2015 PJ2T Station Rebuild

Prepared by:

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Foreword

The redesign of the PJ2T operating positions and antenna switching has been referenced in several other presentations I've developed. This presentation provides some insight into the project.

There are some subtle differences in the degree of automation in the PJ2T system. First and foremost is that in a multi-operator configuration the antenna is not automatically selected. This is done because of the multiple antennas available and most stations are focused on a single band and not band hopping.

The real impact of the presentation is how a larger, more complex design has the same attention to what you are trying to accomplish and a clear statement of the requirements so that you can track your success. This was a multi-year effort that came together quickly once other external events enabled the implementation phase.

I welcome feedback and questions.

PJ2T History

- From 1971 until 2000, John Thompson, W1BIH owned the home at Coral Cliffs on the island of Curacao
- The PJ9JT station became known as one of the most famous contesting and DX locations in the world
- Operators included:
  - W4KFC
  - W3LPL
  - W2TA
  - K4BAI
  - W4BRB (W4OO)
  - K4BVD/4 (W6OAT)
  - W4DQS (W4QM)
  - W4GF
  - K1DG
  - K1XX
  - K2SS
  - K3EST
  - KL2A
  - N3ED
  - N6IG
  - And MANY more…
- In 2000 the Caribbean Contesting Consortium, led by WØCG bought the property and it became ***Signal Point***
- The first contest was the 2000 CQWW CW as a M/S entry with 5,955 Qs and a score of 11.7M

The rest, they say, is history…

Going Forward…

- From that first entry the station grew in both size and complexity
  - From M/S to M/2 to M/M
  - With many top #3 finishes a significant number of which were #1 top scores
- And the competition grew as well…
- And the maintenance of the home/property as well as the antennas and equipment grew even faster!
- As the teams grew in size the complexity of the initial design started to become a limitation
  - Add to that, the team compliment included many first-time operators at PJ2T

In 2015 there were major upgrades planned for the home and station

The Basic Requirements

- Focus on CW and SSB
- 1000-watt continuous duty
- All antennas available at all operating positions
- Flexibility to allow any class of entry based on number of available operators
- All equipment stored during non-contest periods

The Antenna Compliment

Band	Antenna Description
160	Inverted-L - Apex @ 95 ft - 45 radials
80	3el Delta Loop (Fixed to EU) - Apex @ 70 ft
80	2el InvV Wire Beam (Fixed US/JA) - Apex @ 75 ft
80	Inverted-V (Top of Ridge)
40	Cushcraft 40-2CD w/W6QHS Mods
40	InvV (not deployed - backup) - Apex @ 80 ft
30	Inverted-V - Apex @ 55 ft
20	HyGain 205BAS @ 90 ft (Fixed EU)
20	HyGain 205BAS @ 71 ft (Fixed US/JA)
15	5el Optimized Yagi @ 82 ft (Fixed EU)
15	5el Optimized Yagi @ 65 ft (Fixed US/JA)
10	5el Optimized Yagi @ 74 ft (Fixed EU)
10	5el Optimized Yagi @ 48 ft (Fixed US/JA) - Top of Stack
10	5el Optimized Yagi @ 32 ft (Fixed US/JA) - Bottom of Stack
20/15/10	TA-34 @ 79 ft (Fixed PAC)
20/15/10	Cushcraft A-3S @ 45 ft (Fixed SA)
20/15/10	Force 12 C3E/H @ 79 ft - Multiplier (Rotatable)
20/15/10	Skyhawk Top of Ridge (Fixed EU)
6	Cushcraft A50-5S @ 88 ft
2	Cushcraft Ringo Ranger

Receive Antennas

1000 ft Beverage (EU) Fixed
635 ft Beverage (US/JA) Fixed
DX Engineering Rx 4-Square Deployable

In the Beginning…

- 4 Folding tables
- Manual antenna switching
- Miles of coax
- No shelves – equipment stacked

And Yes – When Necessary, the Kitchen Table was Called into Service

The Basic Layout…

Station #3 Amp

Station #2 80 + 10

Station #2 Amp

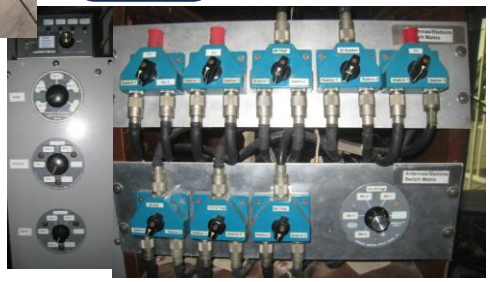
Station #1 160 + 15

Antenna Entry Band Stubs

Antenna and Station Routing #2

Antenna and Station Routing #1

Antenna Selection Station #1 Amp



Station #3 40

Antenna and Station Routing #3

Kitchen
Follow the Needed Band
(Propagation Permitting)

Station #4 20

Station #4 Amp

Antenna Station Routing #4

Station #1 is the Single Op position
Stations #1 / #2 are SO2R and M/S
Stations #1 / #2 / #3 are M/2

Antenna Selection – A Walk Thru: Basic 20M Example

- Basic operation
  - 20M EU Yagi Antenna was selected at the table to the far right and routed to Station #1
  - Station #1 forwards the 20M antenna to Station #2
  - Station #2 forwards the 20M antenna to Station #3
  - Station #3 forwards the 20M antenna to Station #4
- The more complex example
  - 20M SA Tribander is the desired antenna but it is already in use by another station
    - Operator or floater looks at the N1MM+ Network and determines who has the 20M SA Tribander or the rotatable tribander – but some times you can't decide
    - Network message is sent to position using the desired antenna requesting the antenna – is the antenna being used for a mult or run? If possible, the position relinquishes access
    - Antenna is moved through pass-thru switches to position with the greatest need
  - In some cases, determination is made by least interference to another position

There is a lot of shoulder taps and shouts – "Can I have the South America Tribander?"

The Enabler for Change

- In 2015 there was a major building upgrade program planned
  - External and internal tile flooring required removing everything from the porch and main room of the home






The Starting Gun!

- The design proposals had been discussed for a couple of years
- There would be two elements of the PJ2T station upgrade
  - New operating positions
  - New antenna switching
- PJ2T operating principles and requirements would generally remain the same

Goal was to be completely operational for CQWW SSB in October!

Just for Giggles…

- Crated and shipped from Cedar Rapids on 08/28/2015
- The crate arrived on Curacao on 10/7/2015
- I arrived on Curacao on 10/10/2015 @ 8:30pm
- Crate was delivered to PJ2T on 10/12/2015
- First operator arrived on Curacao on 10/16/2015
- Last operator arrived on Curacao on 10/20/2015
- CQWW SSB begins @ 00Z, 10/24/2015

Operator positions assembled – 10/12-14
Station 1 On-the-Air – 10/15
Antenna Switch Installed & Controllers programmed – 10/18
Stations 2-4 Installed and Operational 10/19

Stepping Back…

- Requirements are one thing, but stepping back and assessing “what are we trying to accomplish” became a real eye-opening effort
  - Over the past 5-years we analyzed
    - Predominant class of entry
    - Number of operators
    - Equipment standardization
    - Maintenance issues
    - Balancing “radio” vs “living in the house”

And the answer is…

Results of the "Reality Check"

- M/M was the predominant class-of-entry
- 8-12 person teams with the target of 10 seemed to be the median size
- 25% to 50% of teams were not CCC members
  - Of that you could expect three to five participants that were first timers at PJ2T
- About 25% of the participants brought a spouse or significant other
- Most common "carry in" equipment were headphones and keyer paddles
- The bulk of major contests saw larger team entries – some with smaller teams e.g. 10M contest, 160M contests
- Most arrived a minimum of 5 days before the contest
  - Intent was to familiarize themselves with station and propagation nuance and to tweak the muscle memory of high-rate contesting
- Standard operating shifts – history showed that 4-hour shifts were the most accepted slot
  - Fully supported by 90-minute sleep cycle research plus a 30-minute wind down and 30-minute wake-up/step in orientation to events
  - Goal would be "seamless" shift changes

The largest "orientation" item was antenna selection – keep it simple!

A Key Strategy – Break it Before the Contest!

- Advantage of early arrival was we could put people in front of radios as soon as they arrive
  - In some cases, the equipment just came out of storage
  - Have time to verify that all the hot-swap equipment was functioning properly
  - Burn each position in
  - Find new problems e.g. interstation interference, Rx antenna performance, etc.
  - Contest director and band captains could assess overall team skills and move members around if necessary

The Conclusions

- Minimize the station orientation
  - Standardized look-and-feel of each position
  - Common equipment e.g. standard Elecraft K3 / Ameritron AL-1200 (when possible)
    - Eased maintenance and hot-swaps when necessary
    - Common human computer interface
  - Operating position to be bright and fresh with attention to ergonomics
    - Particularly important for the small-team events e.g. single op, two-person team for 160M or 10M contests

The Design Phase: Operator Positions

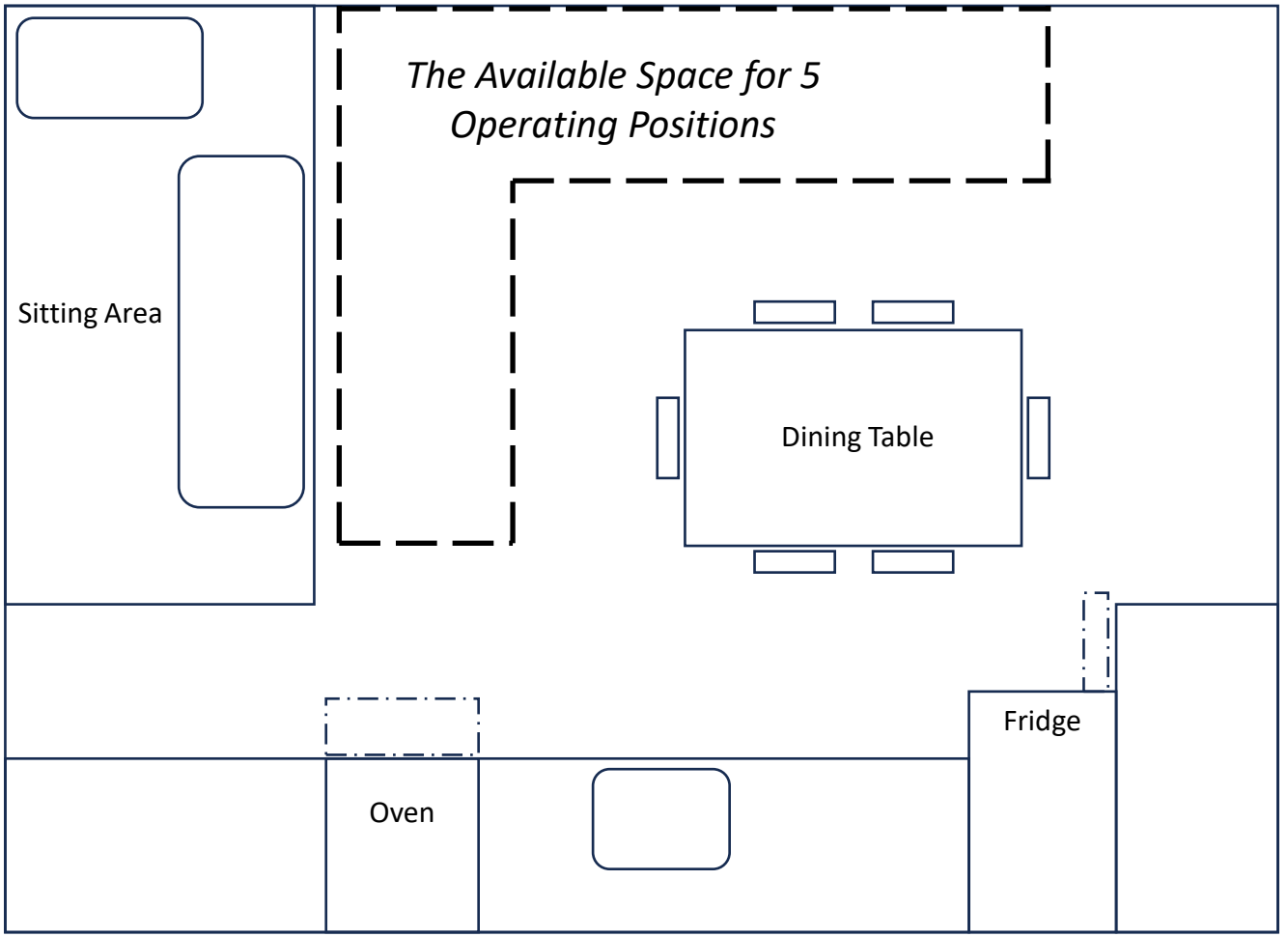
Measure Twice – Cut Once

- Room configuration was fixed
  - Kitchen was fixed – stove and refrigerator doors and walk ways had to be accommodated
  - Dining table had to be accommodated
  - Sitting area needed to be accommodated
- Operator position rear access was necessary
- Operator position should be designed to accommodate two-people at a position
- Maintenance and hot-swaps were critical design criteria

Work Flow

- Rx Antenna access was a key consideration
- The “four operating positions” perspective was a reference
  - Complicated by propagation
    - During Cycle max – 5 stations minimum, 6 a plus e.g. 10M could be open at the same time as low bands
    - During Cycle min – 4 stations were enough with some band sharing e.g. 160/15 and 80/10 could be shared based on band opening and closing
- Needed to ensure antenna switching could be accommodated

A Picture is Worth a Thousand Words…



How to Make it Work!

- Minimize the footprint of each operating position
- Allows an Overshelf
  - But Monitor height is a critical design parameter
- Touch Items include:
  - Keyboard/Mouse
  - Radio front panel
  - Amp front panel
  - Antenna Selection
  - Rotors
  - VSWR/Power Meter
- No Stacked Equipment!
- Undershelf
  - 12V Power Supply
  - Amp Power Supply
  - Computer
  - Bandpass Filters

Ergonomics is #1

Ready, Set, … Wait

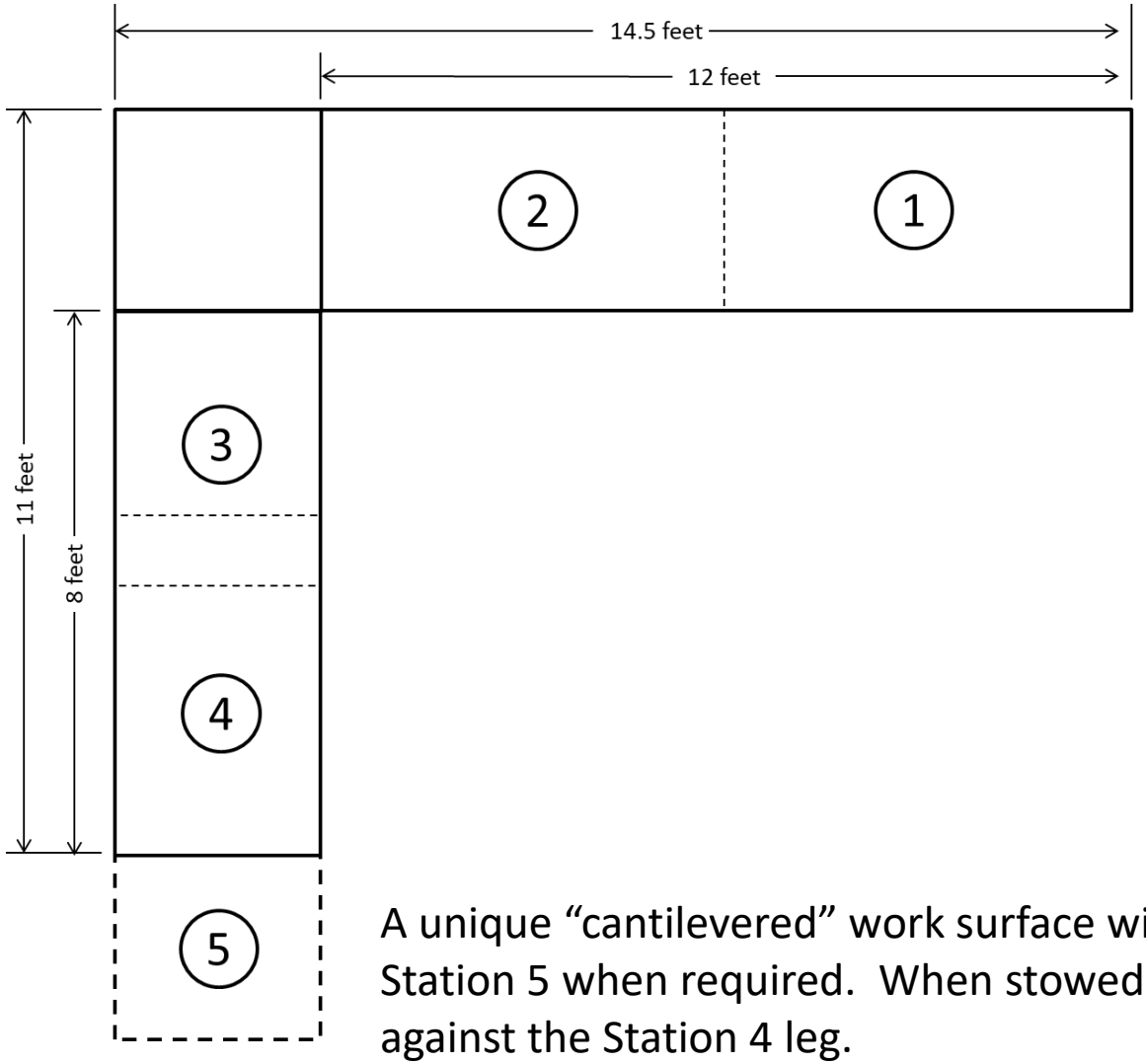
- Environmental considerations?
  - Humid environment – material choice
  - Shelf weight requirements
- How are we going to source things in Curacao?
- What about all the equipment to cut and assemble?

Hmmm… Looks like an ocean shipment is in order!

Operator Console Design Attributes

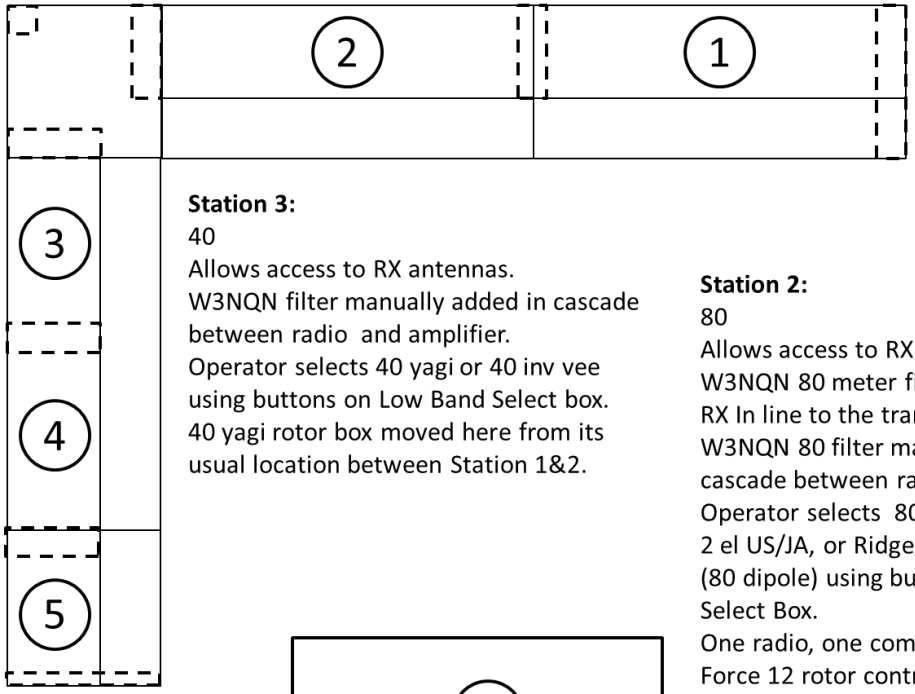
1. Maintains the same general footprint of original operating positions – no reduction in living area
2. Work surface height will be 28 inches above the floor.
3. Casters will be placed under the operating legs to allow movement of the entire set of operating positions
4. Station 1 amplifier remains on separate platform
5. Design supports two operators per position at Positions 1&2
6. Structural infrastructure will allow amplifiers to be placed on the over shelf with monitors and other necessary accessories
7. Nothing on the floor
8. Computers are on the under shelf – not the floor which is intended to improve life cycle
9. Shelf under the operating position allows power supplies and other equipment
10. Design allows for easy access to the rear of the table – no climbing
11. Allows for expansion to two monitors for Stations 1&2
12. Physical design allows for two radios at Stations 1&2
13. Radio choice is transparent. All cables/interfaces are non-ambiguous.
14. Design includes power supplies and power distribution for “bring you own radio” approach

Layout and Dimensions



A unique “cantilevered” work surface will form Station 5 when required. When stowed will be flat against the Station 4 leg.

Worst Case: Multi/Multi/6 Configuration



Station 1:
160
Allows access to all RX antennas including 4 SQ.
20, 15, and 10 meter MicroStack and Triband
Select boxes have been moved to other stations.
The High Band Select and Low Band Select boxes remain here.
Operator selects 160 Inv L using the button on the
Low Band Select box.
One radio, one computer.

Station 2:
80
Allows access to RX antennas.
W3NQN 80 meter filter inserted in the
RX In line to the transceiver.
W3NQN 80 filter manually added in
cascade between radio and amplifier.
Operator selects 80 three el Europe, 80
2 el US/JA, or Ridge Other Than Tribander
(80 dipole) using buttons on Low Band
Select Box.
One radio, one computer.
Force 12 rotor controller here between
Stn 1 and Stn 2 as normal.

Station 3:
40
Allows access to RX antennas.
W3NQN filter manually added in cascade
between radio and amplifier.
Operator selects 40 yagi or 40 inv vee
using buttons on Low Band Select box.
40 yagi rotor box moved here from its
usual location between Station 1&2.

Station 4:
20
No access to RX antennas; none needed.
W3NQN 20 filter manually added in cascade
between radio and amplifier.
Operator selects any of many available 20
meter antennas using MicroStack box and
Triband Select box that were moved here
From Stn 1.
One radio, one computer.
RX antennas re-routed from Station 4 to skimmers.

Station 5:
15
No access to RX antennas; none needed. W3NQN 15 filter manually added in cascade
between radio and amplifier.
15 Micro Stack and its attached 15 Triband Select pushbutton boxes moved here
From Station 1 on a long cable bundle. Operator selects any of many 15 meter
antennas or antenna combinations from these pushbuttons.
Operator throws a switch that routes this station's RF directly to the 15 meter
StackMatch relay box on the wall.

Station 6:
10
No access to RX antennas; none needed. W3NQN 10 filter manually added in cascade
between radio and amplifier.
10 Micro Stack and its attached 10 Triband Select pushbutton boxes moved
here from Station 1 on a long cable bundle. Operator selects any of many 10
meter antennas or antenna combinations from these pushbuttons.
Operator throws a switch that routes this station's RF directly to the 10 meter
StackMatch relay box on the wall.

Maintenance Access

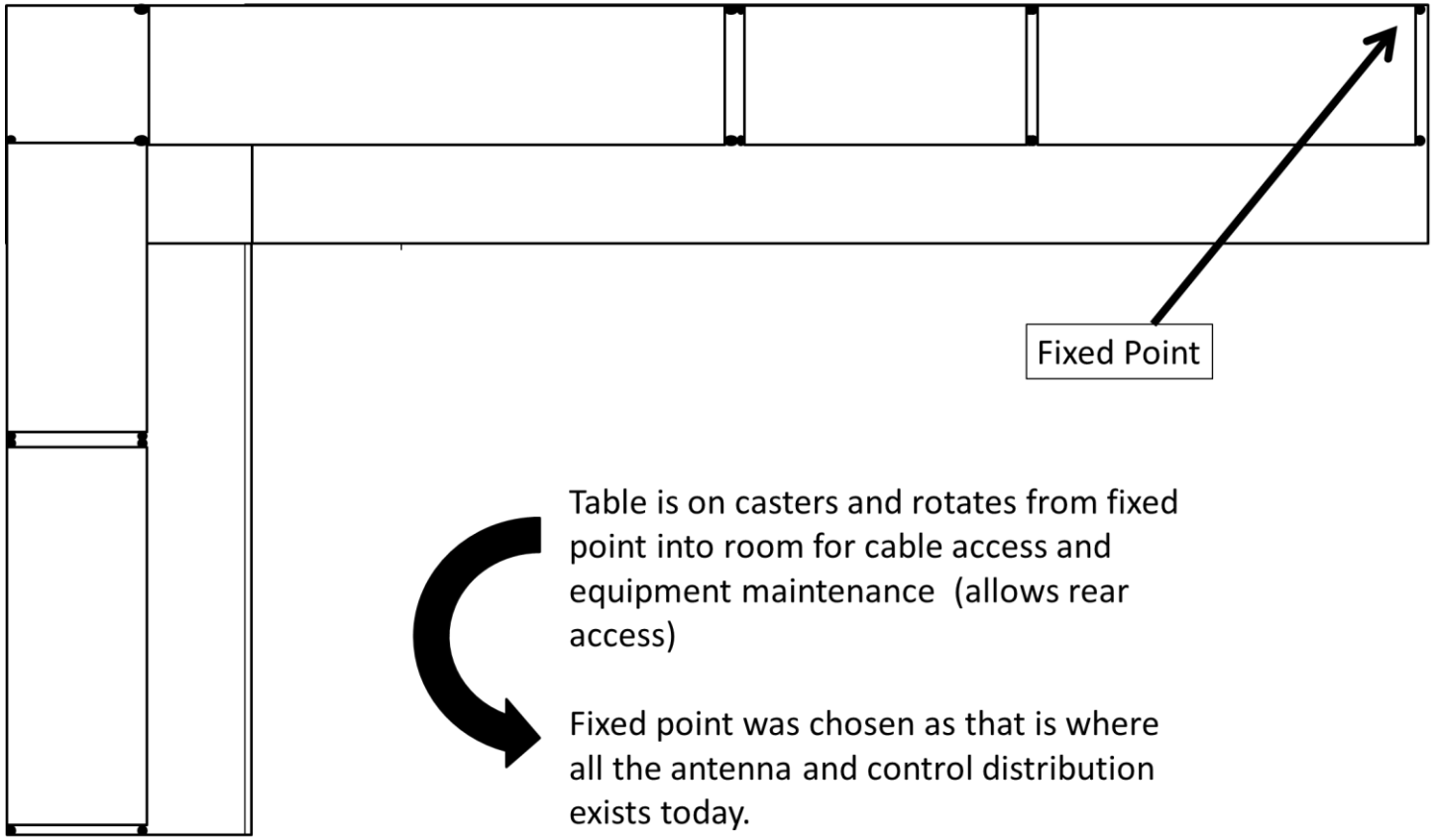


Table is on casters and rotates from fixed point into room for cable access and equipment maintenance (allows rear access)

Fixed point was chosen as that is where all the antenna and control distribution exists today.

Material Sourcing

- Work Surface
  - Special laminate countertop process required for high humidity
  - Was able to source an outdoor laminate countertop using special rubber-based sealing of wood core and vacuum process of attaching the laminate to the core
- Over Shelf
  - Shelf spans required that low-profile aluminum square tubing was necessary to support the weight of station amplifiers
- Casters
  - Small diameter “rollerblade” casters were chosen to ensure no damage to the new tile flooring
- Undershelf lighting
  - LED strip lights were part of the lighting design of the over shelf to ensure that radio panels were readable in all light conditions

This required US materials and tools to build the new operating positions

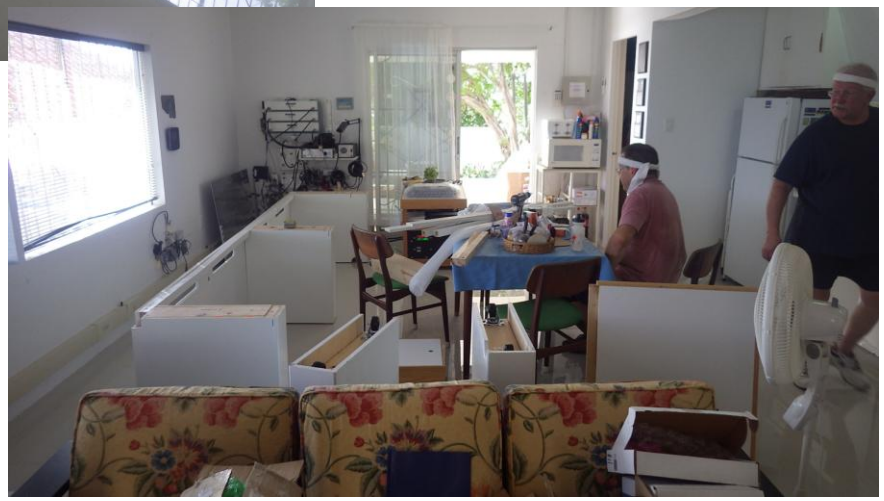
Now for the Fun!

w/Workshop help from WØAWL

Ready to Ship!

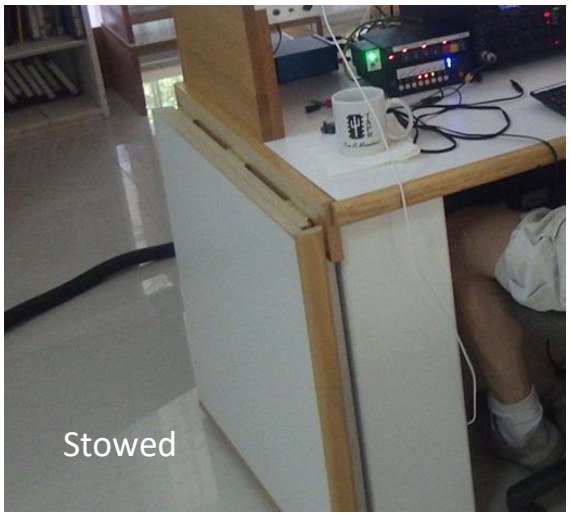
Out with the Old – In with the New

w/WØGXA who helped assemble the new operating positions

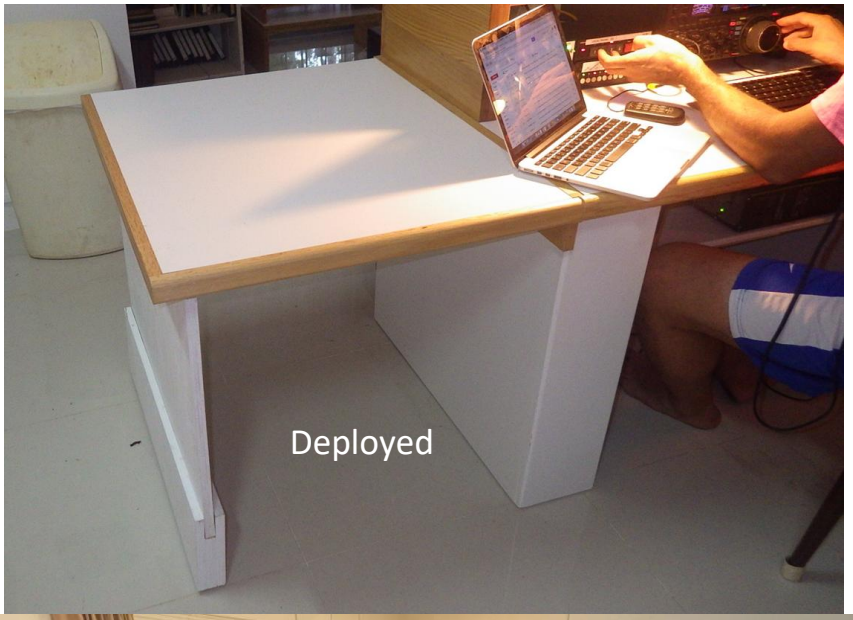


Starting to Take Shape

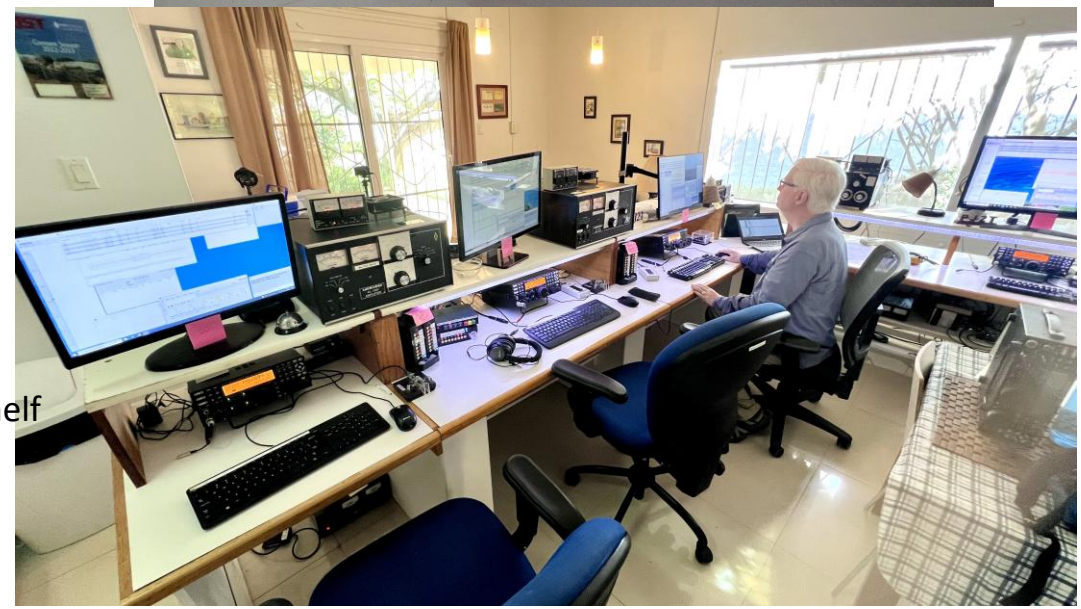
Station 5 – The Cantilevered Desk



Stowed



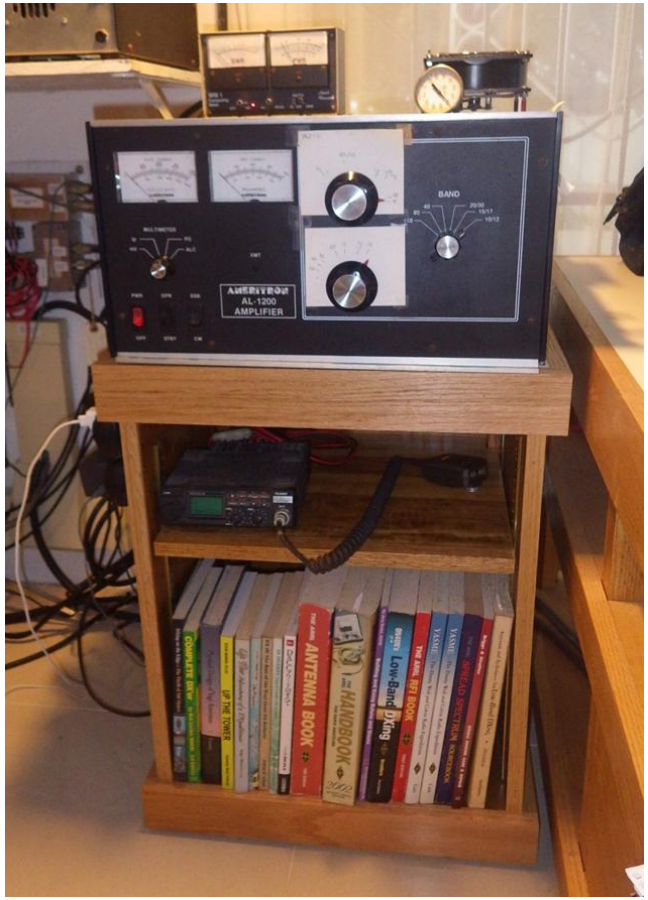
Deployed



w/Over Shelf

And While I Was at It…

Station 1 Amplifier Floor Stand

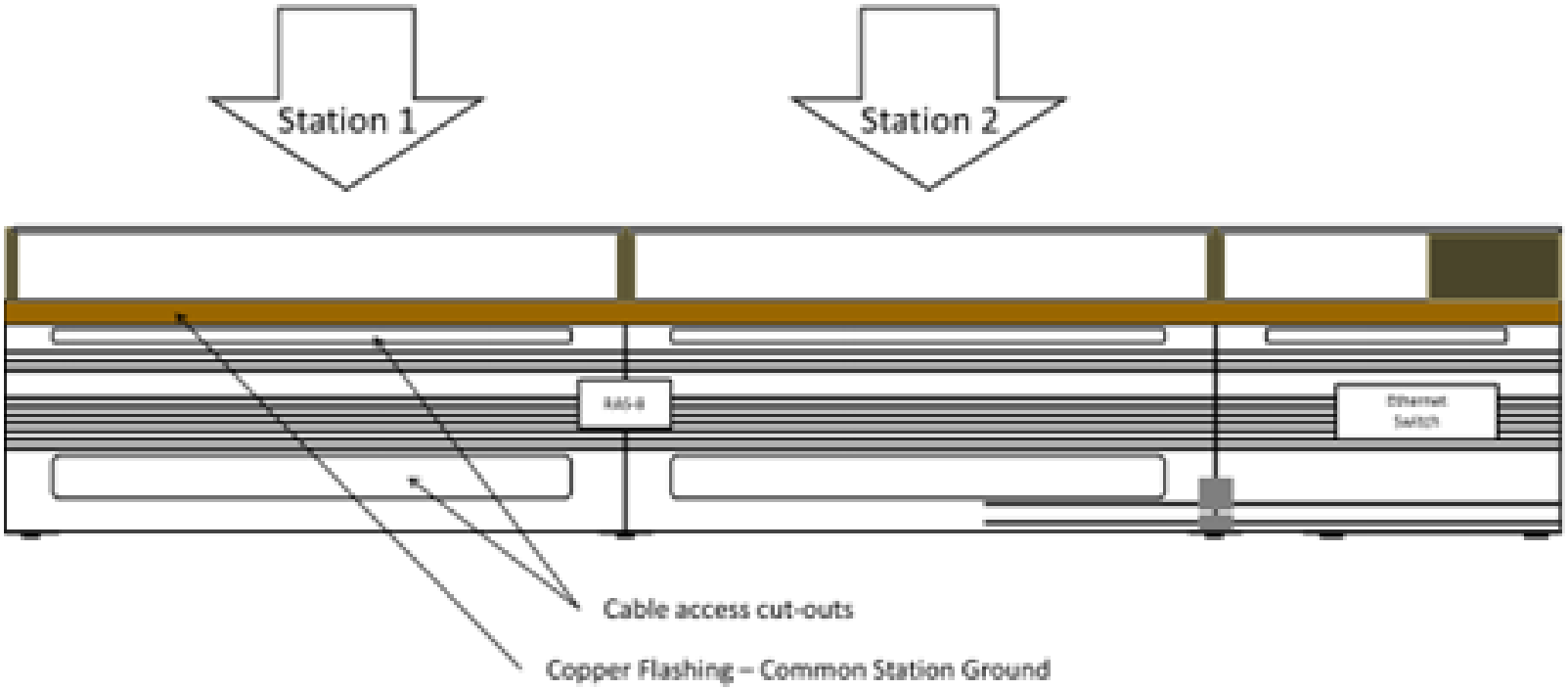


Station AC Power Control

The Under Shelf

Cable Routing and Grounding

Rear View of Back of Desk
(Station 1/Station 2)
Notional cabling and accessory mounting



Nearing the End…

The Design Phase: Antenna Switching

Just for Review… The Antenna Compliment

Band	Antenna Description
160	Inverted-L - Apex @ 95 ft - 45 radials
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Receive Antennas

1000 ft Beverage (EU) Fixed
635 ft Beverage (US/JA) Fixed
DX Engineering Rx 4-Square Deployable

Antenna Switching Goals

- All transmitting antennas to all operating positions
  - This includes Positions 5&6
- Lock-outs to ensure no two stations can select the same antenna
- Two antennas, on the same band, can be selected at the same time (radiating footprint control)
- Rx Antennas to Positions 1/2/3 only
- Antenna use easily determined at each operating position
  - No walking around or yelling "…can I have the South America tribander?"
- All switches, at the 5 primary positions, are exactly the same – no ambiguity

Studying the Alternatives

- Matrix Switching Arrays – key specifications
  - Port-to-Port isolation
  - Unused ports need to be grounded
  - Need the capability to be “daisy-chained” to handle the multitude of antennas
- Controllers
  - Should be stand-alone – not require a computer
    - Most positions will have only one monitor focused on logging
    - Grabbing a mouse vs punching a button is cumbersome
  - Should be networked in some form
  - Buttons should have status lights to clearly show the current state

Is there a single vendor solution?

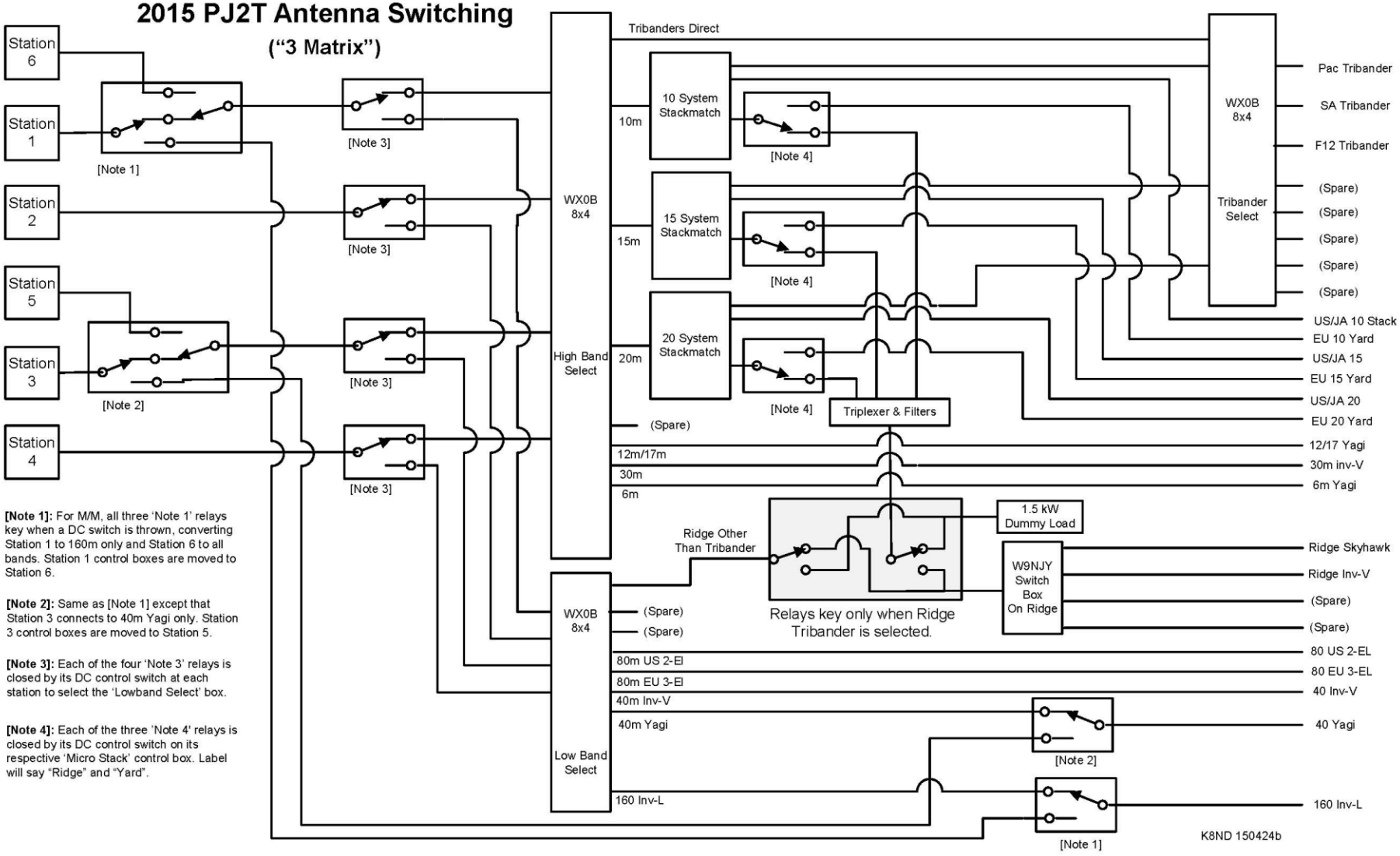
Solutions Considered

- Green Heron + a 4x8 Switch
  - Pros
    - Networked
    - Well established
  - Cons
    - PC centric
    - Multi-vendor
- µHam + a 4x8 Switch
  - Pros
    - Used in many complex stations
  - Cons
    - Focused on band selected antennas
    - Requires a PC for specific antenna selection
    - Multi-vendor
- Array Solutions + Hamation
  - Pros
    - Single Vendor – Hamation provides the controllers for the Array Solutions switches
    - Networked – ShackLan
      - RS-485 industrial network
      - RFI resistant
    - 4x8 Matrix was compliant with:
      - Unselected ports were grounded
      - Good port-to-port isolation
      - Could be “daisy-chained”
    - Well established
  - Cons
    - Proprietary network (ShackLAN) software

Array Solutions / Hamation was selected

2015 PJ2T Antenna Switching

("3 Matrix")



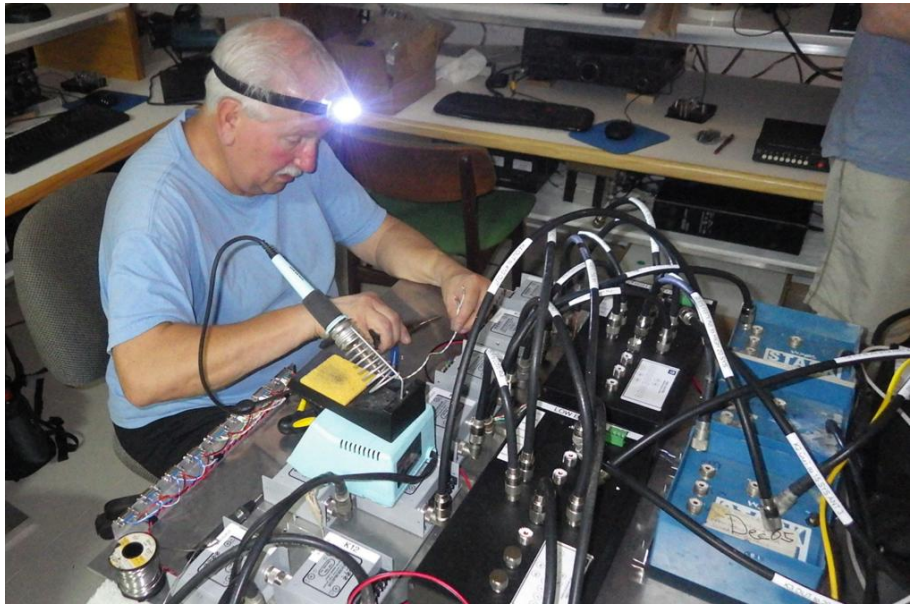
[Note 1]: For M/M, all three 'Note 1' relays key when a DC switch is thrown, converting Station 1 to 160m only and Station 6 to all bands. Station 1 control boxes are moved to Station 6.

[Note 2]: Same as [Note 1] except that Station 3 connects to 40m Yagi only. Station 3 control boxes are moved to Station 5.

[Note 3]: Each of the four 'Note 3' relays is closed by its DC control switch at each station to select the 'Lowband Select' box.

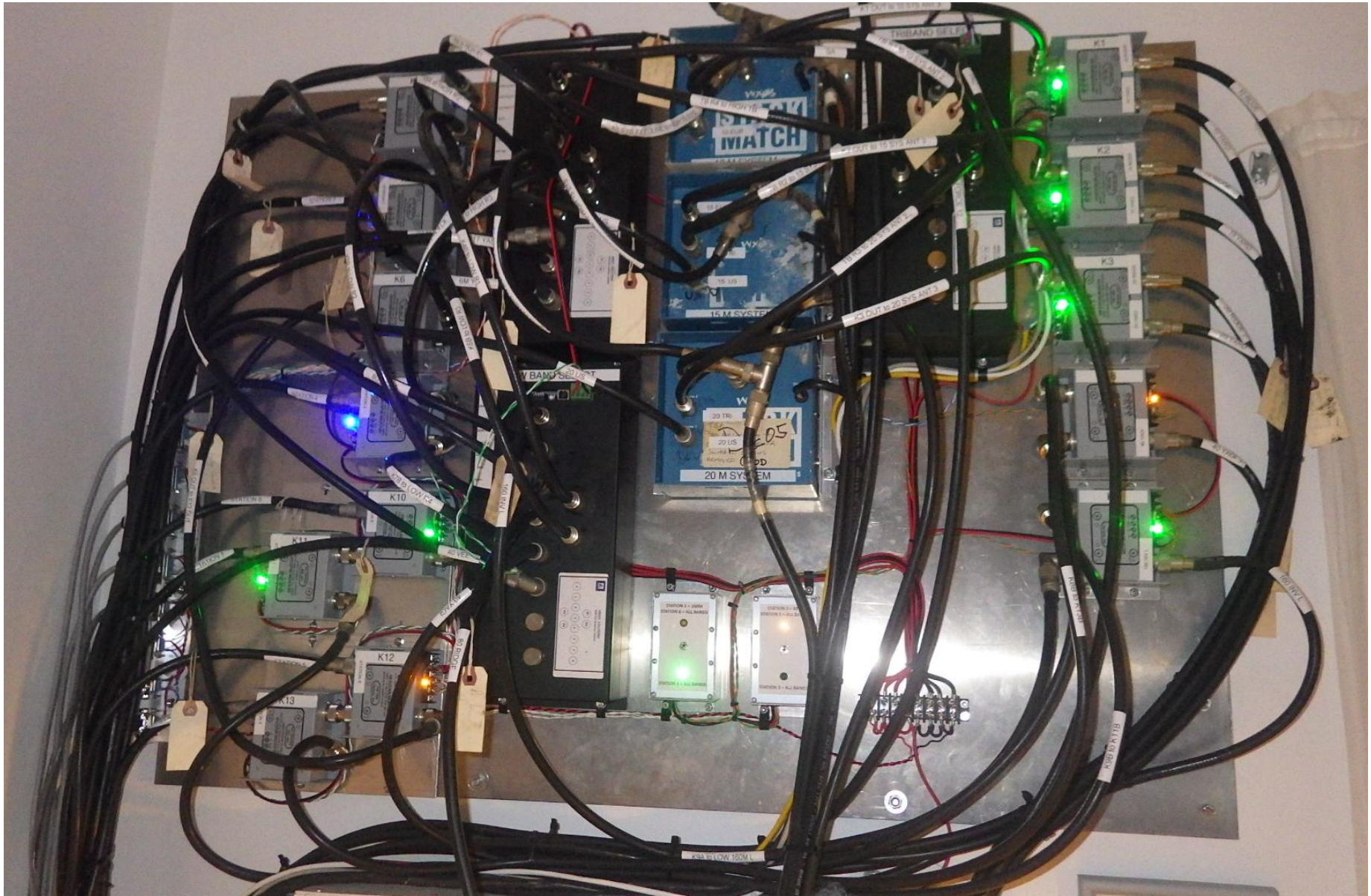
[Note 4]: Each of the three 'Note 4' relays is closed by its DC control switch on its respective 'Micro Stack' control box. Label will say "Ridge" and "Yard".

Some Assembly Required…



Plus Some Homemade Stuff…

The Finished Product!



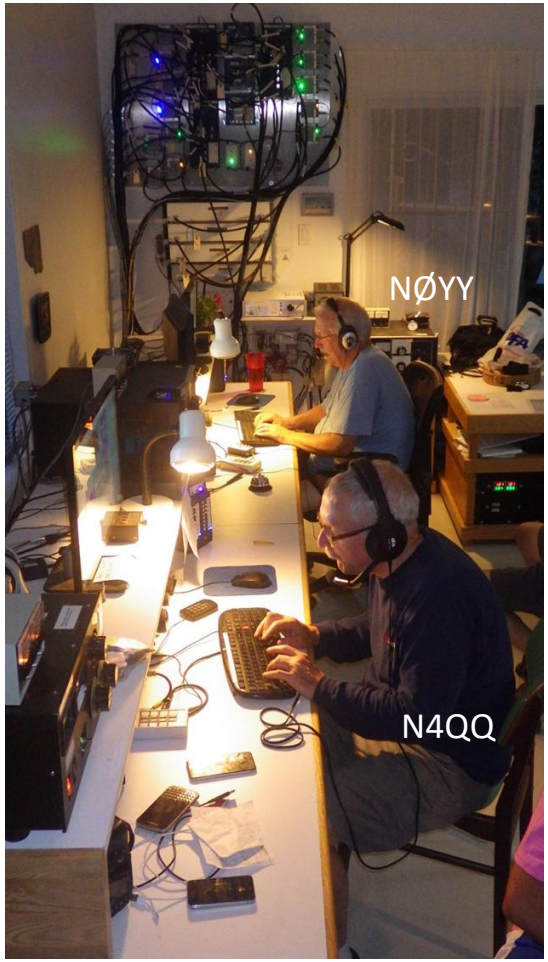
The Controllers

- The same controllers are at all operator positions
- Box on the Right
  - LOW BAND or HIGH BAND matrix is selected by the switch at the top
    - LOW BAND is 160 – 40
    - HIGH BAND is 20-10
- Box on Left selects the tribanders
  - Small switch on far left is for yard vs ridge tribanders
  - Box on top allows transmitting on multiple antennas while selecting a specific receive antenna
  - See example

Operational example of Left side Top box function

- Top box allows selecting two antennas for transmitting and separately selecting a single receive antenna
- Running US on 15M late morning
  - Both Ridge tribander and yard 15M yagi selected for transmit – yard 15M yagi selected for receive
    - This allows Europe to know we are there so they do not steal the frequency while we run the US!
- *Lights on controllers do not reflect the above example*

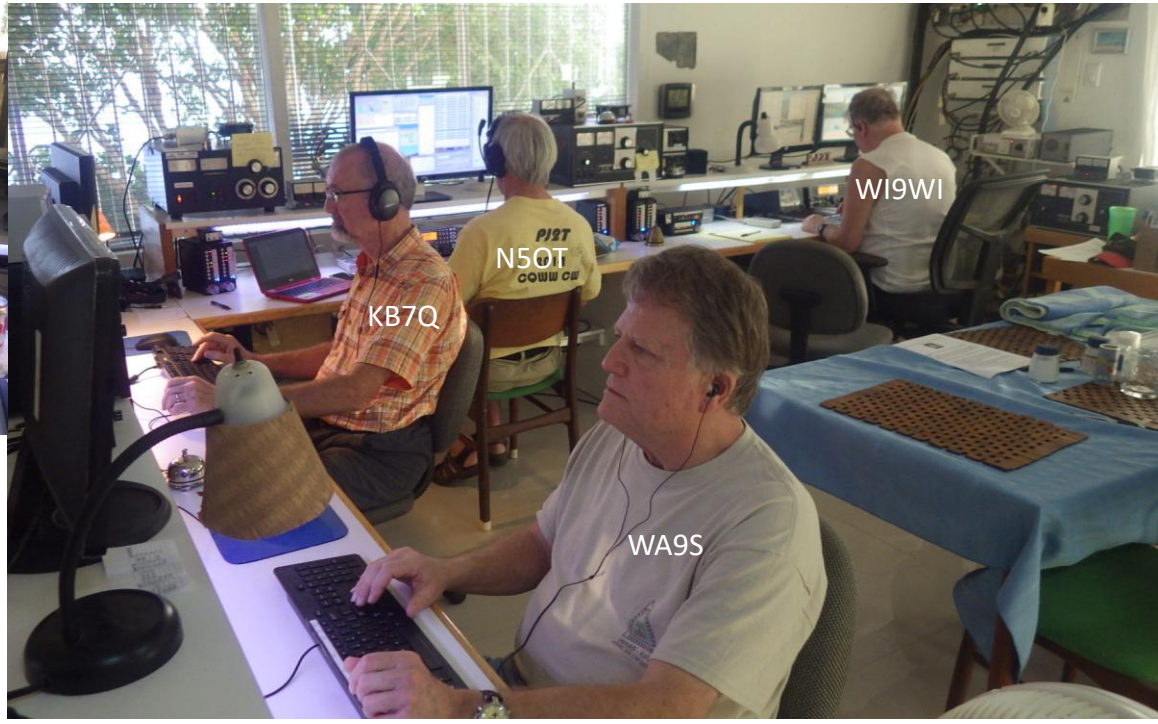
On-the-Air
2015 CQWW SSB
(15 DAYS AFTER THE CRATE WAS DELIVERED!)


NØYY
N4QQ


N4RV
VA6AM
IK7YTT


NØYY

And Some Others…



Addendum 1

- The initial discussions for this project began in 2012. There were countless emails, paper drawings, napkins over a beer or two that worked to resolve the unending "…what if?" questions.
- Technology and product availability has evolved quickly since the 2015 implementation
- There has been significant growth in configurable computer applications that are now available and offer alternative solutions to the ones referenced in this presentation
- That said, the alternatives that now exist may not have met the selection criteria. The good news is that hardware selected for the redesign remain available
- Also note that the adoption of the Elecraft K3 as the common transceiver, while a design goal, is not illustrated in the implementation for the 2015 CQWW SSB contest. They were put into service for the 2015 CQWW CW contest a month later. Mission accomplished!
- It's also important to note that the implementation did not ignore ergonomic goals. e.g. monitor height vs eye placement. Monitors come and go as the salt environment takes its toll. But VESA mounts, on compatible monitors, would solve the lowering of the monitor for proper eye alignment. Amazon can be your friend, but shipping to a non-US location complicates the flexibility of implementation!

Addendum 2

- Sometime in the early 2020's, remote operation of PJ2T was developed
- The foresight we had for how the Controllers were interfaced to the antenna switch allowed for relays mirroring the controller functions when operating remotely
- What began as a control operator-centric implementation has evolved to a fully remotable solution with functionality equivalent to being in Curacao.
- The remote interface is based on the RemoteRig platform for radio and amplifier control and remote computer access for common functions.
- This has been a huge success!