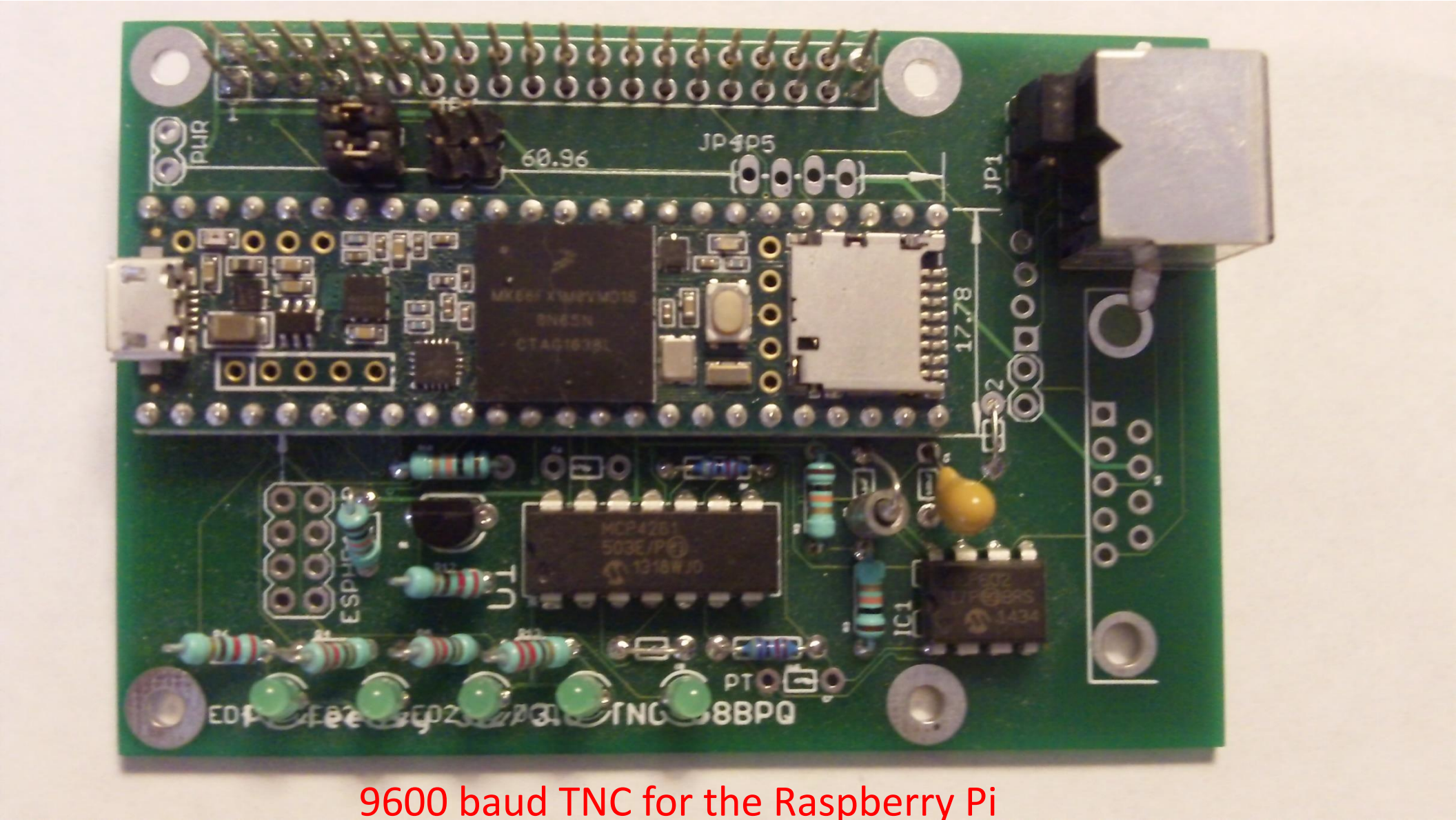
TNC-Pi9k



9600 baud TNC for the Raspberry Pi

Based on the Teensy 3.6 Microcomputer

Available from PJRC Electronics

TNC-Pi9k Developed by John Wiseman, G8BPQ (I named it)

Actual Teensy size is 2.4 by .7 inches

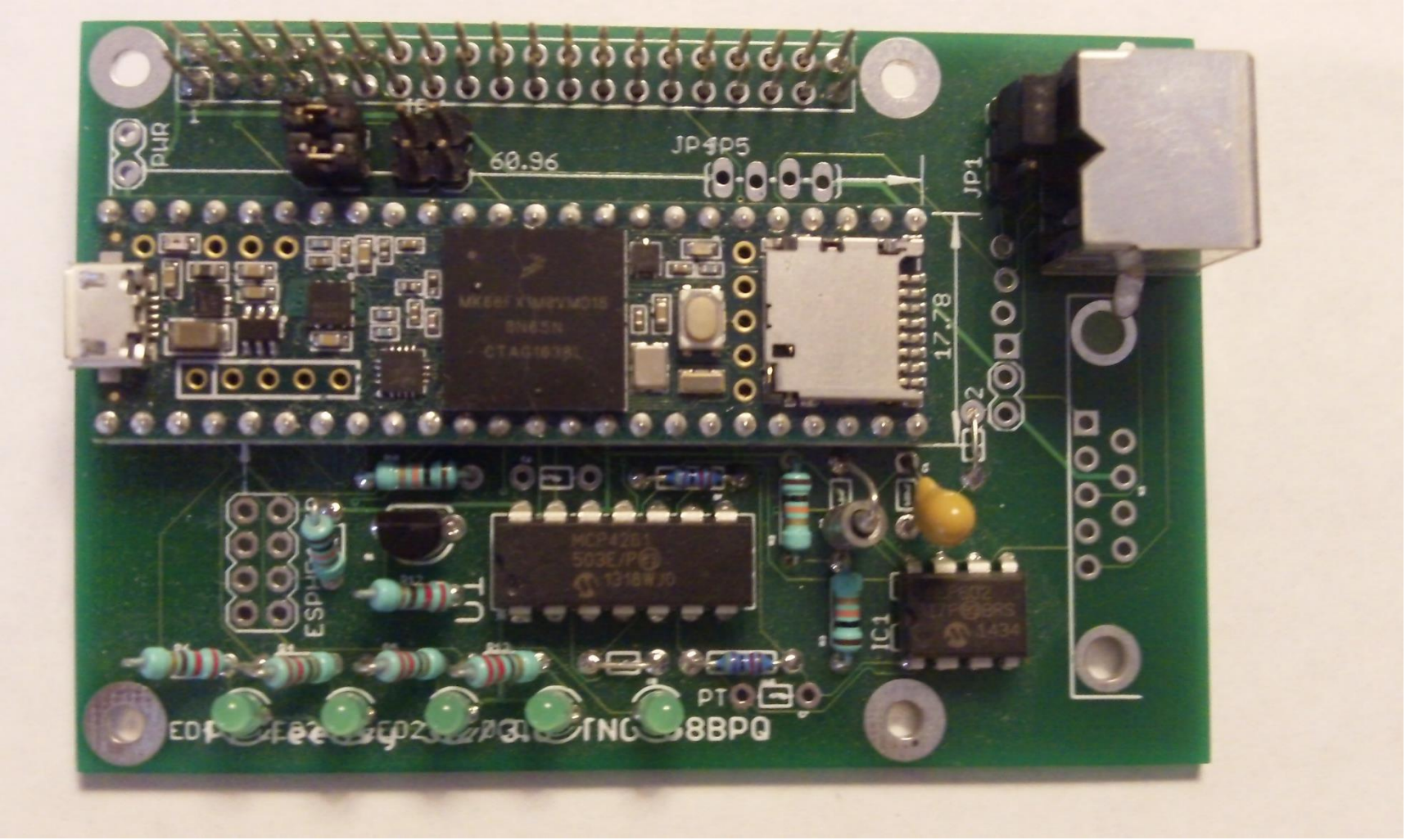
Features a 32 bit 180 MHz ARM Cortex-M4 processor with a built in floating point unit and 512 MB RAM

Other components just a dual op-amp and a digital potentiometer

Everything is done in software!

Mini-USB port on left for programming

Mini-SD card socket on right is not used



Programming done in “C” using the Arduino software development tool on a Windows computer

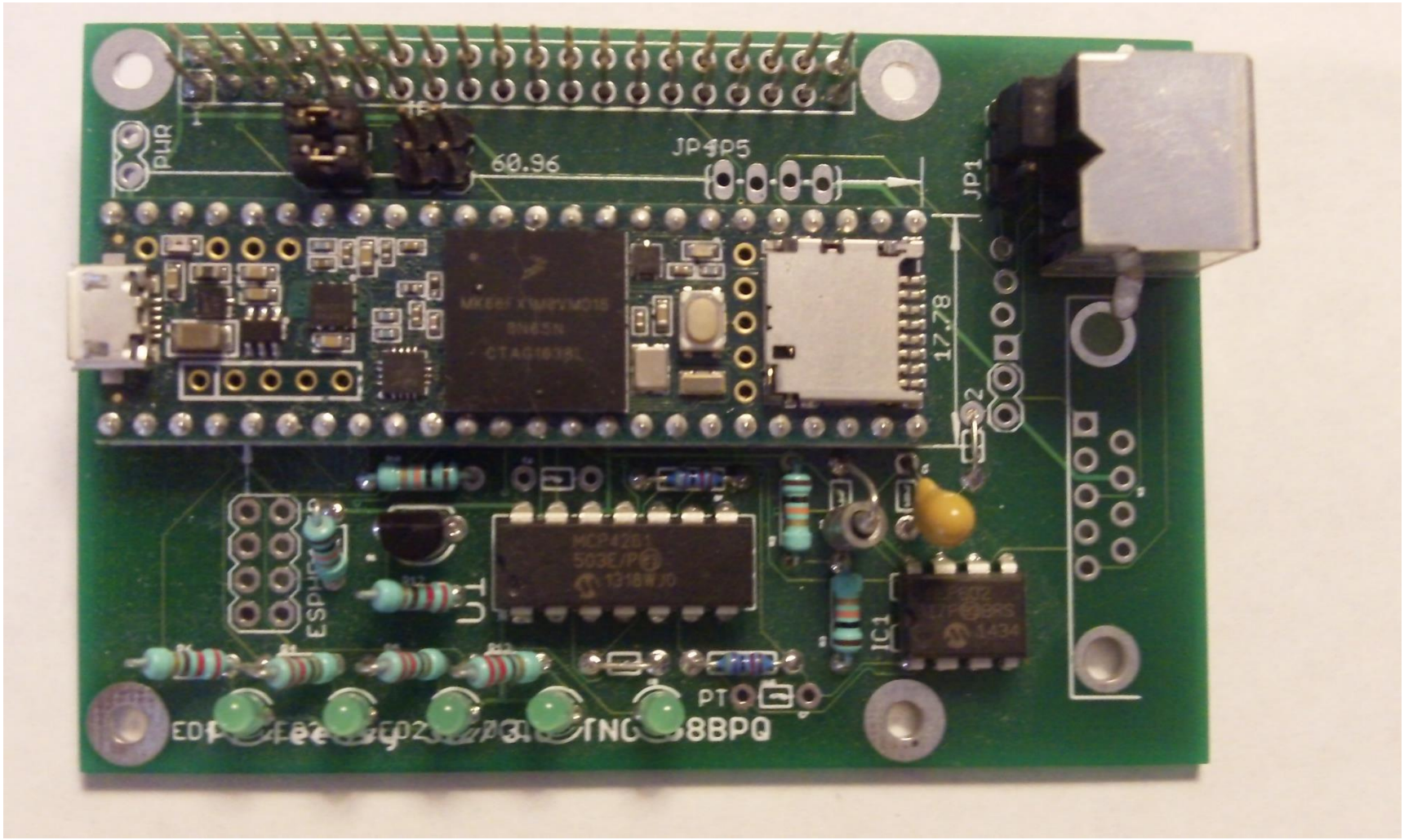
Based upon the Thomas Sailer Soundmodem software

Plug mini-USB into port from Windows machine and compiled software is automatically uploaded and the board rebooted

Can also use the new ARDOP protocol which is faster than 1200 packet (requires recompiling and reloading software)

ARDOP for Linux requires a driver not yet available. May be coming soon.

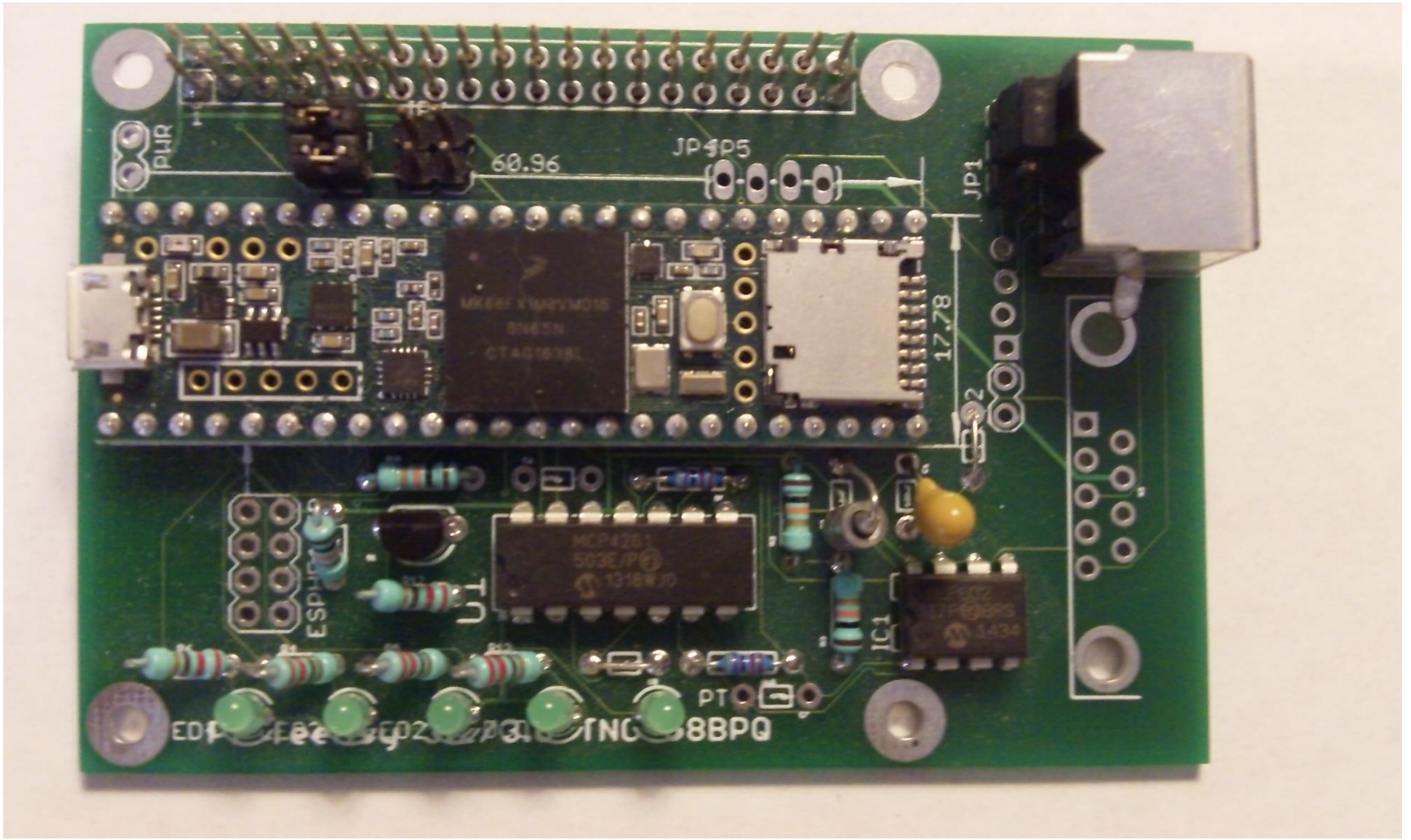
Works with LINBPQ



Appears to the Raspberry Pi as a hardware KISS TNC

Straight plug in replacement for the current TNC-Pi2

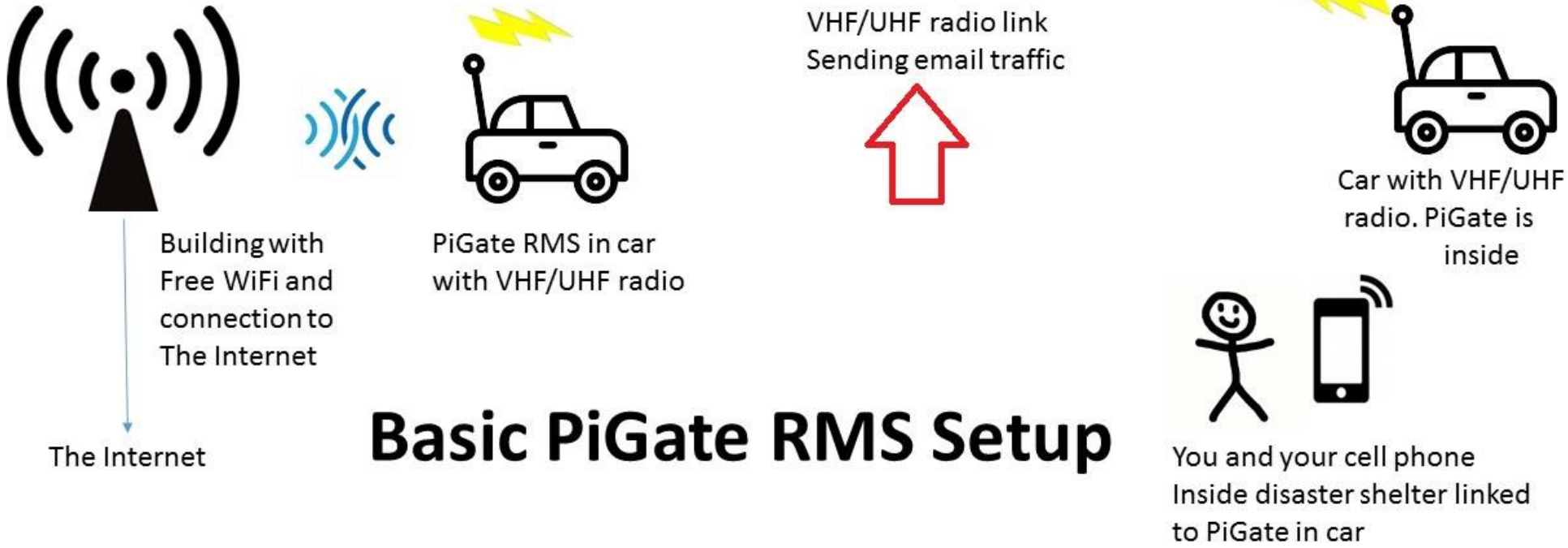
2400 baud mode is available but may not work due to radios



Some Definitions

- Baud = bps (BITS per second)
- BER (Bit Error Rate) nbr of errors / total bits sent, expressed as 10^{-n}
- CRC (Cyclic Redundancy Check) is an error **detecting** code
- Frame and Packet
  - Both are packages of data moving through a network (OSI model)
  - Frames are units of data in the Link Layer (layer 2)
  - Packets are units of data in the Network Layer (layer 3)
  - Both terms are often used interchangeably but not technically correct

My Perspective (Red Arrow)



Radio Data Transfer Speeds

- Highly dependent upon the frequency bandwidth available
- OTA DTv requires 6 MHz bandwidth for 32 Mbps (more with compression)
- 4G LTE cell phones in the 800/900/1200 MHz frequencies can have up to 20 MHz bandwidth to achieve 300 Mbps downloads

Amateur Radio Data Transfer Speeds

- For amateur radio bandwidth is significantly less!
- Slow scan TV must fit into a 3 KHz SSB transmission
- Capabilities can be determined by the Shannon-Hartley theorem

$$C = B\log_2(1+S/N)$$

- C is the channel capacity in bits per second
- B is the channel bandwidth in hertz
- S is signal power measured in watts
- N is the average noise over the band measured in watts

Radio Data Transfer Speeds

- This means for a average 15 KHz FM signal, 100 Kbps is possible under the absolutely BEST conditions (no noise)
- 9600 baud (9.6 Kbps) is easily within reach

Packet Frequencies

- 10 Meters – 1200 baud FM – not very reliable
- 6 meters – 1200 baud FM – works in low noise environments
- 2 meters and up – 1200 to 9600 baud FM
- 220 MHz may be the ideal packet band – hard to find radios
- Useful if you have full control of both ends of the comm link (such as using the PiGate and PiGate RMS system)

Packet Radio Modulation

- Two modes, AFSK and FSK (audio frequency shift and frequency shift keying)
- In use for a long time, starting with RTTY many years ago

RTTY

RADIOTELETYPE

9600 Baud Packet

- Cannot use audio coupling to transceiver so AFSK is out

9600 Baud Packet

- Cannot use audio coupling to transceiver so AFSK is out
- Uses true FSK mode - no tones - sounds like static

9600 Baud Packet

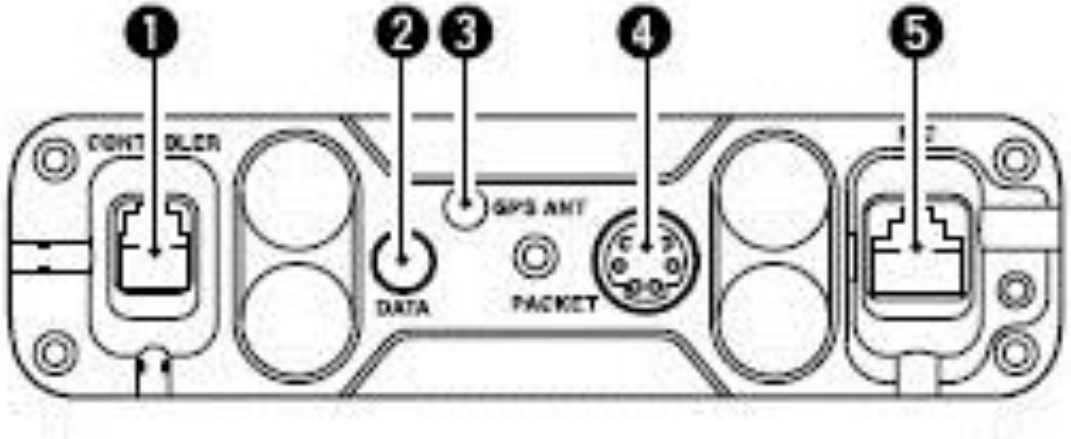
- Cannot use audio coupling to transceiver so AFSK is out
- Uses true FSK mode - no tones - sounds like static
- VERY susceptible to noise – requires strong signals for a link

9600 Baud Packet

- Cannot use audio coupling to transceiver so AFSK is out
- Uses true FSK mode - no tones - sounds like static
- VERY susceptible to noise – requires strong signals for a link
- Can only be used with radios **that are designed** for 9600 baud packet

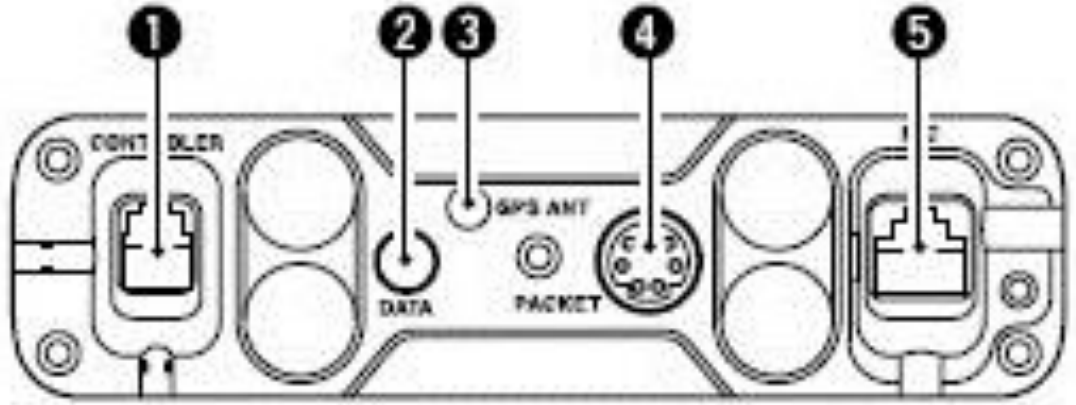
9600 Baud Packet

- Cannot use audio coupling to transceiver so AFSK is out
- Uses true FSK mode - no tones - sounds like static
- VERY susceptible to noise – requires strong signals for a link
- Can only be used with radios **that are designed** for 9600 baud packet



9600 Baud Packet

- Cannot use audio coupling to transceiver so AFSK is out
- Uses true FSK mode - no tones - sounds like static
- VERY susceptible to noise – requires strong signals for a link
- Can only be used with radios **that are designed** for 9600 baud packet



Bit Error Rate (BER)

- Not all radios are equal

Bit Error Rate (BER)

- Not all radios are equal
- Many radios with a packet data port have the BER tested by the ARRL

Bit Error Rate (BER)

- Not all radios are equal
- Many radios with a packet data port have the BER tested by the ARRL
- Not always published – manufacturer does not publish

Bit Error Rate (BER)

- Not all radios are equal
- Many radios with a packet data port have the BER tested by the ARRL
- Not always published – manufacturer does not publish
- Only radios with a good BER will work

Bit Error Rate (BER)

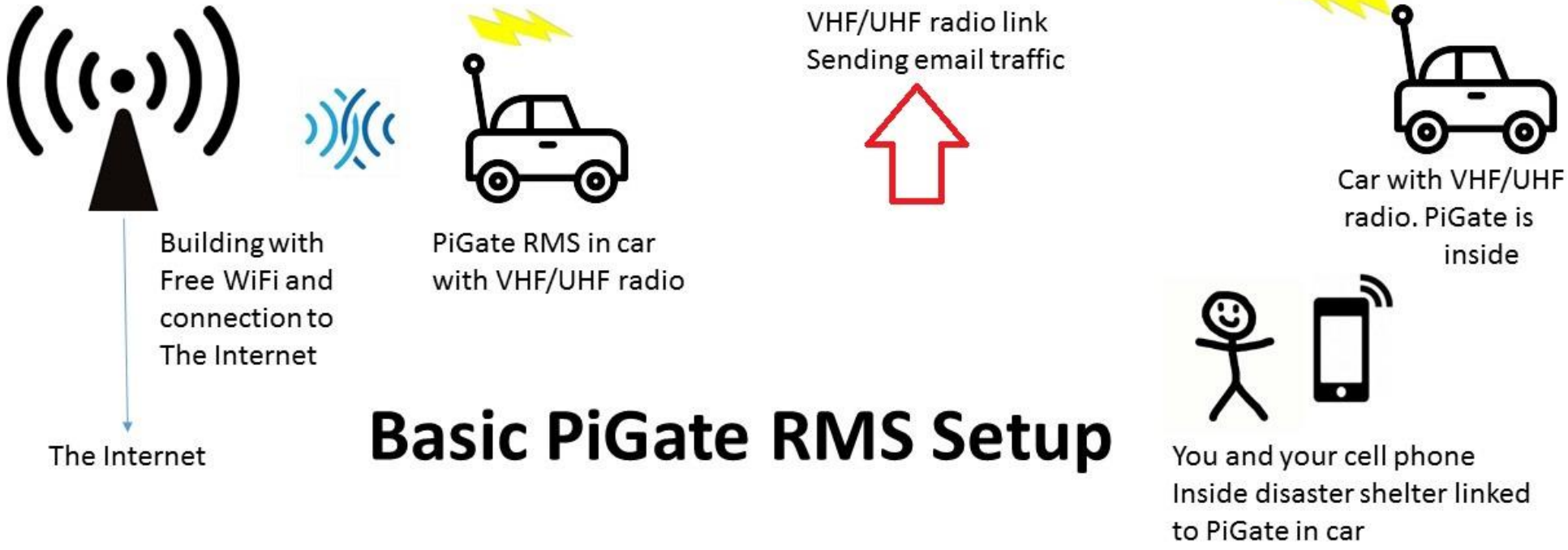
- Not all radios are equal
- Many radios with a packet data port have the BER tested by the ARRL
- Not always published – manufacturer does not publish
- Only radios with a good BER will work
- Good (to me) is less than $5x10^{-4}$

Bit Error Rate (BER)

- Not all radios are equal
- Many radios with a packet data port have the BER tested by the ARRL
- Not always published – manufacturer does not publish
- Only radios with a good BER will work
- Good (to me) is less than $5x10^{-4}$

IC-2820H	**IC-208H**	**FT-8000R**
FT-8800R	**FT-7800R**	**FT-7900R**
TM733A	**TM-D700A**	**TM-D710A**

My Perspective



Basic PiGate RMS Setup

Why do I want 9600 baud?

Faster transfer, duh!

Faster than WINMOR

Faster than PACTOR 1, 2, or 3

Faster than ARDOP

Ability to transfer larger files in a “reasonable” time

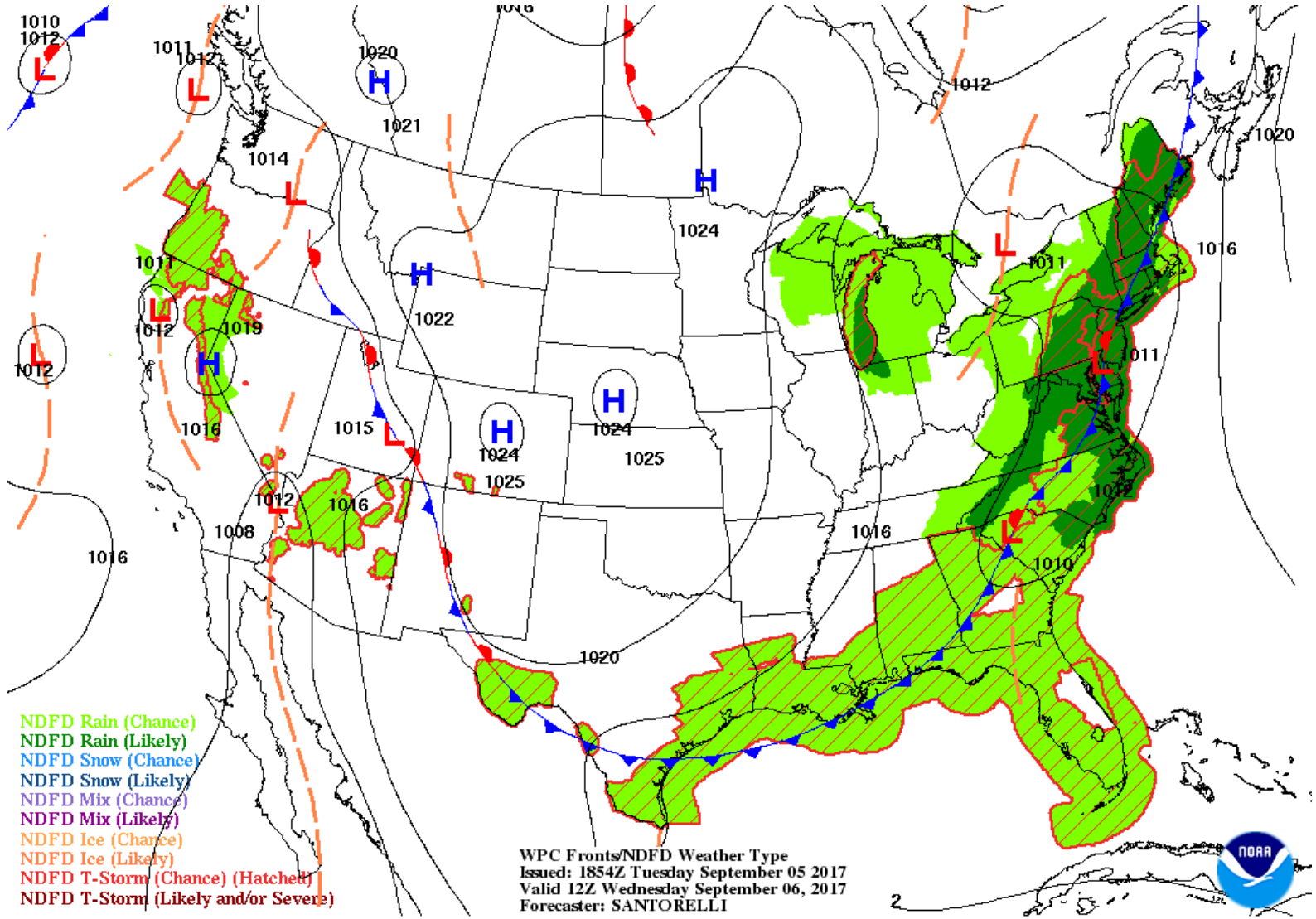
However, no error correction

Good signal link is a MUST

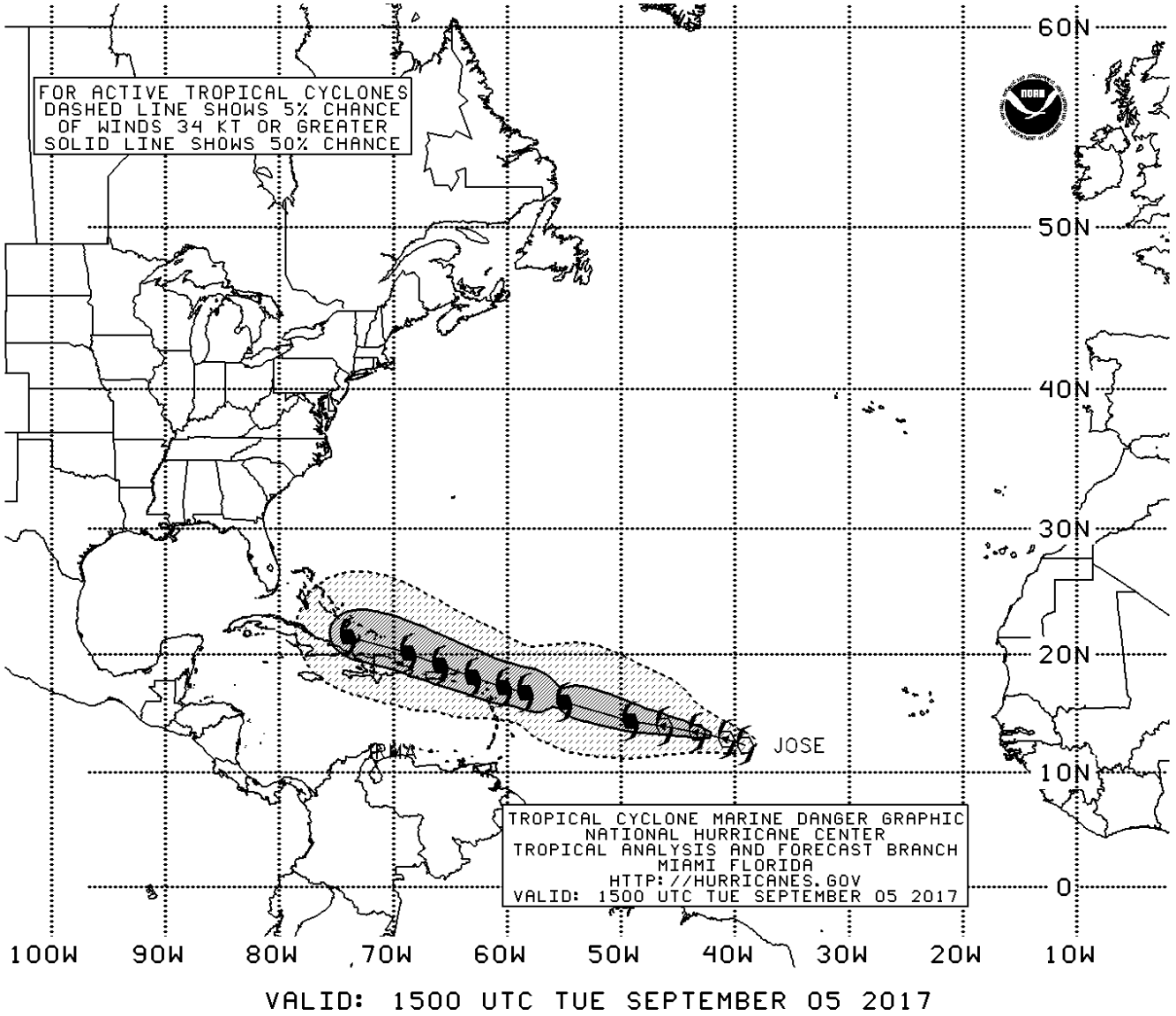
In what real world situations would I need faster data transfers?

Imagine your at a disaster site

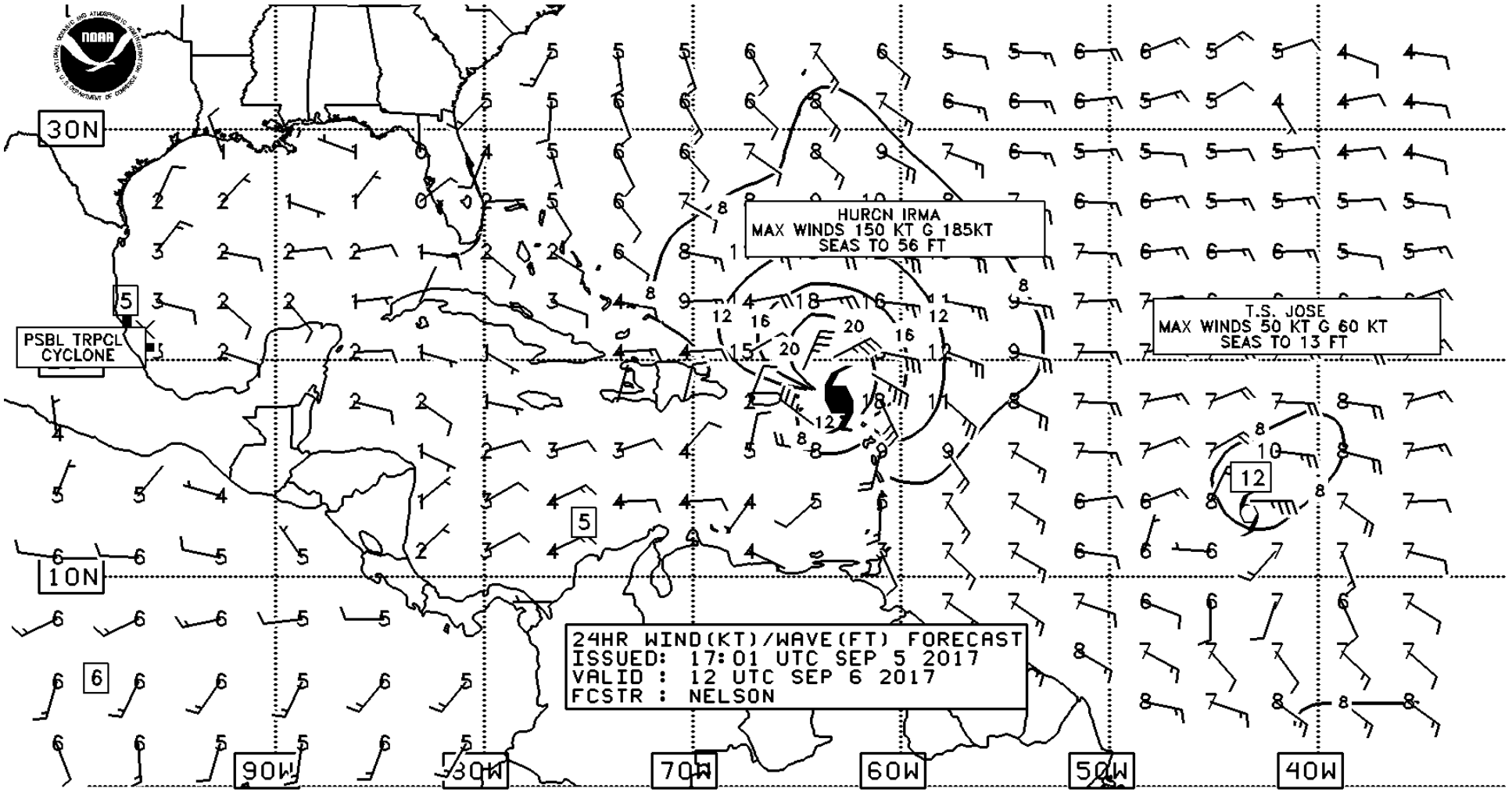
USA 24 Hour Forecast (54KB)



72 Hour Forecast FAX (47KB)

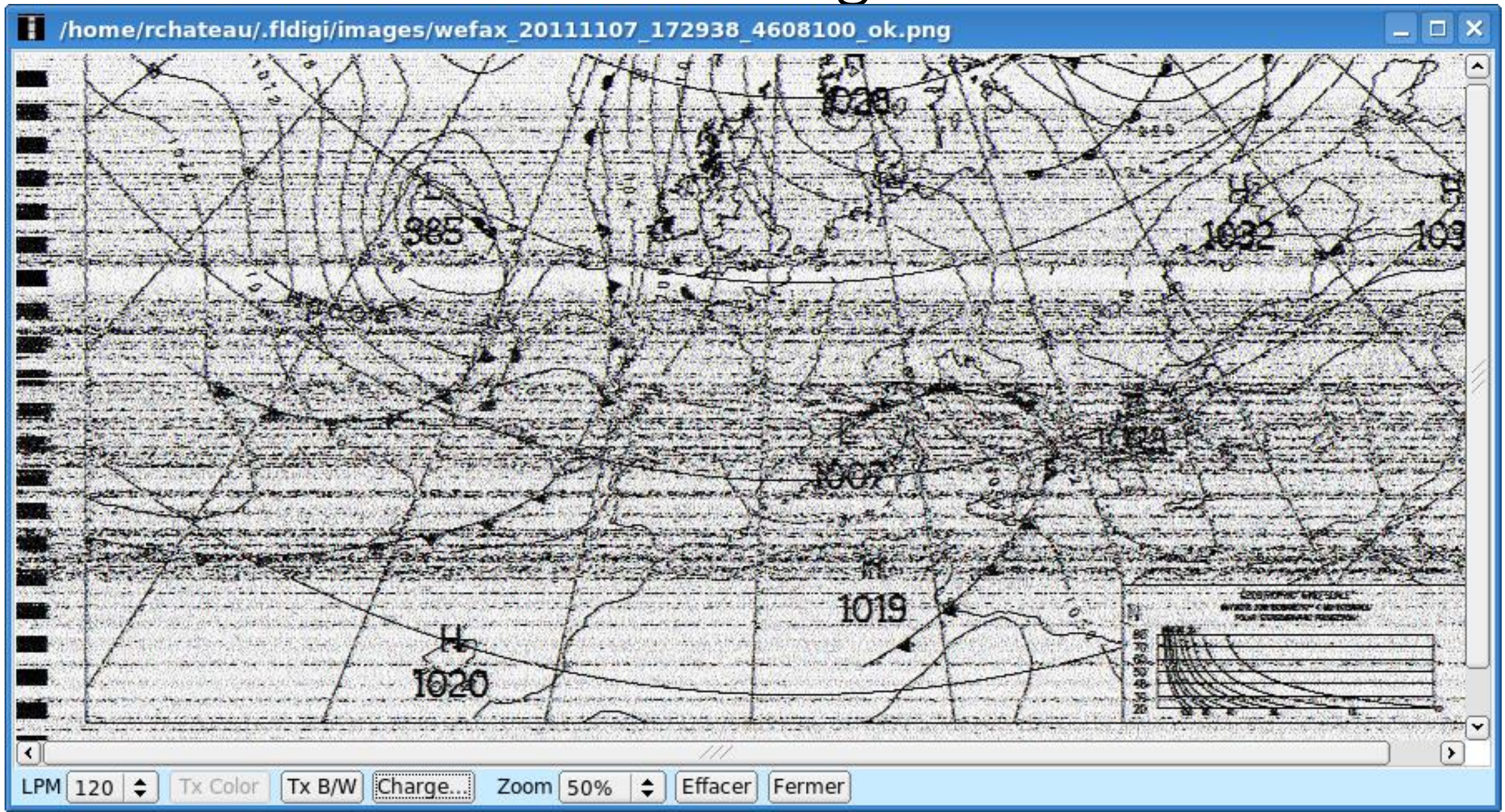


24 Hour Wind/Wave Forecast FAX (51KB)



NWS/NHC/TROPICAL ANALYSIS AND FORECAST BRANCH
SIG WAVE HT IS SHOWN (THE AVG HT OF THE HIGHEST 1/3 OF THE WAVES)

Similar WEFAX Image from FLDIGI



What data transfer rates can I expect?

- Mathematically 9600 baud is 8 times faster than 1200 baud

What data transfer rates can I expect?

- Mathematically 9600 baud is 8 times faster than 1200 baud
- Actual throughput will be slower because of ARQ protocol (automatic repeat request)

What data transfer rates can I expect?

- Mathematically 9600 baud is 8 times faster than 1200 baud
- Actual throughput will be slower because of ARQ protocol (automatic repeat request)
- Many variables can change the transfer rate – more so at 9600 baud

What data transfer rates can I expect?

- Mathematically 9600 baud is 8 times faster than 1200 baud
- Actual throughput will be slower because of ARQ protocol (automatic repeat request)
- Many variables can change the transfer rate – more so at 9600 baud
- Errors and resending packets can slow the transfer rate to the point where it is no faster than 1200 baud

What data transfer rates can I expect?

- Mathematically 9600 baud is 8 times faster than 1200 baud
- Actual throughput will be slower because of ARQ protocol (automatic repeat request)
- Many variables can change the transfer rate – more so at 9600 baud
- Errors and resending packets can slow the transfer rate to the point where it is no faster than 1200 baud
- A GOOD radio link is REQUIRED!

The Test Environment

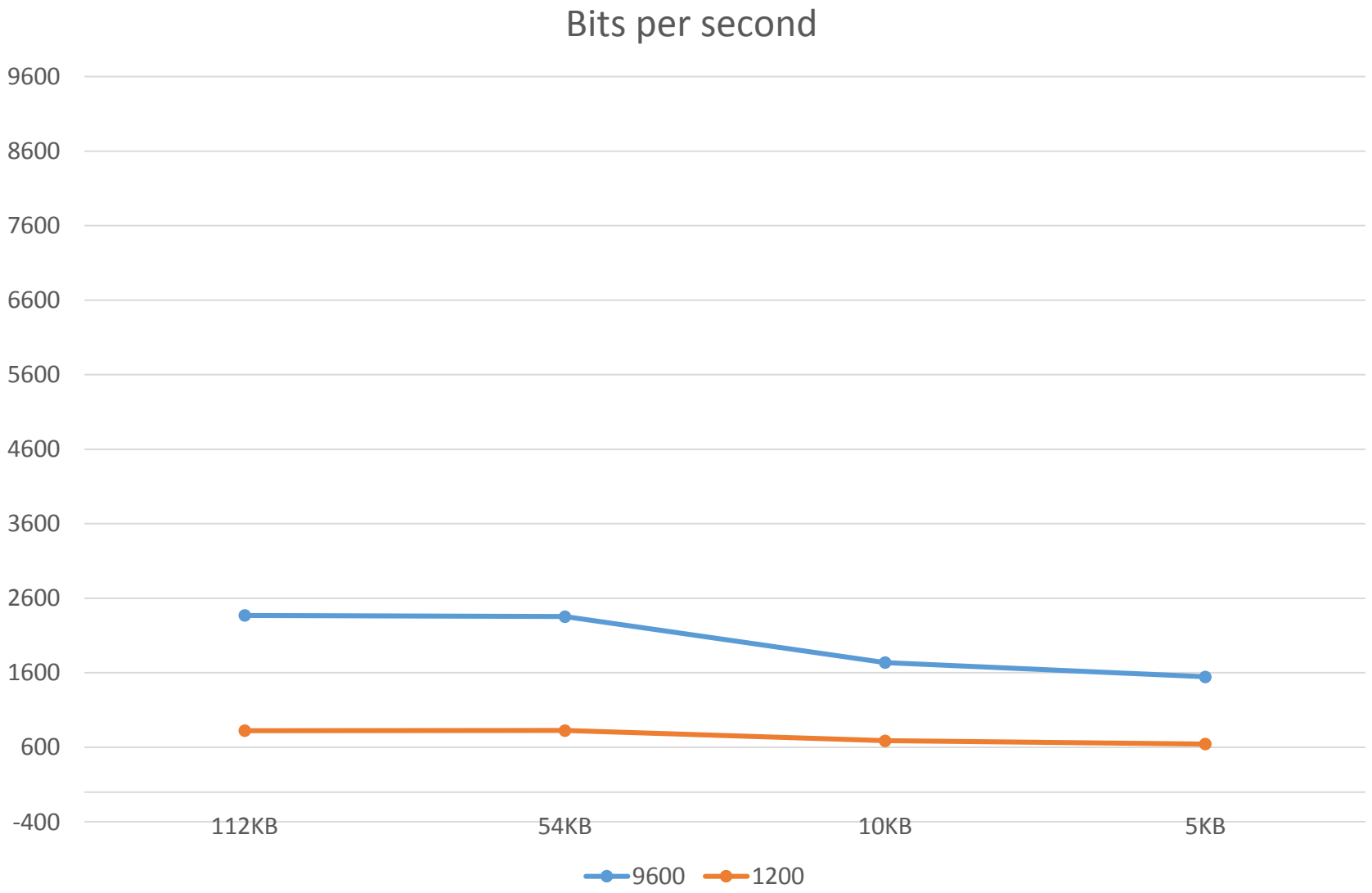
eliminating variables

- Two TNC-Pi9k boards setup exactly the same
- Connected to two FT-7900 radios thru the packet data port
- A PiGate RMS connected to a roof top 2m/70cm omni antenna
- A PiGate in the basement with a 0 gain whip antenna
- Two floors and a roof between them
- Both radios set for 433 Mhz
- Both radios transmit at 5 watts
- Both radios un-squelched
- Packet parameters on both ends setup the same
- Same files used for all tests

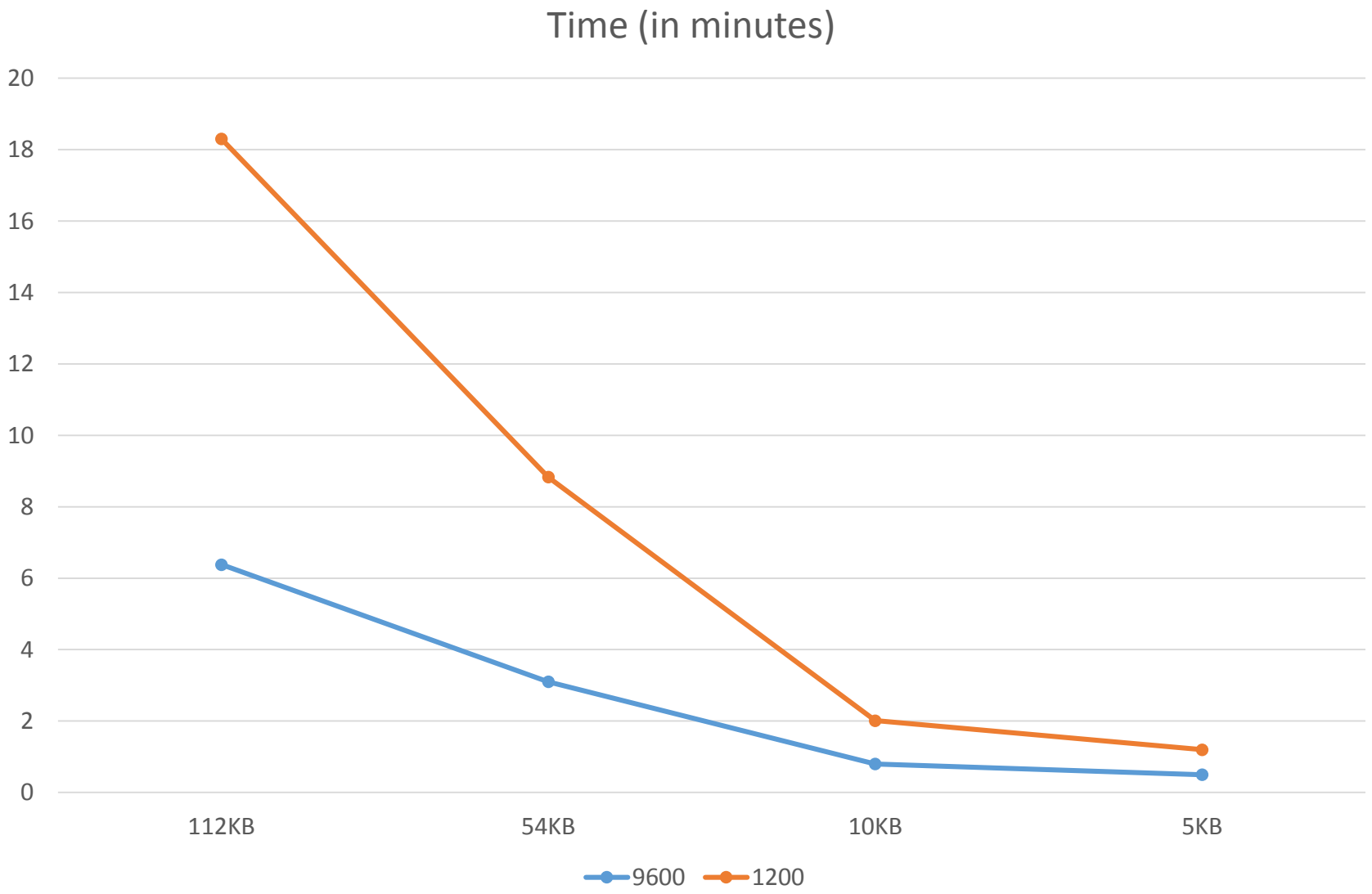
The Test Results

as measured by linbpq

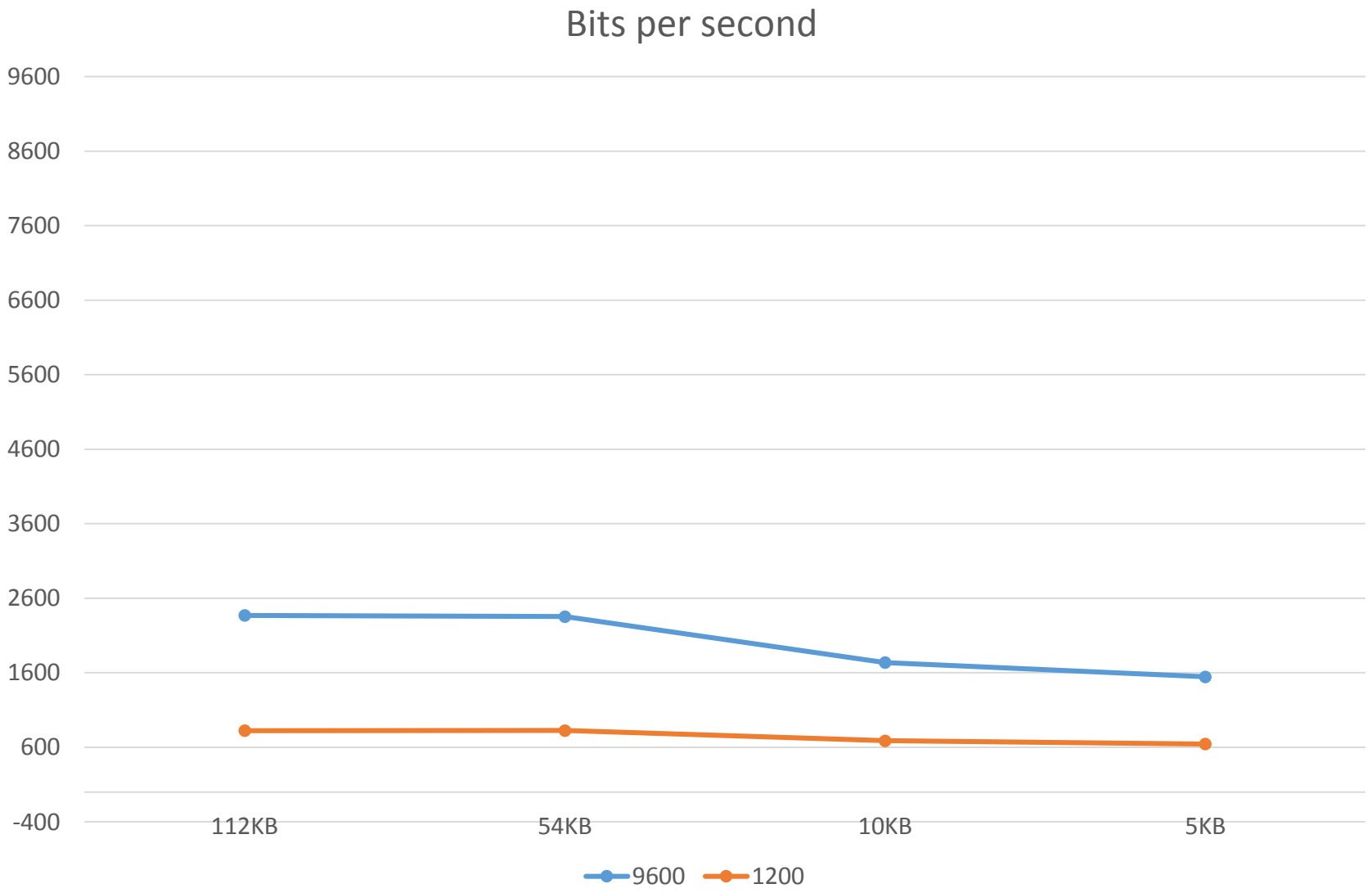
Test Results



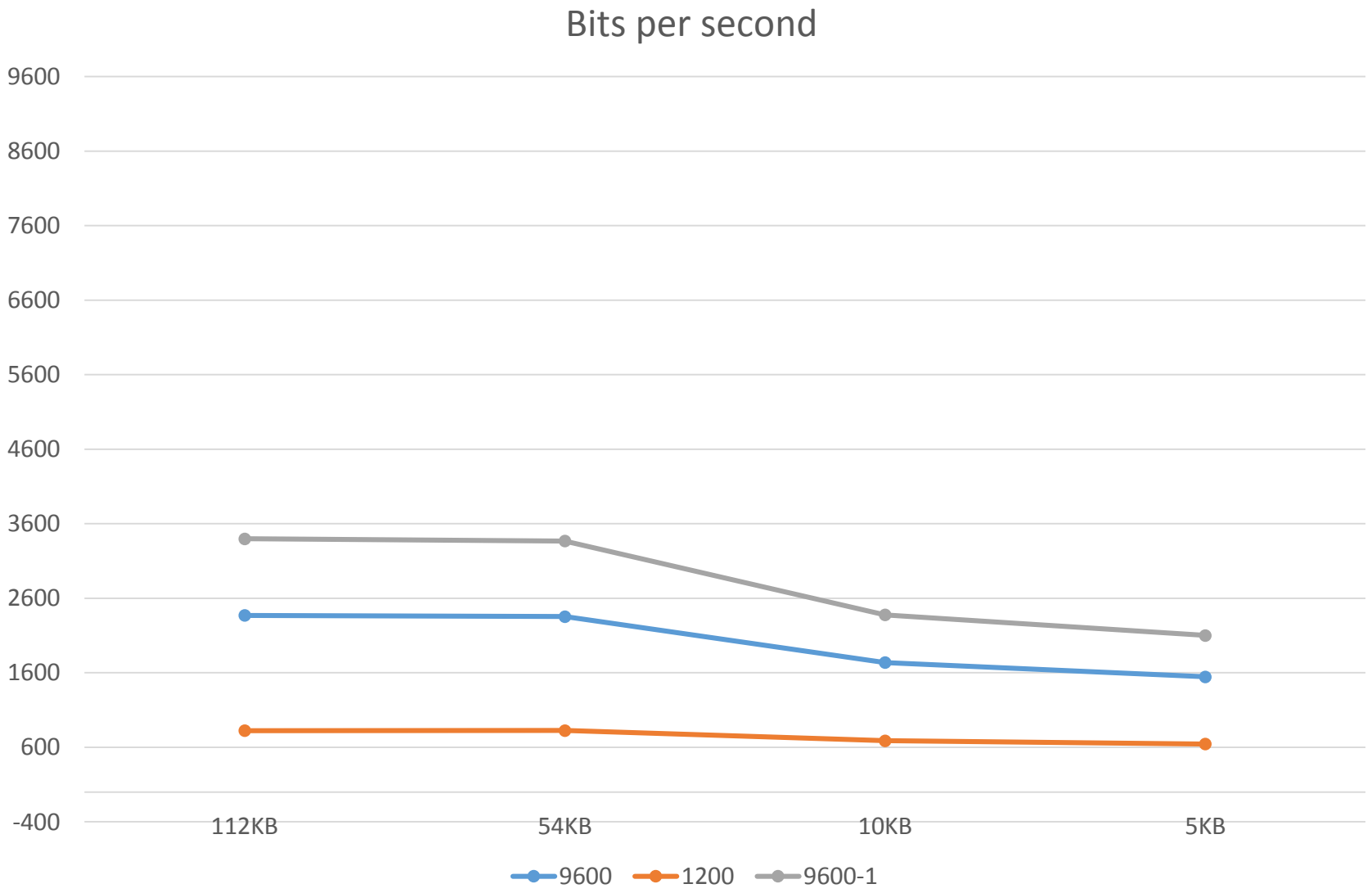
Test Results



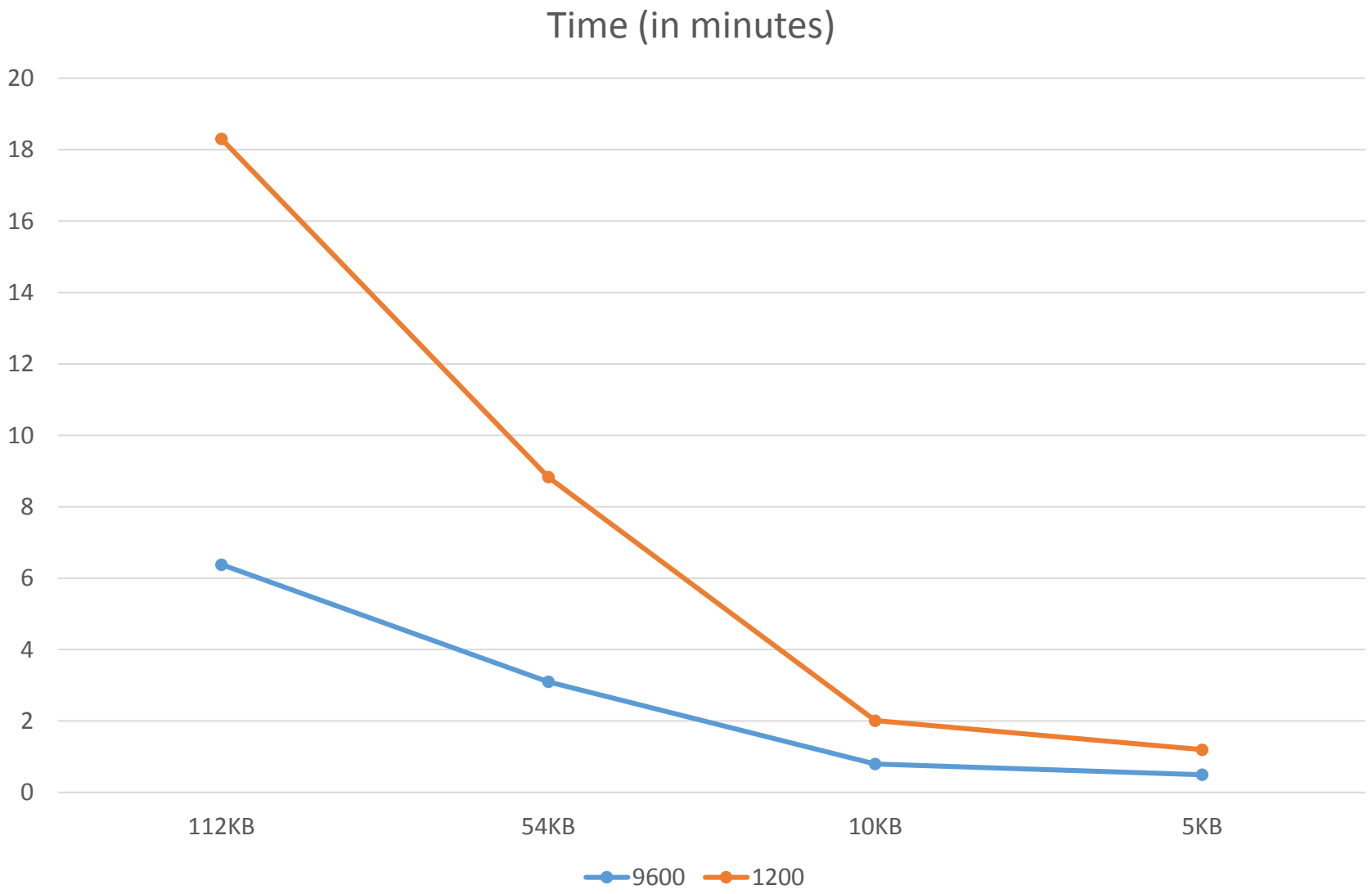
Test Results



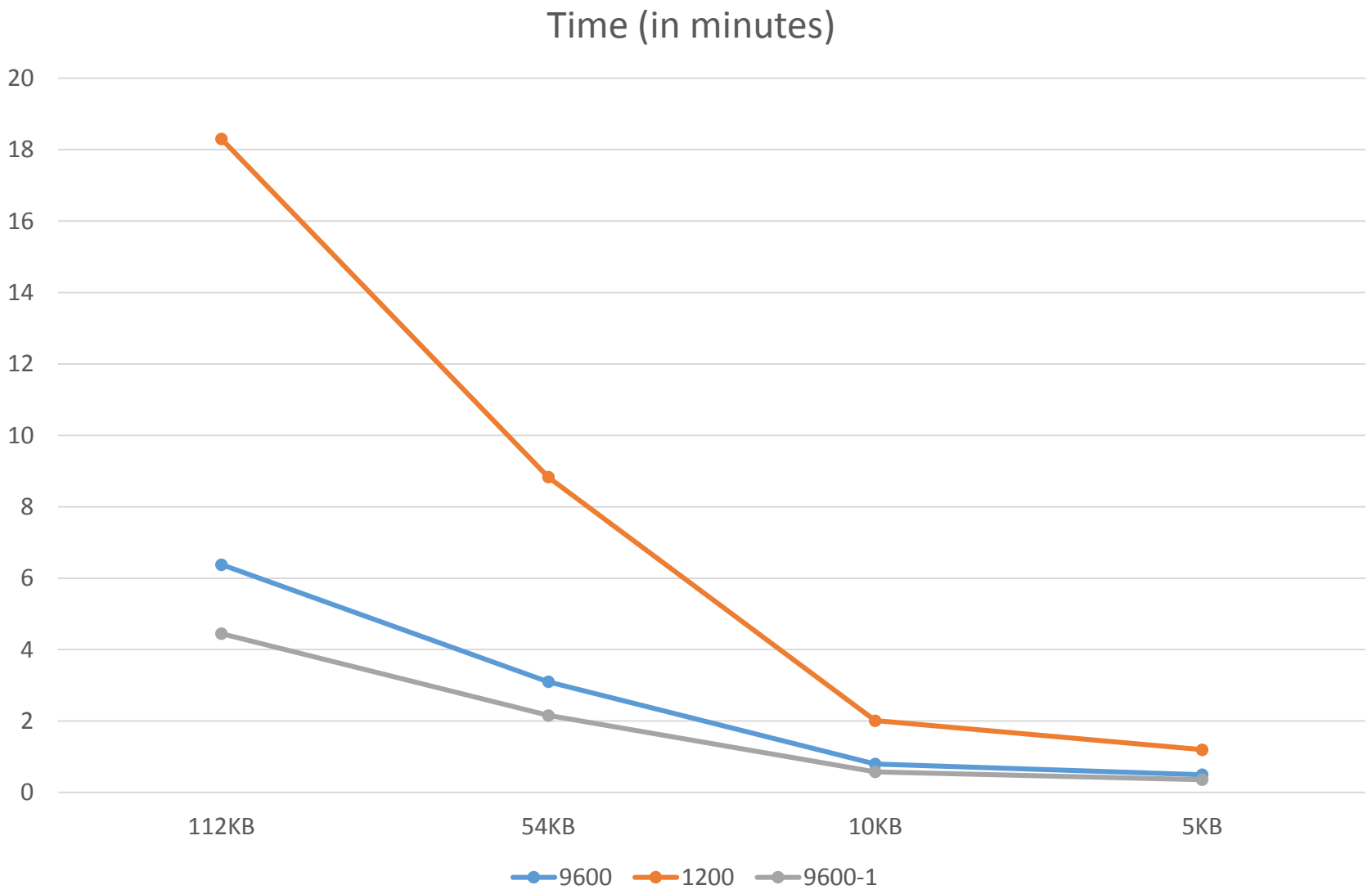
Test Results



Test Results



Test Results



Again – Good Signal Link REQUIRED!

Not this!

This!!

How much will it cost?

Questions?