. The local MINOS shifter then indicates to the Minerva shifter that a remote MINOS shift is starting.
5. The Minerva shifter calls up the Main Control Room (MCR) to indicate that they are now the NuMI contact.

On remote-local hand–off, these steps are, essentially, reversed:

1. Local MINOS shifter calls the remote shifter before the end of shift.

2. Any pertinent information regarding current status should be discussed.

3. They assure that the remote shift notice is removed from prominent display.

4. The local MINOS shifter calls the MCR to indicate MINOS is now the NuMI contact.

4.1 Indicating a Remote Shift is in Session

When starting an RMS, the shifter should place a notice on minos-om stating a remote shift is in session and indicating the RMS contact information. (See the `rms.sh announce` command below). Either the remote shifter should remove this notice at the end of shift or the local shifter may do so.

5 Setting Up a Remote Shift Station

This section describes how to set up an RMS station.

5.1 Overview

A shift station runs various networked applications that monitor the beam, the near detector (ND) or the far detector (FD). For anyone that has taken MINOS shift these should be well known. They are listed here for completeness and to define their abbreviations.

Run Control GUI (RC) monitors and controls the DAQ running, one for ND and one for FD.

Online Monitor (OM) monitors the DAQ output for ND and FD.

Detector Control System Web Pages (DCS) environment monitoring and other slow control for ND and FD.

Big Green Button (BGB) monitor of writing the beam monitor files.

NuMIMon (aka JAS) monitor current beam conditions.

CRL, Elogs, Memo and other web pages intermittent checking and entering of various things.

The RC, DCS, BGB and JAS should remain visible to the shifter by default. When performing OM checklists or other intermittent activities it is okay to temporarily obscure these applications or to switch to other virtual desktops.

5.2 Shift Room

Besides the hardware and software described below, a remote shift station should be decorated with the following:

- Prominent display of phone numbers of the MINOS control rooms at Fermilab and Soudan, MCR, the run coordinators and Minerva shifters.
- A printout of the shift manual.
- A printout of the ND/FD DAQ numerology charts.
- The usual amenities to help a shifter get through the shift without undue discomfort.

5.3 Hardware

The shift station must meet these minimum hardware requirements:

Telephone The telephone must be able to make and receive domestic and international calls.

Network The bandwidth required is modest compared to what any remote institution is likely to provide. A home DSL/cable may be adequate. There must be connectivity with Fermilab such that SSH connections can be made. See more information in section 5.6.

Computer At least one computer is needed however it must be powerful enough to run the software. Splitting the load to two or more is recommended.

Display At least three displays are needed so that the DCS, Run Control and NuMIMon monitors can be visible by default. Additional displays can be useful for viewing the Online Monitors during their check but they can also run in a virtual display.

The test shifts will ultimately be used to determine if the RMS setup is adequate.

As a point of reference, the test setup at BNL runs on two computers. The first system contains dual AMD Athlon CPUs running at 2 GHz with 2 GB RAM and two displays (one normal and one wide-screen HD). They display the RCs and NuMIMon as well as the OMs when doing the OM checklists. The other system contains a single processor Pentium 4 at 1.4 GHz with 250 MB RAM and one display used for DCS web pages and the BGB. The performance of these rather modest systems and the number of displays are considered adequate by the shift takers that have tested them but should be looked at as a minimum starting point.

5.4 Software

At a minimum, the required software is an X11 server, an SSH client, a web browser, the RC and OM ROOT applications and the Java/JAS3 based NuMIMon.

The RC and OM currently rely on a relatively old version of ROOT (v5.16) which does not compile on some modern platforms. Using a more recent version of ROOT leads to object mismatches appearing at run time when OM communicates with its server. Building RC with a modern GCC requires various code clean ups. Because of these issues, existing binaries are used. They were taken from the computers running the Fermilab control room which are based on 32 bit x86 Scientific Linux 5.5 (SL55). Any SL55 system should be able run these binaries without problem. Other platforms may or may not encounter issues.[1]

The software is available[2] as a tar file. Besides the binaries, it includes a central script that runs almost all aspects of the shift software.

While out of scope of this document and provided software, it is recommended that the shift station be set up to provide the shifter simple access to starting the applications via desktop icons that call rms.sh. The web browser should be configured with all pertinent links readily apparent and with the necessary passwords pre-cached.

Some ancillary programs may also be considered based on the experience of the BNL tests:

- If the RMS is in a different time zone than US Central, a clock displaying Central Time is useful (the BGB can provide this but it updates sporadically and trails reality by a few seconds).
- If multiple computers are used with their screens in close proximity consider deploying `x2x` to join them to a single keyboard/mouse.
- Being able to display screen captures of Fermilab shift screens is useful to confirm the `rms.sh announce` command (see below) is correctly displaying the announcement.

Example scripts demonstrating these are available in `rms/examples/`.

5.5 Tour of the software

Unpack the tar file from the shift account's `$HOME`. It will produce a directory called `opt/`. Some directories of interest:

java/ the NuMIMon distribution

om/ provides OM binaries

mcr/ provides RC binaries

[1] They are known to work on Ubuntu 10.04.

[2] `http://minos.phy.bnl.gov/~bviren/minos/rms/rms-opt.tgz`

root/ a copy of ROOT v5.16 needed for RC/OM

sys/ some SL55 system libraries needed for RC/OM

rms/ main (`rms.sh`) and its configuration files.

5.6 Authentication and Connectivity

Whether the shift is local or remote, most applications will connect to their servers over a port forwarded through an SSH tunnel. See section 8 for details on SSH tunneling.

There are two issues with SSH tunnels that must be understood when setting up a remote station. The station must present an accepted Kerberos ticket and it must take care to not use ports allocated to others on a shared SSH gateway. The mechanism for allocating Kerberos tickets to remote shift stations is still under development and not discussed further here other than to say it should uniquely authenticate and authorize each RMS station.

Port allocation is organized through the file:

```
$HOME/opt/rms/config/port_allocations.txt
```

As new sites are added, they must secure unused ports for themselves by being added to a centrally maintained copy of this file.[3] These ports and other information are then used to define a site configuration file stored in that same directory and given a name matching the output of `hostname -f`. Details on this are below.

Some gateways for forwarding ports through SSH tunnels are:

minos-gateway-nd.fnal.gov for ND OM and RC.

minos-gateway.minos-soudan.org for FD OM and RC.

minos-om.fnal.gov for NuMIMon.

minos-acnet.fnal.gov for accessing MCR Elog.

In addition, direct logins are needed for:

minos-beamdata.fnal.gov running the BGB

minos-om.fnal.gov displaying the announcement that an RMS is in session.

5.7 Configuration

Any host running RMS software must specify its configuration, including the issues of port allocation above. This is done by creating a directory via:

```
mkdir $HOME/opt/rms/config/$(hostname -f)/
```

[3] This maintainership is not yet established.

If there are multiple hosts at an RMS site they can share the same configurations or be treated separately, but each host needs a configuration directory. This directory must contain a file called "`config`". For guidance on creating it see the discussion of allocating ports above and read the file:

```
$HOME/opt/rms/config/README
```

In addition you may copy and customize the ND and FD RC configuration files that belong in:

```
$HOME/opt/rms/config/$(hostname -f)/rcgui/{near,far}/gui.config
```

You can find example copies in the directories for pre-existing sites. All that needs modification is the default RC connection labels. Modify the top of each `gui.config` file and set the site's contact info after line `guiLocation#S=` . Doing this saves some effort each time an RC is started and it causes the RC window title to be set correctly.

5.8 Running the Software

All required software is run via the `$HOME/opt/rms/rms.sh` script. The script takes a command as its first argument and possibly some command-specific options. By running the script with no options, or using the command `help`, some guidance will be printed to the screen. It has both internal and user–level commands. These internal commands can be helpful during initial shift station setup:

host print what host names are to be used

port print what port numbers are to be used

***tunnel** several ways to set up SSH tunnels

The commands that shifters will use (likely through GUI icons) are:

kinit refresh the shifts Kerberos ticket

service start an RC or OM application

bgb start a Big Green Button

numimon start NuMIMon/JAS3

announce display a message on minos-om indicated a remote shift is in progress.

Details on these latter commands follow.

5.8.1 `rms.sh kinit`

The `kinit` command assumes that the RMS site is using a keytab file similar to how Fermilab control room systems do. As stated above, how keytab files will be managed is still to be determined. If they are used, this command will produce a ticket that lasts just over one day. It can be run from cron in order to keep the RMS station always ticketed assuming the keytab is not encrypted with a passphrase.

5.8.2 `rms.sh service rc|om near|far`

The `service` command will set up the needed tunnels and then run either the RC or OM, depending on which is requested. If the tunnels have already been set up then just the RC or OM service can be run by calling the applicable one of:

```
rms.sh service_rc far|near
rms.sh service_om far|near
```

5.8.3 `rms.sh bgb`

As mentioned above, to run the BGB the RMS account needs to be able to log into minos-beamdata.fnal.gov. The BGP is displayed by tunneled X11.

5.8.4 `rms.sh numimon`

The compiled Java code provided in the distribution is built against Sun Java 5. It is not guaranteed to work against newer or other releases of Java. It also requires linking to shared libraries. These are provided along with the other SL55 binaries. NuMIMon also works differently in that it expects to have both outgoing and incoming HTTP connectivity with Fermilab Beams Division servers. This bidirectionality is assured when using Fermilab SSH gateways and set up by the command.

5.8.5 `rms.sh announce [YOUR NAME|kill]`

This will create a default message based on the name given on the command line and the value of `RMS_PHONE_NUMBER`, if defined. The caller will be prompted to edit this default and when accepted the command will log in to minos-om and display the message via xmessage. In the special case that the name "`kill`" is given, it will instead log in an remove an existing message.

5.9 Web Pages

The station should have a web browser configured with links to the various web-accessible information prominently available. The actual URLs for these pages are all available from the MINOS Control Room home page.[4]

[4] `http://www-numi.fnal.gov/Minos/ControlRoom`

Open web pages:

- ND/FD DCS monitor

Prominent bookmarked links:

- Control Room Logbook (CRL)
- Links to web pages listed above
- CR Home
- Memopad
- NuMi, MCR and Acc Run Coordinator ELogs

To access the MCR Elog it must appear that the request is coming from inside fnal.gov. This can be achieved via a dynamic SSH tunnel and by configuring the web browser to direct requests through that tunnel. To start a dynamic tunnel:

```
ssh -aXND LOCALPORT somehost.fnal.gov
```

It is recommended that starting this tunnel is made simple for remote shifters using a tunnel manager such as gSTM. Finally, configure the shift account's browser to use a SOCKS proxy of localhost and the specified `LOCALPORT`.

Shift takers should be made aware that all web traffic they create will appear to come from `somehost.fnal.gov` and thus should abide by Fermilab's terms of usage. Because the shifter should be made conscience of this proxy, setting it up automatically with rms.sh is not supported. It is left to the shift station administrator to set it up in a suitable manner.

6 Needed and Potential Improvements

Needed:

- Copies of ND/FD DAQ numerology chart that are taped up to the wall in the Fermilab control room. These are strangely hard to locate. They should be added to the shift manual.
- Understand how to handle remote shift station Kerberos issues. The tests at BNL were done by masquerading as the Fermilab shift account (with permission). This is an unacceptable practice in the long run.
- A central repository for the RMS scripts and configuration files needs to be set up. MINOS and Minerva experts need write access. It is currently tracked in a personal *git* repository.
- A central archive for binary distribution. As of writing, the distributed needs only rare, if any, updates. Static web space is sufficient.

Potential:

- Upgrade ROOT for OM/RC/Online. This will allow native compilation of RC and OM applications and remove the kludge of relying on binaries.
- It would be helpful if a single telephone number could follow the current shifter, be they local or remote. One possibility is Google Voice. Another is a service similar to the "`YELLDAQ`" number for an online expert, if such can be switched quickly and several times per day. Switching this would become the responsibility of the remote/local hand-offs.
- Permanent audio, and maybe video, connections between Fermilab, Soudan and any RMS station. EVO is preferred but there are other options.

7 Conclusion

Given the benefits and because of the stability that NuMI and MINOS has achieved, allowing remote shifts is a change that has come due. It has been shown to work with the BNL test RMS setup after a minimal investment in hardware and time. This effort is payed off in saved travel costs after satisfying a single shift responsibility remotely. The setup described here has been organized to facilitate other institutions to setup their own remote shift stations with an even smaller time investment. An initial remote shift policy and procedure has proposed for consideration and hopeful adoption by the collaboration.

I would like to acknowledge Alex Himmel for his work on adapting the CRL checklists for RMS, Art Kreymer for tech assistance, Mike Kordosky for promptly testing the RMS setup as it was developing and contributing useful improvements and fixes. Finally, I want to acknowledge Mary Bishai for taking one of the test remote shifts, helping to set up the BNL shift room and for inspirational leadership in the art of remote shifting.

8 Appendix: Understanding SSH Tunnels

As should be evident, MINOS shift setup relies heavily on SSH tunneled ports. This appendix provides a brief summary of tunnelling.

There are a few reasons SSH tunnels are used in MINOS shift stations:

1. Some servers are behind firewalls, either at Fermilab or the remote institution, which do not allow arbitrary ports to be accessed but do allow SSH connections.
2. None of the protocols used by the shift applications are secure enough to risk exposing to the Internet.
3. Some resources can only be accessed by connections appearing to come from Fermilab network space.

There are essentially two types of tunneling:

callout: forward a connection made to a port on the local host to a listening port on a remote host accessible via a gateway host.

callback: forward a connection to a listening port on a gateway host back to a port on a host accessible from the local host.

The first is used by a local client to access a server as if the gateway was the connecting host. This is done by RC, OM, NuMIMon during its registration phase and potentially web traffic if the SOCKS tunnel is set up.

The second is used to allow a remote client to access a local server. The remote client connects to the gateway and the local server sees a connection from the localhost. This is done by NuMIMon during its phase were it accepts spill data and by the BGB as it accesses the local X11 display server.

Details on how to set up a tunnel can be found elsewhere. Except for the issue above relating to MCR Elog access they are all provided by the RMS script.

9 Appendix: Local Checklist for BNL RMS

The BNL shift station is shown in Fig. 1. There are three screens. From left to right, the first screen holds NuMIMon on the first workspace and the OM browsers on second (near) and third (far). The center HD screen is for the RC GUIs on the first workspace and the OM histograms on the second and third. These screens are both controlled by the central keyboard/mouse. The third screen is for web pages and the BGB and runs on a second computer. The secondary keyboard/mouse can be used to control its session. When `x2x` is turned on the primary keyboard/mouse can control all screens.

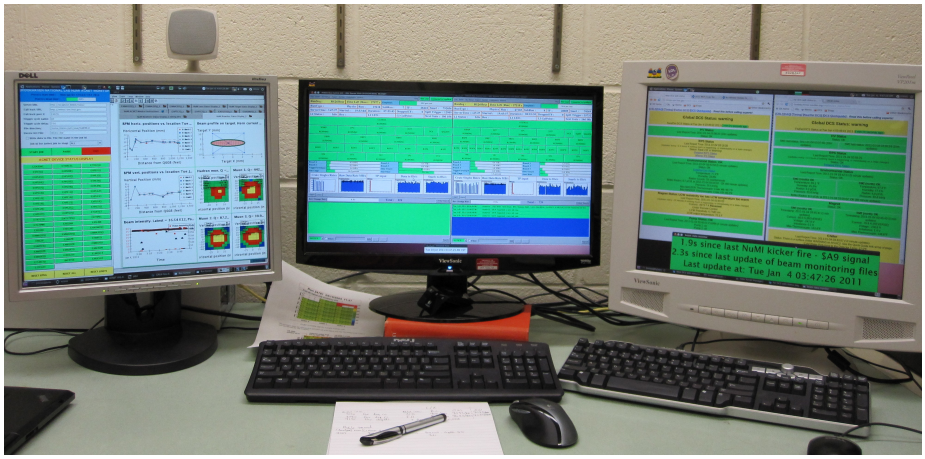

Figure 1: Initial remote MINOS shift station at BNL. See text for details.

All shift software can be started from launcher icons in the desktop panel at the top of screens. Table 1 shows what each icon is for. The shifter can also hover over the icon to get a brief description of what it does.

The following two sections provide the checklists a remote shift taker at BNL is expected to follow to start and end each shift. They are in addition to the standard remote checklist and the checklists that all shifts must follow.

9.1 Initiate

Come to the shift room at least fifteen minutes before the nominal start of shift to assure everything is ready. If it is the first shift that the station has been used for in more than a week this checklist should be run through at least a day in advance. This can be done either by the shifter or a local BNL person supporting the station[5]. On shift days, perform this checklist before contacting the current shift taker for hand-off.

[5] Given a suitable inducement.

1. Locate the shift manual and ND/FD DAQ numerology guide. Familiarize yourself with the phone numbers and any other notes on the whiteboard. Check and clear any messages that may be on the phone.

2. Assure that all shift computers are booted and that the sessions are logged in as user `minos`.

3. If any connection to Fermilab asks for authentication then run `rms.sh kinit`. There is an icon on the top panel.

4. Assure all sessions are running an SSH Tunnel Manager (start via an icon on the top panel) and that the "MINOS Shift" tunnel is active (indicator is green) and the web browser's are configured to use this tunnel as their proxy. Understand this will cause all web browsing to appear as if it originated from minos-acnet.fnal.gov. The tunnel manager applications can be left minimized.

5. If you wish to use a single keyboard/mouse to control all sessions you may need to start `x2x` via the icon on the top panel.

6. In the session for web pages, open up two browsers, side-by-side, populate one with Near DCS and one with Far DCS. Assure the CRL and MCR Elog can be accessed. It is helpful to load them in additional tabs.

7. On the same screen start the BGB from the icon on the top panel. Position it so that it is visible enough to see the time updating. Assure that it is updating (assuming there is beam).

8. In the other session, in the first workspace (see pager in the bottom panel) open up the Near and Far RC GUIs via the icons on the top panel. Position them side-by-side on the HD screen.

9. You may start a clock running in Central time from the icon on the top panel. It is convenient to place it below the RC GUIs.

10. Start NuMIMon/JAS from the icon on the top panel, position both windows in the unused screen and hit the "START JOB" button. Enlarge plot window but do not obscure the NuMIMon buttons. Assure it is updating (assuming there is beam).

11. Move to the second workspace and start the Near OM via the icon on the top panel and position it on the non-HD screen. Click the "Open" button. If the OM was already running but could not make a connection, close it and restart it from the icon in the top panel. Open any histogram and position the resulting histogram display in the HD screen and maximize it.

12. Repeat with the Far OM in the third workspace.

13. Return this session to displaying the first workspace with NuMIMon and the RC GUIs.

14. Check recent CRL entries to familiarize yourself who you will be replacing.

15. Call them up before the end of their shift to begin the standard hand–off procedure.

9.2 Finalize

Plan to stay a few minutes past the nominal end of your shift. After performing the standard remote shift hand–off requirements you should work through the following steps:

1. Collect and dispose of all trash and otherwise tidy up. Place the bin outside the door if it is your last shift or if it is overly full.

2. Turn off the monitors to save power.

3. As applicable, close the window and turn off the heater/AC.

4. Collect your belongings. As you leave make sure the light is out and the door is closed and locked.

	Get a Kerberos ticket
	Big Green Button
	NuMIMon/JAS
	Online Monitor, one near, one far
	Run Control GUI, one near, one far
	Announce start of an RMS
	Remove RMS announcement
	Display minos-om screenshot
	Display a clock in Fermilab time
	Start/Stop `x2x`

Table 1: Launcher icons used by the MINOS shift station at BNL.