

Update ~ LWA TV on the Raspberry Pi ~ Add LWA-SV

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1. Introduction

I previously described using LWA TV on the inexpensive Raspberry Pi computer {[ReeveLWATV](#)}. LWA TV is part of the public outreach program associated with the Long Wavelength Array {[LWATV](#)} and allows anyone with a Raspberry Pi, monitor and internet access to watch real-time observations of celestial radio sources. LWA TV also can be watched on an ordinary PC with internet access.

The first LWA station is called LWA1 and it is about 67 km west of Socorro, New Mexico (figure 1). After I wrote the original paper in 2014, another LWA station was commissioned about 31 km north of Socorro in the Sevilleta National Wildlife Refuge near La Joya, New Mexico. Appropriately, it is called LWA-Sevilleta or LWA-SV for short or simply LWA2. This update shows how to modify the Raspberry Pi software to view the Sevilleta station.

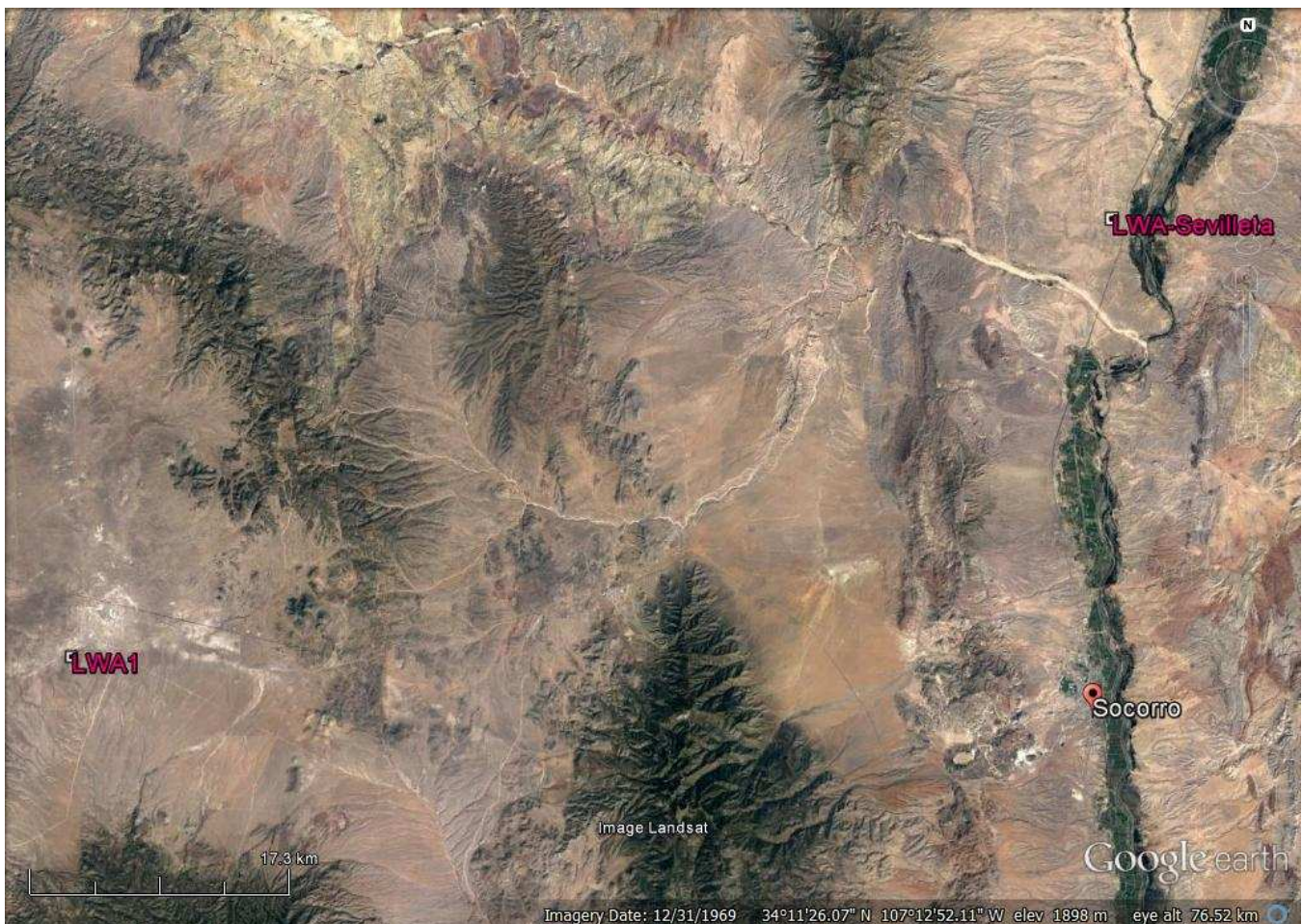


Figure 1 ~ Satellite image showing LWA1 and LWA2 with respect to Socorro, New Mexico (near bottom-right of image), from about 75 km altitude. LWA1 lower-(left side of image) is at the Jansky VLA site west of Socorro, and LWA2 (upper-right) is north of Socorro in the Sevilleta National Wildlife Refuge. Image source: Google Earth.

LWA TV views LWA1 by default. The changes needed to view LWA-SV (figure 2) are easy and reversible and are described in the next section. After that I show how to customize the text that is displayed on LWA TV and how to take screenshots of LWA TV in operation. I also provide a few operational comments on the Raspberry Pi B model 3 (a replacement for the RPi B model 2).

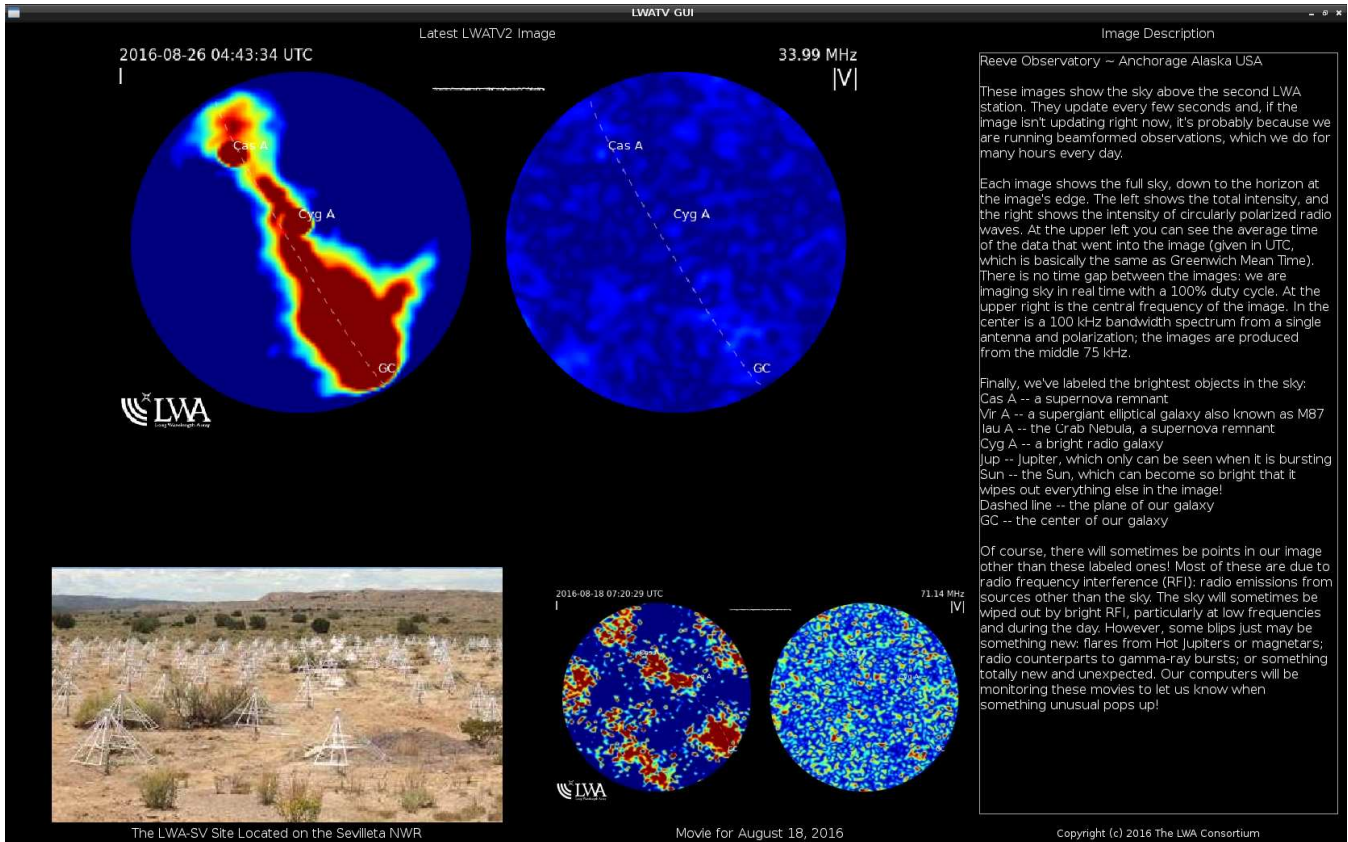


Figure 2 ~ Screenshot of the LWA-SV (LWA2) images taken while running LWA TV at Anchorage, Alaska in late August 2016. The image resolution is 1680 x 1050 pixels. Each of the upper two circles shows the full sky with zenith at the center and the horizon around the edges. The left circle shows total intensity of each point in the sky (Stokes parameter I) and the right circle shows the intensity of circularly polarized radio waves (Stokes parameter V). Sometimes only one image is shown, and it shows total intensity. The smaller circles at the bottom-middle are continuously running movies of the previous seven days made from individual images. The LWA TV software automatically downloads the latest movies every day.

2. Viewing LWA-Sevilleta on LWA TV

The setup described in this section assumes you already have commissioned a Raspberry Pi to view LWA1; if not, refer to {[ReeveLWATV](#)}. The information provided below also is in the latest issue of that document.

Only a couple changes are needed to the LWATV software to view LWA-SV (LWA2). All changes are made through the RPi console (command line interface) – a keyboard and mouse are not needed. The previous document describes installing PuTTY to access the console but other terminal programs will work as well.

The RPi uses a version of the Linux operating system, and in Linux the \$DISPLAY environment variable controls which display the LWA TV graphical user interface (GUI) uses. When using the console to change to LWA2, it is

not possible to start the GUI without first setting \$DISPLAY. There are two ways to do this; one is temporary (until next reboot) and the other is permanent (persistent through reboot). Follow the procedures for one or the other but not both.

Before making any changes to your existing LWA TV installation, it is a good idea to backup your existing RPi software image. Procedures are given in {[RPiBackup](#)}. Also, be sure the latest LWATV software is installed by entering the following in the RPi command line:

```
cd ~/LWATV/  
svn update
```

Temporary: This method requires only a couple changes. First, manually set the \$DISPLAY variable in the console and then set the LWATV2 mode. This method does not download LWA2 movies. At the RPi command line enter the two lines below, following each by Enter:

```
export DISPLAY=:0  
./lwaTV3.rpi.py -2
```

The second line above runs the LWA TV Python program with the -2 option, which downloads the LWA2 images. Do not reboot the RPi after entering these changes.

Permanent: This method is slightly more complicated but requires only a couple minutes. First, set the LWATV2 mode as the boot time default by editing the /etc/xdg/lxsession/LXDE/autostart file and adding the -2 option at the end of the line that calls lwaTV3.rpi.py. Since autostart is a system file it needs to be edited with sudo privileges, as in

```
sudo nano /etc/xdg/lxsession/LXDE/autostart
```

Several lines will be seen in the editor, most of them commented out with the hash “#” character. Look for the line that specifies the lwaTV3.rpi.py file, probably the last line (figure 3).

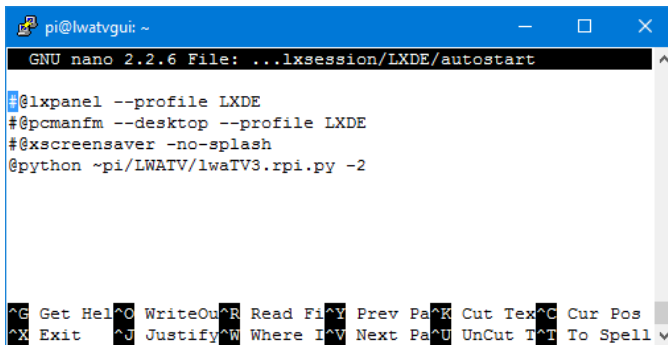


Figure 3 ~ Screenshot of the nano editor with autostart file loaded. The -2 at the end of the first line specifies LWA2 (LWA-SV).

Add the -2 option at the end of that line with a space separator,

```
@python ~pi/LWATV/lwaTV3.rpi.py -2
```

Make no other changes and, when finished, type CTRL-X, Y and Enter.

It also is necessary to modify the cron table (crontab) so that the LWA2 movies are downloaded. To invoke the crontab editor enter at the command line

```
crontab -e
```

Look for the lines about the movie update. It may be necessary to scroll down using the cursor keys:

```
## Update the movies daily
30 18 * * * python ~pi/LWATV/updateMovies.py
```

Change the line that calls updateMovies.py to include the -2 option:

```
30 18 * * * python ~pi/LWATV/updateMovies.py -2
```

Do not make any other changes unless you also want to change the download time. When finished, save the changes by typing CTRL-X, Y and Enter. If the suspension feature is used as described in {[ReeveLWATV](#)}, it also is necessary to put the -2 option at the end of the line that starts lwtv3.rpi.py.

The changes in crontab take effect immediately, but the changes to autostart require reboot:

```
sudo reboot
```

When the RPi reboots it should be in the LWA2 mode.

To go back to the LWA1 mode, simply reverse the changes made above; that is, remove the -2 option from the appropriate lines in autostart and crontab. Be sure to reboot to load the revised autostart file.

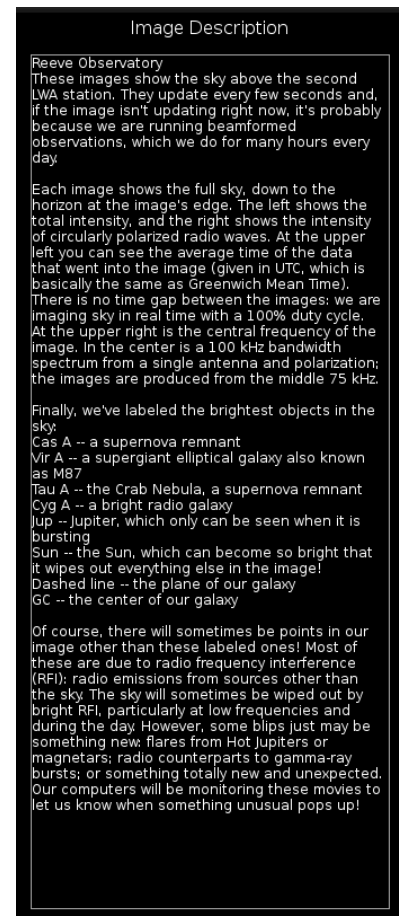
3. Customize the display text

The text in the right frame of the LWA TV display (figure 3) is stored in the directory /home/pi/LWATV/info in text files: beams.txt, lwtv.txt and lwa2tv.txt files. One of these files is used depending on what the main display shows. This text may be modified to suit local purposes; however, it is a good idea to backup the original files or copy them to a safe location before making any changes just in case they are needed later.

Figure 3 (right) ~ Right-hand frame of LWA TV showing Image Description text for LWA-SV

The following uses WinSCP to edit the text files; see [RPiSetup](#) to install WinSCP if not already on your PC. The nano editor also may be used. For WinSCP navigate to the directory /home/pi/LWATV/info and double-click (or right-click and select **Edit**) the file to be edited (beams.txt, lwa1.txt or lwasv.txt). It will open in an editor (figure 4) and you can make the desired changes. When finished click the Save icon at the left end of the Editor Menu bar. If desired, repeat the edit operation for each of the three text files. The changes will take effect when the RPi is rebooted:

```
sudo reboot
```



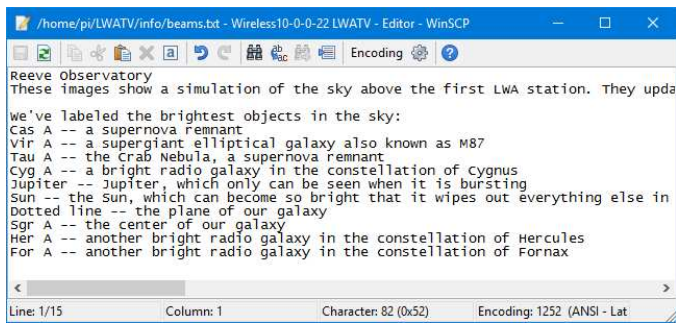


Figure 4 ~ Screenshot of the WinSCP editor with the lwa1.txt file loaded.

4. LWA TV screen capture

If screenshots of LWA TV are needed, a screen capture tool such as scrot (SCReensHOT) must be installed on the RPi. An example screenshot using scrot was presented in section 1 of this paper. From the RPi command line type

```
sudo apt-get install scrot
```

After installation completes, capture a screen by typing in the command line

```
DISPLAY=:0 scrot screenshot.png
```

The above command captures the currently displayed screen and places the PNG image in the /home/pi/ directory. To avoid having to type the DISPLAY=:0 portion of the command each time, it can be assigned persistently (until the next reboot) by using the following sequence:

```
export DISPLAY=:0
scrot screenshot1.png
scrot screenshot2.png
.....
```

When capturing a sequence of screens, be sure to use different filenames. The PNG image files may be copied or moved from the RPi to a Windows folder or desktop with WinSCP. The screen capture operation can be delayed and image directory can be assigned. To learn how to use these and other scrot features use online resources or view the scrot manual by typing

```
man scrot
```

The captured image's pixel dimensions are identical to the display (less any overscan specified in the RPi configuration file). The image at the beginning of this paper is 1136 x 856 pixels. It is the screen size I setup in the RPi when connected to a 22 in Samsung 226BW monitor (1680 x 1050 native resolution) and excludes the vertical and horizontal overscan pixels.

I tried to use LWA TV on the 7 in touchscreen LCD endorsed by the Raspberry Pi project. It has 800 x 480 pixel resolution. As expected, the Image Description text in the right frame is too small to be readable. After several hours of experimentation I was unable to find any video settings that properly center the display. Screenshots also are off-center (figure 5). This apparently is due to a problem in the RPi display driver or display adapter board because a different 7 in LCD with 1024 x 600 resolution with no touchscreen worked fine (figure 6).

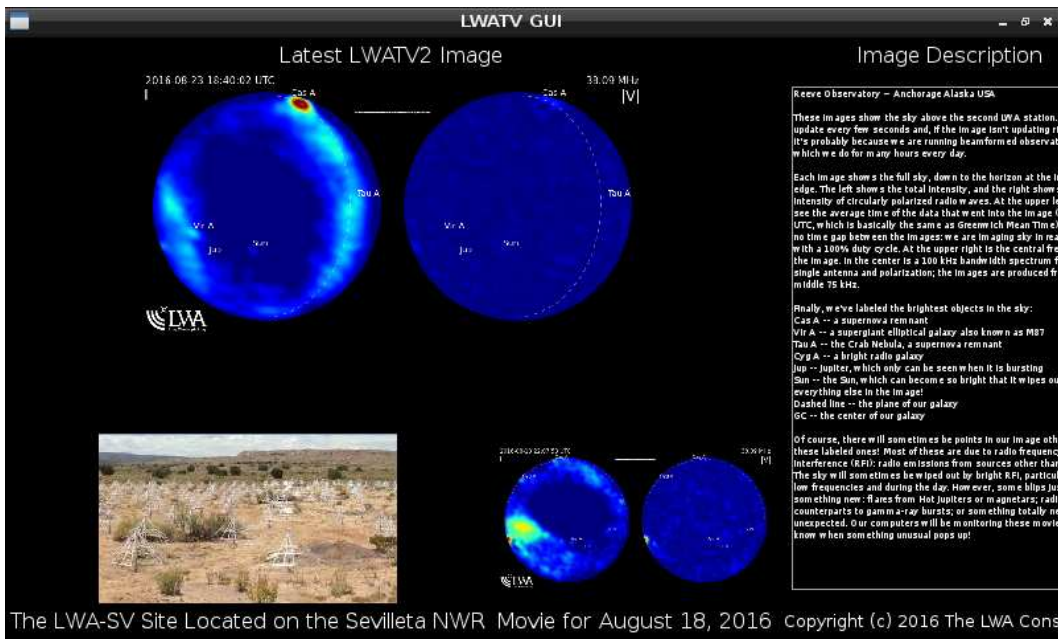


Figure 5 ~ Screenshot image with the RPi connected to a small 800 x 480 pixel touchscreen LCD monitor using the RPi's Display Serial Interface (DSI). The touchscreen function is not used. The actual image size is 784 x 472 pixels. Note that some text is oversized and that the display is not properly centered (it runs off to the right). I was unable to correct this in the RPi configuration file.

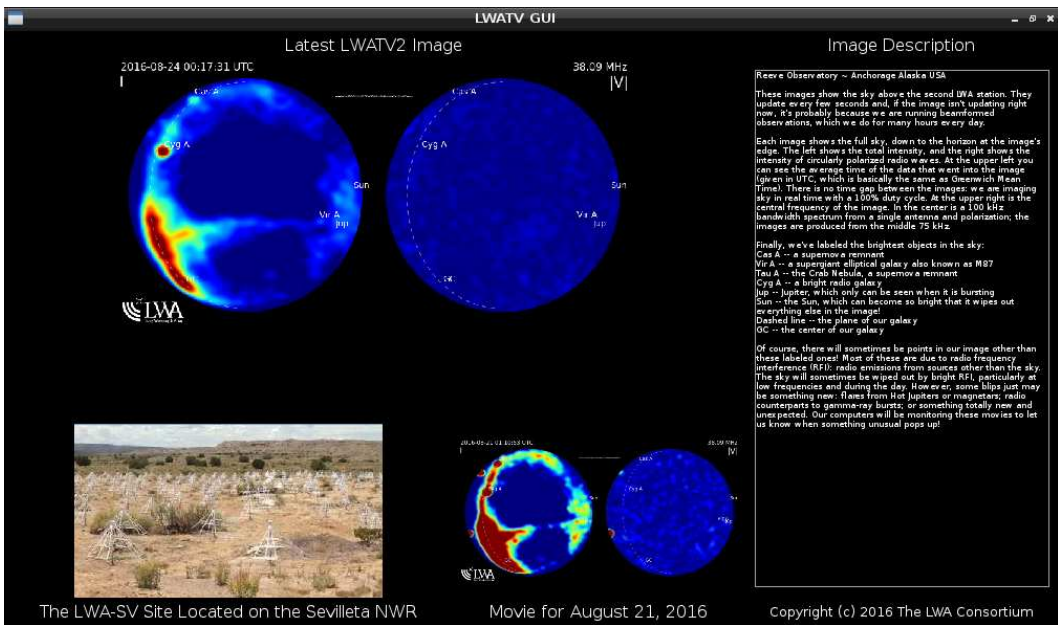


Figure 6 ~ Screenshot image with the RPi HDMI output connected to a Tontec 7 in 1024 x 600 pixel TFT-LCD monitor. The RPi is very easy to configure for this display. The actual image size is 1008 x 592 pixels. Compare the text to the previous screenshot.

5. Raspberry Pi B Model 3

The work associated with this update was carried out on the RPi B model 3 (RPi3) in August 2016. The RPi3 was released in February 2016 and is a replacement for the Raspberry Pi B model 2 (RPi2). The major changes associated with the RPi3 are a faster 64-bit CPU and built-in 802.11n Wireless LAN (WiFi), Bluetooth 4.1 and Bluetooth Low Energy (BLE).

I noticed no obvious operational differences between the RPi3 and earlier versions while using the LWA TV application. However, the WiFi device built into the RPi3 proved to be inconsistent, sometimes blocking download of the LWA TV images and often preventing console login from a Windows 10 laptop. Some problems appear to be related to the default power management setup of the onboard Broadcom wireless integrated circuit (power management is turned on by default). Power management also is a problem with the USB dongle-type WiFi devices and is easy to rectify, see {[RPiWLAN](#)}. Although power management should not be a problem with LWA TV because it downloads new images every 5 s, turning it off appears to correct the download problem. However, the console login problem from the laptop is unrelated to power management and may be due to a firmware or driver problem with the RPi onboard wireless IC. This was not yet fixed as of September 2016.

Another potential problem with the built-in wireless is its tiny onboard patch antenna located near the edge of the RPi3 printed circuit board next to the memory card. As one would expect for such an antenna, the range is very limited. I had good signal level but only slightly above average quality at 3 m distance from the access point. Using a WiFi USB dongle at the same location provided both excellent signal and quality. WiFi USB dongles also have a small antenna but the USB ports are farther from onboard RFI sources. Obviously, the built-in wireless device will be completely useless if the RPi3 is placed in a metal enclosure (an external antenna cannot be connected without a hatchet). In this situation, it will be necessary to use a WiFi USB dongle or wired Ethernet for LAN/internet access.

6. References and Web Links

{[LWATV](#)} <http://www.phys.unm.edu/~lwa/lwatv.html>
{[ReeveLWATV](#)} http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi-LWATV.pdf
{[RPiBackup](#)} http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_BackupRestore.pdf
{[RPiSetup](#)} http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_BasicSetup.pdf
{[RPiWLAN](#)} http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_WLANSetup.pdf

Acknowledgement

Jayce Dowell at UNM helped me immensely with this project including the setup for viewing LWA-SV, and I again extend my thanks and appreciation.

Preprogrammed Memory Card with LWA TV Software Image

A preprogrammed micro-SD memory card may be ordered by emailing:

OrderInfo@reeve.com

The micro-SD card includes an SD carrier and will work in the Raspberry Pi model B or B+, model 2 and model 3 (it has not been tested on other RPi variants). The cost is 15 USD including postage to any US destination. The postage to countries other than the US will be quoted separately.

Document information

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0.1 (Added screen capture and map image, 06 Aug 2016)
0.2 (Cleaned up text, 12 Aug 2016)
0.3 (Minor edits to RPi3 section, 15 Aug 2016)
0.4 (Minor edits, 18 Aug 2016)
0.5 (Added small display, 24 Aug 2016)
1.0 (Distribution, 05 Oct 2016)

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