Slaying the Grim Reaper of Internet Router Noise on 6 Meters

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There is a reason narrow-band VHF activity is referred to as “Weak Signal” work. Simply put, the signal levels we routinely encounter chasing DX, states and grids are very low level at our receive end. As such, achieving and maintaining a low noise environment at your station is imperative.

The W5ZN contest station evolved from a single op arrangement in the 1980’s to a mulit-op configuration today that still allows my single op activity on a daily basis. Also during this time internet popularity exploded and radio amateurs embraced its usefulness in our stations and networked multiple computers to not only enhance our operating experience but also provide greater efficiency.

While this transition was occurring my noise floor on 6 meters began to slowly increase and birdies started appearing all over the band. It seemed no matter what I tried I simply could not eliminate the trouble and had resigned to the fact this was life in today’s networked and consumer electronics world.

At the conclusion of the 2011 ARRL June VHF Contest I was lamenting over this condition when Ward Silver, N0AX, who had joined the W5ZN team that year, suggested I review “RFI, Ferrites, and Common Mode Chokes For Hams” by Jim Brown, K9YC, and published at http://audiosystemsgroup.com/publish.htm

After reading and applying the information from Jim’s article I was extremely pleased with the result of eliminating ***all*** internet router birdies in addition to a reduction in my noise floor. The purpose of this paper is not to restate the excellent technical information contained in Jim’s article, as you can read and study it for yourself, but rather to detail the action taken at W5ZN following my study that is applicable to every VHF station.

W5ZN Internet and Network System

Internet service enters my home through a high speed DSL phone line to a DSL modem with a single Ethernet port. The modem then feeds a router that provides both wired and wireless service. The wireless system basically provides service for iPads, tablets, smart phones and guest access while the wired system feeds my office, my wife’s office and the W5ZN station through a second Ethernet switch. The Ethernet cables range in length from 5 feet to 30 feet.

A router in its basic form is a transceiver, sending and receiving digital signals from various sources and fast “switching” them to the correct device. Unfortunately the Ethernet cables then act as very effective antennas, not wirelessly transmitting the intended signals but rather the byproducts of those signals and the switching components,

thus the resultant birdies and hash noise. This can't be naturally stopped because Mother Nature is in control and the wires want to act like any other wire with an applied current and radiate signals; signals which are simply "Ethernet Trash" (unrelated to the "Internet trash" you may be viewing!)

Ethernet Trash at VHF

The Ethernet trash appears in the form of multiple carriers (birdies) that will have relatively constant amplitude possibly with some form of modulation, and broadband hash. All Ethernet hardware has its own internal clock that generates carriers around 50.044, 50.058, 50.105, 50.120, 50.148 and 50.166. These will vary slightly depending on the model and manufacturer. I tried a variety of different modems, routers and switches over time and experienced the same problem with each of them. The birdies are what first caught my attention when I noticed one had appeared right at 50.110 MHz, the DX Calling Frequency! I then started noticing others at 50.044, 50.052, 50.107, 50.121 and higher. Some of these were 15 to 20 dB above the noise floor! I also began noticing some on the higher HF bands, although not as bad as on 6 meters and it made no difference what radio I would use. During this evolution I used four different radios from four difference manufacturers and all experienced the trash. That's not a bad reflection on the radios, they were simply receiving signals that were being transmitted within the band very well, exactly what they were designed to do!

My effort to eliminate trash, or at best reduce its amplitude, proved fruitless. I read every article and book I could locate on eliminating RFI and I tried ferrite cores, shielded CAT cable with special shielded connectors, grounding the ends of the cable, grounding the computer cases and a variety of other recommended "fixes" all to no avail. After a thorough study of K9YC's paper it became clear that in all of my efforts I had missed two very important points. First, using the proper cores and second utilizing an adequate number of turns on each core. Simply adding a clamp on "RFI Suppressor Core" won't do it or just wrapping a turn or two around a core won't achieve the impedance required to suppress or "choke" the unwanted current flow in the wire.

Identifying the Source

Locating the source of the interference can be relatively easy in this case. With your radio on and listening to or seeing the interference on a panadapter, turn off (remove power from) your internet equipment. If it is the source the birdies will go away. Mine did, but I also noticed a problem I had not previously identified at the time. My noise floor dropped 10 dB! I had attributed my increased noise floor on 6 meters over the years to a variety of problems, from line noise to consumer devices in my neighbor's homes, but definitely not something in MY home!

When I powered up the internet modem and routers sure enough the birdies were back and the noise floor had increased.

The Cure at W5ZN

Following the technical details in K9YC's paper, I placed a Fair-Rite #43 toroid at each end of each CAT5 cable and wrapped five turns through each toroid. Yes, it is very important to place a toroid at each end to choke the unwanted signals at the source. Remember, your computer is also transmitting Ethernet signals! Since I also operate extensively on 160 meters during the winter DX season I wanted to ensure I had sufficient low band suppression so I also used a #31 toroid in line with nine turns. The #31 with a few extra turns provides basically the same result as the #43 on 50 MHz but has just a tad better lower frequency response. See Figure 1 and Figure 2 below.

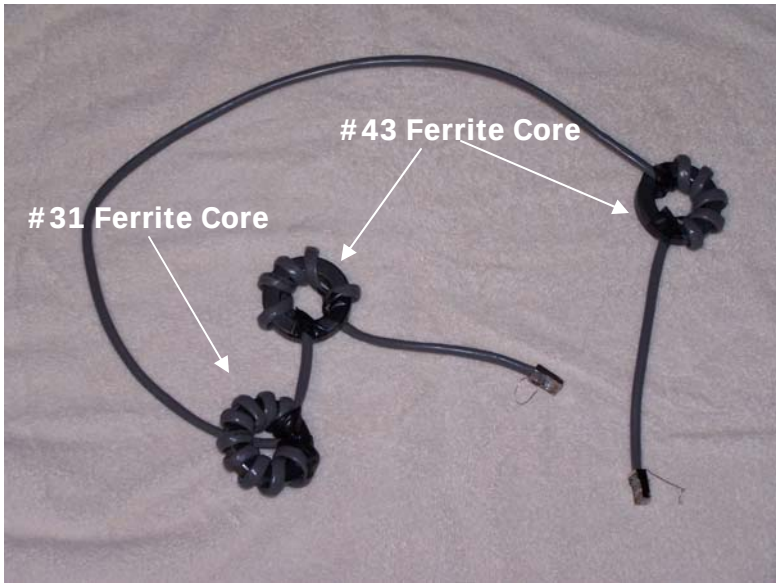

Figure 1

Figure 2

Results at W5ZN

The result was nothing short of amazing! After utilizing the techniques identified the birdies were reduced into the noise and undetectable, and the noise floor decreased 10 dB. Since the original application I have had to replace the internet equipment twice, once due to lightning and the second to an unexplained equipment death. Each time a different make and model of equipment was used and the problem has not reappeared. A quick check has been conducted on three occasions since the cure by connecting an Ethernet cable to the router without cores and sure enough the issues reappeared.

I have also experienced a couple of other RFI issues and after identifying the source the application of a Fair-Rite #31 or #43 core with sufficient turns has cured the problem.

Summary

Effective choking of RFI to amateur radio equipment can be accomplished if you understand the correct cores to use, the number of turns required and why. K9YC's paper will greatly improve your understanding and approach to curing the problem and I encourage you to read it.

While my main issue was on 6 meters, this application also eliminated a couple of birdies that were present on 2 meters.

It is very important to understand this approach will only resolve issues originating in your home with your equipment. It will not eliminate issues originating from a neighbors home or a source you have no control over. I can still detect one weak Ethernet birdie from a neighbor's home a couple hundred yards to the northwest when the antennas are pointed in that direction on about 50.107 but it is not an issue here.

If you operate a 100% wireless internet system you may not experience the issues related to wired systems but if the system contains an Ethernet cable at some point it can and will give you RFI trouble.

The Fair-Rite #31 and #43 cores can be purchased from Mouser or any of the normal suppliers. The Fair-Rite part number for #31 is 2631803802 and the #43 is 2643803802. These are round "donut" cores for cable measuring 2.4" in diameter with a 1.4" diameter hole, 0.5" thick.

Figures 3, 4 and 5 show some additional photos with the cores installed on the equipment.

I will be more than pleased to address any questions you may have regarding the work performed at W5ZN. If you have questions about K9YC's paper you can contact Jim, catch him at a hamfest or on the air. I just worked him earlier this evening on 6 meters! I always enjoy chatting with him.

Figure 3
DSL Modem, Router and Network drive (off right in photo)

Figure 4
Ethernet Cables at the W5ZN Station Switch

Figure 5
Ethernet connection at back of two station computers