RADIO SYSTEM ASSESSMENT & RECOMMENDATIONS REPORT

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INTRODUCTION

Boone County, Kentucky, (County) has a population of 127,712 as of July 2015, and covers a geographic area of 256 square miles. The County is part of the Cincinnati-Middletown, Ohio-Kentucky-Indiana Metropolitan Statistical Area.

The Boone County Public Safety Communications Center (PSCC) operates a Public Safety radio communications system using VHF and UHF conventional analog networks. The UHF police radio system uses 3 channels that are simulcasted throughout the County (SIMULtaneous broadCAST = transmissions made from multiple sites on the same frequency at the same time). This system supports the County Sheriff and the Florence Police Department. The VHF fire radio system uses 2 channels that are simulcasted throughout the County; this system serves 9 fire departments within the County. The PD and FD systems share the same four (4) primary tower sites. Two remote receive-only sites provide improved portable radio talk-back coverage. The simulcast radio network is interconnected with an Alcatel-Lucent OC3 microwave network, utilizing a total of six (6) sites, two of which are microwave-only sites (“hops”).

Cincinnati/Northern Kentucky International Airport (CVG) is located in the County. The Airport is currently undergoing a conversion from its Harris EDACS system to a Harris 800 MHz P25 system (P25 is a digital radio system standard that has been adopted by public safety agencies in the U.S.). Kenton County, to the east of Boone County, and Campbell County, Kenton’s neighbor to the east, are both considering radio system upgrades. Boone County shares borders with the State of Ohio which operates a statewide 800 MHz Motorola Smartnet/Smartzone system (“MARCS”) that is currently undergoing a conversion to P25 digital, and the State of Indiana which also operates a statewide 800 MHz Motorola radio system that is transitioning to a P25 platform (“Hoosier Safe-T”).

In November of 2015 the County published a Request for Proposals (RFP) seeking respondents to help the Boone County Public Safety Communications Steering Committee and Boone County Fiscal Court to understand the status and viability of the current VHF and UHF public safety communications systems, and to serve as a guide to support long-range policy decisions. In February, 2016, the County retained Tusa Consulting Services (TUSA) to address the RFP’s Needs Analysis and Design Consultation tasks.

As required by the County’s RFP, TUSA will assess the current radio system and explore four (4) upgrade options:
1. County-owned system (upgrade existing VHF/UHF, or 800 MHz P25)
2. Join Airport system (Harris P25 800 MHz system)
3. Join MARCS (Ohio Motorola P25 800 MHz statewide radio system)
4. Regional system with neighboring Kentucky counties
1.0 NEEDS ANALYSIS

A radio system “needs analysis” begins with an assessment of how a legacy system works and how the users perceive it to work. Once the current system is understood, a review of what capabilities and features the users would like to have follows. This ranges from improved portable radio coverage to the ability to receive text messages on their portable radios.

When conducting radio system assessments, the following issues are often encountered:

- Portable coverage is unsatisfactory
- Channel capacity is limited
- Interoperability is limited
- Features are limited
- Existing system technology might be reaching end-of-life
- Dispatch centers need to be upgraded
- Neighboring system configurations are changing
- Narrowbanding impacted system coverage (for conventional VHF/UHF)

The following summarizes the Boone County system user interviews, system infrastructure inspection, and coverage analysis.

1.1 Questionnaires

Prior to interviewing users and inspecting the radio system, a TCS Radio System Questionnaire was distributed to the user community. The Questionnaire is used to solicit system use and performance information from the user community; it also asks for details about the user’s equipment and perception of system operation. The Questionnaire specifically requests that the users identify any areas that might not be providing satisfactory service.

Questionnaires were received from the following agencies:

- Hebron FD
- Boone County Emergency Management
- Walton Fire Protection District
- Burlington Fire Protection District
- Florence FD/EMS
- Boone County Animal Control
- Florence PD
- Union FD
- Boone County Sheriff’s Office
- Point Pleasant Fire District
In general, the respondents reported that the FCC’s mandated Narrowbanding had an impact on the overall County-wide system; central and western County coverage is inadequate (the Oakbrook area was specifically mentioned); and, all agencies mentioned that in-building coverage was further degraded by narrowbanding. (The fire departments all mentioned in-building coverage as being a challenge - VHF signals do not penetrate buildings well.)

The following matrix summarizes the Questionnaire replies:

<table>
<thead>
<tr>
<th>Agency</th>
<th>System performance issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Hebron Fire/EMS</td>
<td>in-building coverage – need to communicate with PD</td>
</tr>
<tr>
<td>2 Boone County EMA</td>
<td>Oakbrook – Zig Zag Rd. - buildings list provided</td>
</tr>
<tr>
<td>3 Boone County EMA</td>
<td>some NB degradation - Oakbrook - test list provided</td>
</tr>
<tr>
<td>4 Walton FPD</td>
<td>NB lower audio - list of problem areas</td>
</tr>
<tr>
<td>5 Walton FPD</td>
<td>in-building coverage issues</td>
</tr>
<tr>
<td>6 Burlington FPD</td>
<td>NB impacted rural areas and buildings - list of buildings</td>
</tr>
<tr>
<td>7 Florence Fire/EMS</td>
<td>good city coverage, but in-building issues</td>
</tr>
<tr>
<td>8 Florence PD</td>
<td>good city coverage, but in-building issues - listed</td>
</tr>
<tr>
<td>9 Union FD</td>
<td>in-building issues, list provided</td>
</tr>
<tr>
<td>10 Boone County Sheriff</td>
<td>limited portable coverage along the river, in schools</td>
</tr>
<tr>
<td>11 Point Pleasant FPD</td>
<td>In-building coverage, commercial/industrial areas</td>
</tr>
</tbody>
</table>

(“NB” = narrowbanding)

Respondents provided the following radio equipment inventory information; VHF and UHF user radio equipment consists of:

- Kenwood 5220 portables and portables, 7150 mobiles, TK290 portables, and 701/702/715/726 mobiles;

- Motorola HT750/1250 portables, CDM1250 and XTL1500 mobiles, PM1500 base units, Minitor V and Unication pagers

- Motorola XPR (800 MHz MotoTRBO) digital radios (school buses).

All equipment is reported to be in fair to good condition. The current inventory consists of approximately 800 radios.
1.2 Sites

The VHF/UHF simulcast radio systems share the same four (4) main tower sites, supported by two (2) receive-only sites.

Primary FCC licenses (dispatch channels):

| Police    | RCN200 | 458.700 MHz |
| Fire      | KVV804 | 155.865 MHz |

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Type</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Height (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florence</td>
<td>Repeater</td>
<td>38 59 55.2</td>
<td>84 38 36.8</td>
<td>135</td>
</tr>
<tr>
<td>Francisville</td>
<td>Repeater</td>
<td>39 07 19.0</td>
<td>84 44 26.0</td>
<td>150</td>
</tr>
<tr>
<td>Beaverlick</td>
<td>Repeater</td>
<td>38 52 06.3</td>
<td>84 42 10.9</td>
<td>200</td>
</tr>
<tr>
<td>Walton</td>
<td>Repeater</td>
<td>39 00 19.2</td>
<td>84 47 20.8</td>
<td>180</td>
</tr>
<tr>
<td>Mt. Echo</td>
<td>Receive</td>
<td>39 05 29.0</td>
<td>84 33 59.0</td>
<td>150</td>
</tr>
<tr>
<td>Clarion WT</td>
<td>Receive</td>
<td>38 51 59.0</td>
<td>84 37 29.0</td>
<td>120</td>
</tr>
</tbody>
</table>

Several other sites support backup/tactical/mutual aid repeaters.

The following is a diagram of the current system, showing the relative positions of the primary sites within the County and the microwave “loop” system. The two remote receiver sites are connected to the PSCC via telephone lines. Mt. Echo and Clarion WT (Walton) are both use by Fire (VHF); Clarion WT is also used by PD (UHF).
CURRENT VHF/UHF SIMULCAST RADIO SYSTEM
With MICROWAVE PATHS

= VHF/UHF Primary Repeater Sites  = microwave-only sites
= remote receivers

TUSA CONSULTING SERVICES
1.3 Coverage Analysis

Today’s public safety radio systems are expected to provide coverage to a portable radio worn on the hip; the portable radio is the first responder’s lifeline. System configurations can vary depending upon the types of areas being served (rural, suburban, urban), and the radio frequency band being used. It is typical to base the design upon the use of a portable radio within a certain type of building structure. Depending upon the type of building (residential, strip mall, school, warehouse, hospital, etc.), a radio signal can experience attenuation (“loss”) as a user moves into and throughout a structure. These losses are accounted for in the analysis of current system performance and when developing new system designs. For example, it would be expected that greater in-building losses are experienced in the northeast quadrant of the County than in the rural western part of the County.

Radio Frequency Band Characteristics

The VHF band (150-174 MHz) provides wide area coverage, but is susceptible to atmospheric conditions, electrical noise, and co-channel interference; this frequency range does not penetrate buildings well. The VHF band does not have a consistent “band plan” that separates the transmit and receive channels for efficient repeater use, making it difficult to design multi-channel sites. The VHF band was established for commercial communications post-WWII and at that time all communications was on “simplex” channels: a single frequency was used for transmit and receive (similar to today’s “mutual aid channels”). When repeaters were initially developed, transmit and receive frequencies were randomly assigned, leading to today’s inconsistent VHF band plan.

The UHF band (450-470 MHz) has a shorter coverage range than VHF, but has a consistent band plan (5 MHz split between transmit and receive frequencies), and provides reasonable in-building signal penetration. UHF signals are able to “bounce” between and within structures, making UHF the traditionally-preferred urban frequency band (for example, UHF systems are used in Boston, New York City, Chicago, and Los Angeles – as an example, the New York City Police Department’s UHF radio system is comprised of 200 repeaters and more than 400 remote receivers). The UHF band became available for widespread use in the 1950’s.

- Both the VHF and UHF bands are typically talk-back limited. A portable radio operates at low transmitter power and has an inefficient antenna; it is usually no more than 6 ft. off the ground – more often only 3 ft. off the ground when worn on a belt. Due to these characteristics, a portable radio user’s range is a lot less than that of a mobile radio user. While a portable might hear a base station at a distance, the base station might not hear the portable. This “unbalance” is inherent in VHF and UHF systems.

The following illustrates the VHF and UHF talk-in and talk-out balance issue.
VHF or UHF mobile radios can hear and be heard in a relatively balanced manner. A VHF or UHF portable radio has to be closer to the base station/repeater to hear and be heard.

Remote receivers can provide improved portable talk-back range, but they must be placed in an area where the portable can still hear the base station. Remote receivers are linked to the repeater via telephone lines or microwave. A “voter” at the repeater selects the best-received signal from the receivers for retransmission. Remote receivers in the VHF or UHF bands can be susceptible to distant co-channel interference.
The 800 MHz band, which began to be used commercially in the 1970’s, has similar signal propagation characteristics as the UHF band, with even better in-building penetration capability; and, it has a consistent band plan (45 MHz split between transmit and receive frequencies). The 800 MHz band has been better managed by the FCC since its introduction, meaning assigned frequencies are much less prone to interference. The 700 MHz band is similar to the 800 MHz band, except that the FCC requires the use of P25 digital technology within the public safety allotment within the band.

P25 is a “common air interface” digital technology that has been adopted as the public safety communications standard for the United States; P25 is used by all Federal radio systems. P25 provides a modern feature set that provides for unit ID and emergency ID, private calling (radio to radio), encryption, and seamless interoperability between different-vendor P25 systems, amongst many other features. Any vendor’s portable or mobile radio that is certified to comply with the P25 standard can work on any vendor’s system. P25 Phase II systems can accommodate two simultaneous voice calls on one 12.5 KHz radio channel. P25 systems began to be deployed in the early 2000’s.

Another benefit of the 700/800 MHz radio frequency band is that systems can be designed that are “balanced”; this means a system’s “talk-out” range from the transmitter site to a portable can essentially equal a portable radio’s “talk-back” range to the transmitter site. This is done by means of utilizing high-gain “tower top amplifiers”, or “TTA’s”, that amplify the signal received from the portable user. TTA’s cannot be practically used at VHF or UHF.

A balanced 800 MHz system. The portable and mobile radios have equivalent talk-in/talk-out range.
The following coverage maps provide a graphic view of how the County’s VHF and UHF systems perform; the imbalance between talk-out from the base stations and talk-in from a portable is evident.

The coverage analysis is based upon information from the FCC licensing database. Site locations, antenna heights and transmit output power (Effective Radiated Power – ERP) are used to calculate each sites’ coverage characteristics. Primary focus is placed on performance of the four main tower sites. The targeted user is a portable radio, worn on the hip, “on street”.

The maps were developed using Comsite™, a specialized radio signal propagation software that is used nationwide by many consulting and engineering firms. The signal levels are calculated in “dBm”, which is “Decibels referenced to a milliwatt”. (The “bel” in the word Decibel is from Alexander Graham Bell, the inventor of the telephone and also a renowned audiologist. When the word Decibel is used by itself, it refers to signal power levels measured in reference to each other.) A milliwatt is a measure of a transmitted radio signal. The signal level ranges are in negative numbers, the larger the number, the weaker the signal. A -90 (“minus 90”) dBm signal at a portable radio delivers a noise-free, easily-understood signal. Portable radios can hear signals down to -116 dBm; however, a signal at this level is just about inaudible. A mobile radio can “hear” a weaker signal at the -100 dBm level because a mobile radio has a much more efficient antenna.

GREEN is equivalent to a signal delivered to or from a portable radio. YELLOW is equivalent to a signal delivered to or from a mobile radio.
VHF TALK-OUT TO A PORTABLE
GREEN = portable coverage @ -90 dBm
YELLOW = portable coverage @ -100 dBm
(Clarion Water Tower and Mt. Echo are receive-only sites)
VHF TALK-IN FROM A PORTABLE
GREEN = Portable coverage at the base station @ -90 dBm
UHF TALK-OUT TO A PORTABLE
GREEN = Portable coverage @ -90 dBm
(Clarion and Mt. Echo are receive-only sites)
UHF TALK-IN FROM A PORTABLE
GREEN = portable signal at the base station @ -90dBm
1.4 Coverage Map Analysis- Current VHF and UHF Systems

Talk-out -- base station-to-portable radio:

As mentioned previously, the VHF and UHF bands have different performance characteristics: VHF can cover further from a given site, but does not “fill” varying terrain or penetrate buildings well; UHF covers less as compared to VHF due to its shorter wavelength, but provides more terrain fill-in and in-building signal penetration. VHF signals can be shadowed by hills and river valleys. UHF signals tend to bounce (known as “multi-pathing”) and fill in varying terrain while VHF “skips over” the terrain. In the case of the Boone County sites, the VHF and UHF sites are operating at medium power output levels, providing a limited “signal footprint”. This is attributable to FCC licensing limitations based upon reuse of the same frequencies (“co-channel”) in adjoining counties.

Talk-back – portable-to-base station:

The low power, low height, and inefficient antenna of a portable radio limits the talk-back range on both bands. River valleys and varying ground elevations further impact the ability of the repeater to hear the portable and vice versa.

The two receive-only sites are located in Walton (Clarion), used by both law enforcement and fire, and Mt. Echo (in Ohio) used by fire. Receive-only sites are used to offset some of the system talk-back imbalance. But, if not properly placed, it’s possible a portable can be heard from areas where it cannot hear the base station. Receive-only sites have to be carefully designed; if they are at high elevations on the edge of a service area, co-channel signals from other counties/states might be heard better than in-County signals. There is a point where too many remote receive sites could negatively impact system performance, even though it appears they would contribute to a better balanced system.

1.5 System Inspection

TUSA visited all Boone County radio system sites during the week of April 4, 2016.

Boone County Public Safety Communications Center (PSCC) – the PSCC dispatches all agencies in the County. The centralized facility utilizes five (5) Motorola Gold Elite radio consoles to access the VHF and UHF simulcast radio system and various mutual aid radios. A ZETRON paging terminal is used to back-up the Gold Elite paging capability. All equipment is in good condition, including the “backroom” Motorola Central Electronics Bank (CEB) and other radio-related equipment. The PSCC is connected to the Florence tower, across the street at the Public Works facility, by a 100-pair “copper” telephone-type cable and a Motorola Canopy™ microwave link. It is reported that the 100-pair cable has several “bad pairs” which would indicate that it probably is being impacted by moisture. It is recommended
that the 100-pair cable be "engineered out" of a future system design, replaced by fiber or microwave.

The Motorola Gold Elite consoles, SpectraTAC voters, the Central Electronics Bank, and several other pieces of radio system equipment at the PSCC are in the "manufacturer discontinued" category. Motorola no longer provides spare parts or software support for this equipment.

**Tower Sites** – Sites visited: Florence, Beaverlick, Lassing Point (cellular tower with top space “reserved for County use” but not currently used), John Walton, Conrad (County Jail) microwave site, Hebron microwave site, and Francisville. All sites are in generally good condition; all radio equipment is clean and all cabling is firmly bundled and attached to appropriate racking. Lightning protection grounding is adequate and appears to comply with the Motorola “R56” installation standard. All sites, except for Francisville, appear to have adequate space for additional equipment.

All towers appear to be structurally sound and have adequate space for additional antennas. The Florence/PSCC tower appears to be at its limit for antennas (see below). A vendor-provided structural analysis of each tower would be required as part of a new-system RFP.
The Law Enforcement UHF repeaters are Motorola QUANTAR’s, which have been designated “manufacturer-discontinued” as of 2018. While these radios have been reliable workhorses for many years, they are known to have power supply issues.

The Fire Department VHF repeaters are current-production Motorola GTR8000’s which are capable of operating in the P25 digital mode with a software upgrade.

**Boone County Schools Transportation**

The County’s school bus system utilizes an 800 MHz “Digital Mobile Radio” (DMR) Motorola MotoTRBO™ radio system for bus communications, text messaging, and GPS location data. DMR systems are popular with commercial fleet operators, hospitals, large office/school campuses, and similar operations. These systems utilize a “6.25 KHz equivalent” digital architecture which allows for two simultaneous voice calls on a single 12.5 KHz radio channel.

A single 800 MHz transmitter site located at the John Walton tower supports the bus system. This site provides satisfactory coverage to more than 200 buses (mobile radios) throughout the entire County; few portable radios are used due to the lack of County-wide portable coverage from the one site.

**1.6 Meeting with User Agency Representatives**

TUSA attended meetings with the following agencies during the week of April 4, 2016:

- Burlington Fire District
- Florence Police Department
- Florence Fire District
- Boone County Public Works
- Florence Public Services
- Boone County Schools Transportation
- Union Fire District
- Walton Fire District
- Boone County Administration
- Boone County Water District
- Boone County Emergency Management
- Point Pleasant Fire District

Additionally, meetings were held with representatives from Kenton County, Campbell County, and Dearborn County, IN.

**Users**

The primary reason for meeting with the County’s radio system users is to review the results of the Questionnaires, discuss system performance, and to validate the accuracy of the TUSA coverage maps (all user agencies acknowledged that the maps were accurate). Further discussions were had regarding user requirements; in general, the need for improved County-wide coverage and in-building portable coverage reported in the Questionnaires was reinforced.
Partnerships

Agencies not currently using the County’s VHF or UHF radio systems have shown interest in becoming part of an integrated county-wide radio network.

The County public services agencies indicated there was an interest in a radio-based GPS/data system for vehicle telemetry (location, snowplow up/down, engine temperature, etc.). This requirement could be met by the addition of a data-only channel to a new 800 MHz P25 system. While the data rate would not approach that of the cellular carriers, it would be sufficient for a GPS/telemetry type of application.

The County’s school bus transportation agency’s Motorola 800 MHz MotoTRBO DMR digital radio system could be integrated into a county-wide network by means of system patching. DMR (Digital Mobile Radio) systems are not directly compatible with the public safety digital P25 standard; however, P25 console systems can allow those technologies to be interconnected by means of system patching capability.

Other organizations that might not currently utilize radio systems (such as Code Enforcement officers, or Health Department personnel) would benefit from a county-wide network, not only to support their own operations but to also allow Emergency Management resources to direct their activities during widespread emergencies.

Regional Discussions

A joint meeting with Dispatch Center representatives from Boone County, Kenton County, and Campbell County explored the concept of a tri-county regional 800 MHz P25 network. Both Kenton and Campbell counties are currently considering radio system upgrades. A unified approach to the counties’ radio system upgrades could result in a seamless, wide-area radio network.

TUSA also had an opportunity to meet with the 911 Director from Dearborn County, IN. Dearborn utilizes the State of Indiana’s “Hoosier Safe-T” statewide system; this Motorola Smartnet/Smartzone system is currently migrating to a P25 platform. The State of Ohio is migrating its 800 MHz system to P25 and the City of Cincinnati is in the process to transitioning to the Ohio state P25 system (MARCS).

Future Technology

The federal government is sponsoring an initiative to develop a Country-wide 700 MHz broadband public safety network based upon LTE (Long Term Evolution) cellular technology. This effort is being managed by “FirstNET”, which has been given the task of seeking out a single entity that would build this network. FirstNET released an RFP recently and is currently in the process of providing responses to RFP questions to interested vendors. LTE will be a data-centric “smartphone” network that would be dedicated to public safety users, thus eliminating the access
contention and potential service interruptions that come with trying to conduct public safety business on commercial cellular systems. (Many public safety agencies utilize cellular due to the deficiencies of their own systems in regards to portable radio performance and because of its inherent “privacy”. However, their calls have no more priority on the public cellular network that a teenager who is texting to friends, or playing on-line games. Most commercial cellular systems do not have extensive backup power systems or redundant interconnectivity networks. During major incidents, severe weather, man-made disasters, etc., cellular networks can “block”, denying service to callers.}

It is expected that LTE will not be available for many years. And, it will initially be a “data only” service used for broadband applications such as texting, video, high speed data transfer, and so on. MCPTT, Mission Critical Push-To-Talk, is being developed, but will not be available when the first LTE systems are deployed. Many new-system P25 public safety voice systems designs are considering the “backbone” needs of LTE and especially in regards to the implementation of high-capacity microwave networks.

Several LTE “trials” have been conducted across the Country. Many of them use standard commercial LTE cellular equipment coupled with public-safety-specific “apps” for the subscriber units. Ruggedized “smartphones” are being considered for this service.

A typical LTE “microcell”. LTE systems require hundreds of sites to service metropolitan areas.
2.0 SYSTEM IMPROVEMENT OPTIONS

2.1 Develop system improvement recommendations: upgrade of VHF system, transition to digital technology, etc.

The County has indicated that it wishes to explore the following four (4) options:

1. County-owned system (upgrade existing VHF/UHF, or 800 MHz P25)
2. Join Airport system
3. Join MARCS
4. Regional system

Design Philosophy

It is important to state, upfront, that any of the four above options will require adding tower sites to provide an acceptable, public-safety-grade radio system. No matter what the final system configuration or technology might be, Coverage is King!

Dispatch Center

All radio-related dispatch equipment at the PSCC has to be replaced. Aside from the radio dispatch terminals themselves (PC's), the other equipment will be dependent upon the final system configuration (voters, backup radios, etc.). Radio dispatch terminals cost from $40,000 to $80,000, depending upon the vendor selected.

Subscriber Equipment

The following system Options and estimated budgetary costs do not include subscriber equipment costs (portables, mobiles, control stations). If the County elects to enhance its conventional analog VHF and UHF systems, the current subscriber equipment could continue to be used. As this equipment is replaced (“wear and tear”), new equipment should be capable of digital operation on the most-appropriate radio band. If the County transitions to a P25 digital system, on any band, new equipment would be required.

There are six (6) subscriber equipment vendors offering P25 portables and mobiles that have been certified through the industry’s Compliance Acceptance Program (CAP). Competition has been driving the cost of P25 subscriber equipment downward. P25 radio costs range from just under $1,000 to over $5,000. Radios are available that provide “basic” features suitable for public service agencies, all the way through units that support multi-band operations, LTE and Wi-Fi. All available P25 equipment meets applicable MIL-standards for ruggedness and have varying levels of waterproof/water resistant capabilities.
OPTION #1 - County-Owned System

This Option will consider:

1a. - upgrade of the current VHF/UHF system
1b. - entirely new County-wide 800 MHz P25 digital system

Option 1a  Countywide VHF/UHF Upgrade

Coverage analysis for the current VHF/UHF simulcast system shows reasonable mobile coverage from the north, along the eastern border, and to the south; however, central and western coverage is poor; as expected, VHF talk-out is better than UHF talk-out. Portable coverage is generally less than acceptable, unless the user is within several miles of a repeater or remote receiver site.

Conceptual Upgrade of Current VHF System

The current VHF system has talk-in issues in the northwest and central/western parts of the County. It is estimated that, at a minimum, two additional receive-only sites would improve “on street” talk-in from the western border of the County, especially along the river valley. The sites would connect to the system via microwave, as shown.

This map can be compared with the map on Page 12 of this report.
Improved VHF talk-in with two additional receive-only sites = ⭐️
**Conceptual Upgrade of Current UHF System**

The UHF system is used by the Florence PD and the County Sheriff. The Florence PD requires improved in-building performance; the Sheriff's Department requires improved overall County-wide coverage, as well as improved in-building coverage in schools.

Improving UHF system performance would be more complex than the VHF upgrade due to the UHF band’s shorter wavelength and reduced coverage range. In order to fill in the areas not covered by the existing 4-site UHF simulcast system, more repeater sites would be required. Current FCC licensing of the existing sites has to be considered in developing an improved UHF system, therefore each new site’s transmitter power has to be assumed to be roughly the same as current sites.

A high-level design, considering terrain challenges and potentially available tower sites (including the deployment of one new tower site), estimates 12 UHF simulcast sites would be needed, with an additional receiver-only site (the current Mt. Echo site in Ohio). This would result in a 13-site voted receiver system. The 12-site system would provide approximately 80% portable “on-street” coverage across the County. However, it can be seen that there are still low-lying terrain issues in the western part of the County that will impact overall performance in those areas.

The entire system would be interconnected via microwave.
12-site UHF talk-out
Boone County Fiscal Court - Radio System Assessment & Recommendations

13-site UHF talk-back
Budgetary Estimate – Option #1a – Improved VHF and UHF Systems

The following pricing estimates assume the new VHF and UHF equipment will be digital-ready. It is also assumed the VHF equipment would be purchased from Motorola to remain compatible with current Fire GTR8000 equipment.

It is estimated that upgrading the VHF and UHF systems as described could cost from $500,000 to over $5,000,000, depending upon the desired system capabilities. The more equipment used, the more sites are needed. The more sites needed, the more the need for shelters, generators, microwave paths, potential new towers, and related construction costs.

The “Next Narrowbanding” Mandate

An issue to consider when pursuing upgrades to VHF or UHF systems is that the FCC will eventually be requiring another “narrowband” transition from today’s 12.5 KHz channel bandwidth to a 6.25 KHz bandwidth. Current analog FM radio technology cannot support a 6.25 KHz bandwidth channel due to many technical factors such as stability, FM deviation/capture, etc. This means a VHF or UHF transition to 6.25 KHz will require the use of “digital” technology. The P25 Phase II feature provides two talk paths in a 12.5 KHz bandwidth and it would meet the FCC’s requirement for the next round of VHF/UHF narrowbanding (this is known as a “6.25 KHz equivalent” technology). Any upgrade to the current VHF/UHF systems would have to consider an eventual “digital” upgrade.

VHF/UHF P25 Challenges

Transitioning to a P25 Phase II system at VHF/UHF would address the “future narrowbanding” issue; however, it does not mitigate other “facts”: the VHF band is susceptible to electrical interference; atmospheric conditions can cause disruptions (“skip”); available channels are limited; the band plan does not easily accommodate multi-channel trunked system designs; and, in-building signal penetration is minimal. The UHF band has fewer issues than VHF, but it is also susceptible to co-channel interference and has limited channel capacity; the UHF band does not provide the same coverage on a per-site basis as a VHF system does. Both bands are inherently talk-in limited (as previously discussed). This necessitates adding receive-only sites to the conceptual plan so that portable coverage could be improved.

In the past several years, TUSA has been retained to analyze several newly-deployed countywide VHF P25 systems that did not meet user’s expectations primarily due to channel assignment and self-interference. These poorly-designed systems eventually transitioned to 700/800 MHz. A large UHF P25 system was plagued with receiver site interference; TUSA eventually assisted with obtaining new frequencies.
Option 1b  Countywide P25 Phase II 800 MHz System

System procurement RFP's for 800 MHz digital systems developed by TUSA establish the following System Design Criteria as a guideline for vendor proposals:

The P25 system shall be designed to comply with the following requirements:

- 700/800 MHz MHz Phase II linear simulcast trunking
- 95% County-wide portable-on-hip coverage within a 10 dB (loss) structure
- Coverage within identified Critical Buildings
- Delivered Audio Quality (DAQ) of 3.4 or better
- Sufficient channels for less than 2% blocked calls
- Microwave interconnectivity
- Full capability for ISSI (Inter-Sub-System-Interface) and CSSI (Console-Sub-System-Interface) interconnectivity
- Seamless system transition with no current-system downtime

P25 Features

As mentioned earlier, the P25 digital standard has seen widespread acceptance by public safety agencies throughout the United States (and the world). Developed by the Association of Public Safety Communications Officials (APCO) in the 1990's, this standard provides for a "common air interface" (CAI) which replaces proprietary system designs amongst equipment manufacturers. The Inter Sub-System Interface (ISSI) and Console Sub-System Interface (CSSI) features allow different vendors to tie their systems together, and for users to operate seamlessly between those systems. Until recently, P25 systems supported one digital voice call on a single 12.5 KHz channel bandwidth.

P25 digital systems provide a noise-free signal that provides a perceived 3 to 6 dB signal advantage over an equivalent conventional analog signal. This means the digital calls remain clearer, longer. Then, the signal drops off immediately as the digital signal exceeds a certain bit error rate (BER) level.

P25 system features include:

- Unit Identification
- Emergency Call Notification/ID
- Radio Text Messaging
- Individual (Private) Call
- Over-the-Air Reprogramming of Radios
- Digital Voice Encryption
- Over-the-Air Security Re-Keying
- Voice/data capability
- Talk Group priority
- User ID priority
- Remote enable/disable of user radios
- ISSI Standard allows user roaming with other P-25 radio systems

**P25 Phase II**

Recently-deployed P25 digital systems have been designed to support the P25 Phase II feature which utilizes Time Division Multiple Access (TDMA) to accommodate two simultaneous voice calls on a single 12.5 KHz bandwidth channel. This spectrum-efficient technology allows for the use of fewer radio channels to support desired user traffic. The result: more calls on fewer radio channels. System must specifically be designed to P25 Phase II standards since the distance between sites and other factors could impact Phase II performance.

Most P25 subscriber equipment vendors offer Phase II-capable radios. Phase II systems are backward-compatible with Phase I subscriber equipment and systems.

**Delivered Audio Quality – DAQ**

The “Delivered Audio Quality” requirement is based upon the following:

<table>
<thead>
<tr>
<th>DAQ</th>
<th>Subjective Performance Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unusable, speech present but unreadable</td>
</tr>
<tr>
<td>2</td>
<td>Understandable with considerable effort. Frequent repetition due to Noise/Distortion</td>
</tr>
<tr>
<td>3</td>
<td>Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion</td>
</tr>
<tr>
<td>3.4</td>
<td>Speech understandable with repetition only rarely required Some Noise/Distortion</td>
</tr>
<tr>
<td>4</td>
<td>Speech easily understood. Occasional Noise/Distortion</td>
</tr>
<tr>
<td>5</td>
<td>Speech easily understood.</td>
</tr>
</tbody>
</table>

This chart was developed by the Telecommunications Industry Association (TIA) in a specification designated as TSB-88. DAQ 3.4 is the accepted standard for digital radio audio quality (some vendors try to use 3.0 – TUSA does not accept a design based upon 3.0); 4.0 is the standard for mobile radio audio quality. System acceptance testing is based upon the 3.4 DAQ requirement, amongst other requirements.
Conceptual 800 MHz County-Wide System Design

The following high-level conceptual 8-site design provides better than 95% portable coverage throughout the County, with balanced talk-out and talk-in. An attempt was made to utilize as many County-controlled sites as possible. Three (3) of the sites in the design are existing towers that would have to be leased. These towers are identified by their FCC/FAA Antenna Site Registration (ASR) number. The current John Walton tower site was not used in the conceptual design.

800 MHz sites can typically be licensed for power outputs in the 200-500 Watt range, much more than current VHF or UHF licensed sites. This higher transmitter output power, coupled with the use of the Tower Top Amplifier, and tighter control on co-channel assignments, allows an 800 MHz site to cover better than VHF or UHF.
Boone County Fiscal Court - Radio System Assessment & Recommendations

800 MHz P25 System – Talk-out to a portable

**GREEN** = -90 dBm  **YELLOW** = -100 dBm

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A comparison of the talk-in and talk-out maps shows good talk-out/talk-in balance. This design assumes the use of 10 dB gain Tower Top Amplifiers (TTA’s) at all sites. Some system designs have used TTA’s with gains of 24 dB.
The next map illustrates a suggested conceptual microwave interconnectivity design that is based upon a six (6) site simulcast cluster and two (2) sites being configured as stand-alone “multi-sites”: 1003137 and 1273872. The use of multi-sites lowers costs and improves system efficiency. It is assumed some of the current microwave system equipment could be repurposed, as long as the equipment is not reaching end-of-life. All proposed microwave paths would have to be confirmed.

**RED** = high capacity microwave loop, simulcast site cluster

**YELLOW** = low capacity microwave spur, multi-site connectivity
**Multi-Sites**

A “multi-site” is a stand-alone trunked P25 site that operates with its own radio channel assignments (four channels is typical). For example: the site in Lawrenceburg, IN, (1003137) would provide “local” coverage across the river for users in Petersburg based upon assigned local talkgroups. However, if the Petersburg users switch to a County-wide talkgroup the site would immediately affiliate with the simulcast sites and operate as if it were part of the simulcast system. Conversely, if a County resource (Sheriff’s deputy, for example) drives into the coverage of the Lawrenceburg site, the Deputy’s radio would automatically register with the simulcast system. Any dispatch calls from the PSCC to the Sheriff's talkgroup would be automatically transmitted by the Lawrenceburg site to the Deputy's radio. Should the site lose microwave connectivity with the system it would still function as a “local” trunked P25 site. Most of the P25 system vendors offer this type of site configuration. The “multi-site” configuration is strictly a software-based application.

**Budgetary Estimate – Option #1b - 800 MHz P25 County-Wide System**

While there are many variables to consider, a budgetary cost for each site’s P25 equipment would be in the range of $1-1.5 Million. This does not include site development costs. The actual site costs can be determined based upon a detailed review of existing site conditions and the potential to reuse/reconfigure existing shelters, microwave system components, etc. This budgetary estimate assumes a stand-alone County system, with no sharing of resources with other counties/systems (unless the ISSI interface is used – equipment for two ISSI connections is included in the estimated cost).

The cost of a County-wide 800 MHz, P25 digital system, as described, could cost from **$8,000,000 to $12,000,000**. This does not include costs related to site modifications or other construction related costs.

**Fire Paging and Siren Control**

The County currently operates a VHF fire paging and “two-way” siren control system, with the serving base stations located at the John Walton site. These systems could be retained (and possibly upgraded) or the County could consider converting to 800 MHz, concurrent with an 800 MHz P25 system transition. Fire pagers are now available that operate on 800 MHz P25 systems and the siren radios could be upgraded to 800 MHz (possibly using less-expensive vendor offerings). The siren’s “two-way” telemetry could be accommodated by low-speed data available on P25 systems.
Conventional Radio System Resources (Mutual Aid, etc.)

If the County transitions to 800 MHz, there will still be a need for access to conventional VHF or UHF radio resources to support mutual aid communications. There are several methods used to accomplish this, depending upon the desired results:

1. In-County conventional VHF/UHF radio base station resources can be retained and “hard-patched” into the digital system. The resources become available as a talkgroup on the digital system. However, the coverage of the patched resources is limited to the location of the conventional base station. This would work if out-of-County non-P25 agencies come into the County.

2. Conventional mobile and portable VHF or UHF equipment would be retained to support mutual aid calls; this is typical for County fire departments that would be more prone to respond to out-of-County calls.

3. County agencies requiring access to conventional UHF and/or VHF mutual aid channels could acquire multi-band mobile and portable radios. The drawback is that when these radios are operating on the conventional channels, communications with the County’s trunked system is interrupted. Since the County already has VHF and UHF equipment, it is more operationally (economically) effective to retain that equipment.

4. Vehicular repeaters that operate on the out-of-County conventional channels could be deployed. The input to the vehicular repeater would be the user’s P25 800 MHz County-system radio. (Low-power analog 800 MHz channels are available for this type of configuration; these conventional 800 MHz channels can also be used for fireground communications.) The vehicular repeater would be connected to a VHF or UHF mobile radio (or VHF/UHF dual-band radio) that could be switched to the required VHF or UHF mutual aid channel. These repeater configurations can also be provided in a portable “suitcase”.

OPTION #2 - Join the Airport System

The Cincinnati International Airport (CVG) is transitioning from a proprietary, end-of-life EDACS trunked radio system to a Harris P25 system. The current Airport system is licensed (WP1P979) for 800 MHz repeaters and control stations within the Airport’s terminals and surrounding area. Expanding the Airport’s system across the County would require the County to deploy the same number of sites as proposed for the stand-alone 800 MHz County system in Option #1. A drawback with this scenario is that the Airport’s traffic would be simulcasted across the County, and the County’s traffic would be simulcasted at the Airport. It would be more efficient for the Airport to operate as a standalone multi-site, and for the County to develop its
own P25 “footprint”, as proposed in Option #1. With this design, site 1013008 would be used to serve County traffic in the Airport area, keeping County traffic off the Airport channels. Technologically and operationally, this would be a viable solution.

Harris uses a central “Control Point” system architecture with an option to distribute system control to a backup control point. A backup Control Point option should be considered by the County if it decides to pursue the Airport scenario. It would also be necessary to ensure the availability of the APCO P25 Inter Sub-System Interface (ISSI) and console sub-system interface (CSSI) features so that the Airport/Boone County system could interoperate with Ohio MARCS, Indiana Safe-T, and future Kenton/Campbell county systems.

**Budgetary Estimate – Option #2 – Boone County Joins the Airport System**

Connecting to the Airport system would require the County to build its own Harris P25 network and Control Point, and then interconnect it to the Airport's Control Point. Switching to and from Airport talkgroups would be transparent to the user.

For budgetary purposes, the Airport/Harris system cost would be approximately $12,000,000. The “dual Control Point” configuration adds to basic system cost. The County would have to procure the system as a "sole source" from Harris.

**Option #3 – Join the Ohio MARCS Regional System**

From the State of Ohio’s MARCS website:

**MARCS** (Multi-Agency Radio Communication System) is an 700/800 MHz radio and data network that utilizes state-of-the-art trunked technology to provide statewide interoperability in digital clarity to its subscribers throughout Ohio and a 10-mile radius outside of Ohio. The MARCS system provides statewide, secure, reliable public service wireless communication for public safety and first responders.

The MARCS network operates on three system components:

- **Mobile Voice** – operating on the 700/800 MHZ digital trunked technology
- **Mobile Data** – allowing data transmissions, LEADS inquiries, reformatting of data from Mobile Data Terminals (MDT)
- **Computer Aided Dispatch** - providing GPS-based auto vehicle location, resource recommendation and GGM display

There are currently over 47,500 voice units and over 1,800 mobile data units on the MARCS system with over 1200 public safety/public service agencies statewide. This includes local, state and federal agencies.

There are two (2) MARCS “multi-site” configurations north of Boone County: North Bend and Cincinnati. (And, for information purposes, there are two [2] Indiana State...
800 MHz sites along the western border of Boone County: Lawrenceburg and Switzerland.) Cincinnati is planning to transition to the MARCS system in 2016.

As in the case with the Airport option, if the County should decide to become part of the Ohio Motorola MARCS network, it would still be necessary for the County to develop its own County-wide simulcast system to provide the needed coverage within the County. Conceptually, the County would also want to have its own central control “Core” so that it could operate independently if the MARCS Core (located in Columbus) should fail, or if connectivity is lost.

The benefit of joining MARCS, from a technological standpoint, is that dispatching and “roaming” across the river would be seamless. Boone County could also take advantage of the established mobile data and CAD systems operated by MARCS, for additional costs.

Published in-State MARCS monthly user costs are $20 per radio, $40 per control station, $2,200 per CAD position, and $40 per dispatch position. Since the County would have to make a major investment in the procurement and installation of its own system, paying fees to MARCS would be an additional, recurring cost. Just as in the Airport scenario, joining MARCS places the County in the position of having to sole source its new system from a single vendor so that it would be compatible with MARCS.

**Budgetary Estimate – Option #3 – Boone County Becomes Part of the Ohio MARCS System**

The MARCS scenario is similar to the Airport system requirements. Estimated costs would be approximately $12,000,000. This would include miscellaneous equipment for redundant connectivity to the MARCS system. This does not include the recurring fees associated with being a “user” on the MARCS network, if required. Estimated MARCS fees could be in the $200,000 per year range, not including CAD.

**Option #4 – Become Part of a Regional System**

The fourth option considers development of a regional P25 system across Boone, Kenton, and Campbell counties within northern Kentucky. This regional system would cover more than 580 square miles and serve a population of more than 368,000. Each of these counties currently operates a consolidated PSAP/dispatch center.

Regional systems can be configured with different vendor networks tied together through the APCO P25 ISSI interface. This allows P25 users to roam between different-vendor systems, and for dispatch centers (using the CSSI interface) to access neighboring systems. EF Johnson (Kenwood), Harris, and Motorola have conducted ISSI/CSSI inter-system tests that have successfully demonstrated the
capabilities of the ISSI/CSSI standard. While the use of ISSI has some limitations versus one large integrated, single-vendor network, the actual operational relationships between the counties would have to be assessed; the ISSI feature set might be sufficient.

As in the case of Options 1, 2, and 3, for Option 4 the County would have to build out a suitable in-County system no matter how a regional system might develop. In the conceptual three-county regional system, each county would operate and administer its own simulcast cluster; all three clusters would be interconnected via ISSI and CSSI. Each simulcast cluster’s microwave system would interconnect at two points between each county. Conceptually, each county’s 911/PSAP could be configured to be a backup for the other two counties. Technologically, the regional system could interconnect to the Airport, Ohio MARCS, and Indiana Safe-T systems via ISSI.

Border site locations between the three counties should be coordinated so that the maximum value of each site (coverage provided) can be realized.

![Conceptual Regional System Diagram]

**CONCEPTUAL REGIONAL SYSTEM**

One benefit of regional systems is that member counties can take advantage of the economy-of-scale in the purchase and maintenance of their systems, if the same vendor is used.

- With Campbell County already having a Motorola Core, that could be the primary Core for a Motorola tri-county northern Kentucky system. This Core would then be interconnected to the MARCS Core, providing for a seamless tri-county/MARCS network. Upcoming Motorola software
releases will allow adjacent Core’s to operate in a “concurrent” mode. This scenario provides the ultimate interoperability between the three counties and the adjoining counties in Ohio. Potentially, the tri-state regional system could tie into the Indiana system.

**Budgetary Estimate – Option #4 – Tri-County Regional Radio Network**

The estimated cost to develop an 800 MHz P25 Boone County system that would be capable of becoming part of a regional tri-county network would be $8,000,000 to $12,000,000. It is typical to require at least two ISSI connectivity paths in a standard vendor-proposed P25 system design. The only additional cost is the actual connectivity between systems (microwave links) which is usually a shared cost between the systems. If all three counties procure a single, integrated system, costs could be lower due to the economy of scale of a large system purchase.

**System Maintenance Costs**

The “elephant in the room” of annual P25 system maintenance costs should be clearly understood up-front. The care and feeding of a large county-wide or regional digital network is not an inexpensive undertaking. Unlike today’s conventional radio systems that often operate under a “time and materials” maintenance philosophy, often with minimal or even non-existent annual budgets, large digital systems require on-going vendor support in regards to software and equipment upgrades. Annual maintenance costs could range from thousands to millions of dollars.

Maintenance plans are comprised of many separate elements, some of which are:

- Software upgrade “insurance”
- Software virus monitoring
- Spare parts repair/replace
- 24-hour system monitoring
- On-site technician maintenance (2-hour response)

Examples of maintenance costs quoted for a recent RFP for a P25 county-wide system (each vendor has a different “plan” for maintenance and that has to be taken into account when reviewing these numbers):

<table>
<thead>
<tr>
<th>Vendor</th>
<th># Sites</th>
<th>Annual Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>$357,229</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>$328,802</td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>$261,299</td>
</tr>
</tbody>
</table>

Large P25 systems often require dedicated System Operator Administrative Support; either a full-time employee or a contracted resource would oversee daily operations and maintenance of the system, alarm monitoring, site upkeep, preventative maintenance, subscriber programming, adds, changes, and deletions,
etc. It is estimated that, as a whole, a regional single-vendor system would be less expensive to maintain than three different-vendor systems. The required spare parts alone would be significantly less expensive because they could be “pooled”.

**Regional System Governance**

A large regional network will require oversight by a single administrative entity that is empowered to establish operational and administrative guidelines for all system operators and users. A very important task would be to establish the processes for users to “join” the regional system and to support system maintenance costs through annual “subscriber fees”. Other tasks would be establishment of regional talkgroups, specialized operational procedures, interoperability processes with neighboring systems (Indiana and Ohio), sharing of encryption keys, and other day-to-day system features.

**Conclusion: System Design Considerations**

The primary challenge for Boone County is to develop a modern, reliable, portable-based radio system that serves County agencies with a high degree of reliability, flexibility, and redundancy. No matter how the County might “connect” with neighboring systems, a County-wide system design, with an integral County-based “control” node (if the selected system uses one), is required. It is important to assess how, and how often, County agencies interact (interoperate) with agencies in Kenton County, Ohio, or Indiana. For example, if Boone and Kenton interoperate on a daily basis, it would make sense for their “systems” to be fully integrated. This means they would benefit from utilizing the same vendor’s system architecture. From a higher level, as long as all systems utilize P25 technology and are on the same radio frequency band, “interoperability” is inherently available; it’s just a matter of agreements to share talkgroups, encryption keys, and so on. It would be important that the systems are all designed using the same coverage, capacity and interoperability parameters.

If the County pursues **Option 1**, procuring and owning its own P25 800 MHz system, a competitive RFP would deliver a broad range of system pricing.

By pursuing **Option 2**, joining the Airport, or **Option 3**, joining MARCS, the County would be obligated to procure its system from the respective Airport or MARCS system vendors.

**Option 4** would depend upon inter-county agreements, the final regional system configuration, and operational requirements.
3.0 RECOMMENDATION

This report has addressed the specific requirements set forth in the Boone County consultant RFP:

- understand the status and viability of the current VHF and UHF public safety communications systems
- serve as a guide to support long-range policy decisions.
- explore four (4) options:
  - County-owned system (upgrade existing VHF/UHF, or 800 MHz P25)
  - Join Airport system (Harris P25 800 MHz system)
  - Join MARCS (Ohio Motorola P25 800 MHz statewide radio system)
  - Regional system with neighboring Kentucky counties

TUSA has provided an assessment of the current VHF/UHF systems and provided information regarding an upgrade of the existing systems, or a transition to any of the four (4) options described above.

Analysis of Each Option  X=improvement

<table>
<thead>
<tr>
<th>Feature</th>
<th>VHF/UHF Upgrade</th>
<th>Standalone P25 System</th>
<th>Airport P25 System</th>
<th>MARCS P25 System</th>
<th>Tri-County Regional P25 System</th>
</tr>
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<tbody>
<tr>
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<td>Future value</td>
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</table>

Tusa Consulting Services Recommendation

Any “upgrades” to the current VHF and UHF systems would have short-term benefit. After a major investment in equipment and site development, the law enforcement and fire services would still be on separate radio bands, the operational and technological drawbacks of using VHF and UHF will remain, and the County would find itself surrounded by 800 MHz digital systems. Transitioning the VHF and UHF systems to “digital” (P25) could be problematic due to the uncertainty of obtaining radio channels that would fit into a trunked system plan, and the inherent atmospherics, electrical noise, co-channel interference, and poor in-building
penetration issues would remain. *It is not recommended that the VHF and UHF systems be upgraded.*

TUSA recommends that Boone County consider development of an integrated Northern Kentucky tri-county P25 800 MHz system which would result in the best operational and financial benefit for the region, while being fully capable of seamless interoperability with Ohio and Indiana. With Campbell County reportedly having made a commitment with the acquisition of a Motorola Core, it would be advantageous to parlay that commitment into the basis of a regional system. Approaching Motorola for a high-level quote for a conceptual region-wide system would be a good first step towards understanding the costs involved.

Even if the regional concept cannot come together immediately, Boone County would be on the right path in developing its own 800 MHz P25 system. The County’s public safety and public service agencies need a modern, well-designed and reliable integrated radio network that would allow them to conduct their business safely and efficiently.

TUSA appreciates this opportunity to assess the County’s current systems and provide recommendations. We stand ready to assist with the next steps.