Tioga County, New York Radio System Assessment Executive Report

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Executive Summary

Public safety agencies within Tioga County (County) rely on radio communications systems to fulfill their communications needs during day-to-day and incident response operations. The radio and paging/alerting systems that Fire Services uses operates primarily over VHF Low Band frequencies using equipment that is no longer supported by its manufacturer. Additionally, there are numerous geographic areas within the County where users have difficulty or are unable to communicate due to poor coverage provided by the system. Further complicating matters, Low Band frequencies are susceptible to noise and interference, degrading the quality of radio communications for Fire Services users.

The Sheriff's Office uses a radio system that operates using VHF High Band frequencies. Over the past few years, the Sheriff's Office has upgraded many of the primary components of their radio system and added additional radio sites to improve coverage, however as with the Fire Services system, users have trouble communicating in portions of the County.

The County retained Federal Engineering, Inc. (**FE**) to assess their radio communications systems and provide recommendations to modernize the equipment, improve radio coverage, and interoperability. **FE** proposed a four-step process to assess the County's systems and provide recommendations as the following figure shows.
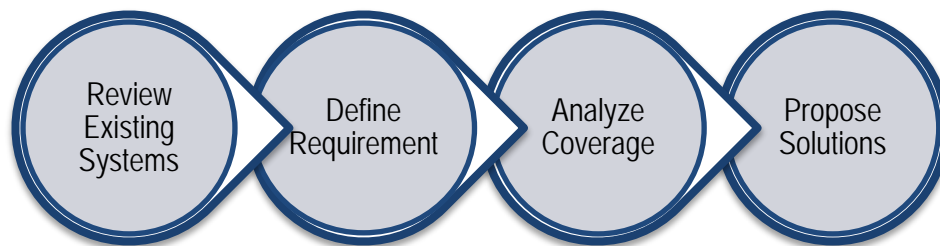
To develop this *Tioga County, New York Radio System Assessment Executive Report* (Report), **FE** reviewed documentation for the County's radio systems and conducted interviews with administrators and users from Fire Services, the Sheriff's Office, Emergency Medical Service (EMS) providers, and radio service providers.

Representatives from the Fire Services and EMS indicated that they are moderately satisfied with mobile radio coverage, but extremely dissatisfied with portable radio coverage when both outdoors and indoors. Sheriff's Office users reported similar ratings,

but were only somewhat dissatisfied with portable radio coverage, likely because of the upgrades implemented in recent years. All users conceded that the system is very easy to use, reliable, and that the training provided for new personnel is adequate. Currently, the equipment serving the radio systems does not undergo routine maintenance and is only serviced if it becomes unusable or needs replacement batteries.

Fire and EMS representatives noted that they would like to see improvements made to the paging/alerting system. As currently configured, dispatchers are required to manually select (steer) which transmitter site to use to initially dispatch the incident and communicate with field units during incident response operations. Oftentimes, they do not select the optimal transmitter for the initial dispatch following the tones and also change transmitter towers during incident response operations.

The term backhaul describes the components utilized to link a group of radio communications sites together to form a single system. The technology comprising backhaul systems can be radio, optical fiber, or copper wire. The County currently uses point-to-point (PTP) microwave radio systems as the primary means for providing connectivity between the radio communications sites and the Public Safety Building (PSB). The backhaul system is predominantly configured in a star, or hub and spoke configuration with the Carmichael radio communications site at the center of the hub using various frequencies. Using this configuration, a catastrophic failure at the Carmichael site would disable both Sheriff's Office channels and reduce the Fire Services system to a single channel at the Candor site.

Recommendations

To address the Fire Services concerns of poor radio coverage, obsolete equipment, and the paging/alerting system, *FE* recommends replacing the existing Low Band system with a new simulcast radio system. Pursuing a system in the UHF band will improve interoperable communications between Fire Services within the County and their surrounding jurisdictions. As budgets allow, *FE* also recommends upgrading the Sheriff's Office system to expand the Main Channel by adding like equipment at the additional radio sites used for the Fire Services replacement system and replace the equipment utilized by the Tactical Emergency Response Team (ERT) Channel. This expansion of the Main Channel and upgrade of the Tactical ERT channel allows the Sheriff's Office to reuse their existing subscriber equipment and also provides them with better radio coverage.

Budgetary Cost Estimate

FE prepared a budgetary cost estimate to replace the Fire Services system and upgrade the Sheriff's Office system. **FE'**s budgetary estimates are conservative, so that the vendor proposal pricing does not exceed the estimates. The cost estimates prepared for this project reflect non-discounted (list) pricing and include a 10% contingency. Frequently, system vendors provide discounts for system purchases of this size. System discounts of 20% to 25% are common, but **FE** has seen them higher. However, it is not possible to forecast the level of discount a vendor will offer at the time of proposal submission.

The budgetary cost estimate to implement the recommendations is $13,386,000. There could be cost savings by reducing the number of Fire Services channels from four to two or three, as in discussions with the County, four countywide simulcast repeated fire channels may not necessary. Additionally, the Sheriff's Office may not initially choose to expand their system, representing a savings of approximately $1,200,000.

Next Steps

FE recommends that the County pursue the recommendations laid out in this Report via a competitive solicitation in the form of a request for proposals (RFP). All of the major system vendors have expressed interest in doing business with the County and by pursuing a competitive procurement, the County will be well positioned to acquire the best system for the lowest price.

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1. Introduction and Methodology

Public safety agencies within Tioga County (County) rely on radio communications systems to fulfill their communications needs during day-to-day and incident response operations. The radio and paging/alerting systems that Fire Services uses operates primarily over VHF Low Band frequencies using equipment that is no longer supported by its manufacturer. Additionally, there are numerous geographic areas within the County where users have difficulty or are unable to communicate due to poor coverage provided by the system. Further complicating matters, Low Band frequencies are susceptible to noise and interference, further degrading the quality of radio communications for Fire Services users.

The Sheriff's Office uses a radio system that operates using VHF High Band frequencies. Over the past few years, the Sheriff's Office has upgraded many of the primary components of their radio system and added additional radio sites to improve coverage, however as with the Fire Services system, users have trouble communicating in portions of the County.

The County retained Federal Engineering, Inc. (*FE*) to assess their radio communications systems and provide recommendations to modernize the equipment, improve radio coverage, and interoperability.

1.1 Methodology

FE proposed a four-step process to assess the County's systems and provide recommendations as the following figure shows.
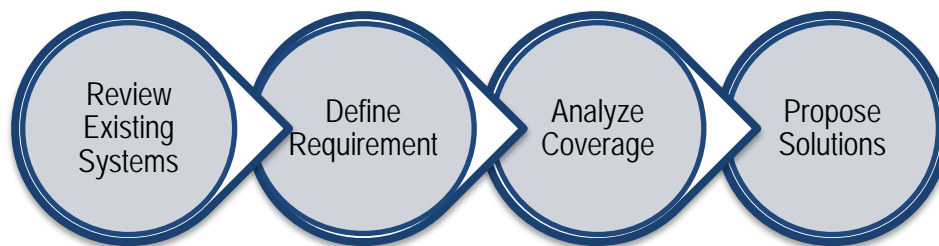
Figure 1 – Assessment Methodology

To begin our assessment, *FE* developed and issued a request for information (RFI) to the County to gather information on the existing radio systems, including supporting infrastructure (e.g., radio towers and equipment shelters) and subscriber or user

equipment. Following our review of the documentation, we conducted an initiation (kickoff) meeting and interviews with administrators and users from Fire Services, the Sheriff's Office, EMS providers, and the County's radio service shop. The *Tioga County Requirements Matrix*, included as Appendix A, contains the requirements *FE* documented from our review of the County's existing radio systems and user interviews.

In advance of analyzing radio coverage for the upgraded/replacement radio system, *FE* performed searches of the Federal Communications Commission's (FCC's) Universal Licensing System (ULS) to determine available channels that the County could potentially license to replace the Fire Services' Low Band frequencies. The focus of our search was to determine if there are public safety-designated frequencies in either the VHF High Band or UHF for Countywide operation. In addition, *FE* evaluated whether any channels currently licensed by nearby agencies could be good candidates for pursuing Letters of Concurrence (LOCs) with those agencies.

FE determined that there are UHF channels available that the County could potentially acquire and modeled radio coverage for the upgraded/replacement radio system by first using the County's existing radio sites, then adding sites identified by the County as potential candidate sites. Our coverage modeling culminated with the *FE*TeamCoverage Workshop™ held on October 12, 2018. During the hands-on session, representatives were able to confirm the existing system coverage and to immediately see the impacts of adding and/or deleting transmitter sites for the upgraded/replacement system.

After identifying the number and location of radio sites that will likely be needed to improve radio coverage within the County, *FE* developed a budgetary cost estimate and included the results of our analysis and recommendations to move forward within this *Tioga County, New York Radio System Assessment Executive Report* (Report).

The next Section of this Report highlights the input *FE* obtained from Fire Services, Sheriff, and Emergency Medical Services (EMS) representatives about their use of the existing radio systems and expectations for an upgraded/replacement system.

2.   User Needs Assessment and Requirements

On September 5, 2018, *FE* conducted a project initiation (kickoff) meeting with representatives from the Fire Services, Sheriff's Office, and Greater Valley Emergency Medical Services (EMS), Inc. During the project initiation or kickoff meeting, *FE* outlined the project's purpose, goals and schedule, and expected benefits. Immediately following the meeting, *FE* interviewed representatives from the Sheriff's Office. Guided by a questionnaire, representatives ranked their level of satisfaction with the existing radio system in the areas of:

- Radio System Coverage and Performance
- Subscriber or User Equipment
- System Ease-of-Use, Reliability, and Maintenance
- Dispatch Process
- Interoperability
- Future Desired Operational Needs/Enhancements

2.1 Fire Services and EMS

Representatives from the Fire Services and EMS indicated that they are moderately satisfied with mobile radio coverage, but extremely dissatisfied with portable radio coverage when both outdoors and indoors. Representatives called out specific geographic areas where they experience poor radio coverage, including the Southwest Corridor of the County (State Route 34) and in other areas of the Northeast, Southwest, and Western portions of the County.

Regarding audio quality or clarity, Fire and EMS representatives said that the quality or clarity of radio communications when using mobile radios is relatively good, but when using portable radios, can be mediocre to poor.

Representatives conceded that the system is very easy to use, reliable, and that the training provided for new personnel is adequate. When asked whether their radios undergo routine maintenance, representatives indicated that there is no maintenance plan in place and that the radios are only serviced if they become unusable or need replacement batteries.

Fire and EMS representatives noted that they would like to see improvements made to the paging/alerting system. As currently configured, dispatchers are required to manually select (steer) which transmitter site to dispatch responders to after the tones. Oftentimes, if dispatchers do select the optimal transmitter site, that site does not remain selected for

the duration of the incident. Additionally, users noted delays between the tone and voice pages/alerts and those received from the Computer-Aided Dispatch (CAD) system.

Regarding interoperability, or the ability to communicate with users other than on the Fire Service radio system, they indicated that the ability to communicate with their neighboring New York State counties, and Bradford County in Pennsylvania is important. They also emphasized that the ability to communicate with the County's Department of Public Works (DPW) would be useful during road closures, flooding, and winter storms.

FE asked the Fire Services and EMS representatives to identify key issues that should be addressed with considering upgrading or replacing their radio system. Representatives agreed that mobile and portable radio coverage must be improved. They also said an upgraded/replacement system should facilitate interoperability within and outside of the County and address the obsolesce of the Low Band infrastructure and subscriber or user equipment as Figure 2 shows.
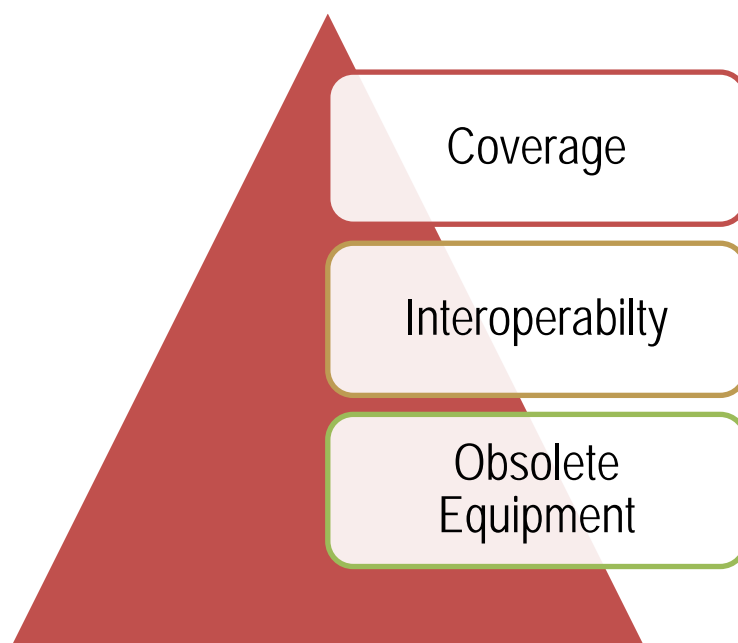
Figure 2 – Fire Services and EMS Key Issues

At the conclusion of the interview, *FE* asked representatives to rank features and functions that they would like to see in an upgraded/replacement radio system. Table 1 shows those features and functions ranked by the representatives.

Table 1 – Fire Services and EMS Features/Functions

Mandatory
Multiband Operation
Water Resistant
Remote Radio Disable
Nice to Have
Waterproof
Man-Down Alert
Intrinsically Safe
Not Needed
Text Messaging on the Radio
Bluetooth® Accessories
Display Screen
Global Positioning System (GPS)

2.2 Sheriff's Office

Sheriff's Office representatives indicated that they are moderately satisfied with mobile radio coverage, but dissatisfied with portable radio coverage, especially when indoors. Representatives called out specific geographic areas where they experience poor radio coverage, including the Town of Barton, Town of Richford, and in other areas of the Northeast, Southwest, and Western portions of the County. They also noted that portable radio coverage inside school buildings and industrial facilities such as Lockheed Martin and Crown Beverage Packaging along with commercial outlets like Best Buy is poor or non-existent.

Regarding audio quality or clarity, Sheriff's Office representatives said that the quality or clarity of radio communications when using mobile radios is relatively good, but when using portable radios, it is relatively poor.

Like Fire and EMS users, Sheriff Office representatives agreed that the system is very easy to use, reliable, and that the training provided for new personnel is adequate. Regarding a routine maintenance program for their radios, representatives indicated that there is no maintenance plan in place and that the radios are only serviced if they become unusable or need replacement batteries.

Sheriff's Office field users reported that their interactions with dispatchers is effective, however due to portable radio coverage issues, sometimes they cannot respond to dispatchers even though they can hear dispatch transmissions. *FE* also interviewed dispatchers working in the County's Public Safety Answering Point (PSAP). They noted that the functionality of their CAD and Record Management System (RMS) could be improved, specifically the performance and mapping capabilities.

Regarding interoperability with users other than on the Sheriff's Office radio system, they also cited that the ability to communicate with the County's DPW would be useful during road closures, flooding, and winter storms.

FE also asked the Sheriff's Office representatives to identify key issues that should be addressed with considering upgrading or replacing their radio system. Representatives resoundingly said officer safety/ability to communicate when using portable radios outdoors and indoors (adequate coverage) was among their greatest concerns as Figure 3 shows.
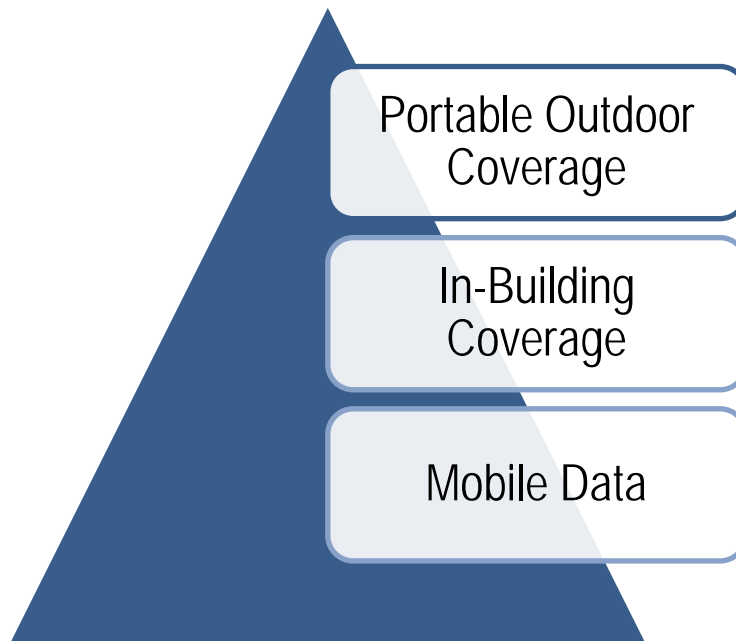
Figure 3 – Sheriff's Office Key Issues

Representatives added that currently, they do not have a mobile data system, requiring them to call-in database checks to the PSAP. Although the Sheriff's Office is planning to implement mobile data services from a commercial wireless carrier, they believe integrating it with the CAD, RMS, and radio system should be investigated.

FE asked Sheriff's Office representatives to rank features and functions that they would like to see in an upgraded/replacement radio system. Table 2 shows those features and functions ranked by the representatives.

Table 2 – Sheriff's Office Features/Functions

Mandatory
Multiband Radio Operation
Encrypted Voice
Nice to Have
Channel Scanning
Remote Radio Disable
Waterproof
Bluetooth® Earpieces and Microphones
Not Needed
Text Messaging on the Radio

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3.   Existing Radio System Analysis

The radio systems currently serving the Fire Services, EMS, and Sheriff's Office utilize analog conventional equipment operating primarily in the VHF Low Band and VHF High Band. A majority of the equipment is manufactured by Motorola Solutions, Inc. (Motorola).

Radio communications systems operate within specific parts of the electromagnetic spectrum. Each specific segment of this spectrum is called a frequency band and is expressed in millions of cycles per second, or megahertz (abbreviated as MHz). Since the radio spectrum contains a limited number of frequencies, many users and many types of systems must share them – broadcast radio and television, mobile radio and cellular, air navigation, commercial, government and military. Figure 4 depicts the electromagnetic spectrum divisions. Note the Low Band and High Band divisions in the upper left of the Figure.
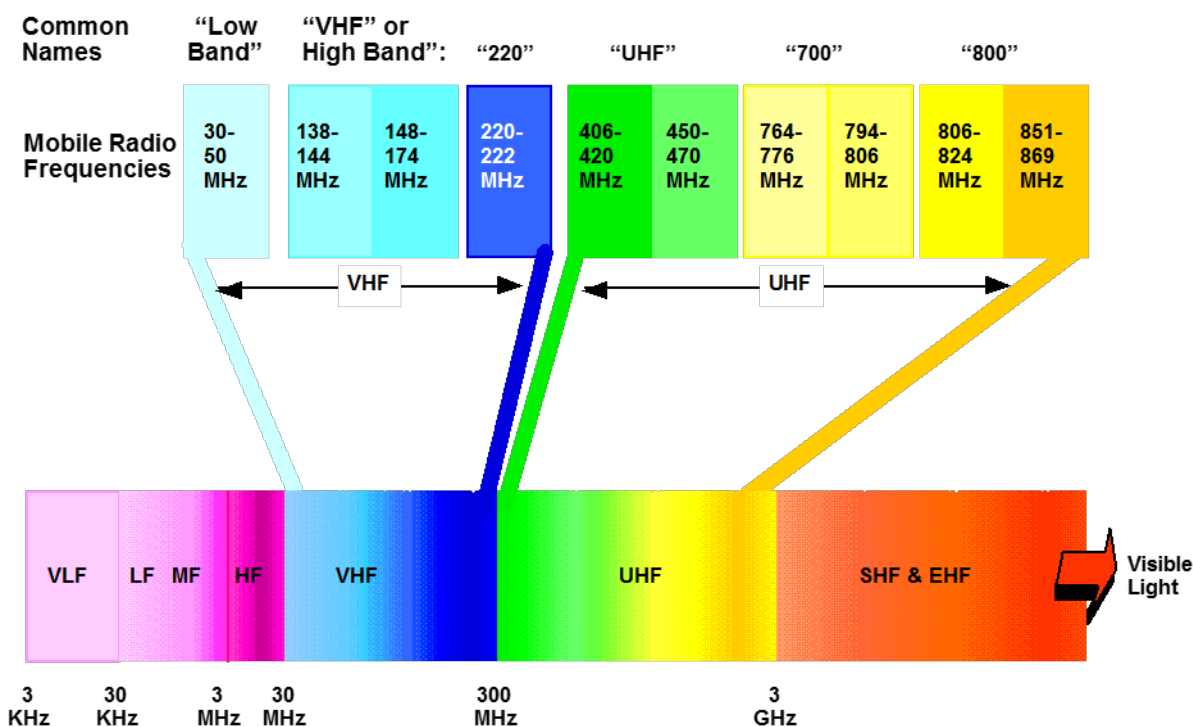
Figure 4 – Electromagnetic Spectrum[1]

The limited number of frequencies available means that public safety entities must share and reuse them throughout the United States. This creates the potential for harmful interference between radio signals. Mitigation of potential interference among communications systems requires careful coordination of channel usage. The FCC

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[1] http://www.pro-lite.co.uk/File/laser_safety_laser_basics.php; accessed on 10/5/2018

coordinates public safety agency needs for radio system frequencies in specific bands through allocation of frequencies for the exclusive use of public safety systems at specific geographic locations. Fire Services within the County and the Sheriff's Office operate on public safety-designated frequencies within the VHF Low and High Bands licensed for operations at the locations Figure 5 identifies.
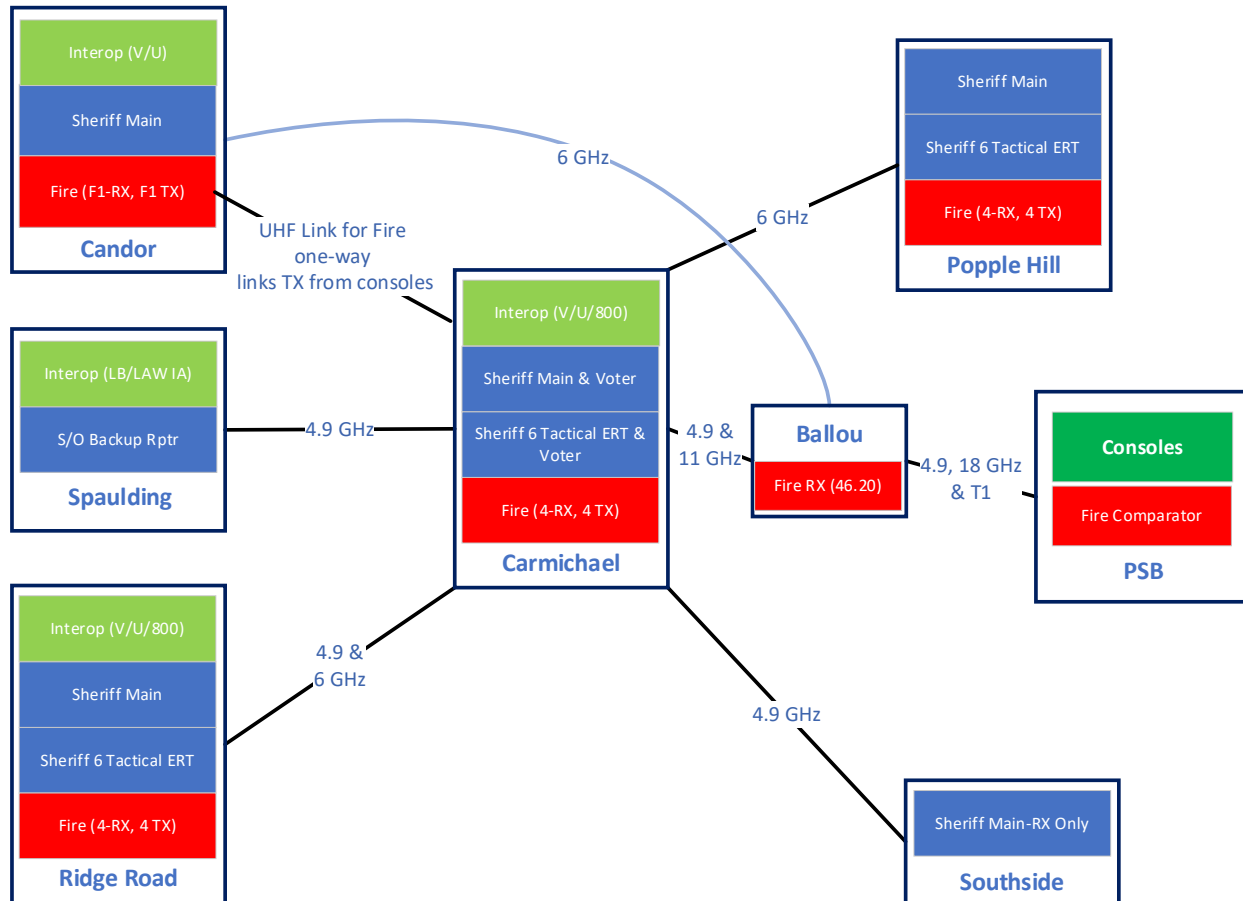
Figure 5 – Fire Services and Sheriff Office's Systems[2]

The Interoperability or "Interop" stations Figure 5 shows in light green allow users to access the Nationwide Interoperability Channels in the VHF, UHF, and 800 MHz bands for interoperability purposes. Shown in red are the Fire Services base radio stations and in blue, the Sheriff's Office base radio stations. The lines between each site or box depict the backhaul links, or how the sites are interconnected to the Public Safety Building (PSB).

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[2] The V/U Interop stations are installed, but not active at Carmichael

The following subsections further describe the Fire Services and Sheriff's Office radio systems.

3.1 Fire Services Radio System

The Fire Service's system is a conventional analog system utilizing voted receiver sites and site "steered" transmitters. The receivers at each site detect the subscriber or user radio signals and send it onto the comparator located at the PSB. The comparator's function is to select the best audio and send this audio to the dispatch console. When the dispatcher "talks back" to the field user, the dispatcher must select which site they think will provide the best audio to the field user. Figure 6 details the main Fire Services system transmitters and receivers.
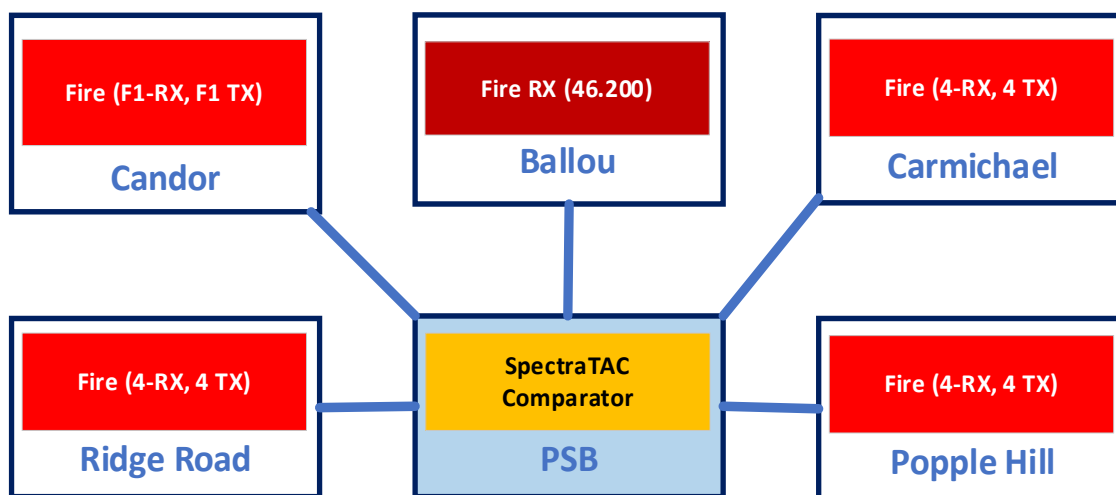
Figure 6 – Fire Services Transmitters and Receivers

Figure 6 shows that Candor and Ballou do not contain four transmitters as the other sites do. Candor contains transmitters and receivers for a single channel and Ballou only contains a single receiver. This figure details logical connections between the equipment at each site and the PSB, which physically connect via the microwave radio and copper lines detailed in Figure 5. The dispatch console system at the PSB controls the Fire Services transmitters via wireline connections to "steer" the transmissions to the desired site.

Carmichael, Ridge Road and Popple Hill contain Motorola DeskTrac units, which are multiple channel radios that allow dispatchers at the PSB to select which of the four available channels to transmit over. Motorola GM300 radios are utilized in some locations in place of the DeskTrac units.

The Fire Services radio system uses equipment manufactured in the 1980s and 1990s that is obsolete and beyond manufacturer support. The DeskTracs and SpectraTAC™ units have been discontinued by Motorola and have not been supported by Motorola for some time now. Table 3 details the main components of the Fire Services system and their lifecycle status.

Table 3 – Fire Services System Components

Item	Discontinued Product	Currently Supported?
Motorola SpectraTAC™ Comparator	Yes	No
Motorola SpectraTAC™ Receiver	Yes	No
Motorola DeskTrac Consolette	Yes	No
Motorola GM300	Yes	No

FE notes that just because the products are no longer supported, this does not imply that they cannot be repaired. However, there is no guarantee that parts will continue to be available even through third party suppliers.

3.2 Other Radio System Channels

There are additional channels operating alongside the Fire and Sheriff's Office main channels. Table 4 below details the additional base stations and their locations.

Table 4 – Additional Channels Equipment

Use	Equipment	Sites	Channels
VHF Interoperability	GTR 8000	Carmichael[3]	VCALL (10-14)
		Ridge Road	VCALL (10-14)
		Candor	VCALL (10-14)
UHF Interoperability	GTR 8000	Carmichael[4]	UCALL 40D, TAC(41D-43D)
		Ridge Road	UCALL 40D, TAC(41D-43D)
		Candor	UCALL 40D, TAC(41D-43D)
800 MHz Interoperability	GTR 8000	Carmichael	8CALL (90-94)

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[3] The VHF Interoperability Station is installed, but not active at Carmichael
[4] The UHF Interoperability Station is installed, but not active at Carmichael

Use	Equipment	Sites	Channels
		Ridge Road	8CALL (90-94)
Inter-County	CDM 1250	Spaulding	Low Band (45.880)
Inter-Agency	XTL™ 2500	Spaulding	VHF
Sheriff Backup	GTR 8000	Spaulding	VHF
Hospital & EMS	XTL™ 2500	Carmichael	Hospital F1 & F2
Fire UHF	XTL™ 2500	Carmichael	Fire UHF
Fire Cross-Band	CDM1250 & GM300	Carmichael	Cross-Band VHF-LB

The variety of VHF, UHF and 800 MHz Interoperability channels exist to accommodate users from multiple agencies and jurisdictions when operating within the County. Traditionally, most subscriber or user radios will have both the CALL (calling) and TAC (tactical) channels programmed. A typical scenario would be for field users, either local, or interoperability users, to call dispatch via the CALL channel, and then dispatch would assign a TAC channel for the users to communicate over when on-scene. It is important to note that dispatchers do not actively monitor the audio on the interoperability channels, as the console screens do not have sufficient space to include them on the main screen.

The Inter-County Channel is a Low Band channel located at the Spaulding site utilizing a Motorola CDM 1250 mobile radio. This CDM 1250 allows for dispatch to have access to the Inter-County Channel at areas provided by its coverage from the Spaulding site. Additionally, there is an Inter-agency XTL™ 2500 mobile radio located at Spaulding as well.

Spaulding also hosts a standalone GTR 8000 repeater, which serves as a backup to the Sheriff's Main Channel.

The Carmichael site contains a few additional channels operating Motorola XTL™ 2500 mobile radios configured as base stations. The stations also allow for dispatchers to monitor these channels. Also located at Carmichael is a cross-band repeater utilized by Fire Services. A cross-band repeater allows for users to transmit on one band and have users receive the audio on another band. This particular cross-band repeater repeats audio between Low Band and VHF High Band, enabling conversations to occur between users on the two bands.

3.3 Sheriff's Office Radio System

The Sheriff's Office radio system contains two main channels, the Sheriff's Main Channel and a Sheriff 6 Tactical Emergency Response Team (ERT) Channel. Figure 7 on the following page provides a logical diagram of the Sheriff's Office radio system configuration.

Figure 7 – Sheriff's Office Radio System
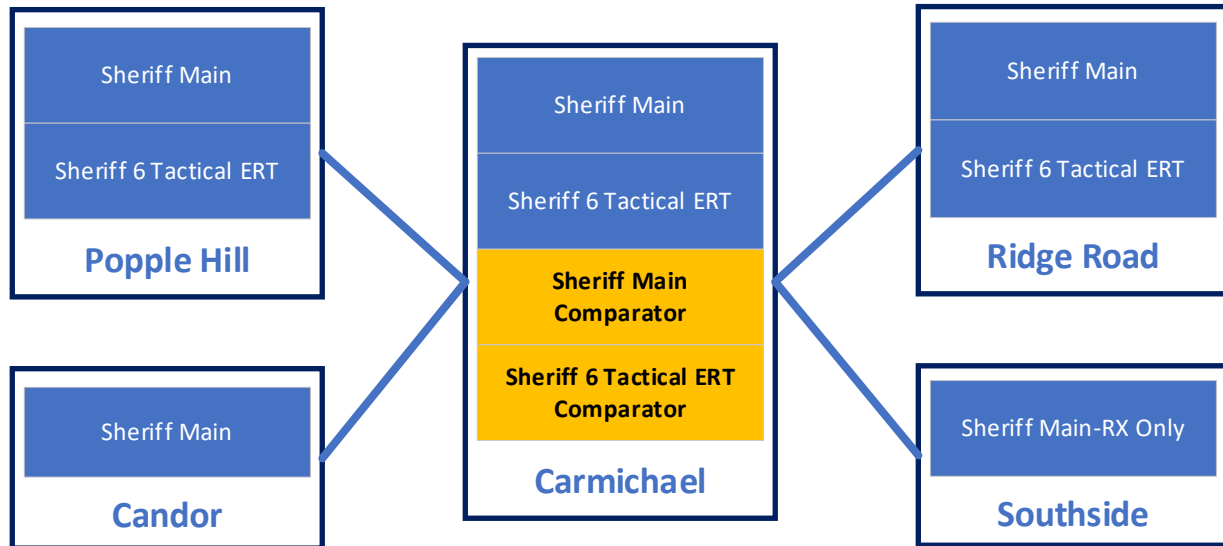
These channels implement simulcast and voting technology, rather than the "steered" transmitters that the Fire Services system uses. Adding simulcast technology allows for each of the transmitter sites to simultaneously broadcast the transmit audio.

3.3.1   Sheriff's Main Channel

The Sheriff's Main Channel is best described as an analog conventional simulcast channel containing four transmitters and five receivers. The equipment is current production Motorola equipment and supported. Table 5 details the main components in use by the Sheriff's Main Channel.

Table 5 – Sheriff's Main Channel Components

Item	Discontinued Product?	Currently Supported?
Motorola GTR 8000 Base Radio	No	Yes
Motorola MLC 8000 Comparator	No	Yes

Item	Discontinued Product?	Currently Supported?
Motorola MLC 8000 Simulcast Controller	No	Yes
TRAK Model 9100 Modular Frequency/Time System	No	Yes

The Motorola GTR 8000 devices are the most current offering from Motorola in terms of base radios and are currently supported by Motorola.

The MLC 8000 Conventional Analog Comparator performs both the voting and simulcast control functions. Simulcast systems require a controller that precisely times when each site transmits the signal. The TRAK 9100 carries out this timing and synchronization function for the Sheriff's Main Channel. The TRAK 9100 ensures that the transmitters are on the same frequency and share the same time.

Figure 7 shows that a single receiver is located at the Southside site. This site is serving as a receive-only site with no transmitter at this location. The purpose of a receive-only site is to improve talk-in coverage, or the ability of the field users to speak with dispatchers.

3.3.2   Sheriff's 6 Tactical ERT Channel

The Sheriff's Office 6 Tactical ERT Channel also uses voting and simulcast technologies. The Sheriff's Office 6 Tactical ERT is an analog conventional simulcast channel containing three transmitters and three receivers. The three sites that contain the ERT channel are Carmichael, Popple Hill, and Ridge Road. The ERT channel uses the same equipment as the Sheriff's Main Channel except for the base radios. This channel uses the Motorola QUANTAR™ base station radios rather than the GTR 8000 base station radios. Motorola QUANTAR™ base station radios have been discontinued by Motorola however, they are currently supported until 2020. Table 6 contains a list of equipment is use by the Sheriff 6 Tactical ERT Channel.

Table 6 – Sheriff's 6 Tactical ERT Channel Components

Item	Discontinued Product?	Currently Supported?
Motorola QUANTAR™ Base Radio	Yes	Yes – Until 2020
Motorola MLC 8000 Comparator	No	Yes
Motorola MLC 8000 Simulcast Controller	No	Yes

Item	Discontinued Product?	Currently Supported?
TRAK Model 9100 Modular Frequency/Time System	No	Yes

Only a single TRAK 9100 is required at each site. For those sites that contain both the Sheriff's Main Channel and the ERT channels, a single TRAK 9100 is utilized for both channels. As previously mentioned, the ERT channel is not represented at all sites with the Sheriff's Main Channel. This suggests that the ERT channel provides less coverage than the Sheriff's Main Channel.

3.4 Subscriber/User Equipment

The term subscriber device refers to various user equipment, including handheld portable radios, mobile radios, pagers, control stations, and other equipment used to communicate over the radio system.

The County provided **FE** with the following estimate of subscriber/user equipment counts for the Fire Services and Sheriff's Office as Table 7 details.

Table 7 – Estimated Subscriber Counts by Department

Department	Portables	Mobiles	Pagers	Control Stations
Fire Services	436	387	675	26
Sheriff's Office	43	30	0	2
Total Estimate	**479**	**417**	**675**	**28**

Portable radios are handheld devices that allow the use of the radio system without the user being "tethered" to a vehicle. Portable radios allow the user to communicate while on foot. Portable radios are typically more limited in range than mobile radios and require routine charging of its battery. The inventory details that there are approximately 479 portables in use in the County. The Sheriff's Office indicated that their portable radios are all VHF Motorola HT750 devices, while the Fire Services Low Band portables are a mixture of Motorola MT1000, HT750 and HT1250 devices. Campville and Waverly Fire Departments reported to have VHF radios. **FE** understands that the Town of Owego reports to have UHF portables, however, a count was not available.

Mobile radios are devices which are permanently installed in vehicles. They typically have more transmit power and antenna systems mounted on vehicle typically perform better

than portable radios. This increase in power and better antenna provides more coverage over portable radios. Fire Services reported having about 387 mobile radios comprised of mostly Motorola CDM750, CDM1250 and MaxTrac mobiles. *FE* understands that some Fire Services users also have Vertex Standard and Kenwood mobile radios.

Pagers are small one-way communications devices typically utilized for alerting personnel for "call of duty," or informational activities. A common method of alerting pagers is via two-tone and voice alerts. Two-tone is simply two consecutive tones which are assigned to agencies, departments, or personnel. When these two tones are sent to the pager, the pager will emit an audible tone and then pass the audio being sent by the dispatcher. Fire Services and EMS providers within the County use two-tone and voice pagers to alert personnel via the Low Band channels. An inventory provided by the County indicates that there are approximately 675 pagers in use by Fire Services personnel, of which most are reported as operating over the Low Band channels.

Control stations are radios which aren't required to be installed in vehicles to operate. Control stations can either be a mobile radio with an external power supply, or a specific radio designed by the manufacturer to include its own power supply. Many agencies simply purchase power supplies to convert mobile radios to control stations. Fire Services within the County have approximately 26 control stations, while the Sheriff's Office reports using approximately two control stations. The Sheriff's Office control stations are located at the PSB and used to connect the dispatch consoles to the Sheriff's Office channels.

Vehicular repeaters allow for portable radios to utilize the higher power and better antenna systems of mobile radios. The user's portable radio communicates to the mobile radio which then transmits this audio to the radio communications sites. This essentially extends the range of the portable radio to that of the mobile radio, or vehicular repeater device. *FE* understands that there are some vehicular repeaters in use by Fire Services and also the Sheriff's Office, but counts were not provided.

3.5 Dispatch Console System Equipment

The dispatch console equipment utilizes Zetron's® Series 4000 common control units. (specifically, the Zetron® Model 4048). Dispatch operator positions use the Zetron® Integrator RD workstations. The workstations provide the user interface to control the backroom common control units. The specifications for the Integrator workstation detail the operating system to be either Windows® Vista, or Windows® XP Professional. These operating systems are not current version of Windows® and support for these operating systems is no longer available. According to Zetron®, the Model 4048 control units will handle up to 48 radio or telephone channels and up to 16 operating positions. The County currently has four dispatch operator positions.

3.6 Backhaul Systems

The term backhaul describes the components utilized to link a group of radio communications sites together to form a single system. The technology comprising backhaul systems can be radio, optical fiber, or copper wire. The County currently uses point-to-point (PTP) microwave radio systems as the primary means for providing connectivity between the radio communications sites and the PSB. Figure 8 details the PTP microwave radio links in place today within the County.
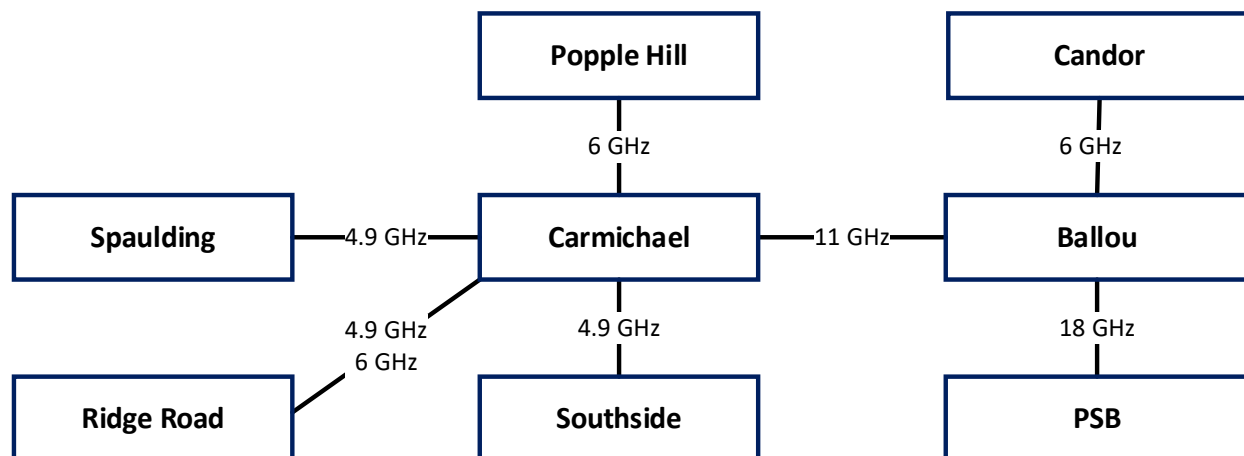
```
    ┌──────────────┐                              ┌──────────────┐
    │  Popple Hill │                              │    Candor    │
    └──────┬───────┘                              └──────┬───────┘
           6 GHz                                        6 GHz
┌──────────┐        ┌──────────────┐        ┌──────────────┐
│ Spaulding├─4.9 GHz┤  Carmichael  ├─11 GHz─┤    Ballou    │
└──────────┘        └──────┬───────┘        └──────┬───────┘
        4.9 GHz        4.9 GHz                    18 GHz
         6 GHz
┌──────────┐        ┌──────────────┐        ┌──────────────┐
│Ridge Road│        │   Southside  │        │     PSB      │
└──────────┘        └──────────────┘        └──────────────┘
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Figure 8 – Backhaul Network[5]

The backhaul system is predominantly configured in a star, or hub and spoke configuration with Carmichael at the center of the hub using various frequencies. Using this configuration, a catastrophic failure at the Carmichael site would disable both Sheriff's Office channels and reduce the Fire Services system to a single channel at Candor. While a ring-protected microwave network could provide more reliable configuration, terrain plays a key role in the configuration of a microwave backhaul network and path feasibility studies must be completed to confirm there are no obstructions between the sites. To improve link reliability in a configuration that is not loop protected, *FE* recommends that the County consider a redundant (1+1) monitored hot standby (MHSB) configuration. A 1+1 MHSB configuration provides for two microwave radios on each end of the link. If a single radio fails, the radio in standby mode takes over and becomes the active radio. This keeps the link operational, even though a radio had failed. The failed radio is then replaced with a known good spare returning the link to MHSB status. The current system does not deploy a 1+1 MHSB configuration. Therefore, if any microwave radio fails the

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[5] See Figure 5 for the copper and other radio backhaul connections between the radio sites

link for that radio would fail and be out of service until the microwave radio is either replaced with a spare or repaired.

The 4.9 GHz microwave links utilize the Exalt™ 4.9i equipment with all other microwave equipment being the PTP 820S manufactured by Cambium Networks. According to the County's radio maintenance provider, the 4.9 GHz equipment in the process of being replaced with the more robust Cambium equipment. The Cambium PTP 820S units appear to be current models and currently supported by the manufacturer.

3.7 Radio Frequency Spectrum Assessment

Fire Services desires to pursue and upgraded/replacement system that utilizes the UHF spectrum rather than the current VHF Low Band spectrum. The reasoning for this is three-fold:

1. Low Band equipment is becoming increasingly hard to acquire due to manufacturers discontinuing product lines and support

2. Most of the adjacent counties and local fire services within the County are already using UHF as their primary radio spectrum

3. Low Band frequencies are susceptible to noise and interference, degrading the quality of radio communications for Fire Services users

Prior to conducting the *FE*TeamCoverage Workshop™, we performed a spectrum feasibility assessment to determine the availability of UHF channels licensable within and around the County's geographic region. Inclusive of this assessment, we also investigated the availability of using the VHF High Band spectrum for an upgraded/replacement system.

3.7.1 Radio Frequency Spectrum Assessment Methodology

FE performed searches in the FCC's ULS to determine available channels that the County could license for the upgraded/replacement system. During our searches, we focused on whether the County could license any FCC Code of Federal Regulations (CFR) Part 90 frequency pairs (reserved for public safety) in either the VHF or UHF bands for countywide operation. In addition, *FE* evaluated whether any channels currently licensed by nearby agencies could be good candidates for pursuing letter of concurrence or LOCs with those agencies. LOCs are usually pursued with nearby incumbent licensees when there are few (or no) frequency pairs that are obviously licensable.

The County provided information to **FE** regarding their existing VHF and UHF channels, which including the following:

- Channel names
- Discipline (fire service, EMS, Sheriff)
- Frequencies / frequency pairs
- Callsigns
- Continuous Tone Coded Squelch System, or CTCSS (if applicable)

Using this information, **FE** was able to determine the channels that the County currently uses in their communications systems.

Additionally, **FE** contacted local Association of Public-Safety Communications Officials-International (APCO), International Municipal Signal Association (IMSA), and American Association of State Highway and Transportation Officials (AASHTO) frequency coordinators from New York and Pennsylvania to determine if any additional methods of obtaining frequencies could be used by the County, in the event that licensing Part 90 public safety channels proved difficult or impossible. Based on these communications, **FE** determined that one common practice for agencies near the County is to procure and/or license Part 22 channels from their current licensees. Part 22 channels, available in both VHF and UHF, were originally auctioned off by the FCC to a variety of entities, each of which has the freedom to transmit on their block of spectrum within a particular area. Since paging systems are not used as frequently as they were during the time of the original auctions, many of the license holders now "sell" their spectrum holdings to interested parties, such as local governments.

3.7.2   Radio Frequency Spectrum Assessment Results

VHF High Band

FE's investigation of Part 90 public safety channels in the VHF High Band revealed that there are currently no channels licensable countywide. While there may be Part 90 channels that the County could pursue by requesting LOCs with current licensees, this process is more difficult in VHF due to two factors:

- VHF tends to propagate farther than UHF, meaning that there are larger licensing contours that need to be considered

- The public safety VHF band is not "structured," which means that the transmit and receive channels need to be individually licensed, which can prove very challenging

UHF Band

Our ULS search in the UHF frequency band showed no Part 90 public safety channels that were licensable countywide. However, there may be better options in UHF for pursuing LOCs since there are at least two to three channels which have adjacent-channel incumbents in nearby counties. In the case of adjacent channels, it is typically much easier to request a LOC (rather than a co-channel license), as there is less potential for interference with adjacent channels.

While licensing new Part 90 public safety channels may prove difficult (due to congestion), the County identified several channels that are currently licensed by either the County, or by local agencies within the County, that could be repurposed for the upgraded/replacement system.

Part 22 (formerly paging frequencies)

As described, *FE* reached out to local frequency coordinators, who stated that Part 22 channels are often procured by local governments to supplement their normal Part 90 channels. With regards to VHF High Band Part 22 channels, *FE* was informed that they are typically much more expensive than non-Part 22 VHF High Band channels, due to fewer license holders (that is, no competition), and the extreme congestion of VHF High Band frequencies in the area.

Within the UHF Band, there are several 25 kHz blocks of channels which may be pursued by the County. *FE* identified 11 Part 22 channel pairs that no government agency appears to have licensed in Economic Area #006 (where the County is located). This means that is likely that the current license holders in those areas have not "sold" their licenses to any local governments. The County should be aware that some of the channels identified are adjacent to each other, and some of them are adjacent to blocks which have been licensed by nearby governments (i.e., Cortland County, Broome County, and others). As a result, there may not be an ability to purchase and use more than two to four of these Part 22 channel pairs, depending on how they are distributed.

Part 90 Industrial/Business

Part 90 outlines the specific frequencies that are dedicated to public safety agencies within various frequency bands. In addition, a separate block of channels are dedicated for industrial/business use. While the FCC typically does not provide public safety agencies access to these industrial/business channels, there have been occasions where a public safety agency has plead hardship based on spectrum scarcity, and the FCC has provided a waiver for some additional channels. This is usually only done when all other methods of obtaining frequencies have been exhausted.

4. Recommendations

FE presents our recommendations for the County to replace the Fire Services radio system and upgrade the Sheriff's Office radio systems within this Section. Inclusive of our recommendations, we provide a site-by-site analysis of the existing and additional radio communications sites that may be necessary to achieve the desired radio coverage levels.

4.1 Fire Services Radio System

Based on the age of the equipment and its obsolescence, *FE* recommends that the County replace the Fire Services radio system. To meet operational requirements, the replacement system should provide three to four simulcast channels. *FE* predicts that approximately nine radio communications sites may be needed to provide the level of mobile and portable radio coverage required by users of the Fire Services system. The replacement system's reliability will be greatly improved by including geo-redundant simulcast and voting equipment at two different locations as Figure 9 depicts on the following page in green.

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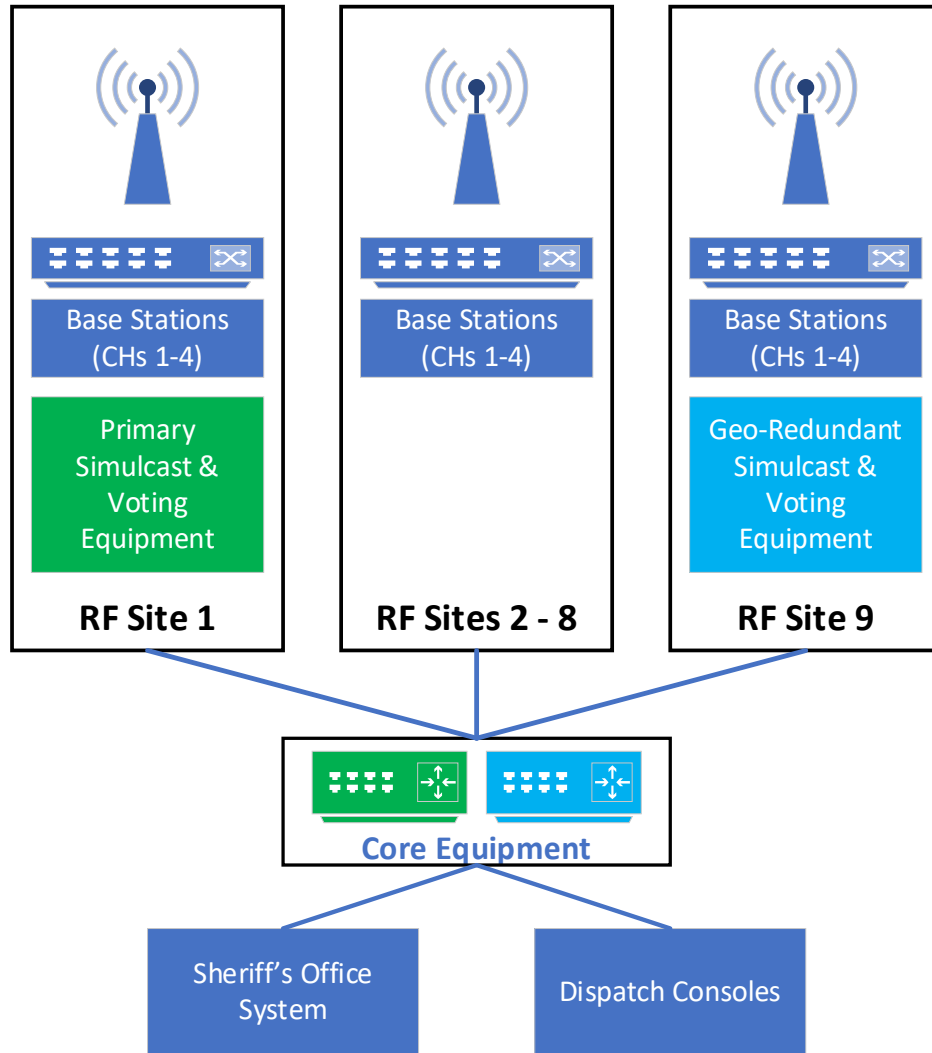
Figure 9 – Fire Services Replacement Conceptual Design

The conceptual design for the Fire Services radio system contains four base stations at each radio communications site providing four separate talk paths. There are redundant simulcast and voting control equipment (in green), which would keep all channels operational in the event of a failure of a single simulcast or voting component. The core equipment would be shared between the Fire and Sheriff's Office systems.

Each radio communications site would contain base stations, antenna network, networking equipment required for simulcast sites. The radio sites would be shared for both the Fire Services system and Sheriff's Office system, allowing for sharing of resources along with promoting similar coverage between systems.

Retaining the existing Fire Services Low Band paging channels allows for a slow migration to a UHF paging channel. Alternatively, the County could purchase all new

pagers and shift paging operations to UHF immediately. This shift from VHF Low Band to a UHF system would require a complete refresh of all fire subscriber or user devices.

4.2 Sheriff's Office Radio System

The Sheriff's Office currently operates two main Sheriff's Office channels. The main dispatch (Sheriff's Main Channel), or operating channels and a second Tactical ERT Channel. These two channels do not currently share the same radio sites and provide different coverage levels within the County. The Sheriff's Main Channel utilizes current equipment whereas the second channel utilizes legacy equipment that has been discontinued and soon to be unsupported by the manufacturer. The upgraded system for the Sheriff's Office would expand the Main Channel by adding like equipment at additional radio sites and replace the equipment utilized by the Tactical ERT Channel with like equipment utilized by the Sheriff's Office Main Channel. This expansion of the Main Channel and upgrade to the Tactical ERT channel allows the Sheriff's Office to reuse their existing subscriber or user equipment. The expansion of the Sheriff's Office Main Channel equipment also leverages the capital investment of the equipment. Figure 10 on the following page shows a block diagram of upgraded Sheriff's Office radio system, which mirrors the Fire Services replacement system configuration.

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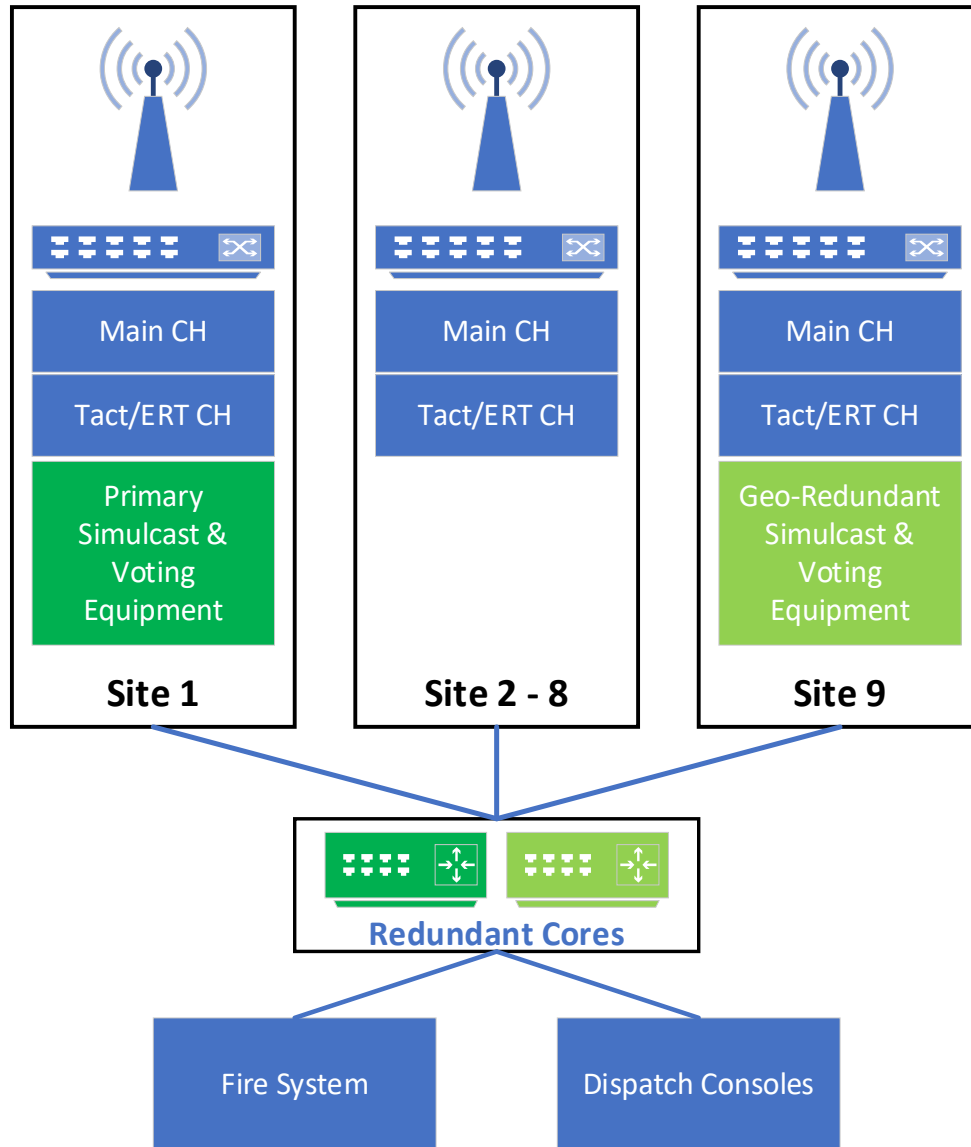
Figure 10 – Sheriff's Office Upgraded Radio System

This expansion of the Sheriff's Office Main Chanel increases the existing site count of the Main Channel from four transmit sites and five receive sites to a total of nine transmit and receive sites. The Tactical ERT channel increases to the same nine sites from the current configuration of three transmit and receive sites. This essentially doubles the number of transmit and receive sites, increasing the coverage to an expected level of 95% portable on the street.

4.3 Radio Communications Sites

As previously mentioned, the new Fire Services and Sheriff Office systems will share the same radio communications sites. The Fire Services system will be comprised of new equipment, whereas the County will leverage their investment in current Sheriff's Office equipment, only adding new equipment were necessary. Table 8 depicts nine radio communications sites that may provide the level of radio coverage required by users and indicates whether the equipment is new or reused.

Table 8 – Potential Radio Communications Sites and Equipment Reuse

Radio Site	Fire System	Sheriff Main	Sheriff TAC/ERT
Carmichael	New	Reuse	New
Popple Hill	New	Reuse	New
Candor	New	Reuse	New
Berkshire	New	New	New
Round Top	New	New	New
Prospect Hill	New	New	New
Chemung EMO	New	New	New
Plexicomm	New	New	New
Crown	New	New	New

The current Sheriff's Office system also contains equipment at Ridge Road and Southside tower sites. These sites did not appear to provide substantive radio coverage improvements in the upgraded/replacement design. The County could have the option of relocating the equipment from these sites or reusing these sites in the upgraded/replacement system if they are not needed at the existing sites.

The following subsections detail information pertaining to each radio site's use for the anticipated system and provides the assumptions utilized in developing the estimated costs for the system. The basis of *FE*'s analysis of the existing sites is from information provided by the County. *FE* did not physically visit each site to assess site conditions.

4.3.1   Carmichael

The Carmichael site is an existing site utilized by the existing Fire Services and Sheriff's Office radio systems. This site contains both the radio equipment and simulcast/voting equipment for the Sheriff's channels, both the Main and Tactical ERT. The equipment utilized in the Sheriff's Office Main Channel will be reused. The Sheriff's Tactical ERT and Fire Services equipment would be replaced.

The site is located at 1788 Carmichael Road in Owego and appears to be in good condition. The equipment shelter, tower, and generator are new and in good condition. A site inspection was conducted in August 2017 by Mid-State Communications. Mid-State did not identify any tower, shelter or site compound issues. Mid-State reports the structure to be a 199-foot guyed tower with a 12 x 32 foot prefabricated equipment shelter. Photographs of the site, tower, and equipment shelter indicate a properly maintained site with some room for expansion. Prior to installing any equipment on the tower, a structural analysis should be performed to ensure the tower is capable of support the existing plus any new loading. Performing a structural analysis on radio communications towers should be done anytime equipment is proposed to be added or removed. The site's electrical grounding systems, including equipment shelter, tower, and compound should be inspected to ensure the site follows industry best practices for lightning and surge protection. This site also contains a 40 kW propane generator for backup power. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Carmichael site:

- Reuse existing radio equipment for the Sheriff's Office Channels
- New radio equipment for Fire Services Channels (Channels 1-4)
- New microwave backhaul network
- The existing tower will support the additional radio antennas and microwave dishes
- Reuse existing equipment shelter
- Reuse existing backup power generator

4.3.2 Popple Hill

The Popple Hill site is located on Popple Hill Road in Berkshire. It contains a new 199-foot guyed tower, new 12 x 27 foot prefabricated equipment shelter, and a new 40 kW propane generator. The site appears in overall good condition and is expected to support the anticipated equipment for both the upgraded/replacement Fires Services and Sheriff's Office systems.

Popple Hill currently supports the existing Fire Services and Sheriff's Office systems. As with Carmichael, the Sheriff's Office Main Channel equipment will be reused and the Tactical ERT and Fire Services equipment will be replaced. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Popple Hill site:

- Reuse existing radio equipment for the Sheriff's Office Channels
- New radio equipment for Fire Services Channels (Channels 1-4)
- New microwave backhaul network
- The existing tower will support the additional radio antennas and microwave dishes
- Reuse existing equipment shelter
- Reuse existing backup power generator

4.3.3 Candor

The Candor site is located on Benton Road in Candor. As with the previous two sites, Candor contains a new tower, new equipment shelter and new generator. The site hosts a 195-foot radio communications tower and 12 x 27-foot equipment shelter. Additionally, a 40 kW generator provides emergency power in the event of commercial power disruption. Candor currently supports the existing Fire Services and Sheriff's Office systems. As with Carmichael and Popple, the Sheriff's Office Main Channel

equipment will be reused and the Tactical ERT and Fire Services equipment will be

replaced. A new microwave backhaul system will also be provided. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Candor site:

- Reuse existing radio equipment for the Sheriff's Office Channels
- New radio equipment for Fire Services Channels (Channels 1-4)
- New microwave backhaul network
- The existing tower will support the additional radio antennas and microwave dishes
- Reuse existing equipment shelter
- Reuse existing backup power generator

4.3.4　Berkshire

The Berkshire site is not currently utilized by the County. This location was previously utilized as a broadcast translator station by CH-46, WSKG. The site currently contains a 195-foot guyed tower and a small, approximately 6 x 6-foot storage shed building utilized as an equipment shelter. Reuse of this site would, at a minimum, require a new communications shelter and generator to be installed. The tower would require a complete structural analysis prior to installing any equipment. Depending on the proposed equipment loads and the structural analysis results, the tower may need to be upgraded or replaced. The photograph to the left is a picture of the current shelter provided by the County. This site would receive all new radio equipment for both the Fire Services replacement system and Sheriff's Office upgrade system. A new backhaul network would be implemented to provide the required connectivity. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Berkshire site:

- New radio equipment for the following channels

  o Sheriff's Office Main Channel
  o Sheriff's Office Tactical ERT Channel
  o Fire Services (Channels 1-4)

- New microwave backhaul network
- The existing tower will support the additional radio antennas and microwave dishes
- In the event the tower cannot support the new equipment, it will be upgraded or replaced
- New prefabricated communications shelter and electrical grounding system
- New backup power generator

4.3.5   Round Top

The Round Top site is another site not currently utilized by the County. This site contains a self-supported tower of roughly 120-feet. The site does contain a couple of communications shelters however, these shelters are relatively full of equipment and expansion to support the County's equipment is not expected. The use of this site would require either a new communications shelter, or outdoor enclosures. *FE* also expects the addition of a new backup power generator. This site would be furnished with all new equipment and antennas for the Fires Services and Sheriff's Office channels. In addition, a new microwave backhaul network will be required. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Round Top site:

- New radio equipment for the following channels

  - Sheriff's Office Main Channel
  - Sheriff's Office Tactical ERT Channel
  - Fire Services (Channels 1-4)

- New microwave backhaul network
- The tower will support the additional radio antennas and microwave dishes
- New outdoor enclosures to house radio and microwave equipment
- New backup power generator

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4.3.6   Prospect Hill

The Prospect Hill site is not currently utilized to provide coverage for the Fire Services or Sheriff's Office radio systems. The site currently houses a 100-foot guyed tower and equipment shelter configured in a "L-Shape" with a 10 x 12 foot section and a 10 x 20 foot section. The shelter was reported as being in good condition and should be able to be reused to house the new equipment. The tower appears in good condition however, it is currently loaded with five microwave dishes. These dishes are currently unused and are assumed to be removed prior to installing any new dishes, or antennas on the tower. This site will receive all new equipment for the Fire Services replacement system and Sheriff's Office upgraded system for the Main Channel and Tactical ERT. A new microwave backhaul will also be installed.

FE's cost estimate for the replacement/upgrade system assumes the following regarding the Prospect Hill site:

- New radio equipment for the following channels:

    o Sheriff's Office Main Channel
    o Sheriff's Office Tactical ERT Channel
    o Fire Services Channels (Channels 1-4)

- The existing microwave dishes will be removed from tower
- The tower will support new radio antennas and microwave dishes
- The existing equipment shelter will be reused
- The existing generator will be reused
- New microwave backhaul network

4.3.7   Chemung Emergency Management Office (EMO)

The Chemung Emergency Management Office (EMO) site is located at GPS 42° 13' 43.9" N, 76° 34' 5.2" W. It contains a 250-foot self-supporting tower, communications shelter and backup power generator. This site is not currently being utilized by the County and will receive all new equipment for the Fire Services and Sheriff's Office radio systems as well as a new microwave backhaul network. The County did not provide photographs or additional information regarding the Chemung EMO tower for *FE*'s review. *FE*'s cost

estimate for the replacement/upgrade system assumes the following regarding the Chemung EMO site:

- New radio equipment for the following channels:

  o Sheriff's Office Main Channel
  o Sheriff's Office Tactical ERT Channel
  o Fire Services Channels (Channels 1-4)

- The tower will support new radio antennas and microwave dishes
- The existing shelter will be reused
- The existing generator will be reused
- New microwave backhaul network

4.3.8   Plexicomm

The County reported that the Plexicomm site has a 150-foot tower, an equipment shelter, and a 10 kW diesel backup power generator. Plexicomm personnel report that the equipment shelter is full, however, they also indicated that there is sufficient room within the compound to install a 12 x 20 foot prefabricated communications shelter. *FE*'s cost estimate for the replacement/upgrade system assumes the following regarding the Plexicomm site:

- New radio equipment for the following channels:

  o Sheriff's Office Main Channel
  o Sheriff's Office Tactical ERT Channel
  o Fire Services Channels (Channels 1-4)

- The tower will support new radio antennas and microwave dishes
- A new 12 x 20 foot equipment shelter
- The existing generator will be reused
- New microwave backhaul network

4.3.9   Crown

The Crown site a leased tower owned by Crown Castle. According to the FCC Antenna Site Registration (ASR) number (1209126), the tower is 315-feet tall. Being this is a leased tower, *FE* assumes the following for the budgetary cost estimate:

- New radio equipment for the following channels:

  o Sheriff's Office Main Channel
  o Sheriff's Office Tactical ERT Channel

  o Fire Services Channels (Channels 1-4)

- The tower will support new radio antennas and microwave dishes
- A new 12 x 20 foot equipment shelter
- A new backup power generator
- New microwave backhaul network

4.4 Radio Coverage

During the **FE**TeamCoverage Workshop™ held on October 12, 2018, the County and **FE** explored various radio communications site alternatives to achieve the desired mobile and portable coverage levels. Following the workshop, **FE** developed radio coverage prediction maps for a 9-site UHF system.

The radio coverage prediction maps represent both the Fire Service and Sheriff's Office channels utilizing the nine sites previously described. Figure 11 on the following page details coverage in the talk-in direction, or user talking to dispatch. The purple color details mobile coverage, yellow represents a handheld radio operating on the street with green detailing a portable with a building having 12 dB of attenuation from the outside signal when compared to the inside. A 12-dB attenuation is typical for a residential type structure. This map shows that mobile talk-in coverage is expected to be 99% of the County, portable on the street within 95% of the County and portable within 12 dB buildings is expected to serve 74% of the County.

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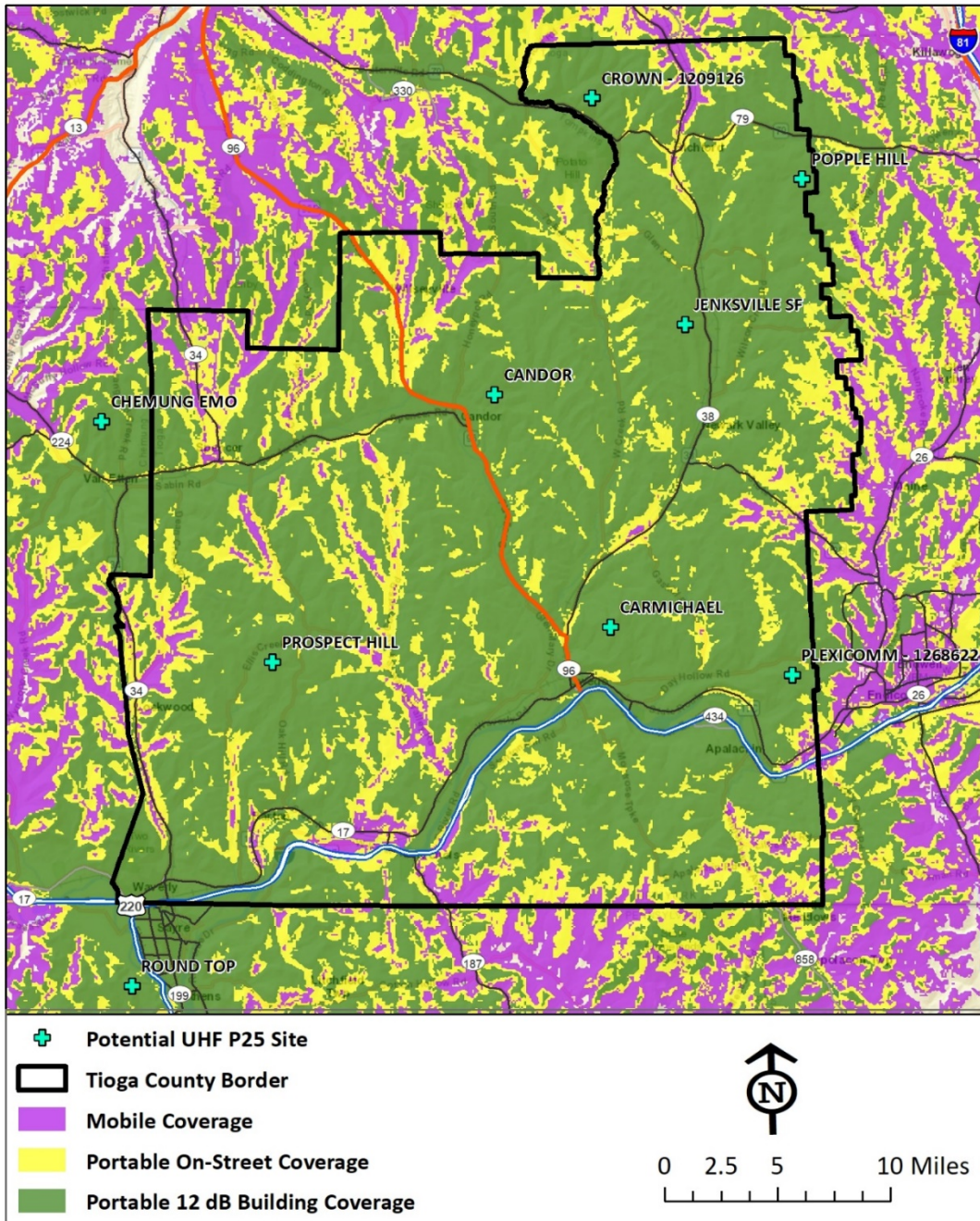
Figure 11 – Talk-in Coverage Predication Map

Figure 12 details talk-out or dispatcher to field user predicted coverage.

Figure 12 – Talk-out Coverage Prediction Map

Figure 13 details predicted paging/alerting coverage with in the County.

Figure 13 – Predicted Paging/Alerting Coverage

Quantitatively, Table 9 details the amount of predicted coverage for each of the different design parameters depicted in the previous maps.
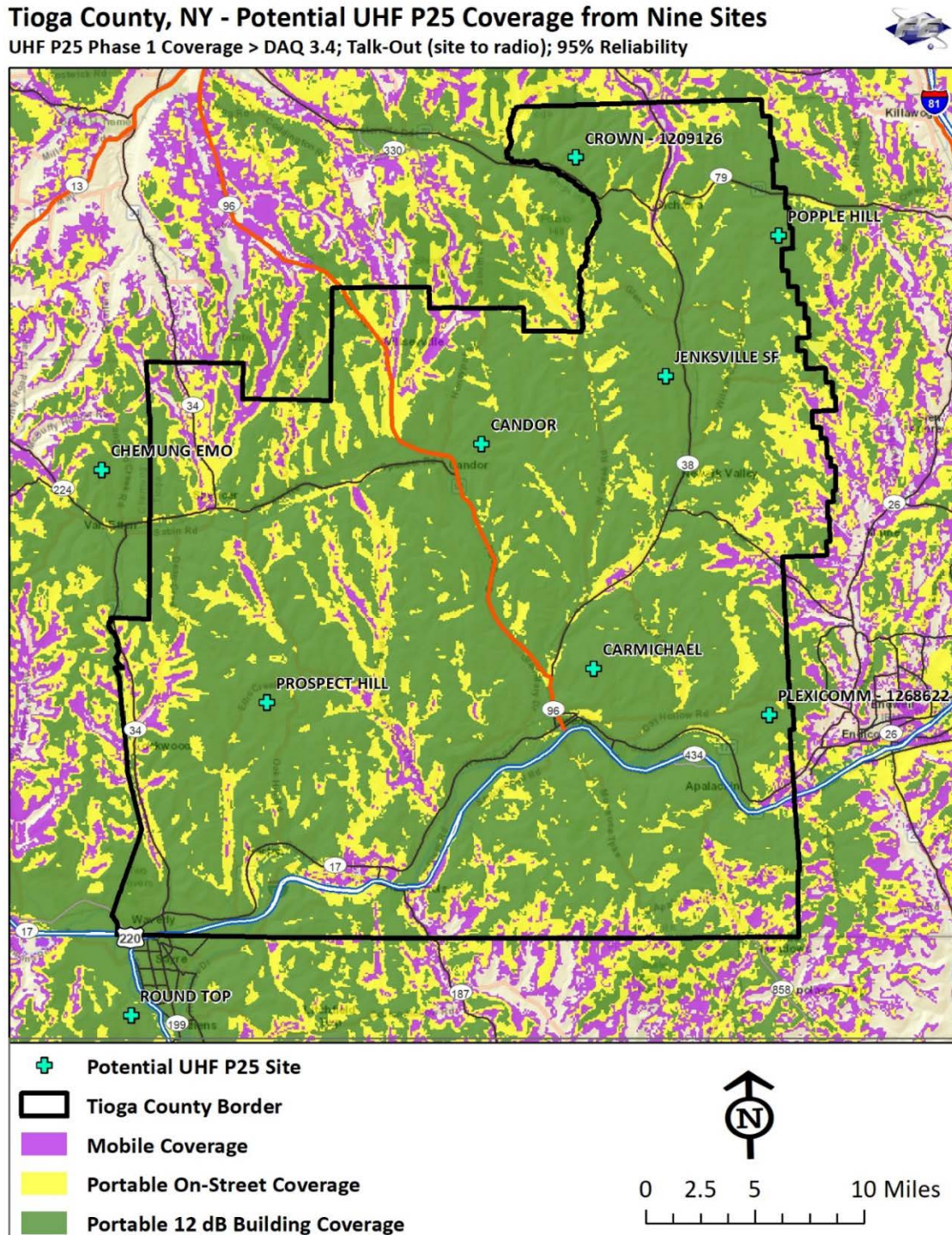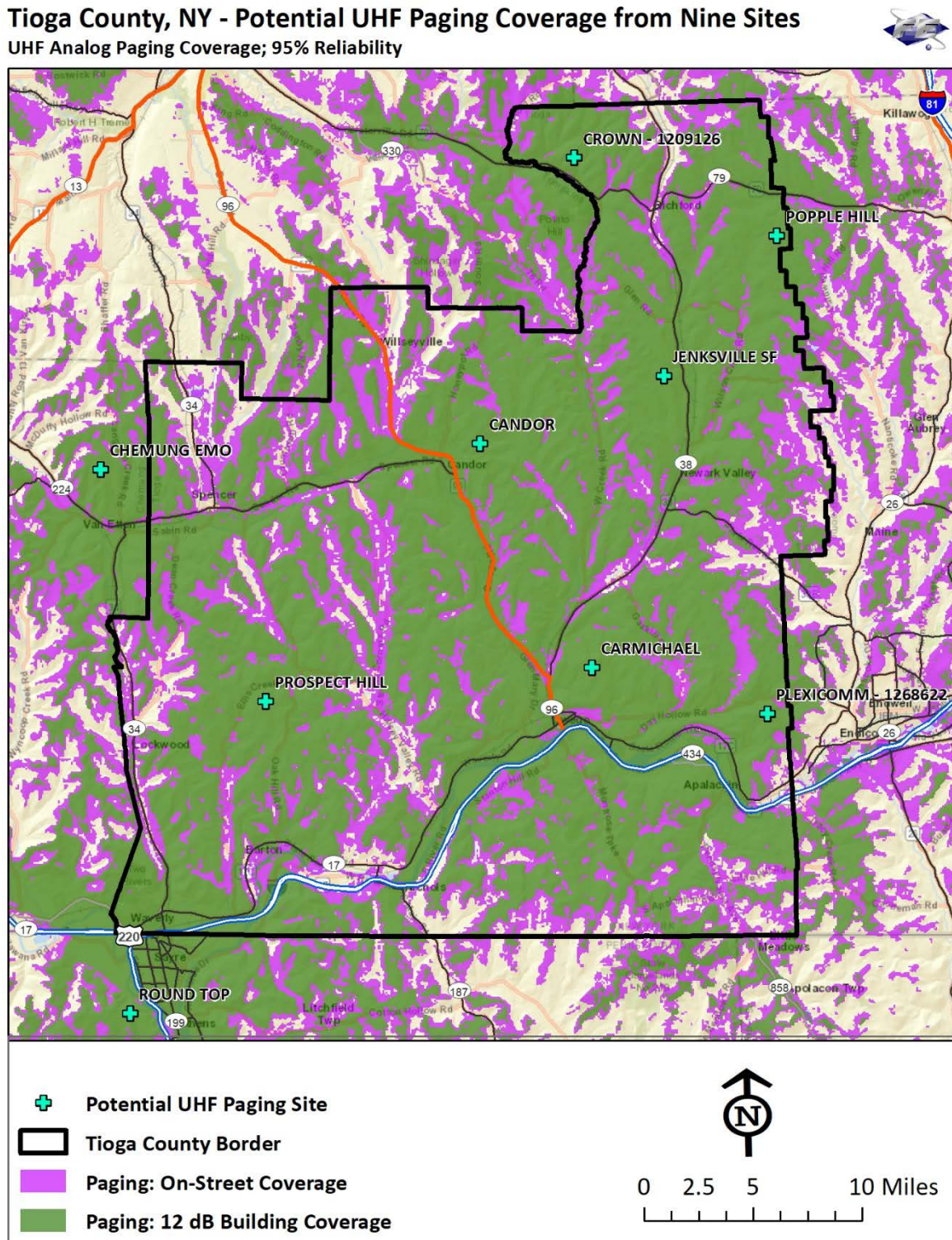
Table 9 – Estimated Radio Coverage Percentages

Configuration	Talk-in	Talk-Out
Mobile Coverage	99%	99%
Portable (on-street/12 dB Buildings)	95%/74%	95%/74%
Pagers (on-street/12 dB Buildings)	N/A	92%/70%

4.5 Subscriber/User Equipment

Section 3.4 details the subscriber or user radio equipment currently in use by Fire Services and the Sheriff's Office. Fire Services' migration from the Low Band system to a UHF radio system requires the replacement of their subscriber or user equipment. *FE*'s budgetary cost estimate accounts for the replacement of 436 Portables, 26 control stations, 387 mobiles and 675 pagers.

The Sheriff's Office subscriber or user equipment are primarily Motorola HT750 portable radios and Motorola XTL2500 mobiles. Both of these models have been discontinued by Motorola. While a discontinuation does not mean the radio will suddenly fail, it simply indicates that the manufacturer has replaced these units with newer models. As these radios do fail, they can simply be replaced with newer models currently in production and supported by the manufacturer. The HT750 portable units are analog only units while the XTL2500 mobile do support digital operation however, these units are currently not supported by Motorola and purchasing digital software for these units is not an option any longer. As with the portables, as the mobile units fail, they should be replaced with newer models that support digital operation, specifically Project 25 (P25) digital. Given that the Sheriff's Office channels will initially continue operating in VHF analog mode, the existing subscribers can be reused and will not require a complete refresh until they may migrate to the UHF system in the future. *FE* understands that the Sheriff's Office currently has 30 mobile units and 43 portables.

4.6 Interoperability

Interoperability is the ability for agencies to communicate with other agencies within the County and other public safety and public service users from other counties, the State, and national responders. The combined implementation of a Fire Services replacement system and new dispatch console equipment may improve interoperability within the County between the Fire Services and Sheriff's Office. One option to improve interoperability is to leverage the existing interoperability channels. The existing UHF and VHF interoperability stations could be patched together allowing Fire Services to communicate with Sheriff's Office users as needed. The Fire Services and Sheriff's Office channels could also be directly patched together, however, this would tie up one of each agency's channels. The utilization of the interoperability channels and equipment would not tie up any agency's working channel. Another option for interoperability could be through the use of multi-band subscriber devices. A multi-band subscriber device can operate on multi-bands, such as VHF and UHF spectrum. This would allow for the person utilizing a multi-band subscriber device to talk directly on the Sheriff's Channels and the Fire channels. The use of multi-band devices would also extend interoperability to any outside agency operating on either the VHF, or the UHF spectrum.

Interoperability between the Sheriff's Office and surrounding jurisdictions would remain unchanged, as the Sheriff's Office is initially maintaining operation in the VHF band. Fire Services should see the greatest improvement in interoperability with neighboring jurisdictions especially, with those agencies currently using the UHF spectrum. Neighboring systems operating in the UHF spectrum were reported as being in Cortland and Chemung Counties with Broome County moving towards a UHF system in a couple of years.

4.7 Dispatch Console System Equipment

The current dispatch equipment was reported as being computers utilizing the Windows® XP operating system. This operating system is no longer supported by Microsoft®. **FE** assumes that the computers hosting the XP operating system will not support a current operating system. The dispatch consoles are also based upon circuit switched technology. **FE** recommends that the current consoles be upgraded to an IP-based dispatch console system. This move to IP-based consoles will improve the redundant features and allow for a future upgrade to P25 operation. Implementing a system capable of operating in P25 mode is also a requirement when applying for grants to assist in funding.

The new dispatch console equipment would contain four dispatch consoles and the associated networking equipment to interface the consoles with the replacement Fire Services system, existing Sheriff's Office system, and the interoperability stations.

4.8 Paging/Alerting

Fire Services currently accomplishes paging/alerting via two-tone and voice paging utilizing the Low Band transmitters. These Low Band transmitters could continue to be used as the UHF replacement system is being deployed. Once the County is ready to migrate to UHF paging, the paging could be simultaneously sent out via both the legacy Low Band transmitters and the Fire Services new UHF system. This would allow for a slow migration to UHF paging. If and when the UHF system migrates to P25, two options would then be available, either maintain a single UHF channel in analog mode, or utilize P25 call alert for paging. The use of P25 call alert would require the deployment of P25 compatible pagers such as those available from Unication. If the County expects to migrate to P25 in the near future, it may be advantageous for the County to deploy UHF pagers capable of analog and P25 operation.

4.9 Logging Recorder

A new logging recorder system, capable of recording P25 digital, would also be required. This new logging recorder is be capable of recording P25 audio and the existing analog audio. It would also be capable of recording any 9-1-1 and administrative phone lines currently being recorded by the County's existing logging recorder.

4.10 Backhaul System

Although the County could continue to leverage their existing PTP microwave links, they expressed the requirement for a new microwave system configured in a ring configuration to enhance reliability and redundancy. Figure 14 contains a conceptual design of the microwave network to support the 9-site radio system.
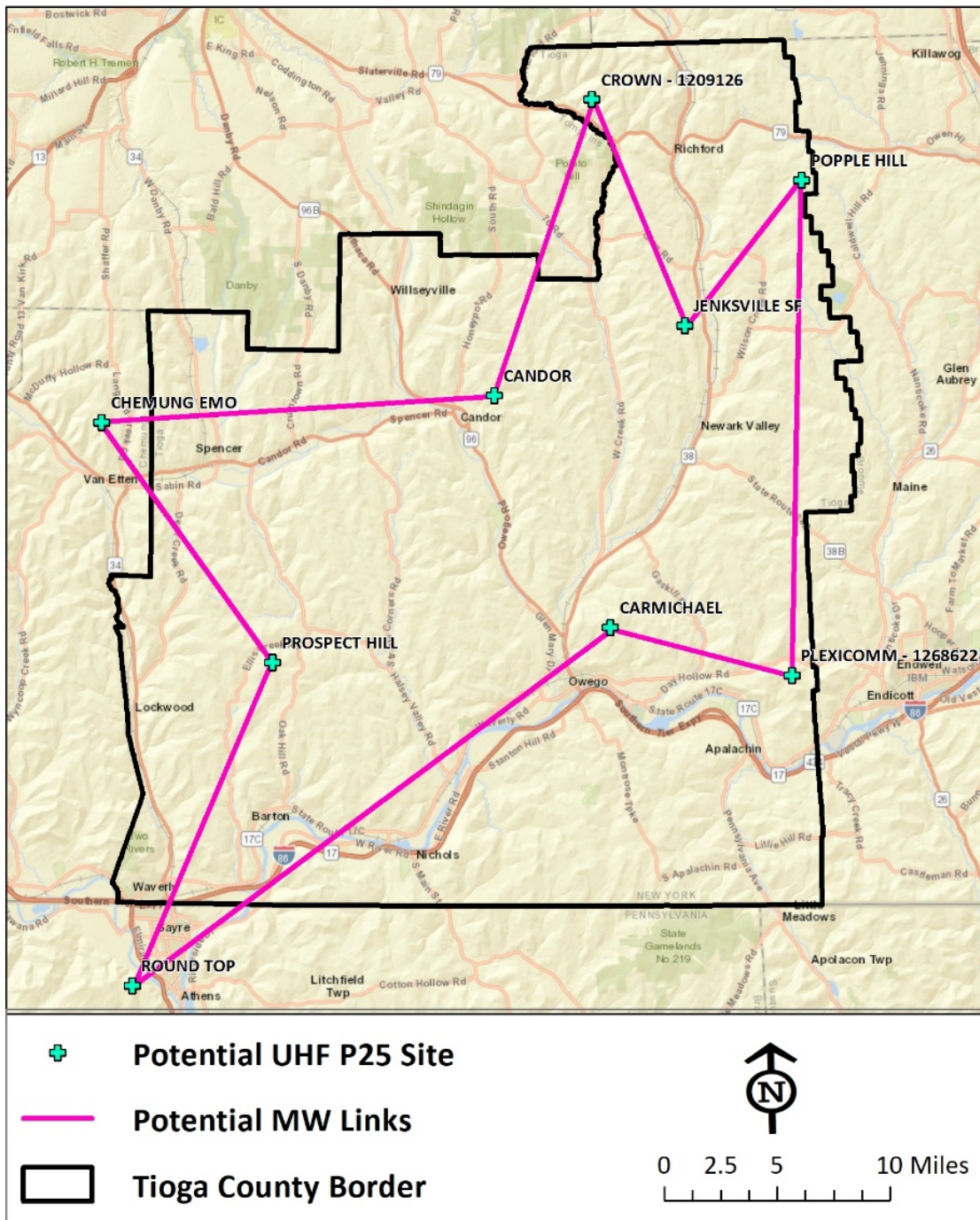
Figure 14 – Conceptual Microwave Network

The ring configuration of the microwave network would allow for a microwave radio to fail at any site and connectivity would still be established between all sites. As previously mentioned, all microwave sites would receive new microwave radios, microwave dishes, dehydrators and direct current (DC) power plants. The microwave will also be provisioned to provide 150 Mbps bandwidth.

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5. Budgetary Cost Estimate

Using our in-house cost analysis tool, *FE* prepared a high-level budgetary cost estimate for the County's Fire Services UHF radio replacement system, including implementation services and site improvements. We also included equipment and services to implement two channels for the Sheriff's Office in the event they decide to migrate to the UHF band in the future. These estimates reflect results from previous project activities, our knowledge of the County systems, our experience designing radio systems comparable to this project, and publicly available industry information. Actual system costs are highly dependent on final system design choices as well as conditions in the markets during the system procurement phase.

*FE'*s budgetary estimates are conservative, so that the vendor proposal pricing does not exceed the estimates. The cost estimates prepared for this project reflect non-discounted (list) pricing and include a 10% contingency. Frequently, system vendors provide discounts for system purchases of this size. System discounts of 20% to 25% are common (and mirror many state contracts), but *FE* has seen them higher. However, it is not possible to forecast the level of discount a vendor will offer at the time of proposal submission.

5.1 Estimated Cost Assumptions

Table 10 details the basis of *FE*'s budgetary cost estimate assumptions for the radio system, microwave backhaul, dispatch consoles, subscriber equipment, implementation services, and site improvements.

Table 10 – System Cost Assumptions

Cost Assumptions	Quantity	Notes
Radio System Infrastructure		
Number of Core Sites	1	With redundancy
Core Networking Equipment	1	Redundant routers, switches, firewalls, etc.
Number of Simulcast Cells	1	Single cell with multiple channels
Number of Simulcast Sites	9	Leverage existing sites to extent possible
Number of Channels per Site	6	Fire – 4, Sheriff's Office – 2
New Antenna Systems	18	Two per site, one VHF, one UHF
RF Site Networking Equipment	9	New routing / switching at each radio site
FCC licensing and coordination	54	Total of 6 channels at 9 simulcast sites
Network Management System		
Network Management Server	1	

Cost Assumptions	Quantity	Notes
Network Management Terminal	1	Can reside anywhere on network
Fault Management Server	1	Redundant / geographically separated
Fault Management Equipment	9	Needed at all of the simulcast sites
Dispatch Center Equipment		
Number of Logging Recorders	1	Replace with new IP-based recorders
New Dispatch Consoles	4	Replace with new IP-based consoles
Backup RF Control Station	4	One per operator position for backup
Control Station Antenna System	4	New cables, combiners, and antennas
Gateway Device	8	Interface for "other" base stations/repeaters
Networking Equipment	1	Redundant routing / switching equipment
Microwave Loop Equipment		
150Mbps Microwave Loop Radio	18	For high-capacity microwave sites
Service Router for IP/MPLS	9	Allows various interfaces at each site
Rack, Cabling and Accessories	9	Rectifier and batteries, -48VDC
48VDC Battery/Rectifier System	9	One per microwave radio site
Single Polarized Parabolic Antenna	18	One per microwave radio per site
EWP63-59W or EW90 Waveguide	18	One per microwave radio per site
Antenna / Waveguide Accessories	18	One per Waveguide per site
Dehydrator with Full Alarm Package	9	One per microwave radio site
FCC licensing and coordination	18	Total of all high capacity radios
Subscriber Equipment		
Fire Portables	387	Project 25 ready, analog operation
Fire Mobile	436	Project 25 ready, dash mount, analog operation
UHF Pagers	675	800 MHz P25 Phase 2 mobile radio
Sheriff's Office	0	Reuse existing subscribers
Site Improvements		
Tower Structural Analysis	9	Per Industry Best Practices, existing site
Existing Site Renovations	9	Assumed for misc. grounding/electrical improvements
New Prefabricated Shelter	3	Sites – Berkshire, Crown & Plexicomm
Generator/Transfer switch/fuel tank	3	Sites – Berkshire, Crown & Round Top
New Outdoor cabinets	2	Round Top – 2 cabinets
A&E, Environmental Compliance	11	Per Industry Best Practices
Implementation Services		
Spare / Test Equipment	10%	Based on total of all system components
Project Management	10%	Based on total of all system components
Installation	10%	Based on total of all system components
Engineering	10%	Based on total of all system components

Cost Assumptions	Quantity	Notes
Removal of Existing Equipment	2%	Based on total of all system components
Training	1%	Based on total of all system components
Staging	5%	Based on total of all system components
Acceptance/Coverage Testing	1%	Based on total of all system components
Documentation	1%	Based on total of all system components

5.2 Estimated System Summary Costs

Tables 11 shows the estimated costs for the County's Fire Services and Sheriff's UHF radio replacement system, including subscriber or user equipment. Note that there could be cost savings by reducing the number of Fire Services channels from four to two or three, as in discussions with the County, four countywide simulcast repeated fire channels may not necessary.

Table 11 – UHF Radio System Replacement Estimated Cost

UHF Simulcast System Cost Estimate	
Component	*Estimated Cost*
System Core Equipment	$202,000
Fire 4-Channel System	$3,430,000
Sheriff's Office System Expansion	$1,178,000
Dispatch System	$405,000
Microwave System	$900,000
Site Improvements	$942,000
Implementation Services	$3,673,000
System Subtotal	**$10,730,000**
Subscriber Equipment	$2,656,000
Total	**$13,386,000**

6. Next Steps

FE recommends that the County pursue the recommendations laid out in this Report via a competitive solicitation in the form of a request for proposals (RFP). All of the major system vendors have expressed interest in doing business with the County and by pursuing a competitive procurement, the County will be well positioned to acquire the best system for the lowest price.

Appendix A - Requirements Matrix

Provided in electronic attachment is Appendix A – *Requirements Matrix*

Tioga County, New York
Requirements Matrix

REQ ID	STAKEHOLDER	FUNCTION	TECHNICAL OR FUNCTIONAL REQUIREMENT	CRITICAL/ MANDATORY	HIGHLY DESIRABLE	DESIRABLE	UNIMPORTANT/ NOT NEEDED	Notes
COV-001	Fire, Sheriff, EMS	Coverage	The upgraded/replacement system shall provide mobile and portable outdoor radio coverage, and in-building portable coverage consistent with current standards and industry best practices, such as outdoor - 95% portable and mobile coverage of the geographically bounded County; 95% portable coverage of County area including in-buildings of 13 dB loss or less	X				
COV-002	Fire, Sheriff, EMS	Coverage	The upgraded/replacement system shall have improved voice coverage (currently poor voice coverage in Southwest and Northeast portions of County, especially in the Town of Barton (SW), Town of Richford (NE), and Southwest Corridor of County along State Route 34)	X				
COV-003	Fire, Sheriff, EMS	Coverage	The upgraded/replacement system shall have improved portable in-building coverage for VHF and UHF at 13 dB or less	X				
COV-004	Fire, EMS	Coverage	The upgraded/replacement system shall have improved paging coverage and be simulcasted to remove requirement for dispatchers to manually select/steer pages. Replacement paging system should be designed for reliable in-building paging coverage of 13 dB or less		X			
COV-005	Fire, Sheriff, EMS	Coverage	The upgraded/replacement system shall provide for portable coverage based on the portable transmitting and receiving while on the users hip (and use of speaker mics)	X				
COV-006	Fire, Sheriff	Coverage	The upgraded/replacement system shall provide improved portable radio coverage in schools	X				
COV-007	Fire, Sheriff	Coverage	The upgraded/replacement system shall provide improved portable radio coverage in Industrial Complexes and Stores, including Lockheed Martin (Owego), Best Buy (Nichols), Crown Beverage Packaging (South)			X		
CAP-001	Fire, EMS	Capacity	The upgraded/replacement system capacity shall be design to meet public safety standards Grade of Service (GoS = 1% or less) taking into account the current number of **Fire and EMS subscribers** and usage as well as system growth over the next ten years.	X				Initial upgrade/replacement is Fire/EMS focused
CAP-002	Fire, Sheriff, EMS	Capacity	The upgraded/replacement system capacity shall be design to meet public safety standards Grade of Service (GoS = 1% or less) taking into account the current number of **Fire, Sheriff, and EMS subscribers** and usage as well as system growth over the next ten years.			X		If sufficient channels available at UHF, consider Sheriff and local PD subscribers
RES-001	Fire, Sheriff, EMS	System Resilience	The upgraded/replacement system shall reflect industry best practices for maximizing system resilience (system availability) through use of a fault tolerant network topology to the greatest extent possible through a distributed architecture, or a centralized architecture with redundancy, and no single point of failure	X				
RES-002	Fire, Sheriff, EMS	System Resilience	The upgraded/replacement system shall reflect industry best practices for maximizing system resilience (system availability) such that when equipment failures occur, the upgraded/replacement system shall "degrade gracefully," and there shall be multiple levels of decreased functionality (i.e., based on what equipment fails)	X				

REQ ID	STAKEHOLDER	FUNCTION	TECHNICAL OR FUNCTIONAL REQUIREMENT	CRITICAL/ MANDATORY	HIGHLY DESIRABLE	DESIRABLE	UNIMPORTANT/ NOT NEEDED	Notes
RES-003	Fire, Sheriff, EMS	System Resilience	The upgraded/replacement system shall provide improved microwave performance, through ring-based loop topology and more reliable equipment	X				Existing configuration is point-to-point with little/no microwave redundancy
SPEC-001	Fire	Spectrum	The replacement system shall use the UHF spectrum for voice radio and paging		X			Low Band obsolesce and noise necessitates migration to higher bands
SPEC-002	Sheriff	Spectrum	The upgraded/replacement system shall use the VHF or UHF spectrum for voice radio		X			VHF spectrum-constrained
FEA-001	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall utilize analog simulcast conventional technology (conventional analog FM)		X			
FEA-002	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall utilize digital simulcast conventional technology			X		Mixed-mode operations supported?
FEA-003	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall utilize trunking technology				X	Required for many subscriber features
FEA-004	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall support conventional P25 Phase 1 operations	X				NYS grant requirements mandate infrastructure and subscribers be purchased with Phase 1 options
FEA-005	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall support P25 Phase 2 operations				X	
FEA-006	Fire, EMS	System Features	The upgraded/replacement system shall provide two-tone sequential voice paging	X				
FEA-007	Fire, EMS	System Features	The upgraded/replacement system shall operate in simulcast mode to eliminate dispatcher steering and minimize store-and-forwarding	X				
FEA-008	Fire, EMS	System Features	The upgraded/replacement system shall provide tone and voice alerting for individual on hip pagers, fire station alerting receivers, siren/horn activation, and KNOX-BOX® key access	X				
FEA-009	Fire, EMS	System Features	The upgraded/replacement system shall support digital text paging	X				Dispatch/CAD-user
FEA-010	Sheriff	System Features	The upgraded/replacement system shall support Voice Encryption (256-AES as a minimum) for law enforcement			X		Operation mode dependent
FEA-011	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall record designated radio channels and telephone lines with 25% future growth	X				Existing Verint Audiolog using 55/64 channels to record radio traffic, 9-1-1 lines, and administrative lines. Likely not compatible with digital nor P25 without upgrades
FEA-012	Fire, Sheriff	System Features	The upgraded/replacement system shall provide for subscriber unit ID and number display at dispatch consoles		X			
FEA-013	Fire, Sheriff, EMS	System Features	As part of the upgraded/replacement system project, all remote sites and the PSB shall undergo an electrical grounding audit and upgrades	X				Significant grounding deficiencies noted at PSB and remote sites
FEA-014	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall provide for site equipment monitoring and alarms and standby/backup power (UPS/battery/generator)	X				No UPS/backup power between utility and generator power
FEA-015	Fire, Sheriff, EMS	System Features	The upgraded/replacement system shall support remote radio disabling		X			Requires trunking

Tioga County, New York
Requirements Matrix

REQ ID	STAKEHOLDER	FUNCTION	TECHNICAL OR FUNCTIONAL REQUIREMENT	CRITICAL/ MANDATORY	HIGHLY DESIRABLE	DESIRABLE	UNIMPORTANT/ NOT NEEDED	Notes
FEA-016	Sheriff	System Features	The upgraded/replacement system shall support status alert function for mobile radios	X				Fire/Dispatch awareness
DIS-001	Fire, Sheriff, EMS	Dispatch Equipment	The upgraded/replacement system shall provide dispatch consoles to support additional system features	X				
DIS-002	Fire, Sheriff, EMS	Dispatch Equipment	The upgraded/replacement system shall be provided with a console backup system to allow continuity of operations in the event of console failure	X				
DIS-003	Fire, Sheriff, EMS	Dispatch Equipment	The upgraded/replacement system shall provide upgrades or a new logging recorder for the radio/911/CAD systems			X		Depends on cost to upgrade Verint Audio Log and NG-capabilities
DIS-004	Fire, Sheriff, EMS	Dispatch Equipment	The County shall explore new CAD and RMS systems			X		Dispatchers noted issues with CAD and RMS functionality and performance. Although not part of the radio project, this item noted for consideration
DIS-005	Fire, Sheriff, EMS	Dispatch Equipment	Windows XP software shall be upgraded on PCs for existing Intergraph CAD system	X				PCs supporting Intergraph are running Windows XP. County to confirm with vendor about compatibility
DIS-006	Fire, Sheriff, EMS	Dispatch Equipment	The upgraded/replacement console system shall support RF and wireline control	X				Existing configuration
DIS-007	Fire, Sheriff, EMS	Dispatch Equipment	The upgraded/replacement console system shall support replacement paging system	X				Migrate from manually-steered to simulcast
GEN-001	Fire, Sheriff, EMS	General	The upgraded/replacement system shall maintain the ease-of-use users experience with the existing system	X				All users reported that the existing system is very easy to use
INT-001	Fire, Sheriff, EMS	Interoperability	The upgraded/replacement system shall provide interoperable communications between Fire and DPW and Sheriff and DPW	X				Options: Console patching; VHF/UHF interop patching
INT-002	Fire, Sheriff	Interoperability	The upgraded/replacement system shall maintain current interoperability links between Fire Services and Law Enforcement Services Intra- and- Inter County (notably Broome and Chemung), and State agencies	X				
INT-003	Fire, Sheriff	Interoperability	The upgraded/replacement system support the existing VHF, UHF, and 800 MHz Interoperability Channels	X				
MAI-001	Fire, Sheriff, EMS	Maintenance	The upgraded/replacement system shall have ongoing maintenance, ideally provided by one vendor. If a replacement system is procured a 3-year warranty is recommended.		X			Currently, there is no routine/planned maintenance program for any users
MAI-002	Fire, Sheriff, EMS	Maintenance	The upgraded/replacement system shall provide for a network management system (fault monitoring, performance reporting, configuration management, security management, and reporting)	X				
SUB-001	Fire, Sheriff, EMS	Subscriber Equipment	Upgraded/replacement subscribers shall retain the direct-mode (simplex) ability	X				
SUB-002	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement subscribers shall be provided speaker microphones for all mobiles and portables	X				
SUB-003	Fire	Subscriber Equipment	The upgraded/replacement subscriber mobiles shall provide for specific vehicles to have dual head radio units (two control heads operating one radio)		X			1/3 remote mounts 2/3 dash mounts

Tioga County, New York

Requirements Matrix

REQ ID	STAKEHOLDER	FUNCTION	TECHNICAL OR FUNCTIONAL REQUIREMENT	CRITICAL/ MANDATORY	HIGHLY DESIRABLE	DESIRABLE	UNIMPORTANT/ NOT NEEDED	Notes
SUB-004	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement mobile subscribers shall provide for specific vehicles to have two radio units				X	
SUB-005	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement system shall provide for the replacement of subscriber equipment that is at end of life, and where vendor support will be terminated soon with equipment that is not at end of life (or planned for discontinuance)	X				
SUB-006	Sheriff	Subscriber Equipment	The upgraded/replacement subscriber equipment shall support Voice Encryption (256-AES as a minimum)			X		
SUB-007	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement subscriber equipment shall support Emergency Alarms	X				
SUB-008	Fire, Sheriff, EMS	Subscriber Equipment	Some subscriber equipment shall have multiband capability/ interoperability features	X				Mike to provide breakout of dual/multi-band radios for pricing NLT 10/19/18
SUB-009	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement subscribers shall provide for channel scanning (programmable scanning)	X				
SUB-010	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement subscribers shall provide for the assignment of priority access by user type			X		
SUB-011	Fire	Subscriber Equipment	Some subscriber portable radio equipment shall be intrinsically safe rated, as an option			X		
SUB-012	Fire	Subscriber Equipment	The subscriber portable radio equipment shall be water resistant or waterproof		X			
SUB-013	Fire, Sheriff, EMS	Subscriber Equipment	The subscriber portable and mobile radio equipment shall have a display				X	
SUB-014	Fire, Sheriff, EMS	Subscriber Equipment	The subscriber portable and mobile radio equipment shall be provided with a partial or full keypad, as required by user type				X	
SUB-015	Fire, Sheriff, EMS	Subscriber Equipment	The subscriber portable radio units provided shall have appropriate accessories (speaker mics, single and multiple unit chargers, Bluetooth, standard and high-capacity batteries, etc.)	X				
SUB-016	Fire, Sheriff, EMS	Subscriber Equipment	The subscriber mobile radio units provided shall have appropriate accessories (external speakers, dual-head control units, antennas, etc.)	X				1/3 remote mounts external speaker
SUB-017	Sheriff	Subscriber Equipment	Sheriff portable units shall be Bluetooth capable and equipped with Bluetooth earpieces		X			
SUB-018	Fire, Sheriff, EMS	Subscriber Equipment	The upgraded/replacement subscriber equipment shall include conventional P25 Phase 1 operations set at time of purchase	X				NYS grant requirements mandate infrastructure and subscribers be purchased with Phase 1 options
TRA-001	Fire, Sheriff, EMS	Training	The upgraded/replacement system vendor shall provide training: technical and system administration, fleetmapping, profile and subscriber program development, console configuration, installation, and equipment maintenance; operator training for consoles, portables, and mobiles. Classroom, instructor lead technical training, onsite fleetmapping/program development; onsite train-the-trainer operational	X				

Tioga County, New York
Requirements Matrix

REQ ID	STAKEHOLDER	FUNCTION	TECHNICAL OR FUNCTIONAL REQUIREMENT	CRITICAL/ MANDATORY	HIGHLY DESIRABLE	DESIRABLE	UNIMPORTANT/ NOT NEEDED	Notes
USER-001	Fire, Sheriff, EMS	Users	The upgraded/replacement system shall support Fire, Sheriff, and EMS users	X				Sheriff will likely remain on VHF system for foreseeable future, but consoles will be replaced and support their communication

P25 PHASE 1 & PHASE 2 REQUIREMENT MATRIX

	Radio System Type	Must I Purchase Infrastructure Equipment with P25 Phase 1 Options?	Must I Purchase Subscriber Equipment with P25 Phase 1 Options?	Must I Purchase Infrastructure Equipment with P25 Phase 2 Options?	Must I Purchase Subscriber Equipment with P25 Phase 2 Options? *
NEW RADIO SYSTEM[1]	Analog - Conventional	Yes	Yes	No	No*
	Analog - Trunked	Yes	Yes	Yes**	Yes**
	Digital – Conventional	Yes	Yes	No	No*
	Digital - Trunked	Yes	Yes	Yes**	Yes**
IMPROVING EXISTING RADIO SYSTEM	Analog - Conventional	Yes	Yes	No	No*
	Analog - Trunked	Yes	Yes	No	Yes
	Digital – Conventional	Yes	Yes	No	No*
	Digital - Trunked	Yes	Yes	No	Yes

Note: *If Subscriber Equipment to be purchased with the Round 4 Grant will operate on a trunked radio system (e.g. currently, planned or via mutual aid), the new Subscriber Equipment must support P25 Phase 2 as delivered (no further upgrades required).

Note: ** Systems can be deployed as Phase 1 or Phase 2, depending on the county's need for compatibility with existing equipment and frequency use.