National Capital Region (NCR)
Land Mobile Radio Strategic Plan and
Capabilities Assessment *(Condensed Version)*

Submitted June 2014 to:

Northern Virginia Emergency Response System (NVERS)

MissionCriticalPartners

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EXECUTIVE SUMMARY

The National Capital Region will seamlessly share data, communications, information, and resources across jurisdiction and discipline boundaries and make decisions collaboratively to enhance the safety of our communities.

Through a National Capital Region (NCR) Urban Area Security Initiative (UASI) grant opportunity, the Metropolitan Washington Council of Governments (MWCOG) retained Mission Critical Partners, Inc. (MCP) to perform a radio capabilities assessment and develop a Land Mobile Radio Strategic Plan for the NCR. The goal of the radio capabilities assessment was to evaluate the current state of radio interoperability within the NCR, identify interoperability gaps, evaluate how recent technological advances could mitigate those gaps, and set a long-term vision for the future of technology within the region. The goal of the NCR Land Mobile Radio Strategic Plan was to develop a vision for the future of communications interoperability and recommend goals that would improve regional voice communications interoperability.

Establishing a shared vision and identifying goals for improved regional voice interoperability are the cornerstones to delivering the best service to the citizens of the NCR in the most fiscally responsible way. Until the region can agree to a desired end goal for voice interoperability, it is not approaching voice interoperability in the most fiscally responsible manner, nor is it capitalizing on its collective buying power. In an era where public safety is having to do more with less, it is imperative that public safety leaders collaborate regionally to more efficiently use their resources in a way that positively impacts the ability of first responders to perform their duties in a more safe and effective manner. With recent advancements in technology, there is a greater opportunity than ever to construct robust regional solutions rather than disparate solutions in order to benefit from that collective buying power while simultaneously improving the ability of first responders to complete their duties in a more safe and effective manner. Once the NCR agrees to its desired end state and its vision for the future, jurisdictions can leverage economies of scale and more efficiently share resources for improved safety and effectiveness.

PROJECT SYNOPSIS

Radio Capabilities Assessment

MCP gathered information regarding the existing land mobile radio (LMR) system within the region through meetings with radio managers of each NCR jurisdiction. Information regarding the present configuration of each radio system, future plans for upgrades and interoperability challenges with the present environment was obtained. Based on this information, MCP established a baseline for the present configuration of systems across the NCR, and identified a total of ten interoperability limitations with the current configuration.

MCP notes that overall, NCR radio managers agree that the region has a very high level of interoperability that satisfies the majority of first responder requirements. The most notable limitations were:

1. The inability to monitor radio traffic for an incident before entering the coverage footprint of the serving system
2. The inability to communicate with home system dispatchers when roaming off system
3. The inability to carry primary system coverage during extended pursuits, emergency medical services (EMS) transports, prisoner transfers, or other wide-area responses
4. The cluttered and complicated nature of interoperability fleet maps

Based on research of industry trends and input from NCR radio managers, MCP developed a list of five possible technological solutions that could mitigate a range of identified interoperability limitations. The evaluated solutions include a conventional simulcast overlay system, a trunking overlay system, system connections via Inter-zone, system connections via Inter-RF Subsystem Interfaces (ISSI), and shared systems. For each option MCP identified strengths and weaknesses, identified interoperability gaps that would be satisfied, and performed a gap analysis to determine what steps would be necessary to implement each solution given the present state of NCR communications systems.

Several of the identified options would lead to a considerable increase on the loading of primary communications networks, reducing the overall available capacity. MCP developed loading projections for the increased interoperability traffic and developed recommended capacity increases to support each interoperability solution.

Conceptual designs were developed for each option to provide a better idea for what each solution would require. As part of the conceptual design, radio coverage and backhaul diagrams were developed for each option to further define the respective requirements. Based on this information, MCP developed cost estimates for each alternative. Costs were broken down according to fees necessary to implement the interoperability solution, fees necessary to support capacity increases in primary networks to support each solution, and fees necessary to upgrade the system release platform of primary systems to support each system.

The following table summarizes the costs associated with each identified option. MCP notes that these costs are based on numerous assumptions which are defined in Appendix C Section 5.2. A change to these assumptions could result in substantial changes to the estimated costs.

Technology Option	Interoperability Solution Costs	Capacity Increase Costs	System Upgrade Costs
Option 1 – Conventional Simulcast Overlay	$2,695,000	$0	$0
Option 2 – Trunking Overlay	$7,180,000	$0	$0
Option 3 – Inter-zone	$5,470,000	$15,774,500	$3,000,000
Option 4 – ISSI	$17,079,927	$15,774,500	$3,000,000
Option 5 – Shared Systems	($5,138,000)	$15,774,500	$3,000,000

MCP notes that there is a considerable level of complexity associated with each of the identified options that is not reflected in the cost alone. The Inter-zone and shared system options require radio system identification (ID) changes, necessitating substantial radio programming and coordination efforts as well as operational risks during system cutovers.

Based on the strengths, weaknesses, and costs associated with each evaluated option, it is MCP's recommendation that the NCR implement ISSI in the short-term and plan a long-term migration to a single regional shared system if the benefits can be validated through the use of ISSI. In the short-term, ISSI will meet most of the interoperability gaps identified by NCR radio managers; ISSI is also particularly well adapted to the current radio system environment within the NCR. ISSI is a tool utilized to tie disparate Project 25 (P25)-compliant systems together, allowing subscriber radios with properly configured talkgroups to roam freely between the coverage areas of the disparate systems without changing channels. ISSI can be implemented on Motorola networks operating at system release level 7.13 or later. Most jurisdictions in the region are already operating on Motorola P25 trunking systems and have plans to update to release level 7.13 within the upcoming years. The remaining jurisdictions operate legacy Motorola networks and are planning P25 procurement in the near future. ISSI is a P25 standard and connections will be available regardless of which vendor the jurisdictions with pending procurements ultimately select.

In the long-term, MCP recommends that the region migrate toward shared networks as the present P25 systems reach end-of-life. Operation on a single shared network will reduce the costs for each jurisdiction, maintain and improve the levels of interoperability provided by ISSI, and provide a more reliable cloud-based network.

MCP recommends that the region target the implementation of an ISSI pilot in northern Virginia by the end of 2015. If the pilot project and planned ISSI usage within the state of Maryland validate the benefit of ISSI, then MCP recommends that ISSI be implemented throughout the NCR by the end of 2017. With this solution the region may implement designated wide-area talkgroups for specialized radio

traffic that can be used anywhere within the interconnected systems. Such usage is possible within the present capacity levels of existing NCR radio systems. By 2021, MCP recommends that the NCR expand its level of roaming to support primary operational traffic, providing increased coverage and roaming capabilities. To accommodate the increase in roaming, MCP recommends each system implement Phase II time division multiple access (TDMA) to provide increased capacity. MCP recommends that the migration to shared systems be completed by 2030 as existing systems reach end-of-life.

To coincide with the recommended technology updates, operational changes are recommended to provide for the optimal usage of the new solutions. Governance organizations will need to be developed to manage shared resources for the new solutions. Standard operating procedures (SOPs) will need to be developed that clearly define how the new technologies should be utilized by first responders. MCP recommends a migration toward a regional approach to talkgroups to reduce the overall number of available talkgroups for first responders, thus simplifying interoperable communications. The NCR could accomplish this by establishing designated wide-area channels that operate regardless of jurisdictional boundaries.

MCP recognizes that recommendations are provided for system configurations over 15 years away. Recognizing that the technological solutions that may be available are not defined, it is MCP's recommendation that the region continue to move toward a shared network, but evaluate developing technology to determine what the appropriate technology should be when the time comes.

NCR Land Mobile Radio Communications Plan

Following a series of planning meetings with the three NCR Statewide Interoperability Coordinators (SWICs), MCP met with radio managers, emergency managers, chief information officers (CIOs), homeland security advisors, and members of public safety from counties, agencies, organizations, and committees across the NCR to discuss their regional vision for communications interoperability.

Participants shared their thoughts on the current state of regional communications interoperability, the strengths within the NCR, opportunities to enhance regional collaboration, and the goals and capabilities considered most important for continued operational success. The stakeholders assigned the NCR a grade for regional planning and collaboration to improve communications interoperability:

- 20 percent gave the NCR an A.
- 40 percent gave the NCR a B.
- 27 percent gave the NCR a C.
- 13 percent gave the NCR a D.

Participants recognized that the NCR is more advanced than many of its national counterparts, and light years ahead of where it was following the events of 9/11, but believe that regional planning and collaboration can still be improved. To that end, stakeholders expressed a willingness to sacrifice some

technical autonomy (independent, local systems) for shared, regional systems if it resulted in improved regional interoperability. Holistically, respondents acknowledge that individual jurisdictions are investing too much in infrastructure compared to what could be saved by working together to leverage their buying power.

The interviews revealed a common belief that the region's greatest strengths were the strong relationships and an overall willingness to collaborate and share information and resources to meet the public safety mission. Largely, interviewees also agreed that the region's robust radio systems were largely interoperable.

Despite marked progress since the Air Florida crash and the events of September 11, NCR stakeholders identified ongoing challenges around planning and implementation, training and exercises, governance, technology, and the management or availability of resources. The number one challenge reported repeatedly across jurisdictions, states, staff levels, and disciplines was the lack of a regional plan for the future of communications interoperability in the NCR. Those interviewed pointed to a lack of clarity on the current state of interoperability in the NCR, a lack of vision, and a scarcity of metrics to help measure progress.

The vision proposed for adoption is as follows:

> *The region's interoperability partners will seamlessly share data, communications, information, and resources across jurisdiction and discipline boundaries and make decisions collaboratively to enhance preparedness, responsiveness, and the safety of our communities.*

Based on the input of regional stakeholders, MCP identified a total of nine recommendations to help improve regional planning and ultimately improve interoperability for first responders.

1. Adopt the proposed NCR strategic vision and NCR Land Mobile Radio Strategic Plan.
2. Implement or re-adopt a region-wide schedule for radio reprogramming.
3. Leverage regional buying power with vendors.
4. Regionally support and use the Metropolitan Washington Council of Governments (MWCOG) area inter-jurisdictional mutual aid memorandum of understanding (MOU) template.
5. Review, potentially revise, and communicate the MWCOG communications interoperability governance structure.
6. Clarify NCR plans for encryption adoption; commit to an implementation roadmap.
7. Prioritize goals and objectives to develop a regional common operating picture.
8. Develop a regional strategic plan for network and information management.
9. Plan additional NCR-wide training and exercises.

Adopting a common vision for the future of the NCR's communications interoperability, and aligning specific, measurable goals to that vision through the Land Mobile Radio Strategic Plan will help the NCR manage the process of reaching and/or refining the desired future state of interoperability.

1. INTRODUCTION

The NCR is one of the most multi-jurisdictional population centers in the United States with a metropolitan statistical area (MSA) population of almost 6,000,000 people. Due to open jurisdictional borders, interoperability between disparate agencies that comprise the NCR is not an infrequent event, but rather part of routine daily operations.

To help determine overarching goals for the future of communications interoperability, the NCR, through the Urban Area Security Initiative (UASI), contracted with MCP, a public safety consulting company, for the following:

1. Review the radio systems within the NCR, identify if there are any additional capabilities that would benefit first responders within the region, review the technological capabilities that could improve or mitigate interoperability gaps, recommend a direction for improving interoperability, and develop cost estimates to implement those recommendations.

2. Document the region's communications interoperability strengths and weaknesses, draft a vision for the future of NCR communications interoperability, and develop a roadmap of recommendations for the NCR public safety community to advance interoperability and information sharing through regional coordination.

2. METHODOLOGY

2.1. INTERVIEWS

MCP met weekly with the three NCR SWICs to identify representatives across D.C., Maryland and Virginia to speak to who would share their vision for the future of interoperable communications across the NCR. MCP interviewed these individuals to help identify regional shortcomings, strengths and opportunities for regional improvement.

In summer 2013, MCP conducted interviews with NCR radio managers, emergency managers, CIOs, homeland security advisors, and members of public safety from the following counties, agencies, organizations, and committees:

- City of Alexandria, Virginia
- Arlington County, Virginia
- Charles County, Maryland
- DC Homeland Security and Emergency Management Agency (DC HSEMA)
- Fairfax County, Virginia
- Frederick County, Maryland

- Loudoun County, Virginia
- Montgomery County, Maryland
- Prince George's County, Maryland
- Stafford County, Virginia
- Maryland Emergency Management Agency (MEMA)
- Maryland Office of the Governor
- Metropolitan Washington Airports Authority (MWAA)
- Metropolitan Washington Council of Governments (MWCOG) CIO Subcommittee
- Northern Virginia Emergency Response System (NVERS)
- Virginia Department of Emergency Management (VDEM)
- Virginia Department of Transportation (VDOT)
- Washington, D.C.
- Washington D.C. Interoperable Communications Committee (ICC)
- Washington Metropolitan Area Transit Authority (WMATA)

During each interview, stakeholders answered strategic questions regarding the following:

1. The current state of communications interoperability
2. Their vision for the future of communications interoperability in the NCR
3. The strengths and weakness of the NCR's communications capabilities and interoperability
4. How communications interoperability could be improved
5. Opportunities for improved regional collaboration
6. Top communications priorities and capabilities in the NCR

A copy of the interview questions is included in Appendix A.

For the radio capabilities assessment, stakeholders answered technical questions regarding the following:

1. Existing radio system strengths and weaknesses
2. Current state of radio systems and planned upgrades
3. Interoperability requirements for each jurisdiction
4. Methods for achieving interoperability with interoperability partners
5. Interoperability gaps experienced by users
6. Challenges with addressing interoperability

A copy of the radio assessment interview questions is included in Appendix B.

3. FINDINGS

3.1. STRENGTHS

Holistically, every stakeholder interviewed had something positive to say about the NCR's communications achievements and progress since the crash of Air Florida. Many interviewed felt very strongly that the region had even reached the desired level of interoperability identified 12 years ago following the events of September 11 and that the primary focus today was to maintain the current level of interoperability.

Overall, the most common response was that members of public safety within the NCR had forged strong relationships and were willing to collaborate, and share information and resources to meet the public safety mission. On par, stakeholders also believed that the region's robust radio systems, built on compatible platforms, were key to interoperability success, allowing users to communicate when needed and as necessary.

> *"There's nowhere in the NCR that I can't send my units where they wouldn't have communications with everyone around them while still using their own radio system."*
>
> *"We could talk to the moon."*

Additional strengths are listed below.

- The NCR radio cache is available to provide important backfill and expand regional capabilities when necessary
- Consistent rhythm of meetings for radio managers, and police and fire chiefs through MWCOG
- Development of the NCRNet, a fiber backbone designed to increase bandwidth, to transmit data in big chunks between localities
- Fewer instances of jurisdictions acting like "rogue nations," out for their own interests
- Increased regional unity and alignment in planning and communicating about challenges, plans, and solutions; NCR members are collectively moving in the same direction
- State-of-the-art technology, equipment and assets
- Regional use of CAD-to-CAD
- SWICs in D.C., Maryland, and Virginia mesh well and are working together

Some examples of what works well are detailed below.

Charles County, Maryland, was unable to erect a tower in an area that would help provide voice communications coverage. To close the interoperability gap, Fairfax County, Virginia, provides Charles County with access to four of its talkgroups to help it overcome that blind spot. Most importantly, the coverage occurs seamlessly without Fairfax County radio users ever realizing that Charles County users are sharing the same space.

Fairfax County, Virginia, uses several frequencies on the Montgomery County, Maryland, radio system because it provides better coverage for them along the Potomac River. In exchange, Fairfax County uses two talkgroups on the Montgomery County system that provide better coverage in the Great Falls area. The use of the frequencies and talkgroups is seamless; law enforcement and fire personnel have no reason to notice they are on the Fairfax County system because the channels are programmed into their radios, and when they turn it on, it works.

Code plugs are labeled similarly across the NCR. For example, the code plugs for Loudoun County, Virginia, look similar to Fairfax County's code plugs. This consistency is a direct result of planning at the Communications Subcommittee level at MWCOG.

3.2. ONGOING CHALLENGES

Through the years, the NCR has faced and overcome many challenges through thoughtful planning, governance, experience, and strong relationships. Despite progress, NCR stakeholders continue to identify ongoing challenges around planning and implementation, training and exercises, governance, technology, and management or availability of resources.

3.2.1. Planning and Implementation

The number one challenge repeatedly shared across jurisdictions, states, staff levels, and disciplines was the lack of a regional plan for the future of communications interoperability in the NCR. Stakeholders pointed to a lack of clarity on the current state of interoperability in the NCR, a lack of vision and a scarcity of metrics to help measure progress. Additionally:

- The NCR is viewed as "three states" trying to interoperate
  - The inevitable result is sub-regionalism
- Unclear picture of the NCR's level of interoperability
  - Limited understanding of the other two partners' communications interoperability requirements or status
- Silos and proprietary mindsets still persist
  - The tug of autonomy versus a regional mindset
  - *"Everyone wants their own network and yet wants to communicate with the world"*
- Ongoing confusion about definition of "Level 6" interoperability
  - It is seen as either an undefined or moving target
  - It is unclear who has the authority to determine the level of interoperability

Some sample comments are provided below.

> *"We're always chasing interoperability."*

"It's hard to map out where we're going and make funding decisions when we don't understand where the NCR stands today."

"Without a clear idea of our goals, it's impossible to know if we are over-investing or under-investing in interoperability."

"Nobody at a senior level can define where we are with interoperability. Level 6? What is this? Can someone describe this?"

"There is no interoperability report card we can use to measure progress or weaknesses. The region needs to be evaluated on progress made to date before it can determine what direction to go or where to spend future funds."

"We need all three SWICs to come to common agreement on where we're going and then get buy-in. We need a vision, a few goals, and clear metrics behind them."

"We need to identify the next phase – not what we need to be able to do today, but what we need to be able to do tomorrow. We need to have those visioning discussions very soon to make sure we know what the end point is and how we'll need to continue to invest in it."

It is worth noting the skepticism and loss of faith in the NCR's ability to successfully develop a plan that could be adopted and followed. One stakeholder suggested that there are "bodies littered across the NCR" – in other words, a number of individuals have unsuccessfully attempted to create an adoptable, actionable plan for the NCR.

3.2.2. Training and Exercise

In multiple jurisdictions, stakeholders expressed concerns about a lack of training, radio familiarity, and an understanding of the importance of communications interoperability across all levels of public safety.

- Regional leaders appear under-informed about how to capitalize on infrastructure already in place
- Radio subscribers do not understand the full suite of capabilities of their radio system
  - Limited knowledge on system limitations
  - Responders often skip reporting a problem when radios fail and instead adapt to the situation by turning to a cell phone to replace radio communications
- Senior-/Chief-level leaders may benefit from a refresher course about communications interoperability and radio use
  - *"I see that a lot of folks in charge don't understand how important (or what's important in) communications interoperability. It's technical and they just expect it to work – they can't expect that. They need to be asking the hard questions to make sure this stuff works."*

3.2.3. Governance

The two most common responses about governance collected during the interviews were related to the organization and functionality of MWCOG, and the feeling that the era for passionately pursuing communications interoperability has now shifted away from visionary thinking and more toward maintaining current interoperability levels.

Stakeholders frequently expressed at least some level of confusion about how MWCOG is organized to make decisions, and whether its structure still serves the larger purpose, often asking the following questions:

- How are funding requests approved?
- What is the chain of command for approval?
- Which meetings are the most important to attend?
  - How can leaders in the room trust what is being said?
- Which group within COG has ultimate decision-making authority?

The conversations about MWCOG also resulted in the following comments:

> *"COG has too many 'chiefs,' and not enough 'indians' being listened to."*
>
> *"There are many meetings, but not a good flow of information from the work group level to the coordinator and then to the SPG level."*
>
> *"COG is a big, cumbersome, lumbering beast. I have no issue with the SPG making decisions, but I often wonder if they are making decisions with the most information available."*
>
> *"Nobody can provide me with a list of all the COG Committees and members. Who should the members be? There are so many governance groups it's unclear who is in charge."*
>
> *"The region does not currently excel at managing access to data, systems, talkgroups, etc. through SOPs or MOUs."*

Approximately one quarter of those interviewed expressed that the level of communications interoperability that the NCR has today is due to a group of "interoperability idols" who helped define and plan for what is now the current state of interoperability. Approximately seven years ago through the Regional Programmatic Working Group for Interoperability (RPWG), goals were defined; the region has largely reached the goals that were set then. Some individuals perceived a "brain drain" that has resulted in an NCR mission of *maintaining* interoperability versus searching for and implementing further improvements.

3.2.4. Technology

While stakeholders presented a variety of technical interoperability challenges, the most commonly reported concerns pertained to a radio programming schedule, mixed plans for encryption across the region, and no common operating picture.

- Stakeholders reported that the region had either not yet created a consensus-driven schedule for reprogramming radios at the same time regionally, or that it did once, but that the schedule was not adhered to.
  - As soon as one jurisdiction makes one change there is a domino effect that often requires other jurisdictions to touch their radios again, too frequently, and with added expense
- Encryption inspired a variety of mixed responses from different disciplines and jurisdictions – negative and positive.
  - Current state:
    - Maryland would like to encrypt selected talkgroups for law enforcement
    - Northern Virginia (NoVA) police and fire generally do not intend to move to full scale encryption, but would offer select encrypted talkgroups for law enforcement and fire and rescue
    - D.C.'s Metropolitan Police Department (MPD) has fully encrypted its tactical radio channels
    - D.C.'s Fire and Emergency Medical Services (FEMS) have FEMS has a select number of encrypted talkgroups
  - Historically in the NCR, instead of coordinating at the front end, one individual agency makes a decision and then other jurisdictions have to chase whichever agency jumps first to catch up and fix whatever connectivity is compromised.
  - Stakeholders noted that when D.C. encrypted, all other entities had to adapt and work around it during an emergency. The perception is that it was done for the right reasons, but it still "broke" interoperability.
  - Numerous agencies had to complete P25 subscriber upgrades when Arlington County, Virginia, upgraded to P25 in order to maintain interoperability.
  - Several agencies within the region have implemented P25 Phase II systems; TDMA talkgroups are not compatible with radios used by most jurisdictions throughout the NCR.
- There is no common operating picture used across all of the NCR.
- Infrastructure (like radio towers) is vulnerable to weather and other damage so resiliency and redundancy remain critically important.
- Law enforcement units are dispatched based on jurisdiction, not based on the closest unit.
- There is no region-wide patient tracking system or plan for family reunification.
- The NCR is not as integrated with local military bases as it likely should be. Increased interaction would result in a better understanding of how localities and military bases can interact with each other and coordinate during unplanned emergencies on base or on the borders.

- There is a significant interoperability gap between federal agencies and city/county/state agencies. This gap is largely attributed to usage of different frequency bands, although a lack of channel sharing by federal agencies is a primary gap.

3.2.5. Resources

Repeatedly, stakeholders reported that it takes time and human resources to maintain interoperability. Some reported that the level of complexity within the NCR should merit full time employees with responsibilities devoted to preserving and expanding communications interoperability. Unfortunately, most local budgets do not support such measures, so it is often one person wearing many hats trying to juggle their daily responsibilities while also working to improve interoperability locally and regionally.

> *"Our radio systems are pretty much without holes at this point. Our bigger holes are in resource allocation and management."*
>
> *"We're so busy trying to keep the lights on that we sometimes fail to look at challenges and we delay stepping back and seeing if there's a way to address problems without reinventing the wheel."*
>
> *"It takes a lot of time to make sure that people are maintaining code plugs in radios and to ensure that we communicate about any programming updates we're making to our radios."*

Many reported that long-term strategic planning is often neglected due to the demands of daily tasks and limited human resources. Brainstorming solutions, one stakeholder asked if there was an opportunity to establish a COG subcommittee wholly devoted to focusing on the future state of the NCR's communications interoperability. While it would not solve the daily struggle of available resources in each jurisdiction, it would commit the resources necessary to narrow the region's focus on the efforts of future planning, and establish goals and objectives to reach the region's vision.

As mentioned previously, many stakeholders indicated that the world of communications planning and interoperability has slowly lost passionate, strategic people who were involved in the planning that helped the region get to where it is today. Additionally, changes in administration and job transitions or retirements often occur without a successor trained to serve as a sufficient replacement, resulting in efforts dying on the vine.

4. RECOMMENDATIONS

NCR stakeholders interviewed for this effort were asked to assign the NCR a grade for regional planning and collaboration to improve communications interoperability.

- 20 percent gave the NCR an A.
- 40 percent gave the NCR a B.
- 27 percent gave the NCR a C.
- 13 percent gave the NCR a D.[1]

Some stakeholders struggled to grade the NCR because they believe the region should receive different grades for its radio interoperability versus its coordination on activities beyond radio (planning, implementation, etc.).

These grades indicate a belief that regional planning and collaboration can still be improved. To that end, stakeholders expressed a willingness to sacrifice a little autonomy for the benefit of the greater good. For example, one person suggested:

> *"Each agency must be flexible in 'bending' toward another agency's needs, and ask itself if the decision it's making is going to help or hurt the bigger interoperability picture."*

Repeatedly, across many of the stakeholder interviews, MCP heard that the NCR often tries to tackle everything instead of focusing on a few concrete efforts in agreement across the breadth of the MWCOG committees and subcommittees. One stakeholder said:

> *"We pay lip service to unrealistic goals. We say we're going to have a regional 'everything' and that's simply not true. We need to accept our limitations up front: D.C., Maryland and Virginia are three sovereign states. We can create a governance structure resulting in good decisions made well, or we can create one that is consensus based and won't offend people."*

This comment bluntly captures the reality of the NCR: it is made up of three states trying to interoperate, and the inevitable side effect is sub-regional planning. Using this NCR Land Mobile Radio Strategic Plan as the platform, the NCR has the opportunity to recognize this reality, accept it, and determine how to best meet the needs of each of the sub-regions while still identifying and focusing on broader NCR-wide goals.

Based on the findings above, and MCP's analysis of the NCR's challenges and opportunities, as well as the region's different interoperability solutions available, MCP is providing the following strategic and technical recommendations for improving communications interoperability in the NCR.

[1] Some respondents struggled to grade the NCR because they believed the region should receive separate grades for its radio interoperability versus its coordination on activities beyond radio (planning, implementation, etc.).

4.1. STRATEGIC PLANNING RECOMMENDATIONS

MCP's strategic planning and implementation recommendations below include the following topics:

1. Vision and land mobile radio strategic plan
2. Region-wide schedule for radio reprogramming
3. Regional buying power
4. Inter-jurisdictional mutual aid MOU template
5. COG communications interoperability governance structure
6. Encryption adoption and implementation roadmap
7. Regional common operating picture
8. Regional data solution plan [2]
9. NCR-wide training and exercises

4.1.1. Vision and Land Mobile Radio Strategic Plan

The NCR should adopt the vision and Land Mobile Radio Strategic Plan.

The NCR has an opportunity to build upon legwork that has been underway for years in Northern Virginia to define a strategic vision. In 2010, Northern Virginia localities worked through the Region 7 Regional Preparedness Advisory Committee for Interoperability (RPAC-I) to determine the overarching goals of the NoVA region. Their intent was to stop reacting to interoperability problems with "band aid" solutions and instead build an incremental roadmap that helped the region maintain current levels of interoperability and identify areas for improvement or enhancement. The regional vision developed and approved by more than 120 partners from public safety disciplines and jurisdictions in Northern Virginia is as follows:

> *The National Capital Region will seamlessly share data, communications, information, and resources across jurisdiction and discipline boundaries and make decisions collaboratively to enhance the safety of our communities.*

MCP recommends that the NCR use the NoVA vision as its starting point and either assign an existing COG subcommittee or stand up a new subcommittee to focus on expanding on this vision as the foundation of the NCR's communications interoperability planning. Beginning with the vision, the subcommittee could use this NCR Land Mobile Radio Strategic Plan and its recommendations to determine priority items for action, and work through stakeholder meetings and committees to build consensus for each initiative. The final list of priorities would ultimately be approved by the Senior Policy Group (SPG).

[2] While data is an important component of communications interoperability, it is beyond the scope of this plan, which is focused on voice communications. Worth noting, many respondents referred specifically to a desired computer aided dispatch (CAD-to-CAD) solution to improve data sharing in the NCR.

The Land Mobile Radio Strategic Plan should include the regional priorities, recommended governance, and a list of responsibilities aligned to someone with the authority to help deliver on the promise. The plan should address commonly agreed upon requirements, including region-wide coverage and the life cycle of existing technology and systems in place today.

The Plan should be reviewed and updated annually, approved by the SWICs, and included as an appendix to the D.C., Maryland, and Virginia Statewide Communication Interoperability Plans (SCIPs).

MCP recommends establishing a Project Management Office (PMO) to support the implementation of the actions that help meet the goals and objectives in the Land Mobile Radio Strategic Plan.

4.1.2. Region-wide Schedule for Radio Reprogramming

The NCR should formally adopt an agreement that establishes a region-wide schedule for radio reprogramming.

Touching radios once with code plug updates for all jurisdictions saves money, time and resources. The NCR should work at the COG subcommittee meetings to determine the update schedule (likely twice yearly), circumstances that constitute an emergency update, and communicate this guideline to NCR members.

4.1.3. Regional Buying Power

The NCR should leverage regional buying power with vendors.

The NCR operates in a comparatively unique way when compared to the rest of the nation, and its stakeholders should leverage that position with vendors to create a partnership and strengthen their negotiating and buying power.

Until the NCR jurisdictions spend time mapping out upcoming technology purchases and sharing those plans with NCR partners, opportunities to leverage buying power will be missed.

For example, two NCR partners were both recently negotiating with a vendor to purchase antennas. One jurisdiction closed their deal with the vendor, and then found out about the other jurisdiction's need approximately a week later. If the two had leveraged their need and buying power, they may have been able to negotiate the equipment for less.

4.1.4. Inter-jurisdictional Mutual Aid MOU Template

The NCR should regionally support and use the MWCOG area inter-jurisdictional mutual aid MOU template.

This MOU template, crafted by the MWCOG Communications Subcommittee, is a great example of regional cooperation. It will allow participating agencies to have direct access to other participating agencies' public safety trunked radio systems, including all information necessary to configure and program user radios for operation.

Each participating agency has agreed to provide the partner agencies with a list of radio identifications (IDs) and aliases (if available), and each participating agency with encrypted dispatch channels agrees to use a regional encryption key.

4.1.5. COG Communications Interoperability Governance Structure

The NCR should review, potentially revise, and communicate about the COG communications interoperability governance structure.

The NCR should consider establishing a group to approach communications planning and interoperability similar to the way it was approached in 2006 when the first plan was written.

- Balance and embrace "sub-regionalism" by creating three equal entities for negotiation and planning: Establish the Maryland Emergency Response System (MDERS) and a DCERS to match the Northern Virginia Emergency Response System (NVERS) governance structure.
- All three sub-regions could roll up to a RPWG comprised of representatives from fire, law enforcement, emergency management, technologists, CIOs, SWICs, etc.
- The RPWG could confirm the plan and create a strategy for execution.

4.1.6. Encryption Adoption and Implementation Roadmap

The NCR should clarify its plans for encryption adoption and develop or follow an implementation roadmap.

The stakeholders in the NCR must agree to either adopt the NCR Regional Strategic Interoperable Encryption Plan drafted by the COG Communications Subcommittee or further discuss what must be changed in order to reach consensus for adoption. Based on recent decisions by some jurisdictions to encrypt, it is imperative that the whole of the NCR UASI evaluate how to best incorporate encryption across the region without breaking interoperability or preventing communication. If all NCR jurisdictions – D.C., Maryland, and Virginia – plan to move to encrypted channels or talkgroups, then the region should also discuss how it can be supported financially at the UASI level.

4.1.7. Regional Common Operating Picture

The NCR should prioritize goals and objectives to develop a regional common operating picture.

The NCR should fuse the regional needs with the practicality of creating a regional common operating picture using data, voice, video, automatic vehicle location (AVL), geographic information system (GIS), CAD-to-CAD, Virtual USA, and the NCR Geospatial Data Exchange (NCR GDX) technology to enhance awareness and informed decision making.

Working through a COG Subcommittee, the NCR should establish a project to assess the level of coordination needed at the NCR level to create a common operating picture, evaluate capabilities and infrastructure already available, and review the required resources to reach the desired level of sharing, interoperability, and coordination it desires.

- The subcommittee should identify SOPs, develop governance around the use of data, develop or adhere to standards for sharing the data, determine justifications for the type of data sharing that can occur, determine the procedure for transferring data, and clarify who owns the data once it is shared.
- To be successful, the subcommittee will need to understand and/or explore funding sources and existing procurement schedules, and a plan for reaching out to stakeholders for socialization and adoption of the approach prior to implementation. The group should set immediate goals, but plan for technology advancements that may be five to 10 years out; the NCR should consider possibilities that may offer capabilities that sound futuristic today, like three-dimensional real-time display, etc.

4.1.8. Regional Data Solution Plan

While this plan is focused on voice communications, interviewees repeatedly shared the need and desire for improved data sharing within the NCR, most often referencing a CAD-to-CAD solution. To address that need, the NCR should develop a strategic data communications plan to address communications interoperability needs, requirements, and goals beyond voice communications.

Many interviewees recognized the growing opportunities and advancements in CAD-to-CAD interoperability and the exchange of regional data, including video. They often expressed that data sharing would help move the region closer to long-term goals of closest unit dispatching, regional dispatching, and the development of a common operating picture for situational awareness.

The NCR data plan could identify common requirements for purchasing new CAD systems across the region, map out the path forward for connecting NCR CAD systems, and develop standard operating procedures of MOAs for accessing, sharing, and leveraging video for increased situational awareness.

4.1.9. NCR-wide Training and Exercises

The NCR should plan additional NCR-wide training and exercises.

The NCR should focus on developing a cycle that links investments with training and exercises. If the NCR invests in interoperability communications, it then includes training responders how to use the investment, and then conducts exercises using the investment.

Based on the needs shared during the interview process, MCP recommends that the NCR plan for the following training and exercises:

- Training
  - General NCR-wide basic training about radio interoperability.
  - Jurisdiction-specific training on the suite of capabilities that exist on a jurisdiction's home radio system.
  - A primer course for NCR leaders that focuses on the importance of communications interoperability – what it is, what it is not, how a 9-1-1 call works, how the radio system works, highlighting existing infrastructure in the locality and how it might serve as a shared resource, etc.
  - Several interviewees expressed their desire to better understand the NCR's position and plans for broadband and FirstNet.

  "On broadband, I feel like we're only hearing things from the National Public Safety Telecommunications Council (NPSTC) and nobody else. It's like the Ford guy telling me what a piece of junk the Chevy is."

- Exercises
  - Radio managers often piggyback on scenario-based drills and often only discover a radio problem while in the midst of a scenario. Radio shops across the NCR should run radio-specific communications testing drills independent of a larger exercise.

4.2. REGION-WIDE TECHNICAL RECOMMENDATIONS

Based on research of industry trends and input from NCR radio managers, MCP developed a list of five possible technological solutions that could mitigate a range of identified interoperability limitations. The evaluated solutions include a conventional simulcast overlay system, a trunking overlay system, system connections via Inter-zone, system connections via Inter-RF Sub System Interfaces (ISSI), and shared systems. The NCR Radio Capabilities Assessment report may be found in Appendix C.

Based on the benefits, shortcomings and costs associated with each identified technical solution, MCP has prioritized each technology for implementation.

1. Regional shared P25 system
2. ISSI with seamless roaming
3. Inter-zone connections
4. Conventional simulcast overlay
5. P25 trunking overlay

Not all options are mutually exclusive. The benefits offered by shared systems, ISSI and Inter-zone are very similar, and solutions could be recognized that utilize a combination of these options. The conventional and trunked overlay solutions are standalone systems and would need to be wholly implemented independently.

4.2.1. Regional Shared Systems Recommendations

MCP recommends that the NCR pursue migration to a single shared regional system as the ultimate goal for radio interoperability within the region. This migration is recommended to take place over the next 15 to 20 years as current systems reach end-of-life and will need to be replaced. Migration to a regional shared network will provide the greatest level of interoperable capabilities offered, provide improved reliability through the development of "cloud"-based backhaul networks, and provide cost savings through elimination of separate controllers for each jurisdiction. This solution satisfies the greatest number of interoperability gaps identified by radio system managers.

The cost estimate developed by MCP includes costs associated with upgrading every system to support additional capacity for increased subscriber roaming across jurisdictions. The specific amount of roaming will depend on the operational procedures and talkgroup restrictions put in place by NCR agencies. These costs may be reduced if strict limits are placed on the specific talkgroups with roaming capabilities. MCP has allocated these costs for all systems that will leverage primary system infrastructure for interoperability purposes. In the event an interim solution such as ISSI or Inter-zone is implemented, then capacity upgrades could very well be completed in advance of interconnecting systems.

Based on the current communications environment within the NCR, MCP does not foresee migration to a regional shared system to be reasonable within the short-term for most jurisdictions. Most jurisdictions have recently invested in the procurement of P25-compliant systems. Transitioning these existing systems to shared systems would result in the abandonment of numerous system controllers and require additional licensing costs for the "host" controller(s). A migration to shared systems is, however, feasible for those agencies operating legacy networks that have not yet implemented P25 systems. For these agencies, connecting to existing P25 controllers will provide cost savings and interoperability roaming benefits. WMATA is currently exploring options for a shared system controller.

MCP recognizes that each jurisdiction recognizes complete system autonomy in the present communications environment, and migration to shared systems will require a completely new ownership and operational model. With the premise that all existing systems will continue to be operated until they reach end-of-life, there will be a lengthy period where the governance and SOPs

associated with a regional system can be developed. With a regional design, the majority of radio equipment will continue to be owned and operated by each jurisdiction. Agreements will need to be in place among all agencies to coordinate system upgrades and other changes that impact all member jurisdictions.

In the interim, MCP believes solutions such as ISSI and Inter-zone will allow the NCR to slowly implement regional solutions and adapt to the interoperability model provided by shared systems while maintaining system autonomy.

4.2.2. ISSI Recommendations

MCP recommends that the NCR implement ISSI as an interoperability solution as an interim solution to building out a shared regional network. The roaming capabilities offered by the current revision of ISSI will satisfy the majority of interoperability gaps identified by radio system managers.

The primary benefit of ISSI is that the technology adapts very well to the current communications system environment within the NCR. The solution will leverage existing P25 systems already purchased and existing backhaul networks. The flexible nature of the solution will enable each agency to maintain the complete autonomy of their network infrastructure, and tightly control the level of roaming to ensure capacity is maintained on primary networks. Adapting to the capabilities provided by ISSI will provide the region a long-term migrating path to implement shared system solutions.

Implementing ISSI will require existing Motorola P25 networks to be a system release level 7.13 or later. Several jurisdictions within the NCR are either already at release level 7.13 or have plans to be at 7.13 or a more current release within the next two years. Jurisdictions with legacy systems will be purchasing P25 systems in the near future, and will be at the current system release offered by their system vendor. The additional costs associated with the implementation of ISSI include the purchase of an ISSI gateway by each jurisdiction, licensing ISSI roaming capabilities through the equipment vendor, and establishing backhaul connectivity through NCRNet. Subscriber flash upgrades to add ISSI roaming software and talkgroup modifications will be required for most jurisdictions.

Additional costs will be necessary to accommodate additional roaming traffic if ISSI is implemented in a manner that permits a high-level of system-to-system roaming. This capacity increase will be most effectively handled through the upgrade of primary systems to support P25 Phase II TDMA. Migration to TDMA is a logical progression for most jurisdictions within the next 5–7 years as widely fielded XTS/XTL series subscribers reach end-of-life and are replaced with Phase II-compliant radios. The level of ISSI roaming in each jurisdiction can be tightly controlled to maintain the capacity until the point that capacity increases can be accommodated.

The greatest cost associated with ISSI is the licensing required to interconnect each jurisdiction to multiple other interoperability partners. Motorola has provided a proposal to establish ISSI connectivity for existing NCR jurisdictions that includes cost savings above and beyond list pricing for ISSI connections.

Alternatively, ISSI may be configured in a “hosted” environment where every agency establishes a connection to a single NCR jurisdiction. Once this connection is established, talkgroups configured on the host system will be permitted to roam anywhere within the interconnected systems. Every jurisdiction would have the ability to program these talkgroups and roam on those talkgroups where permitted. This solution would only necessitate one connection for each jurisdiction, and multiple connections for the host jurisdiction. Overall this represents a significant decrease in the total number of connections. The primary limitation with this configuration is primary operational talkgroups would not have the ability to roam into surrounding jurisdictions. Only designated wide-area channels configured in the host system will have roaming capabilities. This configuration will result in fewer needs identified by area radio managers being addressed.

4.2.3. Inter-zone Recommendations

Systems interfaced with Inter-zone act as one interconnected system and provide similar capabilities to shared networks. Inter-zone requires interconnected systems to be maintained at the same system release level, use the same system ID, and have shared subscriber databases. With this configuration some autonomy of each jurisdiction is lost. However, unlike a completely shared system, interconnected agencies possess all the components necessary to separate back to a standalone network. The costs associated with an Inter-zone connection are minimal, depending primarily on establishing backhaul connectivity and reprogramming subscribers to transition to the common system ID.

In the near-term, Inter-zone may prove to be a challenge as most jurisdictions are on separate procurement and upgrade schedules. Ideally, agencies connected via Inter-zone would have SUAII and regularly coordinated system release updates.

MCP supports Inter-zone as an alternative to ISSI, permitting similar capabilities to ISSI for a lower cost. The primary difference between the alternatives is that ISSI offers a greater level of autonomy between agencies and permits connections in a standards-compliant manner that could be used to interface with systems manufactured by other vendors.

Like shared system and ISSI options, costs will be necessary to raise all systems wishing to interconnect to a shared release level, and to add capacity to support increased roaming. Capacity increases will depend on the level of roaming permitted, and may be completed over time as the region increases roaming capabilities.

4.2.4. Conventional Overlay Recommendations

MCP believes that the conventional simulcast overlay could be completed for a relatively low cost and provide wide-area communications capabilities throughout the NCR on designated channels. However, MCP believes that this alternative is less beneficial than other options due to the fact that coverage will be significantly lower than that offered by primary communications systems. Due to the weaker

coverage in general, the lack of in-building coverage compared to primary systems, and the requirement to switch off primary trunking systems for channel changing, MCP believes that such a system would not be regularly utilized.

4.2.5. Trunking Overlay Recommendations

MCP believes that a trunked overlay solution could be completed for a relatively low cost if using an existing P25 core and provide wide-area communications capabilities throughout the NCR on designated talkgroups. Compared to the conventional solution, a trunked overlay solution will offer significantly more capacity. However, MCP believes that the limitation with such a system will be coverage, and not capacity. Obtaining spectrum for a regional system could prove to be a challenge, and introduce uncertainty as to whether such a system could be constructed.

4.3. MIGRATION PLAN

MCP has developed a high-level migration plan for the implementation of the recommended interoperability technologies. The implementation plan is based upon already planned upgrades, funding sources and equipment life cycle considerations.

4.3.1. 2013 – 2015

By 2015, MCP recommends that each NCR jurisdiction implement ISSI to permit the use of designated wide-area roaming talkgroups. Most jurisdictions operating Motorola P25 systems have plans in place to update their system release level within the upcoming years. Most jurisdictions operating legacy networks have plans for P25 procurements in the near future, and should be operating P25 systems by the end of 2015. At this point, the majority of pre-conditions for ISSI will have been met, and the additional costs will strictly be attributed to ISSI gateways and licensing. MCP's recommendation is strictly for designated wide-area talkgroups in this time period, which should result in nominal strain on the capacity of primary systems. For this configuration, a "hosted" ISSI solution should suffice which would reduce up-front ISSI costs.

4.3.2. 2018 – 2021

Within five years, the legacy Motorola XTS/XTL subscribers used by most agencies in the NCR will reach end-of-life, and radio replacement is imminent. Upgrading subscriber radios is the largest anticipated cost associated with upgrading systems to support TDMA. A TDMA upgrade will provide a substantial increase to the capacity offered by the systems of each jurisdiction, providing additional overhead to support additional roaming capabilities. At this time, MCP recommends that the NCR expand to support the roaming of primary operational talkgroups. This change will allow radio users to benefit from the strongest signal strength available, regardless of which jurisdiction's radio tower is providing the coverage. Users will be able to freely roam outside their county for mutual aid or pursuits without needing to change to another system or a designated wide-area channel. It is MCP's opinion that this level of roaming will result in a significant increase in system traffic, thus necessitating the

additional capacity provided by TDMA. Additional ISSI connection licenses will be needed for each agency at this time if they are not purchased up-front.

4.3.3. 2025 – 2030

As recently installed P25 networks reach end-of-life, MCP recommends the region migrate toward a shared interoperable network with common control equipment and a "cloud"-based backhaul network. A shared network will result in significant cost savings and additional interoperability enhancements compared to those offered by ISSI. Recognizing that the technology solutions that will be available are not yet defined, MCP recommends the region is cognizant of the solutions available and implements a cost effective shared network model. Based on present technology such a system would include a standards-based P25 network with geo-diverse control equipment with redundant backhaul connections. With the anticipated public safety broadband network (FirstNet), it is altogether possible that long-term evolution (LTE) will become the new standard for mission critical voice. It is for this reason that MCP recommends the region establish a long-term goal to migrate toward a regional shared system, and narrow down the specific technology as the time gets closer and technology projections become more accurate.

4.4. OPERATIONAL RECOMMENDATIONS

While the technical abilities offered by the solutions discussed on this report will provide greatly enhanced interoperable capabilities for the region, operational changes are required to recognize those benefits. These operational changes directly correlate to specific interoperability gaps defined by radio system managers. The following section discusses MCPs recommendations as to what operational changes are required to bridge these gaps in conjunction with the recommended technical solutions.

1. **Wide-area Talkgroups** – All interoperability solutions discussed involve the establishment of wide-area talkgroups that can be utilized to communicate anywhere within the region without switching channels. Wide-area talkgroups provide a valuable tool that could be utilized for numerous circumstances, including command and control of wide-area events spanning multiple jurisdictions, police chases across jurisdictional boundaries, EMS and prisoner transports, and unpredictable requirements that cannot even be fathomed. Implementing these talkgroups requires operational changes to ensure the channels are used to their greatest effectiveness. At a minimum, MCP recommends creating a common zone in each subscriber radio with 16 interoperability talkgroups (or the four conventional channels if a simulcast solution is implemented). SOPs should be developed that outline the specific use of the wide-area channels, including when users should access them, and what channels will be monitored throughout the region. Training and exercise plans should be implemented to provide users scenarios when the channels should be utilized and practice using them. The channels will be utilized to their greatest effectiveness when usage is integrated with the daily operational model of all first responders.

2. **Simplify Interoperability** – Simplifying interoperability was one of the greatest challenges noted by most area radio managers. The interoperability solutions in place today require users to change channels as they enter a jurisdiction for mutual aid purposes. Because of the large number of talkgroups in each system, most NCR radios have countless banks of talkgroups. For most users, locating and accessing the appropriate talkgroup is an operational challenge, especially if they are entering a jurisdiction that is not part of their daily requirements. With the implementation of new interoperability solutions such as wide-area channels and roaming capabilities, the opportunity exists to simplify interoperability for end users. MCP recommends this be accomplished by moving to a regional model for talkgroups, where the number of agency-specific talkgroups are reduced and replaced with designated interoperability talkgroups. Through this model, events throughout the region may be concentrated on a single bank of designated wide-area interoperability talkgroups. Placing these talkgroups on the second or third primary zone will permit users to access these channels without using the keypad on their radio. By utilizing these channels for primary traffic, users should be able to quickly and effectively access these channels regardless of their location within the NCR.

3. **Subscriber Programming** – Virtually every radio manager within the NCR commented about the frequent need for reduced subscriber programming. The technology solutions discussed in this report will not inherently reduce the need for subscriber programming. Reducing programming requirements will depend upon reducing the frequency of code plug changes across the region. Radio managers indicated that prior to rebanding code plug updates were coordinated once a year so that programming efforts across the region could be limited. MCP recommends that this policy is re-initiated. Migrating to regional systems and talkgroup plans should reduce the overall number of talkgroups, limiting the potential changes. Technology solutions such as OTAP are available to reduce the time and effort associated with programming. MCP anticipates that the requirement for code plug changes should reduce inherently based on the fact that most jurisdictions have already completed rebanding and migrations to P25 systems.

4. **Coordinated System Updates** – Coordinating procurements was indicated by many jurisdictions to be an interoperability challenge. Historically, whenever a single agency implements a new technology or feature, every other agency must update their system or subscribers in order to be compatible with the new feature sets. At the present time, some NCR jurisdictions have implemented TDMA systems that are not compatible with the FDMA radios with neighboring jurisdictions on primary operational channels. Separate FDMA talkgroups or patching is necessary in these circumstances. Numerous agencies indicated that interoperability has been optimal when all jurisdictions have had sufficient time to upgrade to compatible platforms. Some of the solutions proposed by MCP will necessitate operating at equivalent platforms or using shared networks, requiring coordinated system upgrades. However, the optimal method for maintaining systems on compatible platforms is for each agency NCR jurisdiction to coordinate updates with neighboring jurisdictions. While aligning procurement cycles will help this effort, extensive interoperability planning should be performed in advance of procurements to ensure interoperability plans are in place. This can be

coordinated with a set of mandatory requirements for all radio system upgrades that are agreed to by all NCR agencies.

5. CONCLUSION

If regional leaders commit to planning, coordination, and implementation through regional, consensus-driven work groups, the recommendations in this plan are achievable.

The entities of the NCR – D.C., Maryland, and NoVA – can maintain their individual missions and autonomy while collaborating at a higher level for mutual benefit, seamless communication, and improved information sharing.

The NCR COG subcommittees, in partnership with the SPG, must agree on the NCR's regional priorities based on desired future-state capabilities, and agree on next steps for action.

Appendix A – Stakeholder Interview Questions

The stakeholder interview questions may be found on the following pages.

1. What is your role and agency/organization?
2. How long have you been interfacing with other members of the NCR (through COG)?
3. How do you think interoperability improves day-to-day operations and service delivery to citizens?
4. What are your agency's interoperability priorities?
5. What are the strengths of the NCR? // What is working well and how does it benefit the NCR?
6. What are the operational or interoperability challenges you face when working with other members of the NCR?
7. What are the NCR's interoperability weaknesses? // What is not working well in the NCR and what is the impact this has on the Region? Do you have any suggested changes?
8. What are the NCR's interoperability opportunities (Voice, data and video)?
9. If you assigned the NCR a grade for regional planning and collaboration to improve communications interoperability, A – F, what grade would you give it?
10. What would help the NCR better plan and collaborate regionally?
11. How should we maintain our interoperability awareness? Training? Testing? What works or doesn't work today?
12. What is your vision for your locality or agency (big picture)?
13. Please tell us your vision for the NCR. Please share a few ways to help the NCR go from where it is today to your vision.
14. What capabilities should the NCR be working toward for 5, 10, 15 years out?
15. Is there anything that excites you about the NCR Strategic Plan?
16. Are there any governance bodies with best practices that you think could be leveraged within the NCR?
17. Who else would you recommend we reach out to for an interview?

Appendix B – Radio Assessment Interview Questions

The interview questions for the radio assessment may be found on the following pages.

1. Can you please describe the vision your locality has for public safety communications?
2. What do you consider your existing systems strengths and weaknesses?
3. What plans, if any, do you have for future upgrades?
4. How important is it for your public safety stakeholders to communicate across jurisdictional boundaries?
5. Where do those boundaries begin and end (immediate neighbors, regional neighbors)?
6. What other systems do your agency's users regularly access (change channels off of primary system)?
7. When your agency's users switch off of the home system how do your home-system's users and dispatchers communicate with them?
8. What other agency's regularly access your system for interoperability purposes?
9. How do those users communicate with their home system users and dispatchers when they are roaming on your system? Does your system have sufficient capacity to support a regular influx of users from neighboring jurisdictions?
10. Is there overlapping coverage from neighboring systems that would be of benefit for your agency's primary jurisdiction?
11. What systems or policies do you currently have in place to accomplish interoperability with your neighbors?
12. What are the burning issues or challenges interoperable communications/technology the NCR has in terms of communications?
13. What are the risks of not tackling those challenges?
14. Do you see ISSI as a possible solution to interoperable communications within the NCR?
15. What would you personally like to see happen?
16. Is autonomy for communications important to your locality?
17. Would your locality be willing to share resources if autonomy could be maintained?
18. What history should I be aware of? What past events are likely to exert an influence on the future of interoperability within the NCR?
19. Do you believe interoperable communications is an officer/firefighter/EMS provider safety issue?
20. How do interoperable communications play a role in command and control?

Appendix C – Radio Capabilities Assessment Report

The NCR Radio Capabilities Assessment report may be found in its entirety on the following pages.

National Capital Region
Radio Capabilities Assessment *(Complete Version)*

Submitted June 2014 to:

Northern Virginia Emergency Response System
National Capital Region

MissionCriticalPartners
690 Gray's Woods Boulevard | Port Matilda, PA 16870 | 888.8.MCP.911 or 888.862.7911 | www.MCP911.com

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EXECUTIVE SUMMARY

Through a National Capital Region (NCR) Urban Area Security Initiative (UASI) grant opportunity, the Metropolitan Washington Council of Governments (MWCOG) retained Mission Critical Partners, Inc. (MCP) to perform a radio capabilities assessment and develop a Land Mobile Radio Strategic Plan for the NCR. The goal of the assessment was to evaluate the present state of radio interoperability within the NCR, identify interoperability gaps, evaluate how recent technological advances could mitigate those gaps, and set a long-term vision for the future of technology within the region.

MCP gathered information regarding the existing land mobile radio (LMR) system within the region through meetings with radio managers of each of the NCR jurisdictions. Information was gathered regarding the present configuration of each radio system, future plans for upgrades and interoperability challenges that are faced with the present interoperability environment. Based on this information, MCP established a baseline for the present configuration of systems across the NCR, and identified a total of ten interoperability limitations with the current configuration of systems. MCP notes that, overall, NCR radio managers agree that the region has a very high level of interoperability that satisfies the majority of first responder requirements. The most notable limitations were:

1. The inability to monitor radio traffic for an incident before entering the coverage footprint of the serving system
2. The inability to communicate with home system dispatchers when roaming off system
3. The inability to carry primary-system coverage during extended pursuits, emergency medical services (EMS) transports, prisoner transfers, or other wide-area responses
4. The cluttered and complicated nature of interoperability fleet maps

Based on research of industry trends and input from NCR radio managers, MCP developed a list of five possible technological solutions that could mitigate a range of identified interoperability limitations. The evaluated solutions include a conventional simulcast overlay system, a trunking overlay system, system connections via Inter-zone, system connections via Inter-RF Sub System Interfaces (ISSI), and shared systems. For each option MCP identified strengths and weaknesses, identified interoperability gaps that would be satisfied, and performed a gap analysis to determine what steps would be necessary to implement each solution given the present state of NCR communications systems.

Several of the identified options would lead to a considerable increase on the loading of primary communications networks, reducing the overall available capacity. MCP developed loading projections for the increased interoperability traffic and developed recommended capacity increases to support each interoperability solution.

Conceptual designs were developed for each option to provide a better idea of what system components each solution would require. As part of the conceptual design, radio coverage and backhaul diagrams were developed for each option to further define the respective requirements. Based on this information, MCP developed cost estimates for each alternative. Costs were broken

down according to fees necessary to implement the interoperability solution, fees necessary to support capacity increases in primary networks to support each solution, and fees necessary to upgrade the system release platform of primary systems to support each system. The table below summarizes the costs associated with each option.

Technology Option	Interoperability Solution Costs	Capacity Increase Costs	System Upgrade Costs
Option 1 – Conventional Simulcast Overlay	$2,695,000	$0	$0
Option 2 – Trunking Overlay	$7,180,000	$0	$0
Option 3 – Inter-zone	$5,470,000	$15,774,500	$3,000,000
Option 4 – ISSI	$17,079,927	$15,774,500	$3,000,000
Option 5 – Shared Systems	($5,138,000)	$15,774,500	$3,000,000

MCP notes that there is a considerable level of complexity associated with each identified option that is not reflected in the cost alone. The Inter-zone and shared system options require radio system identification (ID) changes, necessitating substantial radio programming and coordination efforts as well as operational risks during system cutovers.

Based on the strengths, weaknesses and costs associated with each evaluated option, it is MCP's recommendation that the NCR implement ISSI in the short-term and plan a long-term migration to a single regional shared system. In the short-term, ISSI will meet most of the interoperability gaps identified by NCR radio managers; ISSI is also particularly well adapted to the current radio system environment within the NCR, permitting continued autonomy of the disparate radio systems. ISSI is a tool utilized to tie disparate Project 25 (P25)-compliant systems together, allowing subscriber radios with properly configured talkgroups to roam freely between the coverage areas of the disparate systems without changing channels. ISSI can be implemented on Motorola networks operating at system release level 7.13 or later. Most jurisdictions in the region are already operating on Motorola P25 trunking systems and have plans to update to release level 7.13 within the upcoming years. The remaining jurisdictions operate legacy Motorola networks and are planning P25 procurement in the near future. ISSI is a P25 standard and connections will be available regardless of which vendor the jurisdictions with pending procurements ultimately select. Inter-zone connections provide similar benefits and may be used in place of ISSI connections if jurisdictions can agree to coordinate system upgrade schedules.

In the long-term, MCP recommends that the region migrate toward shared networks as the present P25 systems reach end-of-life. Operation on a single shared network will reduce the costs for each jurisdiction, maintain and improve the levels of interoperability provided by ISSI, and provide a more reliable cloud-based network.

MCP recommends that the region target the implementation of ISSI by the end of 2016. With this solution the region may implement designated wide-area talkgroups for specialized radio traffic that can

be used anywhere within the interconnected systems. Such usage should be able to be accommodated within the present capacity levels of existing NCR radio systems. By 2021, MCP recommends that the level of roaming be expanded to support primary operational traffic, providing increased coverage and roaming capabilities. To accommodate the increase in roaming, MCP recommends each system implement Phase II time division multiple access (TDMA) to provide increased capacity. MCP recommends that the migration to shared systems be completed by 2030 as existing systems reach end-of-life.

To coincide with the recommended technology updates, operational changes are recommended to provide for the optimal usage of the new solutions. Governance organizations will need to be developed to manage shared resources for the new solutions. Standard operating procedures (SOPs) will need to be developed that clearly define how the new technologies should be utilized by first responders.

MCP recommends a migration toward a regional approach to talkgroups to reduce the overall number of available talkgroups for first responders, thus simplifying interoperable communications. This would be accomplished through the establishment of designated wide-area channels that will operate regardless of jurisdictional boundaries.

MCP recognizes that recommendations are provided for system configurations over 15 years away. Recognizing that the technological solutions that may be available are not defined, it is MCP's recommendation that the region continue to move toward a shared network, but evaluate developing technology to determine what the appropriate technology should be when the time comes.

1. INTRODUCTION

The NCR is one of the most multi-jurisdictional population centers in the United States with a metropolitan statistical area (MSA) population of almost 6,000,000 people. Due to open jurisdictional borders, interoperability between disparate agencies that comprise the NCR is not an infrequent event, but rather part of routine daily operations.

The current communications environment within the NCR dates back to the Air Florida Flight 90 crash on the I-395 bridge between Washington, D.C., and Arlington County, Virginia, in 1982. The event was further compounded by a Metro derailment the same day. The disaster exposed significant weaknesses in the ability of first responders in different jurisdictions to communicate with each other effectively. Within the years following the event, most jurisdictions within the region implemented shared interoperability channels and eventually 800 megahertz (MHz) Motorola trunking platforms. By the year 2000, most jurisdictions within the NCR operated Motorola trunking systems with subscriber radios capable of operating on most of the other radio systems within the region. During the events at the Pentagon on September 11, 2001, communications remained intact and were used to effectively coordinate first responders throughout the region.

During the mid-2000s, the Association of Public-Safety Communications Officials – International (APCO) P25 standard for trunking systems became available, and systems began being deployed compliant with this new technology. By 2010, many of the legacy Motorola 800 MHz trunking systems had reached the end of their useful life and the availability of support to keep systems operational was diminishing. As of 2013, most NCR agencies have replaced their last-generation (“legacy”) systems with P25-compliant systems. Several agencies are still operating legacy networks and are planning migration to P25.

With the migration of radio systems within the region to P25, the opportunity has become available to potentially improve interoperable communications within the NCR. New features such as the P25 compliant ISSI as well as the ability to interconnect and share systems have opened the door to provide additional capabilities between interoperating agencies.

The purpose of this assessment is to review the radio systems within the NCR, identify if there are any additional capabilities that would benefit first responders within the region, review the technological capabilities that could improve or mitigate interoperability gaps, recommend a direction for improving interoperability, and develop cost estimates to implement those recommendations.

2. METHODOLOGY

This section describes the various steps taken by MCP to complete the NCR radio capabilities assessment.

2.1. INTERVIEWS

MCP met with Motorola Solutions Inc. on March 22, 2013, and Harris Corporation on April 2, 2013, to discuss the current interoperability solutions available. The discussions were focused on ISSI offerings.

MCP conducted interviews with NCR radio managers to solicit feedback regarding the state of each NCR radio system, future upgrade plans and interoperability gaps. Dates that interviews were conducted with each NCR agency are as follows, alphabetical by date:

- Arlington County – April 30, 2013
- Fairfax County – April 30, 2013
- Fauquier County – April 30, 2013
- Stafford County – May 14, 2013
- City of Alexandria – July 8, 2013
- Loudoun County – July 8, 2013
- Washington DC – July 9, 2013
- Montgomery County – July 17, 2013
- Prince George's County – July 17, 2013
- Washington Metropolitan Area Transit Authority – October 10, 2013
- Frederick County – October 11, 2013
- Charles County – October 25, 2013
- Metropolitan Washington Airports Authority – October 28, 2013

During each interview, questions were asked regarding the following subjects:

1. Technical makeup and history of each radio system
2. How interoperability is accomplished today
3. How interoperability could be improved
4. How current technology could be used to improve interoperability

A copy of the interview questions is included in Appendix A.

2.2. CONCEPTUAL DESIGNS

To evaluate each identified system option, MCP developed conceptual system designs that included the selection of radio sites and the development of backhaul connection plans. Radio sites were selected based upon radio propagation modeling using EDX® SignalPro® software. Conceptual designs were developed to gain a better understanding of what would be required for each system

option to be designed to a level that would meet NCR requirements. These conceptual designs were utilized as a baseline for the development of cost estimates.

2.3. COST ESTIMATES

Cost estimates were developed for each evaluated system option based upon list and vendor-provided pricing for the various components that would be required for each option. Cost estimates were broken down based upon costs associated with system release updates, costs associated with capacity increases, and costs associated with the implementation of interoperability solutions. Costs were broken down in this manner because costs associated with system release updates are likely to be incurred through the regular system update cycle of each jurisdiction within the NCR whether or not the identified interoperability solutions are implemented. Costs associated with capacity updates are dependent on the specific operational model that will be implemented for each interoperability solution. Costs associated with the interoperability costs are those anticipated costs directly related to the implementation of the recommended solutions.

2.4. REPORT DEVELOPMENT

Based on the information collected, this report was compiled which summaries MCP's findings, analysis and recommendations. The report is broken down into the following sections:

- **Findings** – The findings section includes the current state of affairs within the NCR. This section includes the current operational model, the current radio systems environment, interoperability gaps, and a summary of governance organizations.
- **Analysis** – The analysis section includes a review of the available technologies that could potentially address the identified interoperability gaps, a comparison of which gaps each option addresses, a loading study to determine the impact of each solution on system loading, and a gap analysis to determine what steps are necessary to implement each alternative.
- **Conclusions and Recommendations** – The conclusions and recommendations section includes conceptual system designs for each alternative, cost estimates, technology recommendations, a recommended technology migration plan, and operational recommendations.

3. FINDINGS

3.1. OPERATIONAL BASELINE

The NCR is defined as Washington, D.C., and portions of Maryland, Virginia and West Virginia that surround the Nation's capital. As of 2012, the estimated population according to the US Census was 5,860,342, making the Washington, D.C., area the seventh largest metropolitan area in the United States. The combined geographic area of the region is 6,361 square miles. Table 1 summarizes the cities and counties that comprise the Washington MSA.

Table 1 – Washington MSA

Political Subdivision	Population	Land Area (square miles)	Population Density (people/square mile)
Washington, D.C.	623,323	68.3	9,126.3
Fairfax County, VA	1,118,602	407	2,748.4
Prince William County, VA	430,289	348	1,236.5
Loudoun County, VA	336,898	521	646.6
Arlington County, VA	221,045	26	8,501.7
City of Alexandria, VA	146,294	15.4	9,499.6
Stafford County, VA	132,719	280	474.0
Spotsylvania County, VA	124,526	412	302.2
Fauquier County, VA	65,203	651	100.2
City of Manassas, VA	40,605	10	4,060.5
Warren County, VA	37,575	216	174.0
Culpepper County, VA	36,689	382	96.0
City of Fredericksburg, VA	27,307	10.5	2,600.7
City of Fairfax, VA	22,565	6.3	3,581.7
City of Manassas Park, VA	15,798	2.5	6,319.2
Clarke County, VA	14,034	178	78.8
City of Falls Church, VA	13,229	2.2	6,013.2
Rappahannock County, VA	7,373	267	27.6
Montgomery County, MD	1,004,709	507	1,981.7
Prince George's County, MD	871,233	498.5	1,747.7
Frederick County, MD	233,385	352	663.0
Charles County, MD	146,551	643.2	227.8
Calvert County, MD	88,737	345.1	257.1
Jefferson County, WV	54,225	212	255.8

Figure 1 represents members of the Metropolitan Washington Council of Governments (MWCOG). Fauquier County was included in addition to the listed MWCOG member agencies.

Figure 1 – NCR Geographic Area

The communications systems specifically addressed in this study are operated by those agencies that fall in jurisdictions identified on the map above. MCP focused on County agencies; Washington, D.C.; the independent City of Alexandria; the Metropolitan Washington Airports Authority (MWAA); and the Washington Metropolitan Area Transit Authority (WMATA).

3.1.1. NCR Communications

The NCR is one of the most, if not the most, progressive regions in the country when it comes to interoperable communications. Despite political and jurisdictional boundaries, NCR agencies have proven to work regularly across jurisdictional boundaries, effectively deploy the incident command system (ICS) and share an unprecedented amount of information.

Interoperable communications is employed through the use of compatible radio system technologies deployed by most agencies within the NCR. These systems include a combination of Motorola P25 and legacy 700/800 MHz trunking systems. The handheld and mobile (subscriber) radios for these systems are compatible with all other systems within the region. A well-structured region-wide ID scheme and information sharing effort has permitted virtually every subscriber radio within the NCR to be programmed with every other system.

During typical interoperability scenarios when a user responds to an event outside their jurisdiction, the user will switch to the appropriate talkgroup for that jurisdiction, which is being monitored by the primary public safety answering point (PSAP) for that jurisdiction. By switching talkgroups, the user switches from their primary radio system and to the system corresponding to the area in which they are responding. Prior to switching from their home system, the user will report to their primary PSAP (communications center) that they are responding to an event off system. When the user has completed the response, they will re-establish communication with their home PSAP.

3.1.2. NCR Response Scenarios

While interoperability can be accomplished technically, the interoperability scenarios within the NCR are quite complex. There are different mutual aid requirements for public safety disciplines and for the different states that comprise the NCR. The following sections detail the different interoperability scenarios by jurisdiction and state.

3.1.2.1. Cross-state Interoperability

For mutual aid purposes, Washington, D.C., functions as a standalone state bordered by the states of Virginia and Maryland. Within each respective state, fire and EMS may be dispatched across jurisdictional boundaries. Mutual aid is provided across state boundaries only during special circumstances such as pre-planned events, major disasters, events occurring directly on the border between two states, hospital or prisoner transports, events requiring special equipment from a cross-state jurisdiction, or felony in-progress pursuits. These events occur regularly between Fairfax County, Virginia, and Montgomery County, Maryland, and less frequently between Fairfax County and Prince

George's County, Maryland. Shared jurisdictional responses occur between local, state, and federal users for water rescue operations occurring on the Potomac River.

3.1.2.2. Fire and EMS Communications

Most jurisdictions within the NCR dispatch fire and EMS units based on proximity to the event, and not jurisdictional boundaries. This type of dispatch is limited to users within each given state, with Washington, D.C., only dispatching fire and EMS units from within the District. Therefore, these response scenarios primarily take place among the northern Virginia jurisdictions and among the Maryland jurisdictions. For these reasons, fire stations falling near the border of two jurisdictions within a given state are regularly dispatched outside of their primary jurisdiction.

When a fire or EMS 9-1-1 call is received, the dispatching PSAP will select the most appropriate station and dispatch the corresponding users on the appropriate talkgroup designated for dispatch of that station. In most cases the station will be dispatched on the station's primary serving radio system, which is a different system from the primary system of the cross-jurisdictional dispatching PSAP.

After dispatch the responding units will report to their primary dispatch and then switch systems to the appropriate response talkgroup for the jurisdiction they are entering. The units will remain on this talkgroup in communication with the dispatching PSAP for the duration of the event. Following the event, the users will return to their home station, switch back to their primary dispatch talkgroup and report their status to their primary PSAP.

Stations further from a jurisdictional border may be dispatched if the primary serving station is already on an active call. Additional stations may be dispatched during larger events requiring more response units. Specialty response units such hazardous materials (HazMat) or airport foam trucks may be called for mutual aid further outside their jurisdiction if the specific need arises, including responses across state lines. Hospital patient transports may necessitate EMS units traveling several jurisdictions away depending on the needs of a patient and the occupancy of area hospitals. Pre-planned events such as the Presidential Inauguration require out-of-state response, but are coordinated using pre-planned talkgroups and procedures. Larger events such as wide-area wildfires have required units from several jurisdictions removed to respond, in many cases across state lines.

Most fire and EMS units are pre-programmed with the talkgroups of all area trunking systems and can switch to the primary system serving the area when they respond further outside their jurisdiction. If the talkgroups are not pre-programmed then the radios will need to be re-programmed before the users are deployed, or the users will need to depend on alternate methods of communication, including simplex operation, mobile gateways or cache radios.

3.1.2.3. Law Enforcement Operations

All law enforcement agencies within the NCR are dispatched according to political boundaries. When a 9-1-1 call is received, the dispatch center will send the closet available unit within the home jurisdiction

on the primary dispatch talkgroup. Law enforcement personnel are only permitted to pursue a suspect outside of the primary jurisdiction if there is a felony in progress. During these scenarios, the user will remain on their home system talkgroup until the pursuit can be transferred to the local jurisdiction.

Other scenarios that may require law enforcement mutual aid include pre-planned events such as the Presidential Inauguration, events occurring on the border between two jurisdictions, prisoner transports, and major disasters that surpass the capabilities of the primary serving jurisdiction.

3.2. STAKEHOLDER REQUIREMENTS

The following sections detail interoperability strengths and limitations or challenges that were noted by one or more radio managers.

3.2.1. Interoperability Strengths

- System Compatibility
  There was fairly unanimous agreement among all area radio managers that the NCR had one of the highest levels of interoperability of any region in the country. This level of interoperability was attributed to a significant investment in compatible radio systems following the Air Florida Flight 90 crash between Arlington County and Washington, D.C. In the years following the event, each jurisdiction implemented Motorola trunked networks, which permitted subscriber radios the ability to access all neighboring systems. This level of interoperability has been maintained as most jurisdictions within the region have implemented Motorola P25 systems with subscriber radios that remain compatible with legacy Motorola trunked networks.

- Operational Model
  The current operational model is for users to switch systems when they cross a jurisdictional boundary to permit communications with the PSAP responsible for the event. This operational model aligns with the geographic coverage limitations of each system. As long as users switch systems when they cross jurisdictional boundaries, there is an infrequent need for users to communicate in areas with inadequate radio coverage from their home system.

- Subscriber IDs
  The NCR has developed a comprehensive subscriber ID plan that allots specific ID ranges for P25 radios to each NCR jurisdiction. The subscriber ID plan permits each specific radio to have a unique ID regardless of which system that user is operating on within the NCR. A specific ID remains the same from system to system. The ID plan does not apply to legacy Motorola “Type II” systems.

- Information Sharing
  NCR radio managers regularly collaborate to discuss and resolve interoperability challenges. This level of communication permits different jurisdictions to quickly and effectively diagnose and resolve problems as they occur.

- Equipment Sharing
  Because most jurisdictions within the NCR operate similar radio system platforms and technologies, there is immediate access to spare parts or system knowledge from neighboring jurisdictions. Several instances were noted where equipment failures were easily remedied because of spare parts provided by a neighboring jurisdiction.

- System to System Backup
  Because most NCR radio systems provide a good amount of overlap into neighboring jurisdictions, the systems provide an inherent backup in the event any one system should fail completely. These backup scenarios are part of the continuity of operations plans for multiple jurisdictions throughout the NCR.

3.2.2. Interoperability Limitations

- Interoperability Everywhere
  The current system configuration permits radio users to access any other radio system as long as they have the system programmed in their radio and are within the coverage footprint of the system they are accessing. Dispatch centers only have access to the primary serving radio system and, in most cases, those systems from immediately neighboring jurisdictions. Connectivity is not provided to radio systems further removed than one county. This significantly limits the ability of first responders to communicate with their home PSAP when they are outside of their primary jurisdiction, and limits first responders from monitoring traffic from distant events to which they are responding. Several radio managers expressed the desire to have the ability to communicate on any NCR talkgroup from any location within the NCR. While most mutual aid scenarios do not require this level of connectivity, this level of interoperability would permit a near limitless level of connectivity among NCR jurisdictions to accommodate any conceivable interoperability scenario. Examples of specific response scenarios that would benefit from this level of connectivity include situational awareness for large-scale disasters requiring response from across the region or responses for specialty units such as HazMat or foam trucks that may respond several jurisdictions away.

- Wide-area Channels
  The current system configuration limits specific talkgroups to use within the coverage area of any one system. Once a user roams outside of the primary jurisdiction that user must switch to the talkgroups of another system. This frequent channel changing can be difficult for users, especially during events such as a police pursuit that crosses many jurisdictional boundaries. Designated wide-area channels would permit users to switch to one specific channel that would operate regardless of which jurisdiction the user resided in. Such channels would simplify interoperability during police pursuits and could be used for other events requiring cross-jurisdictional communication such as prisoner transports, EMS transports or large-scale disasters.

- Coverage from Other Systems
  Several instances were noted where specific areas in one jurisdiction were covered more optimally by a neighboring radio system, particularly in portions of Fairfax and Fauquier counties. Currently subscriber radios will only affiliate with the primary system unless the user manually switches to a talkgroup on the secondary system. Several select talkgroups have been setup in the current systems' configurations to access this more beneficial coverage when it is necessary.

  To document specific areas that could benefit from this extended coverage, MCP conducted a "best server" propagation study of all radio sites within the NCR. A best server study displays a color gradient around each radio site for which that site is calculated to provide the strongest signal of any surrounding site. Any areas where the colored gradient from a site lying in one jurisdiction extends to an adjacent jurisdiction are areas that would benefit from the extended coverage.

  Figures 2 and 3 depict the best server studies.

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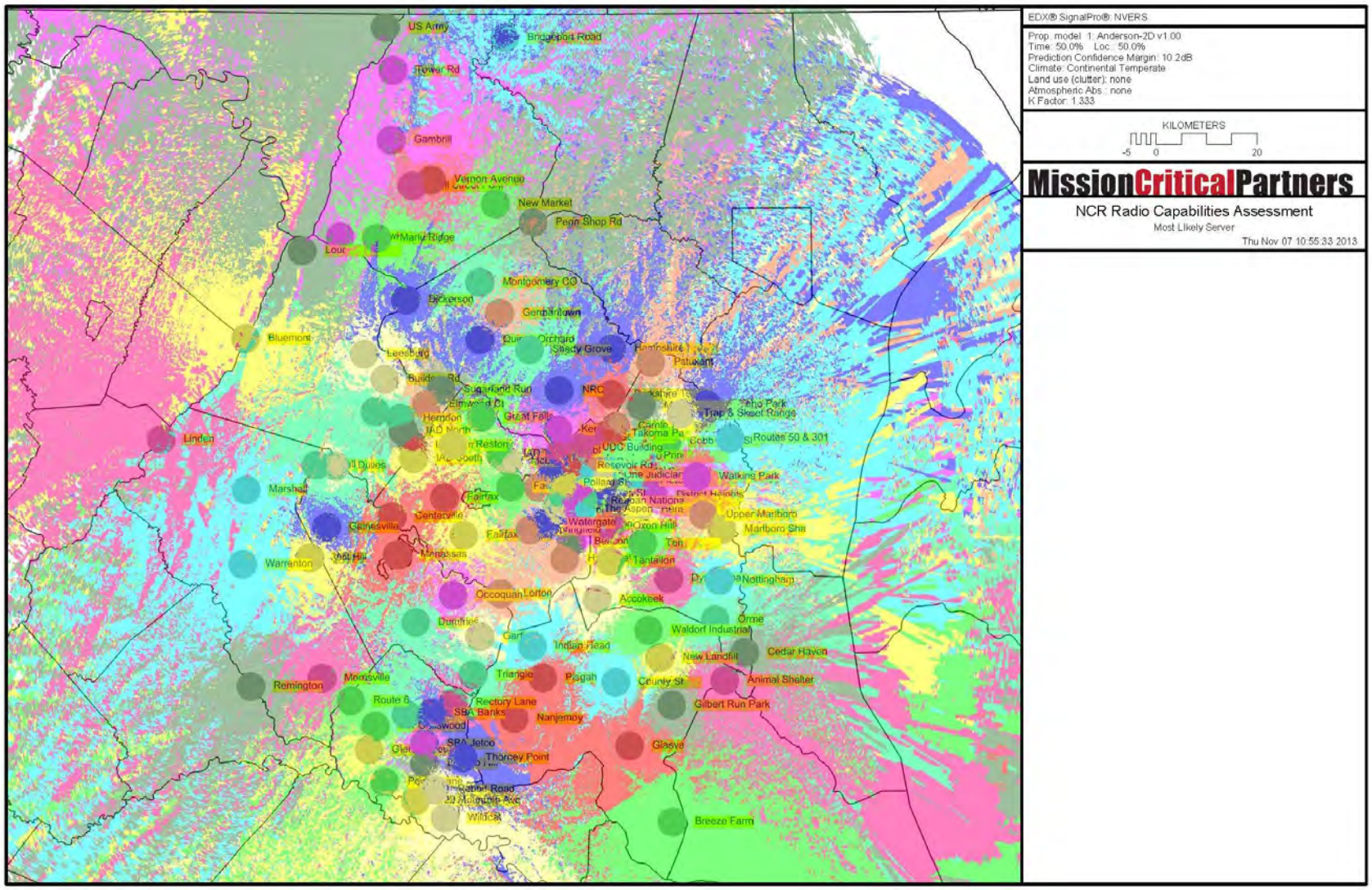

Figure 2 – NCR Most Likely Server

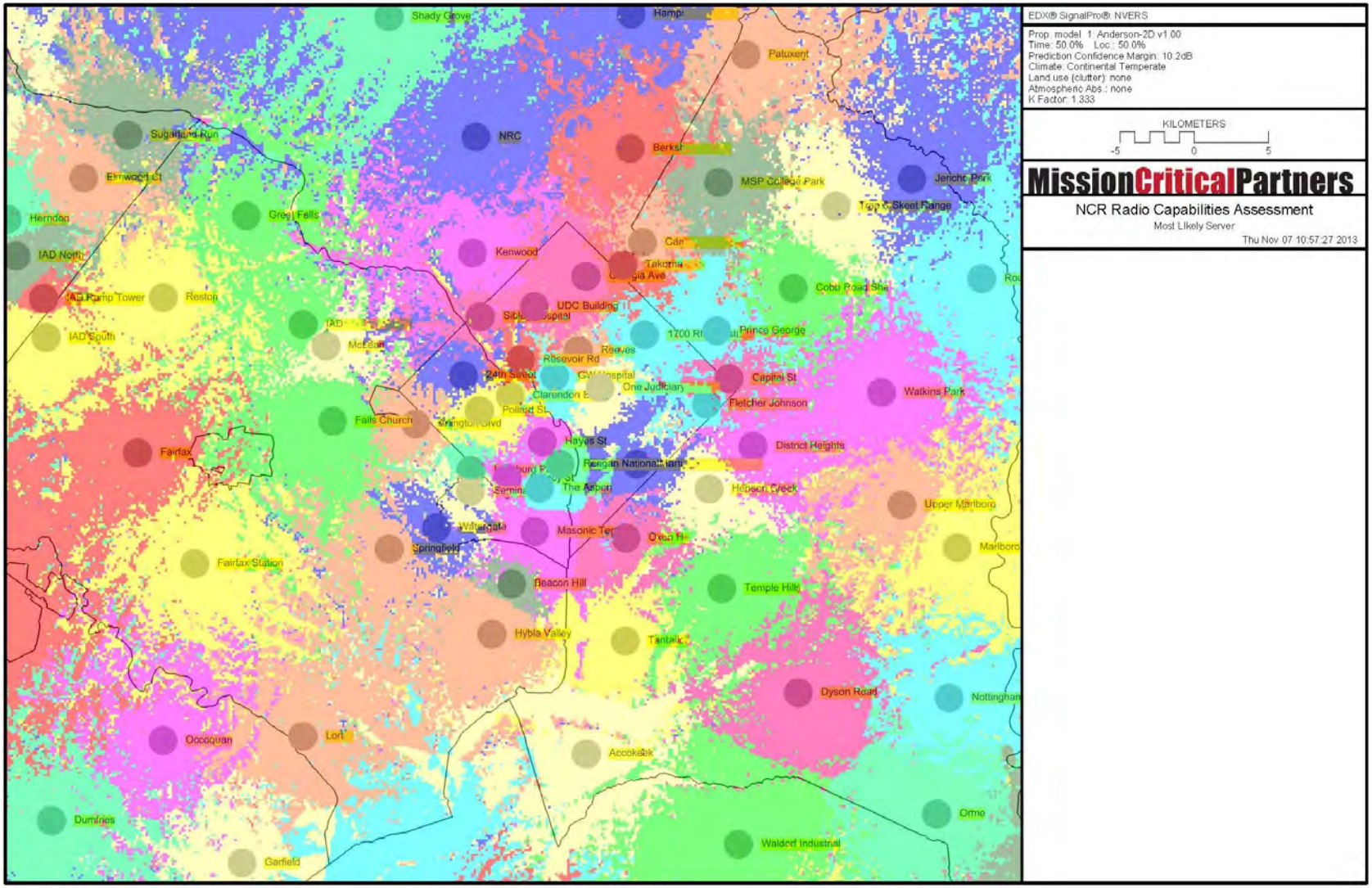

Figure 3 – NCR Most Likely Server (Zoomed In)

- Extended Coverage for Mutual Aid
  In most circumstances users responding for mutual aid events are in close proximity to the neighboring jurisdiction they are assisting and can immediately switch channels to the corresponding system after dispatch. However, circumstances were noted where users could not immediately access channels due to coverage limitations and could only monitor the event once they were close enough to access the system serving the event. One example of this scenario is on Reagan National Airport where the MWAA system does not provide coverage within the Crystal City area immediately outside of the airport campus. Major disasters requiring response from across the region is an infrequent example of when users responding to an event would need to be in range of the serving system before they could monitor radio traffic for situational awareness purposes.

- Simplified Interoperability
  Currently most NCR radios are programmed with talkgroups from all NCR systems. The result is a very large number of talkgroups that occupy numerous zones on radio fleetmaps. Challenges were noted with the complexity of fleetmaps for users who do not frequently access neighboring systems for mutual aid purposes. This issue is exacerbated with legacy radios with limited displays and limitations on the number of characters that can be used in talkgroup names. Newer model radios currently being deployed alleviate this problem by using larger and clearer displays with less character limitations.

- Distant System Programming
  While most jurisdictions program talkgroups from most other NCR jurisdictions, circumstances were noted where users responded for mutual aid purposes to areas where the local system was either not programmed or in a non-compatible frequency band. Current solutions for these scenarios are radio programming in advance of deployment, interoperability repeaters, simplex channel usage, or mobile gateways.

- System Changes
  Because of the complex interoperability environment, changes to any one system in the NCR results in changes for every interoperability partner in order to maintain the same level of interoperability. Examples of changes requiring updates from all neighboring jurisdictions are system upgrades, changes in talkgroup configurations, or use of encryption. In several circumstances, these changes required extensive radio programming efforts or radio upgrades. Until such upgrades or programming efforts were completed, interoperability was limited.

- Upgrade Funding
  Maintaining interoperability requires all jurisdictions to coordinate upgrades and feature sets. Most NCR systems are on different replacement cycles and funding for upgrades is not coordinated between jurisdictions. This places strain on the different system operators to be able to improve system performance and maintain or improve interoperability.

- Alias Databases
  Each trunking system requires an alias database that correlates subscriber IDs to a specific user identifier on dispatch consoles. In order for aliases to be current in every NCR system, every NCR system manager must update the alias database whenever one agency makes an alias change. Reports from radio managers indicate that changes are not always coordinated; as such, aliases for out-of-jurisdiction users are not always current.

- Frequent Radio Programming
  Any time an agency changes configurations on interoperability talkgroups shared throughout the NCR, every other system must re-program all impacted radios. Numerous radio managers indicated that these updates were previously coordinated for a once a year region-wide programming effort. Within the last several years, numerous agencies have made updates outside this schedule, particularly because of system replacements and 800 MHz rebanding. As a result, many agencies have found it difficult to keep up with programming changes, resulting in instances of limited interoperability.

3.3. RADIO SYSTEM CAPABILITIES

Radio systems in the NCR are comprised primarily of 700 and 800 MHz trunking systems. Most agencies are either in the process of a P25 migration or have already implemented P25-compliant systems. Motorola is the primary vendor for municipal and county systems within the NCR, although a number of agencies are planning to release requests for proposals (RFPs) for their P25 systems, which could introduce additional vendors to the radio system environment.

Table 2 summarizes the NCR radio systems and their current P25 migration plans. Additional details regarding each NCR radio system follow the table.

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Table 2 – Radio Systems and Upgrade Status

System/Agency	Current Platform	Current Vendor	System Release	Repeater Model	FDMA[3] / TDMA	Planned Upgrades	Frequency Band
Washington, D.C.	P25 Phase II	Motorola	7.13	GTR8000	TDMA		700/800 MHz
Arlington County, VA	P25 Phase I	Motorola	7.5	STR8000	FDMA	7.7 and GTR8000 base stations	800 MHz
City of Alexandria, VA	P25 Phase I	Motorola	7.9	GTR8000	FDMA		800 MHz
Fairfax County, VA	P25 Phase I	Motorola	7.9	GTR8000	FDMA	7.13	800 MHz
Fauquier County, VA	SmartZone	Motorola	4.1	Quantar	FDMA	P25 n 2019–2020 timeframe	800 MHz
Loudoun County, VA	P25 Phase II	Motorola	7.11	GTR8000	TDMA	7.14 February 2014	800 MHz
Prince William County, VA	P25 Phase II	Motorola	7.13	GTR8000	TDMA	Current system complete in 2013	800 MHz
Stafford County, VA	P25 Phase I	Motorola	7.6	GTR8000	FDMA	P25 Phase II per FCC 700 MHz mandate	700/800 MHz
MWAA	SmartZone	Motorola	4.1	Quantar	FDMA	P25 Phase II via RFP	700/800 MHz
WMATA	SMARTNET™	Motorola	3.0	Quantar	FDMA	P25 Phase II via RFP in 2017/2018	UHF T-Band
Charles County, MD	SmartZone	Motorola	4.1	Quantar	FDMA	P25 by 2017	800 MHz
Frederick County, MD	P25 Phase I	Motorola	7.9	GTR8000	FDMA	7.13	800 MHz
Montgomery County, MD	SmartZone	Motorola	3.0	Quantar	FDMA	P25 via RFP	800 MHz
Prince George's County, MD	P25 Phase I and X-2	Motorola	7.11	GTR8000	TDMA	7.13 or 7.14	700 MHz

[3] Frequency division multiple access

3.3.1. Washington, D.C.

Washington, D.C., operates a Motorola 700/800 MHz P25 Phase II trunking system. Cutover to the current system was completed in 2012. At the time of the interview, the District had plans in the immediate future to upgrade to Motorola system release 7.13. This system is a 14-channel, 11-site system employing simulcast technology across all sites. The system operates in dual mode, supporting a combination of P25 Phase I limited XTS/XTL series radios and new Phase II-compliant APX series radios. The current system replaced a legacy Motorola trunking system operating in both the Ultra high frequency (UHF) and 800 MHz frequency bands.

Washington, D.C., is bordered by Arlington County and the city of Alexandria, Virginia, and Montgomery and Prince George's counties, Maryland. Each of these jurisdictions operates 700 or 800 MHz P25 or legacy Motorola trunking systems that are compatible with the District's radios. Based on mutual aid agreements, Washington, D.C., users do not regularly respond to events outside of the District. During pre-planned events such as the Presidential Inauguration, the District hosts users from throughout the NCR. Designated Very high frequency (VHF) interoperability channels are used for interoperability with federal users operating in the VHF band. The District's law enforcement channels are encrypted, limiting the ability of surrounding jurisdictions to monitor or access these channels for interoperability purposes.

3.3.2. Arlington County, Virginia

Arlington County operates a Motorola 800 MHz P25 Phase I trunking system. The current system was the first P25 system within the NCR. The system is currently operating on the Motorola 7.5 system release and uses STR series base stations. The system has a total of six radio sites and 18 channels employing simulcast technology across all sites. The County recognizes the need to upgrade to the current Motorola system release but faces significant financial challenges to fund the upgrade, which will require the replacement of all STR series base stations with GTR units.

Arlington County is bordered by Fairfax County and the city of Alexandria, Virginia; MWAA; and Washington, D.C. The most frequent mutual aid responses for Arlington County occur with Fairfax County and Alexandria. Arlington County users do not access the MWAA system because of a lack of dedicated fire dispatch. All the surrounding jurisdictions operate 800 MHz P25-compliant radio systems that are compatible with Arlington County radios.

3.3.3. City of Alexandria, Virginia

The City of Alexandria operates a Motorola 800 MHz P25 Phase 1 trunking system. Cutover to the current system was completed in 2012. The system is currently operating on Motorola release 7.9, with plans in place to upgrade the system to the current Motorola release during the third quarter of 2013. The system has a total of six radio sites and 11 channels. The City previously operated a Motorola SmartZone 4.1 trunking system.

The city of Alexandria is bordered by Arlington and Fairfax counties, Virginia; Washington, D.C.; and Prince George's County, Maryland. The most frequent mutual aid events occur with Arlington and Fairfax counties. All primary interoperability partners operate 800 MHz trunking systems that are compatible with Alexandria radios.

3.3.4. Fairfax County, Virginia

Fairfax County operates a Motorola 800 MHz P25 Phase I trunking system. Cutover to the current system was completed in the summer of 2012, with an upgrade to Motorola system release 7.9 completed in December 2012. The system includes a total of 12 radio sites and 20 channels. Fairfax County is geographically located in the center of the northern Virginia (NOVA) region, and provides a considerable amount of overlapping coverage into the surrounding jurisdictions. For this reason, the Fairfax County system is used as a backup in the event of a system failure from one of the neighboring systems. Fairfax County operates a Motorola SmartZone 4.1 trunking system that serves as a backup in the event of a failure of the P25 system.

Fairfax County is bordered by Arlington, Loudoun and Prince William counties, and the cities of Alexandria and Manassas, Virginia; MWAA; and Charles, Montgomery and Prince George's counties, Maryland. The most frequent mutual aid events occur within the surrounding NOVA jurisdictions, although Fairfax County units do on occasion respond to Prince George's County and Montgomery County in Maryland.

3.3.5. Fauquier County, Virginia

Fauquier County operates a Motorola 800 MHz SmartZone 4.1 trunking system. The system is shared by Culpepper and Rappahannock counties. The system was first installed in 2002 as an 8-channel system. Culpepper County joined the system two years later with a 4-site 6-channel simulcast cell. Rappahannock County joined in 2006 with a single site. The County plans to replace the master site and dispatch consoles in the 2016 timeframe, with P25 radio sites to follow in the 2019–2020 range. The counties primarily use Motorola XTS/XTL series subscribers, with a small contingent of APX series radios. All new subscriber purchases are Motorola APX series.

Fauquier County borders Stafford, Prince William and Loudoun counties, which operate 800 MHz systems. Only those Fauquier County users with P25-compliant radios can operate on Stafford, Prince William and Loudoun counties' systems. Warren and Clarke counties operate VHF conventional systems. Multiple radios are deployed to users with frequent interoperability needs with Warren and Clarke counties. Shared talkgroups are used for interoperability with the remaining neighboring agencies.

3.3.6. Loudoun County, Virginia

Loudoun County operates a Motorola 800 MHz P25 Phase II system. The system was first installed in 2009 and was one of the first systems in the country to operate in the TDMA mode. The County has plans to upgrade to the 7.14 platform in February 2014. The system includes a total of nine radio sites arranged in a single simulcast cell with a total of 11 channels. Of the voice channels, nine are configured to operate in the dynamic TDMA/FDMA mode and one is configured to operate exclusively in the FDMA mode. Subscriber units are exclusively Motorola APX7000 and APX7500 series radios.

Loudoun County has complex interoperability requirements, bordering counties in Virginia, Maryland, and West Virginia operating on three different frequency bands. Fauquier, Prince William and Fairfax counties, Virginia, operate 800 MHz trunked systems; Montgomery and Frederick counties, Maryland, operate 800 MHz trunked systems. Clarke County, Virginia, and Jefferson County, West Virginia, operate a VHF conventional systems; Washington County, Maryland, operates a UHF trunked system. Multiple radios and multi-band radios are used for departments bordering agencies that operate in non-800 MHz frequency bands.

3.3.7. Prince William County, Virginia

Prince William County is in the process of implementing a Motorola 800 MHz P25 Phase II system that will be completed by the end of 2013. The new system will replace the County's legacy Motorola SMARTNET™ analog 800 MHz system 6-site 14-channel simulcast system. The new system is being installed with Motorola release 7.13. The County has purchased ISSI connections to permit connectivity with up to five different agencies.

Prince William County borders Fairfax, Loudoun, Fauquier, and Stafford counties, and the city of Manassas, Virginia; and Charles County, Maryland. Charles County lies across the Potomac River with no bridges between the two counties, limiting the mutual aid response scenarios between the counties. These agencies all operate P25 or legacy Motorola 800 MHz trunking systems that are compatible with Prince William County radios. Fairfax, Loudoun and Stafford counties have implemented P25 systems, permitting P25-compliant Prince William County subscribers the ability to operate on those systems. Prince William County must maintain subscriber units capable of operating on legacy Motorola systems to continue to operate on systems in Fauquier County, the City of Manassas, and Charles County.

3.3.8. Stafford County, Virginia

Stafford County operates a Motorola 700 MHz P25 Phase 1 trunking system. Cutover to the current system was completed in 2010. The system is currently operating on Motorola system release 7.6. Plans are in place to upgrade the system to 7.14 in 2014 to permit TDMA operation in order to comply with the Federal Communication Commission (FCC) 6.25 kilohertz (kHz) channel efficiency mandate for 700 MHz channels. The system has a total of six radio sites and 11 channels. Prior to the installation of the current system, Stafford County operated a conventional system that was not

compatible with the NCR. For this reason, Stafford County is relatively new to the NCR interoperability environment and is still adapting to NCR communications.

Stafford County is bordered by Prince William, Fauquier, Culpepper, Spotsylvania, Caroline, and King George counties; and the city of Fredericksburg, Virginia. Prince William, Fauquier and Culpepper counties operate 800 MHz systems that are compatible with Stafford County subscribers. Spotsylvania County operates a Harris 800 MHz EDACS system that is not compatible with Stafford County subscribers, although conventional analog channels may be shared between the jurisdictions. Caroline and King George counties and Fredericksburg operate VHF conventional systems that are not compatible with Stafford County subscribers. Stafford County relies heavily on its own cross-border coverage and gateways to interoperate with these agencies.

3.3.9. Metropolitan Washington Airports Authority (MWAA)

MWAA operates a Motorola 800 MHz SmartZone 4.1 trunking system covering Dulles International Airport, Reagan National Airport and the Dulles Toll Road. The system was first installed in 1997 as a SMARTNET™ system and was upgraded to the current platform in the late 2000s. MWAA is in the process of developing an RFP to procure a new P25 system to replace the existing system. The RFP is expected to be released during the fourth quarter of 2013 or the first quarter of 2014. The current system includes a total of five simulcast radio sites with a total of nine channels at each site. The MWAA system supports law enforcement, fire/EMS, airport operations, and airport engineering and maintenance users.

MWAA is bordered by Fairfax and Arlington counties, Virginia. MWAA is responsible for law enforcement operations along the Dulles Toll Road and MWAA fire units regularly respond for mutual aid to the surrounding jurisdictions. MWAA users depend on the Fairfax County system to maintain communication as they travel between the two systems. MWAA public safety users operate P25-compatible subscriber radios that can operate on the surrounding P25 and legacy Motorola systems.

3.3.10. Washington Metropolitan Area Transit Authority (WMATA)

WMATA operates a Motorola UHF T-band SMARTNET™ 3.0 trunking system. The system covers the jurisdictional boundary of WMATA, which includes Washington, D.C.; Montgomery County and Prince George's County, Maryland; and portions of Howard County, Maryland; and Arlington and Fairfax counties, and Alexandria, Virginia. The service area is expanding to the edge of Loudoun County as the Washington Metro is extended to Dulles International Airport. The system provides coverage for WMATA Transit Police in addition to other WMATA employees including bus/subway drivers, maintenance workers, etc. The system includes a total of ten radio sites arranged in a simulcast configuration. The system supports approximately 8,000 subscriber radios with about 500 being used by Transit Police. WMATA covers the subway stations and tunnels through the use of bi-directional amplifiers (BDAs). WMATA is currently planning an upgrade to replace the existing SMARTNET™ controller with a new Motorola P25 core that will interface with the existing radio sites and consoles using SmartX and Motorola gold elite gateways (MGEGs) respectively. Within four to five years,

WMATA plans to replace the existing radio sites and consoles with 700/800 MHz equipment operating on the P25 Phase II platform.

WMATA has limited interoperability with other NCR jurisdictions, primarily due to the use of the UHF T-Band, which is incompatible with the 700/800 MHz subscribers used by most other jurisdictions in the NCR. Concurrent BDAs are deployed in subway tunnels and stations in the 800 MHz band to support usage by other public safety agencies. While mutual aid does occur between WMATA and other NCR jurisdictions, there is no direct radio-to-radio communication that takes place. WMATA will have significantly increased connectivity once they complete their P25 upgrade in the 700/800 MHz frequency bands. Due to the wide-area coverage crossing multiple jurisdictions provided by the WMATA footprint, there is a high deal of interest in leveraging the WMATA system as a regional overlay for public safety across the region.

3.3.11. Charles County, Maryland

Charles County operates a Motorola 800 MHz SmartZone 4.1 trunking system. The system includes a total of ten radio sites arranged in an 8-channel simulcast configuration. The system operates in a mixed analog and ASTRO digital mode. Charles County anticipates that a migration to P25 will be completed by 2017, although migration plans are not currently in place. The County is exploring the possibility of integrating with the Maryland FiRST system either through a standalone system with ISSI or as a shared user on the system. The County has approximately 1,800 subscriber radios on the system, with 1,400 representing public safety users and 400 representing public service departments.

Charles County is bordered by Prince George's, Calvert, and St Mary's counties, Maryland, and Fairfax, Prince William, Stafford, and King George counties, Virginia. Prince George's, Fairfax, Prince William, Calvert, and Stafford counties operate 700/800 MHz systems that are compatible with Charles County portable radios. Charles County operates a significant number of ASTRO Spectra mobile radios that are not P25-compliant, and thus cannot operate on neighboring systems that operate in the P25 mode. St. Mary's County is in the process of implementing a P25 trunking system that will be compatible with Charles County radios once completed. Limited interoperability is present with King George's County, which operates a VHF system. Charles County maintains connectivity to all neighboring systems through a control station interface, permitting system-to-system patching, dispatch-to-dispatch connectivity, and the ability to monitor users when they roam off the Charles County system.

3.3.12. Frederick County, Maryland

Frederick County operates a Motorola 800 MHz P25 Phase 1 trunking system. The system includes a total of seven radio sites arranged in a 12-channel simulcast configuration. An additional 4-channel multicast site is utilized for coverage fill-in. The system supports all municipal, county, state, and federal agencies within Frederick County. The County is planning an upgrade to system release 7.13 during the first quarter of 2014. The County is planning to integrate with Maryland FiRST via ISSI 8000. The County is currently replacing aging XTS/XTL subscribers with APX series radios to support an

eventual migration to TDMA. The system supports approximately 3,700 native subscriber units and an additional 2,100 subscribers from other agencies that access the system on a regular basis.

Frederick County is bordered by Montgomery, Howard, Carroll, and Washington counties, Maryland; Loudoun County, Virginia; Jefferson County, West Virginia; and Adams and Franklin counties, Pennsylvania. Montgomery, Howard, Carroll, and Loudoun counties operate 800 MHz trunking systems that are compatible with the subscribers utilized by Frederick County. Frederick County utilizes 800 MHz conventional interoperability channels and gateways to communicate with UHF users in Washington and Jefferson counties. Once ISSI is deployed, users from the State of Maryland will be able to freely roam within Frederick County. Planning is underway to ensure the influx of roaming traffic will not degrade capacity on the Frederick County system.

3.3.13. Montgomery County, Maryland

Montgomery County operates a Motorola 800 MHz SmartZone 3.0 trunking system. The current system was initially installed during the late 1990s. At the time of the interview, the County planned to release an RFP for a new P25 system during October 2013. The current system includes a total of 11 simulcast radio sites with a total of 20 channels at each site. Once installed, the County plans to integrate with the State of Maryland using ISSI.

Montgomery County is bordered by Frederick, Howard and Prince George's counties, Maryland; Washington, D.C.; and Loudoun and Fairfax counties, Virginia. All surrounding jurisdictions operate Motorola P25 or legacy 700/800 MHz trunking systems that are compatible with P25-compliant Montgomery County subscriber radios. Montgomery County users maintain subscriber units compatible with legacy Motorola networks to provide operability on the Fairfax County public works system, the MWAA system, and the Montgomery County system.

3.3.14. Prince George's County, Maryland

Prince George's County operates a Motorola 700 MHz P25 X-2 TDMA trunking system. The system includes a total of 21 radio sites split between two simulcast cells. The northern simulcast cell includes a total of 14 channels and the southern simulcast cell includes a total of 11 channels. The system is currently operating on Motorola system release 7.11. Plans are in place to upgrade the system to 7.13 or 7.14 during 2014. The County plans to integrate with the State of Maryland through an ISSI interface during 2014 as a pilot for the State system. Prior to the installation of the current system, Prince George's County operated a mix of VHF and UHF conventional systems that had limited interoperability with the NCR.

Prince George's County is bordered by Montgomery, Calvert, Charles, and Anne Arundel counties, Maryland; Washington, D.C.; and Fairfax and Arlington counties and the city of Alexandria, Virginia. These jurisdictions all operate 800 MHz P25 or legacy Motorola trunking systems that are compatible with Montgomery County subscribers. Some of the surrounding Maryland jurisdictions do not have P25-compliant radios and cannot operate on the Prince George's County system. Prince George's

County operates dynamic channels to permit access by FDMA users. Law enforcement talkgroups are limited to TDMA operation; as such, different interoperability talkgroups are needed for interoperability with incoming FDMA users.

3.4. GOVERNANCE AND STANDARD OPERATING PROCEDURES (SOPS)

Decisions regarding public safety operations within the NCR are governed by regional committees and SOPs. The following sections detail the governing organizations and SOPs in place within the NCR.

3.4.1. Governing Organizations

MCP documented three organizations/groups within the NCR that facilitate meetings among decision makers to coordinate decisions and resolve challenges regarding radio communications:

1. Metropolitan Washington Council of Governments (MWCOG)
2. Northern Virginia Emergency Response System (NVERS)
3. Region 20 Regional Planning Committee

3.4.1.1. MWCOG

MWCOG's website provides the following information:

> ***What is COG?***
>
> *The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association that brings area leaders together to address major regional issues in the District of Columbia, suburban Maryland and Northern Virginia. COG's membership is comprised of 300 elected officials from 22 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.*
>
> *Policies are set through the COG Board of Directors, the National Capital Region Transportation Planning Board, and the Metropolitan Washington Air Quality Committee. These three boards are responsible for a broad range of issues under the COG umbrella. Supporting committees help shape programs through the dedicated work of a wide array of public servants, from police chiefs to social workers.*
>
> *Founded in 1957, the Council of Governments is supported by financial contributions from its participating local governments, federal and state grants and contracts, and donations from foundations and the private sector.*

COG Vision and Mission

Region Forward is our vision. It's a commitment by COG and its member governments, who together seek to create a more accessible, sustainable, prosperous, and livable National Capital Region.

COG's mission is to make Region Forward happen by being a discussion forum, expert resource, issue advocate, and catalyst for action.

Key COG Documents

- *COG Annual Report*
- *COG Strategic Plan*
- *Region Forward: A Comprehensive Guide for Regional Planning and Measuring Progress in the 21st Century*
- *COG Work Program and Budget*

For COG's *Audited Financial Statements, Bylaws, Rules of Procedure, and Policy Platform*, visit the COG Board's document page.

COG History

For more than 55 years, COG has helped tackle metropolitan Washington's biggest challenges, such as restoring the Potomac River, ensuring the Metro system was fully built, and strengthening emergency preparedness after September 11, 2001. Today, COG's top priority is advancing the Region Forward vision through the work of its Board of Directors, policy boards, committees, and programs.[4]

3.4.1.2. NVERS

NVERS' website provides the following information:

What is NVERS?

Located within the National Capital Region (NCR), Northern Virginia is comprised of 25 towns, cities, and counties with approximately two million residents. The Northern Virginia Emergency Response System (NVERS) was developed from the Metropolitan Medical Response System (MMRS) in 2005. NVERS supports a regional approach to coordinated preparedness, response, mitigation, and recovery across jurisdiction and discipline boundaries during day-to-day emergencies and multi-jurisdictional and/or

[4] Metropolitan Washington Council of Governments, http://www.mwcog.org/about/, accessed October 30, 2013.

multi-disciplinary incidents through strategic planning, priority-setting, information sharing, training, exercises, equipment acquisition, and policy-making.

Who is part of NVERS?

Active participants in NVERS include representatives from fire & rescue, emergency medical services (EMS), hazardous materials, law enforcement, emergency management, hospitals, public health, public information, and information technology. The System operates as a dynamic regional organization with a focus on sharing knowledge and resources while building regional capacity. NVERS is led by a Steering Committee that meets monthly and has open attendance.

Who are NVERS' partners and how does NVERS work with these partners?

NVERS serves as a collaborative partnership between local governments, the Commonwealth of Virginia, and the private sector to build the emergency management and homeland security capacity through the regional integration of policies, training, resources, information-sharing, and program management for the health and welfare of Northern Virginia residents. NVERS also coordinates closely with its neighbors and partners through the Metropolitan Washington Council of Governments (COG) in the District of Columbia and Maryland.

What is the ultimate goal of NVERS?

With support from NVERS:

The Region operates collectively to set priorities and support preparedness, response, mitigation and recovery activities.

Processes, functions, and appropriate equipment and technology are standardized enabling operability, interoperability, and surge support across partner agencies in the Region.

Capable responders receive the necessary equipment and training to effectively and efficiently do their jobs.

Citizens are engaged and prepared for emergency events; there is increased awareness region-wide about where to go for information and what to do in emergency situation.

What are a few examples of NVERS projects that have benefited the Region?

NVERS is supporting dynamic emergency preparedness efforts that include but are not limited to: coordinating training, policies, and processes across the Region's hospitals;

pharmaceutical inventory and procurement for medical surge; helping citizens with preparedness; improving regional logistics; updating operational plans, SOPs, and manuals; regional public health planning; Medical Reserve Corps training and coordination; and recovery resource planning.[5]

3.4.1.3. Region 20 700/800 MHz Regional Planning Committees

The use of narrowband radio spectrum is an essential portion of any LMR communications system. Frequency assignments are tightly controlled to limit interference between agencies operating on the same or closely spaced channels.

The FCC has delegated responsibility for public safety frequency assignments to third-party organizations. Designated frequency coordinators are responsible for VHF (150 to 160), UHF (450 – 570 MHz), and 800 MHz interleaved (854 – 860 MHz) bands to oversee channel assignments and ensure interference-free operation. The certified public safety frequency coordinators include APCO, the International Municipal Signal Authority (IMSA), the American Association of State Highway Transportation Officials (AASHTO), and the Forest Conservation Communications Association (FCCA).

For two public safety frequency bands, the FCC has designated authority to local regional planning committees (RPCs) to authorize frequency assignments. The regional authorities are comprised of representatives of state and local public safety agencies. The frequencies for which this authority has been granted include the 800 MHz National Public Safety Planning Advisory Committee (NPSPAC) covering 851 to 854 MHz, and the 700 MHz band (769 to 775 MHz). In most cases, RPCs are organized by state, but in some regions RPCs are concentrated around metropolitan areas.

The Region 20 RPC includes the state of Maryland; Washington, D.C.; and the NCR counties of Virginia. This committee typically meets every two to three months to discuss and vote on submitted FCC applications. The meetings provide an opportunity for attending agencies to discuss pending system upgrades, FCC legislation and other events that could impact radio communications within the region. Any public safety agency representative can serve as an RPC member and vote on actions regarding FCC application for which the RPC has authority.

3.4.2. Standard Operating Procedures (SOPs)

SOPs define the specific policies that govern usage of radio communications system. The NCR operates in a complex environment with two adjoining states and Washington, D.C. MCP documented the following SOP documents:

1. NOVA Agreements
2. Inter-Jurisdictional Police Mutual Aid Communications
3. State Communications Interoperability Plan (SCIP)

[5] Northern Virginia Emergency Response System, http://www.nvers.org/about, accessed October 30, 2013.

4. Tactical Interoperability Communications Plan (TICP)

3.4.2.1. NOVA Agreements

The NOVA Agreements (formerly the "Northern Virginia Emergency Services Mutual Response Agreement") is a memorandum of understanding (MOU) establishing the standard for the mutual aid of fire and EMS users in the Northern Virginia portion of the NCR. The original agreement was executed December 12, 1975, and was reaffirmed in March 2009.

The document establishes the standard for dispatch based upon the responding unit's proximity to an incident and not on jurisdictional boundaries. Key elements regarding the mutual aid agreement include the following:

1. Establishes parties to the agreement
2. Establishes the standard for dispatch based upon the most appropriate response resource(s) available without regard to jurisdictional boundary lines
3. Establishes the responsibility for each agency with determining the most appropriate response resource
4. Requires each jurisdiction to maintain direct links to other communications centers throughout the region to be used for coordinating mutual response requests
5. Requires use of the National Incident Management System (NIMS) ICS and NOVA operational procedures for mutual aid calls
6. Requires development of specific SOPs for mutual aid response

3.4.2.2. Inter-Jurisdictional Police Mutual Aid Communications

Mutual aid SOPs for law enforcement agencies in the Northern Virginia portion of the NCR are governed by an MOU for "Inter-Jurisdictional Police Mutual Aid Communications" dated November 8, 2000.

The MOU defines member agencies and specific procedures regarding the shared use of trunked radio systems. Key elements regarding the mutual aid agreements include the following:

1. Allows each agency to directly access the public safety trunked radio system of other member agencies
2. Requires each member to provide the other members the necessary information to program trunked talkgroups
3. Defines procedures when direct system access is appropriate; as stated "Direct access is reserved for emergency, priority or other incidents where its use creates a significant advantage to law enforcement, including felony pursuits, officer needs emergency assistance, lookouts for incidents near political boundaries, perimeter search operations, and task force operations"
4. Establishes protocols for the sharing of "dispatch" and "primary tactical" channels between agencies sharing a jurisdictional boundary
5. Establishes plain English as the standard for mutual aid communications and not "10 codes" or slang

6. Establishes standards for dispatcher notification when a user switches off of their primary radio system
7. Establishes procedures for unit designation for mutual aid calls
8. Establishes the Northern Virginia Police Mutual Aid Communications Committee as the governance entity responsible for the MOU and mutual aid procedures for law enforcement agencies in the Northern Virginia region

3.4.2.3. SCIP

The development of SCIPs is an initiative promulgated by the Department of Homeland Security (DHS). Developing SCIPs was a requirement for past federal grants; thus SCIPs were developed by every state and Washington, D.C.

Within the NCR region, separate SCIPs were developed by Virginia, Maryland, and Washington, D.C. Because the NCR is comprised of multiple states, the initiatives defined by the SCIPs are more relevant to state-level communications and not the NCR specifically.

DHS' website provides the following information:

> *Statewide Communication Interoperability Plans (SCIPs) are locally-driven, multi-jurisdictional, and multi-disciplinary statewide plans to enhance emergency communications. SCIPs should outline and define the current and future vision for communications interoperability within the State or territory. In addition, SCIPs should align emergency response agencies with the goals, objectives, and initiatives for achieving that vision.*
>
> *SCIPs are living documents that should be updated on an annual basis, or as frequently as needed. The SCIP provides strategic direction and alignment for those responsible for interoperable communications at the State, regional, and local levels.*[6]

The Virginia SCIP focuses on the following initiatives:

1. Use of the Commonwealth's Link to Interoperable Communications (COMLINC) system
2. Use of the Statewide Agencies Radio System (STARS) as the statewide system to be used for interoperability
3. Support and sustainment for the Commonwealth Strategic Reserve program (radio caches)
4. Planning and training for interoperability exercises
5. Broadband initiatives based on robust regional requirements
6. Development of information-sharing initiatives

[6] Department of Homeland Security, http://www.dhs.gov/statewide-communication-interoperability-plans, accessed October 31, 2013.

7. Assess the Commonwealth's existing mutual aid assets, identifying gaps in coverage, and developing a plan to mitigate gaps

The Maryland SCIP focuses on the following initiatives:

1. Develop a statewide network (Maryland FiRST) to support communications interoperability
2. Strengthen and review inter- and intra-state partnerships
3. Codify existing governance structure
4. In partnership with local government, complete interoperable radio communication networks in 2016 that provide first responders with interoperable radio communications across county lines, within their region and on Maryland's waterways.
5. Establish and maintain a recurring statewide communications-related SOP development process
6. Add nationwide interoperability channels and establish related process or structure to tie the channels into the new statewide 700 MHz system
7. Provide access to the Nationwide Public Safety Broadband Network (NPSBN) to all Maryland first responders and emergency management partners
8. Coordinate the development of regional communications-focused learning and exercises across the state
9. Encourage familiarity of communications systems, interoperability technology and emerging technologies
10. Enhance capabilities to share communications-related emergency information in real-time
11. Invest to build a state-of-the-art computer aided dispatch and records management system for Maryland's State law enforcement agencies and share real-time data on emergency service dispatches and critical records with local jurisdictions
12. Develop a process to establish a long-term funding plan for the operations maintenance and system administration of current LMR systems while addressing the long-term needs of the State

The Washington, D.C., SCIP focuses on the following initiatives:

1. Develop a sustainable interoperable governance body with effective administration processes to address evolving interoperable communications challenges
2. Develop more effective communications plans and SOPs to facilitate planned event and emergency incident voice and data communications interoperability
3. Access District-wide data sources to determine requirements for achieving maximum interoperability
4. Develop interoperability solutions with agencies that utilize commercial cellular service for voice communications
5. Develop interoperable communications modules into existing planned events or emergency incident exercises
6. Develop a public safety committee charged with defining and managing the specialized requirements of the District's mission-critical communications infrastructure
7. Establish a working group to manage planning efforts for the NPSBN

3.4.2.4. TICP

The TICP is a mutual aid SOP document that defines the specific interoperability assets within the NCR and the processes for using each of those resources. Unlike the SCIPs, the TICP focuses specifically on the NCR, including Washington, D.C., and the associated jurisdictions in Maryland and Virginia. The document defines the specific interoperability assets as defined by the SAFECOM interoperability continuum. For each resource, the document defines the location, description, point of contact, purpose, and specific resources for usage.

The following interoperability resources are covered within the TICP:

1. Radio caches within the NCR
2. National NPSPAC interoperability channels
3. Police Mutual Aid Radio System (PMARS)
4. Fire Mutual Aid Radio System (FMARS)
5. Citywide channel
6. Regional Interoperability System (RINS)
7. Metropolitan Interoperability Radio System (MIRS) gateways
8. Mobile gateways
9. NIMS Communications Unit Leaders
10. Communications Asset Survey and Mapping (CASM)
11. Future Interoperability Initiatives
12. Shared system resources, covering primary 800 MHz trunking systems

4. ANALYSIS

4.1. INTEROPERABILITY TECHNOLOGIES

Interoperability within the NCR today relies on the use of shared talkgroups between users on each of the different radio systems. Most non-federal systems operate legacy or P25 Motorola 700 or 800 MHz trunking systems with Motorola subscriber radios. This configuration permits any subscriber radio within the region to operate on any of the other radio systems by switching to a talkgroup properly programmed to operate on that system.

When a user switches systems to either provide mutual aid to another agency or because they have lost coverage on their primary system, communication is lost between the roaming user and the home system users. This is the primary interoperability limitation identified by system users in the NCR region.

MCP has identified several technology alternatives that can mitigate this connectivity gap between systems. Alternatives include the following:

1. Configure existing conventional interoperability channels in a simulcast configuration
2. Install a trunked overlay system
3. Connect systems via “Inter-zone”
4. Connect systems via ISSI
5. Connect all radio sites to shared system controllers

The following sections provide information regarding each of these technology alternatives.

4.1.1. Simulcast Interoperability Channels

The FCC has designated certain frequencies in each public safety frequency band for interoperability purposes. The mode of operation is restricted to conventional analog or P25 to permit access by any public safety radio within the band that has the channels programmed. The interoperability channels in each band include a minimum of one calling channel, and multiple tactical channels. The calling channel is designated for responding units to “call” the local serving dispatch center. Tactical channels are then assigned by the dispatch center for response.

The FCC has designated five 800 MHz channels (one calling and four tactical) and thirty-two 700 MHz channels (two calling and 30 tactical). The 800 MHz interoperability channels have been widely deployed throughout the NCR by most jurisdictions.

The challenge with conventional interoperability channels is that a single radio transmitting on one of the channels may be received by multiple repeater stations. When this occurs, each station receives and repeats the audio. The conflicting signals from multiple base stations will interfere with each other, resulting in echoed or non-understandable messages. To address this problem, SOPs are in place that require interoperability channels to be maintained in the receive-only mode. This permits dispatchers to monitor the channels and activate the repeater capability of specific sites to serve a given response. The repeater capability is disabled when the event is over.

One solution that could be used to expand interoperable capabilities within the NCR would be to configure a select number of interoperability channels in a simulcast configuration. Simulcast technology coordinates the timing of multiple stations on the same frequency. Within the combined coverage area of simulcast sites, users can communicate among each other without switching channels between radio sites. Throughout a large area, the simulcast interoperability channels would effectively serve as a limited capacity region-wide overlay system. For each channel arranged in this configuration, users could communicate with any other users or dispatch centers throughout the overlapping coverage area.

Arranging the channels in a simulcast configuration would require providing backhaul connectivity between the stations, installing central simulcast controller and voting equipment, and ensuring compatible timing equipment is at each site. Backhaul connectivity could be established through the NCRNet or by connecting the respective radio backhaul networks of each jurisdiction.

There will be a number of technical challenges associated with simulcasting the interoperability channels. Ideally, analog simulcast requires all base stations to be of the equivalent manufacturer, model and revision. The existing repeater systems across the NCR have been purchased by different agencies at different times and will not satisfy these criteria. The result is that simulcast timing between stations will be less than perfect, which may result in distorted audio throughout some of the coverage area. Connecting the radio backhaul networks could present some challenges given the fact that most radio backhaul networks are maintained independently by each jurisdiction. Expanding connectivity will introduce additional security and governance challenges that will need to be overcome. Compatible timing equipment will need to be installed at each repeater site. Most interoperability repeaters are co-located at trunked simulcast sites that already have global positioning system (GPS) timing equipment. Compatibility with this equipment will need to be verified and new GPS equipment will need to be installed at sites with no timing equipment.

Operationally, simulcasting interoperability channels throughout the NCR would allow users to communicate anywhere within the region on a single channel. While this would provide an expanded coverage area and wide-area communication, a single user operating on one of the simulcast channels would tie up the channel throughout the entire region. With the current configuration, multiple repeaters could conceivably be used on the same channel as long as there is sufficient spacing between the events.

Table 3 summarizes the strengths and weaknesses associated with simulcasting the interoperability channels.

Table 3 – Simulcast Interoperability

Strengths	Weaknesses
Relatively inexpensive solution to provide low capacity region-wide connectivity	Technical challenges associated with interconnecting backhaul network
Reuse of existing equipment to reduce costs	Imperfect simulcast solution because of different model base stations
Use of existing channels permits implementation without requiring subscriber programming	Technical and logistic challenges associated with connecting backhaul costs
	Additional costs likely for simulcast controllers, voting equipment, backhaul links, and GPS timing equipment
	Governance challenges associated with gaining concurrence from all agencies in region to pool existing resources
	One event would tie up channel throughout the entire region
	Coverage provided by system would be significantly less than coverage provided by primary systems

4.1.2. Trunked System Overlay

The concept behind a trunking system overlay is that an entirely distinct 700 or 800 MHz trunking system would be installed throughout the NCR to provide connectivity on a single system throughout the region. Such a system would permit users operating on the system to roam anywhere within the coverage footprint. Primary systems' talkgroups could be patched to wide-area talkgroups on the overlay system to provide cross-region communication for users operating on their home systems. Such a system would leverage existing NCR agency radio sites strategically placed throughout the NCR to provide in-street portable coverage and a limited amount of capacity at each site (5–6 channels). This type of overlay system has been implemented by the Central Maryland Area Radio Communications (CMARC) region in the areas surrounding Baltimore.

The strengths of an overlay system include using the system as a backup in the event of a failure to a primary system, having wide-area talkgroups that could be used for police pursuits or other cross-border events, and additional capacity to be leveraged for special events. By co-locating on existing radio sites, lease costs could be reduced and existing backhaul networks could be leveraged.

A P25 overlay system would necessitate the purchase of P25 controllers and base stations at each site. The capacity provided by modern day P25 cores would permit the overlay system to share a central controller with an existing P25 system in the region.

Alternatively, the NCR possesses a substantial amount of legacy 3600 series controllers and Quantar base stations that could be re-purposed for a regional system. While this approach would save upfront costs, this equipment is already at the end of its useful life and would reduce reliability and serviceability of the regional system. In addition, only Motorola subscribers could access the regional system, which would limit competition for radio system and subscriber purchases throughout the NCR.

One underlying challenge associated with a regional system is securing radio spectrum. A substantial number of channels would be required to populate each radio site in the regional system. 800 MHz channels have long since been depleted and much of the 700 MHz spectrum has been acquired by Washington, D.C.; Prince George's County; Stafford County and the State of Maryland. While it is likely some additional 700 MHz spectrum could be acquired through Region 20, it is not certain that there is enough to populate the entire regional system or that each locality would agree to assign channels to a system that is not used for primary operations. A second pool of potentially available channels includes 800 MHz Sprint "giveback" frequencies that have been freed up by Sprint's move out of the 800 MHz interleaved band.

WMATA's build-out in the 700 MHz band could inherently provide such a wide-area overlay system. WMATA serves a large area spanning much of the NCR. As long as sufficient capacity is built into the system, the system should be able to accommodate additional wide-area traffic for interoperability purposes. WMATA has previously expressed an interest in leveraging their system build-out for region-wide interoperability.

Table 4 summarizes the strengths and weaknesses associated with an overlay system.

Table 4 – Overlay System

Strengths	Weaknesses
Region-wide in-street portable coverage to be used for wide-area communication	Locating spectrum will be a challenge
Backup to primary systems in the event of a failure	Investment required for base station equipment and backhaul
Leverage existing radio site and backhaul to reduce costs	Overlay system will provide significantly less coverage than primary systems
Potential reuse of legacy equipment	Capacity on overlay will be greater than a conventional overlay, but not substantial enough to fully support a major event
Through multicast design, traffic within a given area will not occupy channels throughout the system	Overlay systems will not permit traffic from primary systems to be carried outside primary system coverage area
Possibly addressed through WMATA build-out in the 700 MHz band	Channel changing required for users to switch to the wide-area system

4.1.3. Inter-zone

Inter-zone is a proprietary Motorola solution that permits two or more Motorola P25 system controllers to be connected together. When the systems are configured with the same system ID, the interconnected systems act as one single wide-area system. Subscriber radios have the capability to roam to any radio site within the interconnected network, and talkgroup calls can be configured to transmit on any or all radio sites. In essence, systems configured together provide the same capabilities as one single system with a single controller. The primary difference is that the controllers do not provide redundancy for each other. Each set of radio sites is dependent on the controller to which they are connected, and will revert to the appropriate fallback modes if there is a controller failure.

Figure 4 displays how two Motorola P25 systems can be connected with Inter-zone.

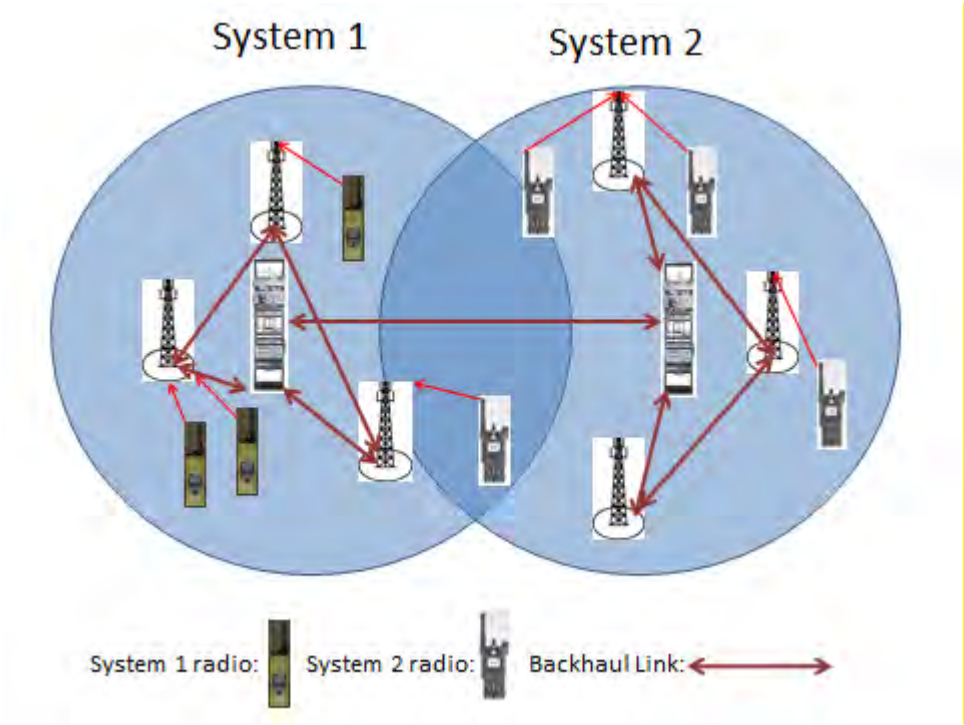

Figure 4 – Shared System Configuration with Inter-zone

Systems inter-connected with Inter-zone will address the interoperability gaps that were expressed by NCR users. When two systems are interconnected with Inter-zone, users will have the flexibility to roam anywhere within the interconnected systems as long as the talkgroups are authorized on the appropriate radio sites. A user responding for interoperability purposes will have the ability to switch talkgroups and still maintain communication with home area dispatchers and users as long as those users are monitoring the appropriate talkgroup. A user will also have the flexibility to roam outside of their primary area on their home system talkgroup.

The benefit of an Inter-zone connection is that completely autonomous systems may be interconnected with minimal additional hardware costs. The connection requires a data link capable of supporting all the traffic that could potentially be passed between the networks. In most cases, a 50 megabit per second (Mbps) link should be sufficient, although larger systems with a high amount of shared traffic and dispatch sites could potentially require more.

While there are benefits to connecting systems with Inter-zone, there are a number of limitations. In order for systems to be interconnected with Inter-zone, the systems must be P25 systems manufactured by Motorola. Inter-zone is a proprietary connection that does not support connectivity with other manufacturers. Systems interconnected by Inter-zone must be at the same Motorola system release. This can create a challenge depending on the system upgrade timelines and release versions of the connected systems. Once systems are connected, a joint decision of the interconnected agencies must be agreed upon to proceed with an upgrade. Because the interconnected systems must

utilize the same system ID, the system ID for all but one of the interconnected systems must change, necessitating the reprogramming of subscriber radios. All system controllers must have all system IDs for each interconnected system appropriated; thus requiring a substantial amount of coordination and effort in advance of a connection.

The efforts associating with changing system IDs should not be underestimated. Such an effort requires coordinated efforts across all participating jurisdictions to ensure the migration occurs in a manner that does not negatively impact first responder operations. With approximately 40,000 subscriber radios across the NCR, a change to any one system ID will require multiple programming efforts and coordination to ensure interoperability is maintained before, during, and after the transition of any one jurisdiction.

Use of shared resources requires the development of system governance and SOPs to establish the decision-making authority over the interconnected resources and establish common usage requirements for the shared resources. Existing SOPs do not cover shared system resources; as such, revisions to existing SOPs or new SOPs must be developed.

Table 5 summarizes the strengths and weaknesses associated with an Inter-zone connection.

Table 5 – Inter-zone Connection

Strengths	Weaknesses
Provides capabilities of one system with a shared controller	Solution only available for Motorola systems, excluding agencies that utilize systems from other vendors
Provides one large coverage footprint that permits users anywhere within the interconnected systems to roam without changing channel knobs	Solution requires agencies to utilize the same operating platform, requiring additional costs to reach the same platform level and coordination for future upgrades
Addresses interoperability gaps expressed by users	Systems must utilize the same system ID, requiring a complex migration plan involving all interoperability partners to ensure interoperability is maintained throughout the transition
Permits different agencies to interconnect existing autonomous systems	Subscriber radio unit IDs must be appropriated for all interconnected system radios in each system controller
Permits agency to maintain complete ownership of their equipment	Systems must have sufficient capacity to support the larger potential unit loading
Permits agencies to separate from the connection in the future if they desire	Governance and SOPs must be established to coordinate usage of the shared resources

4.1.4. ISSI

ISSI is a P25 standard that permits the interconnection of autonomous P25 systems. The intent of the standard is to create a common format to which proprietary data from different vendor's P25 systems can be converted. Using this common "language," data can be carried between systems from different vendors or the same vendor.

To connect two or more systems with ISSI, a hardware gateway must be installed for each system. A backhaul connection must be established between the two gateways to provide the connectivity between the systems.

Figure 5 displays how two or more P25 systems can be connected with ISSI.

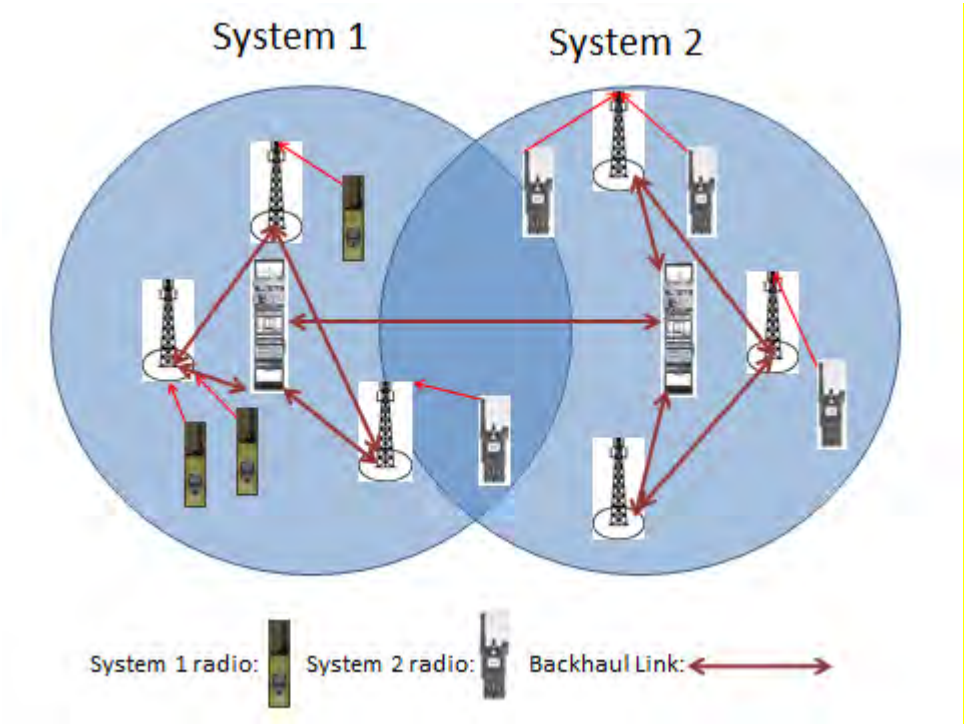

Figure 5 – Shared System Configuration with ISSI

The capabilities provided by ISSI depend on a series of individual feature sets defined by the Telecommunications Industry Association (TIA). Each feature set defines the technical parameters for establishing the listed feature through an ISSI gateway.

There are several specific ISSI feature sets that are critical for improved interoperability application in the NCR. These features sets include:

- Automatic Inter-system Roaming: This feature permits a user to automatically roam from one system's coverage area into another without changing channels on their radio. In a P25 system, subscriber unit roaming is accomplished by the radio evaluating the signal strength of the currently affiliated radio site and any adjacent radio sites. When the signal strength of an adjacent site is sufficiently superior to the affiliated site, the radio will roam to the adjacent site. This feature permits the subscriber unit to monitor the signal strength of adjacent radio sites that lie in separate systems that are ISSI-connected. When operational, the interconnected systems act as one single coverage area and subscriber units can roam anywhere within the shared footprint. Restrictions on roaming can be made by talkgroup so that only certain channels are permitted to roam if system loading is a concern.
- Subscriber Unit Registration: Subscriber unit registration allows a roaming subscriber unit to be assigned a dynamic subscriber ID throughout the duration of their roaming period. A maximum amount of dynamic IDs can be assigned by the system administrator so a limit can be placed on the total amount of roaming units on a given system. The benefit of this feature is subscriber unit IDs do not need to be separately assigned for every potential radio that may roam onto a given system in advance. No ID coordination is required; the setup time and effort for configuring systems to support ISSI roaming is greatly reduced.

4.1.4.1. Vendor ISSI Offerings

While standards have been developed for a number of ISSI features sets, it is dependent on the equipment vendors to implement the features. ISSI features will only work if the specific feature sets are implemented in all interconnected systems.

MCP surveyed the equipment offerings of the two largest radio system providers, Motorola and Harris, to evaluate their current ISSI offerings and future planned offerings.

4.1.4.1.1. Motorola

To date, Motorola has released two versions of ISSI that are available on P25-compliant systems. The first version, referred to as ISSI.1 by Motorola, has been available for several years and is available on all Motorola system releases. ISSI.1 does not include features such as automatic roaming between systems or dynamic subscriber ID assignments. When two systems are equipped with ISSI.1-compliant features, a user is required to change talkgroups when roaming into an ISSI-connected system. The subscriber unit ID is not transmitted through the ISSI gateway. When a user roams off the home network, home system users and dispatchers can still monitor the user as long as the talkgroup traffic is properly transcoded or patched to the appropriate channel. The user can send emergency calls when roaming with ISSI.1, but the calls will not activate emergency alarms on dispatch consoles.

Motorola's second release of ISSI is referred to as "Next Generation ISSI" or "ISSI 8000" by Motorola. This version of ISSI is available on all Motorola P25 systems at release version 7.13 or later. The release supports automatic subscriber roaming, dynamic ID assignment, and TDMA compatibility. User IDs are transmitted through the ISSI gateway, permitting users on all interconnected systems an effective way to monitor user transmissions. The seamless roaming feature requires the use of GTR8000 base stations, APX subscribers, or XTS/XTL subscribers with a firmware upgrade.

In addition to the ISSI standard features, Motorola offers several additional proprietary features that are only available when two Motorola systems are interconnected via ISSI. These features include a faster roaming time between systems, the transmission of user aliases across systems, flexibility with "All Start / Fast Start" configurations, and busy queuing for calls over the ISSI link.

4.1.4.1.2. Harris

Harris has offered ISSI connectivity for several years. Unlike Motorola, Harris has implemented ISSI on a tiered basis, with additional ISSI features being implemented with each subsequent system release. The current Harris ISSI release includes dynamic ID assignments for ISSI roaming and transmission of user IDs across the ISSI gateway. Harris does not currently offer automatic subscriber roaming to permit users to roam between systems without changing channels. However, this feature is planned to be implemented in the future. There are no subscriber or base station restrictions with the current ISSI features supported by Harris.

4.1.4.2. Strengths and Weaknesses

Table 6 summarizes the strengths and weaknesses associated with interconnecting systems with ISSI.

Table 6 – ISSI

Strengths	Weaknesses
Allows primary talkgroups or designated interoperability talkgroups to be used anywhere within the NCR	Added costs for ISSI gateways, ISSI licensing and backhaul connectivity
Permits users to access the tower sites that provide the most optimal coverage	Every two systems requiring an ISSI interconnection require separate ISSI licenses, leading to an exponential cost increase
Allows jurisdictions to maintain their autonomy with separately owned and operated systems	Risk for abuse by users monitoring primary channels when outside of primary jurisdiction without proper reason, causing an adverse impact to system capacity
Restrictions available to limit ISSI roaming traffic to preserve system capacity for primary users	Capacity on primary systems must be sufficient to accommodate primary traffic and additional traffic from ISSI roaming
Uses in-building portable coverage provided by primary systems	Existing Motorola systems would need to be upgraded to 7.13 or later to support seamless roaming
Requires minimal additional infrastructure to install	
Permits sharing of alias databases between Motorola	

Strengths	Weaknesses
systems	
Part of the P25 standard, permitting integration from systems manufactured by vendors other than Motorola	
NCRNet available for backhaul connectivity between existing system cores	

4.1.5. Shared Systems

As trunking technology has evolved, the ability of systems to accommodate additional radio sites, channels, simulcast cells, and users has greatly increased. Current controllers are able to accommodate entire states with hundreds of radio sites.

Radio users on a shared system are not limited by system coverage areas. Talkgroups can be carried anywhere within the entire system coverage area as long as the talkgroups have the proper permission. Based on the SAFECOM Interoperability Continuum, shared systems provide the highest level of interoperability available. Shared systems provide ubiquitous interoperability amongst all user agencies. Interoperability on a shared system is only limited by the ability to implement standard operating procedures to both preserve system capacity where it is limited and allow connectivity between different user agencies when it is needed.

Figure 6 displays how two or more existing systems can be connected into a shared system.

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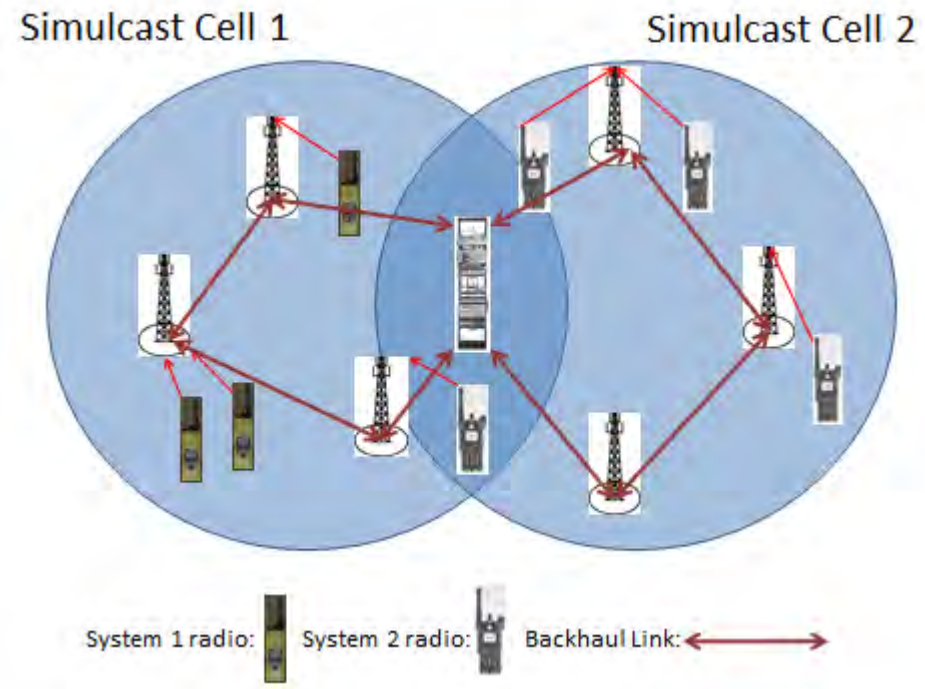

Figure 6 – Shared System Configuration

Typically, capacity is controlled on shared systems by restricting the primary talkgroup access for a given agency to the radio sites immediately covering their jurisdiction. Wide-area or regional "roaming" talkgroups may access a wider coverage area for use during wide-area events, prisoner transports, police pursuits, or other circumstances as needed. This configuration prevents users from monitoring their home area talkgroups when outside of the primary coverage area.

With the advent of P25, Internet Protocol (IP)-based backhaul circuits and geo-diverse system controllers have greatly expanded the reliability and survivability of trunked networks. Using multi-protocol label switching (MPLS) backhaul networks, diverse multi-path backhaul networks using a combination of microwave, T1 and fiber circuits can be created providing previously unrecognizable levels of backhaul reliability. The result is that radio networks act more as a "cloud"-based network than the previous point-to-point circuit switched or microwave loop networks. Networks can truly be developed that have no single point of failure. Even with equipment or connectivity failures, current systems are able to operate in several tiers of fallback modes before the ability for users to communicate is lost altogether. As reliability and survivability have increased, less dependence is needed on backup systems or neighboring systems to support operation in the event of a system failure.

In addition to improved interoperability, shared systems provide an opportunity for cost savings amongst user agencies. With shared networks, less overall system controllers are needed to support each agency. All users are maintained on the same system release with the same feature sets, a

challenge currently faced by NCR member agencies. The number of radio sites may potentially be reduced if single sites can be identified that provide coverage along the border between two neighboring jurisdictions. Maintenance costs as a whole would be reduced through the sharing of resources between multiple agencies.

Perhaps the greatest challenge with implementing shared networks is overcoming political obstacles to implementing shared system resources instead of the separately owned and maintained systems of today. With the current configuration of systems, combining systems to a shared system would require interconnecting backhaul networks with ensured bandwidth to provide sufficient connectivity to all dispatch centers. A single system ID would be required, necessitating the reprogramming of subscriber radios for all agencies but the host agency. The host agency system core will need to have the appropriate capacity to accommodate all potential users, sites and dispatch locations. With most jurisdictions already operating distinct P25 systems, migrating toward shared systems would result in the least operational impact if the upgrades occurred during the subsequent system technology refresh. In the interim, solutions such as ISSI or Inter-zone would be simpler, less expensive and cause less of an operational impact to implement.

The challenges associated with migrating to a regional shared system should not be underestimated. Such a migration would require a tremendous amount of coordination and effort between the participating jurisdictions to ensure operability and interoperability is not lost before, during, and after the transition. With the number of jurisdictions and subscriber radios involved, such a migration would perhaps provide the greatest coordinated effort ever required for radio communications within the NCR, far exceeding the efforts associated with 800 MHz rebanding.

Table 7 summarizes the strengths and weaknesses of a shared system approach.

Table 7 – Shared System

Strengths	Weaknesses
All users sharing the system have the highest technical level of interoperability available	Requires sharing of resources, resulting in some loss of autonomy
Cost savings recognized over purchase of new standalone system through less control equipment and potentially less radio sites	Most jurisdiction have already implemented P25 systems, so it will be some time before the next wave of system replacements where shared systems could be implemented
Improved system reliability through diverse backhaul and control equipment	Merging two or more P25 systems will require a complex cutover and extensive subscriber programming efforts to ensure operability and interoperability is maintained before, during, and after cutover
Reduction in operating expenses and maintenance	Governance, SOPs and ownership models must be agreed upon to ensure the shared system is used properly and fairly by all user jurisdictions
Users have access to the radio sites that provide the	Likelihood of increased usage on each system, further

Strengths	Weaknesses
best coverage, regardless of where they are located	straining system capacity and possibly requiring an increase above current capacity levels
Ability to restrict talkgroup access in order to preserve capacity where necessary	Shared systems limited to one primary system vendor, limiting competition for future infrastructure purchases
Coordinated upgrades in feature sets so interoperability is not limited when any one agency upgrades their system	

4.2. OPERATIONAL ANALYSIS

MCP identified five different technology solutions that could be implemented to expand radio capabilities within the NCR. However, these solutions are useless unless they fill a specific interoperability need. This section correlates each solution to the specific interoperability gaps identified by radio managers.

4.2.1. Summary of Operational Requirements

Based on interviews conducted with radio managers in each NCR jurisdiction, the following list summarizes the identified interoperability gaps:

1. Interoperability Everywhere – The ability to carry any talkgroup from any NCR radio system to any other interconnected jurisdiction within the NCR
2. Wide-area Channels – Designated channels distinct from primary operational channels that could be utilized anywhere within the NCR
3. Coverage from Other Systems – The ability for subscribers to access tower sites that provide the most optimal coverage regardless to which jurisdiction the tower sites belong
4. Extended Coverage for Mutual Aid – The ability to monitor a mutual event before arriving on scene when there is insufficient coverage for the hosting system from the point of origin of the responding unit
5. Simplified Interoperability – The ability to reduce the complexity of channel changing and large fleetmaps to simplify interoperable communications for first responders
6. Distant System Programming – The ability to access any system's infrastructure without specifically programming talkgroups with the appropriate system ID
7. System Changes – The ability to coordinate system changes so an upgrade or modification from any one agency does not inhibit the ability of other agencies to interoperate with that agency
8. Upgrade Funding – The ability to coordinate procurements so all interoperable partners can coordinate decisions and changes that would otherwise negatively impact interoperability
9. Alias Databases – The ability to easily share alias database information without manually making changes every time one agency updates their alias database
10. Frequent Radio Programming – The ability to reduce the occurrence of code plug changes by any one jurisdiction that subsequently requires changes by interoperability partners

4.2.2. Ability to Satisfy Operational Requirements

Each of the five technical solutions proposed satisfy some of the identified operational gaps. This section describes how each solution either does or does not satisfy each of the gaps.

4.2.2.1. Conventional Simulcast Interoperability System

The following bullets summarize how a conventional simulcast interoperability system, as described in section 4.1.1, could satisfy or fail to satisfy the identified operational gaps.

- **Interoperability Everywhere** – A conventional simulcast solution will permit users anywhere within the NCR to operate on designated conventional frequencies. This solution will not permit primary talkgroups to operate beyond their primary system coverage boundary, and this will not permit interoperability throughout the region on any channel. The conventional system may be used for wide-area communications across jurisdictional boundaries, but only when users switch to the channels. Because of the limited coverage and capacity that would be offered by the conventional system, the circumstances with which users would access the system would be limited to certain infrequent scenarios. While users anywhere in the regional could communicate directly through this system, the system could not operationally handle all interoperability traffic throughout the region as a primary interoperability system.

- **Wide-area Channels** – A conventional simulcast solution would provide wide-area channels that could be used anywhere within the NCR. Users anywhere within the coverage footprint could monitor these channels. The primary limitation is that a conventional system would provide a limited amount of coverage and capacity. Coverage would be limited to mobile units, and capacity would be limited to several channels. These channels could potentially be utilized for wide-area mobile usage such as police pursuits or EMS transports, or fire wide-area coordination across multiple jurisdictions for large-scale events. However, usage would be limited to circumstances where the primary trunking systems do not provide sufficient wide-area coverage serving the specific event.

- **Coverage From Other Systems** – A conventional simulcast system would not allow subscribers to benefit from the coverage of neighboring systems. Radio users would have to manually switch to channels on the conventional system, and coverage would be limited to the footprint of the conventional overlay system.

- **Extended Coverage for Mutual Aid** – A conventional simulcast system would only provide extended coverage for mutual aid if radio traffic for the interoperable event is carried on the wide-area system or if traffic from the event is patched to a wide-area conventional channel. Due to coverage and capacity limitations, it is not likely that most routine interoperable events

would operate on a conventional overlay system. Patching is possible, but would be cumbersome and tie up one conventional overlay channel throughout the region.

- **Simplified Interoperability** – A conventional simulcast system would not replace the way that users respond for mutual aid for routine calls. Users would still be required to switch to the primary operational channel of the jurisdiction they are entering. This would still necessitate maintaining complex fleetmaps with talkgroups for all systems within the NCR. Therefore it is not likely that a conventional overlay system alone would greatly simplify interoperability.

- **Distant System Programming** – An overlay system would permit radio users to communicate outside of their jurisdiction as long as they operate on the overlay system. If those users were responding to a covered jurisdiction for which the primary trunking system was not programmed, the responding units could operate with limited coverage and capacity on the overlay system. Connectivity could then be established to the local trunking system through a patch. While this method of connectivity is not ideal and would not provide the optimal coverage level, any user would have the ability to maintain some level of radio connectivity regardless of how their radios were programmed.

- **System Changes** – An overlay system would not solve interoperability gaps that arise when any one jurisdiction upgrades their system. Most interoperability calls will still require changing talkgroups to the channel being used by the serving PSAP for an event. The overlay system will provide an alternate means to communicate if interoperability cannot otherwise be accomplished between two jurisdictions, but will not solve the problem of system changes.

- **Upgrade Funding** – The overlay system will not result in any cost savings, and will not enhance the ability of localities to support upgrades.

- **Alias Databases** – The conventional overlay system will not permit a way to share alias databases between trunking systems.

- **Frequent Radio Programming** – The conventional overlay system will not prevent agencies from updating their code plugs. This problem is primarily operational and should be addressed through better coordination amongst NCR agencies.

4.2.2.2. Trunked Overlay System

The following bullets summarize how a trunking overlay system, as described in section 4.1.2, could satisfy or fail to satisfy the identified operational gaps.

- **Interoperability Everywhere** – A trunking overlay solution will permit users anywhere within the NCR to operate on the designated overlay system. This solution will not permit primary talkgroups to operate beyond their primary system coverage boundary, and will not permit

interoperability throughout the region on any channel. The trunking system may be used for wide-area communications across jurisdictional boundaries, but only when users switch to the channels. Because of the limited capacity that would be offered by the trunked overlay system, the circumstances with which users would access the system would be limited to certain infrequent scenarios. While users anywhere in the regional could communicate directly through this system, the system could not operationally handle all interoperability traffic throughout the region as a primary interoperability system. The system would support substantially more traffic than a conventional system and thus could be used for more routine interoperability events.

- **Wide-area Channels** – A trunked overlay solution would provide wide-area channels that could be used anywhere within the NCR. Users anywhere within the coverage footprint could monitor these channels. The primary limitation is that a trunking overlay system would provide a limited amount of coverage. Coverage would be limited to mobile units, and capacity would be less than primary systems but still substantial enough to be used for more regular events. These channels could be utilized for dispatch communications, wide-area mobile usage such as police pursuits or EMS transports, or fire wide-area coordination across multiple jurisdictions for large-scale events.

- **Coverage From Other Systems** – A trunked overlay system would not allow subscribers to benefit from the coverage of neighboring systems. Radio users would have to manually switch to channels on the trunked overlay system, and coverage would be limited to the footprint of the trunked overlay system.

- **Extended Coverage for Mutual Aid** – A trunked overlay system would only provide extended coverage for mutual aid if radio traffic for the interoperable event is carried on the wide-area system or if traffic from the event is patched to a wide-area trunked overlay talkgroup. Due to coverage limitations, it is not likely that most routine interoperable events would operate on a trunked overlay system. Patching is possible, but would be cumbersome.

- **Simplified Interoperability** – A trunked overlay system would not replace the way that users respond for mutual aid for routine calls. Users would still be required to switch to the primary operational channel of the jurisdiction they are entering. This would still necessitate maintaining complex fleetmaps with talkgroups for all systems within the NCR. Therefore it is not likely that a trunking overlay system alone would greatly simplify interoperability.

- **Distant System Programming** – An overlay system would permit radio users to communicate outside of their jurisdiction as long as they operate on the overlay system. If those users were responding to a covered jurisdiction for which the primary trunking system was not programmed, the responding units could operate with limited coverage on the overlay system. Connectivity could then be established to the local trunking system through a patch. While this method of connectivity is not ideal and would not provide the optimal coverage level, any user would have

the ability to maintain some level of radio connectivity regardless of how their radios were programmed.

- **System Changes** – An overlay system would not solve interoperability gaps that arise when any one jurisdiction upgrades their system. Most interoperability calls will still require changing talkgroups to the channel being used by the serving PSAP for an event. The overlay system will provide an alternate means to communicate if interoperability cannot otherwise be accomplished between two jurisdictions, but will not solve the problem of system changes.

- **Upgrade Funding** – The overlay system will not result in any cost savings, and will not enhance the ability of localities to support upgrades.

- **Alias Databases** – The trunked overlay system will not permit a way to share alias databases between trunking systems.

- **Frequent Radio Programming** – The trunked overlay system will not prevent agencies from updating their code plugs. This problem is primarily operational and should be addressed through better coordination amongst NCR agencies. While a trunked overlay system could potentially be used for over-the-air-programming (OTAP) to update subscriber templates, this would require coordination amongst all jurisdictions and would be operationally challenging to implement.

4.2.2.3. Inter-zone

The following bullets summarize how systems connected via Inter-zone, as described in section 4.1.3, could satisfy or fail to satisfy the identified operational gaps.

- **Interoperability Everywhere** – Systems interconnected with Inter-zone operate as one single shared system, and thus permit any talkgroup within the interconnected systems to be configured to operate anywhere within the coverage footprint. The coverage provided by this connection will equal the primary coverage offered by both systems. Therefore there is no limit to interoperability between agencies sharing an Inter-zone connection. Interoperability will not be enhanced with agencies that are not part of the Inter-zone connection.

- **Wide-area Channels** – With an Inter-zone connection, interconnected systems can restrict talkgroups to specific sites or simulcast cells. Certain talkgroups may be configured with wide-area communications that can work on any site or simulcast cell within the system. Therefore, both wide-area and restricted talkgroups are available for interconnected agencies.

- **Coverage From Other Systems** – With systems connected via Inter-zone, talkgroups may be configured to roam to any radio site or simulcast cell within the system. Therefore, users can benefit from the coverage of tower sites of neighboring jurisdictions as long as roaming is

permitted. This level of roaming will result in additional system loading for the neighboring jurisdiction.

- **Extended Coverage for Mutual Aid** – Systems connected with Inter-zone will permit users to switch to talkgroups that fall outside of their primary jurisdiction as long as wide-area communications is permitted on those talkgroups. This will permit users to monitor mutual aid traffic when responding as long as they are within the coverage footprint of interconnected systems.

- **Simplified Interoperability** – Systems interconnected with Inter-zone have the potential to simplify interoperability if operational changes are made to the way talkgroups are organized across the region. With the shared system approach, a pool of regional talkgroups may be assigned for events, instead of disparate talkgroups, on each independent system. With this channel assignment scheme the overall number of talkgroups a user may potentially need to access for interoperability events would be greatly reduced.

- **Distant System Programming** – Talkgroups permitted for wide-area communications could operate anywhere within the coverage footprint of the interconnected systems. Separate programming would still be required for systems not connected with Inter-zone. Regionalized tactical talkgroups would greatly reduce the number of talkgroups for different systems that would need to be programmed.

- **System Changes** – Systems connected with Inter-zone are required to remain at the same Motorola system release level. Therefore the system changes that could be implemented by any one jurisdiction would be limited. Regionalized talkgroups would provide an alternate means to interoperate even if one jurisdiction implements a feature such as encryption that could potentially limit interoperability.

- **Upgrade Funding** – Inter-zone permits the interconnection of existing Motorola master sites, and thus would not likely result in any cost savings. System changes would be more difficult to accomplish because every interconnected system would need to secure funding and participate.

- **Alias Databases** – Systems interconnected with Inter-zone share an alias database and thus aliases would be universal throughout the interconnected systems.

- **Frequent Radio Programming** – Systems interconnected with Inter-zone would not inherently mitigate frequent radio programming needs. A regional approach to talkgroup assignments would reduce the number of total talkgroups and likely reduce the need for changes. Operational procedures are the best option to address this gap.

4.2.2.4. ISSI

The following bullets summarize how systems connected via ISSI, as described in section 4.1.4, could satisfy or fail to satisfy the identified operational gaps.

- **Interoperability Everywhere** – Systems interconnected with ISSI and the cross-system roaming feature will have the ability to utilize any talkgroup within any interconnected system as long as that talkgroup has the appropriate ISSI roaming permissions. The coverage provided by this connection will equal the primary coverage offered by the interconnected systems. Therefore there are few limits to interoperability between agencies interconnected with ISSI seamless roaming. Some features such as mobile data, GPS and scanning will not be available to users when they are roaming. Interoperability will not be enhanced with agencies that are not interconnected with ISSI.

- **Wide-area Channels** – With an ISSI connection, interconnected systems can restrict talkgroups to specific sites or simulcast cells. Certain talkgroups may be configured with wide-area (roaming) communications that can work on any system, site or simulcast cell within the interconnected systems. Therefore, both wide-area and restricted talkgroups are available for interconnected agencies.

- **Coverage From Other Systems** – With systems connected via ISSI, talkgroups may be configured to roam to any radio site or simulcast cell within the interconnected systems. Therefore, users can benefit from the coverage of tower sites of neighboring jurisdictions as long as roaming is permitted on those talkgroups. This level of roaming will result in additional system loading for the neighboring jurisdiction.

- **Extended Coverage for Mutual Aid** – Systems connected with ISSI will permit users to switch to talkgroups that fall outside of their primary jurisdiction as long as wide-area communications is permitted on those talkgroups. This will permit users to monitor mutual aid traffic when responding as long as they are within the coverage footprint of interconnected systems.

- **Simplified Interoperability** – Systems interconnected with ISSI have the potential to simplify interoperability if operational changes are made to the way talkgroups are organized across the region. With the shared system approach, a pool of regional talkgroups may be assigned for events instead of disparate talkgroups on each independent system. With this channel assignment scheme, the overall number of talkgroups a user may potentially need to access for interoperability events would be greatly reduced.

- **Distant System Programming** – Talkgroups permitted for wide-area communications could operate anywhere within the coverage footprint of the interconnected systems. Separate programming would still be required for systems not connected with ISSI. Regionalized tactical

talkgroups would greatly reduce the number of talkgroups for different systems that would need to be programmed.

- **System Changes** – Systems connected with ISSI are compliant as long as they meet the minimum seamless roaming requirements. For Motorola systems the requirements include system release 7.13 or later, GTR series base stations or later, and MCC7500 or MCC7100 consoles or later. Harris has not yet released their version of ISSI system-to-system roaming. This scenario allows agencies to make certain changes to their systems without impacting interoperability through the ISSI gateway. However, certain feature sets, including current and future features, may not be part of the ISSI standard and therefore may not work through the ISSI gateway. Jurisdictions should coordinate with their vendors to verify which features will and will not work through the ISSI connection.

- **Upgrade Funding** – ISSI provides an interconnection between disparate systems that would not immediately result in any cost savings. Cost savings could only be recognized if newly constructed systems leveraged coverage from existing P25 infrastructure to avoid the construction of additional radio sites. This approach is currently being undertaken by the State of Maryland. Since all NCR agencies currently operate 800 MHz trunking systems, these types of cost savings are not likely in lieu of the costs for ISSI.

- **Alias Databases** – While ISSI does not support alias sharing per the P25 standard, Motorola has implemented alias sharing as a proprietary feature. Motorola systems interconnected with ISSI will have the ability to share alias databases.

- **Frequent Radio Programming** – Systems interconnected with ISSI would not inherently mitigate frequent radio programming needs. A regional approach to talkgroup assignments would reduce the number of total talkgroups and likely reduce the need for changes. Operational procedures are the best option to address this gap.

4.2.2.5. Shared Systems

The following bullets summarize how shared systems, as described in section 4.1.5, could satisfy or fail to satisfy the identified operational gaps.

- **Interoperability Everywhere** – Shared systems permit any talkgroup within the system to be configured to operate anywhere within the coverage footprint. The coverage will span all radio sites and simulcast cells within the system. Coverage may be restricted by talkgroup to specific sites or simulcast cells in order to preserve capacity. There is no technical limit to interoperability between agencies operating on a shared system other than capacity. Interoperability will not be enhanced with agencies that are not part of the shared system.

- **Wide-area Channels** – With a shared system, talkgroups can be restricted to specific sites or simulcast cells. Certain talkgroups may be configured with wide-area communications that can work on any site or simulcast cell within the system. Therefore, both wide-area and restricted talkgroups are available for interconnected agencies.

- **Coverage From Other Systems** – With shared systems, talkgroups may be configured to roam to any radio site or simulcast cell within the system. Therefore, users can benefit from the coverage of tower sites of neighboring jurisdictions as long as roaming is permitted. This level of roaming will result in additional system loading for the neighboring jurisdiction.

- **Extended Coverage for Mutual Aid** – Shared systems will permit users to switch to talkgroups that fall outside of their primary jurisdiction as long as wide-area communications is permitted on those talkgroups. This will permit users to monitor mutual aid traffic when responding as long as they are within the coverage footprint of shared systems.

- **Simplified Interoperability** – Shared systems have the potential to simplify interoperability if operational changes are made to the way talkgroups are organized across the region. With the shared system approach, a pool of regional talkgroups may be assigned for events instead of disparate talkgroups on each independent jurisdiction. With this channel assignment scheme the overall number of talkgroups a user may potentially need to access for interoperability events would be greatly reduced.

- **Distant System Programming** – Talkgroups permitted for wide-area communications could operate anywhere within the coverage footprint of the interconnected system. Separate programming would still be required for systems not interconnected with the regional system. Regionalized tactical talkgroups would greatly reduce the number of talkgroups for different systems that would need to be programmed.

- **System Changes** – Shared systems must inherently remain at the same release level. Therefore the system changes that could be implemented by any one jurisdiction would be limited. The only features that could potentially limit interoperability are subscriber-centric features such as encryption.

- **Upgrade Funding** – A shared system approach provides the greatest opportunity for cost savings of all available alternatives. Through a shared system, the total number of system controllers could be reduced, overall reliability could be increased, recurring maintenance costs will be reduced, and coverage will be enhanced by permitting users access to all available tower sites. Users of the shared system will be required to migrate system platforms together, so there will be less of a risk that any one jurisdiction will be left behind.

- **Alias Databases** – A shared system would utilize a single alias database; therefore aliases would be universal across the system.

- **Frequent Radio Programming** – A shared system would not inherently mitigate frequent radio programming needs. A regional approach to talkgroup assignments would reduce the number of total talkgroups and likely reduce the need for changes. Operational procedures are the best option to address this gap.

4.2.3. Operational Summary

Table 8 summarizes the operational gaps and which gaps each available technology option could potentially mitigate.

Table 8 – Operational Gap Comparison

	Interoperability Everywhere	Wide-area Channels	Coverage from Other Systems	Extended Mutual Aid Coverage	Simplified Interoperability	Distant System Programming	System Changes	Upgrade Funding	Alias Database Sharing	Frequent Radio Programming
Option 1 – Conventional Simulcast		x				x				
Option 2 – Trunked Overlay		x				x				
Option 3 – Inter-zone	x	x	x	x	x	x	x		x	
Option 4 – ISSI	x	x	x	x	x	x	x		x	
Option 5 – Shared Systems	x	x	x	x	x	x	x	x	x	

4.3. LOADING ANALYSIS

One of the primary limitations with implementing the discussed interoperability solutions is the impact on capacity of the primary trunking systems. Capacity on trunking systems is determined by the number of available talkpaths. P25 Phase I systems utilize one talkpath per frequency; P25 Phase II systems utilize two talkpaths per frequency. When every talkpath within a system is occupied, subsequent call requests will be placed in a queue. The queued radio call will be given system access once another call drops.

Capacity for trunked systems is evaluated based on statistics. For a given system, there is a probability that a given user will make a certain number of radio calls of some duration each hour. For the number of active users on the system, the probability is compounded that multiple calls will occur simultaneously. Erlang C calculations are used to determine the maximum number of users a system can accommodate for a given number of talkpaths. Grade of Service (GoS) is the industry standard term used to indicate the probability that a trunking system will reach capacity and provide a busy tone

to a radio user. The typical design standard for trunking systems is a GoS of 1 percent or less, indicating that the probability is less than 1 percent that a user will receive a busy.

The current systems in the NCR are designed to provide sufficient capacity for the primary system users. While most systems do not regularly operate near the limit of their capacity on a day-to-day basis, the additional capacity is available for larger events or disasters that result in increased radio traffic. With the current level of ID sharing and interoperability within the NCR, a large number of users could potentially respond to the coverage of one jurisdiction during a major event, resulting in a usage surge that will quickly utilize the available spare capacity.

Capacity on the current systems is maintained in part due to the simulcast design of each system. Most trunking systems in the NCR utilize single simulcast cells. Within a simulcast cell every talkgroup call is re-broadcast at each radio site. If users monitor those channels from anywhere within the system coverage area than no additional capacity is utilized. Conversely, in multi-zone or multi-cast systems, radio calls are only broadcast at sites or simulcast zones where there is an affiliated radio user on a specific talkgroup. If a user is monitoring a talkgroup outside of the primary serving simulcast cell or site, then the system will allocate additional channels so that the user's affiliated radio site will broadcast the call. This scenario results in a less efficient channel use and reduced capacity.

4.3.1. Impact of System Options on Loading

Each proposed interoperability option will have some impact on the capacity of trunking systems within the NCR.

4.3.1.1. Capacity for Overlay System Options

The conventional and trunking overlay systems will provide the least direct impact to the capacity provided by the primary operational systems. The overlay systems will operate on distinct standalone systems, and thus usage of these systems will have no direct impact on the capacity provided by the primary trunking systems. For the conventional option (Option 1), frequencies would be re-allocated from already assigned interoperability channels. For the trunking option (Option 2), frequencies would be required out of the available 700 and 800 MHz pools. Assignment of these channels to a regional overlay system would mean that these frequencies are no longer available to assign to a primary operational system to increase capacity. Therefore the impact for a trunking overlay system in capacity would be on the lost opportunity to use those channels for channel increases on primary systems. Because most systems within the NCR have an adequate level of capacity today and can achieve additional increases in capacity through TDMA upgrades, it is uncertain whether additional channels assigned to an overlay system would ever be needed.

4.3.1.2. Capacity for Shared System Options

The greatest potential impact to the capacity of primary trunking systems lies with the implementation of either Inter-zone connections (Option 3), ISSI (Option 4), or shared systems (Option 5). With these

options interoperability traffic will be carried on the primary trunking systems, thus impacting system capacity.

The impact on capacity will depend on the type of roaming permitted. If roaming is permitted on dedicated wide-area channels that are distinct from primary operational channels, then a minimal impact on capacity is anticipated. In this configuration additional capacity will only be utilized when users switch to designated wide-area channels. These channels would only be utilized as operationally required during such events as a police pursuit or prisoner transport. Such an event would be infrequent and only utilize a minimal number of talkgroups. With this configuration only a minimal amount of the operational challenges noted by the NCR radio managers would be addressed.

The greatest impact to system capacity would occur if the primary operational channels of each jurisdiction were permitted to roam. This configuration would act as a coverage extension, allowing users to regularly roam to the tower sites and simulcast cells that provide the most optimal coverage. Every time a user roams to the tower of a neighboring jurisdiction, an additional talkpath will be utilized throughout that system's entire simulcast cell. Additionally, users monitoring a home talkgroup outside of their primary jurisdiction will occupy a talkpath on whatever system they are located. This scenario will be particularly challenging for TDMA systems that were properly sized based upon TDMA loading. For these systems, users monitoring channels from outside the jurisdiction with non-TDMA-compliant radios will occupy two talkpaths instead of one. These scenarios are compounded during major events where there are additional users from more jurisdictions monitoring and responding to events.

While there is a potential risk for greatly increased capacity use, technical and operational solutions are available to mitigate the risk. For any of these options, restrictions can be placed on talkgroups so their operation can be limited to specific simulcast cells. Procedures can be put in place to deter the unnecessary monitoring of channels in areas where the monitoring will result in decreased system capacity. ISSI provides additional options by allowing system managers to restrict the number of simultaneous ISSI roaming talkgroups or affiliated users on their system. A balance must be found between operational benefit and restraint to achieve the optimal level of capabilities while preserving capacity. These challenges are well documented in shared systems across the country.

4.3.2. Loading Calculations

MCP performed Erlang C calculations to determine the number of talkpaths necessary for each jurisdiction in the NCR to accommodate additional traffic that can be anticipated from the implementation of Inter-zone, ISSI or shared systems. The total subscriber and current talkpath counts have been provided by each NCR radio manager.

MCP utilized the assumptions that follow for the loading analysis.

1. Twenty-five percent of the total subscriber count for each jurisdiction is considered “active users” for the Erlang C analysis. This takes into account the fact that not all users are on shift at any one given time and a user may have both a portable and mobile radio, but will only use one at a time.

2. Of the active users, 15 percent of the traffic will be carried to each immediately neighboring jurisdiction. This assumes worst-case where primary talkgroups are permitted to roam unrestricted.

3. Calculations assume an average of five calls per hour with an average duration of four seconds.

4. Channel increases are based the current technology (FDMA or TDMA) used on the system.

5. Conversions from FDMA to TDMA have not been considered for this study, although such conversions may be implemented as an alternative to increasing channels.

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Table 9 – Loading Analysis

System/Agency	FDMA / TDMA	Talkpaths	Subscribers	Adjacent Jurisdictions	15% From Neighbors	Total Subscribers	Total Channels Required	Additional Channel Required
Washington, D.C.	TDMA	26	2,500	Arlington County, VA Alexandria, VA Prince George's County, MD Montgomery County, MD WMATA	525 200 1,549 1,125 75	5,974	16	0
Arlington County, VA	FDMA	17	3,500	Fairfax County, VA Alexandria, VA Washington, D.C. MWAA WMATA	930 200 375 102 75	5,182	14	0
City of Alexandria, VA	FDMA	10	800	Fairfax County, VA Arlington County, VA Washington, D.C. Prince George's County, MD MWAA WMATA	930 525 375 1,549 102 75	4,356	13	2
Fairfax County, VA	FDMA	19	6,200	Arlington County, VA Alexandria, VA Prince William County, VA Loudoun County, VA Montgomery County, MD Prince George's County, MD Charles County, MD MWAA WMATA	525 200 726 375 1,125 1,549 270 102 75	11,147	24	4
Fauquier County, VA	FDMA	7	1,400	Stafford County, VA Prince William County, VA Loudoun County, VA	180 726 375	2,681	10	2

System/Agency	FDMA / TDMA	Talkpaths	Subscribers	Adjacent Jurisdictions	15% From Neighbors	Total Subscribers	Total Channels Required	Additional Channel Required
Loudoun County, VA	TDMA	19	2,500	Prince William County, VA Fairfax County, VA Fauquier County, VA MWAA Montgomery County, MD Frederick County, MD WMATA	726 930 210 102 1,125 555 75	6,223	16	2 (Due to FDMA on roaming users)
Prince William County, VA	TDMA	26	4,842	Fairfax County, VA Loudoun County, VA Fauquier County, VA Stafford County, VA Charles County, MD	930 375 210 180 270	6,807	17	0
Stafford County, VA	FDMA	10	1,200	Fauquier County, VA Prince William County, VA Charles County, MD	210 726 270	2,406	9	0
MWAA	FDMA	8	2,300 (678 public safety)	Loudoun County, VA Fairfax County, VA Arlington County, VA City of Alexandria, VA	375 930 525 120	4,250	13	4
WMATA	FDMA	TBD (700 MHz)	8,000 (500 public safety)	Arlington County, VA Alexandria, VA Fairfax County, VA Loudoun County, VA Washington, D.C. Montgomery County, MD Prince George's County, MD	525 200 930 375 375 1,125 1,549	13,079	27	19 total (primary users) 28 total with interop users
Charles County, MD	FDMA	7	1,800	Prince George's County, MD Fairfax County, VA Prince William County, VA Stafford County, VA	1,549 930 726 180	5,185	14	3

System/Agency	FDMA / TDMA	Talkpaths	Subscribers	Adjacent Jurisdictions	15% From Neighbors	Total Subscribers	Total Channels Required	Additional Channel Required
Frederick County, MD	FDMA	11	3,700	Montgomery County, MD Loudoun County, VA	1,125 375	5,200	14	2
Montgomery County, MD	FDMA	19	7,500	Frederick County, MD Prince George's County, MD Washington, D.C. Loudoun County, VA Fairfax County, VA WMATA	555 1,549 375 375 930 75	11,359	26	6
Prince George's County, MD	TDMA	26 (north) 20 (south)	10,325	Charles County, MD Montgomery County, MD Washington, D.C. Alexandria County, VA Fairfax County, VA WMATA	270 1,125 375 200 930 75	13,300	28	1 north 4 south

4.4. GAP ANALYSIS

MCP has completed a gap analysis to determine what steps must be taken to implement each of the identified technology options. The gap analysis is necessary to determine the level of complexity and cost that will be associated with each option. The following sections detail the specific steps that must be undertaken to implement each of the identified options.

4.4.1. Conventional Overlay Gap Analysis

The conventional overlay solution will act as a standalone system and thus will not require significant modifications to the primary radio systems. The following list outlines the steps necessary to implement a conventional overlay system.

1. **Buy-in** – The conventional overlay solution will require the installation of simulcast equipment at strategic radio sites selected to provide optimal coverage throughout the NCR. Such a system will require the cooperation of all agencies within the NCR to contribute radio sites and backhaul connectivity, commit funding where necessary, and agree on an implementation strategy for the system.

2. **Secure Frequencies** – NCR member agencies must come to an agreement on which specific frequencies to use in the overlay system. While the national 8CALL/8TAC channels could be used, these frequencies are designated for interoperability use throughout the country and it will be challenging to use these channels in a manner differently than defined in the National Interoperability Field Operations Guide (NIFOG) or other similar interoperability plans. Identifying new channels for use would permit the most flexible usage; however, existing resources could not be leveraged and there would likely be challenges associated with identifying new spectrum.

3. **Select Radio Sites** – Radio sites must be identified that provide optimal coverage, have space to accommodate additional equipment, will not result in significantly increased lease fees, have connectivity with available bandwidth, and will be relatively easy to implement. Overall the network will likely provide either mobile or in-street portable coverage, thus requiring only a subset of the sites utilized on the primary systems.

4. **Evaluate Existing Equipment** – Existing equipment used on the frequencies identified for simulcast operation will need to be evaluated to determine compatibility. Ideally analog simulcast equipment requires the use of identical model base stations. Co-located simulcast timing equipment will need to be evaluated for compliance with the proposed conventional simulcast solution. Once existing equipment is documented, a specification can be developed for implementation of the solution.

5. **Vendor Contract** – Once specifications are developed a vendor can be selected for the implementation of the system. It is anticipated that some number of additional base stations will be required to provide NCR-wide coverage at the desired levels.

6. **Backhaul Connectivity** – Backhaul connectivity will need to be established between each of the radio sites in the simulcast design. With each primary radio system already operating backhaul networks, it is anticipated that connecting the simulcast sites will require integration of specific backhaul links between systems. The NCRNet may be leveraged to provide connectivity between disparate radio networks if no other interface points exist. MCP expects that backhaul connectivity will be the most complex aspect of implementing a conventional simulcast solution.

7. **Governance and SOPs** – A governance structure will be necessary to make decisions regarding such an overlay system and establish usage standards. The governance structure will need to be organized to accommodate sustainment of the system. SOPs will need to be developed that define appropriate usage of the system.

8. **System Integration** – Minimal effort is anticipated to integrate the new simulcast system with primary radio and dispatch systems. If the national interoperability channels are used, no subscriber programming will be necessary. Radio programming will be necessary if alternate channels are identified. Console integration will only be necessary on those systems that do not already monitor the national interoperability channels or on all consoles if alternate channels are identified.

4.4.2. Trunking Overlay Gap Analysis

The trunking overlay solution will act as a standalone system, but will require some integration with the primary radio systems. The following list outlines the steps necessary to implement a trunking overlay system.

1. **Buy-in** – The trunking overlay solution will require the installation of simulcast equipment at strategic radio sites selected to provide optimal coverage throughout the NCR. Such a system will require the cooperation of all agencies within the NCR to contribute radio sites and backhaul connectivity, commit funding, and agree on an implementation strategy for the system. The costs for such a system are likely to be considerably more than those expected for a conventional system.

2. **Secure Frequencies** – Securing frequencies for a regional trunking system is expected to be a challenge. For conceptual design purposes, MCP is assuming a total of five FDMA channels per site in a multi-cast configuration. 700 MHz channels are the most likely source, although many of the available channels have already been acquired by 700 MHz system operators in the region. Use of orphan channels may be possible due to the ability to use channels without a specific geographic restriction for coverage. There must be significant representation from NCR

member agencies committed to the project at Region 20 meetings to ensure any 700 MHz channels identified as available will be approved by the region. In addition to 700 MHz channels, a substantial number of 800 MHz Sprint vacated channels were recently released and may be available. Given the challenges associated with spectrum acquisition, it may not be possible altogether to identify sufficient spectrum to support such a system. If this is the case, use of a wide-area WMATA system could be the only feasible overlay solution.

3. **Select Radio Sites** – Radio sites must be identified that provide optimal coverage, have space to accommodate additional equipment, will not result in significantly increased lease fees, have connectivity with available bandwidth, and will be relatively easy to implement. Overall the network will likely provide either mobile or in-street portable coverage, thus requiring only a subset of the sites utilized on the primary systems.

4. **Evaluate Existing Equipment** – There is minimal fielded equipment that could potentially be reutilized in a trunking overlay solution. To reduce costs, an existing Motorola master site could be leveraged to host the overlay network, if a master site can be identified with sufficient capacity to accommodate the additional sites. Alternatively, retired legacy Motorola 3600 series equipment could be re-fielded for the system. This equipment would provide some up-front cost savings but would have limited support available for sustainment and would be proprietary to Motorola subscriber radios.

5. **Develop Specifications** – Specifications will need to be developed for the system to detail performance requirements for the selected vendor. The specifications should include performance requirements for coverage, capacity, redundancy, etc. Any equipment to be reused should be defined within the specifications.

6. **Vendor Contract** – Once specifications are developed a vendor can be selected for the implementation of the system. It is anticipated that the trunking overlay system cost will be substantial.

7. **Backhaul Connectivity** – Backhaul connectivity will need to be established between each radio site in the trunking overlay design. With each primary radio system already operating backhaul networks, it is anticipated that connecting the simulcast sites will require integration of specific backhaul links between systems. The NCRNet may be leveraged to provide connectivity between disparate radio networks if no other interface points exist. MCP expects that backhaul connectivity will be the most complex aspect of implementing a trunking overlay solution.

8. **Governance and SOPs** – A governing entity will need to be responsible for the ownership and usage of the system. Possible organizations that could manage this effort include a subcommittee of MWCOG, an alternate existing committee, or a new committee altogether. The committee must have the ability to secure funding to both install and maintain the network. SOPs will need to be developed that define appropriate usage of the system.

9. **System Integration** – Integration of the trunking overlay system will require subscriber radio programming for every participating agency and integration of system channels with dispatch consoles throughout the region. Dispatch console integration may be accomplished through a direct IP interface to the master site, or through over-the-air control station links.

4.4.3. Inter-zone Gap Analysis

Interconnecting systems with Inter-zone will require the reuse of existing primary systems. Due to the complex requirements for Inter-zone and the different system releases where each system is currently, the integration of systems through Inter-zone would be expected to be piece-meal on an agency by agency basis. Based on the benefits of alternate solutions such as ISSI or shared systems, it is likely that any Inter-zone connections would be utilized in conjunction with other agencies integrated through ISSI or shared systems. The following list outlines the steps necessary to implement an Inter-zone solution.

1. **Agreement** – The implementation of Inter-zone requires two agencies to operate Motorola P25 trunking systems at the same system release level. The connection between master sites allows the systems to function as one shared system where seamless talkgroup roaming is permitted between all radio sites. While there are minimal costs required for the physical Inter-zone connection, there is a loss of autonomy as any future upgrades will require coordination between all participating agencies. These restrictions coupled with the fact that most NCR trunking systems are operating at different Motorola system releases leads to the assumptions that agencies agreeing to Inter-zone connections would be completed by two agencies at a time. Before a connection can be made, a minimum of two interested agencies must agree on the terms of the connection, and commit funding to any upfront system release upgrades (if necessary). This agreement should be formalized in an MOU or similar legal document obligating all parties to the Inter-zone connection.

2. **Secure Frequencies** – If system expansion is required through the addition of channels, additional frequencies will need to be secured. The most likely available pools include 700 MHz and 800 MHz Sprint Vacated Channels. Frequencies matching the primary frequency band of the system are ideal to simplify transmission system compatibility.

3. **System Expansion** – An Inter-zone expansion will result in increased subscriber roaming between the systems which will result in more radio traffic. Interconnected systems must be sized properly to provide sufficient capacity to accommodate primary traffic and additional roaming traffic. MCP has provided initial estimates for loading requirements, although a more refined model may be developed that takes more realistic roaming scenarios into account. Any capacity expansions required should be completed in advance of the connection. The expansion may include adding channels or converting operations to TDMA. A TDMA upgrade may require subscriber replacements in addition to infrastructure hardware/software upgrades.

4. **System Release Upgrades** – Motorola systems connected with Inter-zone must be operating at the same system release level. Upgrades may be necessary by one or multiple systems integrating via Inter-zone. These upgrades typically require software updates although some hardware upgrades may be required as well. Systems must all be upgraded to the same system release level in advance of the connection.

5. **Backhaul** – Inter-zone requires a physical backhaul connection between two Motorola master sites. Most master sites throughout the NCR are co-located at each agency's 9-1-1 Center. The NCRNet could be leveraged to provide this backhaul connection, although additional research will be necessary to evaluate connection point, bandwidth requirements and redundancy.

6. **Cutover** – Cutover to an Inter-zone connection requires all interconnected systems to operate with the same system ID. Changing the system ID will require the reprogramming of all subscriber and console systems. All subscribers from the interconnected systems will need to be added to the subscriber database of each system. Most subscribers throughout the NCR are already authorized in each system. The challenge associated with cutover is ensuring operability and interoperability is maintained before, during, and after the transition among all NCR radio partners. The level of effort and coordination associated with this effort should not be underestimated. Multiple subscriber touches will likely be necessary for each jurisdiction to permit both "old" and "new" programming parameters to exist in the radio simultaneously. The level of effort associated with such a migration is anticipated to be similar to that experienced during 800 MHz rebanding.

7. **Governance and SOPs** – A governing entity should be established amongst the agencies interconnected with Inter-zone to coordinate usage requirements for roaming. Strict usage rules must be established to ensure system capacity and integrity is preserved through the integration of Inter-zone. These rules should be formalized in a regional SOP guide.

4.4.4. ISSI Gap Analysis

The interconnection of systems via ISSI with seamless roaming provides a balance between autonomy and interoperability benefits. To support a gap analysis, MCP has summarized the requirements for ISSI interconnections:

- Motorola P25 systems must be at system release level 7.13 or later
- Motorola P25 systems must utilize MCC7100 or MCC7500 consoles
- Subscribers must support inter-WACN roaming
- Harris' ISSI offering does not currently include seamless roaming; however, seamless roaming is on the roadmap
- Other P25 vendors offer ISSI options, although the specific feature sets and requirements have not been defined in this report due to a lack of presence within the NCR

The following list outlines the steps necessary to implement an ISSI solution with seamless roaming.

1. **Agreement** – The implementation of ISSI between Motorola systems requires the systems be at release level 7.13 or later. Since system releases can be different as long as long as they are at least 7.13, autonomy can be maintained by the interconnected systems. Interconnecting two systems requires a hardware gateway for each system, a backhaul connection between the systems and software licenses for each interconnected system. Agreements should be made between agencies seeking to interconnect in advance of a physical connection prior to any expenditure on equipment or licenses. ISSI connections can be established piece-meal between two agencies at a time or collectively. Seamless roaming between ISSI requires separate connections between each interconnected system. Therefore the number of connections grows exponentially if every agency wishes to connect to every other interoperability partner. Due to the potential for very high costs, bulk savings may be recognized through a collective approach.

2. **Secure Frequencies** – If system expansion is required through the addition of channels, additional frequencies will need to be secured. The most likely available pools include 700 MHz and 800 MHz Sprint Vacated Channels. Frequencies matching the primary frequency band of the system are ideal to simplify transmission system compatibility.

3. **System Expansion** – An ISSI connection will result in increased subscriber roaming between the systems which will result in more radio traffic. Interconnected systems must be sized properly to provide sufficient capacity to accommodate primary traffic and additional roaming traffic. MCP has provided initial estimates for loading requirements, although a more refined model may be developed that takes more realistic roaming scenarios into account. Any capacity expansions required should be completed in advance of the connection. The expansion may include adding channels or converting operations to TDMA. A TDMA upgrade may require subscriber replacements in addition to infrastructure hardware/software upgrades.

4. **System Release Upgrades** – Motorola systems connected with ISSI must operate at system release level 7.13 or later, have MCC7500 or MCC7100 consoles, and have GTR8000 series base stations or later. Upgrades may be necessary by one or multiple systems integrating via ISSI. These upgrades typically require software updates although some hardware upgrades may be required as well. There are currently agencies with upcoming P25 procurements. In the event Motorola systems are purchased they will most likely be deployed with the current system release which will be post 7.13. ISSI seamless roaming is part of the P25 standard and can therefore be supported by other P25 system vendors as long as the feature sets are implemented.

5. **Backhaul** – ISSI requires a physical backhaul connection between two system controllers. Most controllers throughout the NCR are co-located at each agency's 9-1-1 Center. The NCRNet could be leveraged to provide this backhaul connection, although additional research will be necessary to evaluate connection point, bandwidth requirements and redundancy.

6. **Cutover** – Cutover to an ISSI connection requires minimal intervention as long as roaming is only expanded to existing talkgroups. In the event new talkgroups are appropriated for roaming purposes, the new talkgroups will need to be programmed into subscribers. XTS/XTL series subscribers require a firmware update to support seamless roaming with ISSI and will likely need to be flash-upgraded.

7. **Governance and SOPs** – A governing entity should be established amongst the agencies interconnected with ISSI to coordinate usage requirements for ISSI roaming. Strict usage rules must be established to ensure system capacity and integrity is preserved through the integration of ISSI. These rules should be formalized in a regional SOP guide.

4.4.5 Shared System Gap Analysis

Migrating to shared systems requires the greatest loss of agency autonomy, but results in the greatest interoperability benefits and cost savings. Because most agencies within the NCR have already implemented P25 systems, cost savings will be minimal until the point that future system upgrades or replacements are necessary. MCP has defined a step-by-step approach assuming Agency A is integrating to a shared system with Agency B as an alternative to a system upgrade or replacement.

The following list outlines the steps necessary to integrate two standalone systems into a shared system.

1. **Agreement** – The integration of agencies onto a shared system requires the greatest loss of autonomy for each agency compared to the other options presented. Of the presented options a shared system approach is the only option that will not permit agencies to easily disaggregate their operations back to a standalone configuration. An ownership model will need to be developed for the system controller equipment (core[s]). Agencies agreeing to operate a shared system must define responsibilities for each agency, monetary commitments, and responsibilities. Shared systems typically involve the formation of a governing entity that establishes the procedures for joining the shared system. After initially developed, the governing rules may be used for subsequent agencies joining the network.

2. **Secure Frequencies** – If system expansion is required through the addition of channels, additional frequencies will need to be secured. The most likely available pools include 700 MHz and 800 MHz Sprint Vacated Channels. Frequencies matching the primary frequency band of the system are ideal to simplify transmission system compatibility.

3. **System Expansion** – Shared systems will result in increased subscriber roaming between the systems which will result in more radio traffic. Interconnected systems must be sized properly to provide sufficient capacity to accommodate primary traffic and additional roaming traffic. MCP has provided initial estimates for loading requirements, although a more refined model may be developed that takes more realistic roaming scenarios into account. Any capacity

expansions required should be completed in advance of the connection. The expansion may include adding channels or converting operations to TDMA. A TDMA upgrade may require subscriber replacements in addition to infrastructure hardware/software upgrades.

4. **System Upgrades** – The integration of shared systems requires the equipment to be manufactured by the same equipment vendor. If Agency A is integrating with the control equipment of agency B, then Agency A's equipment must be compatible with the hardware, software and feature sets of agency B. Equipment upgrades or replacements may be necessary for Agency A depending on the specific equipment they are using. Most agencies in the NCR that have migrated to P25-compliant systems are using Motorola systems with compatible equipment. It is not clear what the communications environment will be at the time that agencies may choose to implement shared systems.

5. **Backhaul** – Shared systems require a physical backhaul connection between all radio sites and dispatch facilities. With the development of shared systems, the NCR should explore implementing geo-diverse system cores and multi-path backhaul networks to provide a reliable "cloud"-based radio network that will provide reliable connectivity to agencies that may have a substantial geographic separation from the physical location of the control equipment. Interconnecting existing radio backhaul networks to form one large multi-path ring-of-rings network will provide a highly reliable backhaul network with minimal additional connections.

6. **Cutover** – Cutover to a shared system will require all interconnected radio sites to connect to a single core or two geo-diverse cores. For an agency operating an existing system with compatible site equipment, the agency will bypass their existing core and connect to the core(s) of the host network. Subscriber IDs will need to be appropriated in the host system for all member agencies. Subscriber radios will need to be reprogrammed to reflect the new system ID. Any new talkgroups will need to be programmed into subscriber radios. The challenge associated with cutover is ensuring operability and interoperability is maintained before, during, and after the transition among all NCR radio partners. The level of effort and coordination associated with this effort should not be underestimated. Multiple subscriber touches will likely be necessary for each jurisdiction to permit both "old" and "new" programming parameters to exist in the radio simultaneously. The level of effort associated with such a migration is anticipated to be far greater than that experienced during 800 MHz rebanding.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on MCP's analysis of the different interoperability solutions available for the NCR, MCP has provided conclusions and recommendations as to what is believed to be the best direction for the NCR to improve interoperability.

This section is broken down as follows:

1. Conceptual Designs – This section includes conceptual designs for each technology option to demonstrate what each option would look like using assumed coverage and capacity requirements. Preliminary radio sites and coverage studies have been provided for each option.
2. Cost Estimates – Cost estimates have been provided for each of the technology options based upon the conceptual designs.
3. Technology Recommendations – MCP's recommendation for the most optimal technologies for the NCR based on user requirements and cost/benefit.
4. Operational Recommendations – MCP's recommendations for changes to operations above and beyond technology.

5.1. CONCEPTUAL DESIGNS

MCP has developed a conceptual design for each recommended option. The conceptual designs are utilized to construct a model system that would meet critical design considerations for each option. The design is conceptual in that a selected vendor will ultimately be responsible for constructing the system to meet contractual requirements. The conceptual design allows MCP to develop reasonable cost estimates for each solution, and better identify potential strengths and weaknesses with each option.

5.1.1. Conventional Simulcast Conceptual Design

MCP has developed a conceptual design for a conventional simulcast overlay system utilizing the following assumptions:

1. Portable talk-out in-street coverage at hip-level throughout 90 percent of NCR jurisdictions
2. Four total channels utilizing national interoperability frequencies
3. Operation in the conventional analog mode
4. Tower sites selected based on optimal coverage
5. Selected tower sites have available shelter and tower space to accommodate additional equipment
6. Only currently utilized trunked tower sites considered for potential sites
7. Assumed existing radio backhaul links have sufficient capacity to accommodate four analog channels at each identified tower site
8. Central simulcast equipment including simulcast controllers and voters located in Fairfax County (can be located at any location with reliable connectivity)
9. A combination of existing radio backhaul links and the NCRNet utilized for connectivity

Using these design criteria, MCP identified potential radio sites and modeled coverage for the overlay system. The modeled coverage and backhaul plan for the conceptual design can be found on the following pages.

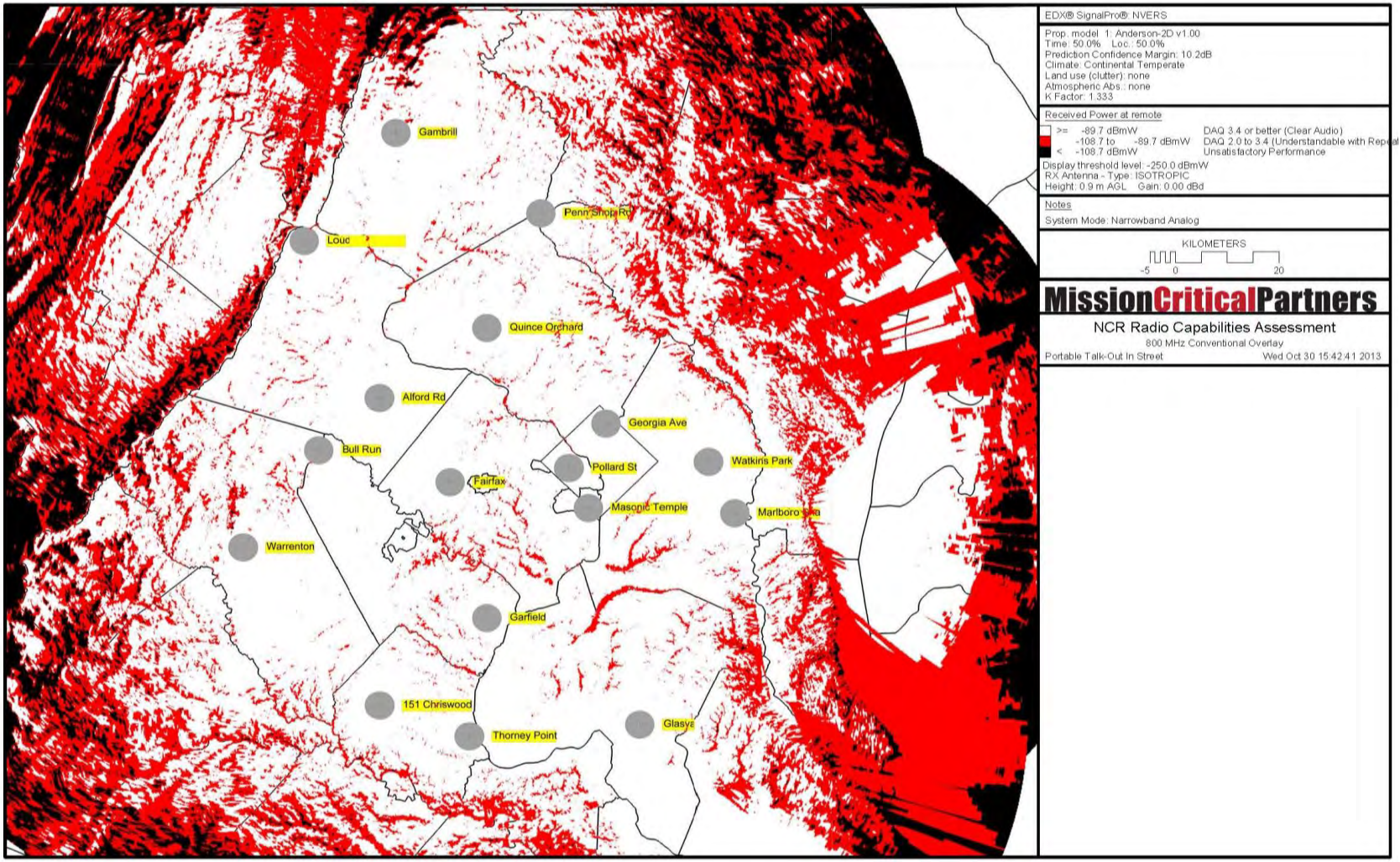
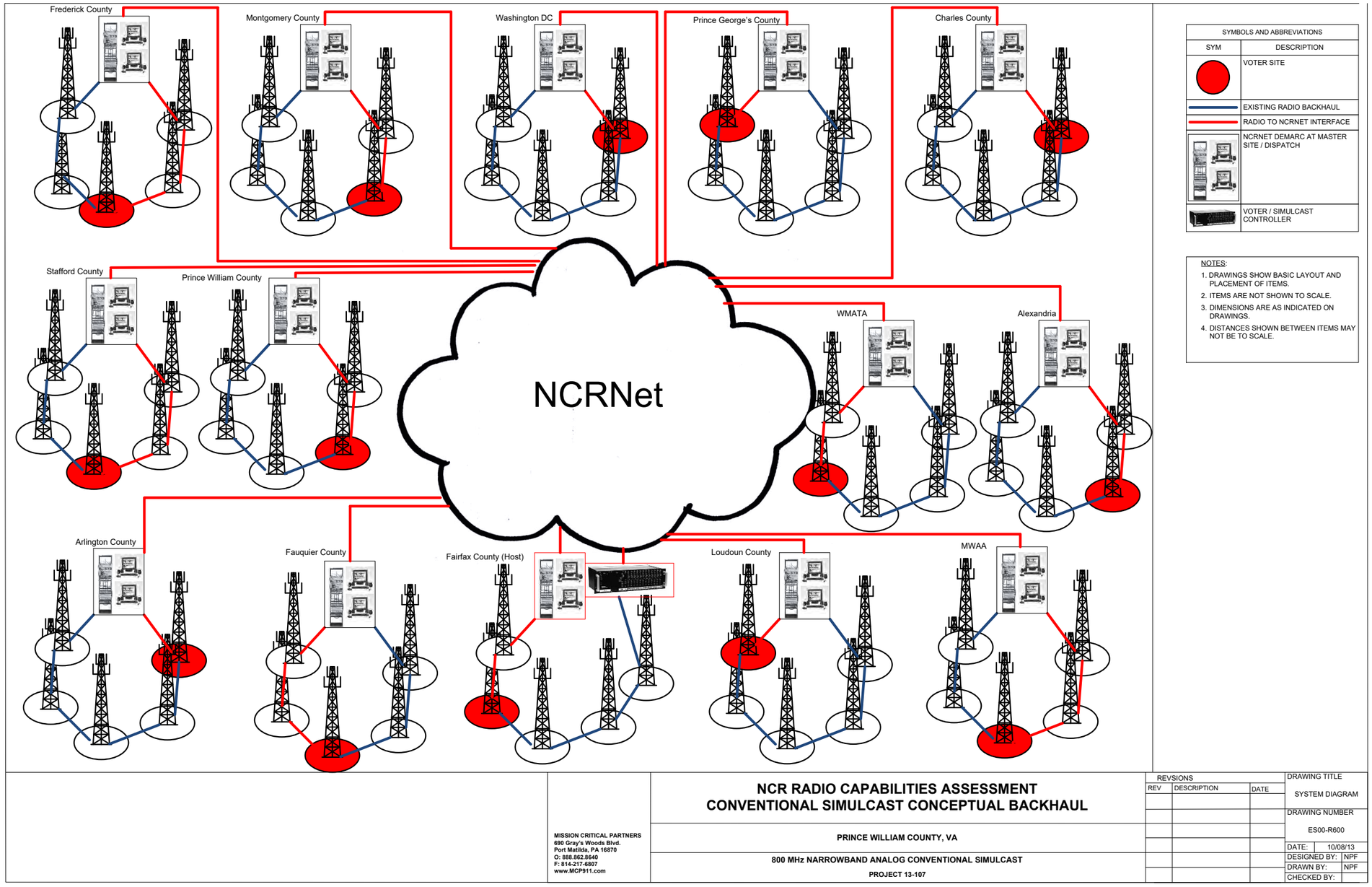


Figure 7 – Conventional Overlay Coverage Map



SYMBOLS AND ABBREVIATIONS	
SYM	DESCRIPTION
	VOTER SITE
	EXISTING RADIO BACKHAUL
	RADIO TO NCRNET INTERFACE
	NCRNET DEMARC AT MASTER SITE / DISPATCH
	VOTER / SIMULCAST CONTROLLER

NOTES:

1. DRAWINGS SHOW BASIC LAYOUT AND PLACEMENT OF ITEMS.
2. ITEMS ARE NOT SHOWN TO SCALE.
3. DIMENSIONS ARE AS INDICATED ON DRAWINGS.
4. DISTANCES SHOWN BETWEEN ITEMS MAY NOT BE TO SCALE.

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NCR RADIO CAPABILITIES ASSESSMENT
CONVENTIONAL SIMULCAST CONCEPTUAL BACKHAUL

PRINCE WILLIAM COUNTY, VA

800 MHz NARROWBAND ANALOG CONVENTIONAL SIMULCAST

PROJECT 13-107

REVSIONS		
REV	DESCRIPTION	DATE

DRAWING TITLE	SYSTEM DIAGRAM
DRAWING NUMBER	ES00-R600
DATE:	10/08/13
DESIGNED BY:	NPF
DRAWN BY:	NPF
CHECKED BY:	

Figure 8 – Conventional Overlay Backhaul Plan

Based upon this design, radio sites have been identified for use in each jurisdiction.

Table 10 – Identified Radio Sites

Jurisdiction	Radio Site(s)
Frederick County, MD	Gambrill Penn Shop
Montgomery County, MD	Quince Orchard
Washington, D.C.	Georgia Ave
Prince George's County, MD	Watkins Park Marlboro SHA
Charles County, MD	Glasva
Stafford County, VA	151 Chriswood Thorney Point
Prince William County, VA	Garfield
Alexandria, VA	Masonic Temple
Arlington County, VA	Pollard St
Fauquier County, VA	Warrenton Bull Run
Loudoun County, VA	Loudoun Heights Alford Road
Fairfax County, VA	Fairfax

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5.1.2. Trunking Overlay Conceptual Design

MCP has developed a conceptual design for a trunking overlay system utilizing the following assumptions:

1. Portable talk-out in-street coverage at hip-level throughout 90 percent of NCR jurisdictions
2. Five total channels at each site in a multi-cast configuration
3. Operation in the P25 trunking mode
4. Tower sites selected based on optimal coverage
5. Selected tower sites have available shelter and tower space to accommodate additional equipment
6. Only currently utilized trunked tower sites considered for potential sites
7. Assumed existing radio backhaul links have sufficient capacity to accommodate five P25 trunked channels at each identified tower site
8. Shared P25 master site utilized by Fairfax County (can operate off any master site with sufficient capacity)
9. A combination of existing radio backhaul links and the NCRNet utilized for connectivity

Using these design criteria, MCP identified potential radio sites and modeled coverage for the overlay system. The modeled coverage and backhaul plan for the conceptual design can be found on the following pages.

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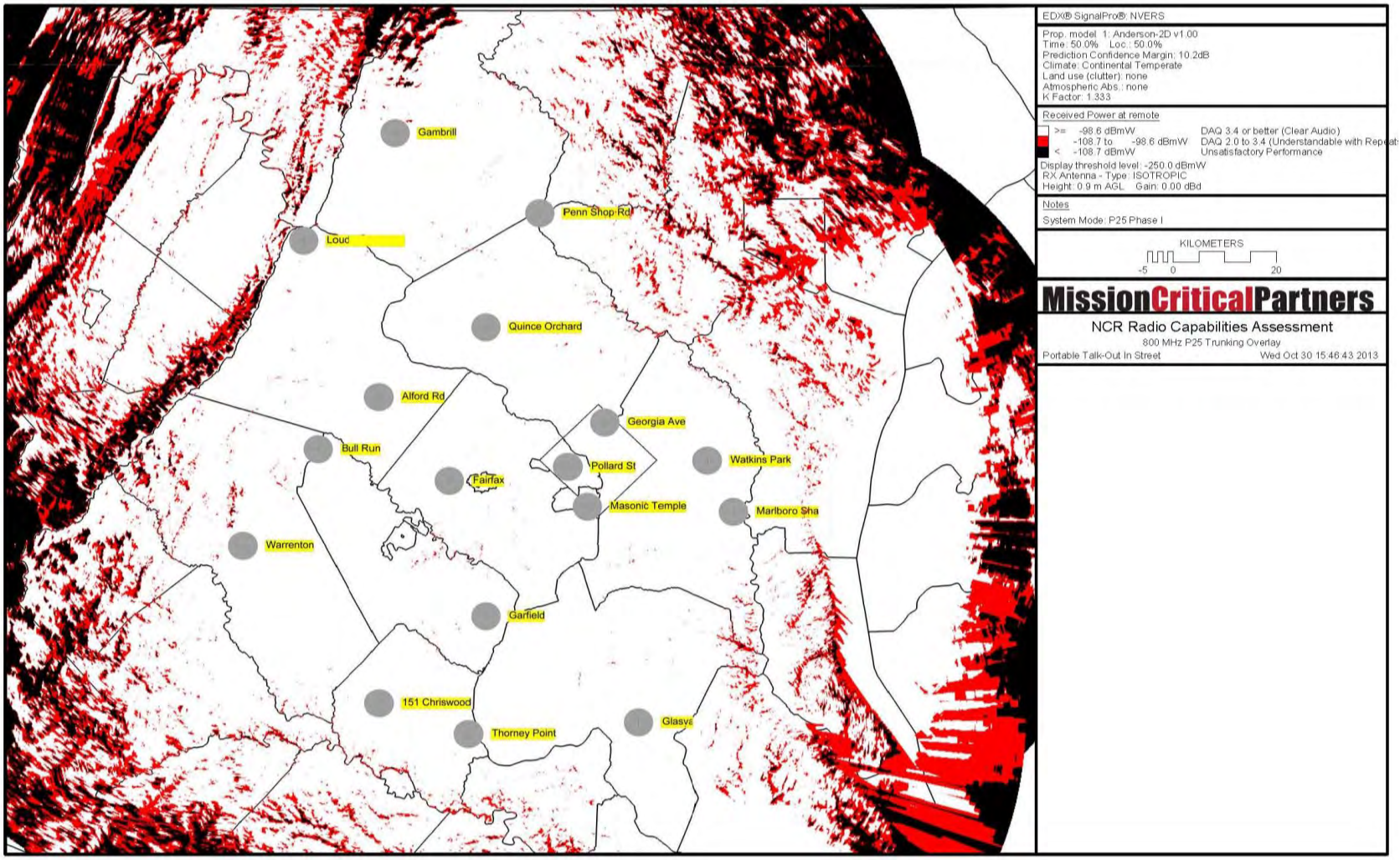

Figure 9 – Trunking Overlay Coverage Map

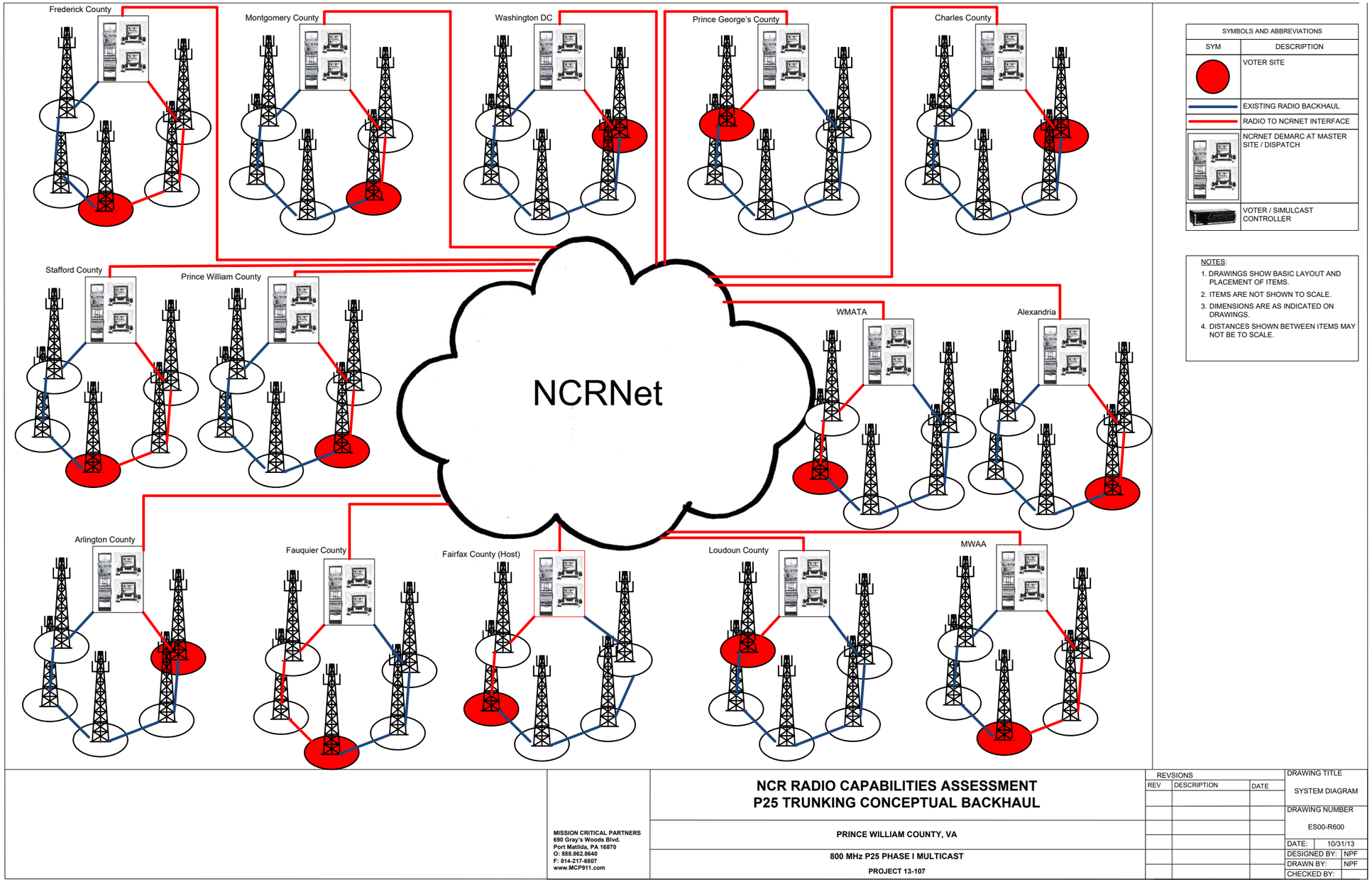

Figure 10 – Trunking Overlay Backhaul Plan

Based upon this design, radio sites have been identified for use in each jurisdiction.

Table 11 – Identified Radio Sites

Jurisdiction	Radio Site(s)
Frederick County, MD	Gambrill Penn Shop
Montgomery County, MD	Quince Orchard
Washington, D.C.	Georgia Ave
Prince George's County, MD	Watkins Park Marlboro SHA
Charles County, MD	Glasva
Stafford County, VA	151 Chriswood Thorney Point
Prince William County, VA	Garfield
Alexandria, VA	Masonic Temple
Arlington County, VA	Pollard St
Fauquier County, VA	Warrenton Bull Run
Loudoun County, VA	Loudoun Heights Alford Road
Fairfax County, VA	Fairfax

The remainder of this page intentionally left blank.

5.1.3. Inter-zone Conceptual Design

MCP has developed a conceptual design for a regional Inter-zone solution utilizing the following assumptions:

1. All agencies utilize Motorola P25 systems (should any agencies procure non-Motorola systems connections must be accomplished via ISSI)
2. All existing radio sites maintained with Inter-zone connection
3. Sufficient subscriber IDs available to accommodate all interconnected users
4. All agencies upgrade to current Motorola system release prior to connection
5. Network designed to handle talkgroup roaming on both primary talkgroups and designated wide-area talkgroups
6. Capacity expanded to meet loading requirements calculated by MCP (a more detailed analysis is necessary using actual system operating statistics prior to implementing the specific capacity improvements identified by MCP)
7. Existing radio backhaul networks upgraded to support MPLS and interconnected for “ring-of-rings”

Using these design criteria, MCP identified potential radio sites and modeled coverage for the Inter-zone connected systems. The modeled coverage and backhaul plan for the conceptual design can be found on the following pages.

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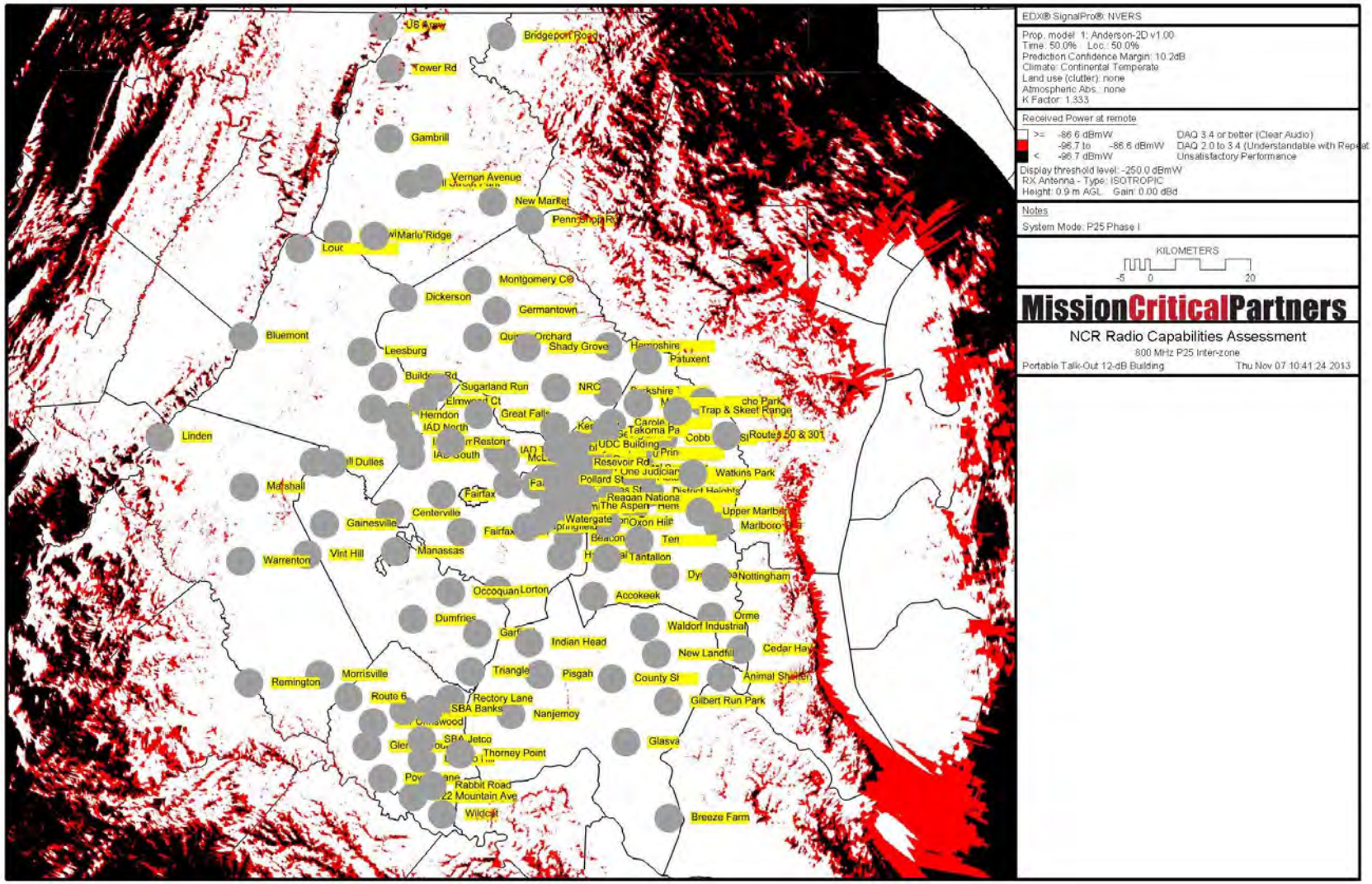

Figure 11 – Inter-zone Coverage Map

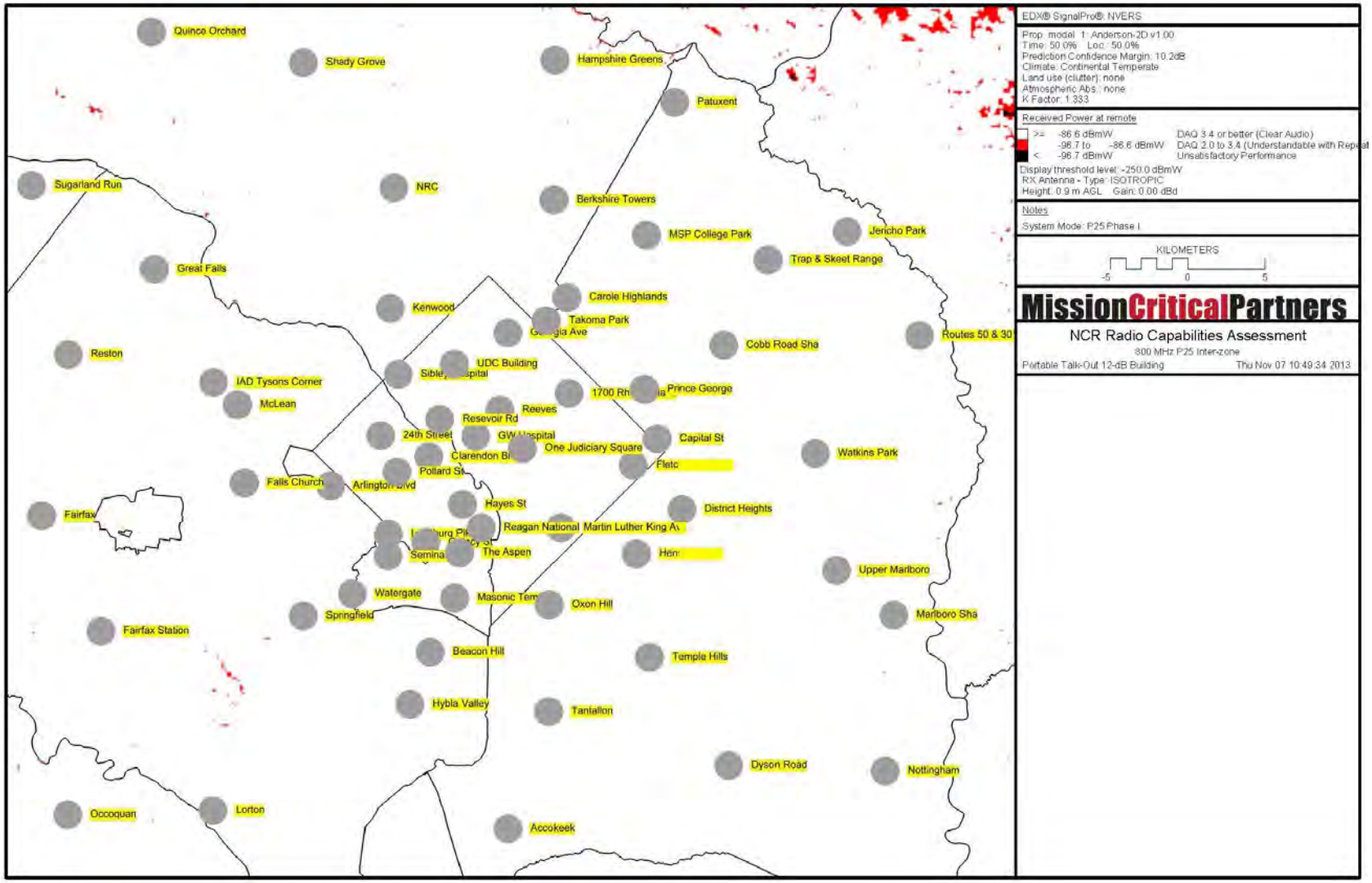

Figure 12 – Inter-zone Coverage Map (Zoomed In)

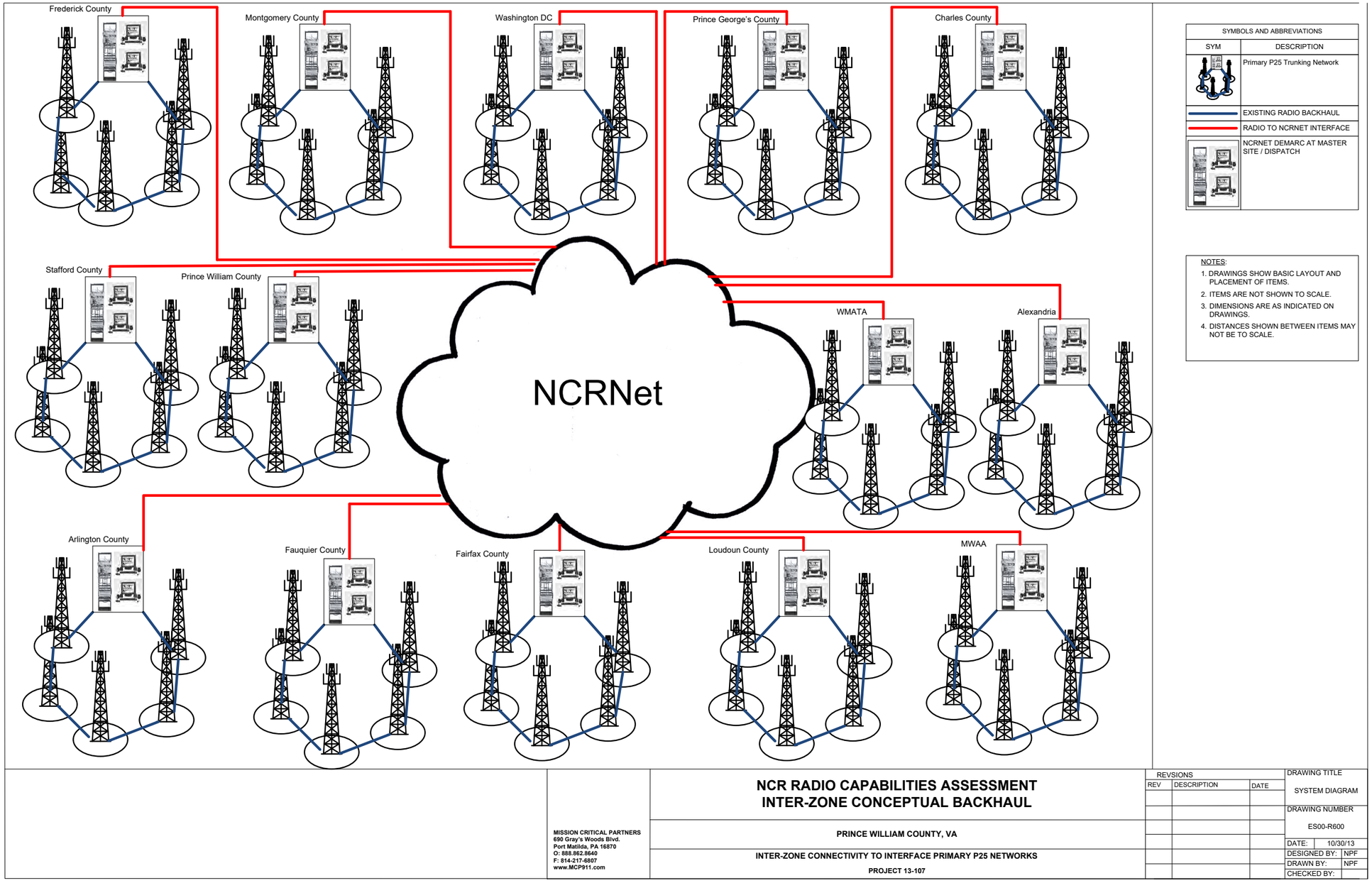

Figure 13 – Backhaul Plan

5.1.4. ISSI Conceptual Design

MCP has developed a conceptual design for an ISSI solution utilizing the following assumptions:

1. All agencies utilize P25 systems supporting seamless roaming
2. All existing radio sites maintained with ISSI connections
3. All Motorola agencies upgrade to Motorola release 7.13 (minimum)
4. Agencies who procure systems from other vendors ensure equipment will support ISSI seamless roaming when it is made available by that vendor
5. Network designed to handle talkgroup roaming on both primary talkgroups and designated wide-area talkgroups
6. Alternate options included for “hosted” ISSI with all ISSI connections utilizing one host agency system, and fully connected ISSI where each agency is connected to every other interoperability partner
7. Capacity expanded to meet loading requirements calculated by MCP (a more detailed analysis is necessary using actual system operating statistics prior to implementing the specific capacity improvements identified by MCP)
8. NCRNet utilized to provide backhaul connectivity between system controllers

Using these design criteria, MCP identified potential radio sites and modeled coverage for the ISSI connected systems. The modeled coverage and backhaul plan for the conceptual design can be found on the following pages.

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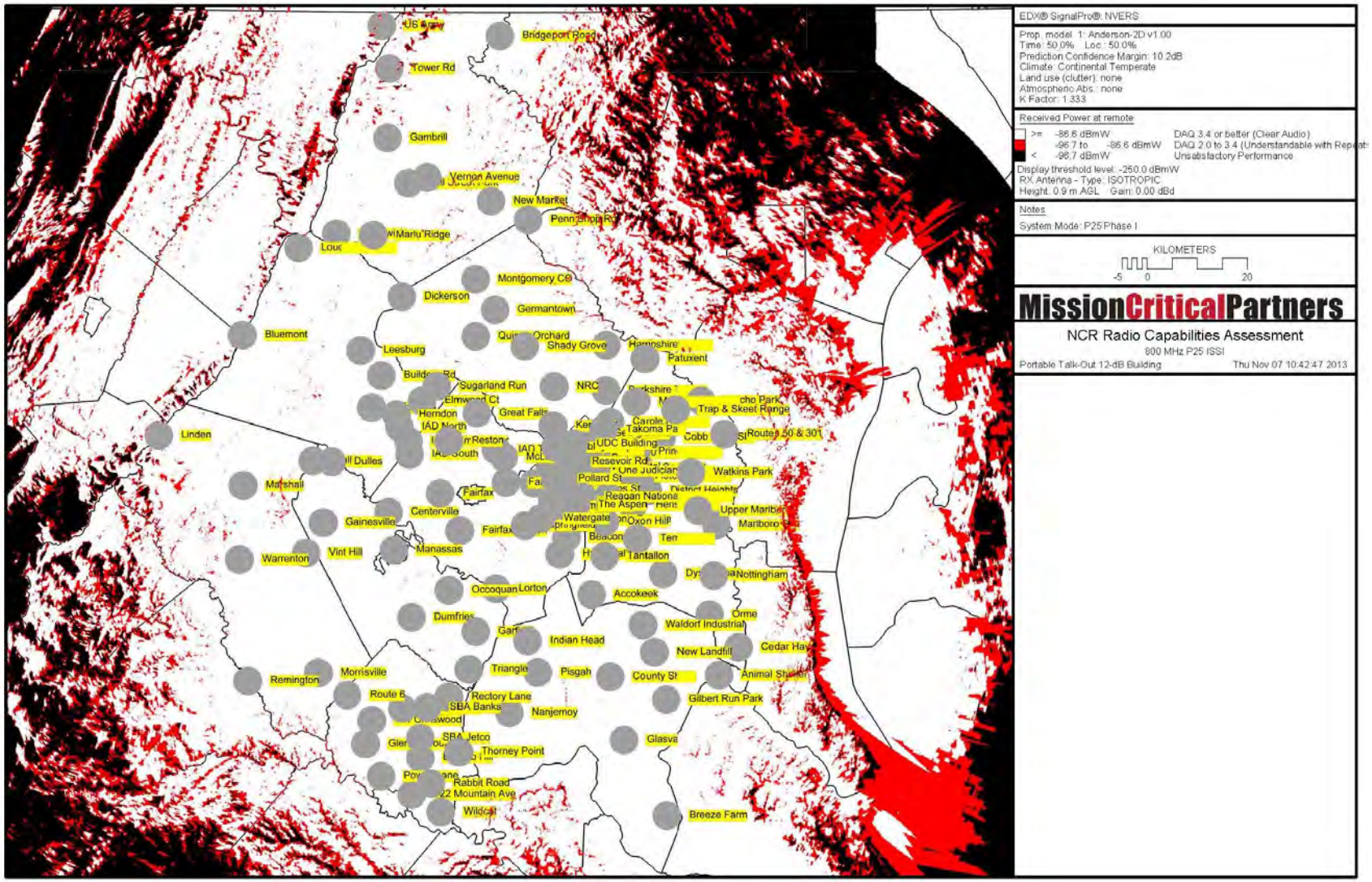

Figure 14 – ISSI Coverage Map

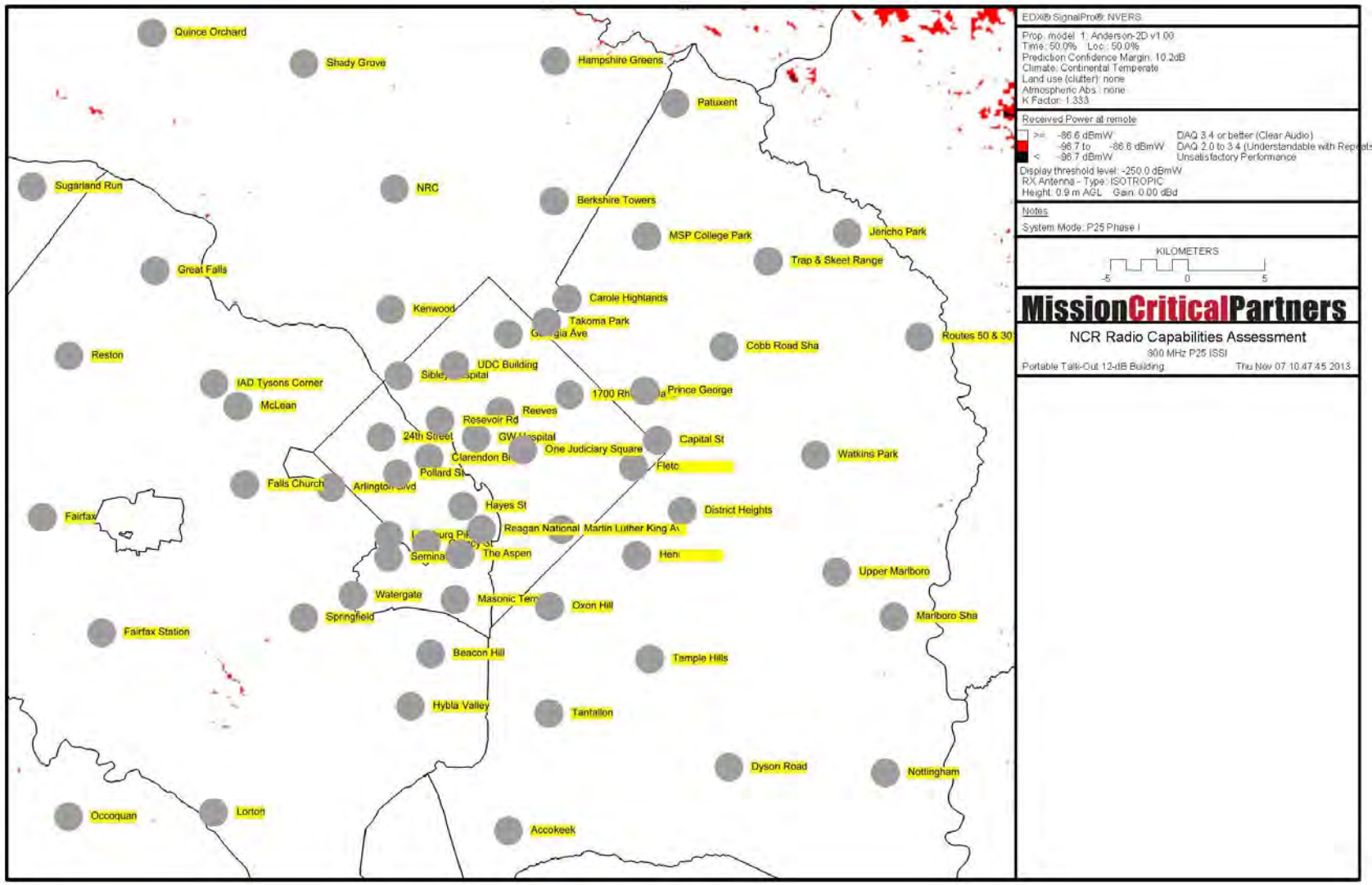

Figure 15 – ISSI Coverage Map (Zoomed In)

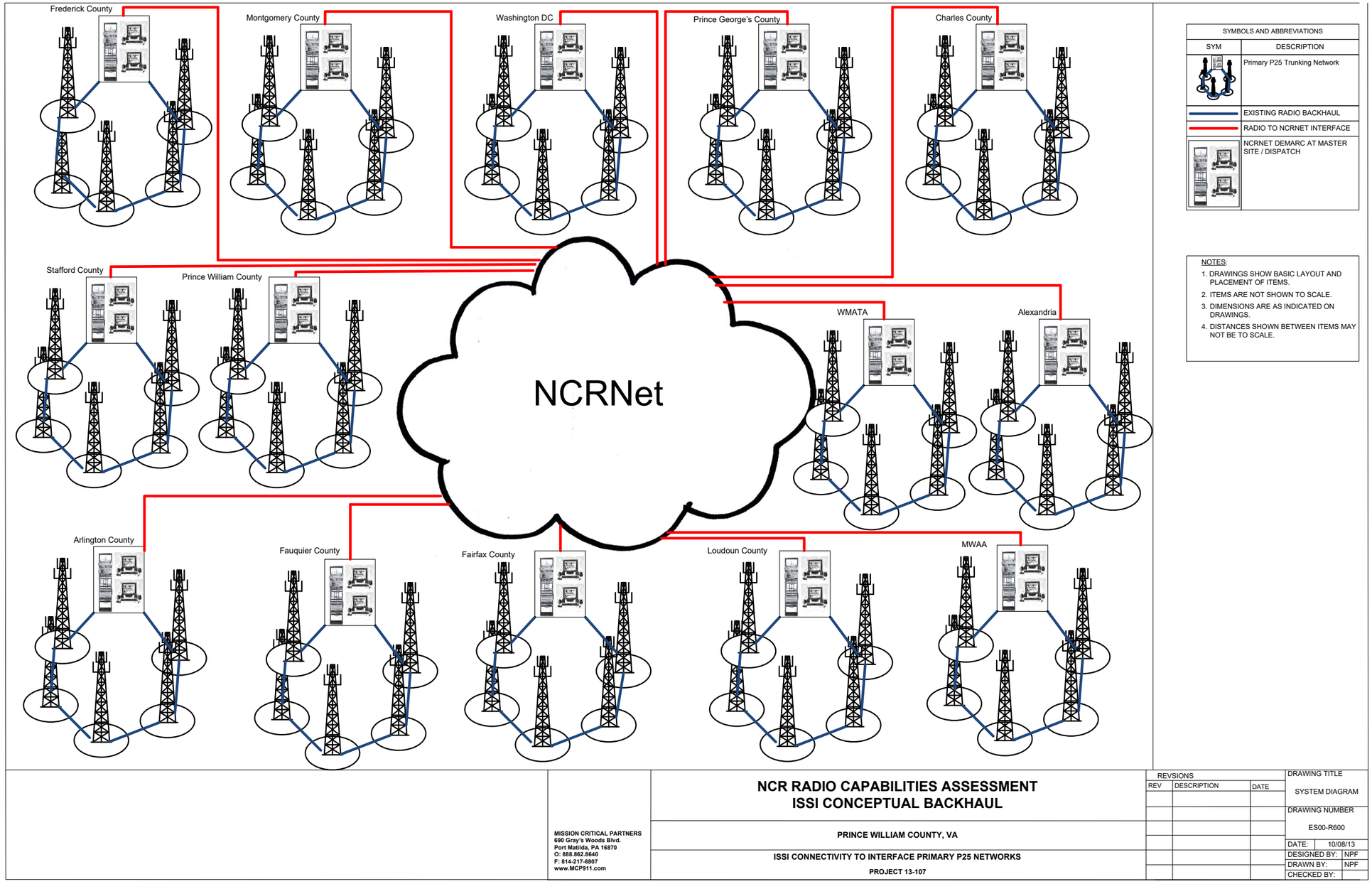

Figure 16 – Backhaul Plan

5.1.5. Shared Systems Conceptual Design

MCP has developed a conceptual design for a shared system solution utilizing the following assumptions:

1. Migration to shared systems occurs as current first generation P25 systems require replacement
2. Shared systems utilize geo-diverse system controllers
3. Network designed to handle talkgroup roaming on both primary talkgroups and designated wide-area talkgroups
4. Capacity expanded to meet loading requirements calculated by MCP (a more detailed analysis is necessary using actual system operating statistics prior to implementing the specific capacity improvements identified by MCP)
5. Existing radio backhaul networks upgraded to support MPLS and interconnected for “ring-of-rings”

Using these design criteria, MCP identified potential radio sites and modeled coverage for the shared system. The modeled coverage and backhaul plan for the conceptual design can be found on the following pages.

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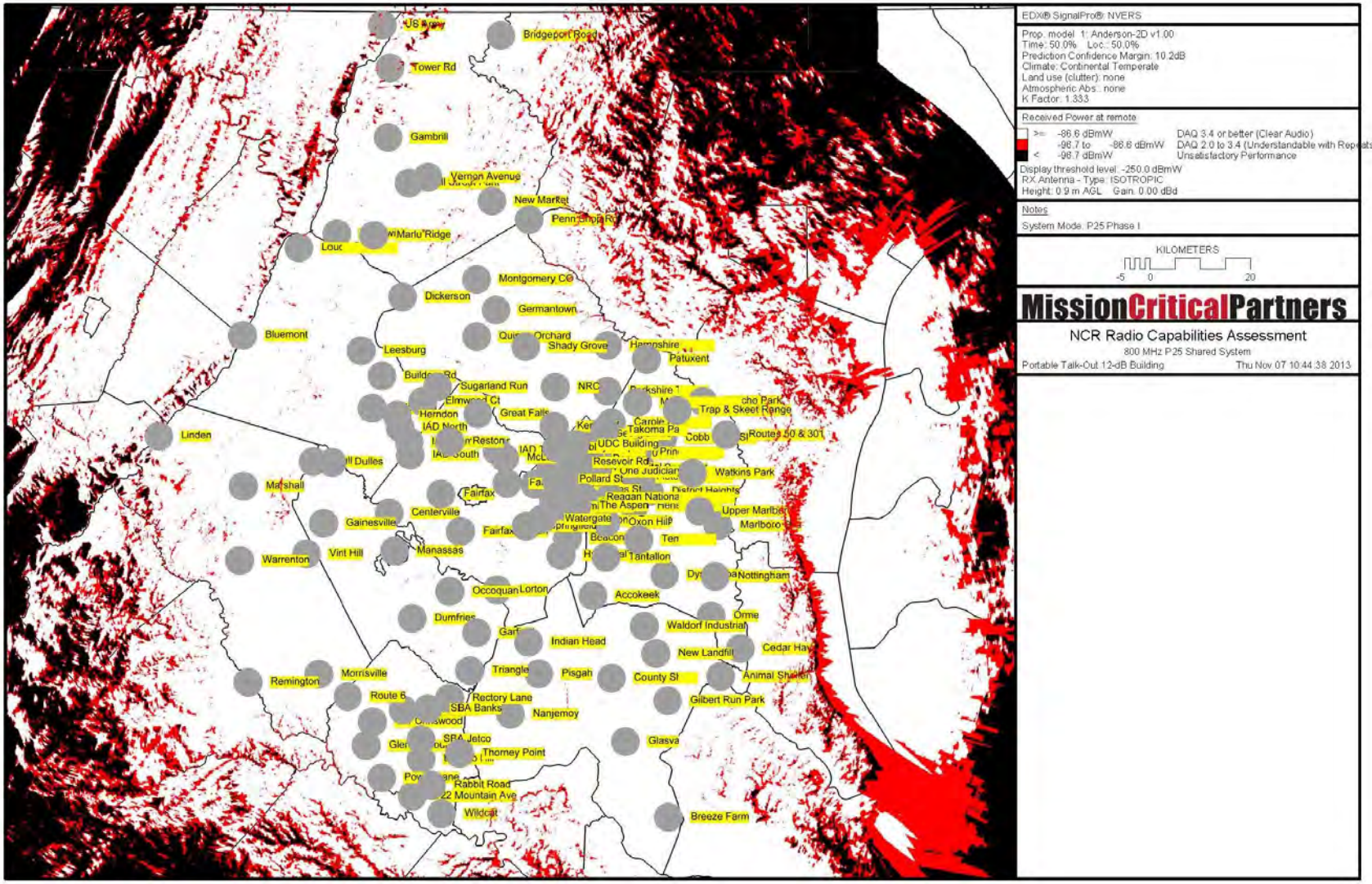


Figure 17 – Shared System Coverage Map

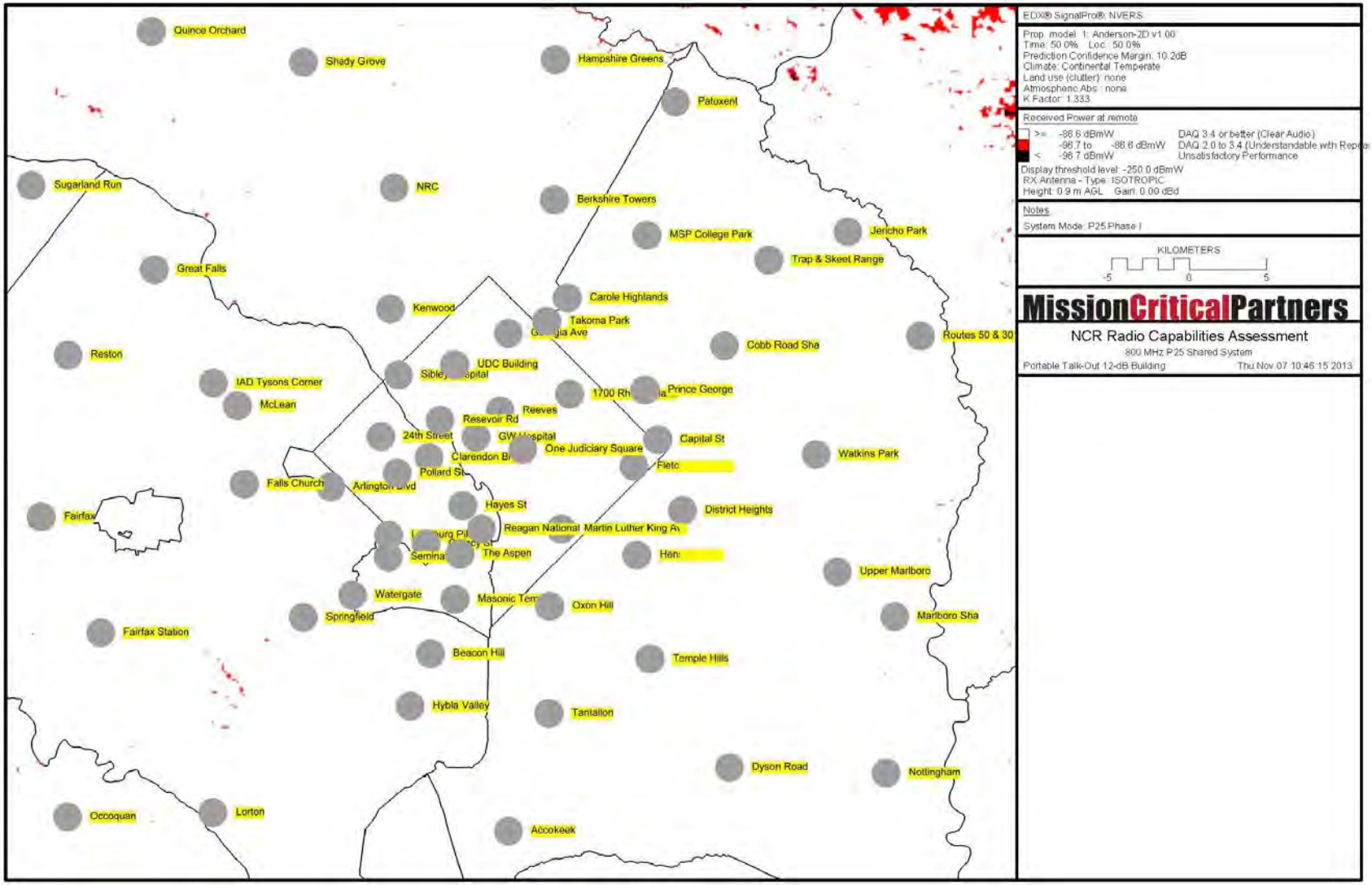
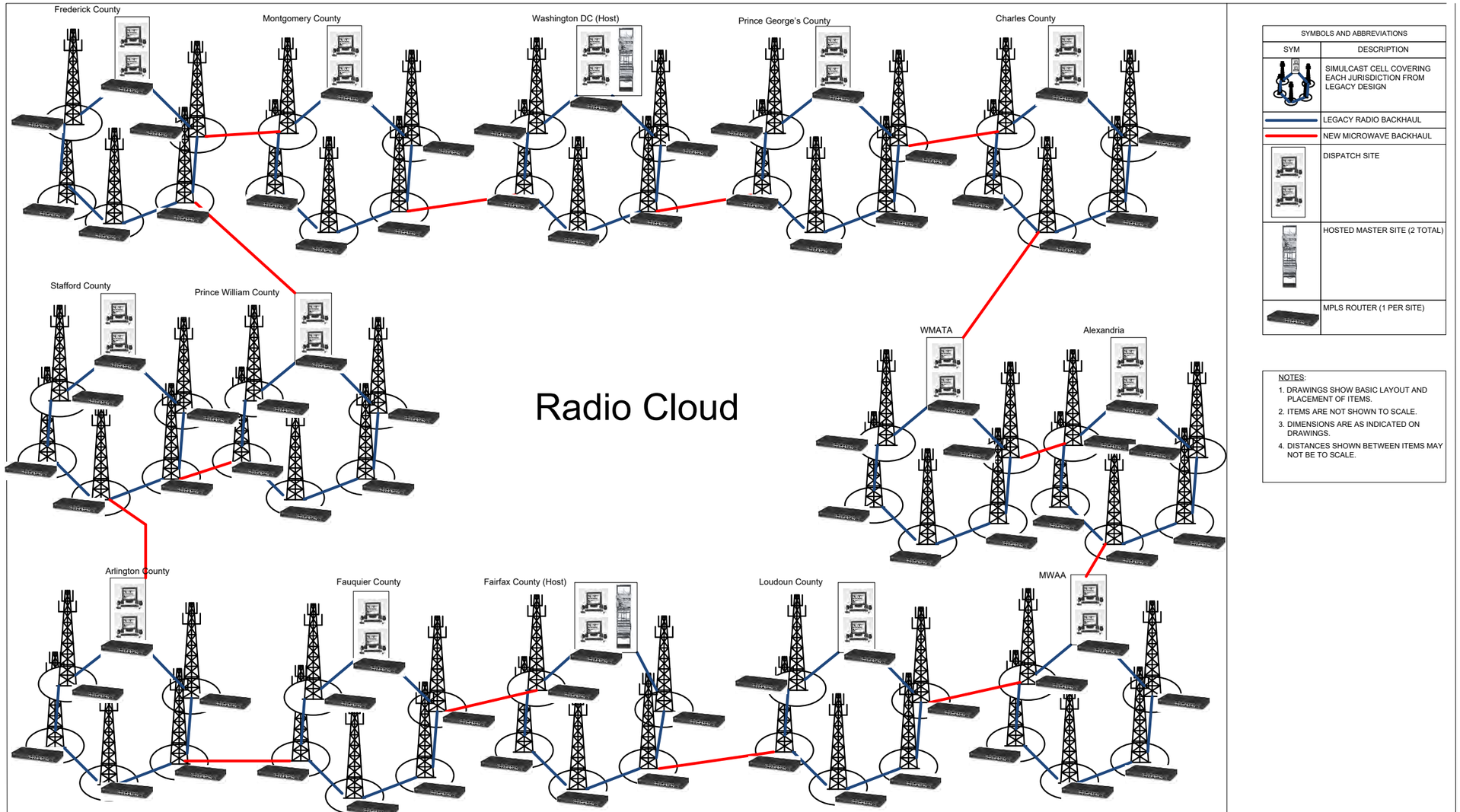


Figure 18 – Shared System Coverage Map (Zoomed In)



SYMBOLS AND ABBREVIATIONS

SYM	DESCRIPTION
	SIMULCAST CELL COVERING EACH JURISDICTION FROM LEGACY DESIGN
	LEGACY RADIO BACKHAUL
	NEW MICROWAVE BACKHAUL
	DISPATCH SITE
	HOSTED MASTER SITE (2 TOTAL)
	MPLS ROUTER (1 PER SITE)

NOTES:
1. DRAWINGS SHOW BASIC LAYOUT AND PLACEMENT OF ITEMS.
2. ITEMS ARE NOT SHOWN TO SCALE.
3. DIMENSIONS ARE AS INDICATED ON DRAWINGS.
4. DISTANCES SHOWN BETWEEN ITEMS MAY NOT BE TO SCALE.

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NCR RADIO CAPABILITIES ASSESSMENT
SHARED SYSTEM CONCEPTUAL BACKHAUL

PRINCE WILLIAM COUNTY, VA

BACKHAUL TO INTERFACE REGIONAL SHARED P25 NETWORK

PROJECT 13-107

REVSIONS		
REV	DESCRIPTION	DATE

DRAWING TITLE: SYSTEM DIAGRAM
DRAWING NUMBER: ES00-R600
DATE: 10/08/13
DESIGNED BY: NPF
DRAWN BY: NPF
CHECKED BY:

Figure 19 – Backhaul Plan

5.2. COST ESTIMATES

MCP has developed cost estimates to implement each identified interoperability solution. Costs have been differentiated based on the following:

1. Cost estimates for system release updates to support interoperability platform
2. Cost estimates for capacity upgrades to support increased subscriber roaming
3. Cost estimates for implementation of interoperability solutions

MCP has utilized equipment list pricing for most of the identified solutions. This pricing is intended for budgetary purposes to provide a comparison of the different options. Actual pricing will depend on vendor discounts, competition, equipment reuse, and the amount of equipment purchased through a single procurement. Typical vendor discounts are 10 to 30 percent off list pricing.

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5.2.1. Conventional Overlay Cost Estimate

Cost estimates for the conventional simulcast overlay utilize the following assumptions:

1. Total of 17 radio sites with four conventional analog repeaters at each site
2. Use of four out of the five national interoperability channels
3. Radio sites have sufficient space to accommodate additional equipment
4. Centrally located voters and simulcast controllers
5. Reuse of existing radio backhaul networks in each jurisdiction using a total of four 4-wire connections for the four repeaters at each site
6. Interface with NCRNet from master site locations to provide connectivity between disparate systems
7. Backhaul networks have sufficient capacity to accommodate additional traffic
8. Interface costs considered for radio backhaul and NCRNet integration
9. Reuse of existing simulcast timing equipment
10. No subscriber programming required

Table 12 – Conventional Simulcast Interoperability Cost Estimate

Equipment Description	Unit Price	Quantity	Total
Conventional Analog Repeater / Base Station	$20,000	68	$1,360,000
Network Equipment (Site) + Misc	$15,000	17	$255,000
Network Equipment (NCRNet) + Misc	$20,000	17	$340,000
Antenna System (4 Channel)	$30,000	17	$510,000
Analog Voter	$25,000	4	$100,000
Simulcast Controller	$25,000	4	$100,000
Licensing	$30,000	1	$30,000
		Sub-total	**$2,695,000**
Services (30% of sub-total)	30%		$808,500
Contingency (10% of sub-total)	10%		$269,500
		Total	**$3,773,000**
Yearly site lease increase	$12,000	17	$204,000
Yearly equipment maintenance increase	$94,325	1	$94,325
		Yearly Maintenance Increase	**$298,325**

5.2.2. Trunking Overlay Cost Estimate

Cost estimates for the trunking overlay utilize the following assumptions:

1. Total of 17 radio sites with five trunking repeaters at each site
2. Use of five 700 and 800 MHz repeaters at each site
3. Operation in the P25 Phase I mode
4. Shared use of existing P25 master site
5. Costs included for master site licensing upgrades to support additional radio sites and traffic
6. Reuse of existing radio backhaul networks in each jurisdiction using a total of one T1 interface for the five repeaters at each site
7. Interface with NCRNet from master site locations to provide connectivity between disparate systems
8. Backhaul networks have sufficient capacity to accommodate additional traffic
9. Interface costs considered for radio backhaul and NCRNet integration
10. Subscriber programming required for every NCR jurisdiction

Table 13 – Trunking Overlay Interoperability Cost Estimate

Equipment Description	Unit Price	Quantity	Total
P25 Phase 1 Repeater	$25,000	85	$2,125,000
Network Equipment (Site) + Misc	$15,000	17	$255,000
Network Equipment (NCRNet) + Misc	$20,000	17	$340,000
Antenna System (4 Channel)	$40,000	17	$680,000
Controller Licensing / Upgrades	$200,000	1	$200,000
Licensing	$100,000	1	$100,000
		Sub-total	**$3,700,000**
Services (30% of sub-total)	30%		$1,110,000
Contingency (10% of sub-total)	10%		$370,000
		Total	**$5,180,000**
Yearly site lease increase	$12,000	17	$204,000
Yearly equipment maintenance increase	$129,500	1	$129,500
		Yearly Maintenance Increase	**$333,500**
Subscriber Programming	$50	40,000	$2,000,000
		Subscriber Programming Total	**$2,000,000**

5.2.3. Inter-zone Cost Estimate

Cost estimates for the Inter-zone solution utilize the following assumptions:

1. Use of primary networks to carry interoperability traffic
2. Existing P25 systems upgraded to current Motorola release
3. Capacity expanded to meeting interoperability roaming requirements
4. Capacity increase based on either channel increases of TDMA conversion
5. Backhaul networks interconnected via microwave
6. Backhaul networks upgraded to support MPLS
7. Backhaul networks have sufficient capacity to support additional traffic
8. No elimination of existing radio sites
9. Two subscriber touches required for every NCR jurisdiction

Table 14 – Inter-zone System Upgrade Costs

Equipment Description	Total
Arlington County 7.7 to 7.13	$2,000,000
Alexandria 7.9 to 7.13	$1,000,000
Total	**$3,000,000**

Table 15 – Inter-zone Capacity Expansion Costs

Equipment Description	Total	Estimated Yearly Maintenance Increase
Loudoun County Channel Increase	$1,260,000	$31,500
Fauquier County Channel Increase	$686,000	$17,150
Fairfax County TDMA (Infrastructure)	$2,352,000	$58,800
Alexandria TDMA (Infrastructure)	$588,000	$14,700
MWAA Channel Increase	$980,000	$24,500
Prince George's County Channel Increase	$3,570,000	$89,250
Montgomery County Channel Increase	$3,080,000	$77,000
Charles County Channel Increase	$2,572,500	$64,313
Frederick County TDMA (Infrastructure)	$686,000	$17,150
Capacity Expansion Total	**$15,774,500**	**$394,363 / year**

Table 16 – Inter-zone Interoperability Costs

Equipment Description	Unit Price	Quantity	Total
NCRNet Network Connections	$25,000	14	$350,000
Inter-zone Connection / System ID Change	$50,000	14	$700,000
		Sub-total	**$1,050,000**
Services (30% of sub-total)	30%		$315,000
Contingency (10% of subtotal)	10%		$1,050,000
		Inter-zone Interoperability Total	**$1,470,000**
Subscriber Programming	$50	80,000	$4,000,000
		Subscriber Programming Total	**$4,000,000**

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5.2.4. ISSI Cost Estimate

Cost estimates for the ISSI solution utilize the following assumptions:

1. Use of primary networks to carry interoperability traffic
2. Existing P25 systems upgraded to Motorola release 7.13 or later
3. Capacity expanded to meeting interoperability roaming requirements
4. Capacity increase based on either channel increases of TDMA conversion
5. ISSI costs based on Motorola proposal to interconnect each NCR jurisdiction with each surrounding jurisdiction
6. Backhaul networks interconnected using NCRNet
7. Backhaul networks have sufficient capacity to support additional traffic
8. No elimination of existing radio sites
9. One subscriber touch required for every NCR jurisdiction for expanded talkgroup use

Table 17 – ISSI System Upgrade Costs

Equipment Description	Total
Arlington County 7.7 to 7.13	$2,000,000
Alexandria 7.9 to 7.13	$1,000,000
Total	**$3,000,000**

Table 18 – ISSI Capacity Expansion Costs

Equipment Description	Total	Estimated Yearly Maintenance Increase
Loudoun County Channel Increase	$1,260,000	$31,500
Fauquier County Channel Increase	$686,000	$17,150
Fairfax County TDMA (Infrastructure)	$2,352,000	$58,800
Alexandria TDMA (Infrastructure)	$588,000	$14,700
MWAA Channel Increase	$980,000	$24,500
Prince George's County Channel Increase	$3,570,000	$89,250
Montgomery County Channel Increase	$3,080,000	$77,000
Charles County Channel Increase	$2,572,500	$64,313
Frederick County TDMA (Infrastructure)	$686,000	$17,150
Capacity Expansion Total	**$15,774,500**	**$394,363 / year**

Table 19 – ISSI Interoperability Costs

Equipment Description	Unit Price	Quantity	Total
NCRNet Network Connections	$25,000	14	$350,000
		Sub-total	**$350.000**
Services (30% of sub-total)	30%		$105,000
Contingency (10% of sub-total)	10%		$35,000
ISSI Hardware/Software/Installation (Motorola quote)	$14,589,927	1	$14,589,927
		ISSI Interoperability Total	**$15,079,927**
Subscriber Programming	$50	40,000	$2,000,000
		Subscriber Programming Total	**$2,000,000**

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5.2.5. Shared Systems Cost Estimate

Cost estimates for the shared system solution utilize the following assumptions:

1. Use of primary networks to carry interoperability traffic
2. Assumes migration occurs during system replacements funded by local jurisdictions
3. Capacity expanded to meeting interoperability roaming requirements
4. Capacity increase based on either channel increases of TDMA conversion
5. Backhaul networks interconnected via microwave
6. Backhaul networks upgraded to support MPLS
7. Backhaul networks have sufficient capacity to support additional traffic
8. No elimination of existing radio sites
9. Two subscriber touches required for every NCR jurisdiction
10. Eliminated need for additional system controllers has been reflected as cost savings

Table 20 – Shared System Capacity Expansion Costs

Equipment Description	Total	Estimated Yearly Maintenance Increase
Loudoun County Channel Increase	$1,260,000	$31,500
Fauquier County Channel Increase	$686,000	$17,150
Fairfax County TDMA (Infrastructure)	$2,352,000	$58,800
Alexandria TDMA (Infrastructure)	$588,000	$14,700
MWAA Channel Increase	$980,000	$24,500
Prince George's County Channel Increase	$3,570,000	$89,250
Montgomery County Channel Increase	$3,080,000	$77,000
Charles County Channel Increase	$2,572,500	$64,313
Frederick County TDMA (Infrastructure)	$686,000	$17,150
Capacity Expansion Total	**$15,774,500**	**$394,363 / year**

Table 21 – Shared System Interoperability Costs

Equipment Description	Unit Price	Quantity	Total
Shared Core Saving	($1,500,000)	12	($18,000,000)
MPLS Routers	$30,000	141	$4,230,000
Microwave Hops	$150,000	14	$2,100,000
		New Equipment Sub-Total	**$6,330,000**
Services (30% of sub-total)	30%		$1,899,000
Contingency (10% of sub-total)	10%		$633,000
		Shared System Total	**($9,138,000)**
Subscriber Programming	$50	80,000	$4,000,000
		Shared System Total	**($5,138,000)**

5.3. TECHNOLOGY RECOMMENDATIONS

Based on the benefits, shortcomings and costs associated with each identified solution, MCP has prioritized each technology for implementation.

The following list summarizes the options prioritized by MCP:

1. Regional shared P25 system
2. ISSI with seamless roaming
3. Inter-zone connections
4. Conventional simulcast overlay
5. P25 trunking overlay

Not all options are mutually exclusive. The benefits offered by shared systems, ISSI and Inter-zone are very similar, and solutions could be recognized that utilize a combination of these options. The conventional and trunked overlay solutions are standalone systems and would need to be wholly implemented independently.

5.3.1. Regional Shared Systems Recommendations

MCP recommends that the NCR pursue migration to a single shared regional system as the ultimate goal for interoperability within the region. This migration is recommended to take place over the next 15 to 20 years as current systems reach end-of-life and will need to be replaced. With many jurisdictions on regular system upgrade schedules, such a migration could be performed in alignment with major upgrades, including dispatch consoles and RF equipment. With a relatively new system sustainment model being employed with regular software and hardware updates, it is not known whether systems will reach a true end-of-life, thus necessitating a forklift replacement. In this event, migration to a regional system may require bypassing some equipment that still has useful life remaining.

Migration to a regional shared network will provide the greatest level of interoperable capabilities offered, provide improved reliability through the development of “cloud”-based backhaul networks, and provide cost savings through elimination of separate controllers for each jurisdiction. This solution satisfies the greatest number of interoperability gaps identified by radio system managers.

The cost estimate developed by MCP includes costs associated with upgrading every system to support additional capacity for increased subscriber roaming across jurisdictions. The specific amount of roaming will depend on the operational procedures and talkgroup restrictions put in place by the NCR. These costs may be reduced if strict limits are placed on the specific talkgroups with roaming capabilities. MCP has allocated these costs for all systems that will leverage primary system infrastructure for interoperability purposes. In the event an interim solution such as ISSI or Inter-zone is implemented, then capacity upgrades could very well be completed in advance of interconnecting systems.

Based on the current communications environment within the NCR, MCP does not foresee migration to a regional shared system to be reasonable within the short-term for most jurisdictions. Most jurisdictions have recently invested in the procurement of P25-compliant systems. Transitioning these existing systems to shared systems would result in the abandonment of numerous system controllers and require additional licensing costs for the "host" controller(s). A migration to shared systems is, however, feasible for those agencies operating legacy networks that have not yet implemented P25 systems. For these agencies, connecting to existing P25 controllers will provide cost savings and interoperability roaming benefits. WMATA is currently exploring options for a shared system controller.

MCP recognizes that each jurisdiction recognizes complete system autonomy in the present communications environment, and migration to shared systems will require a completely new ownership and operational model. With the premise that all existing systems will continue to be operated until they reach end-of-life, there will be a lengthy period where the governance and SOPs associated with a regional system can be developed. With a regional design, the majority of radio equipment will continue to be owned and operated by each jurisdiction. Agreements will need to be in place among all agencies to coordinate system upgrades and other changes that impact all member jurisdictions.

Migration to a regional system will present tremendous operational challenges to ensure both operability and interoperability is maintained. If performed over time, extensive programming efforts and coordination will be required for all NCR agencies each time an agency migrates to the regional system. Migrating all agencies at a single time could prove to be equally challenging. While cost savings will likely be recognized through a reduction in hardware and through bulk purchasing, the level of effort and risk associated with such a migration should not be underestimated.

In the interim, MCP believes solutions such as ISSI will allow the NCR to slowly implement regional solutions and adapt to the interoperability model provided by shared systems while maintaining system autonomy.

5.3.2. ISSI Recommendations

MCP recommends that the NCR implement ISSI as an interoperability solution as an interim solution to building out a shared regional network. The roaming capabilities offered by the current revision of ISSI will satisfy the majority of interoperability gaps identified by radio system managers.

The primary benefit of ISSI is that the technology adapts very well to the current communications system environment within the NCR. The solution will leverage existing P25 systems already purchased and existing backhaul networks. The flexible nature of the solution will enable each agency to maintain the complete autonomy of their network infrastructure, and tightly control the level of roaming to ensure capacity is maintained on primary networks. Adapting to the capabilities provided by ISSI will provide the region a long-term migrating path to implement shared system solutions.

Implementing ISSI will require existing Motorola P25 networks to be a system release level 7.13 or later. Most jurisdictions within the NCR are either already at release level 7.13 or have plans to be at 7.13 or a more current release within the next two years. Jurisdictions with legacy systems will be purchasing P25 systems in the near future, and will be at the current system release offered by their system vendor. The additional costs associated with the implementation of ISSI include the purchase of an ISSI gateway by each jurisdiction, licensing ISSI roaming capabilities through Motorola, and establishing backhaul connectivity through NCRNet. Subscriber flash upgrades to add ISSI roaming software and talkgroup modifications will be required for most jurisdictions.

Additional costs will be necessary to accommodate additional roaming traffic if ISSI is implemented in a manner that permits a high-level of system-to-system monitoring. This capacity increase will be most effectively handled through the upgrade of primary systems to support P25 Phase II TDMA. Migration to TDMA is a logical progression for most jurisdictions within the next 5–7 years as widely fielded XTS/XTL series subscribers reach end-of-life and are replaced with Phase II-compliant radios. The level of ISSI roaming in each jurisdiction can be tightly controlled to maintain the capacity until the point that capacity increases can be accommodated.

The greatest cost associated with ISSI is the licensing required to interconnect each jurisdiction to multiple other interoperability partners. Motorola has provided a proposal to establish ISSI connectivity for existing NCR jurisdictions that includes cost savings above and beyond list pricing for ISSI connections.

Alternatively, ISSI may be configured in a “hosted” environment where every agency establishes a connection to a single NCR jurisdiction. Once this connection is established, talkgroups configured on the host system will be permitted to roam anywhere within the interconnected systems. Every jurisdiction would have the ability to program these talkgroups and roam on those talkgroups where permitted. This solution would only necessitate one connection for each jurisdiction, and multiple connections for the host jurisdiction. Overall this represents a significant decrease in the total number of connections. The primary limitation with this configuration is primary operational talkgroups would not have the ability to roam into surrounding jurisdictions. Only designated wide-area channels configured in the host system will have roaming capabilities. This configuration will result in fewer needs identified by area radio managers being addressed.

Prior to a wide-scale ISSI deployment, usage in a limited pilot between two or three jurisdictions is recommended to validate the technology and identify opportunities and challenges that will need to be addressed by the region. The State of Maryland is planning ISSI connections with numerous County systems, including several systems that fall within the NCR. While the operational model being employed by Maryland is different than how ISSI would be used among NCR jurisdictions, the State’s deployment should be closely monitored to further validate the technology.

5.3.3. Inter-zone Recommendations

Systems interfaced with Inter-zone act as one interconnected system and provide similar capabilities to shared networks. Inter-zone requires interconnected systems to be maintained at the same system release level, use the same system ID, and have shared subscriber databases. With this configuration autonomy of each jurisdiction is lost. However, unlike a completely shared system, interconnected agencies possess all the components necessary to separate back to a standalone network. The costs associated with an Inter-zone connection are minimal, depending primarily on establishing backhaul connectivity and reprogramming subscribers to transition to the common system ID.

In the near-term, Inter-zone may prove to be a challenge as most jurisdictions are on separate procurement and upgrade schedules. Ideally, agencies connected via Inter-zone would have Software User Agreement II (SUAII) and regularly coordinated system release updates.

MCP supports Inter-zone as an alternative to ISSI, permitting similar capabilities to ISSI for a lower capital cost. The primary difference between the alternatives is that ISSI offers a greater level of autonomy between agencies and permits connections in a standards-compliant manner that could be used to interface with systems manufactured by other vendors.

While the capital costs associated with Inter-zone are lower when compared to ISSI, the coordination and operational risk associated with changing system IDs is significantly higher. If performed over time, extensive programming efforts and coordination will be required for all NCR agencies each time an agency migrates to the connected systems. Migrating all agencies at a single time could prove to be equally challenging. While cost savings will likely be recognized through a reduction in hardware and through bulk purchasing, the level of effort and risk associated with such a migration should not be underestimated.

Like shared system and ISSI options, costs will be necessary to raise all systems wishing to interconnect to a shared release level, and to add capacity to support increased roaming. Capacity increases will depend on the level of roaming permitted, and may be completed over time as the region increases roaming capabilities.

5.3.4. Conventional Overlay Recommendations

MCP believes that the conventional simulcast overlay could be completed for a relatively low cost and provide wide-area communications capabilities throughout the NCR on designated channels. However, MCP believes that this alternative is less beneficial than other options due to the fact that coverage will be significantly lower than that offered by primary communications systems. Due to the weaker coverage and the fact that channel changing would be required to switch off primary trunking systems, MCP believes that such a system would not be regularly utilized.

5.3.5. Trunking Overlay Recommendations

MCP believes that a trunked overlay solution could be completed for a relatively low cost if using an existing P25 core and provide wide-area communications capabilities throughout the NCR on designated talkgroups. Compared to the conventional solution, a trunked overlay solution will offer significantly more capacity. However, MCP believes that the limitation with such a system will be coverage, and not capacity. Obtaining spectrum for a regional system could prove to be a challenge, and introduce uncertainty as to whether such a system could be constructed. Use of the WMATA footprint is the most likely path to implement a trunking overlay.

5.4. MIGRATION PLAN

MCP has developed a high-level migration plan for the implementation of the recommended interoperability technologies. The implementation plan is based upon already planned upgrades, funding sources and equipment life cycle considerations.

5.4.1. 2013 – 2015

By 2015, MCP recommends that an ISSI pilot project be implemented by two to three NCR jurisdictions to validate the usage of ISSI as an operability and interoperability tool within the NCR. By this time the State of Maryland should have implemented ISSI with numerous county-wide systems. These early deployments should provide valuable information regarding how effective ISSI is in providing operational benefits for first responders.

5.4.2. 2016 – 2017

By 2017, MCP recommends that each NCR jurisdiction implement ISSI to permit the use of designated wide-area roaming talkgroups if the pilot projects prove successful. Most jurisdictions operating Motorola P25 systems have plans in place to update their system release level within the upcoming years. Most jurisdictions operating legacy networks have plans for P25 procurements in the near future, and should be operating P25 systems by the end of 2015. At this point, the majority of pre-conditions for ISSI will have been met, and the additional costs will strictly be attributed to ISSI gateways and licensing. MCP's recommendation is strictly for designated wide-area talkgroups in this time period, which should result in nominal strain on the capacity of primary systems. For this configuration, a "hosted" ISSI solution should suffice which would reduce up-front ISSI costs.

5.4.3. 2018 – 2021

By 2021, the legacy Motorola XTS/XTL subscribers used by most agencies in the NCR will likely be approaching end-of-life and will require replacement. Upgrading subscriber radios is the largest anticipated cost associated with upgrading systems to support TDMA. A TDMA upgrade will provide a substantial increase to the capacity offered by the systems of each jurisdiction, providing additional overhead to support additional roaming capabilities. Agencies already operating in the TDMA mode

may increase the total number of channels to provide increased capacity. It is at this time that MCP recommends ISSI be expanded to support the roaming of primary operational talkgroups. This change will allow radio users to benefit from the strongest signal strength available, regardless of which jurisdiction's radio tower is providing the coverage. Users will be able to freely roam outside their county for mutual aid or pursuits without needing to change to another system or a designated wide-area channel. It is MCP's opinion that this level of roaming will result in a significant increase in system traffic, thus necessitating the additional capacity provided by TDMA. Additional ISSI connection licenses will be needed for each agency at this time if they are not purchased up-front.

5.4.4. 2025 – 2030

As recently installed P25 networks reach end-of-life, MCP recommends the region migrate toward a shared interoperable network with common control equipment and a "cloud"-based backhaul network. A shared network will result in significant cost savings and additional interoperability enhancements compared to those offered by ISSI. Recognizing that the technology solutions that will be available are not yet defined, MCP recommends the region is cognizant of the solutions available and implements a cost effective shared network model. Based on present technology such a system would include a standards-based P25 network with geo-diverse control equipment with redundant backhaul connections. With the anticipated public safety broadband network (FirstNet), it is altogether possible that long-term evolution (LTE) will become the new standard for mission critical voice. It is for this reason that MCP recommends the region establish a long-term goal to migrate toward a regional shared system, and narrow down the specific technology as the time gets closer and technology projections become more accurate.

5.5. OPERATIONAL RECOMMENDATIONS

While the technical abilities offered by the solutions discussed in this report will improve interoperable capabilities for the region, operational changes are required to recognize those benefits. Some operational changes will provide immediate benefits to the region within the current communications system environment. These operational changes directly correlate to specific interoperability gaps defined by radio system managers. The following section discusses MCPs recommendations as to what operational changes are required to bridge these gaps in conjunction with the recommended technical solutions.

1. **Wide-area Talkgroups** – All interoperability solutions discussed involve the establishment of wide-area talkgroups that can be utilized to communicate anywhere within the region without switching channels. Wide-area talkgroups provide a valuable tool that could be utilized for numerous circumstances, including command and control of wide-area events spanning multiple jurisdictions, police chases across jurisdictional boundaries, EMS and prisoner transports, and unpredictable requirements that cannot even be fathomed. Implementing these talkgroups requires operational changes to ensure the channels are used to their greatest effectiveness. At a minimum, MCP recommends creating a common zone in each subscriber radio with 16 interoperability talkgroups (or the four conventional channels if a simulcast solution

is implemented). SOPs should be developed that outline the specific use of the wide-area channels, including when users should access them, and what channels will be monitored throughout the region. Training and exercise plans should be implemented to provide users scenarios when the channels should be utilized and practice using them. The channels will be utilized to their greatest effectiveness when usage is integrated with the daily operational model of all first responders.

2. **Simplify Interoperability** – Simplifying interoperability was one of the greatest challenges noted by most area radio managers. The interoperability solutions in place today require users to change channels as they enter a jurisdiction for mutual aid purposes. Because of the large number of talkgroups in each system, most NCR radios have countless banks of talkgroups. For most users, locating and accessing the appropriate talkgroup is an operational challenge, especially if they are entering a jurisdiction that is not part of their daily requirements. With the implementation of new interoperability solutions such as wide-area channels and roaming capabilities, the opportunity exists to simplify interoperability for end users. MCP recommends this be accomplished by moving to a regional model for talkgroups, where the number of agency-specific talkgroups are reduced and replaced with designated interoperability talkgroups. Through this model, events throughout the region may be concentrated on a single bank of designated wide-area interoperability talkgroups. Placing these talkgroups on the second or third primary zone will permit users to access these channels without using the keypad on their radio. By utilizing these channels for primary traffic, users should be able to quickly and effectively access these channels regardless of their location within the NCR.

3. **Subscriber Programming** – Virtually every radio manager within the NCR commented about the frequent need for reduced subscriber programming. The technology solutions discussed in this report will not inherently reduce the need for subscriber programming. Reducing programming requirements will depend upon reducing the frequency of code plug changes across the region. Radio managers indicated that prior to rebanding code plug updates were coordinated once a year so that programming efforts across the region could be limited. MCP recommends that this policy is re-initiated. Migrating to regional systems and talkgroup plans should reduce the overall number of talkgroups, limiting the potential changes. Technology solutions such as OTAP are available to reduce the time and effort associated with programming. MCP anticipates that the requirement for code plug changes should reduce inherently based on the fact that most jurisdictions have already completed rebanding and migrations to P25 systems.

4. **Coordinated System Updates** – Coordinating procurements was indicated by many jurisdictions to be an interoperability challenge. Historically, whenever a single agency implements a new technology or feature, every other agency must update their system or subscribers in order to be compatible with the new feature sets. At the present time, some NCR jurisdictions have implemented TDMA systems that are not compatible with the FDMA radios with neighboring jurisdictions on primary operational channels. Dynamic Dual Mode has been implemented in some circumstances to provide backward compatibility with FDMA subscribers

from interoperability partners. Numerous agencies indicated that interoperability has been optimal when all jurisdictions have had sufficient time to upgrade to compatible platforms. Some of the solutions proposed by MCP will necessitate operating at equivalent platforms or using shared networks, requiring coordinated system upgrades. However, the optimal method for maintaining systems on compatible platforms is for each agency NCR jurisdiction to coordinate updates with neighboring jurisdictions. While aligning procurement cycles will help this effort, extensive interoperability planning should be performed in advance of procurements to ensure interoperability plans are in place. This can be coordinated with a set of mandatory requirements for all radio system upgrades that are agreed to by all NCR agencies.

5. **Training** – While mutual aid calls occur regularly for fire and rescue users, mutual aid events are far less frequent for law enforcement personnel. Mutual aid training for law enforcement was identified as a major gap within the region. Regular training combined with interoperability exercises and greater usage of interoperability tools among law enforcement would provide a substantial benefit to the region within the current communications environment. Proper training should enable law enforcement personnel to make better use of interoperability resources when events occur that necessitate these tools.

6. **No-Steps-Backward** – Numerous instances were noted by most NCR radio managers where interoperability had been broken because of a unilateral decision to make system changes by one jurisdiction. Given the complex interoperability environment within the NCR, a system change by any one jurisdiction has a cascading effect to every other jurisdiction. When a system change is made, subscriber programming is often required by every other jurisdiction. Some system changes, including technology “upgrades” or encryption may completely prevent the ability for other jurisdictions to interoperate. As a whole, MCP recommends that the region take a “no-steps-backward” approach to interoperability. Implementing such an approach will require any system-level changes to be closely coordinated with all other interoperability partners. Coordinating updates so they coincide with regional subscriber programming schedules will help to reduce the overall effort required and enable a better coordination of changes.