Taking the Next Step – A proposal for the WWARA to move to narrowband

Part 97, subpart B-Station Operation Standards reads:

> *(b) Each station licensee and each control operator must cooperate in selecting transmitting channels* ***and in making the most effective use of the amateur service frequencies****. No frequency will be assigned for the exclusive use of any station.*

One could argue that the WWARA moving to narrowband channels for repeater operations is a requirement or at least strongly suggested by the FCC for Amateurs.

Background

The repeater landscape has undergone a significant change, which really began in 2005 when Icom released the first digital mode radios designed specifically for Amateur radio. While other digital modes that originated from the commercial land mobile market had been experimented with, DSTAR was the first to gain wide spread Amateur acceptance. While other modes have existed, only DMR has approached the initial success as DSTAR here in western Washington.

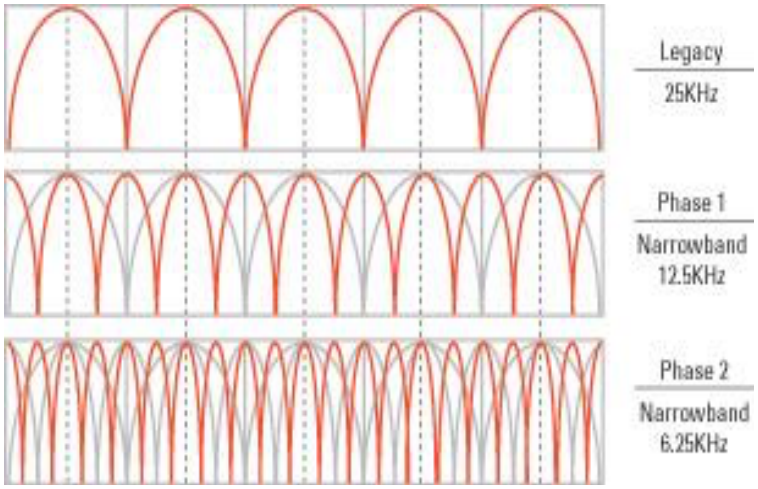
While the WWARA Narrowband Committee have been unable to find data to support the claim, we believe that overall repeater usage has declined over the last 10 years. Using just the random sample of scanning all the available 2m and 70cm repeaters while driving to work from various locations around the Puget Sound, we believe there has been a 50% or more drop off since the mid-2000's. There are exceptions of course, some repeaters in the area are very active, with multiple daily nets and regular QSO's happening all day long.

Another interesting fact is that while the usage of repeaters is declining, the number of repeaters, at least in western Washington is increasing. The WWARA list of coordinated systems has increased 28% since 2013. The number of digital repeaters (defined as DSTAR, DMR, Fusion, NXDN and P25) has increased over the same period by 77%. Based purely on newly coordinated systems, the desire to install a digital repeater is far out pacing analog.

It is a simple fact that most of the coordinated 2m repeaters in western Washington are still wide analog FM systems (as defined by 5 kHz deviation or 20 kHz occupied bandwidth or 20K0F3E FCC emission mask), the same basic technology that was deployed in the 1970's. There are many advantages to it, including the widely available equipment and fairly simple operation/setup. But this paper is about considering what comes next for Amateur repeaters in western Washington.

The FCC forced the land mobile market (of which most of the repeater equipment Amateurs uses comes from) to go to some form of narrowband in January 2013, which was announced in 2007. All commercial uses (with certain exceptions) were required to move from 25 kHz channels to 12.5 kHz channels.

Although not requiring it, the FCC also announced a future move to the 6.25 kHz wide Ultra-narrowband at some point in the future. For many, this meant making the move from wide band FM to a ultra-narrowband option up front would avoid a second transition later. This allowed systems like NXDN (6.25 kHz wide) and P25/DMR (12.5 kHz two time slot TDMA) to become a popular commercial options. Only AM/SSB and ACSSB would meet 6.25 kHz criteria via analog, making the digital options increasingly important.



One of the drawbacks, which were outlined in an FCC document published around the time of the announcement for shifting to narrowband, was the impact when narrowing analog signals from 5 kHz to 2.5 kHz deviation. With the reduction in deviation when going to narrowband, it is estimated to also decrease the signal to noise by 3 dB, this was estimated to mean a loss of 30% repeater coverage, without an increase in ERP to compensate for it.

From the FAQ in the FCC document:

> *It has been estimated that Narrowband compliance can result in a 3 dB loss in signal strength. However, this rule of thumb is based upon a "plain vanilla" Narrowbanding scenario where 25 kHz analog system converts to a 12.5 kHz analog system. Consult with a manufacturer and/or consulting engineer for a better estimate of how Narrowbanding will affect your particular system.*

It should be noted that the repeater coverage issue described in the FCC document will not be universal for repeaters located in the Puget Sound area. Many of the WWARA coordinated repeater systems, specifically the low level systems, are already limited in coverage due to terrain issues. This issue will have the most impact to those high-level systems, which have coverage over large geographical areas.

What are the options? The obvious one is simply increasing the power of radios. That might be doable at the repeater side, but what about the other end of the system? It would mean all the HT's in use will also need to double their power, which means a reduction of usage time due to battery capacity or even larger antennas. The other option, which isn't called out directly in the FCC documents, is moving to a digital signal. All of the current digital solutions leverage high quality codec's and benefit from forward error correction (FEC). This technology allows similar coverage of wide band analog systems, but using narrowband channels and similar ERP.

Given the state of things today, what should the WWARA do, to help move the repeater systems of western Washington forward? The WWARA knows that our users want to construct more repeaters. The WWARA knows there is already a strong interest and adaption for digital solutions. The Narrowband Committee's recommendation is the WWARA begin down the path of restructuring the band plan to align with this vision. We know it won't happen quickly and there

will be many who will get very upset about the prospect. But we believe this aligns with the overall mission of the WWARA and is the right thing to-do.

How will the shift happen?

This is just a thought experiment based on various discussions that have been taking place among the WWARA board and other groups. It isn't meant to be a detailed plan and certainly needs more research and input from others. When developing a plan, it is best to start from the outcome desired and work backwards. To that end, the Narrowband Committee has been using ten years as the point where the WWARA has completely transitioned to a narrow band plan for 2m and 70cm. The logic being that one of the biggest factors in the transition is the wide spread adaption of client radios that supports narrowband, whether that is analog or digital. It appears that most Amateur radios released in the last ten years supports at least a narrowband analog mode, while more than half support at least one type of digital mode. So, projecting out ten years, it seems safe to assume that most client radios in use will support some form of narrowband.

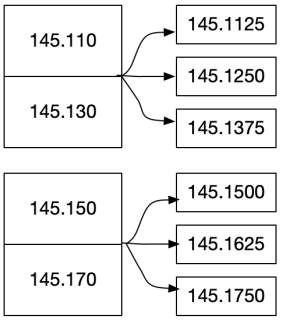
If most of the client radios support some form of narrowband already, the major 'cost' of the switch will be for the repeater owners. Other than a need to retune the filtering to adjust to the new band plan, the biggest cost is the TX/RX systems. The old reliable GE Mastr II systems will probably need to be replaced by something made in the last decade. We don't have an answer for this, other than that is what will need to happen. Based on historical patterns, the commercial land mobile market will also be turning over and replacing many of the first-generation (or second-generation) narrowband system at this point (which is actually already happening). This was the source for the GE Mastr II systems, so it is logical to assume a ready supply of 'cheap' repeater systems available on the market over the next ten years.

The next hurdle is how do we move from the current 20 kHz channel spacing to 12.5 kHz? It is best to imagine this as a giant game of Tetris. As wide analog systems are replaced, it allows the creation of pockets of narrowband channels. The common proposal is that when two adjacent 20 kHz channels have moved to using narrow band repeaters, the 40 kHz of spectrum be converted to three 12.5 kHz channels.

NOTE: *There was an earlier proposal to use two 12.5 kHz channels, with a 6.25 kHz in between them. This proposal had the advantage of overlaying the current 20 kHz channels exactly, but when it was mapped out, the frequency steps didn't work. Most existing radios wouldn't support the spacing. This lead the narrowband working group to come up with the current proposal.*

The complete mapping of the existing 20 kHz pairs to 12.5 kHz pairs for the 2m band is included in Appendix A for reference. The narrowband committee reviewed how the FCC approached this and taking that pattern, applied it to the 2m repeater sub-bands. Using the 145.100 Mhz repeater

sub-band as an example, three 12.5 kHz channels would be created in the space currently used for the 145.110 and 145.130 Mhz wide band pairs. The diagram in Figure 1 provides a visual representation of the conversion of the first four wide band pairs to the six new narrowband pairs.



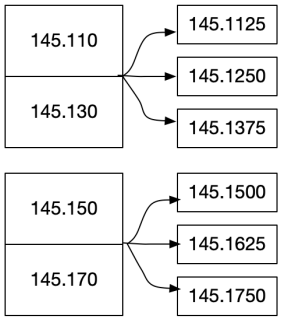


Figure 1: Wide to narrow band conversion

This solution will create 31 narrowband (12.5 kHz) pairs, where there are currently 20 wideband pairs in the 145 repeater sub-band (145.1 to 145.5 Mhz). Similarly, 62 narrowband (12.5 kHz) pairs will be created in the 146 repeater sub-band (146.2-147.4 Mhz). As mentioned above, this approach aligns with the spacing supported by all the modern radios reviewed, which supports at least one type of narrowband mode.

One of the downsides of this channel transition is the 'overlap' between current wideband and narrowband groups. In previous proposals, once two wideband pairs were available for conversion, it immediately created three narrowband channels. That is sometimes the case with the new approach, but there are cases where three wideband channels will need to be converted before all three of the narrowband channels will become available. As an example, the narrowband channel of 145.4125 is a part of the set of three channels that maps to the 145.43 and 145.45 wideband pairs, but any repeater using it would likely cause interference to the existing 145.41 Mhz wideband pair. When the conversion of these pairs happens, special consideration will need to be given and possibly the narrowband channel will be unavailable until the third wideband pair is transitioned.

Narrowband Digital Channels

The last narrowband channel in the new narrowband proposal (147.3875 Mhz) overlaps with the second ultra-narrowband digital only pair (147.3950 Mhz) created several years ago. As part of the transition, it is recommend the existing ultra-narrowband digital only pair would be replaced with the 147.3950 Mhz narrowband pair, when the 147.38 wideband pair is no longer needed.

Similarly, it was discovered the other ultra-narrowband digital only pair (146.005 Mhz) is not practical due to the proximity to the FM cross-band linking frequency at 146.600 Mhz. A coordinated DSTAR repeater on the pair was asked to terminate operation due to the interference with the cross-band linking frequency. It is recommended this ultra-narrowband digital only pair be removed from the WWARA band plan.

Other than proposed changes to the two ultra-narrowband digital only pairs (146.005 and 147.3950 Mhz), no other changes are suggested or needed for the narrowband transition.

Shared Non-Protected Channels

The two Shared Non-Protected (SNP) pairs (145.13 and 145.29 Mhz) will remain wide-band pairs, until their 'partner' convert to narrowband. (145.11/145.13 and 145.27/145.29) At that time the SNP will also convert to narrowband automatically. It is recommended that two of the newly created narrowband channels are designated as shared non-protected pairs.

70cm Band Transition

Up until this point, the focus has been on the 2m band. This was done because the 2m band is the most compressed of any of the amateur repeater sub-bands in the WWARA. In late 2016 for the first time in WWARA history, there were no 'free' repeater pairs available in the 70cm band. Over the years as repeaters were retired, a few free pairs have become available again, but co-channeling is now a common occurrence. Similarly, the seven 70cm narrowband digital only pairs created in June 2016 are now 'full', with several having multiple repeaters co-channeling.

In some ways the 70cm band is 'ahead' of the 2m band with regard to moving to narrowband, because most of the new digital mode systems went to 70cm first, because there were no available pairs in the 2m band. This means a higher percentage of existing 70cm repeaters could immediately switch to a narrow band plan, with only slight changes in frequencies. Another major difference is the 70cm band is still on the older 25 Khz channel spacing, whereas the 2m band moved to 20 Khz pairs decades ago.

It is the belief of the Narrowband Committee that the re-channeling of the 70cm band should following the approach used for the 2m band, but the ultimate path it takes to reach that point may differ. A partial narrowband layout for the 70cm band is included in Appendix B, in future drafts the entire repeater sub-band will be included.

Possible options for the transition

This section will probably be the most controversial, but we hope over time some of these approaches can be implemented, even if not immediately.

Using the ten-year date from the above thought experiment, starting five years in the future, the WWARA could stop accepting new 2m applications for any system which isn't 12.5 kHz or smaller (whether digital or analog). So existing repeater owners would be able to continue to renew the in-place systems, but any new application would need to be narrowband. Additionally, if a 2m system must re-coordinate (due to a site move or any other existing reason which today requires re-coordination), the new system would also have to be narrowband. As wide band 2m channels were vacated, the narrowband pairs would become available, using the scheme described earlier.

This process of would ensure existing 2m wide band repeaters and users wouldn't be 'forced' to go narrowband, but at the same time it would allow the natural transition to the narrowband channels.

There are other more aggressive options for the transition, which center around the general theme of setting a specific date and requiring all systems to transition. This has several problems with it, including the WWARA having no authority to force a system trustee to change. The hope is that by allowing owners and their users to pick when the transition happens, the change will be less impactful, even though it will take longer. It is important to remember that the technology Amateur's enjoy using and experimenting with is going to continue to move forward. Ten years is a long time, which will probably bring many advances we are only dreaming about right now. It is even possible a mixture of spread-spectrum technology, with the continually advancing SDR solutions, will remove the needs for coordination's of repeaters all together.

As described above the 70cm band is starting from a different place than 2m, so it follows that the transition options might also be different. Currently the Narrowband Committee is considering proposals that would more aggressively transition part of the 70cm repeater band, because more of the repeaters currently coordinated are already narrowband and can be easily shifted in frequency with a re-tuning of the duplexers. A recent review showed that nearly 20% of the current 70cm repeater coordination are for systems which are already narrowband, but using the older 25 kHz channel spacing. A proposed first step for the 70cm band is to identify a part of the 70cm repeater sub-band and immediately declare it narrowband, meaning now new wide band coordination's would be accepted. Then by working with existing repeater owners, the existing wide band repeaters in that section would be swapped with existing narrowband repeaters. This has the benefit of immediately opening up additional 70cm repeater (narrowband) pairs with only a minor inconvenience to existing repeater owners.

Appendix A: Existing and Proposed 2m Band Channel Raster

Existing	New
	145.1000
145.1100	145.1125
145.1300	145.1250
	145.1375
145.1500	145.1500
	145.1625
145.1700	145.1750
145.1900	145.1875
	145.2000
145.2100	145.2125
145.2300	145.2250
	145.2375
145.2500	145.2500
	145.2625
145.2700	145.2750
145.2900	145.2875
	145.3000
145.3100	145.3125
145.3300	145.3250
	145.3375
145.3500	145.3500
	145.3625
145.3700	145.3750
145.3900	145.3875
	145.4000
145.4100	145.4125
145.4300	145.4250
	145.4375
145.4500	145.4500
	145.4625
145.4700	145.4750
145.4900	145.4875

Existing	New
146.6200	146.6250
146.6400	146.6375
	146.6500
146.6600	146.6625
	146.6750
146.6800	146.6875
146.7000	146.7000
	146.7125
146.7200	146.7250
146.7400	146.7375
	146.7500
146.7600	146.7625
	146.7750
146.7800	146.7875
146.8000	146.8000
	146.8125
146.8200	146.8250
146.8400	146.8375
	146.8500
146.8600	146.8625
	146.8750
146.8800	146.8875
146.9000	146.9000
	146.9125
146.9200	146.9250
146.9400	146.9375
	146.9500
146.9600	146.9625
	146.9750
146.9800	146.9875
147.0000	

Existing	New
147.0000	147.0000
	147.0125
147.0200	147.0250
147.0400	147.0375
	147.0500
147.0600	147.0625
	147.0750
147.0800	147.0875
147.1000	147.1000
	147.1125
147.1200	147.1250
147.1400	147.1375
	147.1500
147.1600	147.1625
	147.1750
147.1800	147.1875
147.2000	147.2000
	147.2125
147.2200	147.2250
147.2400	147.2375
	147.2500
147.2600	147.2625
	147.2750
147.2800	147.2875
147.3000	147.3000
	147.3125
147.3200	147.3250
147.3400	147.3375
	147.3500
147.3600	147.3625
	147.3750
147.3800	147.3875

Appendix B: Existing and Proposed 70cm Band Channel Raster (partial)

The following shows the just one segment of the 70cm repeater sub-band and how the conversion would be applied to go from the current 25 kHz channel spacing to 12.5 kHz channels.

Current	Proposed
440.0250	440.0125
	440.0250
	440.0375
440.0500	440.0500
	440.0625
440.0750	440.0750
	440.0875
440.1000	440.1000
	440.1125
440.1250	440.1250
	440.1375
440.1500	440.1500
	440.1625
440.1750	440.1750
	440.1875
440.2000	440.2000
	440.2125
440.2250	440.2250
	440.2375
440.2500	440.2500
	440.2625
440.2750	440.2750
	440.2875
440.3000	440.3000
	440.3125
440.3250	440.3250
	440.3375
440.3500	440.3500
	440.3625
440.3750	440.3750
	440.3875
440.4000	440.4000
	440.4125
440.4250	440.4250

Current		Proposed
		440.4625
440.4750		440.4750
		440.4875
440.5000		440.5000
		440.5125
440.5250		440.5250
		440.5375
440.5500		440.5500
		440.5625
440.5750		440.5750
		440.5875
440.6000		440.6000
		440.6125
440.6250		440.6250
		440.6375
440.6500		440.6500
		440.6625
440.6750		440.6750
		440.6875
440.7000		440.7000
		440.7125
440.7250		440.7250
		440.7375
440.7500		440.7500
		440.7625
440.7750		440.7750
		440.7875
440.8000		440.8000