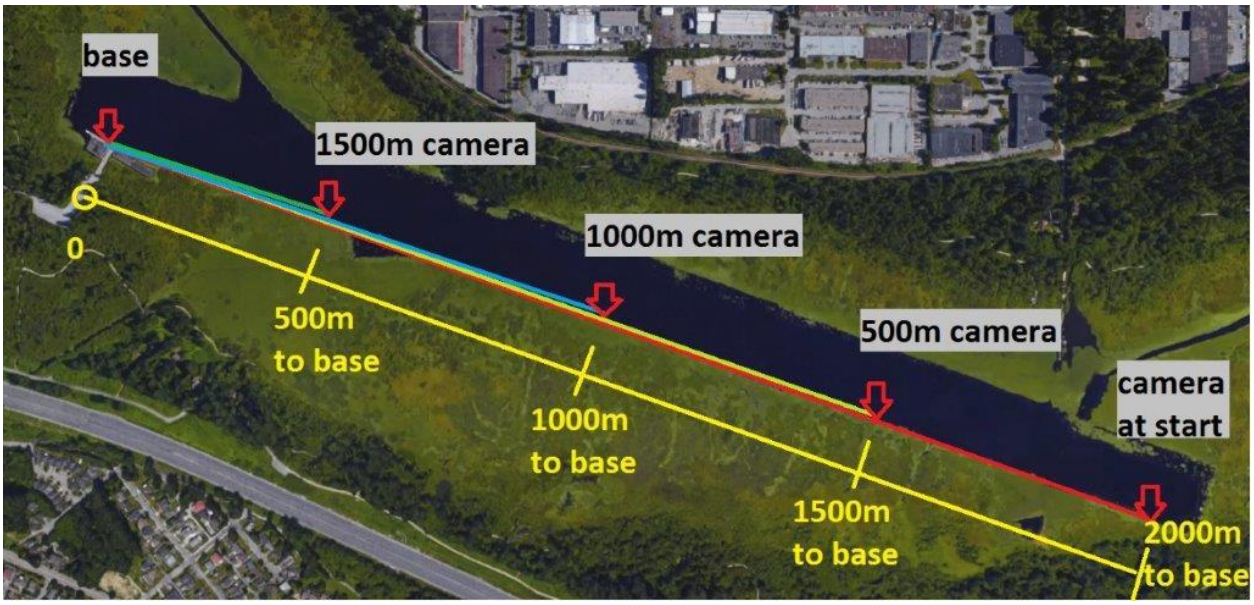
Creation of a wireless video system to improve athlete experience at rowing regattas and simplify the collection of split times using commercially available technology.



Used at the Rowing Canada Aviron National Rowing Championships held at Burnaby Lake, Burnaby BC on November 9, 10 & 11, 2017. Tested at the Canadian University Rowing Championships, held November 3 & 4, 2017 also at Burnaby Lake.

Developed by Simon Litherland of the False Creek Rowing Club, as part of his responsibilities for timing and results for the event as a member of the Local Organizing Committee.

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Purpose:

- Develop a system to reduce the number of volunteers required to stage a sprint rowing regatta with 500 m split timing in August on a lake with water only access to start and 500 metre platforms in November.

Aim:

- to use wireless signal transmission to bring video of the events at the start and 500m, 1000m and 1500m platforms to the finish line with sufficient clarity to provide meaningful images suitable for results gathering.
- Reduce the need to have volunteers stationed on pilings along the 2,000 metre course in November.
- To provide a relay of live stream of events on the course to the athlete area.

What it was not:

- it was not a system to replace the accuracy of the FinishLynx primary race timing system or backup times carried by umpires following the race.
- It was not intended to provide video replay of events at any location.
- It was not a way to display the finish line video to the athlete or coaching audience.

Potential problems:

- If the regatta had had a delay that then triggered shorter intervals between races, the system as used would not have been able to provide the all results needed.
- Finish Lynx operation when everything goes according to plan can be performed by someone with reasonable technical competency. In the event that that doesn't happen (a race restart, missed data capture, change in event order, equipment issue) someone with Finish Lynx knowledge is required.
- The race schedule was set up to use time trials on the first day, then sprint events on the first and second days on 8 minute centres and 7 minute centres on the final day. Having 7 minute centres on the first day would have required dedicated, consistent volunteers the whole day for most roles.
- Using longer straps to attach poles at each station to pilings to allow strapping to be applied in 2 locations per pole to prevent shifting in the wind would have been better.
- Using the 2 GHz Ubiquiti NSM2 transmitters would have encountered too much interference. The NSM5 transmitters provided a better and less conflicted signal.

Actual problems:

- Signal receptions issues were observed (likely due to metal fencing in the finish area) and caused image stutter. This was mostly mitigated by moving the finish line access point on the 2nd day.
- Using a 22" monitor in the finish area during the testing of the system did not provide enough detail for the purpose. It was replaced with a 40" television for the event itself.
- Display of the cameras in the athlete's area was initially done with a projector with insufficient lumens to create a bright image during the test. A generous donor provided a 66" 4K TV monitor

purchased at a large discount due to a flaw in the screen (a single vertical bright line on the image) to use in the athlete's area for the event.

- The distortion of the camera image at the edges does not allow the camera to be pointed too far up the course.
- Competitors who row in a lane other than the one that they started in may get identified incorrectly. Separating volunteer duties in terms of timing and bow order and having several people involved in bow order, and one person collecting that information prior to updating the results system.
- One of the people who was to perform Regatta Master progressions was unable to be onsite. With dedicated internet connectivity they were able to work from an alternate location offsite.
- The Finish Lynx and split timing team had to remain outside (under cover) during the whole regatta. On blustery days, in November. Therapeutic heating electric pads were provided and volunteers wore seasonally appropriate clothing.
- The "open microphone" starts using the official's radios were subject to radio interference. It would have been addressed by having a cell phone at the start with unlimited minutes running in handsfree mode. This was done for time trials, but not sprints. There is a slight lag with cell phones, but the video system also has approximately 0.5 seconds lag so the split timing system would all be running with roughly the same lag time and results would be therefore be as accurate as reasonably possible.
- It was difficult to determine order for the first 500m splits as competitors were still closely bunched at that point. Lots of eyes on the screen helped, and at times, using cell phone cameras to capture the video image and replaying allowed us to get better data.
- The cabling for the solar panel charge controllers was not as secure as I would have hoped. Mounting the charge controllers to a wood panel, then binding the charge controller wiring connections to the panel would have prevented nervous moments.
- The power inverters located on each 500 metre platforms would not turn on when the temperature had been close to 0 degrees C. Holding them for a moment to warm up with body heat worked, but there must be higher quality products out there.
- When the cameras were powered up in the morning, there was fog on the lens. By powering up the cameras in the dark, the infrared lamps in the camera used for lighting up the field of view in the dark warmed the cameras and dispersed the lens fogging.

Potential improvements:

- Install power buttons (wired) at each stations installation to an accessible location at each 500m piling so that the draw on the battery could be disabled nightly rather than removing the battery each night.
- During set up, have the viewing station set up in advance so that a person at the finish area could assist the person installing the camera to direct it properly rather than doing it later.
- Have a much larger monitor at the finish line so that 4 images could be shown simultaneously on the one screen rather than skipping from one image to another.
- Purchasing a system with a 4K network video recorder so that when four cameras are being used simultaneously each image on a 4k monitor is as clear as possible.

- Arrange for a dedicated voice link (such as 2 cell phones in handsfree mode) from the start platform to the finish tent to be open throughout the regatta. The finish line should mute their lines as they are the noisy side of the link except as needed.
- An addition camera mounted on the Start Platform looking at the competitors would have been preferable and could have used the spare camera that came with the system. An additional transmitter would have been required, along with other station devices as described below.
- If racing was to happen with less than 5 minute centres, in order to be able to capture all split times there would need to be either a very large screen display (66”+) in the finish tent, or a separate network video recorder and display for starts and 500 metre cameras. In either scenario, there would also need to be a separate computer for the 500 metre splits.

Basic description of finish tent positions (volunteers and professionals):

- A Finish Lynx (silver version) system was used for primary start and finish timing. When antennas were properly installed (as high as possible and vertically) the system worked flawlessly. This requires 3 individuals:
  - Race start system activation (could be a new volunteer or official).
  - Finish capture. (could be a new volunteer)
  - Results evaluation. (experienced Finish Lynx individual)
- Regatta Master data processing in terms of integrating data from Finish Lynx start & finish timing and Regatta Master split timing. Results where then generated and used for progressions. This required 2 individuals knowledgeable with RegattaMaster:
    - Data integration and results production.
    - Progressions from time trials to reparcharges, heats semi finals and finals from a format defined in advance.
      - This person also did the advance draw (with input from the RCA High Performance Team as to order of start for the first 20 athletes).
      - They also completed the schedule to accommodate specific events in advance: volunteer and officials shift start and stop times, Remembrance Day 11 am minute of silence observance.
- Using a combination of the official’s radios, cell phones and the video system, the Regatta Master start operator captured the start of each race in Regatta Master system (the Regatta Master start timing is used to determine the split times at the 500m, 1000m and 1500m points). This required a dedicated individual who could be trained at the start of their shift. (This person could also have acted as an observer for the split times, but not the finish times as the next race starts were often happening during the finish of the previous race. Finish order is performed by officials in any case).
- Regatta Master split timing was performed by a single dedicated volunteer. Using a computer with multiple displays, and separate windows for the first, second and third 500 metre splits the times were captured from the video system. It worked well having the same volunteer for all shifts of the regatta.
- Regatta Master finish timing was performed by a dedicated volunteer who also controlled the cameras being displayed by the network video recorder onto the TV monitor at the finish. They would take finish times from the horn, or by watching over the heads of the finish line staff

using the Regatta Master dedicated finish line computer. This person also acted as an observer for the split timing.

- A team of three spotters, 1 scribe and 2 observers (see notes above) would watch the split order at each 500 metre location. The scribe would write down the split orders and finish order. The split orders would be provided to the Regatta Master split timing volunteer and the finish order would be provided to the Regatta Master finish timing volunteer and umpire at the finish when they were signing off on results.
- There was a dedicated volunteer operating the finish line horn (sometimes officials performed this function).
- There was a dedicated volunteer for the finish flag.

Basic Description of Start Line Operations

- There was someone pressing the start plunger for Finish Lynx system in addition to the umpire start team with their radios.

Description of the Video System

There were 4 remote stations and a system at the finish.

At each station (start, 500m, 1000m, and 1500m) there was a video camera and wireless signal transmitter powered by a battery with a solar panel backup.

Specific Description of the Start and 500 metre platforms:

- Video camera: Swann 4 MP series camera model NHD-818 labelled with location on the outside so it gets installed in the correct spot. The connections were wrapped in electrical tape to prevent moisture from getting in. The camera was mounted using the screws included in the security camera package onto a wood base and that was mounted on the top of the pole (see below). The cameras on poles were pointed so that they could capture boats approaching their position as well as crossing the 500 m point. The camera has a 75 degree viewing angle and were pointed perhaps 20-25 degrees ahead of the line perpendicular to the course.
    - Camera 1 set to Time Trial Start, then rotated to look at sprint start – camera 1 was not on a pole: it was looking directly out across the time trial start line at the 100 m line. For the sprint starts the camera was redirected at the hinge to point to the start platform.
    - Camera 2 set to 500 M
    - Camera 3 set to 1000 M
    - Camera 4 set to 1500 M
- Transmitter: Ubiquiti Nanostation M model NSM5 with details such as IP address and configuration details labelled on the outside. Mounted on the pole using the shielding kit.
- Shielding kit for transmitters to reduce interference: Nanostation Loco Shield Kit
- Conduit pole to mount camera and transmitter on: Galvanized conduit from Home Depot. (I think this is it – I bought it previously for a different purpose)
- The pole was strapped to pilings at each 500 metre location using straps: MEC (the Canadian equivalent of REI) 3 m straps. If I had used 5 m straps I could have straps the poles with 1 strap in 2 different straps to prevent wind movements.

- The video cameras was connected to the transmitter by: 3’ RJ45 Cat 6 cable from Amazon.ca
- Power for transmitter provided by Power Over Ethernet (POE) using the following cables: 15’ RJ45 Cat 6 cable from Amazon.ca connected to POE injector that comes with the Ubiquiti NSM5.
- Video power adapter: R-Tech 12v 1 A adapter power supply from Amazon.ca
- A power extension cord was required for the camera: 5 m cord from Amazon.ca 5.5 mm long barrel, 2.1 mm tip across.
- The POE injector for the transmitter and the video power adapter plugged into an inverter: Ucerami 350 W DC 12V to 110 AC dual power
- The inverter was connected to the load terminals of the charge controller of: Renogy 50W monocrystalline solar panel starter kit. The inverter came with some cabling. I removed the cigarette plug from some of the wiring included as accessories and tripped one end to connect the charge controller.
- A battery was connected to the battery terminals of the charge controller: 12V 18 Ah scooter (deep cycle) battery. This required some lamp cable and clamps. I should have used the clamps that came with the inverted above (and stripped the ends with the ring connectors) as they had superior clamps than the ones ordered separately.
- The solar panels were also connected to their charge controller.
- Note: Battery chargers were purchased to charge the 12V batteries in the event that there was insufficient solar power being generated. However, the batteries were typically fully charged if disconnected prior to sundown.
- The charge controller, battery, inverter, POE injector, power adapter were placed in a bucket with a waterproof lid. A roughly 1 ¼” hole was drilled in the side, slightly larger than one of the Renogy solar cables to pass through. Bucket from Home Depot, along with a lid. The lid of the bucket was pressed down in 3 spots around the rim to keep it waterproof, but allow it to be opened with cold hands in the morning.

Technology Library

Figure 1 Swann video camera

Figure 2 Ubiquiti NSM5 Transmitter

 *Figure 3 Ubiquiti POE injector*	 *Figure 4 Ucerami power inverter*
 *Figure 5 5m 5m DC Male to Female 5.5x2.1 mm*	 *Figure 6R-Tech 12V 1 A adapter*
 *Figure 7 RJ 45 cables*	 *Figure 8 Renogy Solar Panel Kit*

<table>
<tr>
<td> 

Figure 9 12v 18 Ah battery</td>
<td> 

Figure 10 Bucket.</td>
</tr>
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<td></td>
<td> 

Figure 11 Bucket lid</td>
</tr>
</table>

If you had access to a larger battery and didn't need to use a solar panel to charge the battery your configuration would look like this. Otherwise the inverter would plug into the charge controller as would the solar panels and battery. The charge controller acts as an electricity distribution point.

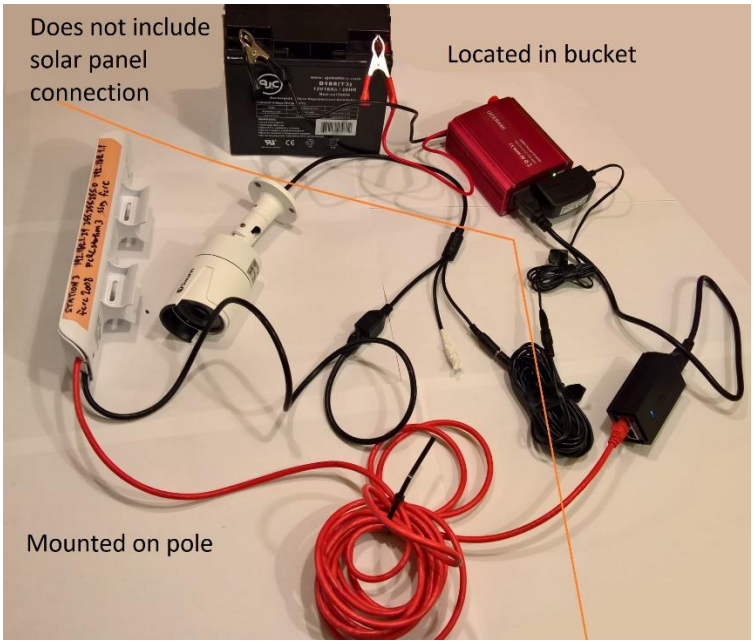


Figure 12 Remote station equipment (not showing solar panel connections)

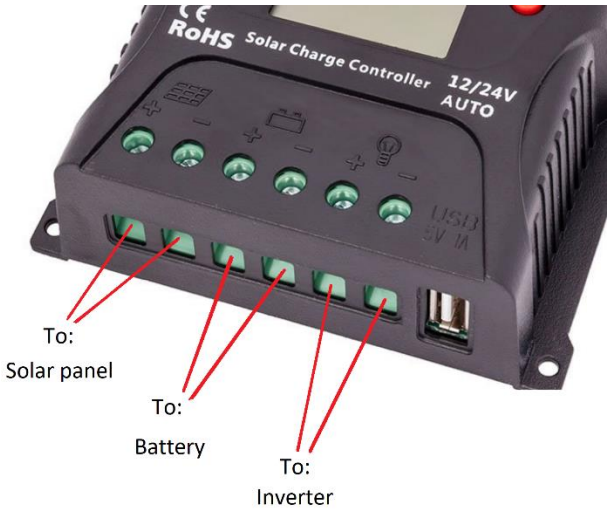


Figure 13 Connecting to Charge Controller instead of Battery

Specific Description of the Finish Tent Technology

- Network Video Recorder (NVR): Swann Security NVR8-7400 8 Channel 4MP Network Video Recorder
- System purchased: Swann 8-channel NVR Surveillance System with 2TB Hard Drive and 6 4MP Bullet Cameras from Costco.ca online.
- NVR Configuration Settings (see manual for details)
    - Update firmware to current release.
    - Configuration of many settings requires all cameras to be connected.
    - Configuration is easier when connected to a 1080P monitor using a VGA cable initially.
    - On the Display menu:
        - Change the camera names so that
            - Camera 1 set to Time Trial Start, then manually rotated to look at sprint start.
            - Camera 2 set to 500 M
            - Camera 3 set to 1000 M
            - Camera 4 set to 1500 M
            - Camera 5 set to Finish
            - Camera 6 could be used for viewing the start from the start tower with more work.
        - Enable Record Date
        - Enable Display Camera Name
        - Under camera parameters enable 60 Hz for North America
        - Copy to all cameras and apply.
    - On the IP Channel Menu (do this after the display menu changes):
        - Assign channels to cameras channel 1 to start, and so on.
        - Disable auto-add.
    - On the Recording Menu:
        - (Encode Menu)

        - Change encoding parameters to “Main Stream”
        - Disable record audio.
        - Change resolution to 1080P (1920 x 1080)
        - Change Frame Rate to 20 frames/second.
        - You might want to change Max bitrate to about 1000 kbps to reduce network traffic if you are having network traffic issues. Each camera generates 6 MB/second with 4 cameras on the wireless network this is 25 MB/s which could cause issues somewhere.
        - Copy to all cameras and apply.
        - (Option Menu)
        - Ensure overwrite is enabled,
        - enable pre-record
        - Change pack duration to 30 minutes.
        - (Schedule Menu)
        - change the recording time to motion (green) and select reasonable recording hours.
    - On the system menu:
        - Change auto-lock time to never.
        - Change the video standard to NTSC if in North America
        - Change the time zone as appropriate.
        - Change the date format to YYYY/MM/DD
        - Change the device name as appropriate.
    - Ensure time is synchronized against the Network Time Protocol server to display correct time.

A 1500 watt Uninterruptable Power Supply (“UPS”) was provided in the finish tent to provide power to finish systems (Finish Lynx, Regatta Master computers, timing and results finish systems) so that in the even that cords were unplugged there would be 30 minutes to resolve the issue prior to system failure.

The UPS serviced 3 power bars (and various extension cords as needed):

Circuit 1 for

- Finish Lynx camera (provided by Rowing Canada Aviron)
- Finish Lynx computer (provided by Rowing Canada Aviron)
- Internet Hub provided by a TELUS providing internet connectivity through wifi and RJ45 ethernet port.
- Network router connecting to Internet Hub hotspot through WAN port and providing 4 ports for local connectivity.
- Network switch providing 8 ports for the same subnet as router connected to port 1.

Circuit 2 for Regatta Master and all other systems.

- Regatta Master start computer.
- Regatta Master finish computer.
- Regatta Master Split Computer
- Secondary monitor connected to Regatta Master Split Computer via VGA cable.

- 4 heating pads to keep volunteers warm: Sunbeam Dry Heating Pad 40 Watts
- 40" television for displaying images from network video recorder.
- Power Over Ethernet injector for finish line Ubiquiti NSM5 transmitter configured as Access Point.
- Power adapter for VGA to ethernet RJ45 Transmitter to support remote viewing of video camera.

Finish Lynx and Regatta Master setup and configuration.

Finish Lynx setup and configuration is not part of this document.

The Finish Lynx computer and the Finish Lynx Camera could have been connected to the timing system router. This would allow the separation of the Finish Lynx Camera (outside) from the Finish Lynx Computer (inside, drinking hot chocolate). For the capture of the finish line using the Finish Lynx camera trigger, that operator could have watched a remote view of a separate camera on the finish line using a separate network video recorder and monitor so that their video requirements did not conflict with the existing split timing process.

Regatta Master PC configuration is not part of this document.

Finish Lynx Computer Setup

3 Regatta Master PC's were used: start, finish and splits.

- Start and Finish line results could not be run on a single computer as starts and finishes could be happening simultaneously with 7 or 8 minute centres, and the operators therefore needed to be performing different tasks.
- Start and Split times could theoretically be operated on a single computer with 2 wide screen monitors, but in the event of catching up after a race delay, starts might be happen on 5 minutes centres. 5 minute centres would allow the split computers to capture the 500, 1000 and 1500 metre splits, but not the Starts and the 1500 metre splits as they would conflict with each other.

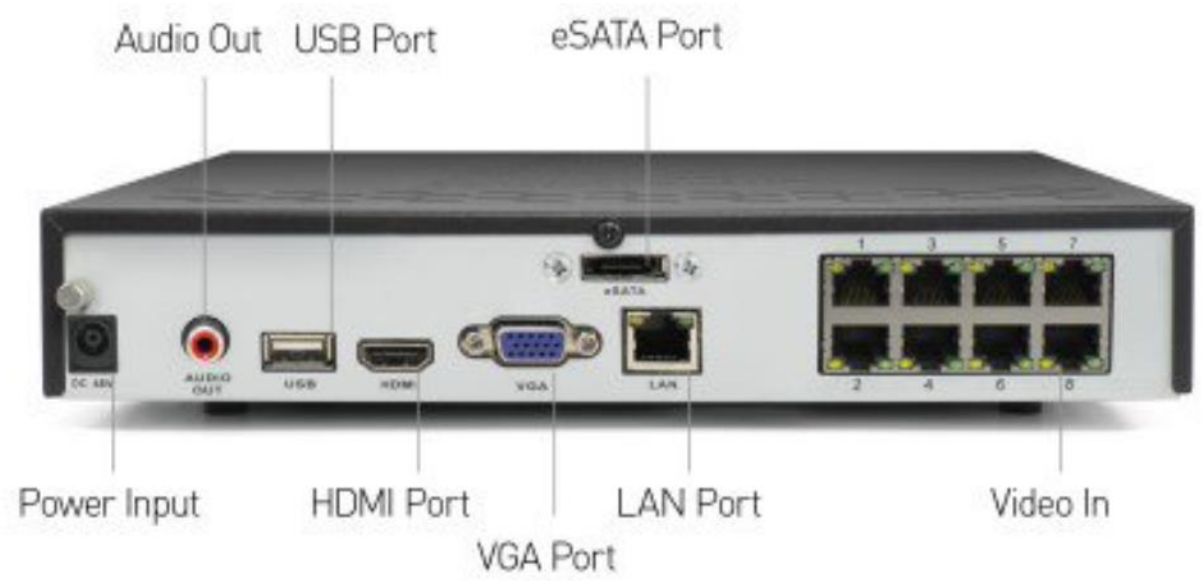


Figure 14 back of the Swann Network Video Recorder

The Network Video Recorder is connected to a number of devices.

- Its power adapter, which needs to be plugged into the NVR before it is plugged into a power bar to the UPS.
- Swann provided Mouse for supporting the NVR.
- HDMI port which was plugged into the 40" Samsung TV monitor in the finish tent.
- The monitor also required a power plug and a 25' HDMI cable to connect it to the NVR so that it could be located 10' from the NVR for easier viewing.
- The VGA port was plugged into the sending unit of a VGA UTP extender from Monoprice using a male to male VGA cable that I had available to me. This would be similar. The VGA UTP extender sending unit required a power plug for its adapter.
    - This was connected to a 500' run of Cat 5e waterproof outdoor cable from Amazon.ca.
    - The ends of the cable required RJ45 ethernet connections which involved boots, ethernet connectors, and a crimping tool, all from Amazon.ca.
    - The far end of the cable connected to the VGA UTP receiving unit. The connection during the test involved a multimedia projector with a VGA interface. That needed a second male to male VGA cable to connect.
    - The VGA UTP receiving unit required power from a power adapter.
    - During the regatta, the large 66" monitor only had an HDMI connection so a VGA to HDMI connector from Amazon.ca was attached. It took its power from the monitor's USB port.
    - The 66" monitor was provided by another volunteer for audience viewing. It required a power plug.
- The LAN port was plugged into the router to provide ethernet IP network connectivity. More on this below. Asus RT-N12 from Amazon.ca.

- The Swann finish line camera was attached to the finish line structure in line with the actual finish line and connected with the ethernet cable included with the Swann system purchased from Costco. That ethernet cable plugs into the NVR in ports on the right side of the back of the NVR that supply POE to connected devices.
- To connect your smart phone to the NVR, please see the Swann manual.

Network Connectivity at the Finish.

The Asus RT-N12 router used for networking and internet connectivity was configured for a non-typical subnet. This allows it to be used with a typical subnet found in many homes and small offices. The usual network definition would be a subnet of 192.168.1.1 with a subnet of 255.255.255.0 allowing for IP addresses to be assigned via the router's DHCP service from 192.168.1.1 to 192.168.1.255.

- The subnet of the router was amended to 192.168.2.1 retaining the subnet of 255.255.255.0 thereby allowing addresses to be assigned from 192.168.2.1 to 192.168.2.255.
- Dynamic IP address allocation was amended to only provide dynamic IP address allocation from 192.168.2.40 to 192.168.2.255.
- This allows the router to be connected via its WAN port to an existing subnet without generating conflicting or duplicated IP addresses.
- This change in subnetting will create specific addressing needs for the Ubiquiti Nanostation M5 transmitters.
- Computers and the Swann camera system will function just as well on the 192.168.2.1 subnet as the 192.168.2.1 subnet.

The Ubiquiti Nanostation M5 devices required configuration to connect properly. See a later section in this document. Generic manuals are available here:

https://dl.ubnt.com/guides/NanoStation_M/NanoStation_M_Loco_M_QSG.pdf

Configuration Guide:
https://dl.ubnt.com/guides/airOS/airOS_UG.pdf

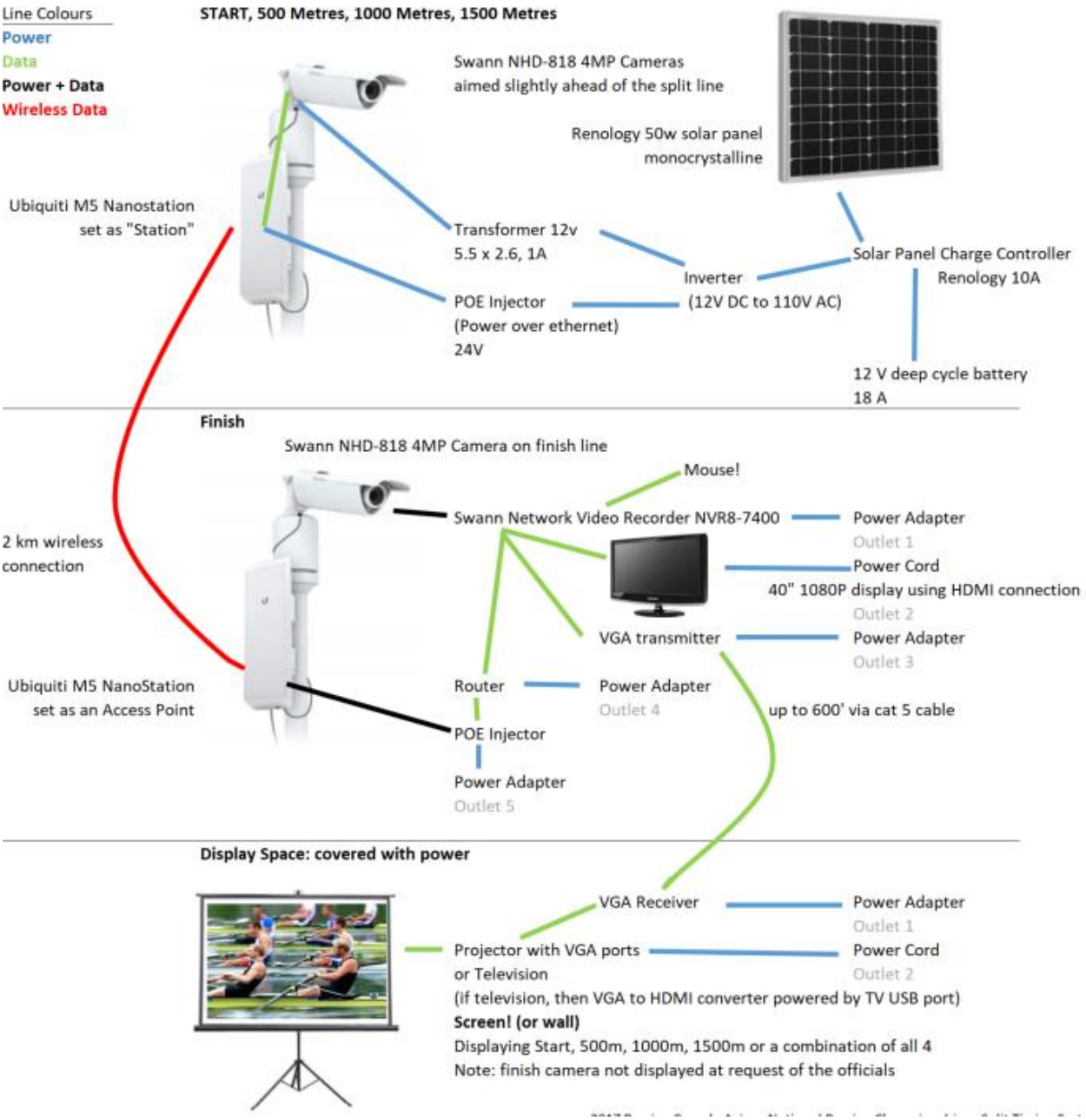


Figure 15 Overall view of video system components and connections.

Figure 16 camera showing label

Figure 17 Cat 6 cable providing power to Ubiquiti transmitter with POE port

Figure 18 cheap connectors not maintaining their connection (damn them). The wires were clamped in place on the battery terminals with the clamps if the clamp fell off the end of the wire.

Figure 19 bucket of gear with top pressed down in 3 locations for ease of access

Figure 20 fully connected solar panel charge controller

Figure 21 solar panel (inverted) connections

Figure 22 stuff to go into station buckets

Figure 23 video camera and Ubiquiti transmitter to be connected to pole

Figure 24 inside of bucket with gear at each station. The silver sheet was for mounting as a shield over the cameras to keep rain drops off the lenses.

Additional Notes – Unused Technology

Apparently, Ubiquiti NSM5 transmitters will operate on 12 volts rather than the 24 volt that their POE injectors provide. To inject 12 volt into POE, the cheapest solution is to create a stable 12 volt source (batteries fluctuate) and then inject that into the Ubiquiti port.

Potentially the load output on the solar charge controllers might provide 12v current, but they might also fluctuate. The load balancer will balance out the load.

- Mean Well SD-15A-12 15W 1.25A 12V single output DC-DC power supply

The RJ45 jacks will allow you to wire the transmitter to the load balancer.

- Tycon Systems POE-PowerTap POE to wire terminal adapters from Amazon.com

If ordering Amazon.com products from Canada, please note that UPS charges a stupid amount of customs brokerage fees.

Configuring the network:

Network Video Recorder

The network video recording is assigned a dynamic IP address through the router's DHCP function.

Network Router

Configuring the router on a different subnet to your home router (assuming you will be testing it there) allows you to connect the WAN port on the camera system's router to a device port on your home router with causing IP address problems.

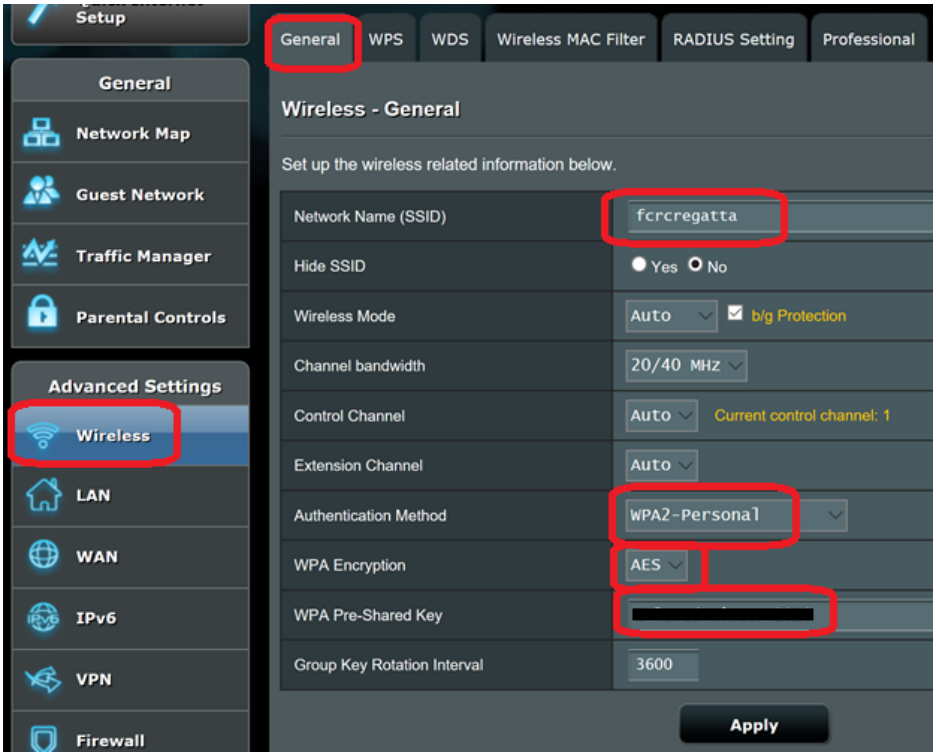
The (video system) system router was configured on the 192.168.2.1 subnet meaning that all IP addresses will be generated from 192.168.2.1 to 192.168.2.255. The static or fixed IP address range was configured to end at 192.168.2.40 so that network infrastructure devices such as the router, transmitters and potentially printers were using the addresses 192.168.2.1 through 192.168.2.39 and computer, cameras, and so on were using addresses from 192.168.2.40 to 192.168.2.255.

Each router is different. I am using a Asus RT-N12D1 router, mostly because it's cheap and don't use the 5 GHz band which might conflict with the wireless network.

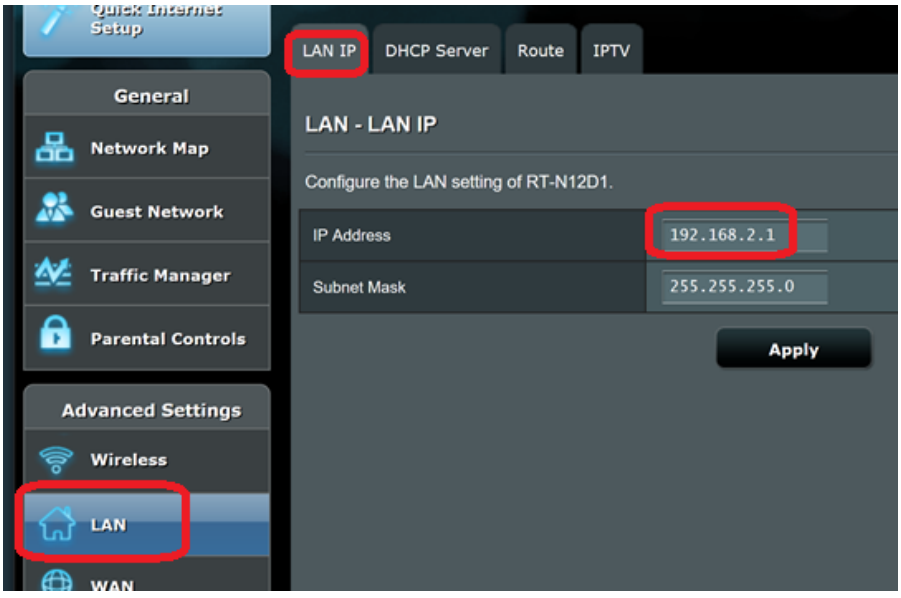
The router is configured according to the manual as follows:

SSID:	**fcrc regatta**
Password:	**[not shown]**
Router Administrator ID:	**admin**
Router Administrator Password:	**[not shown] (must be changed when setup)**

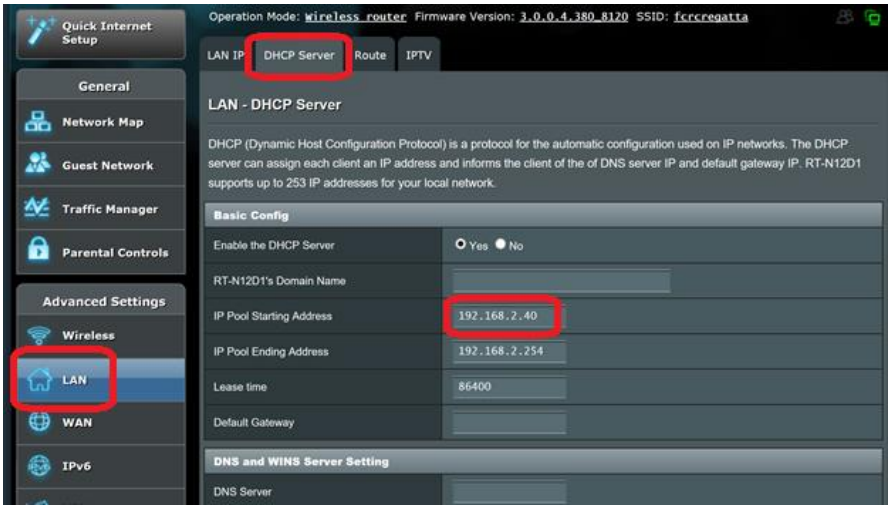
Change the router settings, and write down any settings changed. Change the *SSID network name*: I used **fcrcregatta**. Use **WPA2-Personal** *Authentication method*, **AES** *WPA encryption*, and create a lengthy *WPA pre-shared key.* Ideally write it down before you enter it.



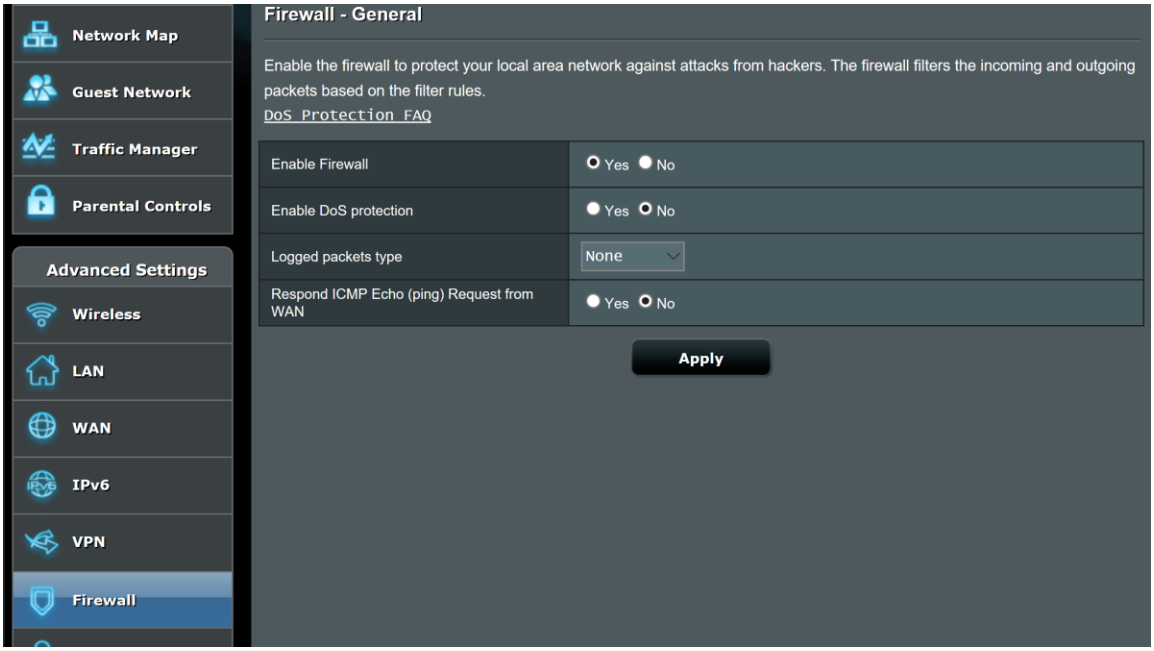
On the **LAN settings/LAN IP** page, this is where I changed the *subnet* from 192.168.1.1 to **192.168.2.1**, so that all devices connected to the router are on a different subnet than my home network to avoid conflicts.



On the **LAN Settings/DHCP Server** page, I amended the *IP Pool Starting Address* to **192.168.2.40** so that no device would be assigned addresses between 192.168.2.1 and 192.168.2.39. I used those static addresses for specific network infrastructure devices such as the wireless transmitters.



I can't remember if there were any change here. I don't think so but make sure the firewall function is enabled.



Ubiquiti NSM5 Wifi Transmitters

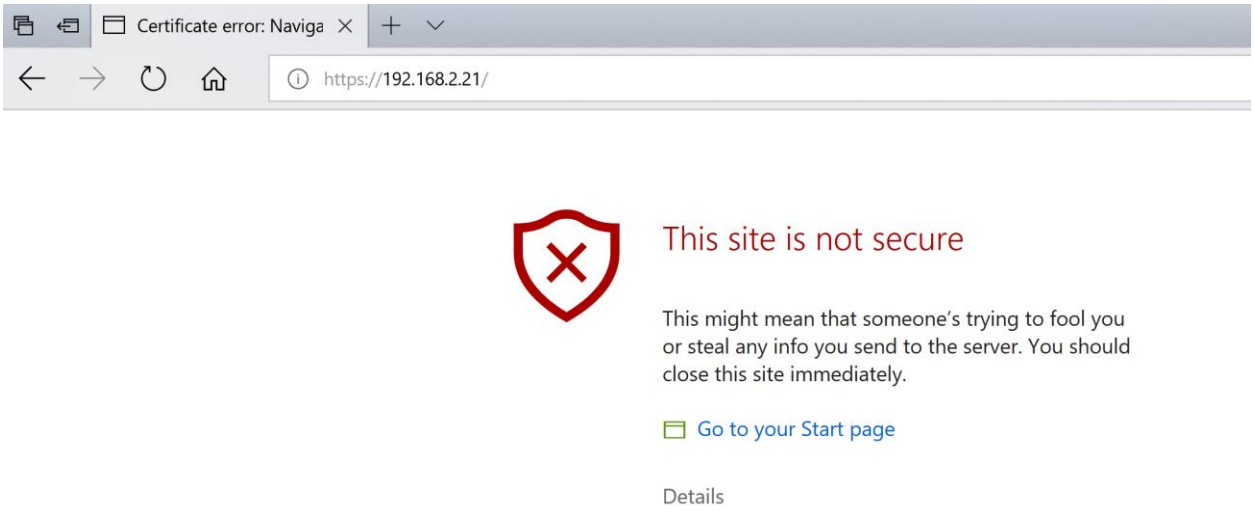
The primary transmitters which connects the remote "**stations"** to the router was configured as an "**access point"**. The remote **stations** were set up to only be able to communicate with the **access point**.

Access Point. Refer to the documentation for the default IP address of the device. Only 1 transmitter can be set up at a time, as they all have the same IP address by default.

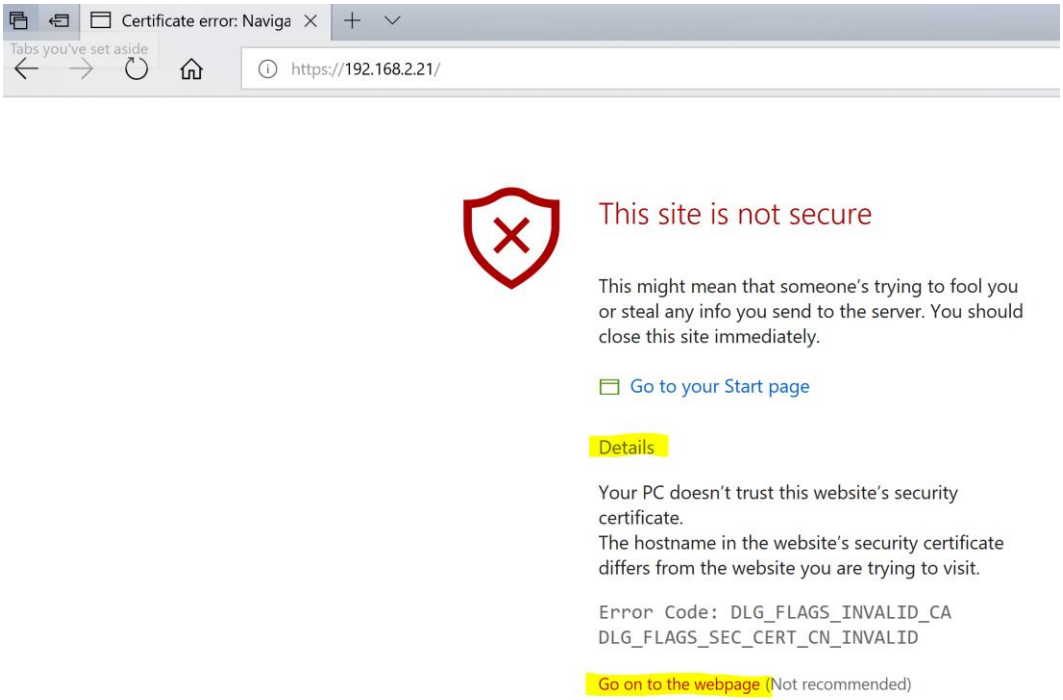
https://dl.ubnt.com/guides/NanoStation_M/NanoStation_M_Loco_M_QSG.pdf

Connect the UBNT NSM5 to your home router on the 192.168.1.1 network through the included POE injector. The default IP address is https://192.168.1.20 . Your browser will indicate that the site is not secure. Go to "details" within the browser window. *Note the picture below shows 192.168.2.21 as it reflects the current functional configuration, not the default one.*

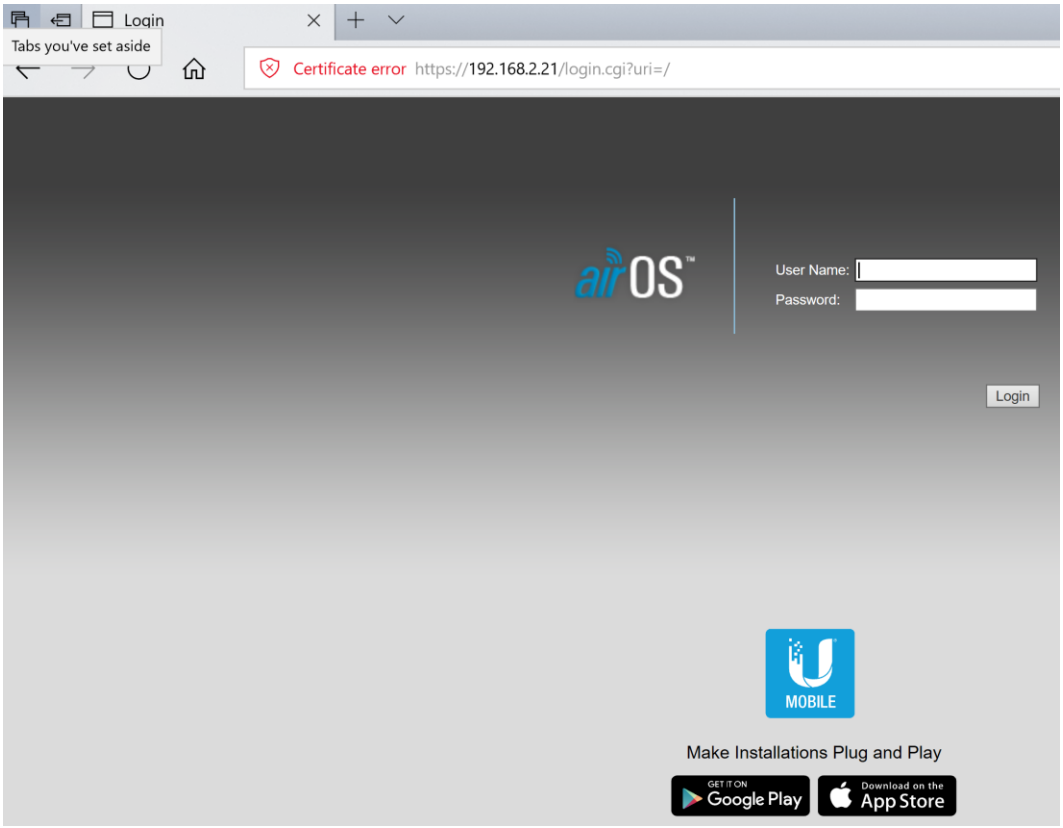
Access Point configuration



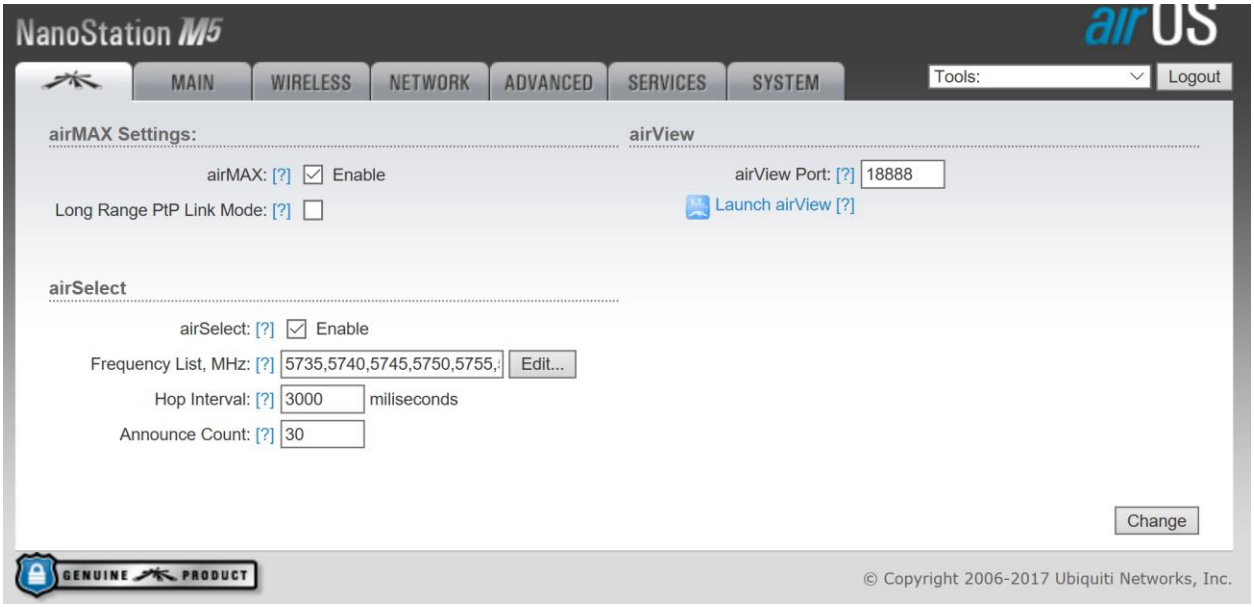
Go on to the webpage



By default, the username and the password are both "**ubnt**".



Make sure **airMAX** and **airSelect** is enabled on the first tab.



The **Main** tab shows you current status. There is only 1 camera functioning in the throughput graph.

Wireless tab:

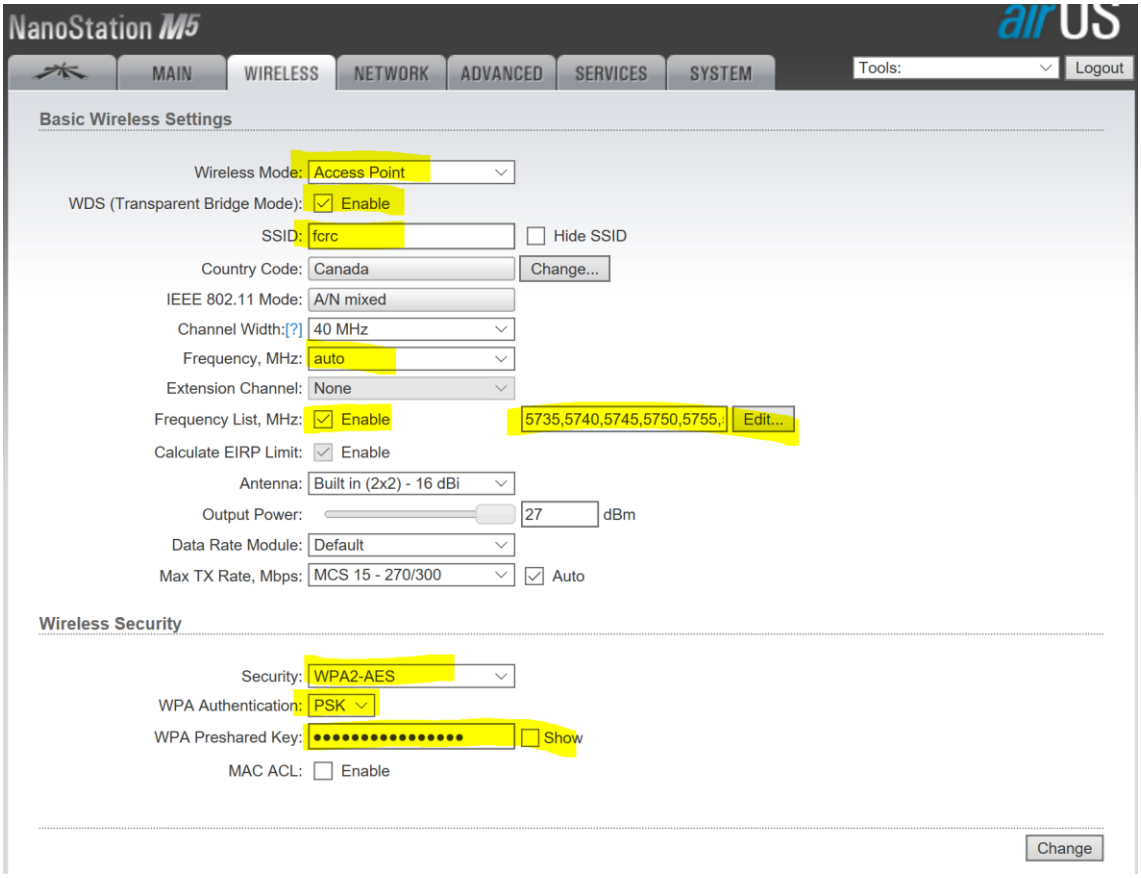
The communication between the NSM5 devices required an SSID. Make it different from any other SSID in use and in range. Directly below are the configuration details used in my setup.

SSID: **fcrc**
Password: **[not shown]** *can include spaces, upper and lower case*

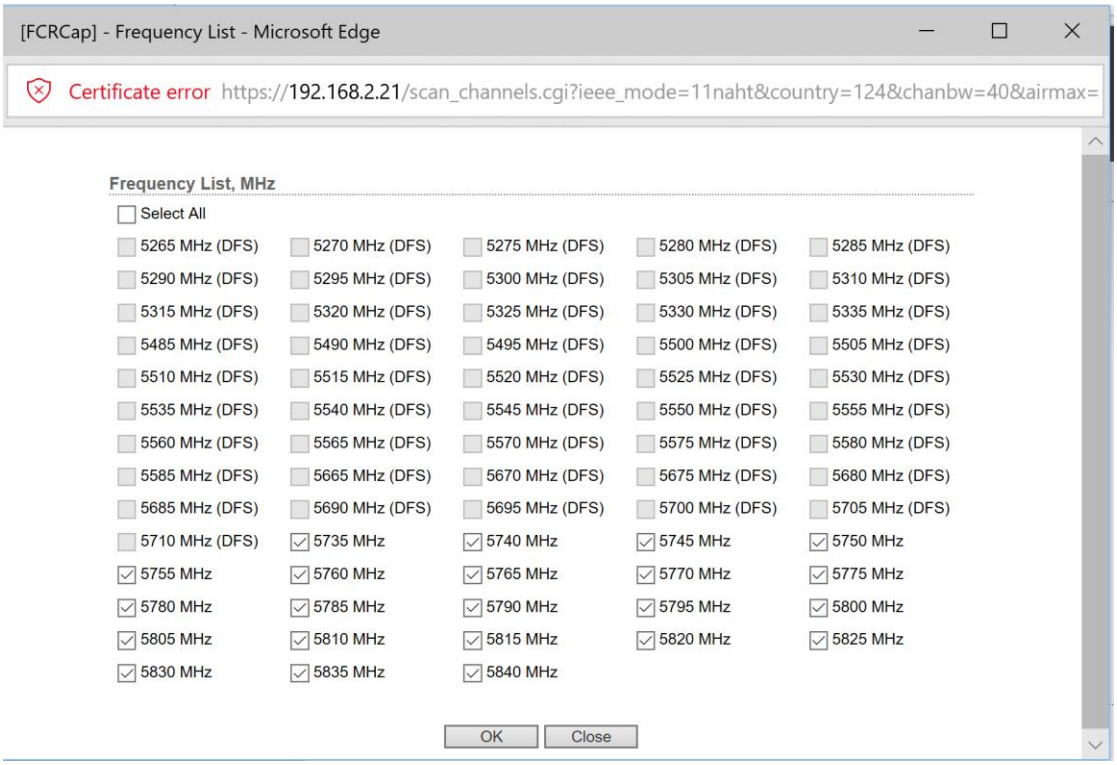
IP address:	Name:	Location:
192.168.2.21	FCRCap	finish
192.168.2.22	station1	start
192.168.2.23	station2	500m
192.168.2.24	station3	1000m
192.168.2.25	station4	1500m

Device username: **fcrc2008** *identical for all devices*
Device password: **[not shown]** *identical for all devices*

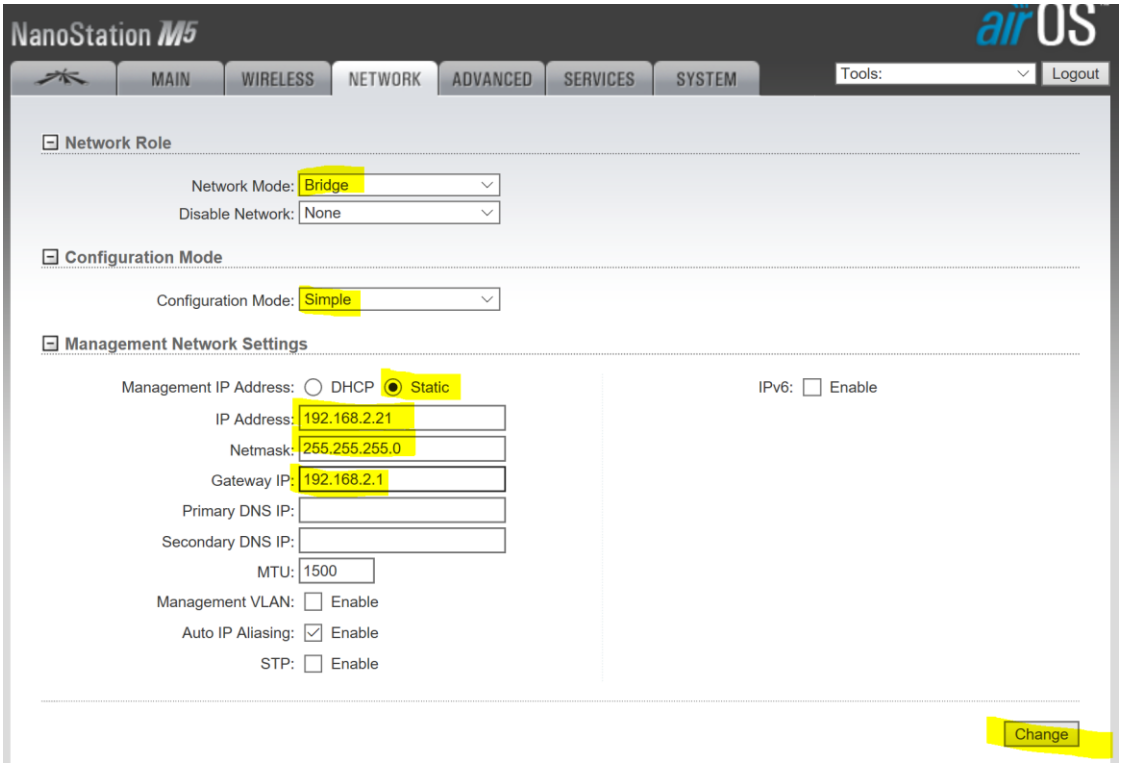
If you have to change any values, you must choose **change** first, then **apply**.



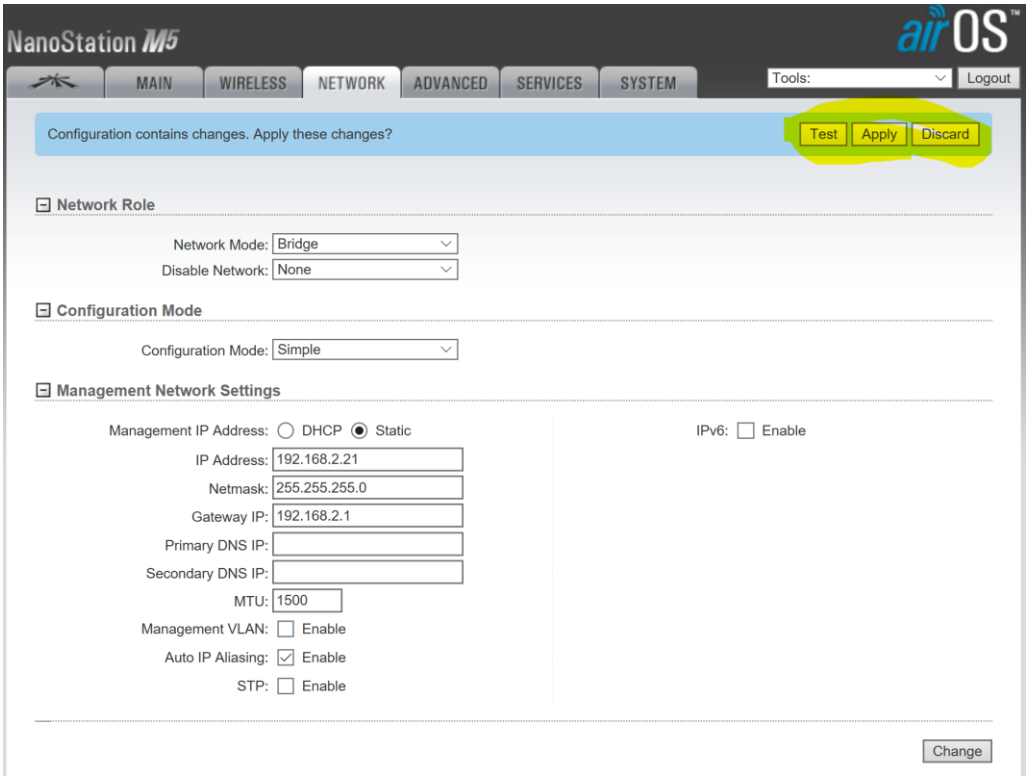
For the Frequency List, use the drop down list to the right and "select all" available frequencies. The devices will automatically hunt for the best channel through magic. Or software engineering.



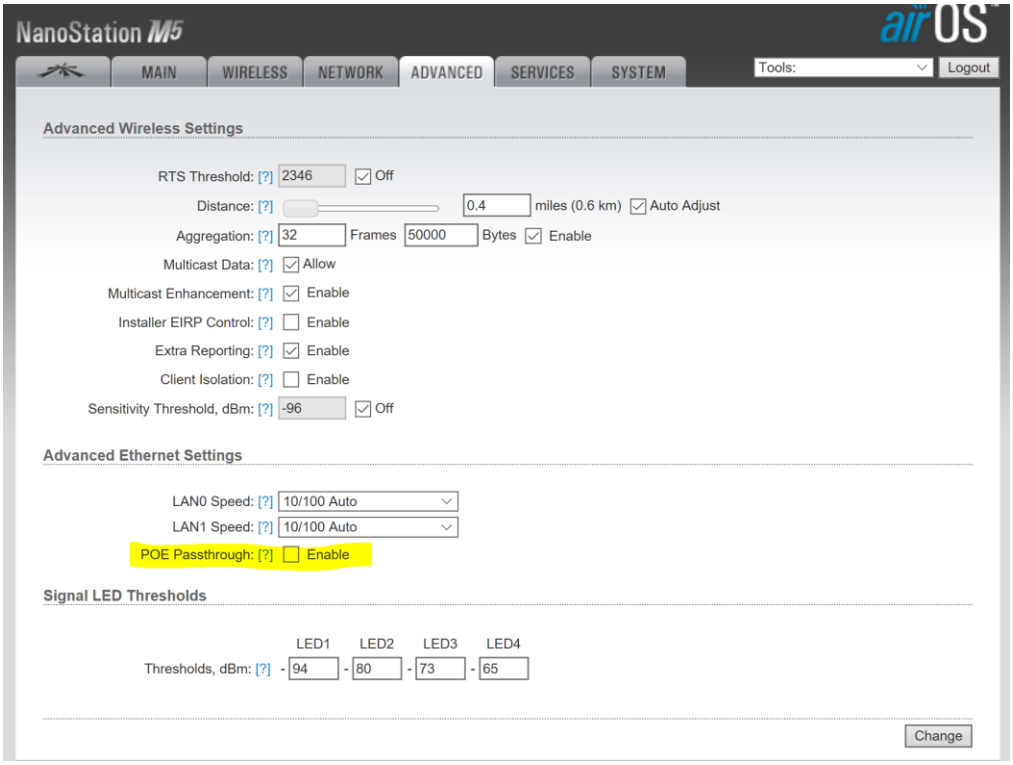
Moving to the Network tab, choose Bridge mode, Simple configuration, and choose your poinon in terms of IP address management. DHCP is no doubt simpler if it goes well, but might be a monster if it goes badly. If using static addresses, enter them here. Note that the gateway must be aligned with the devices' IP address.



If you did make any changes, choose **change**, then **apply**.

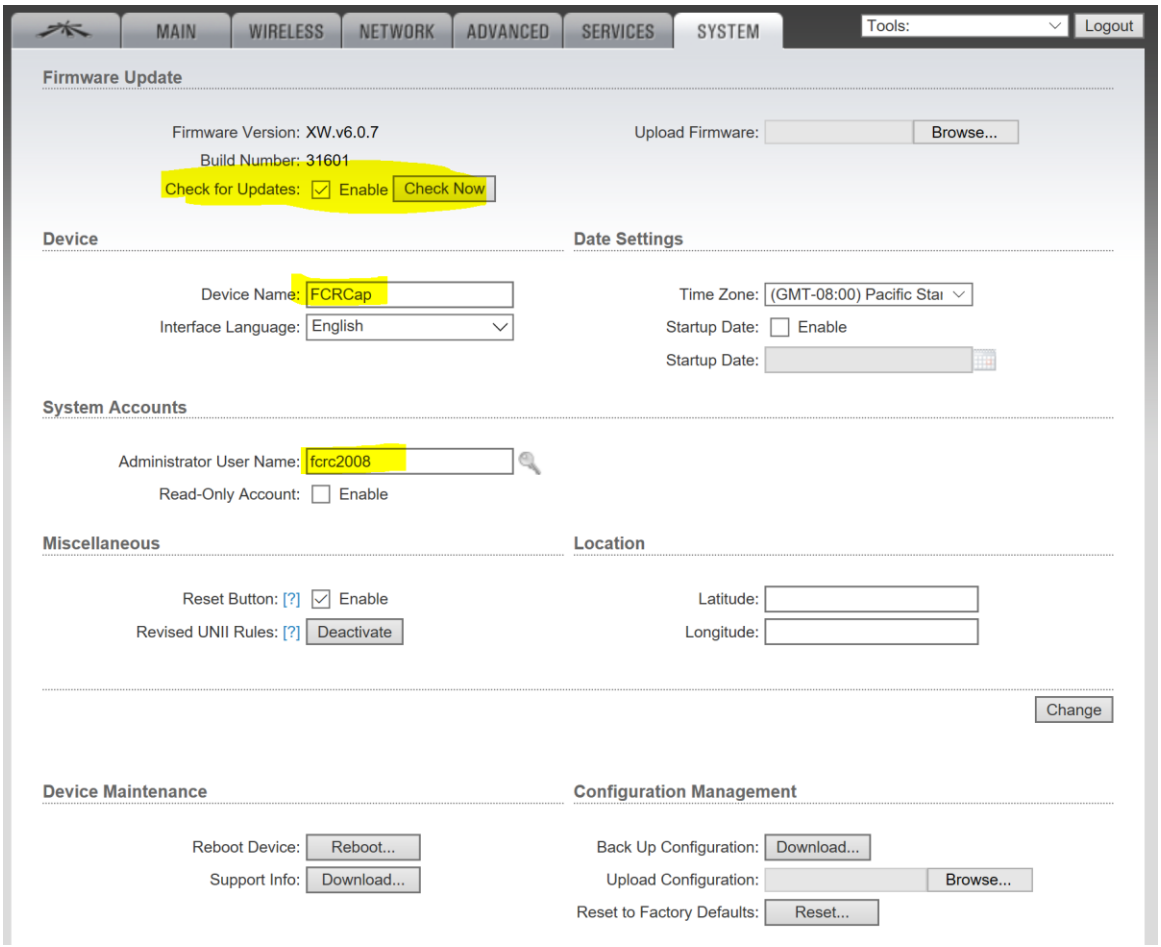


On the **advanced** tab, I disabled the POE passthrough as the camera is working on 12 volts and the UBNT transmitter at 24 watt.



Under the system tab, ensure that you check for updates. When they were new in box, they needed an update.

Given them **device names**, ensure the **time zone** is correct. Create a standardized user name for all the devices. Mine were all the same, but you might choose differently. I guess you could enter the latitude and longitude if the devices on your network needed it. Change the **Administrator User Name** if you haven't already. Write is down somewhere safe for future generations. **Save, Apply** and away you go.



Station Configuration

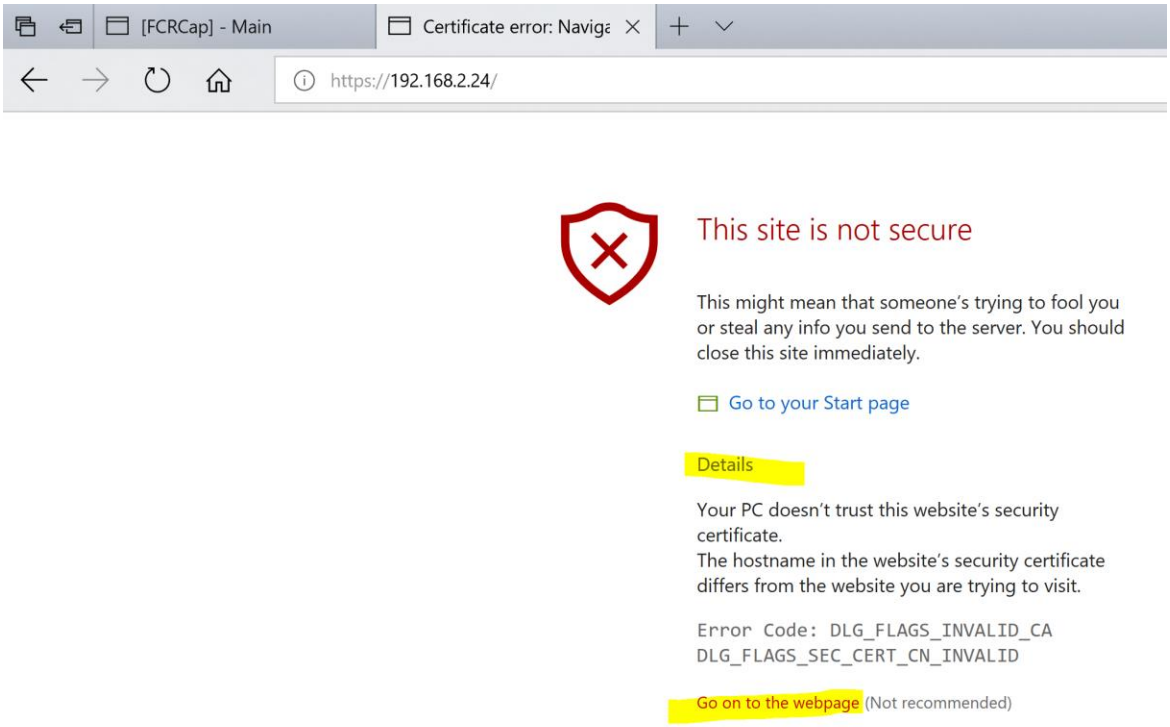
https://192.168.2.24/

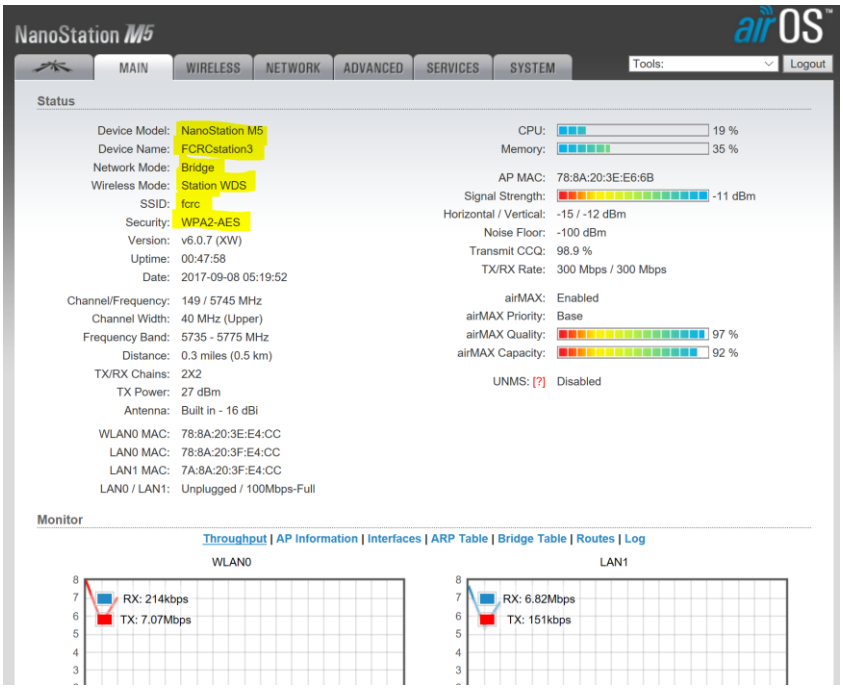
The station pictured in the examples was already configured as **192.168.2.24**, or FCRCstation3 for use at the 1000M station.

SSID: **fcrc**
Password: **[not shown]** *can include spaces, upper and lower case*

IP address:	Name:	Location:
192.168.2.21	FCRCap	finish
192.168.2.22	FCRCstation1	start
192.168.2.23	FCRCstation2	500m
192.168.2.24	FCRCstation3	1000m
192.168.2.25	FCRCstation4	1500m

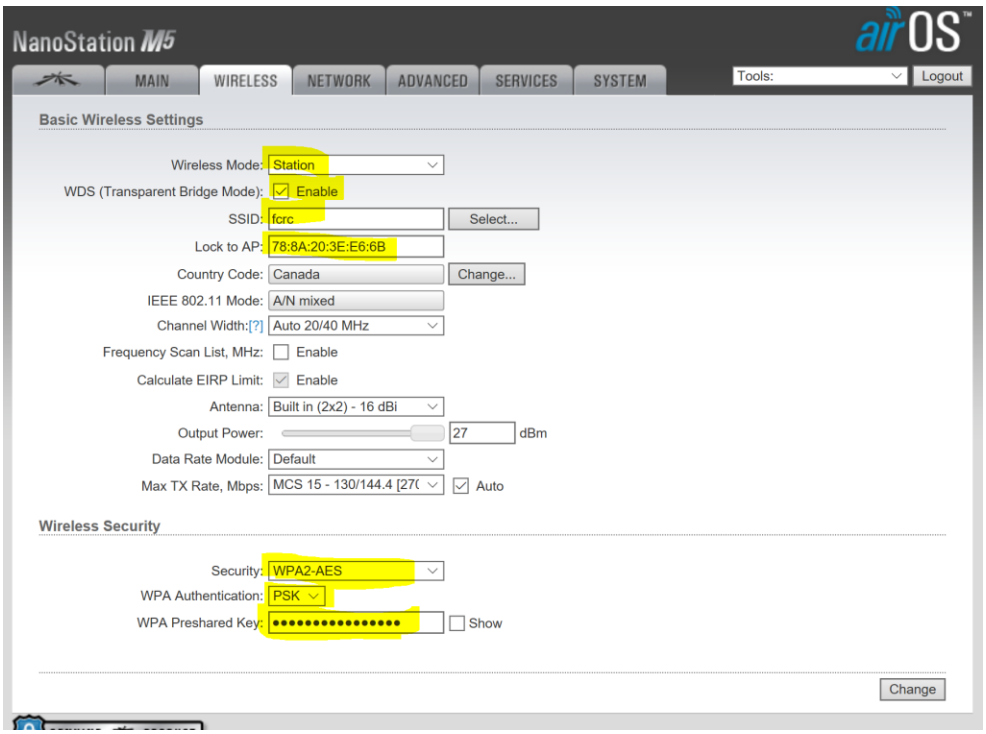
Device username: **fcrc2008** *identical for all devices*
Device password: **[not shown]** *identical for all devices*



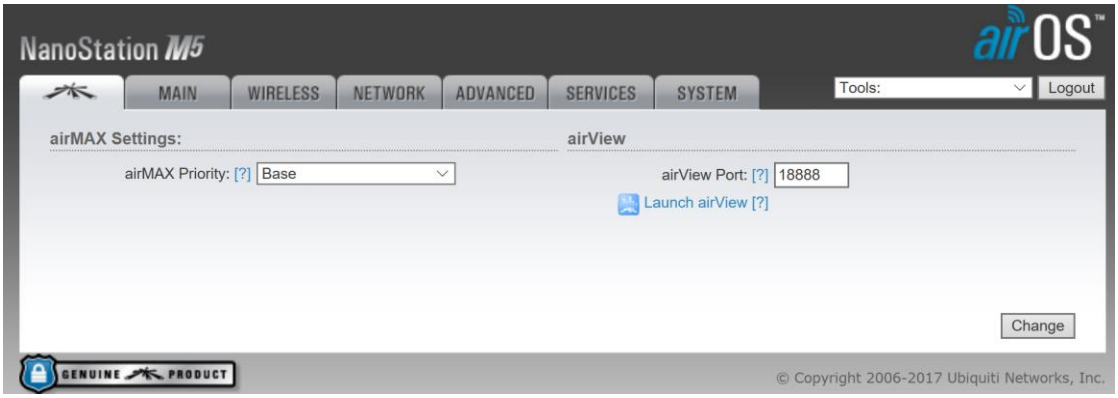


Start with the *Wireless* tab first and assign wireless mode as **Station**. Enter the SSID information at the top and bottom so it matches the previous configuration of the Access Point.

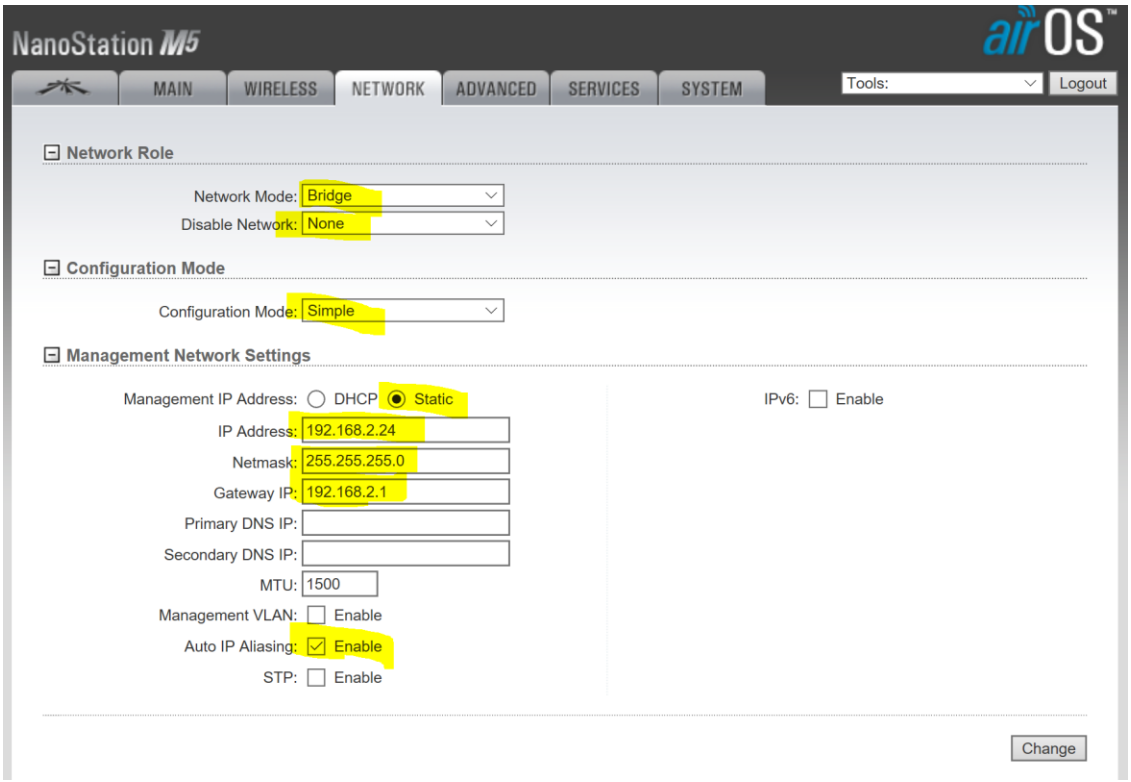
Use the **Lock to AP** function to associate this device with the Access Point you just set up. That AP has to on and active. Enable **WDS (Transparent Bridge Mode)**. There is no *Frequency Scan List* when configured as a *Station*.



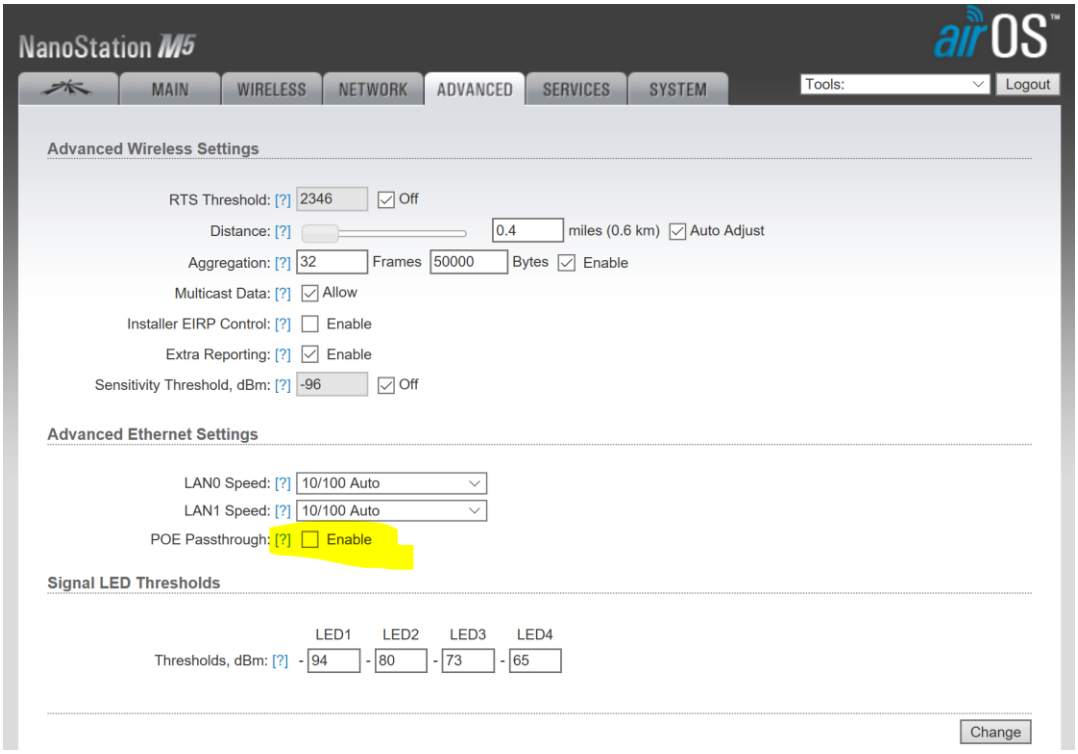
Back on the *first tab*, ensure that the *airMax priority* is set to **Base**. If one station is set higher than the others, the signal may be impaired.



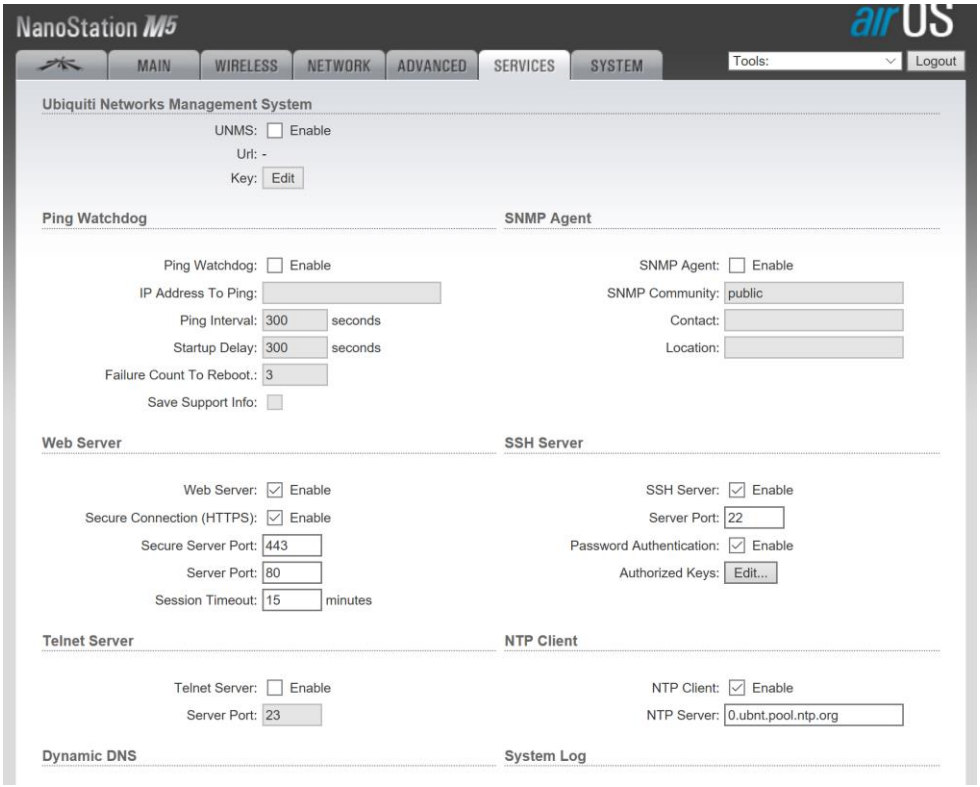
On the **Network** tab, choose **Bridge** *mode*, **none** for *Disable Network*, **Simple** for *configuration*, enter the Static Addresses/Netmask/Gateway IP if that's what you are using. **Enable** *Auto IP Aliasing*. I don't know what it is, but it sounds neat. **Change** and **Apply** as needed.



In the *Advanced tab*, **Disable** *POE Passthrough*. (unless you are using 24volt cameras powered by POE).



I can't remember if I had to **enable** the *NTP client* to automatically set the time on the device.



In the System tab, do the same thing you did for the AP: set the *administrator user name* and *password* (the same as the others for simplicity), and **check for updates**.