NEMETODE Technical Note #05
Hints & Tips for Building a GMN (Global Meteor Network) Camera

This document is an ancillary guide on how to build and your own GMN (Global Meteor Network) camera. It is not intended to replace the documentation that is already in place elsewhere but rather augment it based on the experiences of multiple members of the NEMETODE team who, to date, have built and deployed well over a dozen systems.

Order camera board, lens, PoE injector, CCTV camera housing

Order the following parts, from the specifications and link given here:

Building a GMN meteor camera - Google Docs

and

RMS parts list - Google Docs

Order IMX291 camera sensor board with lens and select 48V PoE cable option. (This cable is ready to use and avoids fiddly wiring by hand).
The 6 mm lens is recommended for suburban locations.
PoE injector can be purchased from UK supplier, but AliExpress is cheaper.
Ethernet waterproof connector cap – also cover the unit by a plastic bag or similar.
CCTV housing – select the plate and bracket option.
Heater and fan shouldn't be necessary.
The list (above) recommends a Pi case – optional
RTC (real-time clock) modules – pack of 10 – can these be purchased in UK?

Order Raspberry PI, microSD card, RJ45 ethernet cables

Purchase all of these from UK suppliers.
Raspberry Pi 4 with 4 GB memory and approved power supply, such as here:
Raspberry Pi Boards – The Pi Hut

128 GB microSD card, such as here:
SanDisk Extreme Pro 128GB microSDXC Memory Card + SD Adapter with A2 App Performance + Rescue Pro Deluxe 170MB/s Class 10, UHS-I, U3, V30, Red/Gold: Amazon.co.uk: Computers & Accessories

Test and configure the camera board

The camera board can be tested and configured before connecting it to the Pi. The GMN Wiki describes how to use CMS software on a Windows computer to test and configure the camera...

Download CMS and install it onto a Windows computer, from the link given here

Focusing your camera - Global Meteor Network

Rather than using these configuration steps, follow Denis Vida's video tutorial

IMX291 camera configuration - YouTube

This explains how to use the POE injector and a couple of RJ45 ethernet cables to connect the camera board to a Windows computer. The lens isn't needed at this stage.

If all works OK, mount the tiny lens onto the board camera as described in steps 1 to 4 here

Building a GMN meteor camera - Google Docs

Note step 3 - fine glasspaper can be used to smooth down the nubbins' edges after having clipped them off.

Step 5 and onwards show how to mount the camera and lens in the housing, but that can be done later. At this stage point the board and camera at the night sky, viewing its FoV using CMS, slowly twist the lens barrel to achieve good focus (there's a few seconds' delay in the display). Note what star fields it shows, the FoV and limiting magnitude.

If the stars are not in good focus across the FoV check that there's no debris left over following the removal of the nubbins and that the lens mounting screws have been tightened.

If the 48V POE Cable is located inside (rather than outside) the CCTV housing then the flashing lights on it can reflect off the inside glass of the housing and back on to the sensor. To avoid this, it's worthwhile covering the lights. This can be done with insulating tape (which over time could leave a sticky residue) or another option is to use a 70mm length of bicycle inner tube, tie-wrapped into position, as an opaque sleeve to cover the lights.

Install the RMS image onto the microSD card

The Pi gets its OS from a microSD card and to run as a meteor station it uses the prebuilt GMN RMS image which is downloaded from the GMN website and flashed to the card.

Download the zipped RMS image for a Pi 3B+ or a Pi 4
:
RPi 3B+: https://www.dropbox.com/s/sa9csd4m3jr1vqo/RMS_image_20191203.zip?dl=1
RPi 4: https://www.dropbox.com/s/a6ix7nz9f27h03d/RMS_RPi4_image_20200604.zip?dl=1

Note: The RMS image for a Pi 4 is a 4.6 GB download.

Unzip the image – this creates an 11.4 GB file

Download and install Etcher (used to flash the RMS image to the microSD card)

https://www.balena.io/etcher/

Insert the microSD card into an adapter, then into the Windows computer
Run Etcher to flash and validate/verify the RMS image to the microSD card – this takes ~15 minutes
Do not format the card
Eject the card from the Windows computer, remove it from the adapter and insert it into the Pi

Install a real-time clock module

The Pi will not maintain date and time when shut down unless it has a RTC (real-time clock) module. These videos show how to install the RTC.

https://thepihut.com/blogs/raspberry-pi-tutorials/17209332-adding-a-real-time-clock-to-your-raspberry-pi

https://learn.adafruit.com/adafruits-raspberry-pi-lesson-4-gpio-setup/configuring-i2c

https://www.youtube.com/watch?v=MthLLRNAGLs

Note:- None of the software configuration steps are required for a Pi 4 running RMS, apart from just entering the command:

sudo hwclock -w (see later)

Provide Pi cooling

The RMS software can put great demands on the PI's CPU when it's capturing video data and analysing the clips, so it's important to add some method of cooling to the Pi otherwise there's increased risk of the Pi crashing.

These videos discuss several options for cooling the Pi, including how to fit a heatsink and fan

https://www.youtube.com/watch?v=RxBaEiQHzLU

Raspberry Pi 4 Cooling - YouTube

This is GMN's recommended case (with cooling fans)

Raspberry Pi 4 Aluminium Metal Case Raspberry Pi 3 Dual Fan Case+Cooling Fan+Heat Sinks Enclosure for Raspberry Pi 4B/3B Plus/3B|Demo Board Accessories| - AliExpress

These work well for individual cards however for multi-camera systems, a Pi Stack built using M2 Brass Standoffs may be worth considering (see here for an example built using a sheet of MDF, a short length of right-angle aluminium and a pair of 5V fans).

Heatsinks

For a Pi 3, apply the smaller heatsink to the little IC adjacent to the USB ports. Apply the copper square to the Broadcom chip, then apply the larger heatsink to the copper square. (Carefully peel back the paper covering to reveal the sticky side of these items).

For a Pi 4, heatsinks and details of positioning are shown here.

Internet Connection

The Pi has x1 ethernet port and this is used to connect to the camera via the POE injector. Internet connection is normally achieved therefore via WiFi however if the Pi is located outside the normal range of your router (eg out in an observatory) then you'll need a second Ethernet port, connected via USB. Not all available adapters work however this one is known to work well with Pi 3 and Pi 4.

Boot the Pi from the microSD card

Insert the microSD card into the Pi (the card must be upside down)
Connect the monitor to the mini-HDMI socket nearest to the USB-C power socket

Power on the Pi and follow the instructions on the screen

It displays:

"Hey, welcome to the Raspberry Pi Meteor Station (RMS) project!"

Before you proceed you need to…

(1) Determine lat and long to 5 d.p., altitude to nearest metre
(2) e-mail these, along with your name, site and camera's pointing alt and az, to denis.vida…

Do not proceed unless you have read the notes above…

At this stage it's useful to perform a couple of setup tasks…

Pi temperature monitor

If the Pi's temperature isn't displayed at the top right of the taskbar:

Right click on the taskbar

Select Add/Remove Panel Items

Click on the Add button in the right menu

Select Temperature Monitor

Click Add

Select and click on it and enter its wireless key password

The Pi should set its correct time after a few minutes

Set the computer's clock

To connect the Pi to the Internet, click on the X-X icon at the top right of the screen, this will list the available WiFi hub
Select and click on it and enter its wireless key password

After a few minutes the Pi should set itself to the correct date and time. This is confirmed by checking the time at the top right of the display and by typing 'date' in a terminal session.

Finally, in a terminal session type:

sudo hwclock -w

Then proceed with the RMS installation…

Expand the file system

This opens 'raspi-config' in a separate window

Select options
7 Advanced Options
A1 Expand File System
OK
Finish
Yes (to reboot)

After the reboot, press Q to skip the prompt to expand the file system

Internet connection

This step was completed earlier, but if it says the Pi isn't connected to the Internet, click on the X-X icon at the top right of the screen
This will list the available WiFi hub
Select and click on it and enter its wireless key password
When connected to the Internet, press Enter to continue the configuration
Reboot the Pi

If necessary, press Q to skip previously completed sections

Change the default password

If this fails, or if you wish to do it later, this can be done by clicking on the Raspberry icon at the top left of the display

Select – Preferences – Raspberry Pi Configuration – Change Password – (keep a note of the password)

Generate a SSH key

This creates a key code which will allow the Pi to upload its meteor data to GMN's server
It will appear as an icon on the desktop
This code should be e-mailed to Denis Vida, although you may wish to wait until the Pi has collected good data

Update the RMS code

The configuration process now updates the RMS code on the Pi
This takes a few minutes and displays lots of code warnings, which can be ignored

Edit the config file

This opens a text editor for changing the following entries to the station's values:

stationID:
latitude:
longitude:
elevation:

This config file, RMS_config.txt, appears as an icon on the desktop. It can be edited by double-clicking on it

Click on File – Save, File – Close Window to exit the editor

RMS starts

It now runs the RMS software and displays the next start time (of meteor detections) and the waiting time until this commences

READ-RPi4_note.txt

This is a readme file on the desktop display which is only relevant to Pi 4 models which require a line to be changed in the config file

Double-click on READ-RPi4_note.txt and RMS_config.txt

In RMS_config.txt, go down to the [Capture] section, then copy and paste the line that begins

device: rtspsrc

Comment out the first line by preceding it with a ';'

In READ_RPi4_note.txt, copy the recommended new line that begins

rtspsrc

and carefully apply the change to the new line in RMS_config.txt

Click on File – Save, File – Close Window

Test the Live video stream

Connect two RJ45 ethernet cables from the PoE adapter, one from its Power / Data port to the camera board and the other from its LAN port to the Pi

Double-click on RMS_ShowLiveStream.sh on the desktop screen
This prompts you to execute the script and it should display a live feed from the camera board
Use File – Close Window to exit the script

Create a detection mask

If there's any local feature in the field of view, create a mask, as described in the Quick Start guide

RMS - Quick start guide - Google Docs

Connect to the Pi from a Windows computer via VNC

To be completed…

Map a Windows network drive to the Pi

Windows can be connected to the SAMBA RMS_data share on the Pi (/home/pi/RMS_data)

On the Pi

cd /etc/samba
ls -l

(This shows that smb.conf is owned by root and has rw-r—r— owner, group, world permissions)

sudo chmod 646 smb.conf
ls -l

(This has changed smb.conf permissions to rw-r—rw-) owner, group, world)
Edit smb.conf
Go down to the RMS_data share and change
Public = No
To
Public = Yes
Save the file

cat smb.conf (to confirm the change has been made)

sudo chmod 646 smb.conf (to reset the permissions of smb.conf)
ls -l

Now restart SAMBA. The simplest way is to reboot the Pi

On the Windows computer,

File Explorer – This PC
Map Network Drive
Select a Drive letter
In Folder, enter the Pi's MAC address and its share id, e.g.
\\192.168.1.200\RMS_data
Click Finish

Uploading data to GMN's server

The Pi will have a file called id_rsa.pub on its desktop screen, which is the Pi's unique SSH key which enables data transfer. E-mail this file to Denis Vida denis.vida@gmail.com and he will add it to GMN's server to authorise the transfer process.

When good data have been uploaded to GMN, ask Denis to create a platepar (stellar registration profile). On receipt of this, and a .config file, copy them into /home/pi/source/RMS.

Each morning RMS uses the platepar when processing the previous night's data and it creates various summary files, including a tar archive file which it uploads to GMN's server. Ask Denis Vida if the first data submissions are acceptable, if so he will add your station to GMN's processing pipeline.

System Maintenance

On a periodic basis you may wish to perform routine system maintenance to ensure all security features are kept up to date.
To do this open a terminal window and type the following commands:

sudo apt update

sudo apt full-upgrade

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Alex Pratt, First Issue, 26th March 2021

If you have any questions, feedback or recommendations then please contact the author via ws@nemetode.org