The Radio Hotel -- Phenomenal △ --Data Xfer Rates

What did the snail yell while riding on a turtle's back? Wheeeee!

by Rick Hiller W5RH

Back in the late 1900's, we were excited about 300 baud telephone modems and what they could provide us: a window into the digital world of data transfer with e-mail and chat rooms and the beginning of the World Wide Web. Now, just 25 years later, we are slightly disappointed with data rates of 500 Mbps in our homes with close to zero latency times both up loading and down. Let's look in the rear-view mirror.

Let's start at the Pony Express in 1865. Pony Express was run by Wells Fargo Stage Company. Traveling 1900 miles from Fresno, CA to St. Josephs, MO., it used horse replenishing stations every 25 miles and a corps of young, lightweight, high-endurance riders such as legendary cowboy Buffalo Bill Cody, changing from one of the 500 fast steeds in the livery to a fresh one. It took nominally 10 days to travel the full 1900-mile distance. Note: If you wished your letter to go all the way to the east coast, it took another 4 days via train to get there.

The Pony Express speed. It ran a simplex distance of 1,900 miles (Calif to Mo.)

Typical delivery time: 10 days (Best recorded run: 7 days 17 hours)

Let's use the *best* run because it's a famous benchmark.

Convert to mph: 7 days, 17 hours =185 hours for 1900 miles equals **10.27 mph**.

Converting the Pony Express into a **"data rate"** …

Pony Express riders carried about 200 letters in the 4 locked cantinas of "la Mochila" pouch

If each letter page was, for example, about 2KB of ASCII text then the total data payload is 200 x 2KB or 400 KB……delivered in 185 hours is 2.16 KB/hour.

Convert to bytes per second: 2.16KB /3600 seconds (per hour) = .0006KB/sec

That's 0.6 bytes per second, at 8 bits per byte, equals **4.86 bits per second.**

OK, so the speed was slow and the latency might as well be infinite, BUT – the error rate was very close to zero…pending the occasional Indian attacks.

Comparing 4.86 bps to the nominal "250 Mbps" Internet of today….250 million bits per second

That's 250,000,000 / 4.86 = **5.14×10^7 times faster than the Pony Express. A phenomenal change.**

Now, Hams aren't so concerned with sustained data transfer. We just wish to link to another station and for them to link back to us to complete the QSO. Weather/QRN is an issue in both cases, as is propagation versus Indian attacks. How have ham data rates changed for hams? A quick glance…

Mode	Era	Approx. Useful Data Rate	Key Strength
RTTY	1930s–	~50–60 bps	Simple, classic
AMTOR	1980s	~100–200 bps	Error-correcting RTTY
PACTOR-I	1990	~200 bps	Reliable HF email
PACTOR-II	1990s	~1400 bps	Adaptive
PACTOR-III	2000s	~3600 bps	High-speed HF
FT-8	2017	6.8 bps	Ultra weak signal decodability
Q65	2020	~20-100bps structured	EME & scatter at insane SNR levels

Digital modes didn't evolve in a straight line toward "faster." They evolved toward more reliable and more sensitive, especially for weak-signal work. That's why Q65 can pull Moon bounce signals out of the mud that RTTY wouldn't even notice.

If you are interested in reading more about the old west data days, I can suggest the following:

Wells Fargo -- *https://history.wf.com/the-real-story-behind-the-pony-express/*

Books:

Syntony to Spark – Hugh G. J. Aitken – Princeton University Press

The Victorian Internet – Tom Standage – Berkley Books

Wires West – Phil Ault – Dodd, Mead and Company

Pony Express Equipment

Mochila was the sheet of leather that held a cantina on either side of the horse
Mochila in Spanish translates to "backpack" in English.
It's the everyday word kids use for their school bag.

⭐ In Pony Express history, "la mochila" had a special meaning

The mochila was the leather mail saddle cover that sat over the rider's saddle. It had four locked mail pockets (called *cantinas*) and could be lifted off and thrown onto a fresh horse in seconds.

So:

- **Everyday Spanish: *mochila* = backpack**
- **Pony Express Spanish: *mochila* = the removable leather mail carrier used by riders**

🐎 Mini Diagram of the Pony Express Mochila

(Text-based, classroom-friendly layout)

Code

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┌───────────────────────────┐
│   │      SEAT OPENING      │
│ │ (fits over the saddle horn) │
└───────────────────────────┘
             │         │
   ┌─────────┘         └─────────┐

┌──────────────────┐  ┌──────────────────┐
│ │ CANTINA (Front)│  │ CANTINA (Front) │ │
│  │ Mail Pocket #1│  │ Mail Pocket #2 │  │
│     │ (locked)   │  │ (locked)    │     │
└──────────────────┘  └──────────────────┘
```

MOCHILA BODY
(thick leather cover that
drapes over the saddle)

CANTINA (Rear)
Mail Pocket #3
(locked)

CANTINA (Rear)
Mail Pocket #4
(locked)

CUTOUT FOR SADDLE SEAT
(lets rider sit normally)

What Each Part Does

Cantinas (4 total)

- These are the mail pockets
- Two in front, two in back
- Each one locked
- Riders swapped the whole mochila, not the letters inside
-

Seat Opening

- A big hole so the mochila can slide over the saddle horn
- Makes it easy to lift off and throw onto a fresh horse in seconds
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Mochila Body

- Thick leather sheet
- Drapes over the saddle like a blanket
- Holds all four cantinas together

Rear Cutout

- Lets the rider sit directly on the saddle, not on the mail

📘 Binder-Ready Summary

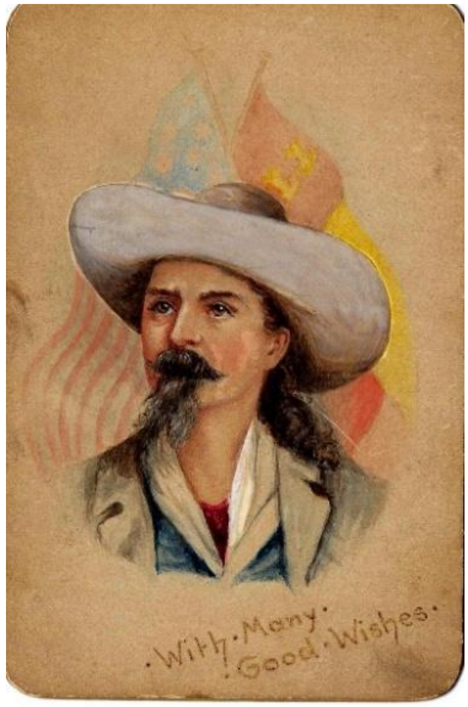
High Speed Data Delivery – Western Style

The mail carrying gear consisted of a mochila, a leather sheet draped over the horse and saddle. 4 locked pockets or "cantinas" were sewn into the sheet carried the mail. Typically, 200 letters were carried on each trip.   So, with those data points gathered from the rich history you can calculate the data rate and latency. Latency is easy. 10 days nominal with some trips being faster. The record was 7.x days. Cool thing is that the error rate was pretty much zero.

The end of the Pony Express came due to the overland telegraph causing a tremendous data rate increase. Hams can estimate 20 to 25 words per minute hence sending the same 200 pages would take about 5 minutes per page times 200 pages is 1000 minutes or 16 hours

Shift forward to today's data rates of say 400 Mbits per second. It would take just a few seconds to send those same 200 pages once they were in digital form. And this rate can be kept up all day long for a cost of pennies (God rest their copper souls) per hour. Whereas the typical letter cost for the Pony Express was $1 on top of the postage (and we think our postage rates are high HI). But, if you needed to tell that girl back east that you wished to marry her, and for her to travel west, then it was worth that dollar.

The above biomechanics versus electromagnetism comparison is pretty crazy.   If you are interested in some detailed Pony Express history, there is much more to the story which can be found on the web at Wells Fargo and other sites. Another interesting historical story is that of the Victorian "Internet", a modern coined term, and that story is how the overland and undersea telegraph was used by everyday folks to communicate just as we do in email. Maybe I'll espouse that story at some later month in the Radio Hotel.



- **The picture of Buffalo Bill, one of the Pony Express riders, is a scan of an original placard given to me by my Uncle Charles Hayes whose parents worked as Bill Cody's PR people. My Uncle even had a few pistols that he donated to the Buffalo Bill museum in Cody, Wyoming.**

Ham Radio Data Rate History – From Chat GPT

1. RTTY (1930s → present)
Speed: ~45.45 baud → ~50–60 bps

- **5-bit Baudot**
- **170 Hz shift**
- **Mechanical teleprinters**
- **About 6 characters per second**
- **Still used today for contests and nostalgia**

Why it mattered: It was the first widely adopted digital mode in ham radio.

🕰️ 2. AMTOR (1980s)
Speed: ~100 bps (Mode A), ~200 bps (Mode B)

- **Error-correcting RTTY successor**
- **ARQ (automatic repeat request)**
- **Much more reliable than RTTY on HF**

Why it mattered: First *robust* HF digital mode with forward error correction.

🕰️ 3. PACTOR (1990 → PACTOR-III in 2005)
PACTOR-I: ~200 bps
PACTOR-II: ~1400 bps
PACTOR-III: up to ~3600 bps

- Adaptive, multi-tone
- Error correction + compression
- Used heavily for Winlink

Why it mattered: First HF mode to break the kilobit-per-second barrier reliably.

🕰️ 4. FT8 (2017)

Speed: ~6.25 baud, ~75 bps raw, ~6.8 bps *useful text*

- 15-second frames
- Extremely narrow bandwidth (50 Hz)
- Decodes at –21 dB SNR
- Not designed for text — only structured messages

Why it mattered: Revolutionized weak-signal HF work; made low-power DX accessible to everyone.

🕰️ 5. Q65 (2020)

Speed: varies by submode, typically ~20–100 bps structured, not free-text

- Designed for EME, troposcatter, ionoscatter
- Decodes at –30 dB SNR or better
- Uses 65-tone QAM-like structure
- Highly time-synchronized

Why it mattered: Made small-station moonbounce practical — your favorite topic.

📈 Speed Comparison at a Glance

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FT8	2017	~6.8 bps usable	Ultra-weak signal
Q65	2020	~20–100 bps structured	EME & scatter work

Digital modes didn't evolve in a straight line toward "faster." They evolved toward more reliable and more sensitive, especially for weak-signal work.

- RTTY → AMTOR → PACTOR: chasing *speed and reliability*
- FT8 → Q65: chasing *decodability at insane SNR levels*

That's why Q65 can pull moonbounce signals out of the mud that RTTY wouldn't even notice.

Introduction to Digital Modes in Amateur Radio

Digital modes in amateur radio have markedly transformed global communication among operators, facilitating the conversion of radio waves into sophisticated digital signals. This technological melding of computer interfaces with radios has precipitated considerable advancements, notably enabling amateurs to decipher weak signals and maintain efficient communication sans voice transmission. This article endeavors to explore prominent digital modes such as FT8, PSK31, and RTTY, among others, detailing their unique functions and applications.

FT8: The Game Changer in Weak-Signal Communication

FT8, a digital mode formulated by Joe Taylor, K1JT, is specifically crafted for weak-signal environments. Utilizing eight-frequency shift keying (8-FSK), FT8 is distinguished by its ability to facilitate contact over extensive distances, even amidst challenging conditions. The mode employs a protocol composed of synchronized time slots, with stations alternating between transmitting and receiving in 15-second intervals. This efficiency, coupled with automated sequencing, ensures FT8's status as a favored choice among operators keen on the challenge of establishing reliable communication under adverse circumstances.

FT8's rise to prominence is attributed to its capacity to operate efficiently within narrow bandwidths, which equips it to overcome obstacles such as interference and atmospheric noise. By optimizing time and frequency use, FT8 allows operators to make rapid contacts, a feature that is particularly valuable during crowded contests or when operating in resource-limited environments. Its automated nature, facilitated by decoding software, reduces user workload and enables seamless operation by conducting exchanges with minimal manual intervention.

PSK31: Optimizing Bandwidth Efficiency

PSK31, which stands for Phase Shift Keying at 31.25 Hz, was crafted by Peter Martinez, G3PLX. It is lauded for its narrow bandwidth and its resilience to errors, making it apt for keyboard-to-keyboard QSO (conversation) on HF (high frequency) bands. The mode employs phase shift keying with a narrow frequency excursion, diminishing interference and optimizing bandwidth usage.

The ergonomic design of PSK31 enables smooth operation over long distances even with modest power levels, making it accessible to all amateur radio enthusiasts. Its slow pace and narrow signals grant users the flexibility to hold lengthy conversations without occupying excessive bandwidth, a feature that continues to promote its popularity among those who seek unhurried communication. The ease of setting up a PSK31 station, coupled with accessible decoding software, further encourages its widespread adoption within the amateur radio community.

RTTY: The Historical Digital Mode

RTTY (Radio Teletype) stands as one of the earliest digital modes, having reliably served as a communication beacon since its genesis. Employing frequency shift keying (FSK), RTTY typically uses Baudot code, a 5-bit character set, as its medium of transmission. This simplicity contrasts with modern digital counterparts yet remains effective in conveying messages, establishing it as a staple in amateur contests due to its straightforwardness and dependable reliability.

The longstanding popularity of RTTY can be attributed to its established nature and the significant community base that upholds traditional modes of communication. Even with the advent of contemporary digital modes, RTTY maintains a robust presence in amateur radio, often regarded as the go-to option for operators engaged in contests desiring a reliable and proven protocol. Operators find solace in its predictability and classic operation style, despite the preponderance of newer modes with advanced features.

Exploring Other Digital Modes

While FT8, PSK31, and RTTY tend to dominate digital mode conversations, several other options present intriguing capabilities worthy of exploration, each tailored for specific applications.

JT65, akin to FT8, is structured for weak-signal operations and frequently utilized for moonbounce (EME — Earth-Moon-Earth) and tropospheric scatter communications. Employing extended transmission cycles, JT65 necessitates precise timing and synchronization to achieve successful contacts.

Olivia, on the contrary, is heralded for its adeptness in decoding audio under challenging conditions. Its ability to mitigate issues like multipath distortion and fading establishes it as a preferred choice for communication in adverse environments, enabling reliable contacts despite impaired signal clarity.

MFSK (Multiple Frequency Shift Keying) modes are noted for their resilience to noise, employing multiple tones for data encoding. This strategy fortifies MFSK's capacity to handle various communication conditions, rendering it a robust option when facing signal disruptions or interference.

Conclusion

The exploration of digital modes within amateur radio unveils a myriad of possibilities for radio enthusiasts, consistently pushing the envelope of communication technology. From reaching international destinations with faint signals via FT8 to savoring protracted conversations with PSK31, the spectrum of digital modes symbolizes the harmonious convergence of tradition and technological progression. As digital communication continues its evolutionary trajectory, radio operators can anticipate even more sophisticated, efficient digital modes in the foreseeable future.

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