Merrimack Valley Digital Network

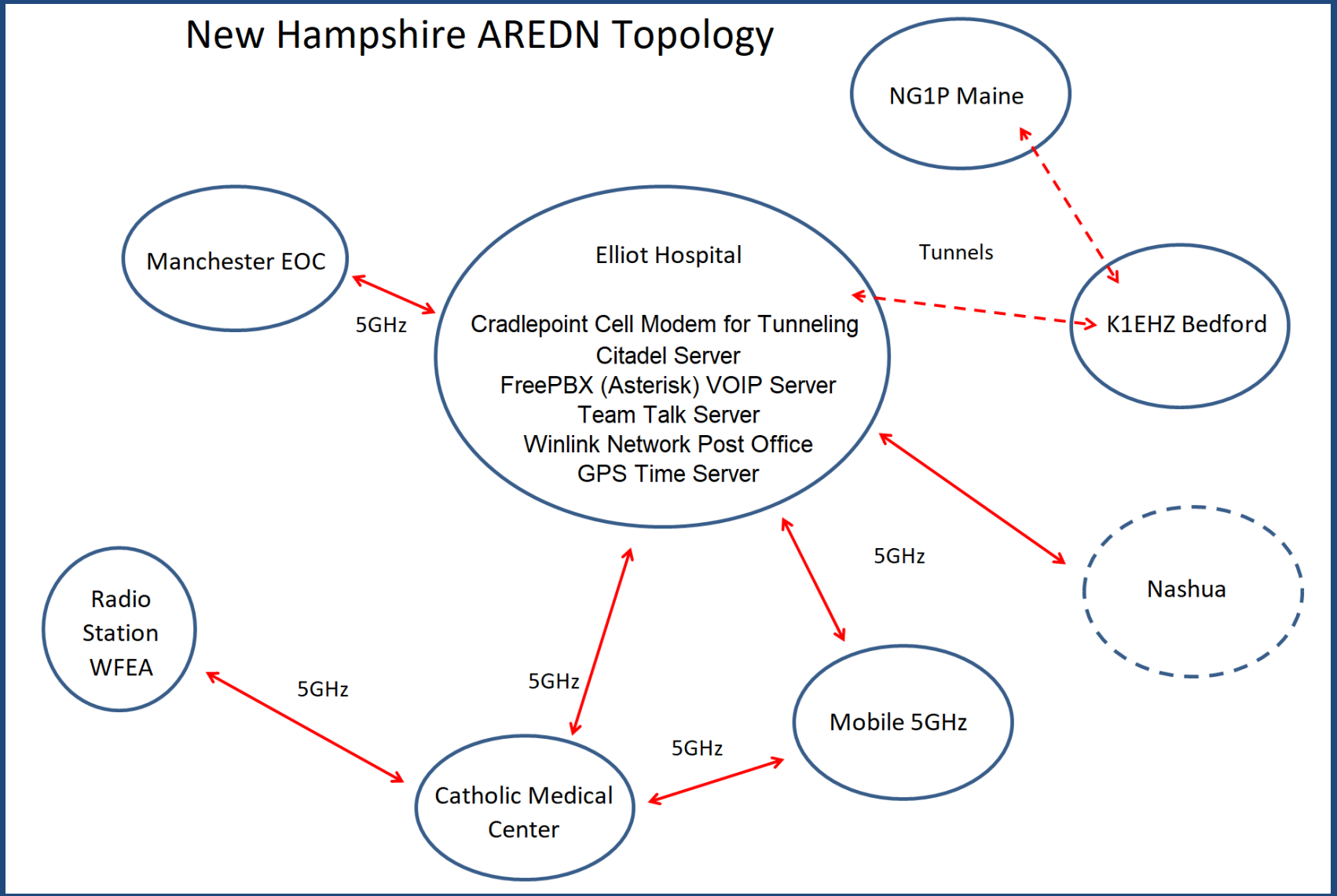
July 2022

Jay Taft K1EHZ

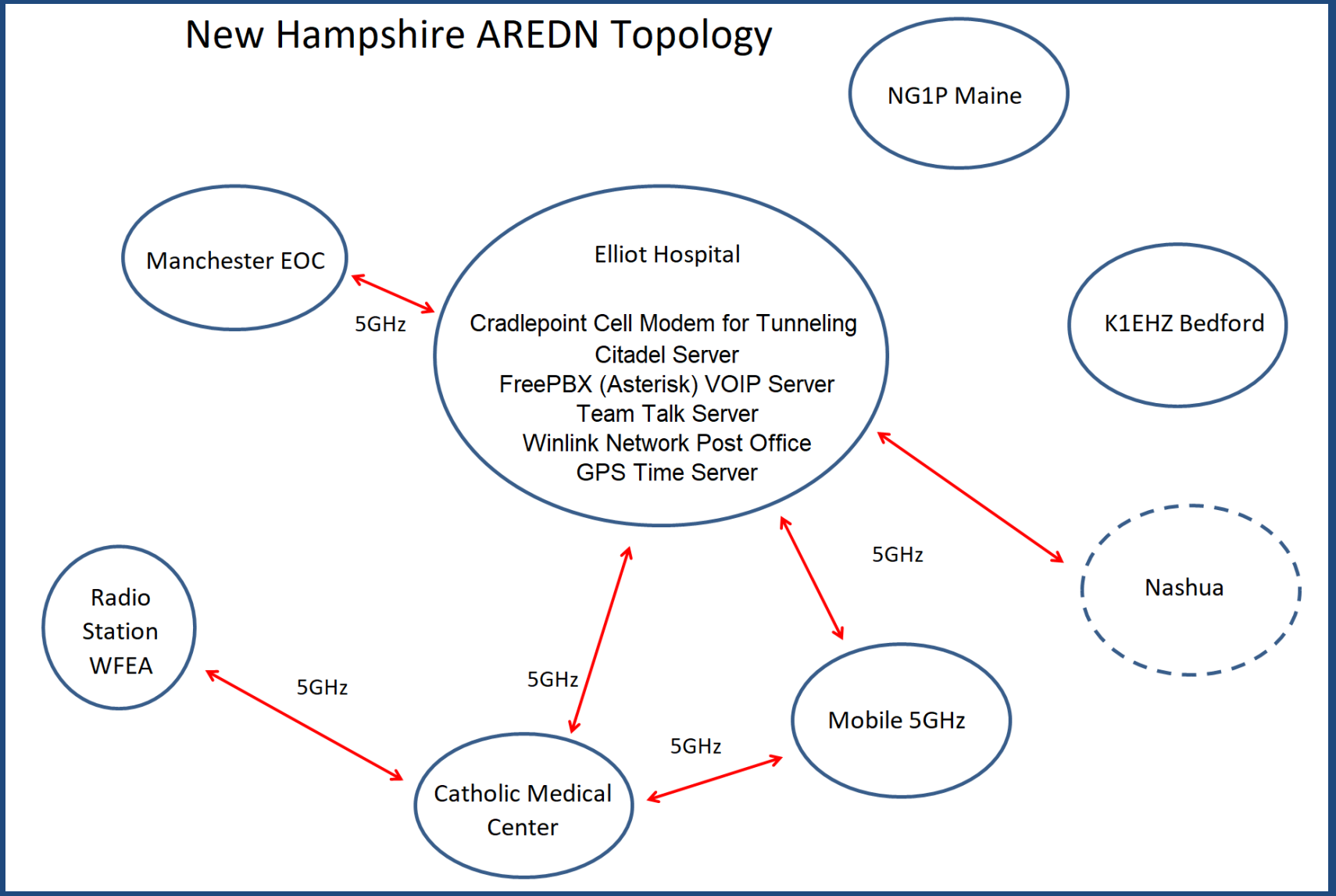
Digital Network

- **IP-based digital network**
- **Must add programs to use the network**
- **Programs on the core network so far**
  - **Citadel Webmail and Chat**
  - **Winlink – Network Local Post Office**
  - **FreePBX - VOIP primarily for Wired Phones and IP WiFi Phones**
  - **TeamTalk – Conferencing and VOIP primarily for Smart Phones**
  - **MeshChat – Chat and Sharing Small Files**
  - **GPS Time Server**

Network Topology with Internet Tunnels



Network Topology without Internet Tunnels



Elliot Hospital 5GHz Parabolic aimed at Nashua with Local Omni-directional above

Catholic Medical Center

Ubiquiti 13dB Omni and Diamond VHF/UHF Antenna

Network Supports Tower Instrumentation

IP-based instruments can be added to monitor tower functions when internet is disrupted

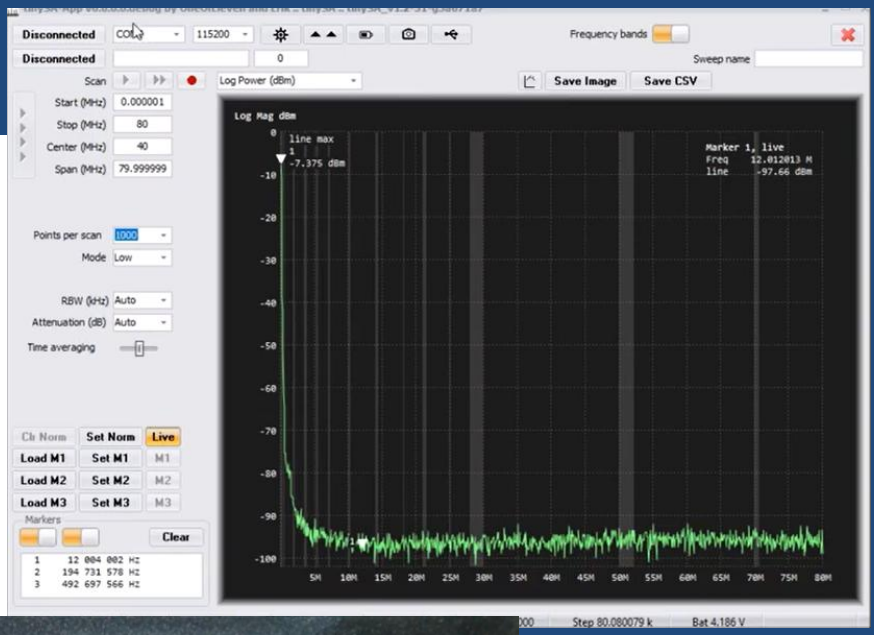
- Repeater remote monitoring / control
- Computer remote operation
- Pan – Tilt – Zoom video camera
- Spectrum analyzer
- Other instruments or sensors?

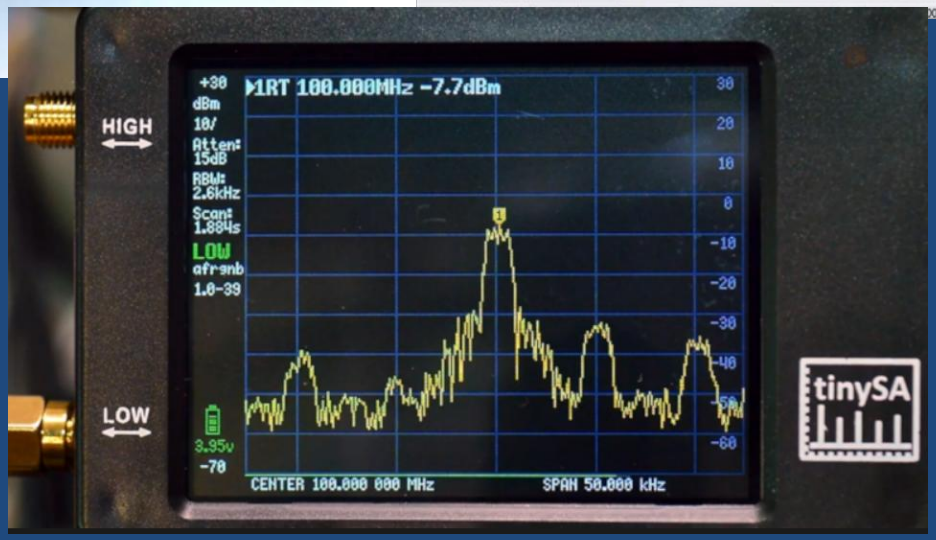
GHz Connections among DMR Repeaters

- DMR repeaters are typically interconnected by internet
- When internet is disrupted, DMR network can be disrupted
- GHz connections between DMR sites could be backup for internet
- RF pathways and Bandwidth between sites needs evaluation

Mini Windows 10 Computer
BeeLink T4 – 5” x 5” x 1”
4GB RAM, 64GB EMMC
12v, 1 Ethernet, 4 USB, 2 HDMI, 1 Headset

Tiny SA Spectrum Analyzer





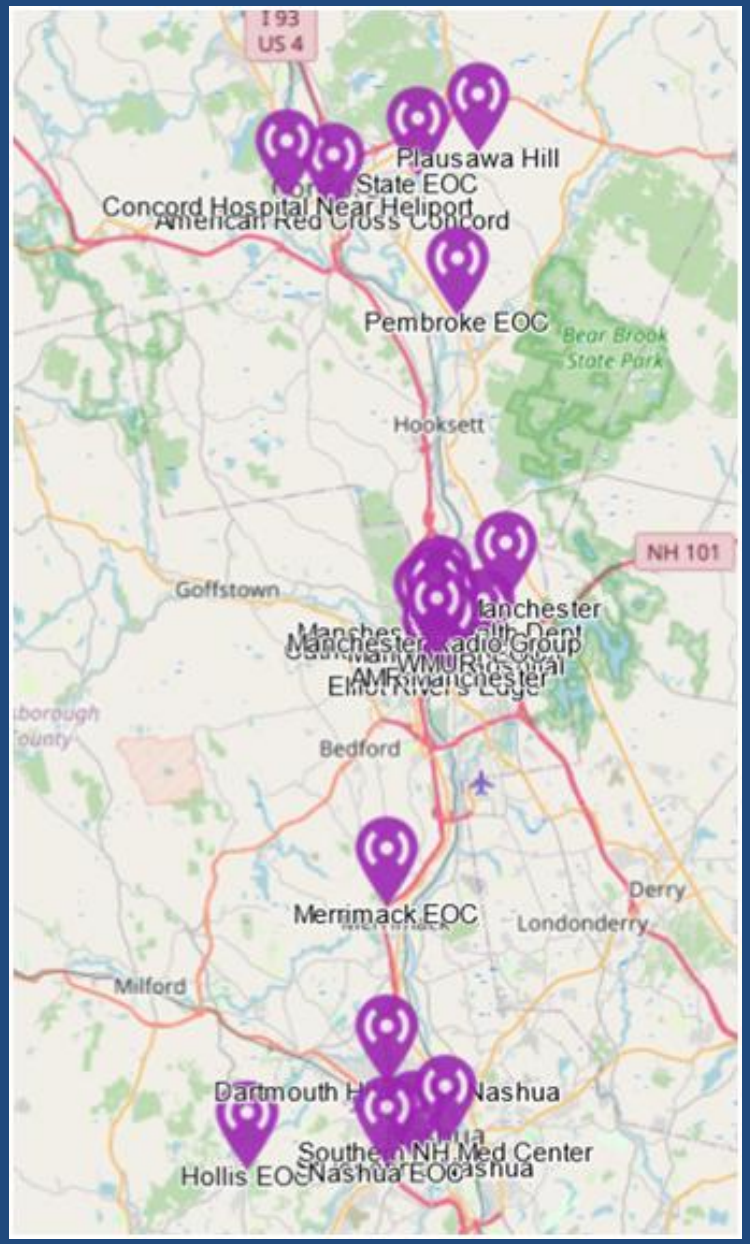
Digital Network

- Importantly, served organization emergency management staff can use the network applications themselves
- It is a Part 97 system so a licensed ham operator needs to monitor network activity, but not be present at every site 24 / 7
- System operates 24 / 7 / 365 without constant technical attention
- Elliot – CMC link has been operating for 3 years with minimum human intervention

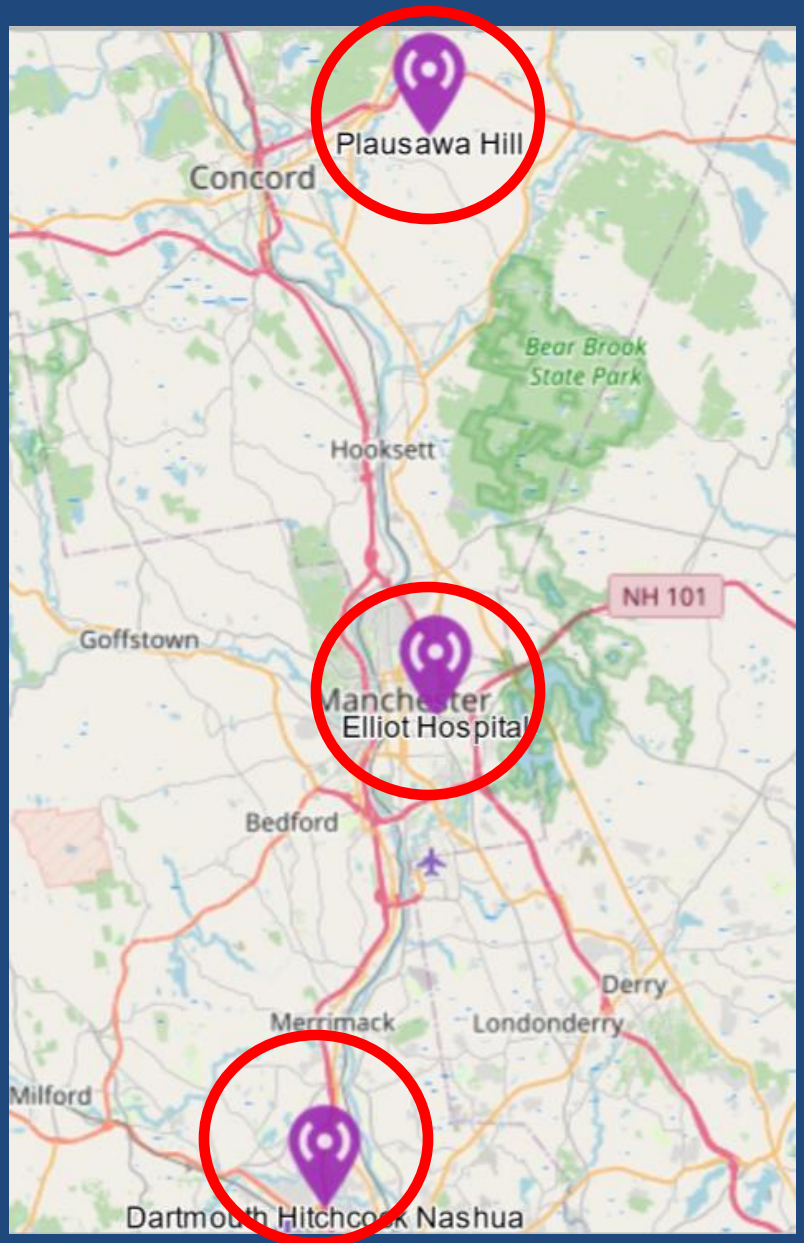
Modeling 5GHz Paths with Radio Mobile Online

Model works well most of the time
On-site surveys still required to confirm model calculations
5GHz is not 2m

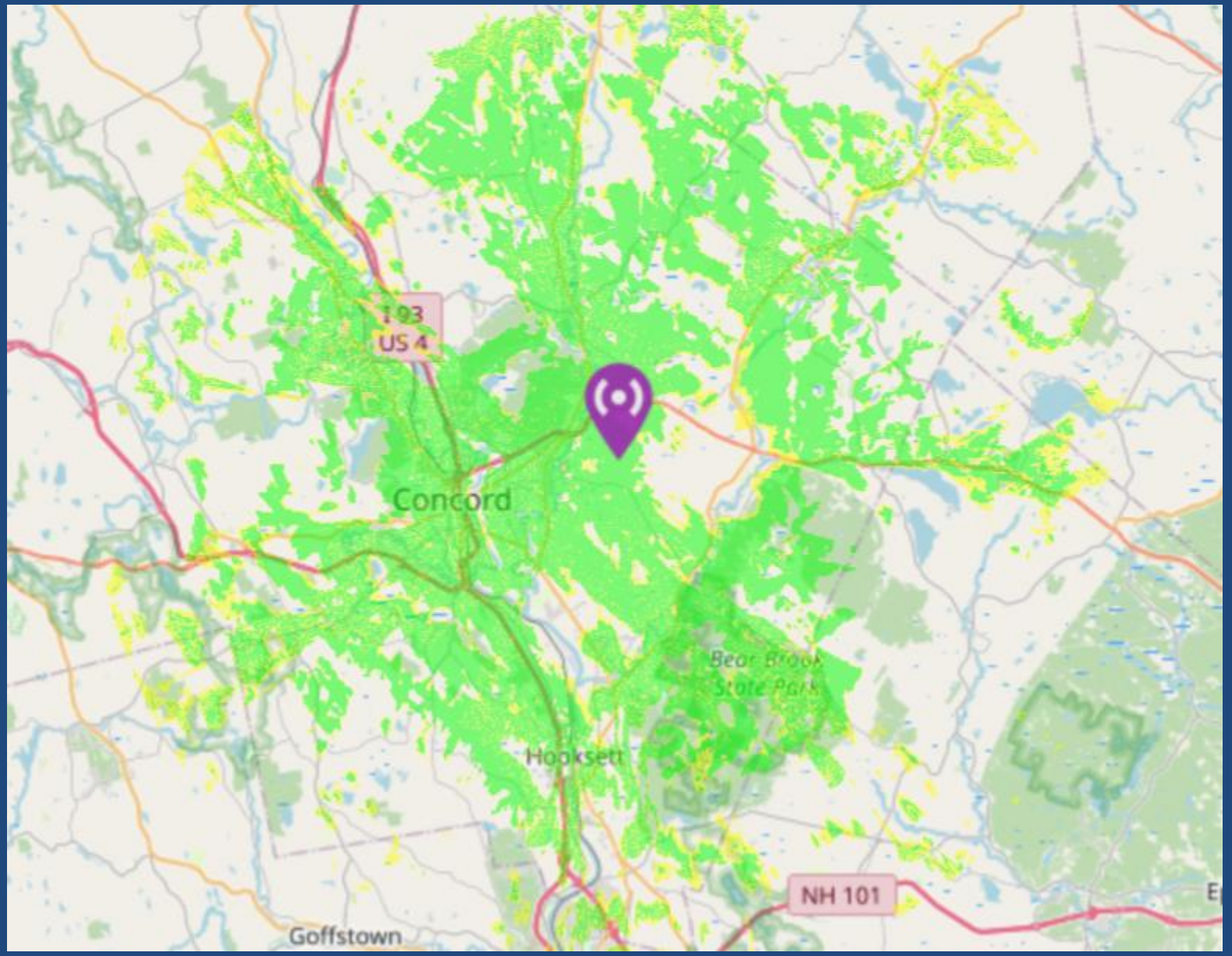
Merrimack Valley Digital Network – 20 Proposed Sites



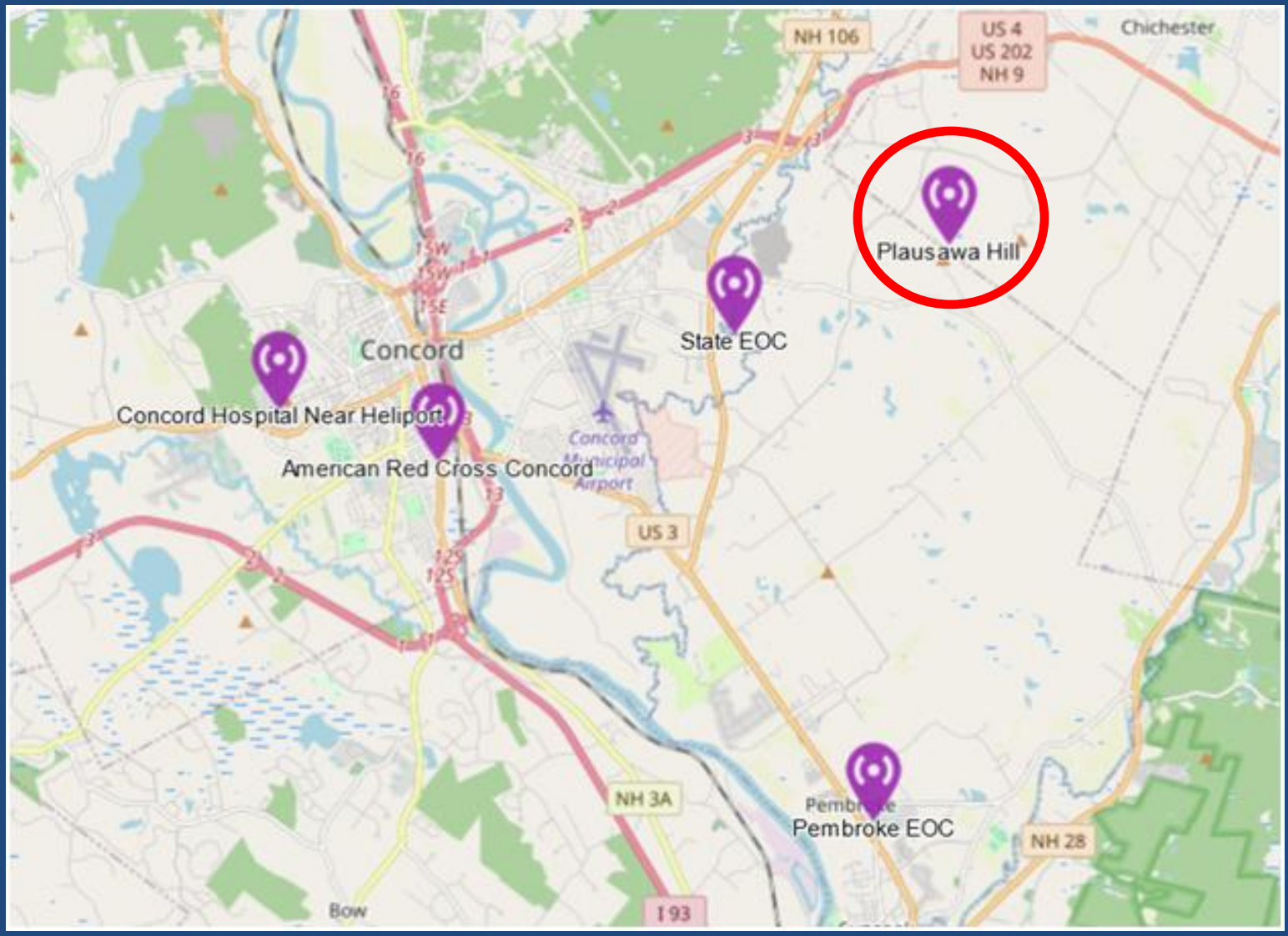
Core Network Backbone Sites



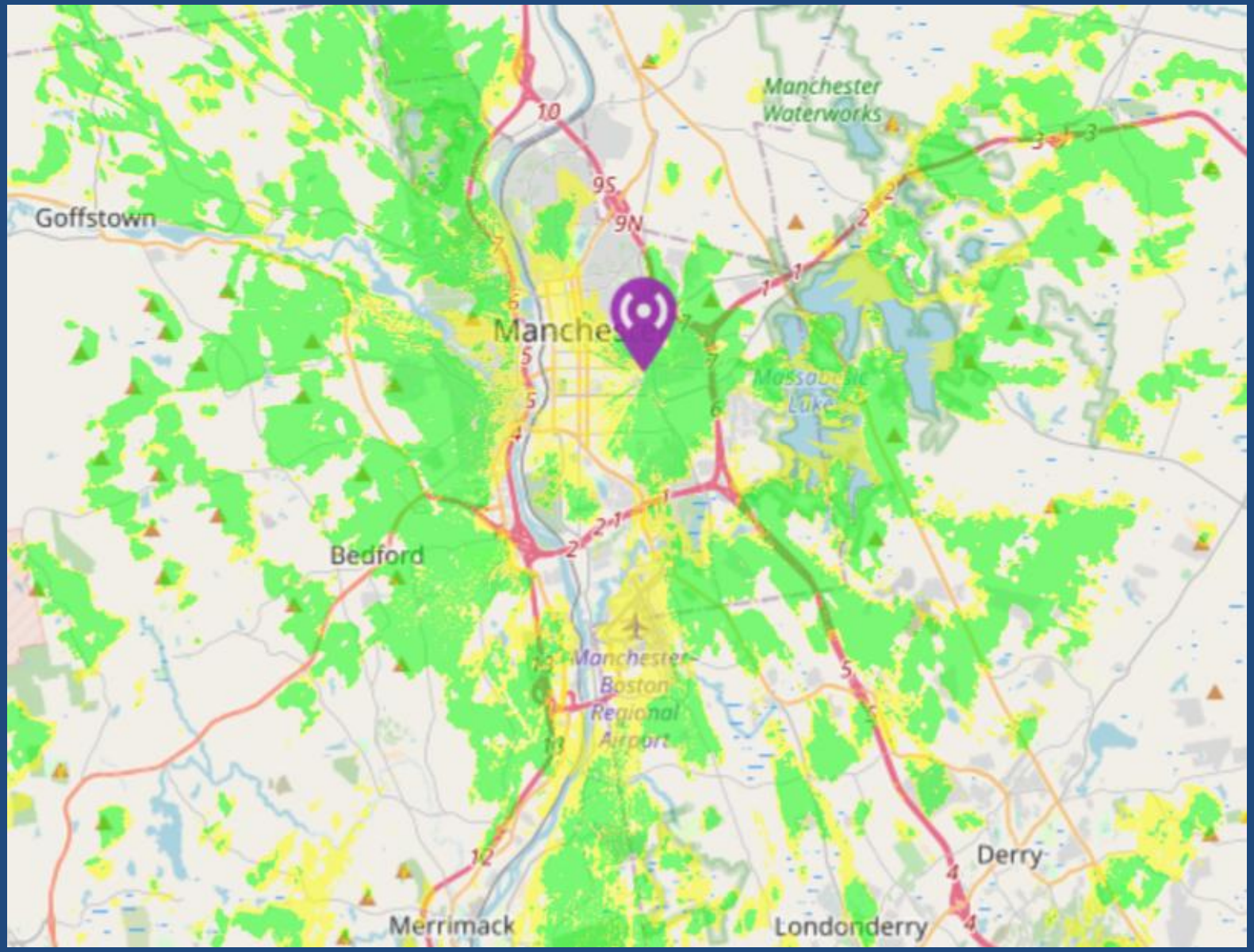
Plausawa Hill 5GHz Coverage



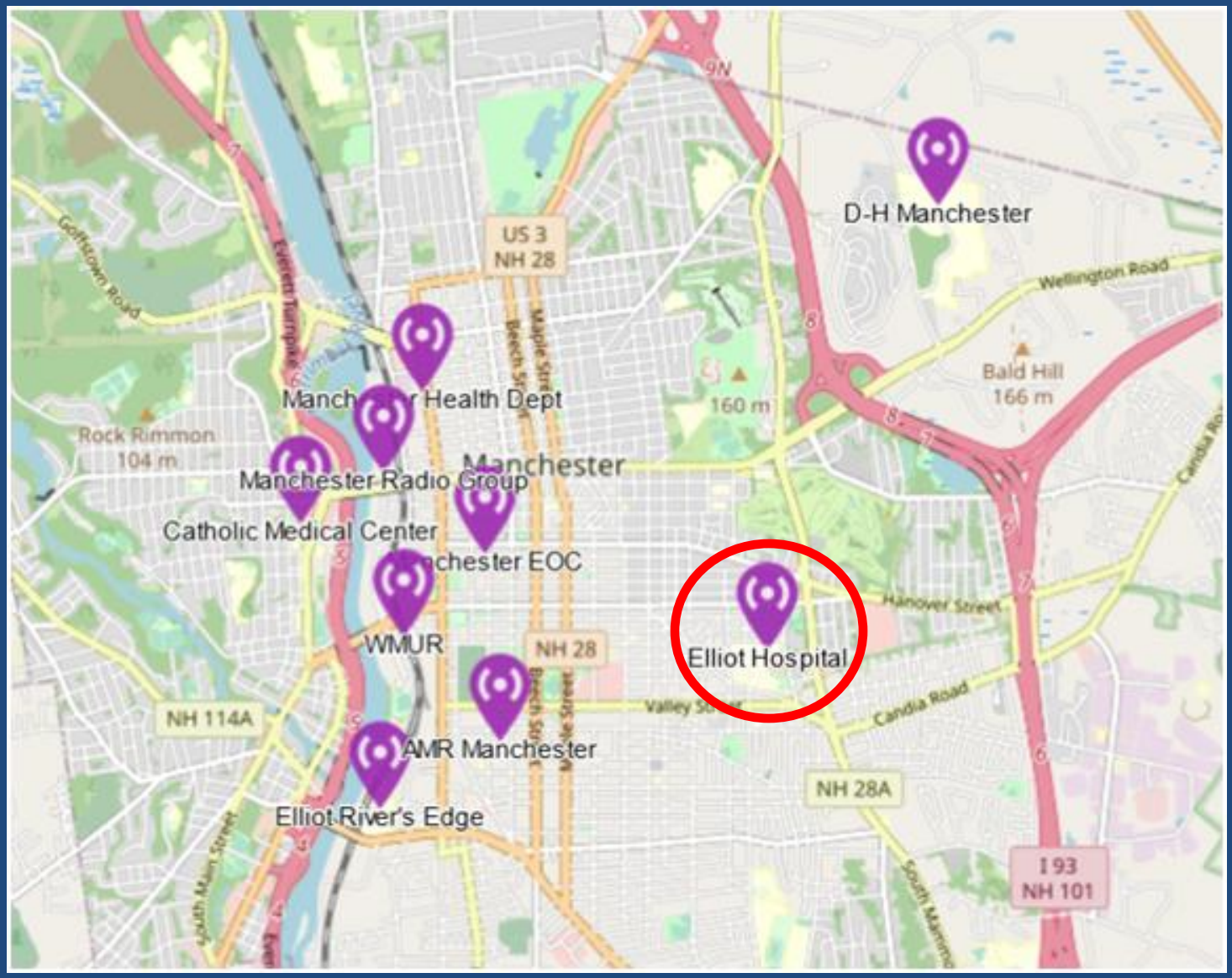
Concord Area Sites



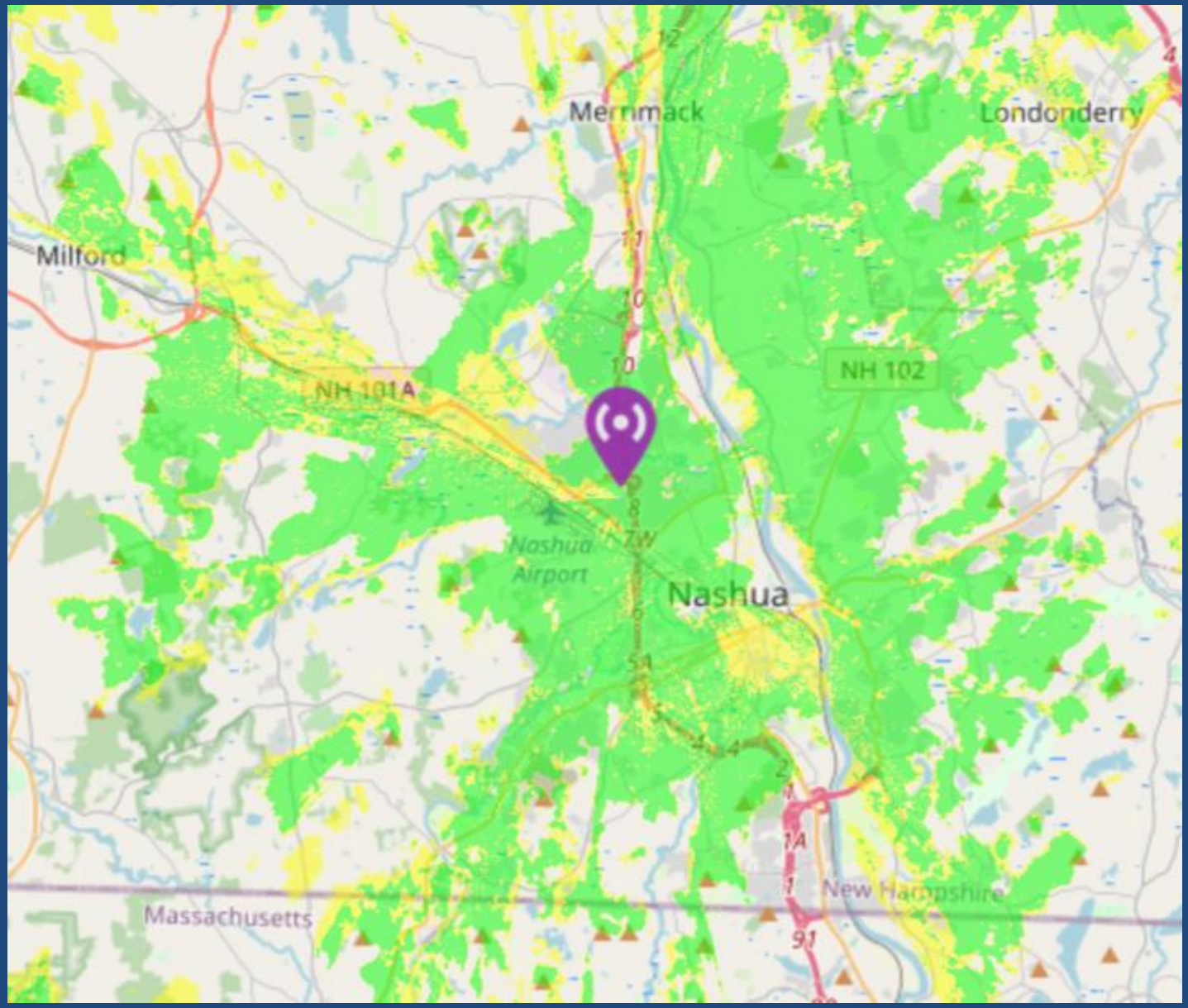
Elliot Hospital 5GHz Coverage



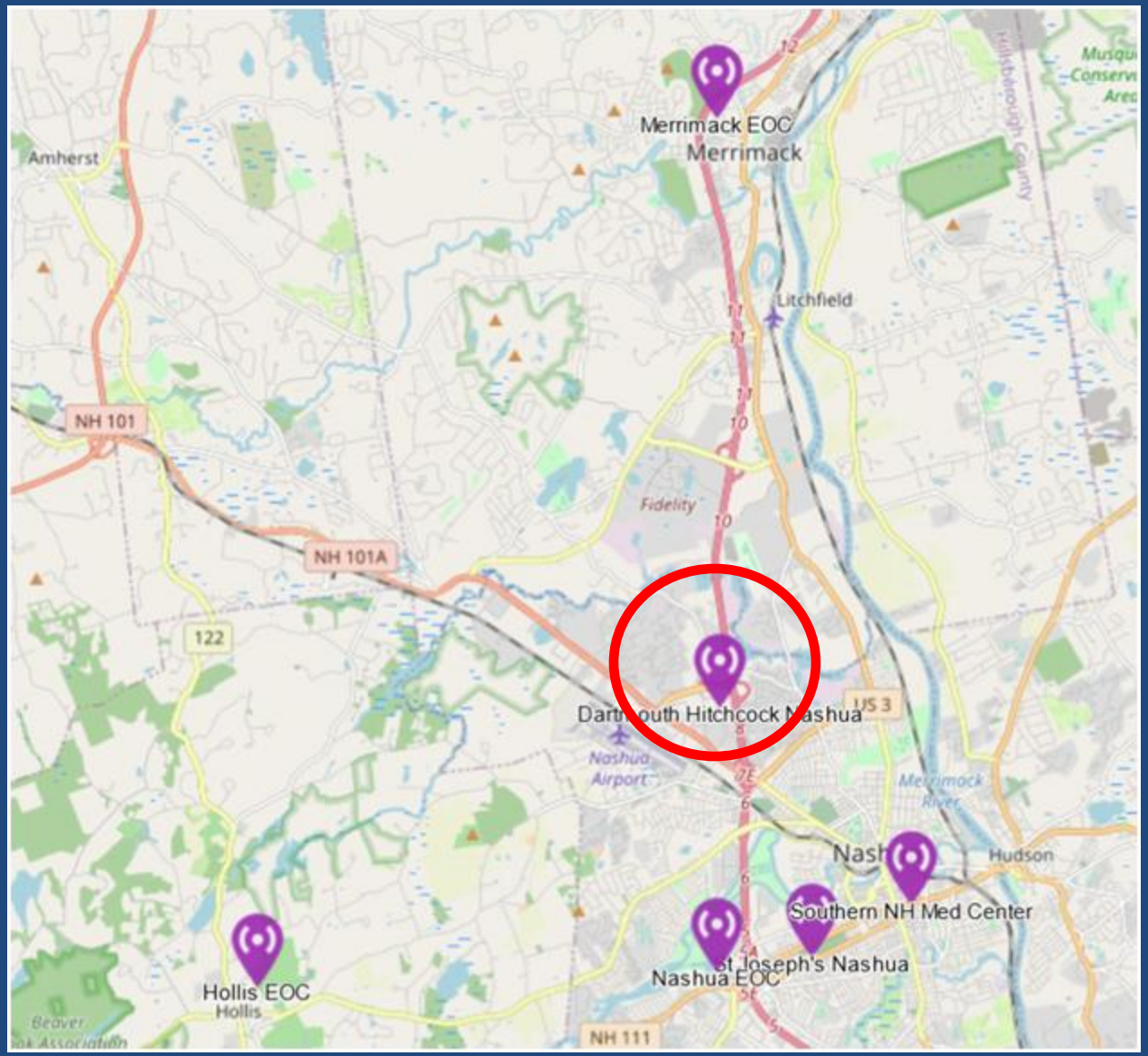
Manchester Area Sites



Dartmouth-Hitchcock Nashua 5GHz Coverage



Nashua Area Sites



How Well Does the Model Work?

- Model is based primarily on topography
- Predicts unobstructed paths very well
- Under-predicts urban paths because it can't account for reflections from buildings that may be significant, such as at Manchester EOC
- Over-predicts paths with vegetation if we don't get antennas above trees, and with buildings very close to one of the sites the model doesn't account for, such as Manchester Health Department
- On-site evaluation with portable gear is important

Greater Manchester AREDN

Elliot Hospital, Catholic Medical Center, Manchester Health Dept, Manchester EOC

5GHz Network Test Results

TX Power 250mw

	Model SNR	Data SNR
Elliot - CMC	32	31 - 34
Elliot - EOC	-4	27
Elliot - MHD	-8	Remote only
CMC - EOC	-3	32
CMC - MHD	21	16 - 23
MHD - EOC	-49	Remote only
CMC- River's Edge	24	25
CMC - Lowe's	5	6

Reflections off buildings not predicted by model

Live Demo

Summary

- Three Manchester sites operating for 1-3 years
- Services on the core network at Elliot Hospital
- ARRL encourages more use of GHz spectrum
- New England Division of ARRL encourages digital network development
- Manchester network connected by internet tunnels to Maine network and to isolated stations in MA and CT
- Tunnels are for training and remote network management, NOT intended for live situations

Next Steps

- Obtain approval for sites
- Apply for grant funding to build out the network
- Equipment budget for 20 sites about $20,000
- ARRL may be willing to support part of the project under the club grant program
- Amateur Radio Digital Communications funds digital network proposals from 501(c)3 organizations