The (Digital) Circle of Life
(and some odds & ends)

BY DON ROTOLO,* N2IRZ

Although the world is analog, more and more of it is being represented digitally. I, personally, am a big fan of the analog world, but as more and more things "go digital," I have come to see the simplicity and, yes, the beauty of digital. Writing this column doesn't hurt my outlook either. This month's column is a bit unusual for me, in that we'll have a look at how so many things in the digital world are intertwined with one another.

The topic idea came to me as I was in the process of renewing my passport, for which two identical photos of a certain size and specification are necessary. Being a ham, I am far too cheap to pay the $8 fee for a pair of passport photos from the local one-hour photo shop, so I decided to do it myself. Driving to a local outlet of a national pharmacy chain that advertises inexpensive prints from digital photos, with the intent of printing out the digital photo I had just taken of myself, a variety of disparate ideas I had been writing about this past year or so came together as a Zen-like whole.

First, I realized that the digital world is no longer encroaching upon our analog world. It has become dominant in everyday life. Tried to activate an AMPS (analog) cell phone lately? They're all digital now. Digital photos, digital TV, e-mail and the internet, even our cars have gone digital, with fiber-optic networks, DSP, and CAN Bus technology. Then I started thinking about my recent columns.

In the past year or so I've written about Digital Radio Mondial (DRM) and the efforts under way to adapt the Orthogonal Frequency Division Multiplexing (OFDM) scheme it uses in HF communications, culminating in the first overseas amateur QSO using that form of digital voice.

I've also written about WinLink 2000, which is essentially an e-mail system that uses the internet for data transport and amateur radio for the "last mile" of the link (which actually can be thousands of miles). The issue there was a recommendation for the use of PacTOR III as an efficient data protocol for data transport over HF. Because of the proprietary nature of PacTOR III, and its relatively high cost, I also mentioned (and will soon write more about) a new high-efficiency data mode being developed—SCAMP.

Before that, I had also written about Digital ATV, for which folks in Europe are essentially deploying terrestrial transmitters that look just like a satellite to a standard digital satellite receiver (think DirecTV or DISH Network), allowing hams to use off-the-shelf receiving hardware for digital ATV signals off the local ATV repeater.

More recently, April's column was about the ARRL's High Speed MultiMedia (HSMM) Working Group. These folks are working toward creating a ham internet, or Hinternet, where data transport becomes ubiquitous. The content of that data—video, image, audio, text, whatever—is (almost) irrelevant, as is the band and specific data rate. What matters to the HSMM folks is that the transport mechanism appropriate for the medium is available and functional.

How does all of this tie together, and what does my passport photo have to do with any of it?

Getting Orthogonal

Okay, let's start with the DRM stuff. OFDM is a fancy way of saying "using a bunch of different fre-

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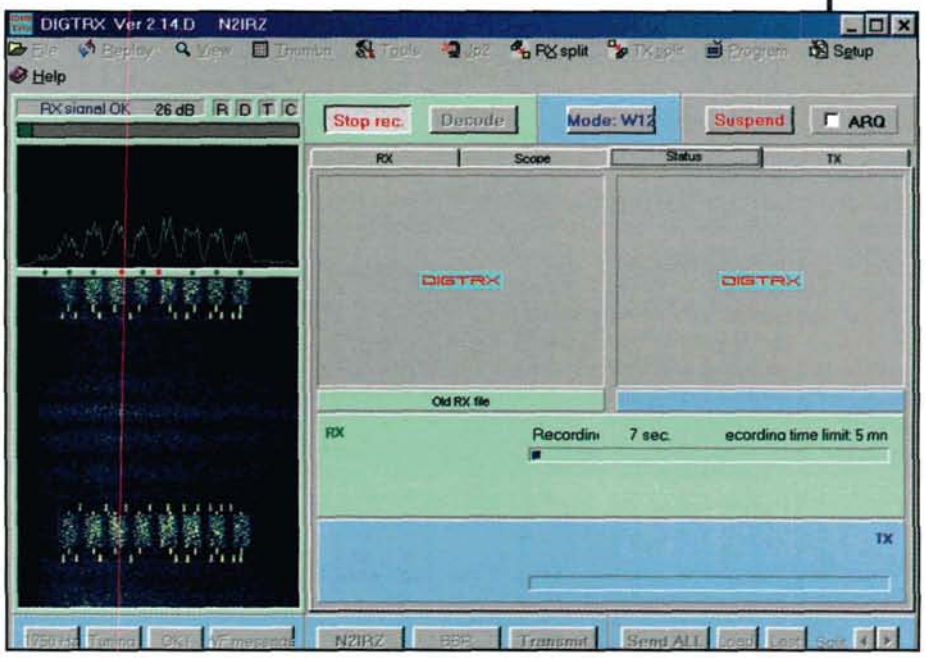


Receiving the "mystery" signals on 14.111 MHz and wondering why my DIGTRX program decoded the file okay but I wasn't seeing any images. As it turns out, I was not seeing DIGTRX digital SSTV signals, but an alpha test of a SCAMP mode. Note the multiple carriers. This is version 2.14; version 3 has already been released. I hope to play with DIGTRX and other DSSTV software, as well as cover SCAMP, in future columns.

quencies at the same time." Think of a PSK31 signal, which can carry about 31 bits per second in about 31 Hz of bandwidth. If we were able to put a hundred of them on the air at the same time, we could (theoretically) send 3100 bits per second of data using just over 3 kHz of bandwidth. OFDM is basically the same idea, but there are redundancies and interdependencies among the different signals which greatly improve the signal's resistance to data loss from (relatively) noisy HF channels. Because TANSTAAFL (There Ain't No Such Thing As A Free Lunch), we lose a bit of the data rate, but the gain in robust quality is well worth it.

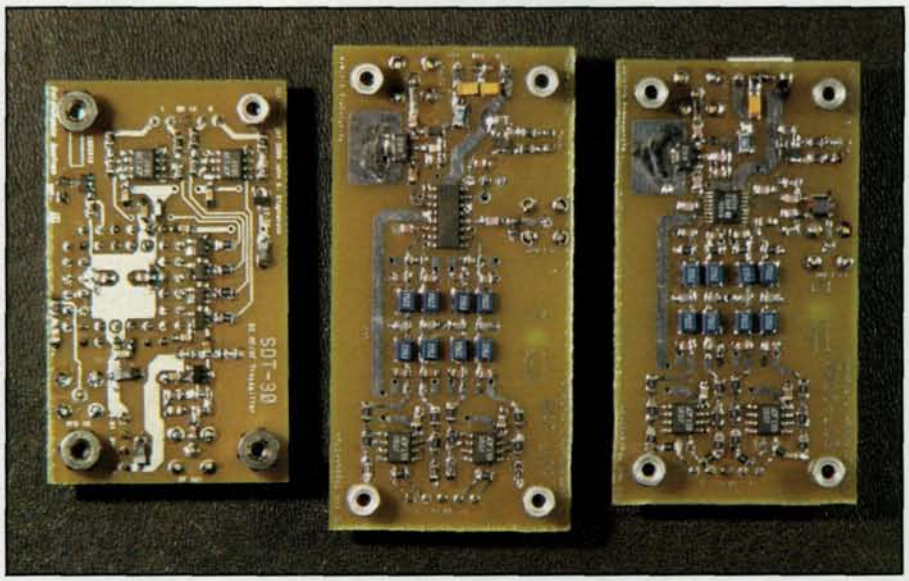
Those redundancies and interdependencies are important to the superior performance of some OFDM methods. Math majors understand the huge value in the term *orthogonal*. It means that we can extract data not only from what is there, but also from what is not there. Do the math right and it becomes very powerful. Similar math techniques are behind the performance of spread-spectrum and PSK31 signals.

Thus, it makes sense to use these techniques if you want a better system. Of course, such things do not exist in the analog world; only digital processors can do the kinds of math necessary. And so it is with SCAMP, which ties in with DRM and OFDM through DIGTRX and HSMM. Allow me to clarify.

A Strange Signal

The HSMM folks have a message reflector where they discuss ideas, and I subscribe to it. After all, HSMM is a big thing in amateur radio, and I'm always looking for new things to write about. Just yesterday someone mentioned a strange signal that appeared on 7095 kHz, one with eight carriers taking up about 3 kHz. Another fellow on the reflector mentioned that it sounded like DIGTRX, a relatively new digital image (think Slow-Scan TV) software for amateurs.

I'll write more about DIGTRX in a future column, but for now understand that it uses OFDM, eight carriers spaced a few hundred Hertz apart, to get data throughput in the few hundreds of bits per second range, depending on the redundancy setting you choose. It is intended and used for image transmission on HF, where a 10-kB JPEG image can be sent in under 2 minutes. It isn't used for data, because data transmissions are limited to 300 bauds below 28 MHz. (It also has a cool feature to display your callsign, or a sample image, on a waterfall display like that used for PSK31).



A view of the quadrature modulator boards for the HSMM modems now in alpha testing. Shown left to right are the HF, VHF, and UHF boards. Add an appropriate local oscillator (LO) and you have a complete HSMM data transmitter, with enough flea power to drive a small RF power-amplifier stage. These are on the air and being tested as you read this. (Photo by John Stephensen, KD6OZH)

After some research, I downloaded DIGTRX and, finding a signal on 14111 kHz, listened in early this morning. I was able to tune in the signal and actually decode it, but I was disappointed that I could not see an image. After all, this is image software and I wanted to play Digital SSTV. (Remember, I still needed to come up with a column at this point, and I had yet to make the "connection" among all these disparate topics.)

After trying every graphics program I had to open the decoded files, I tried WordPad. I have often found that looking at a file in a text editor sometimes gives clues to the file's real format. This was true in this case as well. Right there in the top of the file was the clear text "PaclinkSCD-0.3.2." Not sure what that meant, but something about it sounded familiar.

Cue Simba, Stage Right

At about that time the local pharmacy chain was opening, so I burned the photo of myself onto a CD and hopped into the car. As I drove there, I guess my mind was wandering and thoughts of the photo, Paclink, DRM, OFDM, HSMM, and DSSTV all melted together *(visualize Don's brain resembling a big bowl of alphabet soup—ed.)*. It was then that I realized that it's just a huge circle of life; everything is interconnected with everything else, and it all ties together. I won't bore you with my visions of Gaia, however.

You see, PacLink is what I wrote about in my WinLink 2000 column. It is the software interface between your computer and the WinLink 2000 system via a packet link. What I had been seeing on 14.111 while looking for DSSTV was actually alpha testing of SCAMP. The same basic "DRM" methods of OFDM were also being alpha tested by the HSMM working group (the results of which should be available around the time you are reading this).

The point is all of those very different aspects of amateur radio are related to one another by much more than just being digital, or by being OFDM, or by being something I've written about recently. The critical point is they all are the way of the future—more efficient, robust, easier to use, and (dare I say it?) they bring amateur radio once again to the forefront of technology.

Some years ago I lamented in print that the days of experimentation were over. It was impossible for the radio amateur to develop an integrated circuit, or some other basic building block, because the technology had advanced too far for the average ham to ever catch up. We were slipping towards becoming appliance operators by force, maybe relegated to building some new, unneeded variation of a Yagi or keyer.

That particular column actually ended on a high note, because it rec-

ognized that the new area for amateur experimentation was in software. Regardless of the hardware, there were things that could be done in software that had never been done before, and here we had very powerful, plentiful, and cheap computers on which to do it.

Now, not too many years later, it has come to pass: The one link between all of these many different subjects is software. Variations on a theme, one could say, close enough in implementation for me to see the connection. There, in the software, lies *the basic truth about amateur radio:* It is alive, well, and kicking. Feel free to stay with CW and SSB (modes I enjoy myself), but recognize that we are on the edge of not an evolution, but a revolution in how we use our valuable spectrum. Ride the wave.

Odds & Ends

There are a few subjects I have been meaning to touch upon for some months now. None of them have warranted a column of their own, though, so here they all are together. The first is PSK62.

PSK62

PSK62 is essentially PSK31 doubled. The signal is twice as wide, it runs twice as fast (much faster than I can type!), and it works just great. I have seen fellows trying to respond to a PSK62 signal using PSK31, telling the other operator, "Your signal's too wide; can't decode you OM" (that's a real quote). There is also a PSK124 mode, but I have yet to use it or see it on the air. I guess the point is there are so many new modes coming out these days, whenever you see a new one, it behooves you to take a moment and (try to) learn what it is.

Identifying New Modes

This is where the value of the internet becomes apparent—research. I wish there was one site I could access to help me identify the various modes I might be seeing. One site has many of the digital modes catalogued, with a spectrum display and sound clips, which I found very helpful. Look in the Resources section in this column for the link to "DIG_intro.htm."

Programming

I wish I could write more about programming, but it generally would be far too large a subject, and a bi-monthly column is not the best venue for such a

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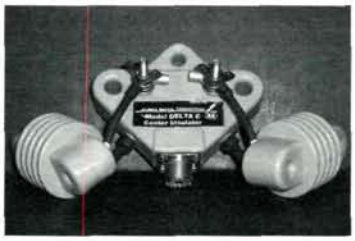

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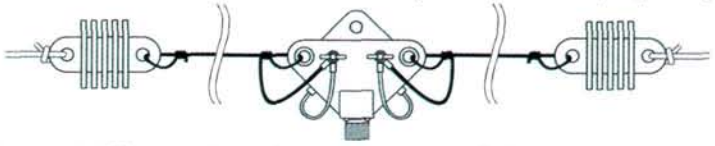

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topic. With my recent robotic dalliances I have been forced to get more and more into software, but not in relation to amateur radio. Since all robots are digital at the start, interfacing with an analog world, there are some valuable lessons to be learned. For instance, I finally found a use for those old packet terminal node controllers (TNCs) I have lying around—moving data to a robot over a flea-power RF link.

No matter what the task, it can probably be done in software. Like the basic point of this column, I urge you to exercise your brain a little, get a microprocessor or a robot kit (such as the ones from Parallax, Inc.), and start learning—err . . . playing.

555 Timers

Despite being a linear circuit, the well-known 555 timer is a boon to digital experimenters seeking a cheap, reasonably stable source of TTL clock signals and other timing signals. I've been using them since before my college days, more than 25 years ago. In my recent forays into robotics, as a mentor for a FIRST team (see Resources) I needed to generate a variable duty-cycle PWM (Pulse Width Modulation[1]) signal to test a motor controller. Looking at the 555 equations, I couldn't see how to get a wide range of duty cycle, so I did what I usually do when I need advice—check the internet.

What I found was a cool freeware/demoware program from Schematica that lets you plug in some basic information (such as frequency and duty cycle) and then out pops a design. I don't want to get too deeply into the (huge) subject of circuit simulation, but as long as you understand the limits of a simulation, it's a lot faster (and cheaper) than soldering together real components. There are plenty of freeware, demoware, and inexpensive costware programs out there that hams will find valuable, and I urge you to learn about them and use them in your next project.

CQ Contest

What I love most about this hobby are its unlimited possibilities. I thoroughly enjoyed my time putting WW2CQ/62 on the air in digital and thank all of you who completed QSOs with me. It really was an odd sensation to have stations calling me, even though I could hardly call it a pile-up. Now I see what it must be like to operate in a contest. I have to try it sometime.

In the coming months I plan on writing more about HSMM, as well as covering SCAMP and Digital SSTV. If there's a special topic that you'd like to read about, drop me a line. I'd love to hear from you. Until next time . . .

73, Don, N2IRZ

Note

1. Pulse Width Modulation (PWM) is used to control direction and speed of remotely controlled objects, such as robots or radio/control models.

Resources

For more information on many of the topics discussed in this month's column, check out the following web links:

The Digital Signals website, which can help you identify a new digital mode you're hearing or seeing, has a large collection of spectrum plots and audio samples for most digital modes. Go to: <http://rover.wiesbaden.netsurf.de/~signals/DIG_intro.htm>.

DIGTRX software can be compared to SSTV, but it is not exactly the same. Like many things digital, either you receive it perfectly or not at all, which is very different from analog SSTV. The homepage of Roland Zurmely, PY4ZBZ, starts out in Portuguese, with English towards the bottom. Explore the various links; it is well worth the time. Go to: <http://paginas.terra.com.br/lazer/py4zbz/>.

WinLink 2000 is found at <http://winlink.org>. If you want more information on SCAMP and the alpha test, review the files at <ftp://winlink.org/scamp/>.

DRM information can be found at <http://www.drm.org>, including links to technical descriptions of the DRM standard and a way to buy the DRM decoder software. I especially like the audio samples; the sound is startling in its clarity and fidelity.

More information on HSMM can be found at <http://www.arrl.org/hsmm/>, and a Google search of "HSMM radio" will yield quite a collection of useful links.

The Official PSK31 homepage is <http://www.aintel.bi.ehu.es/psk31.html>. Almost everything you'll ever need is there, but there are many other sites found with Google that have useful information.

Parallax makes the BASIC Stamp and a bunch of other very fun things to help you get things done and learn programming in the process. Go to: <http://www.parallax.com>.

The 555 timer simulator can be found at <http:www.schematica.com>, and a Google search of "electronic circuit simulation" brings up over a million hits.

For information about FIRST (For Inspiration and Recognition of Science and Technology), a very worthwhile and fun organization that introduces high school kids to science, engineering, and technology, visit <http://www.usfirst.org>.

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