Infrastructure Improvements Update

Calvert RACES

Dec 3, 2020

Project Overview

- Calvert County Emergency Management agreed to fund a significant upgrade to the RACES infrastructure within the county.
- Has become a multi-year effort due to delays in funding.
- Plans include new antennas and feedlines installed on three County towers and two EOC's
- New radio equipment
- All antennas & radios procured by and owned by the County

The Team

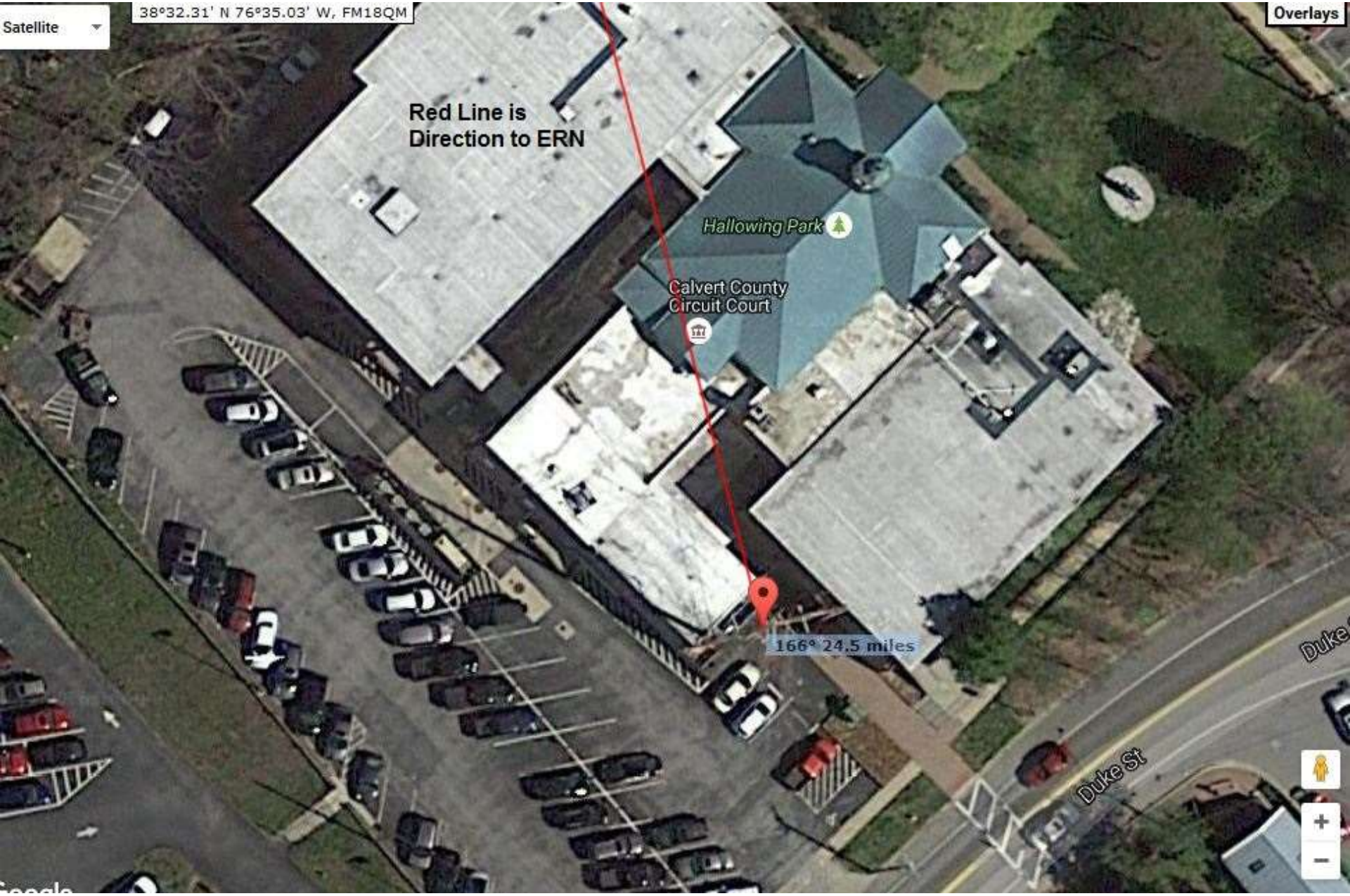
- N3XMZ – Calvert RACES Officer
- N3AE – Calvert ARES EC
- K3UGA – Indispensable effort reviewing design and preparing Bill of Materials
- Jack Anderson from Altairis Technology Partners
  - Consultant hired by County for their big EMCOMM upgrade
  - Also a licensed amateur radio operator

The Initial Plan

- Requirements as jointly developed with the County
  - Support EOC at Prince Frederick Courthouse and backup EOC at Calvert Public Safety Department (PSD) in Barstow
  - Two RACES operator seats at each EOC
  - One voice radio and one digital mode radio
  - Computer at each seat
    - County-provided and connected to their LAN
    - WebEOC
    - Winlink Express application installed
  - Antennas at each EOC high enough to cover tri-county area

Imposed Constraints

- Cannot install any antennas on the courthouse that extend more than 5 ft from the roofline at the back of the courthouse
  - Tests on Courthouse roof show marginal path to 147.105 Davidsonville (Central Regional Net)
    - Could raise 147.105 but well short of full quieting
    - Central Regional Net critical in region-wide call-up
- Need new antennas, feedline and radios at the alternate EOC in Barstow
  - Had no RACES radios or antennas at alternate EOC


Satellite
38°32.31' N 76°35.03' W, FM18QM
Overlays
Red Line is
Direction to ERN
Hallowing Park
Calvert County
Circuit Court
166° 24.5 miles
Duke St

Altairis Proposed Approach

- Locate EOC antennas on the Barstow tower
- Use RemoteRig's from the EOC's to Barstow
  - RemoteRig connectivity using County's dedicated and redundant Virtual LAN (VLAN) from the EOC's to Barstow
  - VLAN Independent of the internet
  - Fiber optics backed up by microwave
    - "0.99999 reliability"

RemoteRig


www.remoterig.com
PWR
USB
COM1
AUX/MIC
TTL
SP
CW
RRC-1258 MkII


Speaker
MIC
AF
CON
Internet
RRC-1258MkII
PA
RS-232
RS-232
COM-1
COM-2
Rotator
Mic
CW-Paddle

The Catch 22 Concern

- The new county emergency communications system will be highly capable and robust
- Unlikely to depend on RACES except in the very worse case scenario
- But the worse case scenario may include loss of the VLAN, which would mean loss of RACES link from EOC's to Barstow.
  - Calvert RACES EOC ops severely limited by low antenna height restrictions
- Another downside - remotely located RF decks make growth to sound card digital modes difficult

Solution to VLAN Loss

- Include a separate radio at Barstow capable of acting as a cross-band repeater to reach Davidsonville and elsewhere
  - Solves voice backup but not packet
  - Select a radio that can change channels by touch tone commands

- Install two small dual-band antennas (Diamond X50A's) on the back Courthouse roof and PSD roof to reach the cross-band repeater as well as CARA repeaters & digipeaters

  - Note: Only radio front panels at EOC seats, so RemoteRig used to reach radio RF deck's in the EOC equipment room
    - These RemoteRig connections would be made by dedicated CAT5 cable. No VLAN.
    - Same configuration at primary and alternate EOC's

Radios

- Need dual band radios capable of working with RemoteRig
- Need a radio capable of operating as a cross-band repeater that can also be remotely controlled (i.e. radio remote control of cross-band enable and disable as well as frequency changes).
- Radios tested:
  - Kenwood TM-V71A
  - Kenwood TM-D710G
- Down-selected to TM-V71A

Early Progress

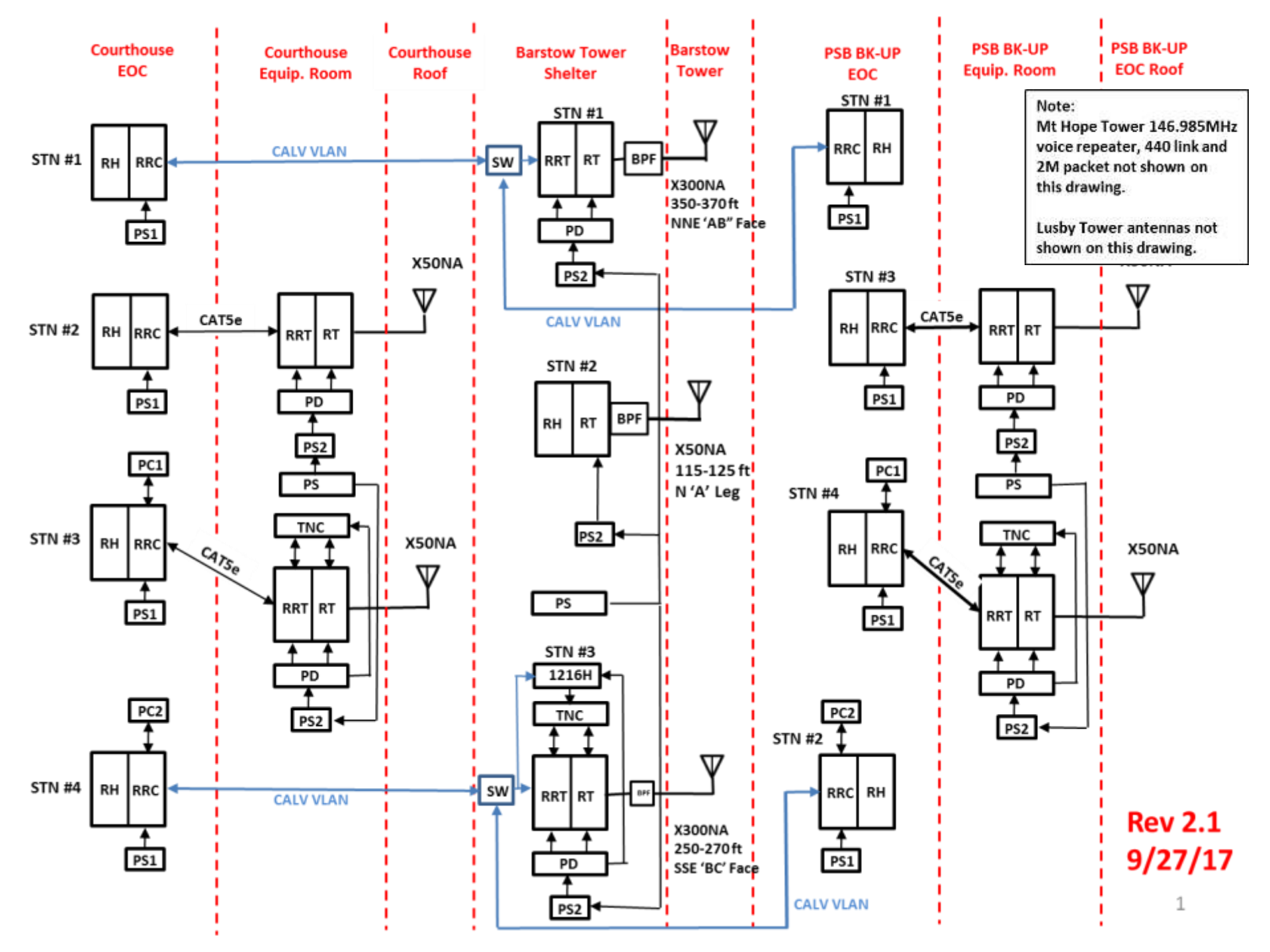
- The county purchased a TM-V71A and a set of RemoteRig terminals for beta testing
- TM-D710G borrowed from a CARA member for testing
- Beta Test Results:
  - Successful voice comm tests using TM-V71A & TM-D710G with RemoteRig
    - Successful with both direct CAT5 connection and connection over a LAN (Note: NOT demonstrated on Calvert VLAN yet)
  - Successful digital packet radio test using aTerminal Node Controller (TNC) located with the remote radio RF deck and using RemoteRig's "transparent" RS-232 link
    - But recommend using RemoteRig 1216H WebSwitches to be able to reboot remotely located TNC's if they should lock up

Beta Test Results, continued

- TM-D710G built-in TNC not usable with RemoteRig
  - This removes the only potential benefit for the TM-D710G
- Verified the TM-V71A & TM-D710G are cross-band capable and can also be remotely controlled using DTMF over the UHF side, but there's a downside:
  - No feedback on mode or frequency they are in after a remote command is received
  - Significant learning curve to use the remote control feature
  - Analogous to using a smart phone while blindfolded
  - Possible solution using PC with DTMF software and scripts
- TM-V71A & TM-D710G have a built-in CW identification to meet FCC requirements when in cross-band, but implementation is not perfect
- Still need to confirm RemoteRig will play over county VLAN.
  - If standard TCP/IP, should not be an issue

Final System Architecture

- Based on beta tests, decided to proceed with Altairis approach but with expanded packet and separate cross-band radio to back-up VLAN
- System diagram on the next slide
- Kenwood TM-V71A radios
- For the diagram on the next slide:
  - Physical locations shown left to right
  - Equipment at leach location shown top to bottom
  - Legend for diagram on slide after the diagram


Courthouse EOC
Courthouse Equip. Room
Courthouse Roof
Barstow Tower Shelter
Barstow Tower
PSB BK-UP EOC
PSB BK-UP Equip. Room
PSB BK-UP EOC Roof
Note:
Mt Hope Tower 146.985MHz voice repeater, 440 link and 2M packet not shown on this drawing.
Lusby Tower antennas not shown on this drawing.
STN #1
RH
RRC
PS1
CALV VLAN
SW
RRT
RT
BPF
PD
PS2
X300NA
350-370 ft
NNE 'AB" Face
STN #2
CAT5e
X50NA
PS
TNC
PC1
PC2
STN #3
STN #4
1216H
X300NA
250-270 ft
SSE 'BC' Face
Rev 2.1
9/27/17
1

Symbol Legends

- RH Radio front panel (radio head) for RT
- RT Radio RF deck TM-V71A
- RRC RemoteRig radio control panel interface, p/n 1258MkIIs-Con
- RRT RemoteRig radio RF deck interface, p/n 1258MkII-Rad
- PS1 RRC power supply “wall wart,” p/n 1258-PS-US
- PS2 13.8 vdc power supply for radio, RRT and TNC. Samlex SEC-1235M
- PD Fused power distribution panel – RigRunner 4005
- SW Managed switch (or manual cable swap – access issues???)
- TNC Terminal Node Controller – Kantronics KPC-3+
- 1216H RemoteRig model 1216H web controlled power relay unit

Not specifically identified on the drawing are:

- DB-9 RS-232 cable and USB converter between RRC’s and PC’s
- DB-9 null modem cable between RRT and TNC
- DC power distribution cables with mating connectors for PD’s, RRT’s, TNC’s
- Audio cables between TNC’s and RT’s (microphone and speaker outputs)
- Microphones , speakers and headsets at EOC positions
- Any customized audio distribution equipment at EOC positions to select radio-to-headphone connections

Antenna Summary

(All are now installed including feedline and Polyphasers)

Calvert RACES Tower Loadings and Antennas as of 8/2/2017 (Revised 11/21/2020)								
Location	**Stn # on Dwg**	**Ant #**	**Antenna Type**	**Freq. (MHz)**	**Height AGL**	**Orientation**	**Primary Function**	**Secondary Function**
Mt Hope	-	26	Telewave ANT150F6-2	144 - 148	280' -300'	SE 'BC' Face	146.985 MHz Voice Repeater	
Top 355' AGL	-	7	Diamond X300NA	144/440	330' - 350'	SE 'BC' Face	VHF/UHF Packet Digipeater	APRS
	-	15	Diamond X50NA	144/440	140' -150'	S 'C' Leg	420.050 MHz link to SHA Tower in Prince Frederick	Repeater Control
Barstow	3	21	Diamond X300NA	144/440	250' - 270'	SSE 'BC' Face	EOC VHF/UHF Packet	Calvert simplex voice
Top 403' AGL	1	12	Diamond X300NA	144/440	350' - 370'	NNE 'AB' Face	EOC to Davidsonville CRN	Calvert simplex voice
	2	107	Diamond X50NA	144/440	115' - 125'	N 'A' Leg	Backup Cross-Band from EOC to Davidsonville CRN	Calvert simplex voice
Lusby	-	64	Diamond X300NA	144/440	**230' - 250'**	SSE 'BC' Face	Future Remote Receive for 146.985	TBD
Top 449' AGL	-	15	Diamond X300NA	144/440	**350' - 375'**	NNE 'AB' Face	Link from Remote RX to Mt Hope	Future packet digipeater
Courthouse EOC	2	-	Diamond X50NA	144/440	~ 25'	West Roof	Access to 146.985 & 444.950 Repeaters	Backup voice to Davidsonville CRN using Cross-Band Repeater at Barstow (Barstow Station #2)
	3	-	Diamond X50NA	144/440	~ 25'	West Roof	Packet, direct or via CARA digipeaters	Backup voice to Davidsonville CRN using Cross-Band Repeater at Barstow (Barstow Station #2)
PSB Bk-Up EOC	3	-	Diamond X50NA	144/440	~ 25'	Alt EOC Roof	Access to 146.985 & 444.950 Repeaters	Backup voice to Davidsonville CRN using Cross-Band Repeater at Barstow (Barstow Station #2)
	4	-	Diamond X50NA	144/440	~ 25'	Alt EOC Roof	Packet, direct or via CARA digipeaters	Backup voice to Davidsonville CRN using Cross-Band Repeater at Barstow (Barstow Station #2)

Courthouse EOC Station Function Descriptions

- Station #1 (Antenna on Barstow Tower at 350 ft)
  - Primary: Voice to CRN & Outside County
  - Secondary: Simplex voice within Calvert
- Station #2 (Antenna on Courthouse Roof)
  - Primary: Access to Calvert voice repeater
  - Secondary: UHF simplex link to the Barstow VHF/UHF crossband repeater in the event of RemoteRig equipment failure or County VLAN link failure

Courthouse EOC Station Functions, continued

- Station #3 (Antenna on EOC Roof)
  - Primary: Packet/Winlink digital messaging within Calvert County either by simplex or using digipeaters
  - Secondary: Backup UHF simplex link to the Barstow crossband repeater in the event of RemoteRig equipment failure or County WAN link failure.

Station Functions, continued

- Station #4 (Antenna on Barstow Tower at 250 ft)
  - Primary: Provide direct VHF/UHF packet/Winlink peer-to-peer messaging communications to adjacent counties and jurisdictions
  - Secondary: Calvert voice simplex

Alternate EOC Station Functions

- The alternate EOC in Barstow is basically a repeat of the primary EOC but the station number sequence on the diagram is different (to match station numbering in Altairis meeting minutes of May 27, 2017)
  - Meeting minutes available upon request

Status as of Dec 2020
-The Chronology-

- May 2017 – Planning starts
  - meeting with County personnel and hired consultant
- June-Aug 2017 – Design effort on system architecture, tower & antenna locations
- Aug 2017 - Bill of Materials (BOM) given to County
  - funds not available
- Fund become available in summer 2020
  - Over $22,000 County funds committed (equipment plus antennas/install)
- June 2020 - BOM updated
- July-Aug 2020 – Antennas & feedlines installed (Motorola)
- Aug 2020 - County releases Request for Quote
- Sep 2020 - Bid won by Holzberg Communications, Inc. in New Jersey
- Oct 2020 – Equipment begins to arrive at County office
- Nov 2020 – Site visits to both EOC's and Barstow shelter

Status & Open Issues

- All antennas, feedlines and Polyphasers have been installed at both EOC's, Barstow, Lusby and Mt Hope
  - still need to check with antenna analyzers
- Equipment listed in BOM is trickling in
  - County will property-tag and store
- Site visits made to both EOC's and Barstow tower to measure for RF jumpers and CAT cables
  - still need to visit Mt Hope & Lusby shelters

Status & Open Issues continued

- Need to fabricate RF jumpers for all sites plus RemoteRig cables to/from TM-V71 and TNC's
  - Source of ½ inch hardline (190 ft plus Mt Hope & Lusby)?
- Need to install racks, equipment, grounding, and program radios & RemoteRigs
- Need better Understanding of Calvert VLAN
  - Does VLAN use fiber as primary with microwave as backup or vice versa?
  - Can we secure static IP's on the VLANs
  - How to switch VLAN between Courthouse and Barstow alternate EOC?
    - If physical cable swap, where exactly would this be located (access concerns)?
    - Is it possible to use a managed switch?
      - Not included in BOM

Open Issues, Continued

- Barstow cross-band radio always powered on or control through the 1216H web switch?
- Should we also update packet radios and TNC's at Mt Hope & Prince Frederick digipeaters ?
  - Currently, both are off the air (failures)
  - Could allow for remote control of frequency
  - Who would pay ?
  - ALTERNATIVE: Set up WL2K Gateway at Hospital and forget digipeaters

Status of Other Calvert RACES Infrastructure

Mt Hope Status

- New county-owned tower completed
- Older American Tower structure will remain for approximately 4 years then be taken down
- 146.985 repeater planned to be moved from PF to the new Mt Hope tower
  - Told we need to begin move soon
- K3CAL-1 145.750 digipeater is off the air
  - Equipment failures

Prince Frederick Status

- Decibel DB-224 2M dipole array and Decibel DB-416 70cm dipole array and/or feedline highly suspect
- CARA 146.985 repeater currently operational at PF using abandoned DNR antenna
  - Good commercial grade VHF antenna
  - Don’t know how long we will be able to use
- CARA 440 repeater removed from site
- K3CAL-10 digipeater off the air
  - Equipment failure

CalvertHealth Hospital

- Diamond X300 installed on roof and hardline run into equipment room
- No further work since COVID outbreak
  - Have asked about internet access for use as a Winlink gateway
  - No answer from hospital IT yet
- If internet available, might set up WL2K 2M packet gateway
  - Equipment not planned or budgeted

Lusby/Appeal Site

- Two Diamond X300 and hardline installed on tower
  - 230 ft facing SSE
  - 350 ft facing NNE
- Intent is to use as a remote receive site for the 146.985 repeater
- Have asked for a VOIP capable VLAN channel from Lusby tower shelter to Mt Hope tower shelter
  - UHF radio link as an alternative
  - Another alternative is a one-way cross-band repeater
    - Receives on 70cm and repeats on 146.385 MHz (CARA input)
    - Local user still receives on 146.985 MHz
- Required radio equipment NOT in the County purchase
  - Would be a CARA responsibility

Need Help with Cable Construction, Equipment Installation and Checkout

Questions

Alternative Approaches Considered

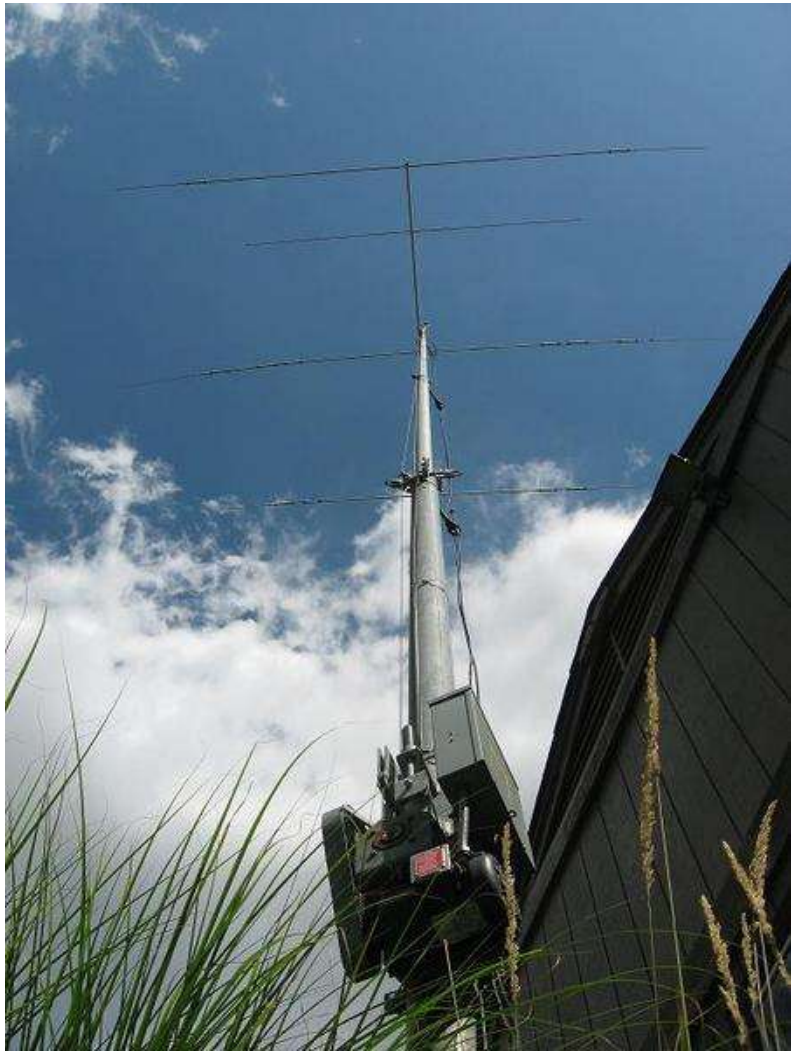
Alternative Approach #1

(Considered but Not Recommended)

- Crank-Up Mast, Crank-Up Tower or trailer tower at Courthouse (in back; can't be seen when retracted)
  - Pros
    - Cuts reliance on county backbone VLAN
    - Somewhat simpler – less to go wrong (unless the mast will not raise…possible single point failure)
  - Cons
    - Not cheap
      - refurbished 60 ft pneumatic mast $6,800 plus cost of air compressor, controls and installation
      - 55 ft MA-550MDP US Tower crank up mast $11,300 plus installation
    - No separation between antennas on shared mast (mutual interference) could be a significant limitation

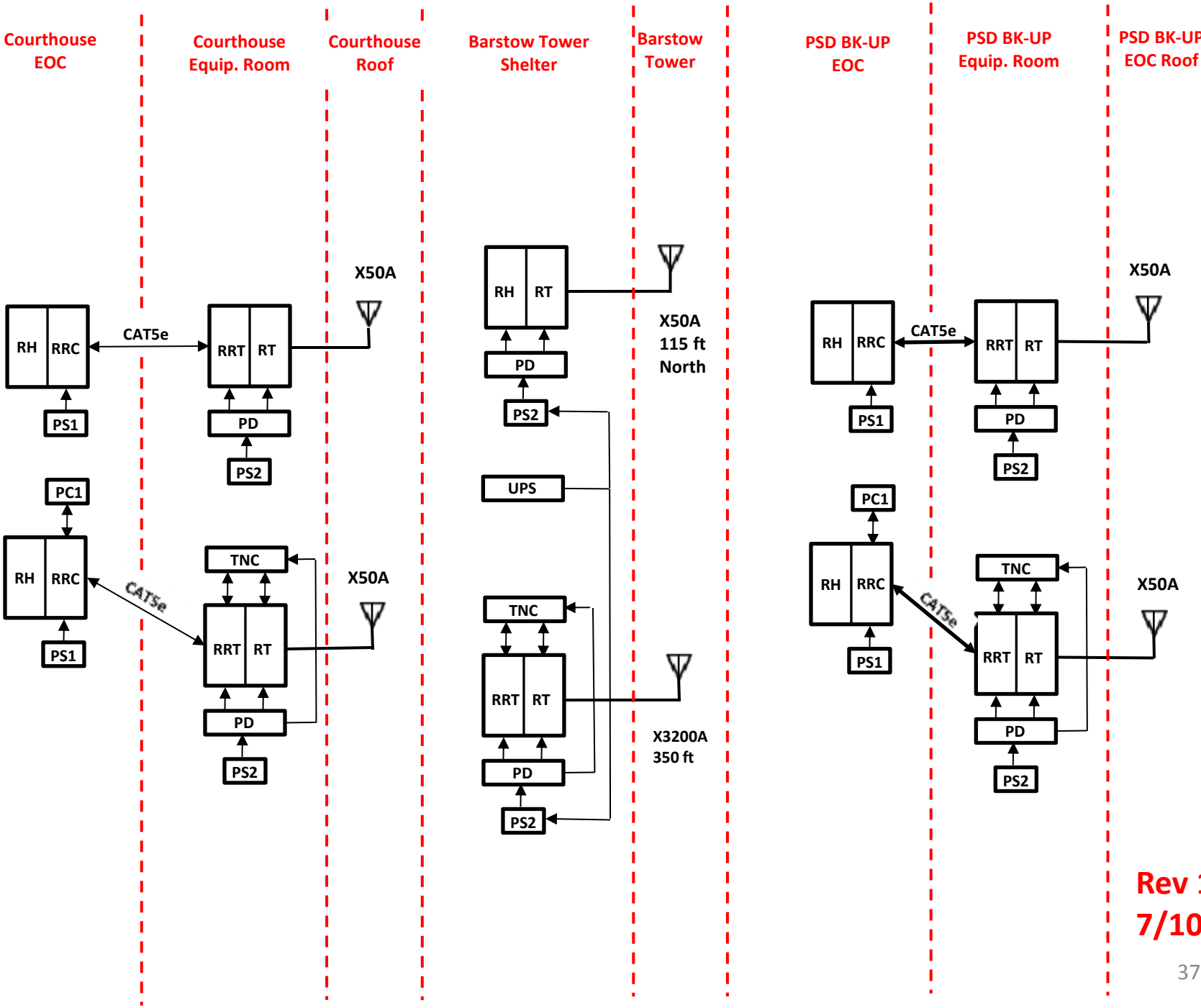
Locking Pneumatic Mast

Motorized Crank-Up Mast



Alternative Approach #2
(Considered but Not Recommended)

- Downsized option using cross-band repeaters at Barstow for “reach” to Davidsonville and for wide area Calvert “simplex.”
- Include a TNC for digipeating
- Both controlled over UHF by DTMF codes
  - Pros
    - Cuts reliance on county backbone VLAN
    - Less hardware to fail
    - Cheaper
  - Cons
    - Steep learning curve for remote control of radios
      - Significant probability of operator error changing radio modes and frequencies via remote control, especially under stress of emergency conditions
    - Lose two radios at each EOC compared to initial plan
      - Difficult to support local net and regional net at the same time


Courthouse EOC
Courthouse Equip. Room
Courthouse Roof
Barstow Tower Shelter
Barstow Tower
PSD BK-UP EOC
PSD BK-UP Equip. Room
PSD BK-UP EOC Roof
RH
RRC
CAT5e
RRT
RT
X50A
PS1
PD
PS2
PC1
TNC
UPS
X50A
115 ft
North
X3200A
350 ft
Rev 1.2
7/10/17

Alternative Approach #3
(Considered but Not Recommended)

- Use initial proposed architecture but replace Calvert VLAN with RACES dedicated amateur radio point-to-point microwave TCP/IP link or separate Mesh Network
  - 3 GHz or 5 GHz (no/reduced competition with Part 15 devices)
  - Pros
    - No reliance on county VLAN infrastructure
    - No issues with FCC Part 97 regulations
    - Possible expansion into county-wide broadband MESH type network
  - Cons
    - FCC phasing out amateur use of 3 GHz band
    - Preliminary look suggests 10+ sites with 100 ft towers needed for Mesh
    - Additional equipment, antennas and stuff that can fail
    - Link margin degrades in heavy rain