

# Multipurpose Remote Nodes

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## Abstract

In [Whatcom County, Washington](#)<sup>3</sup>, in the far Northwest corner of the continental US, a group of Amateur Radio operators that are enthusiastic about data communications have created a number of Multipurpose Remote Nodes (MRNs) in key locations within the county for Amateur Radio data communications nodes that can be reconfigured as needed by remote control via Internet.

Most Amateur Radio Operators are familiar with single purpose data communications nodes such as [APRS digipeaters](#)<sup>4</sup> / [IGates](#), or [Winlink Radio Mail Servers \(RMS\)](#)<sup>5</sup>, or [fldigi](#)<sup>6</sup> ([fsq relay nodes](#)<sup>7</sup>). Typically, such nodes are placed in “practical” locations. For example, APRS digipeaters are typically placed on high locations such as mountaintops or towers. APRS IGates are placed in locations that have reliable Internet access. Winlink RMS stations are usually at an individual’s home where a Winlink RMS station will have Internet access.

A Multipurpose Remote Node (MRN) effectively combines all of the above. Because MRNs are multipurpose, and fully remotely configurable (via Internet), they can be placed opportunistically at locations that offer good coverage of a specific area, Internet access, and provide services in a specific area. When the need arises, such as a Winlink RMS is needed in a communications emergency, an MRN can be reconfigured remotely to provide a new service

The MRNs in Whatcom County can also be remotely reconfigured to different frequencies either in the 2-meter band (144-148 MHz) or the 70-centimeter (440-450 MHz) band.

## Brief History of Development

The beginning of the Multipurpose Remote Nodes project in Whatcom County was to build a fill-in APRS digipeater / IGate to be co-located with a UHF repeater at a [fire station located on a high ridge in Ferndale, WA](#)<sup>8</sup>. KF7VOL was an active user of APRS

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<sup>3</sup> <https://www.whatcomcounty.us>

<sup>4</sup> <http://www.aprs.net.au/vhf/aprs-digipeaters-101/>

<sup>5</sup> <https://www.winlink.org/RMSChannels>

<sup>6</sup> <http://www.w1hkj.com>

<sup>7</sup> [http://www.w1hkj.com/FldigiHelp-3.22/fsq\\_page.html](http://www.w1hkj.com/FldigiHelp-3.22/fsq_page.html)

<sup>8</sup> <https://aprs.fi/#!call=a%2FCHURCH&timerange=3600&tail=3600>

and had noticed that Ferndale was not covered very well by existing APRS digipeaters in Whatcom County. In planning for an APRS digipeater / IGate at the fire station, physical access would have to be arranged in advance, so the “Ferndale digi” had to be designed for remote access via Internet rather than physical access. The co-located UHF repeater already had Internet access, so that was a good fit for a co-located APRS IGate.

Around the same time that KF7VOL got the Ferndale digi online, two other Whatcom County Amateur Radio Operators - Budd Churchward WB7FHC and Steve Magnuson AG7GN were working together to develop hardware and software for what is now the [Nexus DR-X “Digital Radio Cross-patch”](#)<sup>9</sup>. The Nexus DR-X is a multipurpose data communications unit that is based on a Raspberry Pi, a sound card for the Raspberry Pi, and a [closely matched and well maintained “image” of Raspberry Pi operating system and applications, specifically built and tested for the Nexus DR-X](#)<sup>10</sup>. WB7FHC and AG7GN were aided in the development of the Nexus DR-X by an enthusiastic group of testers and users that were members of the [Mount Baker Amateur Radio Club](#)'s<sup>11</sup> [Digital Group](#)<sup>12</sup> (MBARC DG) in Whatcom County.

KF7VOL realized that the Nexus DR-X solved two key issues he had identified in his planning for other low-level data communications nodes that he hoped to deploy at other host facilities in Whatcom County. Using the Nexus DR-X made possible:

- To have remote access to, and management of the system on a par with physical access. The Raspberry Pi is a fully functional Linux computer, which included a robust remote access system called VNC (Virtual Network Computing), that included full remote access to the Raspberry Pi desktop environment, making it possible to (fully remotely) change software applications as needed, as well as perform nearly any function on the Raspberry Pi just as if you were working at a keyboard, mouse, and display that were connected directly to the Raspberry Pi
- Use stable, mature, well-tested applications for an APRS digipeater / IGate, a Winlink RMS, and the fldigi suite of applications, including fsq. Changing the function of the node was a simply a matter of loading different software (remotely).

An additional capability in the Nexus DR-X was an application called flrig which can remotely control the settings of certain radios such as the Kenwood TM-V71A. flrig enabled remote control of the radio's frequency (including changing bands between 144-148 MHz and 440-450 MHz) and other operating parameters.

With the Nexus DR-X, a remote node could be built with standardized components to provide three (or more) different services - APRS digipeater / IGate, Winlink RMS, or as

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<sup>9</sup> <http://wb7fhc.com/nexus-dr-x.html>

<sup>10</sup> <https://github.com/AG7GN/images>

<sup>11</sup> <http://www.mbarc.org>

<sup>12</sup> <http://www.mbarc.org/digital-group>

a relay node for fsq simplex text chat (which is widely used in Whatcom County). KF7VOL's "fill-in digipeater" had evolved into a Multipurpose Remote Node.

### Unobtrusive Electronic Cabinets in Unobtrusive Locations



Photo courtesy of Andy Sayler KF7VOL (The Ethernet switch is not part of the MRN.)



Photo courtesy of Andy Sayler KF7VOL

To "fit in, unobtrusively" at additional host facilities in Whatcom County, KF7VOL decided to build the MRNs in a "6U" cabinet that could be mounted on a wall in an unobtrusive area such as a utility closet or other "out of the way" area.

The key "selling points" of the MRNs were:

- No floor space or desk space or “conditioned space” was required from the host facility, only some wall space in an out of the way area.
- Because the MRNs could be operated fully remotely, physical access to the MRN is rarely required.
- When reaching out to potential new host facilities, KF7VOL leveraged his membership in [Whatcom Emergency Communications Group \(WECG\)](https://wecg.org)<sup>13</sup> which is well-regarded in Whatcom County.
- In approaching additional host facilities, KF7VOL used a soft-sell, take-it-slow, answer-any-questions approach was used. It helped greatly that the original MRN in Ferndale was operational and had proven out the reliability of the system.



Photo courtesy of Andy Saylor KF7VOL

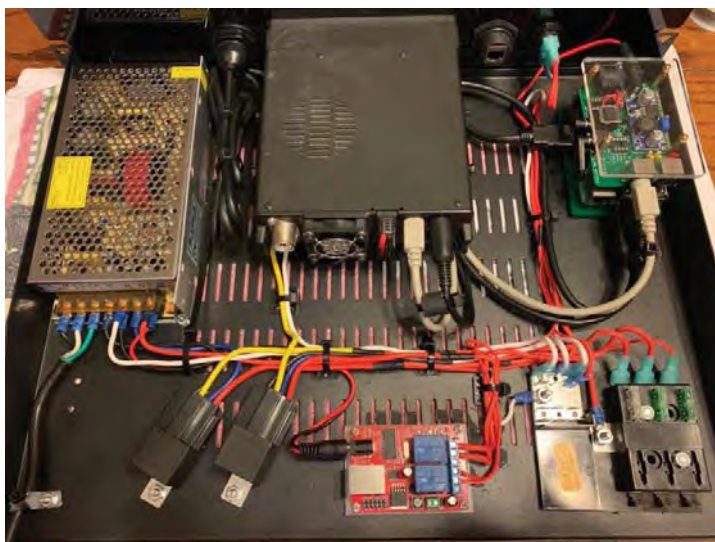


Photo courtesy of Andy Saylor KF7VOL

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<sup>13</sup> <https://wecg.org>

## Components of a Multipurpose Remote Node

A typical MRN consists of the following hardware:

- Dual band omnidirectional antenna plus feed line to the MRN rack
- 11-inch (6U) wall-mount cabinet with a shelf and a plexiglas front cover with a key lock
- Power supply - 12 volts @ 20 amps (typical) - silver unit on left side
- Uninterruptible power supply (AC in, AC out) - bottom of cabinet
- Nexus DR-X Digital Cross-patch unit - upper right corner
- Kenwood TM-V71A 144-148 / 440-450 MHz radio - top, middle
- Internet controllable remote power switch, capable of switching on / off two electrical circuits. This unit allows for a “power off reset” in case the radio or Raspberry Pi locks up and cannot be remotely managed. Bottom, middle
- Fuse / distribution block (12-volt circuits) - lower right corner
- Non-managed Ethernet switch - bottom of cabinet
- “Data” cable (6-pin MiniDIN) between the Nexus DR-X and the radio - beige cable
- “Programming” cable between the Nexus DR-X and the radio - black cable

External connections required for an MRN:

- Coaxial cable to 144-148 / 440-450 MHz dual band omnidirectional antenna (typical),
- 120 VAC power,
- Ethernet / “external” Internet access with at least one static IPv4 IP address
- Provisions are made for the possibility that physical, local access / operation of the MRN might be required by including the microphone for the radio within the cabinet (though it’s not normally connected) and a front panel port provides access to a USB port and HDMI port for the Raspberry Pi.

## Active MRNs in Whatcom County

The MRN concept has proven to be reliable, usable, and scalable. There are now six MRNs in Whatcom County, Washington:

- Acme, WA fire station Winlink RMS on 144.93 MHz (K7SFV-10)
- Bellingham, WA Bellingham Technical College Winlink RMS on 144.99 MHz (KB7TEC-10)
- Bellingham, WA Western Washington University APRS digipeater / IGate on 144.39 MHz (N7WWU)
- Bellingham, WA Whatcom County Search and Rescue building Winlink RMS on 144.93 MHz (W7ECG-10)
- Ferndale, WA fire station APRS digipeater / IGate on 144.39 MHz (W7JIM)
- Lynden, WA private home Winlink RMS on 144.91 (KF7VOL-10)



The result of these MRNs coming online is that Whatcom County, WA now has excellent county-wide coverage for APRS, has a number of Winlink RMS nodes accessible from most areas of Whatcom County, and several nodes that can act as fsq relay stations. And, of course, all this functionality can be reconfigured remotely as circumstances and emergencies dictate.

## **Possible MRN Improvements**

Future features being considered for the Whatcom County MRNs:

- Replacing the problematic AC to AC uninterruptible power supply with a DC-to-DC uninterruptible power supply
- Adding remote voice capability via a second Raspberry Pi unit with an audio interface connected to the radio's microphone input, speaker output, and microphone push-to-talk (PTT) circuit.
- Adding a low-power AREDN node operating on 2.3 GHz to each MRN.
- Identifying suitable radios that can be remotely controlled as the Kenwood TM-V71A is apparently out of production.

Because the services being provided on the MRNs operate solely on 144-148 MHz, there is potential to replace the current dual band radio with a 144-148 MHz radio and a 440-450 MHz radio that can operate simultaneously for uses such as remote repeater inputs, high-speed data communications, etc. There's even the possibility of replacing existing antennas with tri-band antennas and adding a third radio for use on 222-225 MHz

## **Future MRNs in Whatcom County**

Future MRNs in Whatcom County (and surrounding areas) will be projects of, and sponsored by the Mount Baker Amateur Radio Club's Digital Group.

A future MRN is being planned for nearby Lookout Mountain. This MRN will use a remotely controllable HF / 144-148 MHz radio. Potentially, this MRN could offer a remotely controlled HF station, but that will require more research and planning. Another change being made on this MRN is that to provide higher reliability, the Raspberry Pi will boot from and use a solid-state disk (SSD) connected to a USB port, rather than the more usual SD card for booting and operating.

## MRN Lessons Learned

Lessons Learned in deploying MRNs in Whatcom County, WA:

- Sell the benefits of Amateur Radio emergency communications and explain why it's being requested to install an MRN at *their* facility.
- Have at least informal backing of a local organization such as an Amateur Radio club or EMCOM group.
- Explain that there are only modest facilities requirement such as wall space in a utility area, basic power, and a route to the roof for coax, and most antenna installation.
- If the host facility requires that antenna installation can only be done by the facility's personnel or a contractor, do not push back against that requirement - find a way to pay for those services.
- Do not request any funds or anything from the host facility - only "wall space", antenna installation, power, and Internet access.
- Engage early with the host facility's Information Technology (IT) group about the requirement for Internet access and a static IP address. Don't "surprise them" at the last moment - allow sufficient time for IT planning and processes.
- Provide full point of contact information for an individual (preferably more than one) "in case there are problems". This is especially true for the IT department supplying the Internet access and static IP address.
- Provide an easy way to turn off the unit locally (shutdown switch) "in case there are problems".
- Maintain regular contact with the host facility's personnel so they'll feel comfortable contacting you first "in case there are problems", rather than just yanking the power plug or the Ethernet cable.
- Add signage to the front of the cabinet to explain at a glance what this unfamiliar electronics unit (not owned by the facility) actually does, such as "Amateur Radio Emergency Communications System" with point of contact info (again, preferably more than one point of contact), a copy of the Amateur Radio license for the unit, etc.
- Provide the key for the front panel lock to a local facilitator in case you have a cooperative person onsite who can power cycle the unit, check cable connections, etc.

Our thanks to Budd Churchward WB7FHC for contributing background information for this article and his ongoing support for the Multipurpose Remote Node project. Our thanks to Steve Magnuson AG7GN for incorporating changes to the Nexus DR-X software image that make it easier to manage the Whatcom County MRNs and his ongoing support for the Multipurpose Remote Node project.

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