

# Build a Mesh Mobile Tower Fleet



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Volunteer Medical Communications Coordinator,  
Medtronic Twin Cities Marathon

Red White and Boom Half Marathon

Loppet City of Lakes Winter Festival

<http://www.14567.org>

# Agenda

- Nine years of mesh and databases at the Medtronic Twin Cities Marathon
- Mesh overview
- The tower trailer fleet
- A look ahead

# Medtronic Twin Cities Marathon Medical Communications

110 Yellow shirts (hams) backstop 911 /EMS medical communications and dispatch volunteer resources and track injured runners

Injured /dropped out runner location data flows to the server and status dashboard

Course tactical operations are autonomous (ICS)

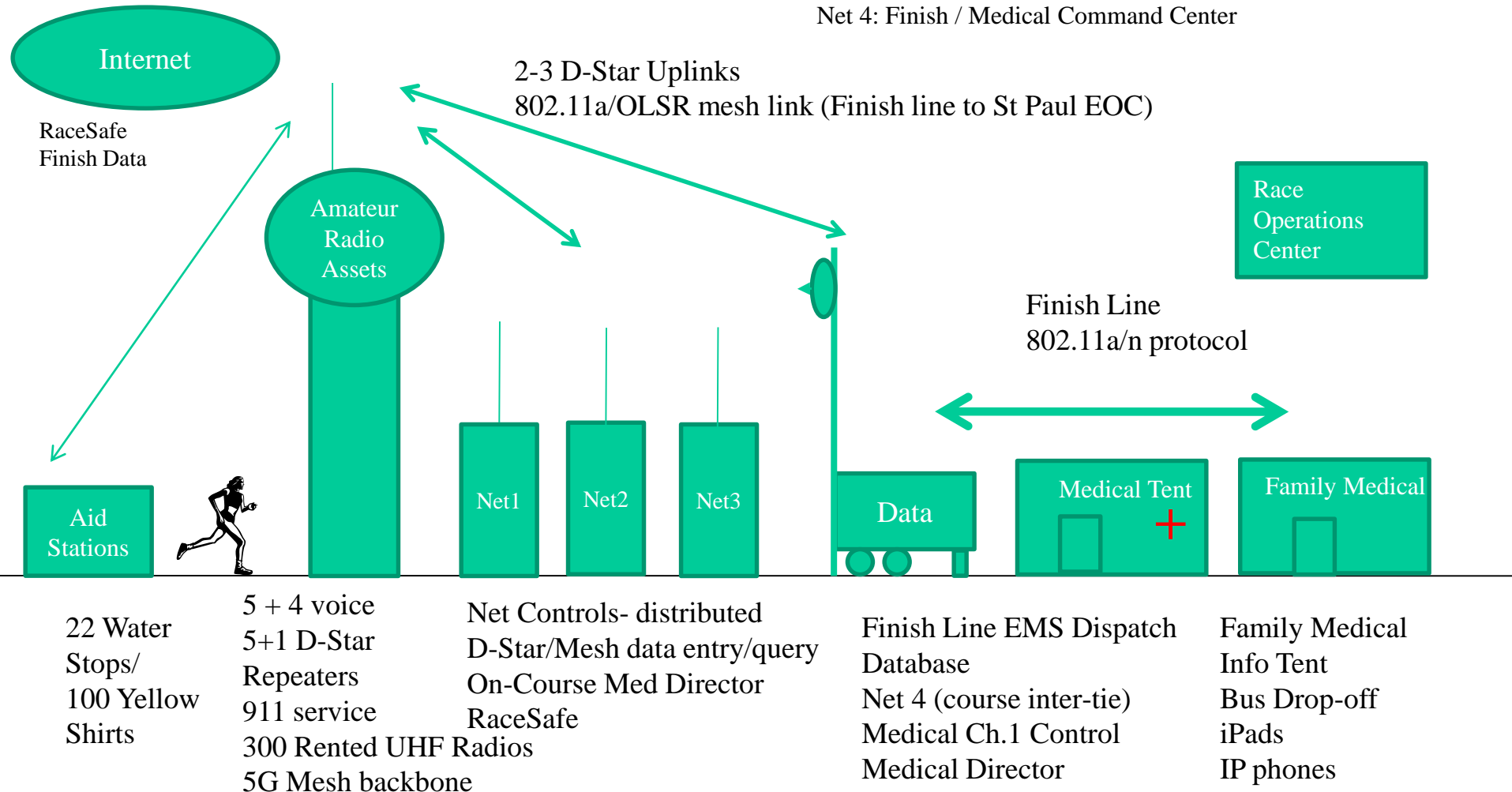
“Runner Down” protocol is always 911

Net 1: (Miles 1-18) Minneapolis (Maple Grove Fire)

Net 2: (Miles 18-22) Hennepin County ICC Truck (ARMER)

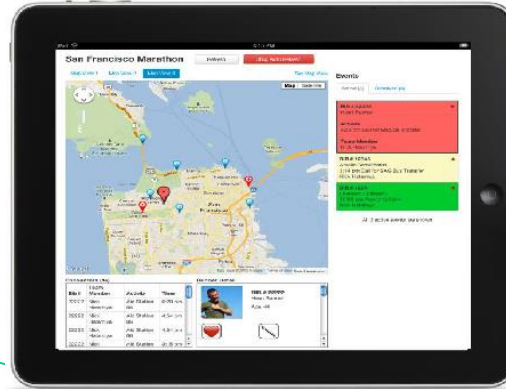
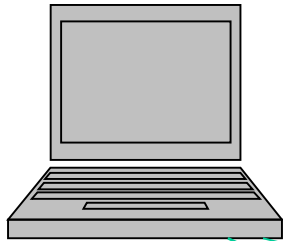
Net 3: (Miles 23-26) St. Paul Dispatch Center (911)

Net 4: Finish / Medical Command Center

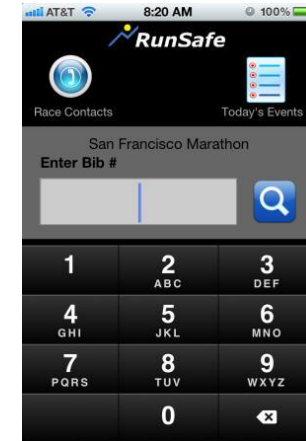


# RaceSafe Commercial Software

Command centers  
Query + updates



MDs  
Medical  
admissions



Mobile  
devices

TCM Race  
Timing Web

trivnetdb in  
the TCM  
data trailer

API

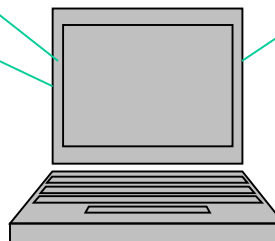
irunsafe.com

EMR  
PHR  
data

Events +  
Timestamps

Part 97 Requirements:  
Non HIPAA event view,  
API feed to trivnetdb

Either a single  
integrated  
view or windows to both/all apps



Amateur Family Medical  
Information Tent agents (6-8)

# Our Open Source Tracking Software: Trivnetdb



TRIVNETDB - Amateur Radio Information Network

[Home](#)   [Search](#)   [Multi-Edit](#)   [Batch Edit](#)   [Messaging](#)   [Admin](#)

Last Name:

First Name:

Bib Number:

Gender:

Race Entered:

Age:

Middle Initial:

Match all (AND search)    Match any (OR search)

or by status message:



Missing /dropped out/ill runner  
web runner lookup and update

0 rows

Last Name:

First Name:

Bib Number:

Gender:

Race Entered:

Age:

Middle Initial:

Match all (AND search)    Match any (OR search)

or by status message:

Runner location only- non  
HIPAA  
Can be used for family  
reunification, vaccine stations

Owner: KD8GBL

# The Database and Dashboard Gap



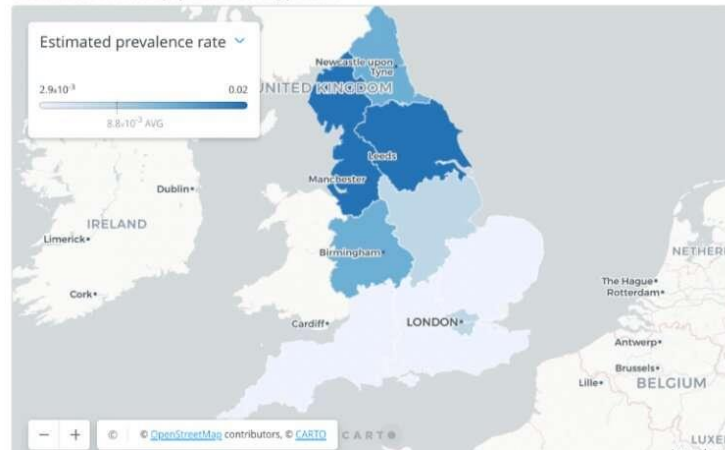
Winston Churchill's WWII War Room.

Message traffic

Phones

Dashboard /Map

3. Estimated % of total population testing positive



What Amateur Radio /ARES software supports real time data and or dashboarding?

# Why Mesh?

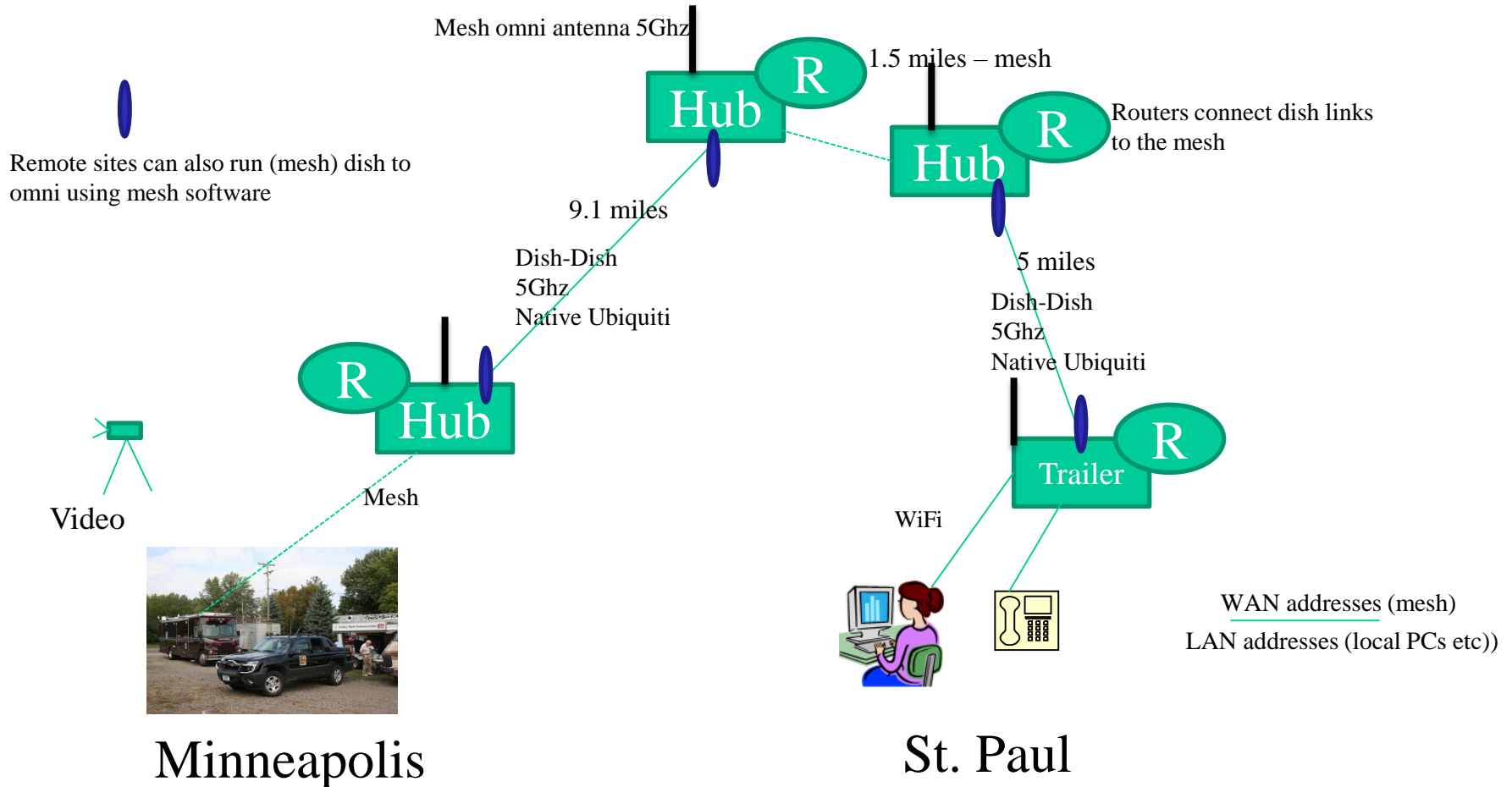
- Served agency leadership is increasingly using real time dashboards, databases and video - “Better data better decisions” is a common request/theme
- The Red Cross is rolling out a new cloud database called RC Care
- Mesh, based on standard, low cost, outdoor rated WiFi hardware, offers high data rates and allows peer-peer connectivity
- Very short tactical range except dish to dish (line of sight)
- MN ARES has adopted AREDN software and Channels -2 and 180, 10m bandwidth:

<https://www.arednmesh.org/content/current-software>

# Network Architecture

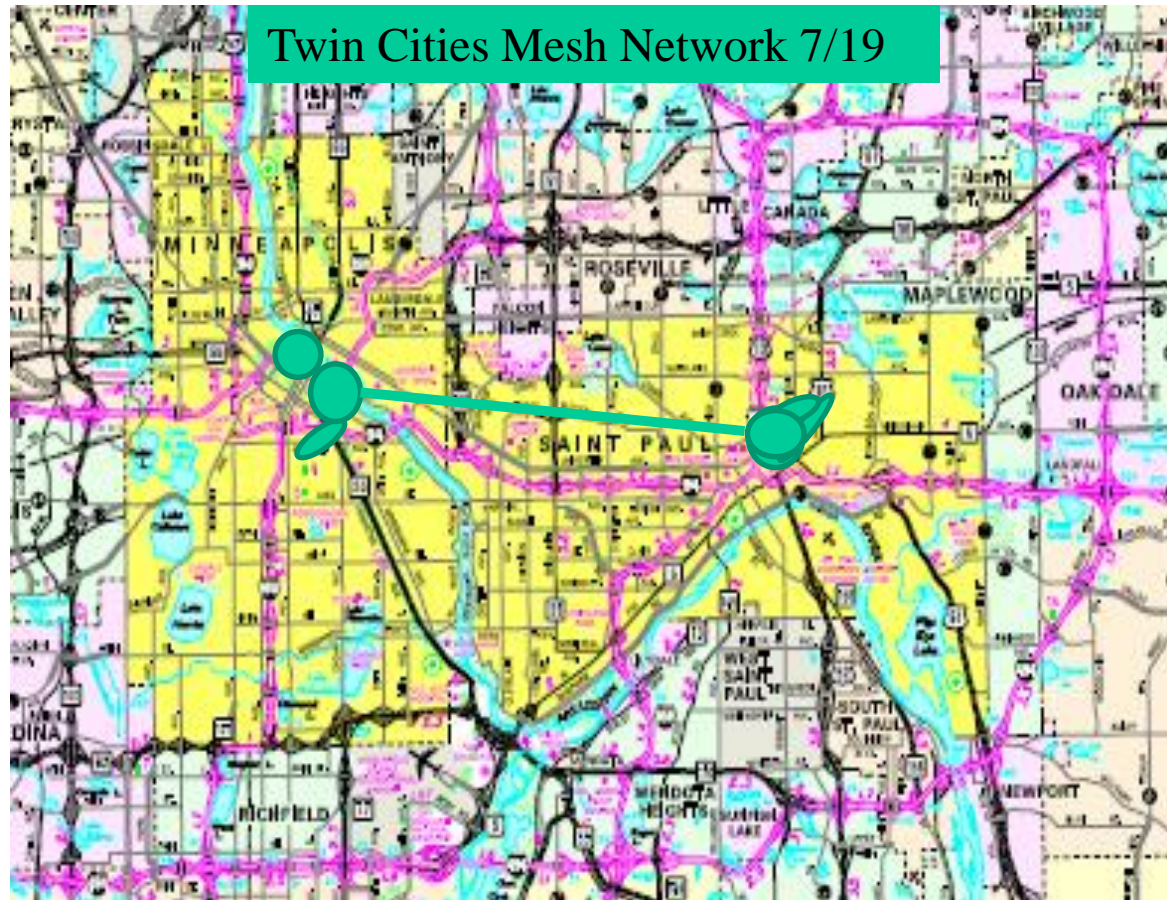
Omnidirectional mesh nodes have a range of a mile or two line of sight

The network routers can “see” all the remote LAN subnets





# 5Ghz Mesh High Speed Part 15\* “TWINSLAN Medical Command Network”



In production since 2011 for live video, dashboard apps, voice and family reunification  
Encryption is supported for medical records, law enforcement as needed

\* Caused the “Revolt of the COMLs”

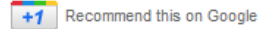
# Ubiquiti Inventory

4X



## Ubiquiti NanoStation Loco M5 Outdoor MIMO 2x2 802.11n 5GHz

\$64 [online](#)



Max 5GHz CPE Performance Breakthrough Featuring 2x2 MIMO technology, the new Loco - Station M links significantly faster and farther than ever before. Next-Gen Antenna Design New antenna array designs featuring 13d - Bi dual-polarity gain at 5GHz with optimized cross-polarity isolation in a compact form-factor. Intelligent POE Remote hardware reset circuitry of Loco - Station M allows for device to be reset remotely from power supply location. In addition, any Loco - Station can easily become 802.3af 48V compliant through use of Ubiquiti's Instant 802.3af adapter. Part number: Locom5-US Power supply: 110-240VAC 24VDC 0.5A US-style plug... [more »](#)

8X



## Ubiquiti NanoBridge M5 25dBi NB-5G25 Outdoor 5GHz Bridge

\$90 [online](#)



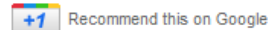
Bridge M5: World's First Cost-Effective 5GHz MIMO Bridging Solution Patent Pending Inner - Feed Antenna Technology Provides breakthrough MIMO antenna cost/performance. Higher Antenna Gain and even more cost-effective. Compact and Robust Product Design Very small visible footprint. Mechanical design provides complete weatherproof performance. Activity and signal strength LED's provided for installers. Enhanced RF and Ethernet ESD/Surge protection enables prolonged operation in harshest environments. Breakthrough Wireless Performance, Air - Max and Air - Control Support 150+Mbps of real outdoor throughput and up to 20km+ range. - Bridge M... [more »](#)

20X



## Ubiquiti BULLET-M5-HP Outdoor 802.11n M5HP

\$73 [online](#)



100Mbps+ of REAL TCP/IP Throughput over outdoor multi-km links Features Include: Processor Specs: Atheros SOC, MIPS 24 KC, 400MHz Memory Information: 32MB SDRAM, 8MB Flash Networking Interface: 1 X 10/100 BASE-TX (Cat. Recommended DC voltage range is 15V to 24V.

[Add to Shopping List](#)

Many older units support the OpenWRT/AREDN firmware

# Mesh FAQ 11/20

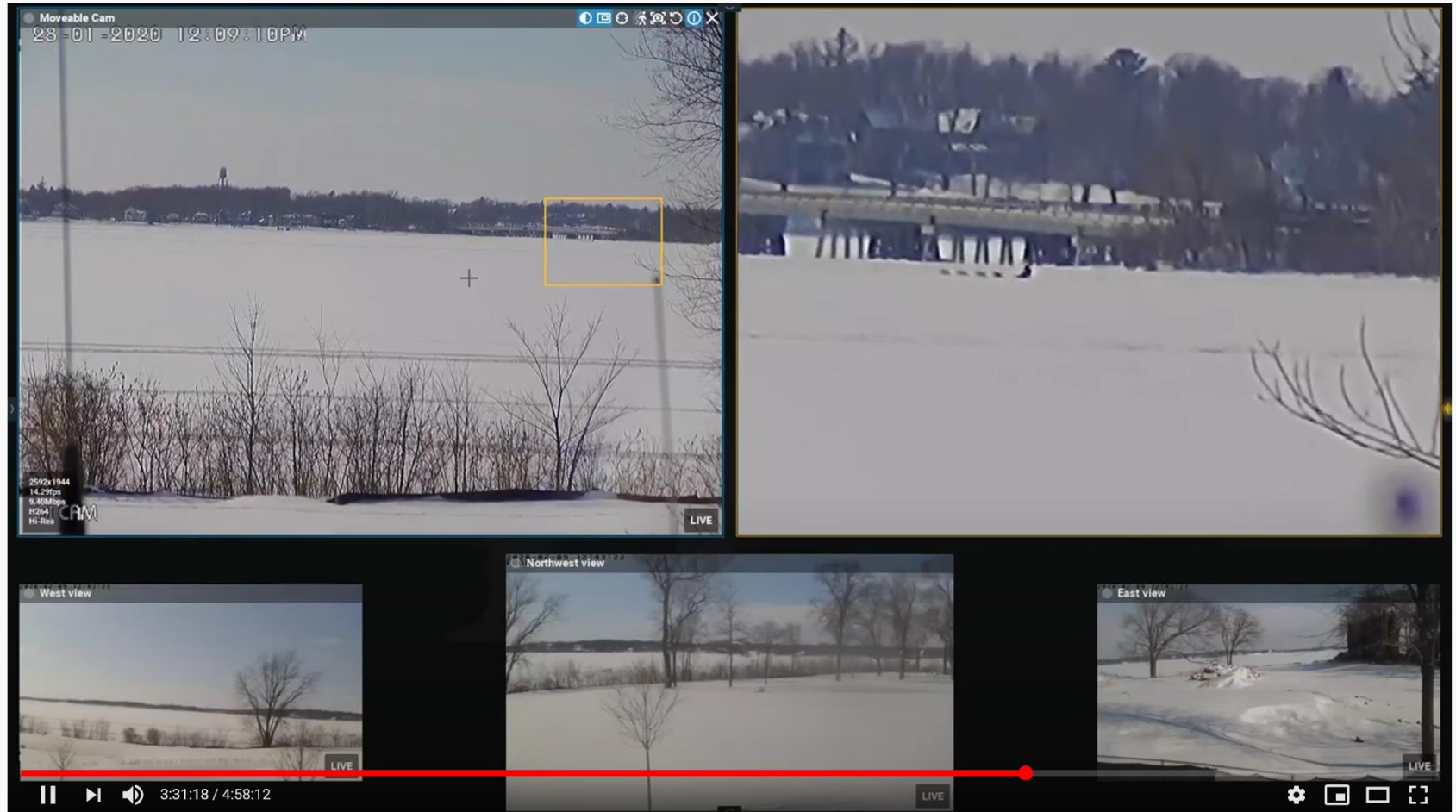
- **Why do we have two mesh networks?** Back in 2011 we built an all-hazard Part 15 mesh backbone for the Marathon and our EMS/law enforcement /hospital partners. EMS asked it not be “ham radio only”- it is used currently for public safety. Two separate networks are more mathematically reliable than one.
- **What do I need for my go-kit?** At ground level the range of mesh radios is in feet. If you have a backbone available you can have a mesh radio that joins the mesh and then has an Ethernet cable so you can plug in a laptop or a video camera. Then you can view the video etc. Mesh without a backbone is like a cell phone with no coverage.
- **What do I need for my home station?** In Los Angeles it is common to connect home stations via dishes to the mesh backbone on mountain tops. The range of a home station is line of sight (with a dish) or until you hit any foliage, terrain or buildings.
- **What is the use case?** So far, live video, databases, web type apps and dashboards. The Part 15 network supports Jitsi, an open source video collaboration app that requires SSL.
- **Is the mesh network an ISP?** The Part 15 one is not.
- **Do you need home stations for the backbone?** Part 15 no.



# Minneapolis Live Video from St Paul Fire Station Four

The image is a screenshot of a live video feed displayed in a web browser. The browser window has a title bar with three tabs: "Bullet-31 - OLSR-Viz - LuCI", "OpenWrt - Traffic - LuCI", and "Video Mobile". The address bar shows the URL "10.0.0.1/web/mobile.html". Below the address bar are navigation buttons (back, forward, refresh, home) and a "Refresh" button. The video feed itself is labeled "Cam 2" in the top left corner and has a timestamp "2019-11-16 12:47:3" in the top right corner. The video shows a fire truck in the foreground, a chain-link fence, and a large industrial building with a yellow staircase. The Windows taskbar is visible at the bottom of the screen, showing the search bar and several application icons. The system tray in the bottom right corner displays the time "12:48 PM" and the date "11/16/2019".

# Mesh Video Aggregation from Command Truck, 15,000 acre lake



Klondike Dog Derby - ICC Brackett's Point

Unlisted

29 views • Streamed live on Feb 9, 2020

LIKE DISLIKE SHARE SAVE ...



## 2/20 City of Lakes Loppet Winter Festival



Urban ski race- five distributed aid stations  
Super volunteer friendly  
42 KM course  
HQ located in a valley  
Needed a tower trailer – none was available

# 2/2020 Broken “Light Tower” Trailer found online\* - \$700



1.0 Vision

30' tower (crank up)

Group 27 deep cycle

50w solar panel

TWINSLAN mesh

2.4 Wifi

GP95 2m/440/1.2

Spare antenna mounts

6KW diesel (soon)

Bent axle

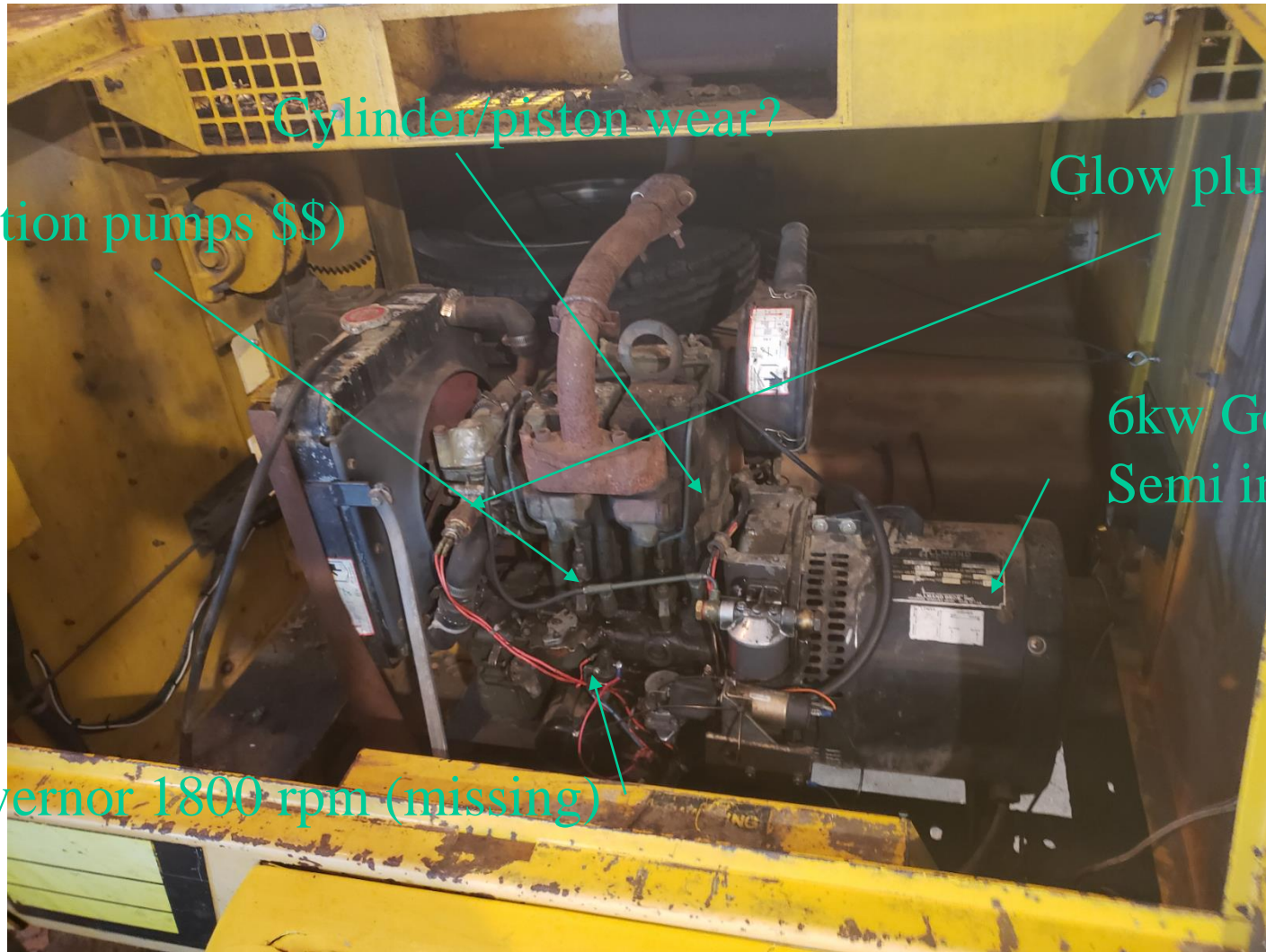
Consultant: NONAS

\*A popular wholesale/surplus market for light towers is on [www.ironplanet.com](http://www.ironplanet.com)



# Decisions -\$500 Broken or \$1500 Running?

This diesel is a Lister-Petter LPW4 (also military)



Injection pumps \$\$)

Cylinder/piston wear?

Glow plugs

6kw Generator -  
Semi interchangeable

Governor 1800 rpm (missing)

Tires, bearings, lift cables and jacks

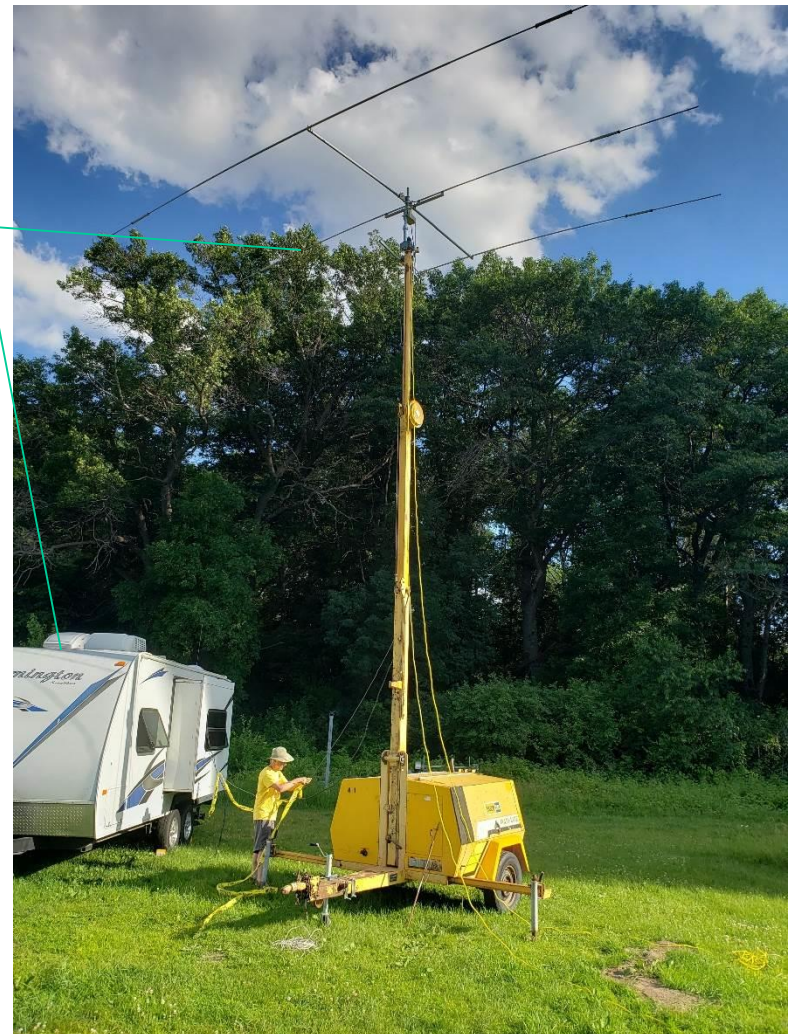


# Field Day 2020



6M beam, propane generator, dipoles, mesh

G5RV



Ta33jr, dipole support

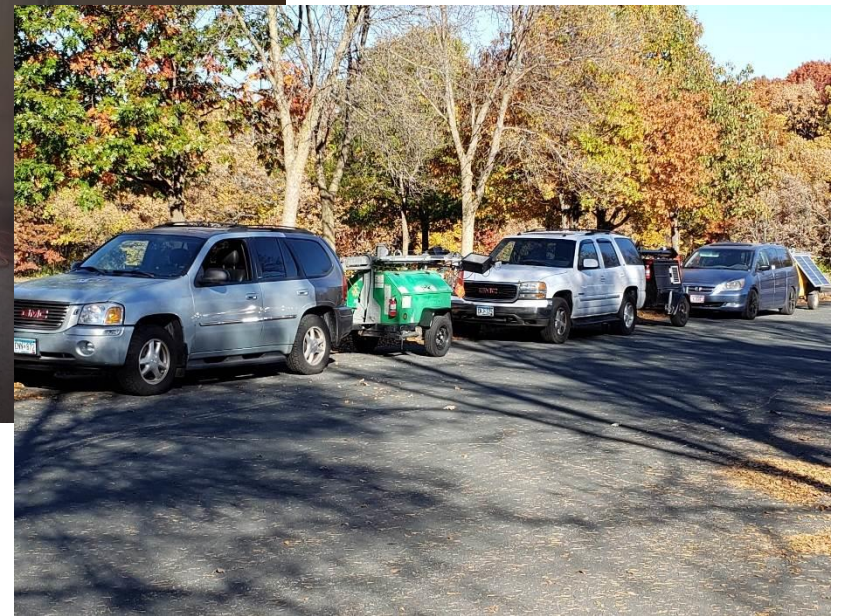
“A broken generator is good ballast”



# Hams in the Park and Convoy Operations



#9



Driveway storage tip: "Is that a BBQ smoker?" – yes



# Was Orange Now Black #1 (L) Jolly Green Generator #8 (R)



5G Part 15  
Mesh

5G AREDN\*

PTZ Camera

2x100K Lumens

3kw propane

Pipe mount

2G AREDN\*

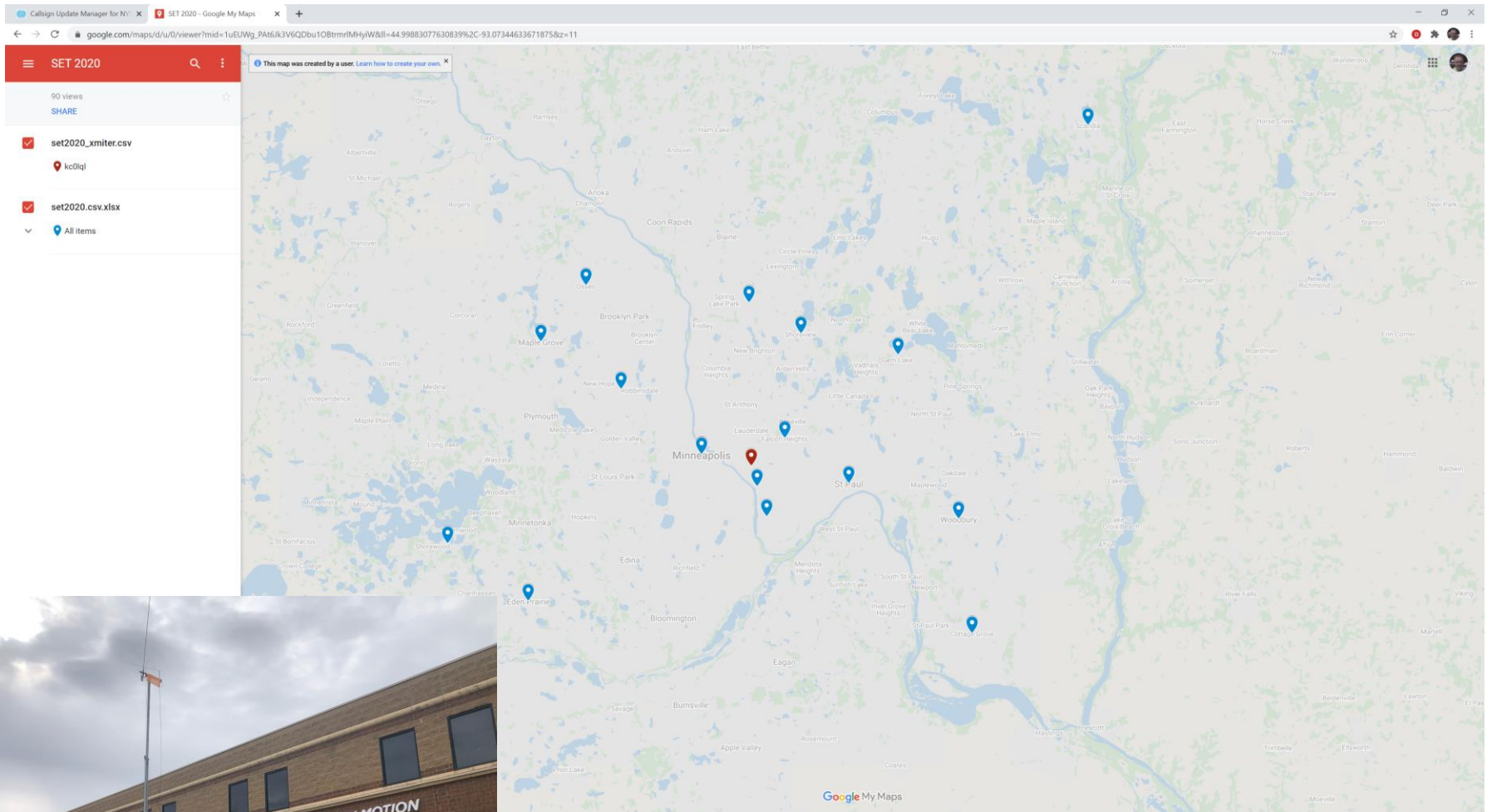
6KW Diesel

\* Solved the "Revolt of the COMLs"- power only air-gapped

7/20



# SET 2020 FM Simplex Net 10/4/2020



We got 17 check in's from Tim's trailer in the Midway in St Paul.

# Proposed Silly\* Trailer Rules

- Trailers get cute tactical names/colors (ask your wife)- consult your kids on the paint job
- Trailers are tested with our Strategic Technology Reserve assets and local mesh standards. We hand out radios and antennas for this. If everyone sets them up their own way they cannot work together or add value.
- The ownership should be widely distributed to prevent any one person from taking them over.
- Ideally we have a three hour response time state wide. My two are plugged in on 20 minute warm standby. Four hours to find which box in the basement has the antennas and which bin has the feedlines is not good.
- Trailers should travel in convoy for the best visual effect. I can see these in parades, county fairs, etc.
- Citizen Science is the idea here- creative technology is encouraged- this is a technology/service/hobby project. Remember "State of the Radio Art" from someplace?
- If more than one trailer is needed at once - ask- "Barn Raising" is the model
- 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 helping others.
- The idea is we are volunteer Ham Radio operators - think bass boat armada for water rescues.

Thanks to N0NAS and KD8GBL for advice and support

\*Every effort is being made to not take this effort too seriously. A beverage cooler was a suggested add-on.

# Amateur Radio Public Service in 2020

- Is waiting around for government radio systems to fail boring?
- Embedded in agencies- EMS, hospitals, counties, NGOs
- Pivot from written message traffic to databases and dashboards
- Capabilities + direct service
  - Missing persons
  - Aid stations /medical support/ medical command centers
  - Family reunification
  - Weather spotting
  - Video
  - Duties as assigned (food distribution, IT support etc.)
- Assets\*- repeaters, networks, generators and tower trailers
- A Ham Radio license is a valid credential
- “Unwanted Volunteers” are prized, trusted and recruited

\*(Go-kits are not welcome at large sporting events )