LMA Display and Processing Software

The software and display directories will be owned by a user on the system. In the discussion below I will assume the username is `lma_admin`. The root directory of the scripts and data is `$HOME/lma`. The root directory for the web display scripts and images is a directory with a name like `/var/www/html/oklma` and is called `www_dir` in the discussion below.

The directory `$HOME/lma` contains the file `lma_config` and the subdirectories `bin`, `display`, `incoming`, `loc`, `log`, `realtime`, `recent`, `status` and `tmp`.

`lma_config` : File used to configure the display software

`bin` : Most executable scripts and programs

`display` : Scripts and data for producing web images

`incoming` : Directory to temporarily store real-time data files from the LMA stations

`loc` : Directory to hold gps file for LMA used in processing the raw data

`log` : Directory to hold the daily log files from each LMA station used in producing the daily status plots. Each station will have its own sub-directory inside `$HOME/log`. The name of each sub-directory will be the upper case of the station letter – e.g. `$HOME/log/B`.

`realtime` : Dirctory to hold the real-time raw and processed data files. This has three sub-directories:

- `rt_data` : Used to hold the raw real-time data files. There will be a sub-directory for each day in the format YYMMDD, followed by a sub-directory for each hour in the format HH, followed by a sub-directory for each minute in the format MM. For example the raw data for the minute 11:07 to 11:08 on May 1, 2020 will go into the sub-directory `$HOME/lma/realtime/rt_data/200501/11/07`. The sub-directories will be made as needed by the script which pulls data files out of `$HOME/lma/incoming`. Periodically the one-minute raw real-time files should be removed from the system. This can be done by adding a line like this to `lma_admin`'s `crontab` file:

```
0 14 * * *  /usr/bin/find $HOME/lma_admin/lma/realtime/rt_data/ \
            -type d -ctime +3 -exec /bin/rm -r \{\} \\; \
            1>/dev/null 2>/dev/null
```

- `processed_data` : The one-minute processed data files produced from the one-minute raw data files. As for the `rt_data` directory, the `processed_data` directory will have sub-directories in the format `YYMMDD/HH/MM`.

- `archive` : On a regular bases the one-minute processed data files should be concatenated into hour-long data files and stored in `$HOME/lma/realtime/archive/YYMMDD`. The one minute processed data files can then be deleted.

`recent` : This directory holds the last hour's worth of processed LMA data in python numpy `.npy` format. When the data files are moved out of `$HOME/lma/incoming` into `$HOME/lma/realtime/rt_data` the script produces a numpy `.npy` file of the data. This is done so the scritps which use the data for producing images don't need to re-read and re-parse the gzipped ASCII processed data files. You might want to link this to a tmpfs filesystem to improve system performance.

`status` : This directory holds the hourly status files from the LMA stations which are used to produce the status page.

`tmp` : For temporary files. You might want to link to a tmpfs filesystem.

The file `$HOME/lma/lma_config` holds configuration information for the network. Here is an example `lma_config` file:

```
Location:     Oklahoma
gps_file:     $HOME/lma/loc/oklma.gps
www_dir:      /var/www/html/oklma
prefix:       OKLMA                # Prefix for real time LMA data files
station_id:   ok_                  # Prefix for LMA station names
z1:           300
z2:           150
z3:           60
anim_len:     180                  # Length of animation in minutes
url:          http://localhost/oklma
delay:        30
```

`Location` : The location of the network. This will be used as the title on web pages and images.

`gps_file` : The name and location of the gps file. This file is used by `$HOME/lma/bin/lma_analysis` for processing the raw data files and is used by `$HOME/lma/display/makeLmaImages.py` for finding the station locations to plot on web images.

`www_dir` : The name of the web directory where the image files will be put.

`prefix` : The prefix of the LMA processed data files.

`station_id` : The ID of the LMA stations. An LMA station typically has a hostname like "`ok_a`"

`z[123]` : The three zoom levels to display on the real-time web pages. A zoom of 300 means that a distance of +/-300 km from the network center will be displayed.

`url` : The URL of the web pages.

`delay` : The number of seconds to wait for the real-time data files to arrive. A delay of 30 means that will start processing the previous minute of data at 30 seconds after the minute.

The directory `$HOME/lma/bin` holds the scripts and programs for the data flow.

The script `$HOME/lma/bin/LMA_Realtime.py` is a simple script which does one thing: it calls the script `$HOME/lma/bin/get_minte_data.py` once a minute. There are two ways data can get from the LMA stations to the server – 1) if the stations have public IP adresses the server can pull the data from the stations; or 2) if the stations do not have public IP addresses then the stations need to push their data to the server. If the server pulls the data `LMA_Realtime.py` will call `get_minute_data.py` at a few seconds after the minute. If the stations push the data to the server `LMA_Realtime.py` should call `get_minute_data.py` after a delay which is long enough that all (or most) of the stations have time to push their data into `$HOME/lma/incoming`. This depends on the speed of the real-time links to the LMA stations. The length of the delay is specified in the `delay:` line in the file `$HOME/lma/lma_config`.

The script `$HOME/lma/bin/get_minute_data.py` gets the latest minute of data from the LMA stations, puts the data into the correct directory in `$HOME/lma/realtime/rt_data`, calls the program `$HOME/lma/bin/lma_analysis` which processes the data, and calls the script `$HOME/lma/display/makeLmaImages.py` which makes the web images. At this point the script `get_minute_data.py` assumes the stations push the realtime data into `$HOME/lma/incoming`. If the server needs to pull the data `get_minute_data.py` needs to add code to pull the data from the stations. The script `get_minute_data.py` also parses the processed real-time data files and stores the processed data as `numpy` arrays in `$HOME/lma/recent`. Each row in the `numpy` array represents one LMA source. There are eleven columns in the array:

Column 0 : The unix second for the day.

Column 1 : The time of the LMA source in seconds after midnight.

Column 2 : The latitude of the LMA source.

Column 3 : The longitude of the LMA source.

Column 4 : The latitude of the LMA source.

Column 5 : The reduced chi^2 goodness of fit for the LMA source.

Column 6 : The receive power (in dBW) of the LMA source.

Column 7 : The station mask for the LMA source.

Column 8 : The number of stations which detected the LMA source

Column 9 : The position of the source east of the array center (in meters)

Column 10 : The position of the source north of the array center (in meters)

The script $HOME/lma/bin/health_summary.py takes the hourly status files in $HOME/lma/status and produces the web status page. At this point the script health_summary.py assumes the stations push the status files into $HOME/lma/status. If the server needs to pull the status files health_summary.py needs to add code to pull the status files from the stations.

The script $HOME/lma/bin/hist_plot.py takes the daily log files in $HOME/lma/log and produces the web status images. At this point the script hist_plot.py assumes the stations push the log files into $HOME/lma/status. If the server needs to pull the log files hist_plot.py needs to add code to pull the log files from the stations.

The script $HOME/lma/display/makeLmaImages.py makes the images for web display. The script is called like this:
$HOME/lma/display/makeLmaImages.py 20 4 29 22 58
This says to make image files for April 29, 2002 for 22:58. If the minute is not modulo 9, the script will make images that go into www_dir/current and it will make a geo-located PNG which can be loaded by Google Earth. If the minute is module 9 the script will produce those files and archive files which go into www_dir/img/YY/MM/DD/HH. Once the script determines the minutes to use it will read the data for those minutes from $HOME/lma/recent.

The script $HOME/lma/display/lma_util.py has some functions which are used by makeLmaImages.py.

The file $HOME/lma/display/state.py has some global variables used by makeLmaImages.py.

The file $HOME/lma/display/mapfile.npz is a numpy .npz file which contains boundary files for plotting on the real-time images. The file contains up to three arrays: admin0, admin1 and poi. The admin0 and admin1 arrays have two columns – the latitudes and longitudes of the polygons to plot. Polygons are separated with a row of (Nan, Nan). admin0 boundaries are plotted in red (typically state boundaries in the U.S. and country boundaries Europe). admin1 boundaries are plotted in light grey (typically county lines in the U.S. and major political sub-divisions in Europe). poi files are just rows of latitudes and longitudes – a red dot will be plotted at each poi location.

The script $HOME/lma/display/extract_map_data.py can be used to generate mapfile.npz. It reads shapefiles, U.S. Census Bureau Tiger ASCII files, and POI shape files.

The sub-directory $HOME/lma/display/maps has a shapefile for the U.S., Tiger ASCII files for the counties in all the states, and an example POI text file.

The www_dir directory holds the images for display on the web and the scripts to display them. Below is a description the some of the scripts and files in www_dir.

www_dir/station.txt This holds a list of the LMA stations in the network as well as some information used by some of the php scripts. Here is an example of a stations.txt file:

```
Network  Oklahoma
Prefix OKLMA
B Bluff
```

The `Network` name is used as the title for some of the web pages and the `Prefix` is used by the scripts to determine the name of the image files. (`Prefix` should be the same as `prefix` in the `$HOME/lma/lma_config` file.)

`www_dir/index.php` The main web page. It uses the style sheets `www_dir/files/style.css` and `www_dir/files/menu-style.css`.

`www_dir/cal.php` A calendar display showing which days have real-time images.

`www_dir/current` The sub-directory with scripts to display the current LMA images

`www_dir/googleearth.php` A page showing how to load the Google Earth overlays

`www_dir/rt.php` PHP script to display the thumbnails for a particular day.

`www_dir/view_rthour.php` PHP script to display the archived image and thumbnails for a particular hour.

`www_dir/view_rt10min.php` PHP script to display the archived image for a particular ten minute interval.

`www_dir/status.html` The status web page created by `$HOME/lma/bin/health_summary.py`.

`www_dir/desc.html` A script which describes the columns of the `status.html` page.

`www_dir/stat_plots.php` A page to show the daily status plots for each station.

`www_dir/plots/[ABCD...Z]` Sub-directories to hold the daily status plots for each station.

`www_dir/img/YY/MM/DD/HH` : The sub-direcories which hold the archival images.

`www_dir/geo_images` : A sub-directory which holds the Google Earth geo-referenced images, a KML file to load those images, and sample image used by `googleearth.php`.