Build a Mobile Mesh Tower Fleet

Erik Westgard, NY9D   ny9d@arrl.net

8/10/2020 1.4 (revised)

Hams in Minnesota have just purchased eight 30' class mobile tower/generator trailers. These are intended for our various mesh networks such as the TWINSLAN Medical Command Network built for the Medtronic Twin Cities Marathon, AREDN and other applications and services as required.

The public service agencies we support have been asking for more real time data and information from us. This includes charts, graphs, dashboards and live video.   "Better data, better decisions" is a regular message from an area Red Cross leader we know well. This is driving the use of more mesh technology.

More towers were purchased than expected, so we are developing a proposed set of standards and a new operational model- based on the bass boat armada of the Cajun Navy – we are not pretending to be from Homeland Security.

Hardware- Surplus Construction Light Towers

In January of 2020 we got a call to provide a medical command center to the Loppet Winter Festival- a popular urban ski event. This had several aid stations and a medical center in the back of a ski chalet. The building was in a valley- and I was worried about repeater coverage. No tower trailers were available- ours was frozen in. A request for a government trailer was rejected.

An online search for "tower trailer" became "light tower" – a forlorn 30 foot unit with a broken generator and missing lights was purchased from a corn field for $700. Sources for these include Craigslist, eBay, Facebook Marketplace and www.ironplanet.com.

Light Towers are common in construction sites and rental fleets. Along with the rotatable 24-30 foot tower you get outriggers, four lights and a 6KW (~12hp) two to three cylinder diesel 115/240V generator. In running condition, they rent for around $50 per day so command a sale price of $500-$4000 used.   Dead engines or burned out generators are expensive to repair and sale prices for scrap /retired units can be very low- $100-$700.   You should view the price as for the tower, and the broken engines are normally in rough shape- fuel injection and rebuilds are costly.

If you plan to use the diesel, running ones can be a better investment, given falling auction prices and the potential repair parts cost.   An injection pump is around $200-$300, and injectors are $100 or so. Running diesels at less than full power causes "wet stacking" which can be bad for them.   There are lots of videos on diesel diagnosis and repair for those so inclined.   If the diesels are hopeless small dual fuel portable generators can be bolted in and are common and cheap.

Ours have usually needed new tires, trailer jacks replaced, the light system transformers removed and new deep cycle 12V batteries. I have installed low cost solar charge controllers and panels.   One thing we learned- some towers have electric/hydraulic hoists, which may require the engine to be running.

We added a "shore power"115V inlet for one. You can often fit one or even two towers in a residential garage.   Be aware there are newer ones with non-tilting vertical towers- these can be 8+ feet tall retracted

Hazards include lead paint and used diesel oil which are toxic and fraying lift cables.   Two of ours have bent axles. Insurance was cheap- $35/year- and unlike a motor vehicle could potentially be assigned to a club.   Assume the trailer lights are broken- bring a magnetic set. Get a bill of sale signed and dated for licensing- title documents are rare. Once in while these have a "pintle" hitch- common on dump trucks.

Trailers come in several sizes- the bigger, usually older ones can perhaps handle a triband antenna- probably with guy ropes. Weight is around 2000-3000 pounds so a large tow vehicle is not required.

Normally one solid antenna mount can be developed at the top (most come with a cross bar for the lights) and with a piece of aluminum square tube you can add a cross bar for additional smaller antennas.

Software /Networking

We tested the early ham radio mesh around 2010 – some consumer grade access points did poorly outdoors and 2.4 GHz had a high noise floor in a crowded finish line space. So in 2011 we adopted Ubiquiti, OpenWRT, OLSR and Part 15 802.11A frequencies. Our addressing system was based on our D-Star DD network which was a /24 per node. And we got an agency complaint about in fighting in one of the ham radio mesh groups. So we made our own standards based setup.

The need for FCC licensed control operators on a mesh network puzzles my leadership who are all medical providers when we talk about area wide incidents. On the other hand we get endless grief from hams for having a "closed/private" mesh on Part 15, but the idea of a 10ish megabit, backup emergency use network also being an ISP and test bed for hundreds of people frightens us, or one that cannot easily support crypto.   We have a 9.1 mile link between Minneapolis and St Paul, and a few omni nodes at each end. So there are two mesh networks. Ours, which supports volunteer medical use cases, and AREDN mesh.

We have each mesh node of ours with static addresses- so video cameras, IP PBXs and database servers can be set up in advance. DHCP is also nice when deploying workstations or IP phones.

We engage with our served agencies using this model:

1. Understand served agency needs
2. Embed our volunteers and technology
3. Execute flawlessly
4. Continuous improvement.

We are trying to support more mature and sophisticated volunteer applications and services. Our events have never used go-kits (bringing backpacks to major sporting events is now discouraged nationally) or formal message traffic.

I have been working with K8JK on a maturity model for the delivery of volunteer emergency services via Amateur Radio. These models are common in Information Technology, and can be applied to us. The idea is you move up on the list over time following best practice.

1. Integrated volunteer emergency management
2. Family reunification /volunteer medical coordination
3. Interoperable communications /backup EOC
4. Amateur Radio traffic handling /shadows
5. Backup communications

Our key deliverable is usually based on updates we made to a software package called trivnetdb. This is a Linux / PostgreSQL port of the old ARES-Data.

At our race events we are handed a flat file (.csv) with the first name, last name, gender and race bib number of participants. We can then query these and record and report status changes, primarily location. This application supports a web interface so works fine over 90kbps D-Star DD links, mesh of all flavors and the Internet. We did experiment with limited AX.25 support.

We have a chat function and any database status updates scroll across that screen which can be used in a management or net control center. Data entry is at Net Control from course deployed hams. Reports arrive by voice radio and updates are then entered there. At the Hospital Tent front desk or in our "Find Your Runner" family information tent, numerous laptops or tablets are used over secure WiFi.

In a disaster, the database allows people to be added- we would use a telephone number or even an email address- those are not particularly protected /private and everyone has one or the other. The database scales- and we have a fleet of 32 old laptops in sets of eight. We toyed with a mobile app- but a web page is free and easy and works on anything. Our Medical team adopted a mobile application with cloud dashboard called RaceSafe. (https://www.iracesafe.com/). In any missing persons situation, the common requirement to pre-register seems a barrier.

The idea is not to be prescriptive here- whatever you find useful can be supported. Standards are needed for mesh backbones and IP addressing and security otherwise you have a mess. There is a lot of work underway on compute packages, IP PBXs, video servers, etc. DNS can also be used. We reject the often cited example case "use the Internet to back up the Internet." Just waiting around for commercial cellular networks to fail seems uninteresting.

Standard load-out

The load out on the first trailer includes several services.   We would hope any trailer would at a minimum support an unmodified radio to support the local mesh network(s) and be a relay node- even if no apps or cameras are provided. AREDN is air gapped (or carefully firewalled) from our production mesh:

Main antenna mount- rotator and beam or tri band omni (2m/440/1.2) as required + a pulley for dipoles

5 GHz 802.11 mesh Ubiquiti radio for our Part 15 network (happy on 12V with a $4 12V POE adapter)

5 GHz 802.11 radio for AREDN mesh (locally channel 180 /10 meg, etc.)

Ubiquiti NanoSwitch™ on the tower (12v POE- waterproof)

2Ghz 802.11 access point (also on 12v POE)

PTZ IP camera (12v supply- 48V POE) Cameras should have a simple local web server /IP not require an encrypted cloud app to be best on mesh IMHO. Hennepin County Sheriff volunteers came up with/tested this idea. Video comes from mobile trailers and is fed via mesh to the command truck which curates the video and feeds it to the Internet for mobile devices and EOCs to use.

2m/440 MHz small dual band antenna

Dual band radio

1200-3500 W dual fuel propane generator (these are $269 and up)

Two Group 27 deep cycle batteries

30A solar charge controller + battery protector ($10)

100W outboard solar /30 W onboard solar

115V Shore power inlet

LTE router if requested

Portable mesh video cameras

Medical command /missing persons database server http://www.kb8zqz.org/trivnetdb/

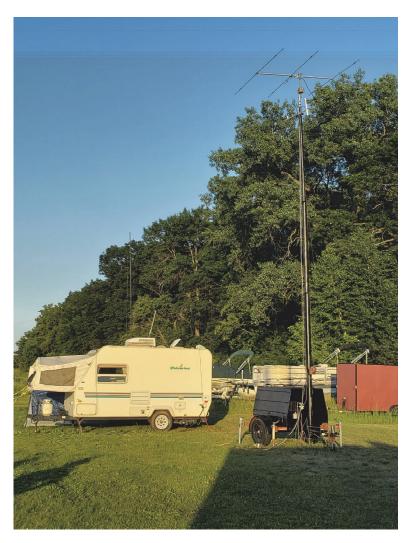IP PBX (Pi based)

Proposed "Rules"

With a fleet of trailers we can cover very large events, or more than one event at a time. The trailers performed well at Field Day with beams and rotators. We tested mesh video with portable cameras at the Klondike Dog Derby- on a 15,000 acre frozen lake.

1. Trailers get cute tactical names/colors (ask your wife). Or it was suggested to have your kids design a paint scheme for them.
2. Trailers are interoperable /tested with our mesh network(s).   This includes our most important area government command trucks. These trucks can act as video and data aggregation points for large events.
3. The ownership should be widely distributed to prevent any one person from taking them over.
4. Ideally we have a three hour response time state wide. My two are plugged in on warm standby. Four hours to find which box in the basement has the antennas and which bin has the feedlines is not good.
5. Trailers should travel in convoy for the best visual effect. I can see these in parades, county fairs, etc.
6. Citizen Science is the idea here- creative technology is encouraged- this is a technology/service/hobby project.
7. If more than one trailer is needed at once - ask- "Barn Raising" is the model

8. These are intended to be cheap and abundant - more like cattle vs a prized race horse. If you have $10,000 in it or it is powering your house it can't be out (or loaned out) helping others.
9. We found epic reflective callsign decals https://www.ebay.com/itm/123054221928 - the idea is we are proud to be volunteer Ham Radio operators and are all about rescuing/helping people.

Thanks to N0NAS and KD8GBL for support and advice.

Erik Westgard, NY9D is the Volunteer Medical Communications Coordinator for the Medtronic Twin Cities Marathon, Red White and Boom Half Marathon and Loppet Winter festival.
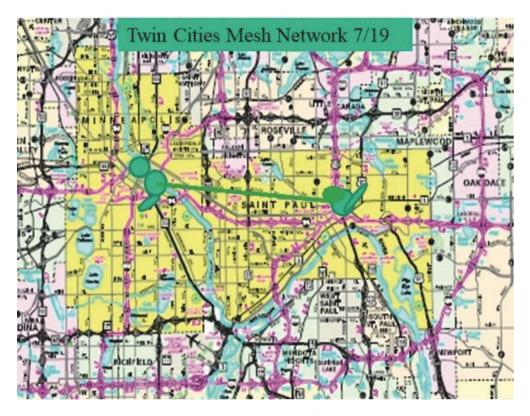

Our first trailer, an Over-Lowe (code name - it used to be orange and is now black)
with a six meter beam, several dipoles and mesh at Field Day 2020

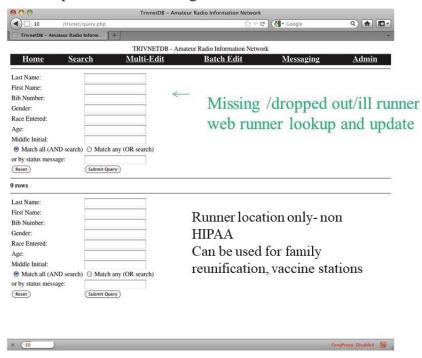An Allmand Brothers ML4- larger and wider with a tri-band beam, dipoles and electric hoist.

Trailer #1 (L) and #8 (R) "Jolly Green Generator" being setup at Hams in the Park here for mesh interop testing.

Our (Part 15) TWINSLAN Medical Command Network

Our Open SourceTracking Software: Trivnetdb

Above - Trivnetdb- our data entry/query screen