

Remote Station Operation setup details & tips

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Target audience: Radio operators who want to make transceivers remotely controllable using Internet protocols, such as for shared club stations. Details of setup and tips for remote operation.

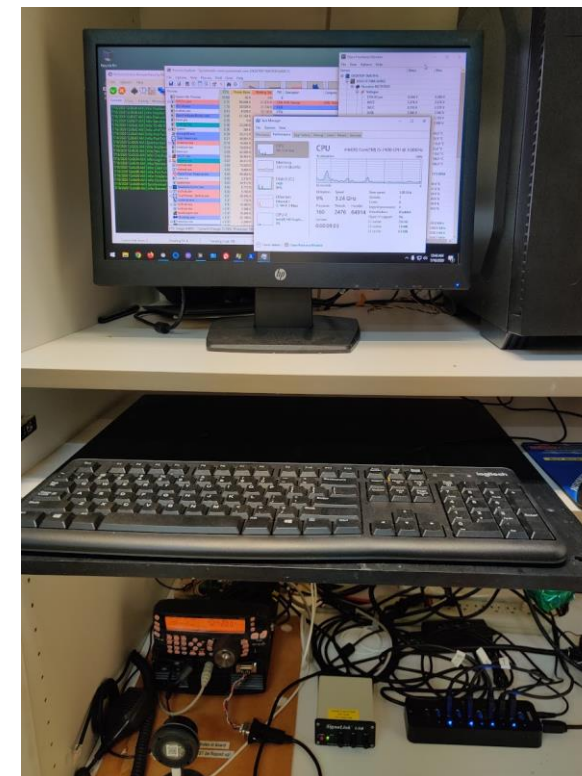
Other concurrent talks at Utah DCC 2024:

Breakout Session #3

Room 1: Intermountain Intertie - Mel Parkes NM7P & John Lloyd K7JL

Room 2: Fox Hunting for All Ages - Larry Jacobs WA7ZBO

Room 3: Remote Station Operation - Gary Crum KK7DV



outline:

- Introduction to remote transceivers
- Example use of UARC HF Remote at Leamington,
using WebSDR and KiwiSDR systems for reception
- Benefits, and challenges of remote, shared, unattended operation
- Example of partial hardware failure and use of low-level control systems
- History and possible configurations
- Architecture of remotes using RemoteHams.com / RCForb Server and Client software

List of specific subsystems that I will cover today:

- Computer hardware and software
 - Windows
 - VNC (open source)
 - RCForb Server (some open source)
 - Open Hardware Monitor
 - USB Hubs
 - Linux, on PCs and Raspberry Pi
 - fault-tolerant keying circuit (custom)
 - rotator controller computer interface (custom, Arduino-based)
- Control relays and power monitoring, UPS
 - TP-Link / Kasa / SwitchBot Smart Plug relays and power monitoring
 - Tripp-Lite and CyberPower Uninterruptable Power Supply (UPS) systems
 - AC A/B power relay (custom)

Introduction to remote transceivers

- operator is in control of remote transceiver
- could be over RF such as on repeater or link system (historically)
- could be over Internet connection controlled by one of:
 - radio control head, as with RemoteRig
 - software on desktop of laptop computer, such as
 - Icom RS-BA1, RigPi or RCForb Client
 - smartphone app such as RCForb Client or EchoLink
 - web interface such as to WebSDR, ka9q-radio and OpenWebRx
- This talk will get in depth about use of RCForb Client, and implementation for the UARC Remote HF transceivers described at
 - <http://utaharc.org>

Example use of UARC HF Remote at Leamington, using WebSDR and KiwiSDR systems for reception

The screenshot shows the 'Utah Amateur Radio Club (UARC) W7SP HF Remote' software interface. The main display area features a digital readout (DRO) showing a frequency of 14.032.500 MHz and a power level of 3.921.000. The interface includes various control panels for antenna selection (Three-LogP), mode (CW), and power settings. A compass rose is visible on the right side of the main display. The bottom section contains a chat window with text messages, a number pad, and a memories list.

The screenshot shows the 'RCForb Client' mobile application interface. The top bar displays the status 'RCForb Client' and various system icons. Below the status bar, there are tabs for 'REMOTES', 'RADIO CONTROL', and 'CHATS'. The 'RADIO CONTROL' tab is active, showing a green display with the frequency '20.200.30' and 'CW' mode. The interface includes a large circular control knob, a 'PTT' button, and a grid of function buttons such as 'Band+', 'Band-', 'Split', 'Voice', 'Round', 'Up', 'Down', 'Rem.Mem', 'Local.Mem', 'Numpad', and 'Down'.



Advantages of very remote operation in mountain areas with low population density

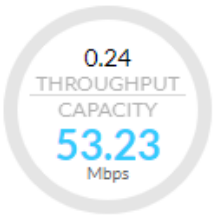
- Space for antennas
- Low noise level
- Little or no nearby neighbors
- Options for Internet connection
 - Microwave data links, often DIY
 - Satellite connections such as Starlink even offer low latency these days
 - UARC Leamington site has link to Delta using Ubiquiti LiteBeam 5GHz link
- Access can be very convenient and shared with club membership
 - HF access enabling for those dealing with antenna restrictions
 - Can be accessed from inside buildings with smartphone
 - Can be accessed from very remote areas using new Internet systems such as Starlink



LOCAL



LeamingtonPassLiteBeam
LiteBeam 5AC LR
60:22:32:D6:33:F1
TX POWER 25 dBm



SSID LeamingtonPass

21.16 mi

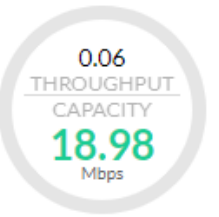
Airtime

3.4%

REMOTE



CBRshoptoLeamPassLite...
LiteBeam 5AC LR
60:22:32:D6:33:5A
TX POWER 25 dBm



Map Link Fresnel

LOCAL DEVICE

RF ENVIRONMENT



5755 MHz
10 MHz 5750 - 5760

SIGNAL -65 (-70 / -67) Δ3 dBm

NOISE FLOOR -84 dBm



REMOTE DEVICE

RF ENVIRONMENT



5755 MHz
10 MHz 5750 - 5760

SIGNAL -65 (-69 / -67) Δ2 dBm

NOISE FLOOR -85 dBm



LOCAL RX DATA RATE 6X (64QAM MIMO) EXPECTED RATE 6X/8X



ISOLATED CAPACITY / THROUGHPUT SIGNAL, NOISE & INTERFERENCE



Capacity RX 53.8 Mbps Throughput RX 114 kbps Latency 3 ms



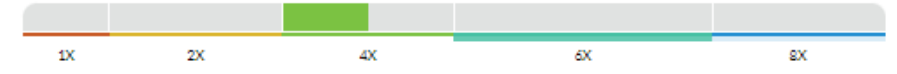
More Details

Table with device model, network mode, UNMS status, memory, and CPU usage for local RX data rate.

WIRELESS

Table with wireless mode, security, distance, and TX/RX bytes for local RX data rate.

REMOTE RX DATA RATE 4X (16QAM MIMO) EXPECTED RATE 6X/8X



ISOLATED CAPACITY / THROUGHPUT SIGNAL, NOISE & INTERFERENCE



Capacity RX 17.9 Mbps Throughput RX 1.44 Mbps Latency 3 ms



Reconnect

Table with device model, network mode, UNMS status, memory, and CPU usage for remote RX data rate.

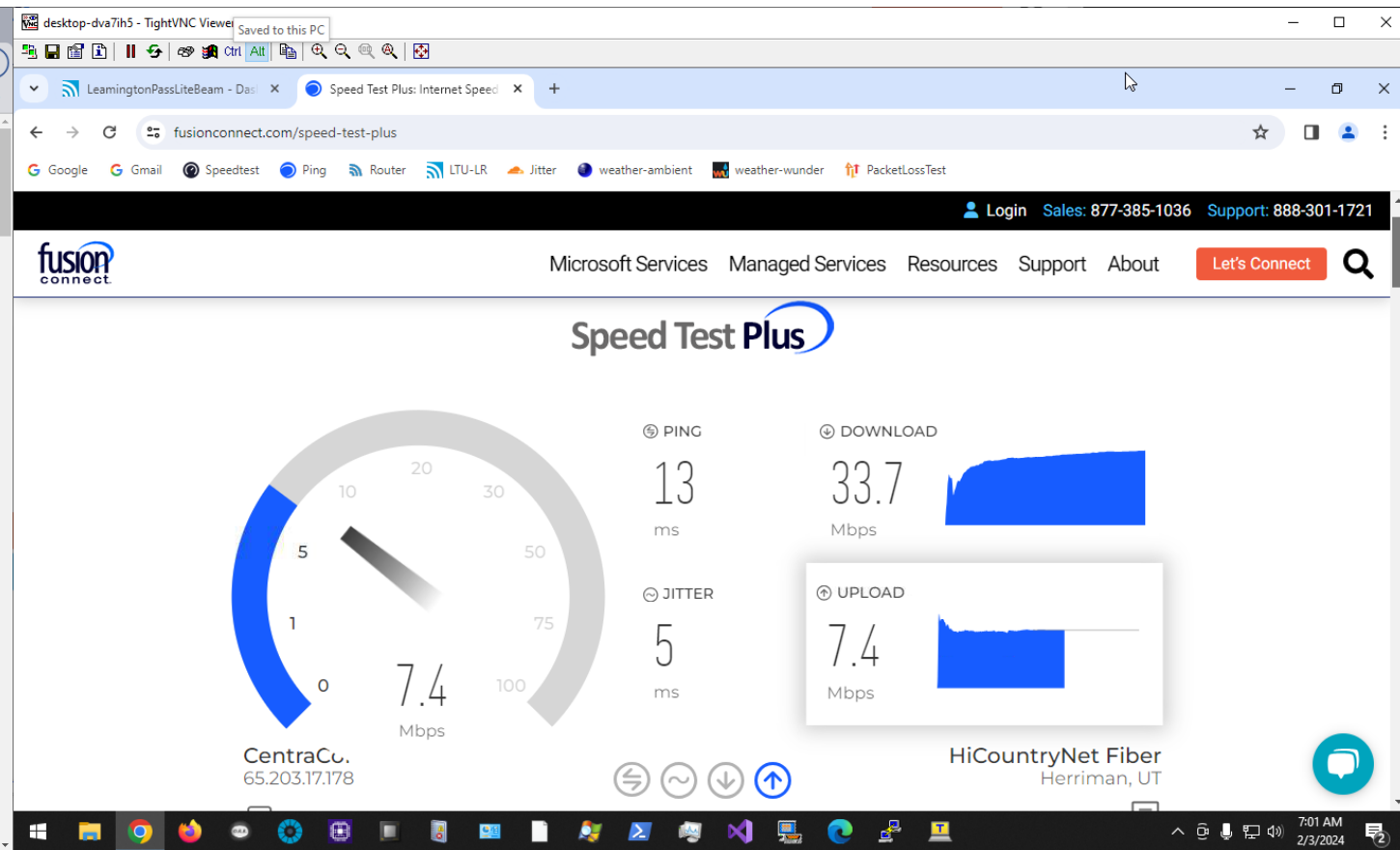
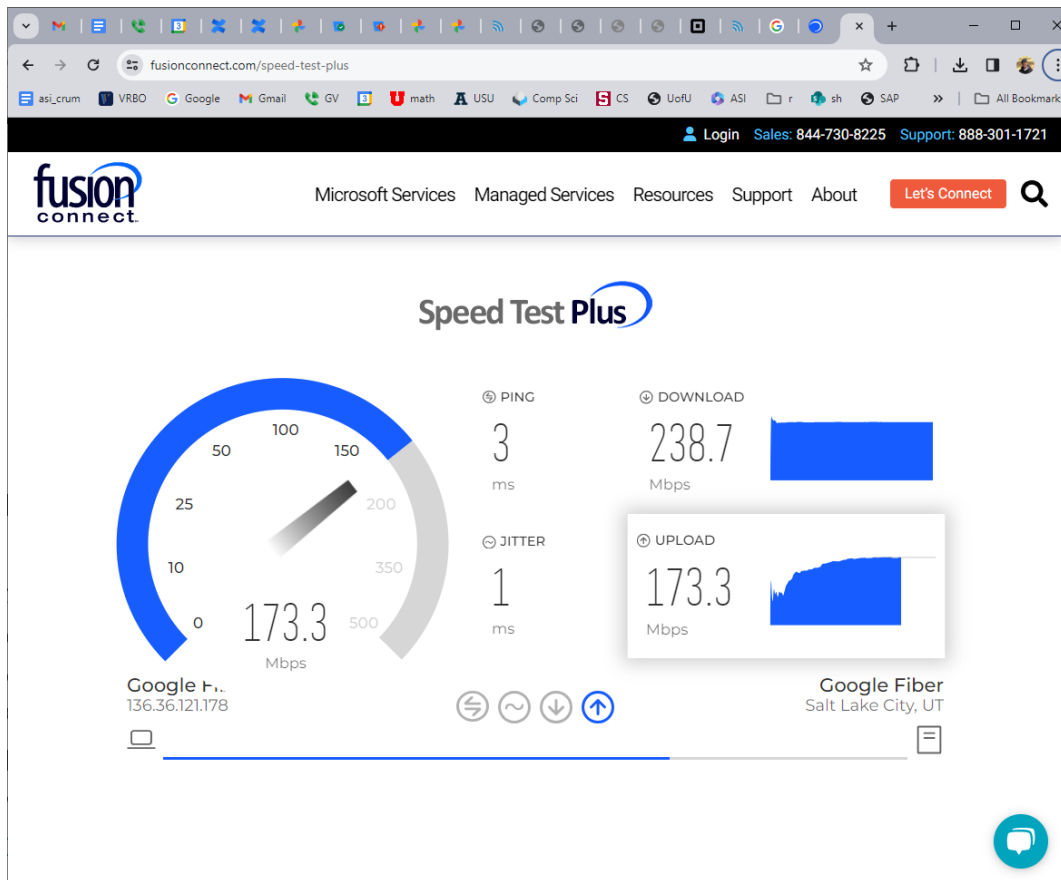
WIRELESS

Table with wireless mode, remote IP, distance, and TX/RX bytes for remote RX data rate.

Internet connection, juicy details

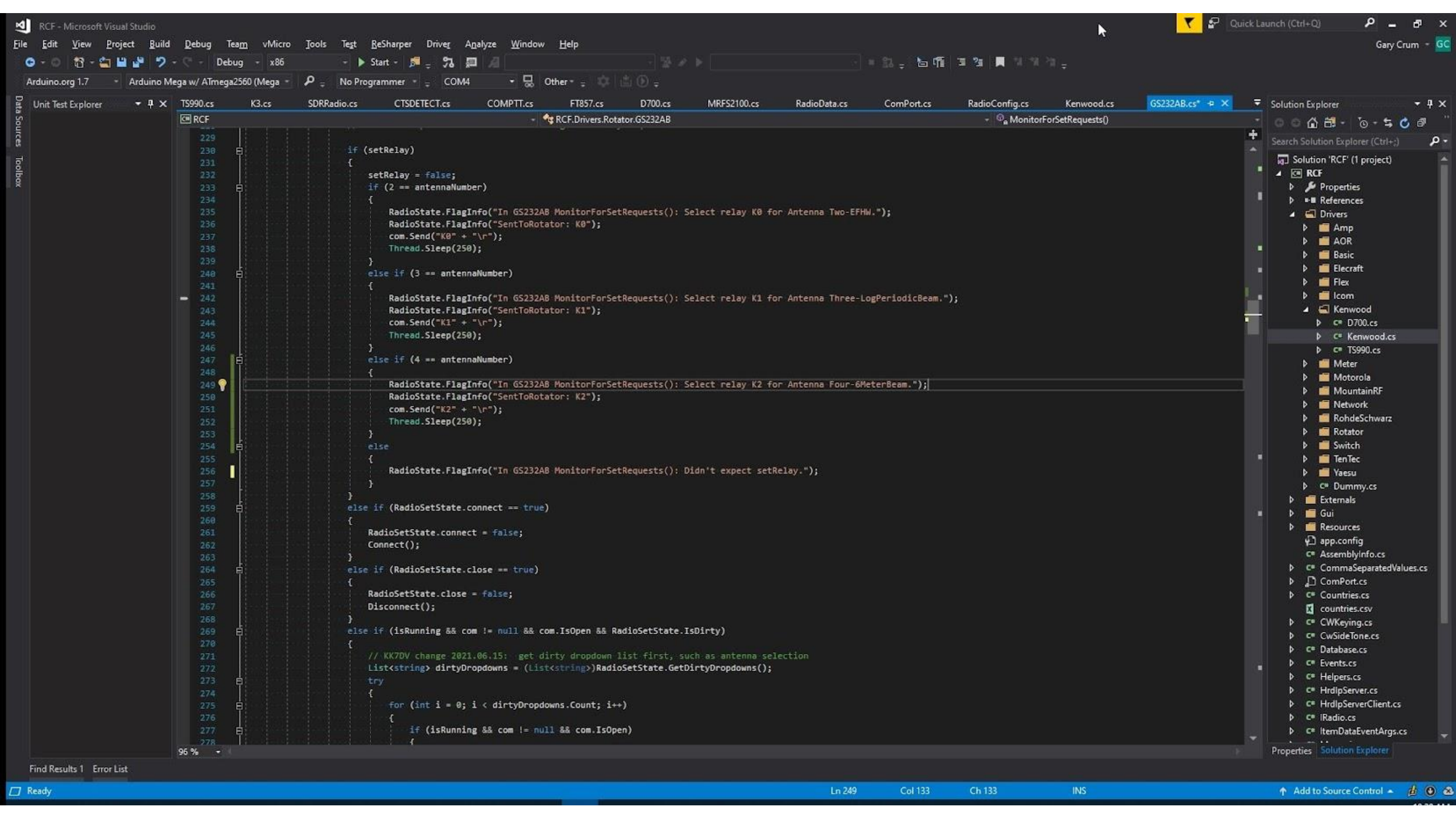
- Static IPv4 address used, excellent for server operation
- Router on site configured for port forwarding using NAT
 - Somewhat ugly but pretty common and effective these days.
- TCP/IP computer communication includes
 - TCP for RCForb control and audio connections
 - TCP for VNC, Virtual Network Computing, cross-platform remote control
- Latency and Jitter are quite important for real-time response
- Some test sites include latency and jitter measurement, such as
 - <https://www.fusionconnect.com/speed-test-plus>

Fiber is excellent with latency down around 3ms, but microwave data links are still quite good with latency around 13ms. Even in rural areas such as using services of CBR in Delta, Utah.



RCForb Server Setup Details

- RCForb: Remote Control Foundation for Online Remote Base
- Client and Server software that goes with <http://remotehams.com>
- Free software and service, fairly stable and useful.
- RCF DLL made available for source code changes by me (KK7DV):
 - Fine tuning menus
 - Antenna switching system using remote relay on tower
 - Uses 2 ports on Kenwood TS-480 transceiver but also beam antennas 3 and 4
 - External LDG-1000 tuner activation using DTR/CTS signals on RS232 port
 - Rotator controller integrated with antenna relay



RCForb Server configuration

- RCForb Server is Windows app, uses multiple COM ports for control.
- Uses database for user access and logging.

The screenshot shows the RCForb (Online Remote Base) by KG6YPI application window. The console displays a series of system logs from 2/3/2024 6:21:28 AM to 7:16:24 AM. The logs indicate the server's initialization, connection to a radio (TS-480), and synchronization with RemoteHams.com. The event viewer on the left shows a filtered log of system events from the kernel boot process.

```
2/3/2024 6:21:28 AM | Info: Initializing...
2/3/2024 6:21:29 AM | Info: Starting...
2/3/2024 6:21:31 AM | Info: RCForb Server (Free)
2/3/2024 6:21:37 AM | Info: Connecting to Radio...
2/3/2024 6:21:38 AM | Info: Radio (TS-480) Connected.
2/3/2024 6:21:38 AM | Info: Connected without handshaking... Detected TS-480SAT. Kenwood Driver v1.63 by KG6YPI
2/3/2024 6:21:38 AM | Info: Connecting to Rotator...
2/3/2024 6:21:38 AM | Info: Connecting to Rotator -> YEASU...
2/3/2024 6:21:39 AM | Info: Rotator Connected.
2/3/2024 6:21:39 AM | Info: Obtaining Orblid from RemoteHams.com...
2/3/2024 6:21:39 AM | Info: RotatorInfo: Initiating Yeasu Rotator... Failed to read rotator position, trying again... Connected to rotator.
2/3/2024 6:21:39 AM | Info: RotatorInfo: In GS23AB MonitorForRequests(, dirty) is: button
2/3/2024 6:21:40 AM | Info: Received Orblid from RemoteHams.com
2/3/2024 6:21:40 AM | Info: Radio Server Running on 0.0.0.0:4525
2/3/2024 6:21:40 AM | Info: Using DirectSound.
2/3/2024 6:21:41 AM | Info: Speakers (TX Audio to Radio): Speakers (USB Audio CODEC)
2/3/2024 6:21:41 AM | Info: Microphone (RX Audio from Radio): Microphone (USB Audio CODEC)
2/3/2024 6:21:41 AM | Info: VoipServer: SetDesiredMaxDelay: 300ms
2/3/2024 6:21:41 AM | Info: VoipServer started on 0.0.0.0:4524
2/3/2024 6:21:42 AM | Info: Flash policy server started on 0.0.0.0:843
2/3/2024 6:21:42 AM | Info: Searching for uPnP Compatible Router...
2/3/2024 6:24:14 AM | Info: TS-480 Ready
2/3/2024 6:24:14 AM | Info: uPnP Requesting Router to Forward Ports
2/3/2024 6:24:14 AM | Info: Port Forwarded: 4525
2/3/2024 6:24:14 AM | Info: Port Forwarded: 4524
2/3/2024 6:26:04 AM | Synchronized with RemoteHams.com
2/3/2024 6:26:04 AM | Info: Port Forwarded: 843
2/3/2024 6:26:08 AM | Synchronized with RemoteHams.com
2/3/2024 6:32:05 AM | Info: VoipServer UserIn: 45.227.254.48:65366
2/3/2024 6:32:05 AM | Info: VoipServer UserOut: 45.227.254.48:65366
2/3/2024 6:36:13 AM | Synchronized with RemoteHams.com
2/3/2024 6:46:15 AM | Synchronized with RemoteHams.com
2/3/2024 6:56:18 AM | Synchronized with RemoteHams.com
2/3/2024 7:06:21 AM | Synchronized with RemoteHams.com
2/3/2024 7:16:24 AM | Synchronized with RemoteHams.com
```

The screenshot shows the RCForb (Online Remote Base) by KG6YPI application window with the hardware monitor and user database views. The hardware monitor displays various system metrics for the ASUS H110M-A/M.2 motherboard, including voltages, temperatures, and fan speeds. The user database view shows a table of users with columns for id, user_id, name, ip, date, allowed, and command.

Sensor	Value	Max
CPU VCore	0.360 V	0.496 V
AVCC	3.376 V	3.392 V
3VCC	3.392 V	3.392 V
3VSB	3.376 V	3.376 V
VBAT	3.088 V	3.088 V
VTT	1.000 V	1.000 V
Temperatures		
CPU Core	66.2 °F	75.2 °F
Temperature #1	60.8 °F	60.8 °F
Temperature #2	251.6 °F	251.6 °F
Temperature #3	57.2 °F	57.2 °F
Temperature #4	239.0 °F	239.0 °F
Temperature #5	239.0 °F	239.0 °F
Temperature #6	237.2 °F	237.2 °F
Fans		
Fan #2	907 RPM	922 RPM
Controls		
Fan Control #1	60.0 %	60.0 %
Fan Control #2	20.0 %	20.0 %
Fan Control #3	49.8 %	49.8 %
Fan Control #4	49.8 %	49.8 %
Fan Control #5	49.8 %	49.8 %
Fan Control #6	49.8 %	49.8 %
Clocks		
Bus Speed	100.0 MHz	100.0 MHz
CPU Core #1	3300.0 MHz	3300.2 MHz
CPU Core #2	3300.0 MHz	3300.0 MHz
CPU Core #3	3100.0 MHz	3300.0 MHz
CPU Core #4	3300.0 MHz	3300.2 MHz

id	user_id	name	ip	date	allowed	command
343173	45385	w7ga	65.130.32.90	2024-02-02 11:24:03 -07:00	1	post:button:VOX:1
343172	45385	w7ga	65.130.32.90	2024-02-02 11:23:58 -07:00	1	post:message:CW:W7GA
343171	45385	w7ga	65.130.32.90	2024-02-02 11:23:58 -07:00	1	post:slider:CW Speed:19
343170	45385	w7ga	65.130.32.90	2024-02-02 11:23:58 -07:00	1	post:button:Pre:1
343169	45385	w7ga	65.130.32.90	2024-02-02 11:23:58 -07:00	1	rotator:start
343167	45385	w7ga	65.130.32.90	2024-02-02 11:23:38 -07:00	1	rotator:bearing:122
343166	45385	w7ga	65.130.32.90	2024-02-02 11:23:09 -07:00	1	rotator:start
343165	45385	w7ga	65.130.32.90	2024-02-02 11:23:09 -07:00	1	rotator:bearing:88
343164	45385	w7ga	65.130.32.90	2024-02-02 11:23:06 -07:00	1	post:dropdown:Antenna:Three-LogPeriodicB
343163	45385	w7ga	65.130.32.90	2024-02-02 11:23:03 -07:00	1	post:dropdown:Mode:CW
343162	45385	w7ga	65.130.32.90	2024-02-02 11:23:00 -07:00	1	post:frequency:14056000
343161	45385	w7ga	65.130.32.90	2024-02-02 11:22:55 -07:00	1	post:frequency:14050000
343160	45385	w7ga	65.130.32.90	2024-02-02 11:22:50 -07:00	1	post:frequency:14100000
343159	42118	nm7p	73.63.28.95	2024-02-01 19:35:50 -07:00	1	disconnect
343158	42118	nm7p	73.63.28.95	2024-02-01 19:31:05 -07:00	1	post:button:TX:0
343157	42118	nm7p	73.63.28.95	2024-02-01 19:30:59 -07:00	1	post:frequency:3937000
343156	42118	nm7p	73.63.28.95	2024-02-01 19:30:59 -07:00	1	post:button:TX:1

Challenges of remote unattended operation

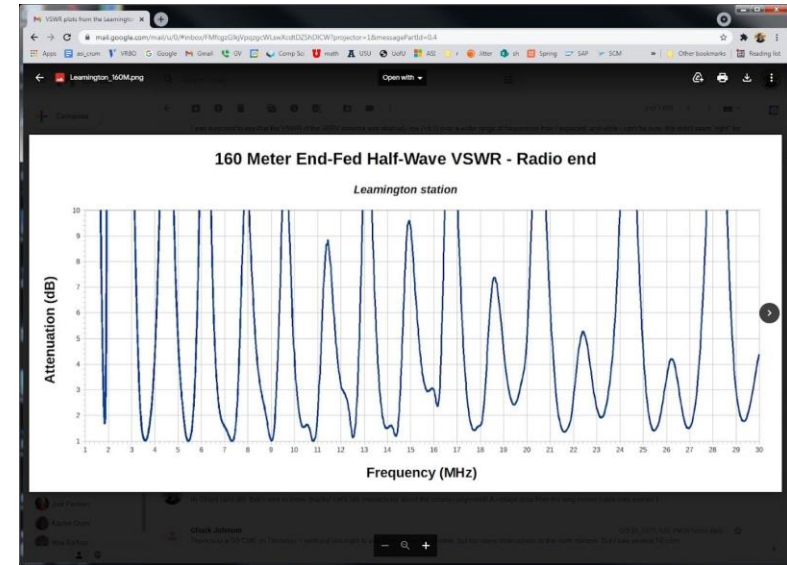
- Site visit may take time, effort and expense
 - 4 hour drive each way
 - Best to be prepared in case of some hardware or software failure
 - Low-level power monitoring and reset circuits are useful
 - Automatic notification of failures is good to have
- In practice, UARC HF Remote sites have run for a year without any on-site maintenance
- Mountain fires have been an issue, several times
- Satisfying, rather like work (autonomous vehicles) and space systems

Pictures and Videos, from last 6 years

- Some images linked on UARC web site under “HF Remotes”
 - <http://utaharc.org>
- Some other videos made available on YouTube such as at:
 - <https://www.youtube.com/@CrumResearch/videos>
 - Example: <https://youtu.be/Z7JmVFBhvW4?si=xD4tTJ79CytU74Pe>
- January 2024, brief trip to recover from power issues
 - 10-port USB hub hung, added controlled power relays for future recovery
 - https://youtu.be/GPaZme_djqY

Antenna evolution

- UARC Leamington HF Remote started with G5RV dipole in 2017
- Added transformer-fed EFHW in 2019
 - added bands such as 160m, 60m
 - group project involving many people
- 8-element log-periodic beam in 2021
 - Even more people involved
 - Rotator, tower extension and switch
- 6-element 6-meter beam in May 2024



Questions?

Interested in any more details about specific items?

- Contact info and links:

- Gary L. Crum, KK7DV
- Gary.Crum@asirobots.com (software engineer there – check out open jobs and join me!)
- Up north in Wellsville, grew up in Salt Lake Valley
- CS & Math degrees from University of Utah
- R&D at Stanford, USC and USU

- Member of all of

- Bridgerland Amateur Radio Club
- Utah Amateur Radio Club
- Utah VHF Society