

# WA4DSY and the GRAPES 56k-Baud Packet Modem

Sometimes there's an interesting story right around the corner, if we would only look. In conversation with Tadd Torborg, KA2DEW — the guy behind TARP, which I wrote about last November — I learned that I'd moved into the same neighborhood as a famous ham — at least famous in some circles. In my January column, I hinted that I hoped to set up an interview, and this actually came to pass. However, instead of delivering this as a straight Q&A-type interview, I think it would be best to simply recount our conversation, with a few key quotes sprinkled in.

## Introducing Dale Heatherington, WA4DSY

Way back over 30 years ago, Dale Heatherington, WA4DSY, designed and built a 56k-Baud packet modem that was marketed and distributed by the Georgia Radio Amateur Packet Enthusiasts Society, or GRAPES. This is a story about how Dale came to the expertise to create such a modem, some info about the modem itself, the impact this had in the context of the latter part of the 20<sup>th</sup> century, and some of the lessons learned.

The GRAPES 56k Modem was introduced in 1987, first at the Dayton Hamvention® and later in detail at the 6<sup>th</sup> annual ARRL Computer Networking Conference (now known as the Digital Communications Conference). Back then, the Internet was a thing, but barely: Access was expensive and generally limited to telephone dial-up access, “high speed” being 2400 baud, and “super speed” 9600

(9k6) baud modems being available for just under \$1,000. Many hams and computer enthusiasts used CompuServe, America Online, or Prodigy as their gateway to the Internet<sup>1</sup>, although these companies had extensive and exclusive content available to subscribers. Packet was coming of age, and 1200 baud was the rule almost everywhere, although there were several instances of somewhat faster experimental connections.

In a very practical sense, it meant that packet radio was generally as fast as Internet access, and it was free (for hams). It was not possible for a user to get a connection to the world-wide data network any faster than 9600 baud, unless you spent many thousands of dollars for a dedicated data line.

Considering that, imagine the impact of a 56-kilobaud modem. Here was the possibility of accessing the Internet (as it was) at speeds used by universities and businesses, but at a price lower than 9k6 telephone access. Oh, and don't forget: There was no such thing as “free long-distance” telephone in those days. You paid for everything except local and (800) numbers.

In those days, many hams knew someone with “fast” Internet access, usually through work. Companies were renting access for less than a dedicated leased line, and some even had the money for a T-1 (1.5 Mb/s) line, and it was usually hams on the Information Technology (IT) teams responsible for these networks. Some ham entrepreneurs saw the possibilities and became Internet Service Providers (ISPs), selling dial-up access to local users, often as a means to finance their own access.

The next natural step was to use packet radio to access the Internet. And here we had the possibility to do it from home, at 56k! For free! Packet was in direct competition with the Internet, and the Internet was losing by a wide margin.

## The Beginnings

Many older packeteers will recognize Dale by his WA4DSY callsign, but some IT folks will recognize his name as one of the founders of Hayes Microcomputer Products. And some BattleBot folks will recognize him as well, but I get ahead of myself. Before retiring from Hayes in 1985 (remember that date), Dale was responsible for the design of telephone modems for the very new world of home computers. Dale was a colleague of Dennis Hayes at National Data Corporation, where they worked designing electronics in support of NDC's maintenance and support group.

As any enthusiast with sufficient cash did, they went in together on an IMSAI 8080 computer kit and started playing around with it. Dale, thinking it might be cool to build and sell a telephone modem for it that wasn't as expensive as one from “Ma Bell,” in 1977 designed and built a 300-baud



*Photo A. A young Dale Heatherington, WA4DSY, in front of his 300-baud modem prototype, the 80-103A. Yes, that's the IMSAI 8080 “home computer” that started Dennis Hayes and him thinking about modems. (Photos courtesy of WA4DSY except as indicated)*

\* c/o CQ magazine  
e-mail: <N2IRZ@cq-amateur-radio.com>



Photo B. A later-version WA4DSY 56k-Baud Modem. At upper left, the white cubes are the backs of the BNC RF in and out connectors. The FPGA is the large Xilinx chip center right, and to the right of that is the EPROM containing the FPGA programming data, waveform tables, modem state machine, TX/RX frequency data and the "secret" remote control codes to optionally allow for a remote PC reset.

modem (Photo A), more as a hobby aimed at supporting fellow enthusiasts than as a business. Dennis handled the digital side, while Dale took care of the analog circuitry.

Business was better than expected, so first Hayes, and then Heatherington, quit their jobs at NDC to devote more time to their modems. The company could just as easily have ended up being called Heatherington Microcomputer Products, but as Dale tells it: "We had that discussion, about what to name the company, and Heatherington was too long. Hayes was nice and short and easy to remember." Some time later, quite some time after they'd quit their jobs at NDC and production moved from Dennis' dining room table to an office park, did the company start to make money. "It was a leap of faith," said Dale. "The salaries were, quote, theoretical, to start with." A story not unlike many start-ups, I suppose.

The big advance brought to the market by Hayes Microcomputer, and Dale Heatherington specifically, was the idea of the command sequence. The modems they'd built until then were designed for specific Bus architectures, and so separating modem commands from data was trivial. Faced with a request to build a modem with an RS-232 interface, to allow a wider compatibility with the proliferation of home com-

puter architectures, the issue was, as Dale put it:

*"There's no problem in dialing the number, then going online and transferring information. The problem is how do you hang up? When you're sending a file, you don't know what's in the file. You can't designate a particular character as a hang-up character, but you'll never get a one-second pause."*

To solve that problem, he proposed a command sequence: A 1-second pause in the RS-232 data to enter Command mode, the hang-up command (+++), and then another short pause to return to Data mode. It worked like a charm. This became the basis of the *Hayes Command Set*, a widely-used set of dozens of commands still used to control virtually all telephone modems. Search the Internet if you're interested in the details.

### The 56k-Baud Beginning

That all happened in the late 1970s, and Dale decided to leave Hayes in 1985 (remember?). Imagine a technical guy, who spent the last several years innovating highly-popular and commercially successful modems, suddenly bored, with lots of time and a little money on his hands: Thus began the design of the 56k-Baud modem. Of course, one can also infer that Dale was having fun at

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Photo C. WA4DSY is demonstrating the output of one of his design sessions for me: iRoll, a self-balancing stool that uses a bowling ball as its wheel. It was absolutely frightening to watch him get on this thing, but it was as stable as a rock. I declined to give it a try, citing some imaginary fear of death and lack of faith in technology.

Hayes, since even after he left, he continued designing modems.

I won't get into the technical details of the modem, other than to make two specific points: The first is that it actually modulates the data into RF, something other packet modems don't do (they operate at baseband frequencies, not radio frequencies). The second is that it is a modem, not a TNC. Thus, we can discuss the weaknesses of the 56k modem, and why such a wildly innovative and ahead-of-its-time product never sold more than a few hundred examples.

### The Issues

The first issue was the *Ottawa Packet Interface* (PI) card. This was an ISA-Bus card designed for the IBM-PC (and clones) that served as the *terminal node controller* (TNC). Of course a TNC-2 could be used, but the RS-232 port in a standard TNC-2 was limited to 9600 baud, or perhaps 19,200 baud with some modifications, still far slower than the 56k-baud modem. The issue wasn't that the PI card didn't work well — it did — but now one needed a computer and all its fragilities and costs. Instead of buying a \$300 56k-baud modem and putting it on the air, now one had to get a computer — and even a 4.77-MHz IBM 5150 was a few hundred dollars, used, in those days, hope the hard drive didn't freeze (some packet sites were essentially outdoors), provide for clean

120-VAC power, space for a monitor, and more. Many concluded that it just wasn't worth the effort.

The second — and in my memory, the dominant — issue was that the 56k-baud modem had a few milliwatts output on 28 MHz and, since its 70-kHz bandwidth was definitely not legal below 220 MHz, also required a transverter, as well as possibly an RF amplifier depending on the transverter. This added a few hundred dollars and a fair portion of complexity to the equation, although it did simplify getting onto some of the less-crowded bands such as 902 or 1240 MHz, especially valuable if you had a decent line-of-sight path. I was deeply involved with packet at the time and I remember the transverter being the big issue, although Down East Microwave has several excellent choices.

### A New Design

In 1995, Dale was asked to redesign the modem: The original design was essentially all analog, delivered as three boards without an enclosure or any status indicators, and needed +5V/-5V and +12V power. The single-board redesign featured modern components including a Field-Programmable Gate Array (FPGA) chip and a single-chip FM receiver, was synthesizer tuned, and came in a durable extruded aluminum case with status indicator LEDs on the front. Best of all, it was being produced and marketed by a (then) leading packet supplier, PacComm, and could be driven by their (then) new SPIRIT-2 PAD design.

Alas, it wasn't enough. Although it is estimated that fewer than a hundred of the original design, and perhaps twice as many of the new design, were sold, I think anyone would be hard-pressed to identify 50 links that were ever put on the air. Even at its peak, GRAPES had only a half-dozen links active at 56k, and these were the guys who started it all. Nonetheless, for those users it was a great pleasure to operate packet: Super high-speed Internet access, lightning-fast messaging and more. At the time, putting in an RF stage for the UHF bands might have made the modem more attractive, but the cost would have surely doomed anything like that.

The sad lesson here is that, even with superior technology, something will come along fast and eat your lunch. In this case, it was the Internet as we know it today which, with its cheap, fast, and good data connections, rendered packet to a historical footnote. If it wasn't for mobile applications like APRS, and a nostalgic few networking enthusiasts, it

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Photo D. Three of Dale's champion fighting robots, and one oddball: Clockwise from upper left we have Death By Twinkies (showing some battle damage), Omega Force (with its unique anti-wedge fingers), Delta Force mini-sumo (a long-time champion), and last, a (non-competition) robot that walks without legs. The motor at the center spins the silver flywheel up to speed, and the hobby servo at the rear (with the wires taped to it) tips the motor-flywheel assembly left and right. Because of gyroscopic precession, the motor/flywheel maintains its vertical orientation, causing the rest of the robot platform to tip and "walk" on those little black feet on the underside. (Photo by N2IRZ)

might be even rarer than AM is on the HF bands.

Just so we don't end on such a low note, I want to share just a brief word on what Dale's up to today, and that word would be *robots*. BattleBots, specifically. Dale showed me several smaller fighting robots he's built over the past several years, including more than a fair share of champions (Photo D). Indeed, he is well-known in those circles, referred to as "a builder of almost mythical stature in the Robot Battles family," and his website <[www.wa4dsy.net](http://www.wa4dsy.net)> offers a glimpse into why that may indeed be so.

### Robots!

To help support his robot habit, he happens to have a fairly complete workshop in his backyard, including any tool you might ever need to have. I was particularly impressed by the CNC mill, but I could live with the lathe instead, I suppose. Dale has managed to keep the mortgage paid all these years, and has retired comfortably, never keeping still.

We should all hope to be as sharp as Dale when we retire, but I've decided to hedge my bets by taking much better care of myself. Sure, I should have started when I was 23, but as the old saying goes, too soon old, too late smart.

I'm finally settling in at my new QTH here in Atlanta, soothing the endless woes of an older house (will it ever end?), and waiting for an ice storm to show up so I can launch some antennas. I have been so busy unpacking mountains of boxes (so that's where my hacksaw went!) that I haven't had time to think of a topic for May, so help out a poor friend and drop me a line.

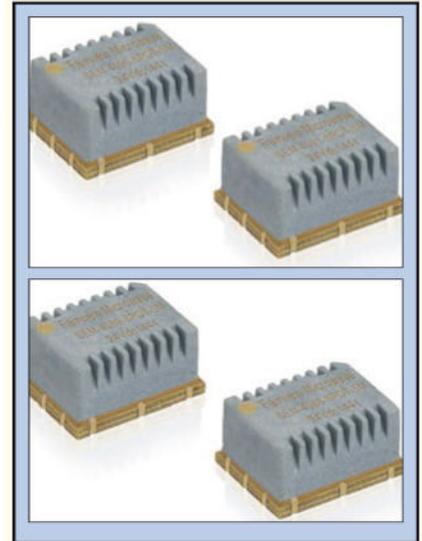
– Until next time, 73 de N2IRZ

### Notes:

1. I'll keep calling it the Internet for the sake of simplicity, but it wasn't anything like what we know today. The World Wide Web was in its infancy, content was generally limited, and inaccessible to non-subscribers, web browsers were in their infancy, and there were only a few hundred "websites."

## what's new

### Fairview Microwave Announces New High-Reliability Electromechanical Switches



Fairview Microwave Inc. has announced a brand new line of high-reliability SPDT (Single Pole Double Throw) surface mount electromechanical RF switches that cover broadband frequencies from DC to 8 GHz.

The new electromechanical SPDT switches utilize compact surface-mount packages and are designed for high-reliability performance rated for 2 million cycles at a minimum. Frequencies for these switches range from DC to 8 GHz and models incorporate either failsafe or latching actuators. Exceptional performance over a temperature range of -40C to +85 C includes a maximum CW power rating of 400 watts, high isolation up to 50 dB and insertion loss as low as 0.1 dB. Operating voltage is +24 VDC.

The package assembly is fully RoHS-compliant and the bottom side consists of a PWB mounting surface that is gold plated and designed to resist the effects of oxidation for ease of soldering. Assembly instructions and downloadable PWB layout software are available from Fairview's website. Another key feature with the package design is the ability to withstand exposure to MIL-STD-202 test conditions for sine and random vibration as well as mechanical shock.

Fairview's electromechanical relay switches are available now with pricing dependent on model. For more information, contact: Fairview Microwave, 1130 Junction Drive #100, Allen, Texas 75013. Phone: (972) 649-6678. Website: <<http://www.fairviewmicrowave.com>>.