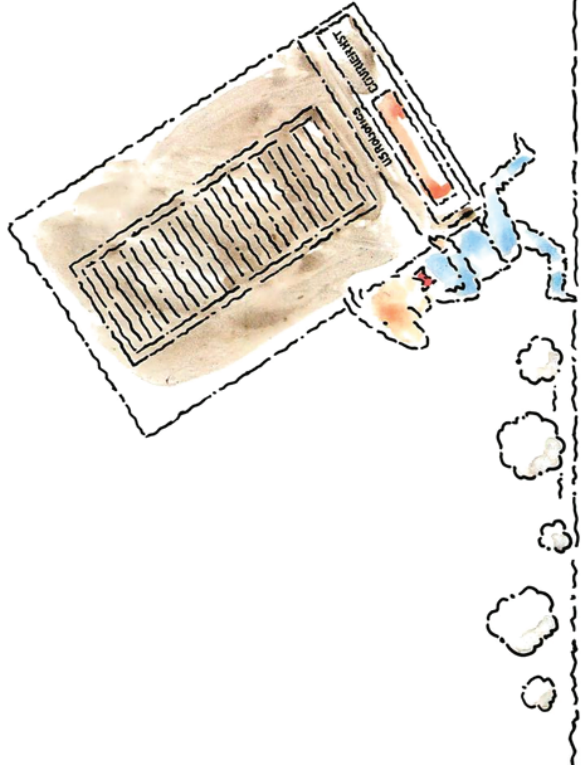


# Modems Matter

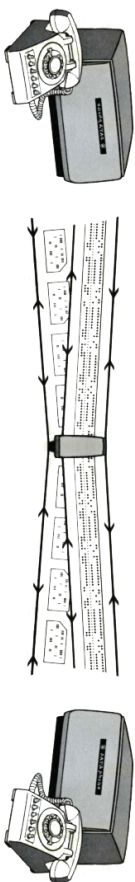
From 300 Baud to 56K



The modem is a gatekeeper, boundary-walker, border-crosser, turnstile-hopper, time traveler, and translator. In the early days of the net, the modem was a technology of distinction. Those who knew the modem's song were identified with it-- they were *modemers*, inhabitants of a modern world, agents of a modern era. Properly cared for and initialized, the modem's incantation revealed a new communicative field enveloping the mundane. Operating at the brittle edge of rationality, the modem was a charged device, transforming data into song using a vibrating crystal to keep time.

The term "modem" is a contraction of its two core functions: modulation and demodulation. In practical terms, a modem transmits a stream of digital information (e.g., 1001110100101) over a plain old telephone line by first generating an audible "carrier" signal and then periodically altering, or "modulating," that signal to represent a sequence of 1s and 0s. The receiving modem recovers the 1s and 0s by listening for changes in the carrier signal. The precise pitches and tempo of the modem's song are defined by a "protocol." Communication protocols are produced by committees of engineers aiming to efficiently push the maximum amount of information through a noisy medium. While modems typically include an error correction mechanism, they don't really care about the meaning of the data they transmit. A rogue messenger, the modem is a technology of communication rather than computation.

In the late 1970s, dial-up modems brought together the long tradition of amateur telecommunications and the emerging technical culture of microcomputing. With the introduction of the modem, the microcomputer was transformed into a medium for communication and the telephone network was remade into a space for experimentation and play. Life online began with the sound of a modem.



In 1962, AT&T began to advertise a new device called the Data Set 103A. The Data Set, also known as the "DATA Phone," was marketed to large organizations as part of a long-distance data communications package. The Data Set weighed 15 lbs. and shipped with industrial mounting brackets. An instructional video showed a woman sitting at a control console, surrounded by data processing equipment. After placing a phone call and exchanging pleasantries with someone on the other end, she asks, "Can my machine talk to your machine?" and proceeds to feed a stack of punched cards into the machine. As each card passes through the reader, a burst of high-pitched, staccato music rang out into the room, our diva's debut.

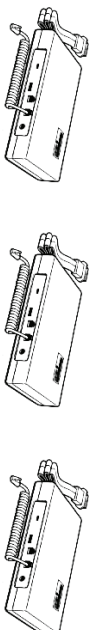
STATION MODE	SIGNAL TRANSMITTED	FREQUENCY (Hz)	
		DATA SET 103A1	DATA SET 103A2
Originating	$f_1$ mark ( $f_1^m$ )	1070	1270
	$f_1$ space ( $f_1^s$ )	1270	1070
Answering	$f_2$ mark ( $f_2^m$ )	2025	2225
	$f_2$ space ( $f_2^s$ )	2225	2025

The Data Set protocol, or Bell 103A, defined four frequencies for the transmission of "marks" (1) and "spaces" (0) between "originating" and an "answering" stations. The protocol also pegged the rate of digital exchange to a steady 300 bits (or about 40 alphanumeric characters) per second. Fifty years later, these same four frequencies continue to provide a fallback communication protocol for the global information infrastructure.

baud was no longer fast enough. But yet again, the International Telecommunication Union's (ITU) standards-making process could not meet consumer demand and modem makers introduced two new competing standards for 56K transmissions: K56flex and x2. Just as everyday folks were starting to explore the modem world, an arcane protocol war threatened widespread incompatibility.

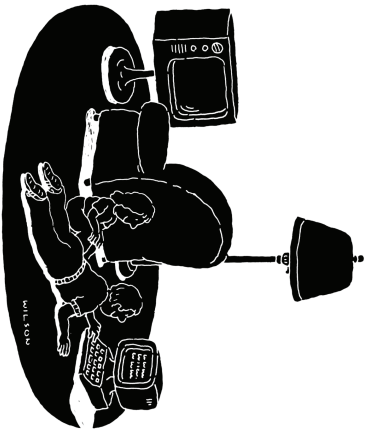
Dial-up modem design reached its technical apotheosis with a cohort of devices released in 1996. Amid the growing confusion over protocols, USRobotics began to court newbies with a promise of "risk-free" compatibility. Humorously dubbed "V-Everything," a riff on the ITU's naming schema, the new Courier modem jammed more than twenty-two different protocols into its tiny flash memory. In late 1997, USRobotics took out a four-page ad in PC Magazine including a \$50 cash-back coupon and a promise to deliver a free firmware update as soon as the ITU published a 56K standard. To risk-averse consumers, the Courier was positioned as a universal modem, the culmination of more than two decades of PC communications.

In practice, few connections ever reach 56K thanks to noisy local telephone lines but the Courier V-Everything remains state-of-the art. In 2016, thousands are still in service, quietly humming their songs to point-of-sale terminals, scientific lab equipment, and network management systems around the world.



For over thirty years, microcomputer enthusiasts experimented with the modem's capacity to sing data over the phone. This small cadre gave rise to a vast network of online communities, many of which continue to thrive. As the modern-day internet took shape in the 1990s, modem connections provided the primary means for curious computer owners to explore the online world from home. They also served as gateways and bridges among disparate systems, whispering bits of data across political, geographic, and institutional boundaries using little more than plain old telephone calls.

Today, the modem's song is an audible symbol of a past that few internet users ever experienced first-hand. In the United States, broadband overtook dial-up in 2005, when just over half of the country routinely accessed the net and almost no one owned a smartphone. By taking a moment to reflect on the technical development of the dial-up modem, we pay tribute to the thousands of modemers who made early homes online. Through their curiosity and creativity, the net became a place to hang out, find love, meet friends, talk smack, and goof off. As the internet continues to fade into the unremarkable background of everyday life, let's remember what it was like when only the song of a modem could bring it into view.







mid-1980s, packet radio amateurs were running their own chat, email, and bulletin board systems on the airwaves, wholly independent of the telephone network.

High speed modems were a technical marvel but they held little appeal for community-oriented modems who could pick up a new 2400 baud modem for less than \$100. The experience of chatting, sending email, and reading forums was perfectly pleasant at slower speeds and many modem buyer's guides recommended cheaper, slower modems to users primarily interested in communicating with other humans rather than other machines. "When reading online," wrote one author, "the limitation is *your* speed, not the modem's."

In late 1991, however, just as the Clinton/Gore campaign was beginning to promote the "information superhighway," Rockwell Digital Communications announced the availability of a new microchip combining multiple protocols and a 14400 data rate that would substantially shift the accepted relationship between price and speed.

At first glance, the external modem released by Supra in 1992 looked like any other Hayes knock-off but its aluminum case housed the new Rockwell chip. At \$400, the SupraFaxModem undercut all of the dominant players by half and precipitated a price war that drove the cost of a high speed modem down to \$250 over the next twelve months. Modems based around the new Rockwell chipset so destabilized the market that reviewers began to recommend the SupraFaxModem as a drop-in replacement for more expensive name brands. This dramatic reduction in price presaged the mass adoption of modems in the latter half of the decade. Whereas the modem was once considered an optional upgrade, it soon became an essential feature of the standard home computer.

By the middle of the decade, the dial-up modem was approaching its technical horizon. According to Claude Shannon's noisy-channel coding theorem, the maximum transmission rate possible for the twisted pair of copper cables leading out of your home is somewhere around 33.4K bits-per-second. Faster 56K rates are possible only for calls that travel partially over digital circuits.

With the swift growth of commercial online services like America Online, the demand for speed increased dramatically after 1995. On the graphical Web, 2400

Initially, AT&T exercised total control over the Bell System and only their modems could be attached to the network. In 1968, the FCC decided that AT&T could no longer prevent users from connecting their own devices, provided that they did no harm to the system. While this decision made modems strictly legal, many American homes lacked standard telephone jacks well into the late-1970s. Even if a modem were available, they would have had nowhere to plug it in!

To circumvent the lack of a standard wall jack, early modems adopted an "acoustic coupler" design. Acoustic couplers featured a speaker and microphone carefully positioned to match the handset of a Western Electric Model 500 telephone. The availability of wall jacks was so uncertain that Radio Shack continued to sell acoustic couplers until 1992.

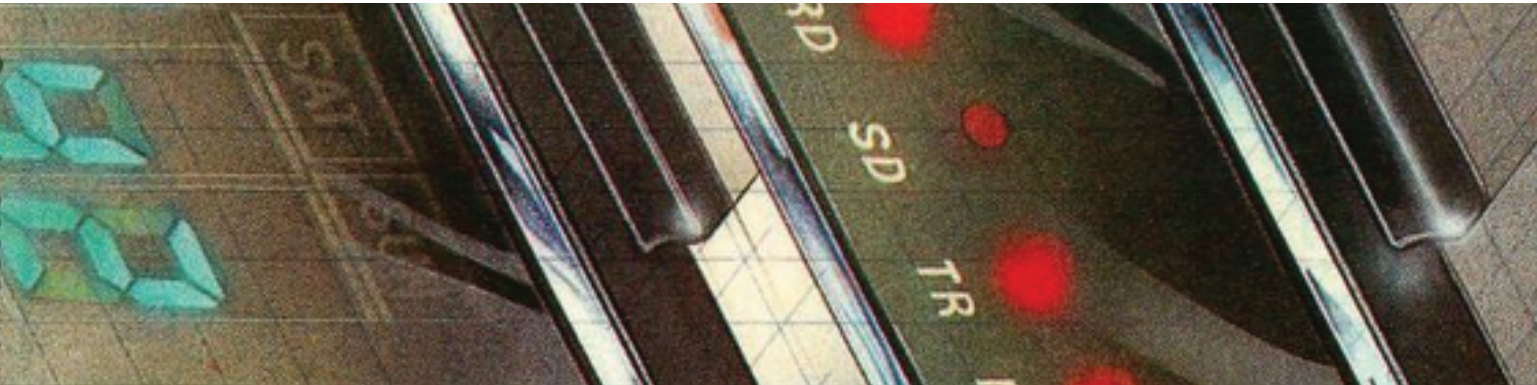


In March 1976, the cover of *Popular Electronics* magazine boasted an "exclusive" modem project by Lee Felsenstein, a radical engineer known for his early experiments with microcomputers and online communities. The "Pennywhistle" busted open the closed world of the microcomputer, enabling hobbyists to more easily move data in and out of their machines--no simple task in the days before affordable floppy drives. In fact, the primary use for the Pennywhistle was not telecommunications but data storage. In addition to its acoustic coupler, the Pennywhistle included an audio jack to interface with yet another new medium: the audio cassette recorder.

Like the Data Set, the Pennywhistle modem was a hands-on device that could not be operated autonomously. A human being still needed to pick up the telephone handset, dial a number, and listen for a carrier tone on the other end of the call.







The Hayes Smartmodem, with its "stackable" aluminum case, blinking red LEDs, and fairy tale origin story, is an icon of 1980s telecomputing. In 1977, at a dining room table in an Atlanta suburb, two friends endeavored to design an affordable modem for the hobbyist community. Their first product was a pre-assembled expansion card for the popular S-100 "Altair" platform. The owner's manual suggested a variety of social applications for the modem such as building a database for your local computer club, running multiplayer games, and telecommuting to save on gasoline.

In 1981, Hayes released the Smartmodem, a sharp-looking device designed to fit neatly beneath a Model 500 telephone. By this time, microcomputing had grown beyond the hardcore hobbyist clique thanks to pre-built machines like the Radio Shack TRS-80 and Commodore PET. Whereas most modems were vendor-specific, the external Smartmodem connected to any PC with an RS-232 serial port. Further, the Smartmodem came with its own microprocessor, a Zilog Z8 chip that could be programmed to automatically answer the phone, dial numbers, change modes, and hang up. Finally, the Smartmodem included an internal loudspeaker to fill your room with that memorable modem song.

By the mid 1980s, the "Hayes command set" had become a de facto standard and nearly all consumer modems were advertised as "Hayes-compatible." While many modem makers were content to produce clones of the Smartmodem, others began to experiment with the notion of a "smart" modem, crafting special-purpose companion devices rather than mere peripherals.

In 1981, Novation Inc. released the Apple-CAT II, a complex piece of telecom hardware billed as "more than just a modem...a personal communication system." The Apple-CAT II shipped with a variety of oddball accessories including a pair of plastic hooks for hanging a telephone handset off the side of the Apple II chassis. Novation packed the device's firmware with a grip of uncommon features including a half-duplex 1200 baud high-speed mode based on the Bell 202 standard, a communications protocol so uncommon that it was practically exclusive. The four-fold speed boost was catnip to data-hungry software collectors and sysops were keen to advertise high speed CAT lines. Beyond file traders, the Apple-CAT offered compatibility for telecommunication devices for the deaf (TDD) and became especial-

ly prized among phone phreakers who took advantage of the programmable dialer, tone generator, and handset interface for spelunking the Bell System.

In the modem world, transmission speed was about more than user patience or convenience. Long-distance dialing was billed according to call duration so it was in a modemer's best interest to get off the line as quickly as possible. Likewise, most bulletin board systems were "one-liners" that could accommodate just a single user at a time. Therefore, it was also in the community's best interest to keep each connection as time-brief and data-rich as possible.

But, a technological chasm yawned between 2400 and 9600 baud. The International Telecommunication Union's standard for 9600 baud transmission, V32, required manufacturers to implement a tricky echo cancellation algorithm, the cost of which would have driven up the price of their modems. At \$700-1200, high-speed modems already exceeded the typical middle-class hobby budget.

The USRobotics Courier HST was one of a handful of new modems to skirt the ITU standard by introducing a proprietary protocol. Competitive with peer devices from Telebit and Hayes, USRobotics was unique in its enthusiastic embrace of the BBS scene. For years, they offered BBS sysops a deep discount in exchange for an electronic shout-out. Thanks to the sysop program, the Courier HST became known as an affordable high-speed workhorse (with positive externalities for its maker!)

Like the Apple-CAT II, the USRobotics Courier HST was a hit among the warez underground (which now involved massive hierarchical organizations) but it also facilitated the growth of translocal messaging networks such as FidoNet, RelayNet, and WWWnet. For both file-traders and message nets, HST connections enabled the global circulation of data by reducing the burden on each transnational link.

Meanwhile, amateur radio operators (or "hams") were finding uses for modems in their wireless hobby as well. In 1978, hams in Canada began to exchange data over the air using second-hand Bell-compatible modems with homebuilt interfaces or "terminal node controllers" (TNC). Doug Lockhart (VE7APU), founder of the Vancouver Amateur Digital Communications Group (VADCG), designed the first widely used TNC kit, which came to be known as the "VADCG TNC." Soon, "packet radio" spread to the U.S. and by the

