Pierre Auger Observatory Communications Task

Auger Southern Observatory

Programming Instructions and Unit Replacement

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1 Introduction

This document describes in detail how to upgrade the firmware on all of the custom-designed units throughout the Pierre Auger Observatory’s communications system. These include a Base-Station Unit (BSU), a Subscriber Unit (SU) and a μLSx unit. The document concludes with a description of how to replace a rack-mounted BSU, BSx and μLSx units at the various tower sites within the observatory.

2 Bench Programming

Several bench leads are provided in the base-station programming kits as shown in Figure 1. The yellow-hooded lead connects to a base-station board and the red-hooded lead connects to an SU radio board. Both of these leads provide an RS232 connection and a pig-tailed DIN lead, enabling the user to connect the unit directly to a computer and to provide power to the unit from a base-station support unit. A base-station support unit is shown in Figure 2.

Figure 1- Bench Programming Leads

Figure 2 - Base-Station Support Unit
3 Programming the µLSx

This section describes several methods of upgrading the µLSx firmware. The firmware upgrade may be performed remotely from a machine running an FTP or NFS server, without the need to visit the tower sites, or locally using the µLSx’s serial port and a laptop computer. The configuration of the µLSx’s IP settings is performed using a dedicated setup program, which is also discussed.

3.1 Upgrading the firmware remotely using an NFS server

1. Copy the firmware image file into an NFS mountable directory on the NFS server.
2. Use the command:

   `telnet xxx.xxx.xxx.xxx`

   where `xxx.xxx.xxx.xxx` is the IP address of the remote µLSx.
3. Hit return when prompted for a username.
4. Type `uclinux` when prompted for a password (case sensitive). You should now be logged into the remote µLSx.
5. Type `cd /bin` to move into the `bin` directory.
6. Type `portmap&` to start the port-mapper utility on the µLSx.
7. Type

   `mount -t nfs -overs=2 yyy.yyy.yyy.yyy:/nfs-directory /usr`

   where `yyy.yyy.yyy.yyy` is the IP address of the NFS server and `nfs-directory` is the directory, starting from the root, where the firmware image is stored. For example, `mount -t nfs -overs=2 192.168.1.11:/home/uLSx/uClinux-dist /usr` will mount the directory `/home/uLSx/uClinux-dist` from `192.168.1.11` into the `/usr` directory on the target. Version 2 of the NFS protocol is used.
8. Type `cd /usr`.
9. Type `ls` and check that the source directory on the NFS server is listed. If not, review steps 5) to 8).
10. Type `ramloader image.bin` to load the new firmware image into ram or `flashloader image.bin` to permanently store the image into the µLSx’s flash ram. Within 3 minutes, the system will automatically reboot and execute the new image. **Do not reset or power down the unit during this time.**

3.2 Upgrading the firmware remotely using an FTP server

1. Copy the firmware image file into the FTP server’s source directory.
2. Use the command

   `telnet xxx.xxx.xxx.xxx`

   where `xxx.xxx.xxx.xxx` is the IP address of the remote µLSx.
3. Hit return when prompted for a username.
4. Type `uclinux` when prompted for a password (case sensitive). You should now be logged into the remote µLSx.
5. Type `cd /var` to move into the `var` directory.
6. Type

   `ftp yyy.yyy.yyy.yyy`

   where `yyy.yyy.yyy.yyy` is the IP address of the FTP server where the image is stored.
7. Log into the FTP server using a suitable username and password setup by the FTP server’s administrator.
8. Type `bin` to change the transmission type to binary.
9. Type `get image.bin` to transfer the firmware image to the µLSx.
10. Type `quit` to leave the ftp program.
11. Type `ramloader image.bin` to load the new firmware image into ram or `flashloader image.bin` to permanently store the image into the uLSx’s flash ram. Within 3 minutes, the system will automatically reboot and execute the new image. **Do not reset or power down the unit during this time.**

### 3.3 Upgrading the firmware locally using the serial port.

Figure 3 shows the connections required to program a µLSx unit using a serial port and laptop computer.

**Figure 3 - Programming a uLSx**

Use the following steps to program the unit:-

1. Set the voltage of a *bench power supply* to 12V or 48V depending on the type of *base-station support unit* you are using. 12V units have stickers on the power supply connection plug indicating that a 12V supply should be used.
2. Connect the *bench power supply* to the base-station support unit using banana leads, ensuring to observe correct polarity.
3. Switch on the base-station support unit and verify that the power LEDs are illuminated and that the 1PPS LED is flashing. If not, check the power supply voltage and cabling.

4. **Switch off the base-station support unit.**
5. Connect the µLSx’s terminal serial port to the host computer using a “straight-through” RS232 lead (grey lead in Figure 3).
6. Use a *yellow-hooded programming lead* connected to the *base-station support unit* to provide power to the uLSx. The *black-hooded connector* on the other end of the lead is not required.
7. Launch the *hyperterminal* program (windows), *minicom* (linux), or your chosen terminal emulation program. Set the terminal’s baud rate, stop bits and parity bits to 9600, 1 and none respectively.
8. Power up the µLSx and within 3 seconds of the µLSx booting, press `Esc`; this causes the µLSx to enter programming mode and prevents the unit booting into the operating code. You should see a similar message to the following :

```
uCbootloader 1.7.6r6
(c) Copyright 2001-2003 Arcturus Networks Inc.
All Rights Reserved.

CACHE on
Autoboot in 3 seconds. <esc> to abort...
FIRST FLASH type 2253 [AM29DL323xB] 8[0x10000000]
DP|002000 DP|004000 DP|006000 DP|008000 DP|00a000 DP|00c000
DP|00e000 DP|010000 DP|020000 D-|030000 D-|040000 D-|050000
D-|060000 D-|070000 D-|080000 D-|090000 D-|0a0000 D-|0b0000
D-|0c0000 D-|0d0000 D-|0e0000 D-|0f0000 D-|100000 D-|110000
```
If not, check the connections and baud rate settings.

9. Increase the baud rate to 115200 by typing `fast`.

10. Change the terminal emulation program’s baud rate setting to 115200.

11. Hit return and you should once again see a `B$` prompt.

12. Type `rx` and the µLSx will be ready to accept the firmware file.

13. Use your terminal program to send the `image.bin` file using the `xmodem` protocol. In `hyperterminal`, use the menu command `transfer->send file` and ensure you select the `xmodem` protocol. In `minicom`, press `ctrl+a` then `s`, select `xmodem` and locate the `image.bin` file. (tap the space bar twice to move into the selected directory).

14. The transfer will take approximately 8 minutes. When the transfer is complete, you can type `program` to permanently store the firmware image or `goram` to test the new firmware without storing it in flash. If `goram` is selected, you will have to repeat the programming procedure to permanently store the image.

### 3.4 Using the uLSxSetup utility.

The `uLSxSetup` utility facilitates the control of the µLSx’s IP address and permits a common software build to be used in all µLSx units throughout the observatory. The `uLSxSetup` utility must be run prior to the unit’s deployment to ensure that the unit has valid IP setting, enabling it to communicate with the CDAS and Network Monitoring PCs. The utility may be run remotely; however, in this case, the existing configuration of the unit must allow remote access. Use one of the following methods to connect to the µLSx:

**To configure the µLSx remotely :-**

1. Use the command

   ```
   telnet xxx.xxx.xxx.xxx
   ```

   where `xxx.xxx.xxx.xxx` is the IP address of the remote µLSx.

2. Hit return when prompted for a username.

3. Type `uClinux` when prompted for a password (case sensitive). You should now be logged into the remote µLSx.

**To configure the µLSx locally using the serial port :-**

1. Use the setup illustrated in Figure 3 and follow step 1 to 6 of section 3.3.

2. Set the terminal’s baud rate, stop bits and parity bits to 19200, 1 and none respectively.

3. Power up the µLSx and allow the unit to boot normally.

4. When booting is complete and the µLSx software banner has been displayed, hit return (you do not need to log in) and you should be given the `#` prompt.

**Using the uLSxSetup program.**

Use one of the configuration methods above to connect to the µLSx. Once the user is logged into the system, the `uLSxSetup` program may be used to configure the unit as follows:

1. Type `cd /bin`.

2. Type `./uLSxSetup` (case sensitive) to launch the setup utility. You will be prompted for the µLSx’s IP address.

   ```
   ULSX_IP_ADDRESS [(192.168.11.200)] :
   ```
Note that the current IP address is displayed in brackets. If this is correct, press return to keep the current setting. If the setting displayed is (null), the uLSxSetup utility is being run for the first time and so enter the correct address in xxx.xxx.xxx.xxx format.

3. Continue entering the IP address settings until the configuration is complete, at which point the new settings are displayed as follows:

```
****************** Current Settings ******************
* uLSx IP              :       192.168.11.200         *
* uLSx Netmask         :        255.255.255.0         *
* uLSx Gateway         :        192.168.11.70        *
* uLSx Gateway Network :              0.0.0.0        *
* uLSx Gateway Netmask :              0.0.0.0        *
* PM Server IP         :        192.168.1.110         *
* PM Port              :                10600         *
* NMPC Server IP       :        192.168.2.151         *
* NMPC Port            :                10000         *
* EngMon Server IP     :        192.168.2.152         *
* EngMon Port          :                10000         *
******************************************************
```

Note that this example is for a uLSx at Los Leones. Also note that when entering the port numbers, a bug in the uLSx’s central library causes the uLSxSetup utility to skip the next IP address setting. To resolve this anomaly, simply re-run the uLSxSetup utility and hit return when prompted for the port number. The IP address may then be entered normally. Repeat the procedure as necessary until all settings are correct.

4. Type `reset` to reset the μLSx and the new configuration settings will be used.

## 4 Programming the E1 and BS DSPs on a Base-Station Board

The BSU comprises of a radio board, identical to the one used in a subscriber unit, and a custom designed board termed the Base-Station (BS) board. The μLSx unit comprises a μCDIMM board and an identical BS board. This section describes how to upgrade the firmware on both the BS board in a BSU and in a μLSx, as well as the radio board in a BSU. This is performed remotely using the network monitoring software or on the bench using the setup shown in Figure 4.

![Figure 4 - Programming the base-station board](image)

### Setup for programming on the bench (Figure 4):

1. Set the voltage of a bench power supply to 12V or 48V depending on the type of base-station support unit you are using. 12V units have stickers on the power supply connection plugs.
2. Connect the bench power supply to the base-station support unit using banana leads, ensuring to observe correct polarity.
3. Switch on the base-station support unit and verify that the power LEDs are illuminated and that the 1PPS LED is flashing. If not, check the power supply voltage and cabling.

4. **Switch off the base-station support unit.**

5. Connect the µLSx's **base-station board** to the **base-station support unit** using a **yellow-hooded** programming lead.

6. Connect the **BSU's radio board** to the **base-station support unit** using a **red-hooded** programming lead.

7. Connect the **BSU's base-station board** to **base-station support unit** using a **yellow-hooded** programming lead.

8. Connect the BSU to the µLSx using **2 x 75ohm BNC-BNC leads**. Ensure that the transmit port of one unit is connected to the receive port of the other unit and vice-versa.

9. Connect the µLSx to a computer using a cross-over Ethernet cable. Alternatively, use straight-through Ethernet cables and an Ethernet switch or hub.

10. Set the IP address of the computer to 192.168.2.151 and disable any personal firewalls.

11. Launch the Netmon software on the computer.

12. Turn on the base-station support unit and within 30 seconds you should see the µLSx connect to the computer.

The upgrade procedure consists of 3 steps that should be completed in the order described:

1. **Copying the image files to the appropriate location on the Netmon PC**

2. Upgrading the BSU_BS DSP in each BSU

3. Upgrading the BSU_E1 DSP in each BSU

4. Upgrading the BSx_BS and BSx_E1 DSPs.

4.1 **Copying the image files to the appropriate location on the Netmon PC**

1. Copy the firmware files BSU_BS_x.x.bnm and BSU_E1_x.x.bnm to the |Netlog|BSU|Builds| directory.

2. Copy the firmware files BSx_BS_x.x.bnm and BSx_E1_x.x.bnm to the |Netlog|BSx|Builds| directory.

4.2 **Upgrading the BSU_BS DSPs**

1. Start the Network Monitoring software and allow all BSUs to connect.

2. Click the **BSU / BSx Firmware Download** tab.

3. Click the **Auto Update** button and the path and filename of the latest firmware files should be shown next to the **BSU and BSx** labels. If they are not, you can manually search for the firmware file by clicking the **Select** button to the right of the appropriate label.

4. Ensure that the **Include in Download** radio button has a tick in it for the BSU BS only. **All other processor must not be programmed.**

5. From the **Base Stations / BSxs** list, select the BSU to download.

6. Click the **-> button** to add the selected BSU to the list of **Target Stations.**

7. Click the **Download Boot Image** button and the firmware upgrade process will commence. This will start by the member list of the BSU being manipulated to disconnect all connected subscribers. The firmware is then downloaded to the BSU and when complete, the radio board in the BSU will reboot. You will be instructed that the firmware download has completed. If a CRC error occurs during the programming phase, repeat the procedure.

8. Once the selected BSU has been programmed successfully, remove it from the **selected targets** list by clicking the **"<- All" button.**

9. Repeat the programming procedure for all BSUs within the E1 ring.

4.3 **Upgrading the BSU_E1 DSPs**

1. Start the Network Monitoring software and allow all BSUs to connect. (if this has not already been performed).
2. Click the **BSU / BSx Firmware Download** tab.
3. Click the **Auto Update** button and the path and filename of the latest firmware files should be shown next to the **BSU and BSx** labels. If they are not, you can manually search for the firmware file by clicking the **Select** button to the right of the appropriate label.
4. Ensure that the **Include in Download** radio button has a tick in it for the BSU E1 only. **All other processor must not be programmed.**
5. From the **Base Stations / BSxs** list, select the BSU to reprogram.
6. Click the -> button to add the selected BSU to the list of **Target Stations**.
7. Click the **Download Boot Image** button and the firmware upgrade process will commence. This will start by the member list of the BSU being manipulated to disconnect all connected subscribers. The firmware is then downloaded to the BSU and when complete, the radio board in the BSU will reboot. You will be instructed that the firmware download has completed. If a CRC error occurs during the programming phase, repeat the procedure.
8. Once the selected BSU has been programmed successfully, remove it from the **selected targets** list by clicking the “<- All” button.

### 4.4 Upgrading the BSx_xx DSPs
1. Start the Network Monitoring software and allow all BSUs to connect. (if this has not already been done).
2. Click the **BSU / BSx Firmware Download** tab.
3. Click the **Auto Update** button and the path and filename of the latest firmware files should be shown next to the **BSU and BSx** labels. If they are not, you can manually search for the firmware file by clicking the **Select** button to the right of the appropriate label.
4. Ensure that the **Include in Download** radio button has a tick in it for the BSx E1 only. **All other processor must not be programmed.**
5. From the **Base Stations / BSxs** list, select the BSx that you want to reprogram.
6. Click the -> button to add the selected BSx to the list of **Target Stations**.
7. Click the **Download Boot Image** button and the firmware upgrade process will commence. This will start by the member list of the BSU being manipulated to disconnect all connected subscribers. The firmware is then downloaded to the BSU and when complete, the radio board in the BSU will reboot. You will be instructed that the firmware download has completed. If a CRC error occurs during the programming phase, repeat the procedure.
8. When complete, repeat steps 4) to 7) for the BSx BS DSP.
9. If necessary, reconnect all of the E1 cabling and power cycle the entire rack. You should now be running the latest version.

### 4.5 Upgrading the SU DSPs
1. Start the Network Monitoring software and allow all BSUs to connect.
2. Click the **BSU / BSx Firmware Download** tab.
3. Click the **Auto Update** button and the path and filename of the latest firmware file should be shown next to the **BSU SU** label. If it is not you can manually search for the firmware file by clicking the **Select** button to the right of the **BSU SU** label.
4. Ensure that the **Include in Download** radio button has a tick in it for the BSU SU only. **All other processor must not be programmed.**
5. From the **Base Stations / BSxs** list, select the BSU to download.
6. Click the -> button to add the selected BSU to the list of **Target Stations**.
7. Click the **Download Boot Image** button and the firmware upgrade process will commence. This will start by the member list of the BSU being manipulated to disconnect all connected subscribers. The firmware is then downloaded to the BSU and when complete, the radio board in the BSU will reboot. You will be instructed that the firmware download has completed.
8. Click the *Connection Status* page, select the unit that has been reprogrammed from the list of *Base Stations* and click the *Reset Base Station* button. This will force the BSU to recover the original stored member list.

4.6 **Assigning an ID to the BS Board**

The BSUs and μLSxs within the radio network are uniquely identified with an identification (ID) number. In the event of equipment failure or the installation of an additional rack, the IDs of the BSUs within the rack must be updated. The BSU IDs should adhere to the following numbering conventions (numbers in brackets not currently used) :-

Los Leones : 11, 12, 13, 14, 15, 16, [17, 18, 19]
Los Morados : 21, 22, 23, 24, 25, 26, [27, 28, 29]
Loma Amarillo : 31, 32, 33, 34, 35, 36, [37, 38, 39]
Colheuco : 41, 42, 43, 44, 45, 46, 47, 48

The μLSx IDs may assume any unique ID within the range 1 to 10 inclusively and 60 to 255 inclusively.

**To assign a new or modify an existing BSU/x ID :-**

1. Connect the BSU to COM1 on a laptop computer using the YELLOW lead as shown in Figure 5 for a BSU or Figure 6 for a BSx.
2. Launch the BSUStationIDProgrammer software and the following dialog will be displayed.
3. The Current BSU ID field will automatically update to the current ID of the BSU.
4. Enter the new ID into the New BSU ID edit box and click the Set button. After a few seconds the Current BSU ID field will update to reflect the new station ID.

5 Programming a BSU-SU DSP using the BIOSProgrammer utility

It is possible to program the radio board in both an SU and BSU using the BIOS programmer utility.

1. Connect the SU to the PC’s COM1 port using the red-hooded programming lead as shown in Figure 7. The yellow-hooded programming lead is not strictly required.
2. Launch the BIOS Programmer software.
3. With the BIOS Programmer software running, power-cycle the SU. The green Connection LED in the BIOS Programmer software should illuminate. If it does not, check the cabling and repeat steps 1) to 3).
4. Click the select image file button and locate the firmware image file.
5. Select page 1 from the list.
6. Click the Program Flash button. A dialog indicating the progress should appear. If a timeout is reported, close the programmer software and repeat steps 1) to 6).
7. Once programming has finished, a dialog should appear indicating that “flash programming completed successfully”. If a bad CRC is reported, close the software and repeat steps 1) to 7).
8. Click the Cancel button to close the application and power-cycle the unit.

Figure 7 - Programming a BSU-SU DSP

6 Programming an SU over-air

It is possible to program an SU radio from the network monitoring terminal. A new software image may be transmitted over-air to an individual SU or all SUs within a single BSU’s sector in one go. As with all the programming procedures, extreme care must be taken to ensure that the correct software image is selected. Selecting the wrong image will prevent the unit from re-joining the network and the unit will have to be retrieved.
Once the correct software image has been selected, the programming procedure is relatively safe. The new image is placed onto a “holding” page and does not overwrite the current image until a CRC check of the downloaded image has been performed to check its integrity.

6.1 Downloading to a single SU

The upgrade procedure dictates that the new image must be tested on a single SU prior to full “roll-out” over a complete sector. Should the programming operation fail, this prevents the need to recover all units. An easily accessible tank should be chosen for the testing procedure.

1. Copy the supplied SU\_x.x.bnm file to the \Netlog directory.
2. If it is not already running, launch the Network Monitoring software and allow all SUs and BSUs to connect.
3. Click the SU Firmware Download tab.
4. In the Image File group box towards the top right hand corner of the window, click the Select button. Navigate to the \Netlog directory and select the current SU\_x.x.bnm file. This is the file that you copied to the \Netlog directory in step 1.
5. If required, use the Tank Finder button to locate which BSU the test tank is connected to.
6. From the Base Stations list, select the appropriate BSU. This causes the Connected Local Stations list populated with a list of subscribers that are currently connected to the selected BSU. Obviously, you may only download to units that are currently connected to the radio network.
7. Select the target SU from the list and click the button to move the SU into the Target Stations list. Please note that due to timing constraints within the SU, units connected on slot 7 or below cannot be downloaded. Simply use the Base Station Connection List tab to move the target SU to a suitable slot, wait for it to rejoin the network and repeat steps 6 and 7.
8. You are now ready to download the image to the target station. To do this simply click the Download Boot Image button. You will be warned about the process you are attempting to perform. Click the Yes button if you are happy to proceed.
9. You will be informed of the progress of the download. The download time depends on the image size and link quality and currently takes approximately 10 minutes for a radio with a good link. Do not attempt to change the programming parameters during the download. It is advised that the Cancel Download button is not used to cancel a download in progress. This will leave an incomplete image in the SU’s flash and a potential for disaster exists if an operator clicks the Update Firmware and Reboot button. This will cause the incomplete image to be copied to the SUs execution page and the unit will have to be recovered from the field.
10. When the image download is complete, click the Update Firmware and Reboot button. This will force the SU to copy the downloaded image to its execution page and the unit will reboot to run the latest firmware image. You will be warned about the impact of your actions. If you are happy to proceed, click the Yes button. The unit should drop the network and reconnect.
11. Use the Timeslot Monitor page to ensure that the SU is running the version of software that has just been downloaded. (See section 6.3)

6.2 Downloading to a sector of SUs

The procedure for downloading to a sector of SUs is almost identical to downloading to a single SU. Please ensure that a trial download to a single SU has been performed before trying to upgrade an entire sector. Repeat the steps outlined in the previous section and use the button in step 7 to place all the connected stations into the Target Stations list.
6.3 Note about SU Firmware Version Numbers

You can determine if an SU is running the latest software release by checking the Connection Status page. The GPS LED will turn blue if the software version reported by the SU does not match the version number in the \Latest SU Build\version.txt file. When a new firmware version has been downloaded, close the Network Monitoring Software and edit the version.txt file to reflect the latest firmware version.

7 Replacing a BSU / uLSx

Prior to replacing a unit, the unit must contain the latest firmware release and have had its ID programmed to match the unit that it is replacing. The following section details how to physically replace a BSU, although the procedures used are similar to those needed to replace a uLSx. The typical layout of the racks found at Los Leones, Coihueco, Los Morados and Loma Amarilla is shown in Figure 8.

Figure 8- A Typical Comms Rack

The tools required to replace a BSU or uLSx unit are as follows:
1. 8mm spanner for the BSU’s SMA connector
2. 2mm Allen key to remove tabs from BSU or uLSx.
3. Small cross head screw driver to remove unit from the rack.

Figure 9 - Tools Required to Replace a BSU / uLSx

Use the following procedure to replace a BSU / uLSx:
1. Switch off the power to all of the units in the rack as shown in Figure 10.
2. Disconnect the cables from the unit to be removed as show in Figure 11.
3. Unscrew the unit from the rack by undoing the 4 mounting screws as shown in Figure 12.
4. Carefully remove the unit from the rack, as shown in Figure 13, being careful not to disturb the other cabling.
5. Using the Allen key, remove the unit’s front cover screws and mounting tabs and reinstate them on the replacement unit as shown in Figure 14.
6. Install the replacement unit in the rack using the 4 fixing screws.
7. Methodically reconnect the cables, ensuring that a spanner is used to tighten the feeder cable. DO NOT OVERTIGHTEN.
8. Switch on the power to the rack.

Figure 10 - Turning off the Power to the Rack Equipment

Figure 11 - Removing the Unit’s Cables
Figure 12 - Unscrewing a Unit from the Rack

Figure 13 - Removing a Unit from the Rack

Figure 14 - Removing the Unit’s tabs