

# The Washington Metropolitan Area Transit Authority's Underground Communications Systems

Evaluation of Effectiveness and Interoperability



METROPOLITAN WASHINGTON  
**Council of Governments**

**Summary Report**

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## **FOREWORD**

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## Introduction

The Metropolitan Washington Council of Governments (MWCOG) and National Capital Region (NCR) agencies, in response to the January 12, 2015 Metrorail smoke incident, initiated a study of the underground communications systems of the Washington Metropolitan Area Transit Authority (WMATA). The goal of the study was to:

*Provide a comprehensive study of the Washington Metropolitan Area Transit Authority (WMATA) underground communications systems with specific evaluation and analysis of systems effectiveness and interoperability with regional government communications systems and recommendations on how to maximize effective communication and emergency response to incidents in the WMATA Metrorail system.*

This report provides an evaluation of the systems, policies, and procedures associated with Metrorail’s underground communications infrastructure as it relates to emergency response—those systems used by fire, emergency medical service (EMS), and law enforcement personnel. It includes a review of the process of discovering an incident within the Metrorail system, the alerting of an incident, the dispatching of resources to the incident, and the communications systems and protocols used by first responders and other personnel to protect life and property. These communications are conducted over a variety of systems that include two-way land mobile radio (LMR) systems, tactical repeaters, cellular phones, landline phones, and face-to-face contact.

The study assessed existing WMATA and public safety radio systems across a range of areas, including testing, reporting, system status, and corrective actions to improve the current system. Additionally, this study evaluated the WMATA plans for communication system upgrades, including options to accelerate the upgrade timetable. It identifies needed improvements to communication system policies and procedures, examines current public alerting 9-1-1 capabilities within the Metrorail underground, and captures lessons learned from reviews of other comparable rail systems.

This study was conducted through a collaborative effort by the ad hoc MWCOG Metro Communications Study Committee. Composition of the Committee and its advisors and consultants may be found in Appendix E.

## Methods

This study’s methodology employed four (4) main techniques to evaluate WMATA’s Metrorail underground communications system: 1) stakeholder surveys and interviews; 2) field tests and measurements; 3) existing network and operational policy document review; and 4) research on other comparable metropolitan transit agencies and jurisdictions.

## Overview: Metrorail Communication Systems

WMATA’s Metrorail system is the second-busiest rapid transit operation in the United States.<sup>1</sup> It services over 800,000 passengers a day throughout 117 miles of track (including over 50 miles of track located underground). WMATA operates 91 Metrorail stations—47 of which are located underground—across

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<sup>1</sup> Ranking based on data from the American Public Transportation Association’s ridership reports.

six jurisdictions<sup>2</sup>. In operation nearly 20 hours a day, seven days a week, since 1976, Metrorail has a very small daily window—a couple of hours at best—to effect repairs and maintenance to the vast system.<sup>3</sup>

It is not surprising, then, that Metrorail’s communications infrastructure is both complex and stressed. The underground components of the communications system are particularly challenged by the physical impediments of transmitting and receiving radio signals within tunnels that are curved and vary in elevation. The physical size of the trains within the tunnels also affects the strength, quality, and reliability of wireless communications, as do other obstacles at the stations, such as escalators.

Additionally, in order for individuals to use the same cell phones and public safety radios below ground as well as above ground, the types of signals and frequencies must be consistently available in strength and quality. For this reason, transportation agencies often use distributed antenna systems (DAS) to take above-ground radio signals and amplify and transport them to serve underground areas. The underground Metrorail is no different and uses four (4) discrete distributed antenna systems: 1) a comprehensive radio communications system (CRCS) that supports WMATA’s daily operational communication needs; 2) a public safety radio system (PSRS) dedicated for emergency, safety, and security functions; 3) a legacy Verizon wireless commercial system for limited mobile phone use; and 4) a relatively new, yet incomplete, Neutral Host system designed to replace the Verizon mobile network and provide wireless coverage for all major carriers.

#### *Comprehensive Radio Communications System (CRCS)*

WMATA owns and operates the CRCS, a single-cell, 10-site, 22-channel trunked simulcast radio system used by Metrorail, Metrobus, and WMATA’s Metropolitan Transit Police Department (MTPD). It operates at a frequency of 490 MHz over a 1,600-square mile service area in the National Capital Region. When WMATA or Metrorail jurisdictions emanate a radio signal on the CRCS, the signal is distributed over a fiber-optic cable to head-end radio amplifiers that are typically located in Metrorail stations.<sup>4</sup> That signal is then propagated over a shared radiating cable in the tunnels and strengthened with intermediate bi-directional amplifiers (BDAs). The BDAs are required to amplify radio signals over the entire length of the CRCS, necessitating one BDA positioned every 2,200 feet of tunnel.

#### *Public System Radio System (PSRS)*

The WMATA PSRS, another DAS, is the dedicated, collective radio system for local public safety agencies and operates at the 800 MHz frequency<sup>5</sup>. The PSRS is similar in technical configuration to the CRCS and, in fact, the two systems share the same radiating cable that lines the Metrorail tunnel walls. The radiating cable used by WMATA for the CRCS and PSRS was deployed as part of an agreement with then-Bell Atlantic Mobile Systems (BAMS), now operating as Verizon Wireless. However, separate BDAs are used for the two systems (PSRS and CRCS). The higher signal loss over the radiating cable at 800 MHz (as compared to the 490 MHz CRCS signal) necessitates a higher number of 800 MHz BDAs

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<sup>2</sup> For the purposes of this study, “Metrorail jurisdictions” include the City of Alexandria, Arlington County, the District of Columbia, Fairfax County, Montgomery County, and Prince Georges County.

<sup>3</sup> On weekdays, Metrorail is in service from 5 am to midnight, except on Fridays when service is extended to 3 am. On Saturdays and Sundays, Metrorail opens at 7 am and closes at 3 am and midnight, respectively.

<sup>4</sup> The transmission method of the signals from the towers varies among Metrorail jurisdictions. For example, the District of Columbia’s land mobile radios (LMR) transmits its signals via fiber-optic cable, whereas Fairfax County’s LMR system is wireless.

<sup>5</sup> Technically, each Metrorail jurisdiction operates its own PSRS, so the “Metrorail PSRS” is actually a collective of six discrete systems.

that must be positioned every 1,100 feet of tunnel. Altogether, more than 750 BDAs are required for the current CRCS and PSRS.

#### *Verizon Commercial Wireless System*

The Metrorail tunnel system also features a wireless radio system to support commercial mobile phone usage. When the CRCS/PSRS radiating cable was installed by Bell Atlantic in the late 1990s, the company also installed its own radiating cable and BDAs to provide service for its cellular customers. Verizon still operates this original Bell Atlantic system in the Metrorail tunnels between the stations. This system, however, is only available to customers of Verizon Wireless or its roaming partner, Sprint. Subscribers to the AT&T or T-Mobile networks do not have wireless signal accessibility throughout the Metrorail tunnel system.

#### *Neutral Host System*

More recently, in order to address the issue of signal accessibility for all mobile phone users, a consortium “Cellular Carrier Team” of the four major providers—Verizon Wireless, Sprint, AT&T, and T-Mobile—was awarded a contract with WMATA in 2009 to deliver a Neutral Host system for all cellular carriers and covering all commercial cellular frequencies (as well as provide WMATA with its own dedicated infrastructure for its DAS). However, the Cellular Carrier Team’s primary subcontractor declared bankruptcy in 2013 and only the underground stations have been completed to date.<sup>6</sup>

#### *Systems Concept of Operations*

These four radio systems—CRCS, PSRS, Verizon Wireless, and Neutral Host— comprise the infrastructure referred to in this study as the current “Metrorail communications systems”. As the Committee’s analysis will show, improvements are recommended across all four subsystems.

Figure 1 represents a basic concept of operations for how the Metrorail underground communication system functions.

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<sup>6</sup> The primary subcontractor was Powerwave Technologies, Inc., a California-based telecommunications corporation. As reported by *Total Telecom*, Powerwave filed for Chapter 11 bankruptcy on January 28, 2013. The company subsequently ceased operations and filed for Chapter 7 bankruptcy on June 10, 2013.



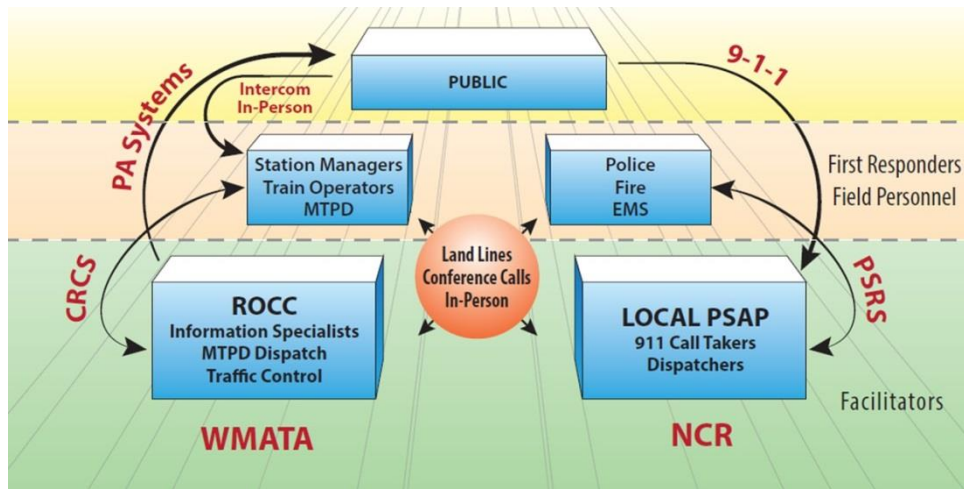


Figure 1: Metrorail Underground Communications Concept of Operations

## Planned Improvements

WMATA and Metrorail jurisdictions were well aware of the numerous challenges resident in the existing underground communications infrastructure prior to the smoke incident on January 12<sup>th</sup>, 2015. Over the past several years, much progress had been made in shoring up the existing radio systems while actively planning for strategic improvements in a next-generation radio system. In fact, various other projects were already underway or well into the planning phase when this study commenced. These projects include enhanced testing and monitoring procedures; replacement of the land mobile radio network/distributed antenna system of the CRCS and PSRS; completion of the Neutral Host system providing commercial mobile service for all major carriers, and the acquisition and testing of various backup communications systems.

### *WMATA Land Mobile Radio Upgrade*

WMATA had instituted plans to upgrade its radio systems prior to January 12<sup>th</sup>. The agency had already concluded that the legacy underground DAS were too problematic to maintain and that a new solution to provide reliable underground communications was needed. Additionally, a Federal law passed in 2012 reclaims the “T-Band” spectrum (490 MHz to 512 MHz) for a new Nationwide Public Safety Broadband Network (NPSBN), necessitating the move of WMATA’s CRCS to a new frequency band. The available spectrum for the new CRCS is not supported by the legacy DAS.<sup>7</sup>

WMATA’s current plans are to deploy a 700 MHz Project 25<sup>8</sup> radio network for all of its LMR needs, including rail, bus, and public safety. WMATA intends to start installation of this new underground DAS with internal resources, commencing in January 2016. WMATA intends to issue a request for proposals (RFP) to contract the buildout of certain elements of the new system in July 2015. Due to the shift in

<sup>7</sup> Please see the “Middle Class Tax Relief and Job Creation Act of 2012,” now Public Law 112-96.

<sup>8</sup> Project 25 is an Association of Public Safety Communications Officials (APCO) sponsored standard for public safety push-to-talk radio systems.

frequencies from 490 MHz to 700 MHz, migration to the new system requires additional above-ground towers and a new underground DAS infrastructure, which will take several years to complete.

Instead of distributing the regional land mobile radio networks underground, WMATA instead intends to implement a networking feature of Project 25 called the Inter RF Subsystem Interface (ISSI) that will allow regional public safety personnel to “roam” on WMATA’s new 700 MHz network. Metrorail jurisdictions are in various stages of capability to support WMATA’s plan.<sup>9</sup>

#### *Planned Neutral Host Upgrades*

Following the bankruptcy of the prime subcontractor in 2013, WMATA is working with the Cellular Carrier Team to resume the construction of the Neutral Host system. Integral to the installation of WMATA’s underground DAS, the agency is installing a cable-mounting apparatus that should make it significantly easier for the Cellular Carrier Team to install its cable along the tunnel walls.

A substantial amount of work remains to provide the infrastructure that would allow all wireless carrier service throughout the Metrorail underground system, including the tunnels. It will take several years just to install the radiating cable in all of the tunnels to support the Neutral Host system. In July 2015, the Cellular Carrier Team expressed their intention to “restart the project by the end of this year.”<sup>10</sup>

#### *Planned Backup Systems*

The National Capital Region has three public-safety radio caches that include backup communications systems that can be deployed at major events. Metrorail jurisdictions have had programs in place for years to address radio coverage-constrained environments, such as parking garages and building basements. The equipment needed for these and other types of contingencies is identical to the backup equipment anticipated for Metrorail underground emergencies. The NCR purchased new “tactical BDAs” in response to coverage problems experienced during the January 12<sup>th</sup> incident. These tactical BDAs are portable and can extend the coverage of the above-ground radio systems below ground. The agencies that have received this equipment are in various stages of training and are readying themselves for operational deployment for underground incidents.

## Findings and Recommendations

Per the study’s goals and based on the findings contained herein, the Committee developed numerous recommendations for corrective action and improvement planning for the Metrorail underground communications system. Some of these recommendations identify interim methods and plans that can be put in place to improve performance of the current systems prior to WMATA’s longer-term planned system upgrades. In all cases, the recommendations included in this study should be given due consideration without delay. As noted for a number of the longer-term deliverables, the duration of the task necessitates immediate activities to achieve the solution in the recommended timelines. The recommendations identify the responsible parties associated with the recommendation implementation of

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<sup>9</sup> All of the regional radios will need to support 700 MHz and the regional radio networks will need to support the ISSI.

Furthermore, regional radios will also require support of a newer technology, called TDMA, which doubles the capacity of the system based on the expected load of both the WMATA and public safety traffic.

<sup>10</sup> Letter dated July 24, 2015 from the Cellular Carrier Team to Mr. Stuart A. Freudberg, Deputy Executive Director, MWCOG.

the recommendation, as well as, to the extent possible, estimated potential costs to implement the recommendation *above and beyond existing or planned investments*.<sup>11</sup>

This summary highlights the key study findings and recommendations. A number of the recommendations are fairly complex with important nuances, which are described in greater detail in Section 3 of the main report. In addition, the recommendations can be found in a single table in Appendix A.

The study identifies 15 key findings and 21 associated recommendations regarding Metrorail underground communications. These findings and recommendations are organized into four categories:

- Infrastructure
- Radio System Operations and Maintenance
- 9-1-1 Service
- Policy and Procedures

From a timing perspective, each of the recommendations is characterized as either a near-term or long-term initiative, with the following definitions applying:

- **Near-term:** recommendation pertains to improvements or enhancements to *existing* systems, equipment, structures, policies, and/or procedures;
- **Long-term:** recommendation pertains to *future or next generation* systems, equipment, structures, and/or legislative or regulatory requirements.

#### *Infrastructure*

- **The existing Metrorail underground communications systems are at the end of their useful lifecycle and are extremely difficult to maintain.** The communications infrastructure is comprised of hundreds of key components and parts, and due to their age and frequent failure of any particular part at any one time, the system overall does not meet public safety standards.<sup>12</sup>

**Recommendation #1 (Long-Term):** *WMATA should prioritize the installation of the new leaky coaxial cable along those tunnel walls that have current and/or persistent radio performance issues over other areas of the system that are in better working condition.*<sup>13</sup> *Additionally, rather than waiting until the entire 100 miles of cable is installed throughout the entire system, these prioritized segments of leaky coaxial cable should be made operational as soon as possible.*<sup>14</sup>

- **Bi-Directional Amplifiers (BDAs) used to boost tunnel signal levels are often inaccessible and lack real-time monitoring.** BDAs are installed in stations and on the tunnel walls in the rail right-of-way (ROW). Those on tunnel walls are inaccessible to maintenance crews while trains are operational within the system. This limited access (~ 90 minutes per night) makes repair efforts difficult to accomplish quickly given time requirements for repair crew mobilization

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<sup>11</sup> Cost estimates can be found in Section 3 and in Appendix A.

<sup>12</sup> Please see “Defining Public Safety Grade Systems and Facilities”, a report of the National Public Safety Telecommunications Council, May 2014.

<sup>13</sup> “Leaky”, as applied to coaxial cable, is an industry design term and does not refer to a physical flaw in the cable.

<sup>14</sup> There are two (2) tunnels with a length of approximately 50 miles each for a total of 100 miles of tunnel and associated cabling.

and demobilization, as well as competing tunnel access priorities. The BDAs lack real-time remote monitoring and control capability, which forces maintenance personnel to physically visit the BDAs in the tunnels. This lack of remote monitoring also contributes to the extended repair times.<sup>15</sup> Analysis conducted in the study concluded that replacement of the fiber-optic head-end PSRS BDAs in stations is a cost-effective, short-term, feasible safety improvement. Replacement of cascaded BDAs in the tunnels is not cost-effective. Instead, other short-term PSRS enhancements— as well as back-up options—offer an appropriate, alternative solutions.

**Recommendation #2 (Near-Term):** *WMATA should replace the existing fiber-optic PSRS head-ends in Metrorail stations with new fiber-optic head-ends that can be monitored and controlled remotely and in real-time. Due to the impact of the technology on WMATA and local jurisdictions, this should be a joint WMATA and Metrorail jurisdictions effort. Additionally, the replacement head-end BDA alarm-reporting software should provide notification to regional stakeholders through different technologies such as computer-aided dispatch (CAD) sharing or possibly a paging alert system.<sup>16</sup> This enhancement will provide better management of the radio frequency (RF) noise that affects communications performance and will improve the overall quality of in tunnel radio service.<sup>17</sup>*

- **WMATA’s new 700 MHz Radio system RFP provides for the deployment of a single, underground, 700 MHz public-safety radio communications system that would resolve many existing problems, but the current approach presents some risks.** According to the WMATA RFP, the new infrastructure would eliminate the existing 800 MHz PSRS radio systems and requires local first responders to “roam” on the WMATA 700 MHz system using an Inter RF Subsystem Interface (ISSI) link. Some stakeholders expressed concern (and the Committee concurs) that the ISSI link specified for the new 700 MHz radio system may not have sufficient capacity for both WMATA and the local jurisdictions and may not provide the full functionality currently enjoyed by local first responders.

**Recommendation #3 (Long-Term):** *WMATA should replace the existing PSRS underground radio systems at the same time they are replacing the CRCS radio system. The Inter RF Subsystem Interface (ISSI) link should be used to provide redundancy and not serve as the primary PSRS radio communication system.*

- **Direct radio communications capabilities between the WMATA CRCS, the Metro Transit Police Department, and other local law enforcement agencies are challenging.** The radio system is technically “interoperable”, but the practical manner in which responders communicate and their inherent aversion to switching channels from their home frequency during an incident renders much of the interoperability ineffective.<sup>18</sup> Truly realized interconnectivity between

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<sup>15</sup> WMATA has developed a plan to replace the signal amplification system. The plan involves the installation of new cables that do not require individual amplifiers along the tunnel walls. It is expected to take several years to install the new system due to limited access to the tunnels (i.e., installation requires cessation of train activity).

<sup>16</sup> Replacing *all* of the BDAs in the tunnels would be 1) time consuming and take valuable track-rights time away from other more important work, and 2) not add significant value to the system. As a result, the study team’s recommendation is to find a “manual” approach to the problem of identifying BDA failures. Specifically, to conduct measurements frequently to find failed BDAs.

<sup>17</sup> WMATA recently authorized proceeding with this recommended enhancement.

<sup>18</sup> Interoperable and interoperability as used throughout the report reference the ability of first responders to directly communicate with one another over one another’s radio networks and the underlying radio frequency (RF) spectrum, some of which are in different radio spectrum bands.

WMATA and Metrorail jurisdiction police agencies will enhance emergency responsiveness if the equipment is properly maintained and if policies and standard operating procedures (SOPs) are followed.<sup>19</sup> A protocol for data information (such as computer-aided dispatch) flow between WMATA and partner agencies does not exist, but if implemented could provide additional interoperability benefits.

**Recommendation #4 (Near-Term):** *WMATA and Metrorail jurisdictions should explore their interoperability requirements in more detail and determine if other forms of communication-sharing capabilities would work more efficiently for alerts and warnings. This could include the use of radio communications patches or gateways, sharing of computer-aided dispatching (CAD), regional paging systems, and direct telephone line, to name a few. If these systems are found to be necessary, then establishing standard operating procedures to leverage those communications channels should be explored.*

- **Reviews of two comparable mass transit systems’ public safety communications capabilities indicates that WMATA is generally on par with other commensurate systems.** The Committee discovered that in some ways, WMATA underground communication is significantly better than other agencies. Some mass transit systems use first responder radio human relays as the primary means of underground communications. However, there is one communications capability resident elsewhere that WMATA may want to consider employing. In the San Francisco/Oakland metropolitan region, the Bay Area Rapid Transit (BART) rail operations control center communicates with rail passengers directly via radio over the train’s public address (PA) system. BART uses this capability two to three times per day and finds significant value in this communication. At present, only Metrorail train operators have the ability to communicate with passengers on the same train. Direct communications to the riding public from the rail operations control center (ROCC) may provide significant benefits to WMATA and the riding public during emergency situations.

**Recommendation #5 (Near-Term):** *WMATA should explore the integration and ability to directly transmit messages from the ROCC to the public over the train public address systems during emergency situations.*

Infrastructure Findings and Recommendations Summary			
No.	Finding	Recommendation	Timing
1	The existing Metrorail underground communications systems are at the end of their useful lifecycle and are extremely difficult to maintain.	WMATA should prioritize the installation of the new leaky coaxial cable along those tunnel walls that have current and/or persistent radio performance issues over other areas of the system that are in better working condition.	Long-Term
2	Bi-Directional Amplifiers (BDAs) used to boost tunnel signal levels are often inaccessible and lack real-time monitoring.	WMATA should replace the existing fiber-optic PSRS head-ends in Metrorail stations with new fiber-optic head ends that can be monitored and controlled remotely and in real-time.	Near-Term
3	WMATA’s new 700 MHz radio system RFP provides for the deployment of a single, underground, 700 MHz public-safety radio communications system that would resolve	WMATA should replace the existing PSRS underground radio systems at the same time they are replacing the CRCS radio system. The Inter RF Subsystem Interface (ISSI) link should be used to	Long-Term

<sup>19</sup> When WMATA migrates its radio operations to the new 700 MHz system, there will likely be simpler and more effective interoperability opportunities between WMATA and law enforcement agencies.

	many existing problems, but the current approach presents some risks.	provide redundancy and not serve as the primary PSRS radio communication system.	
4	Direct radio communications capabilities between the WMATA CRCS, the Metro Transit Police Department, and other local law enforcement agencies are challenging.	WMATA and Metrorail jurisdictions should explore their interoperability requirements in more detail and determine if other forms of communication-sharing capabilities would work more efficiently for alerts and warnings.	Near-Term
5	Reviews of two comparable mass transit systems' public safety communications capabilities indicates that WMATA is generally on par with other commensurate systems.	WMATA should explore the integration and ability to directly transmit messages from the ROCC to the public over the train public address systems during emergency situations.	Near Term

Table 1: Summary of Infrastructure Recommendations

*Radio System Operations and Maintenance*

- **The current method of voice-quality testing, despite recent enhancements and ongoing improvements, still lacks the precision and specificity to reliably identify individual BDA failures.** Metrorail jurisdiction agencies conduct voice-quality testing throughout the Metrorail system to identify potential problems. Many recent improvements have been realized. The testing process, however, is not systematic enough to ensure full coverage throughout the entire underground system and provides very little troubleshooting or diagnostic data.

**Recommendation #6 (Near-Term):** *WMATA should conduct detailed uplink, downlink, and noise signal-level testing throughout the underground tunnel system on a routine basis. At a minimum, these tests should be conducted weekly. However, daily testing is recommended.<sup>20</sup> These test results should be analyzed in a timely manner to identify performance issues such as a failed or noisy BDA. The results should be shared with the applicable public safety agencies and logged into the corrective action system for repair.*

- **WMATA did not routinely inform Metrorail jurisdictions of Public Safety Radio System (PSRS) failures prior to January 2015, but this has been corrected.** Interviews with regional public safety agencies indicated that WMATA did not routinely inform NCR stakeholders of PSRS radio issues prior to January 2015. Furthermore, the status of repair efforts after initial fault reporting by local agencies was not communicated to the local first responders very effectively. However, in March 2015, WMATA implemented a radio outage display portal that improves communication regarding PSRS maintenance activities and this system logs all radio system testing by jurisdictions and WMATA personnel. However, interviews with local first responders and the Committee’s analysis indicate that additional improvements could be made to the radio outage display.

**Recommendation #7 (Near-Term):** *WMATA should enhance its online radio outage display to provide information on all known problem areas. The radio outage display should also identify the timeframe and planned corrective action to address each known problem. The radio outage display should also identify the cause of the communication failure and allow the local jurisdiction to confirm that the reported problem is indeed corrected. The radio outage display should also allow WMATA to communicate planned maintenance actions that may impact the operation of the PSRS radio systems. Metrorail jurisdiction*

<sup>20</sup> Downlink is currently tested on a weekly basis; uplink is not currently tested.

*agencies should consider linking this information with their computer-aided dispatch messages to emergency responders.*

- There is no central database of PSRS and CRCS radio systems configuration data that would enable maintenance crews to coordinate and understand work effort between the multiple radio maintenance crews.** RF noise and signal levels within the existing radio system(s) vary dramatically and interact with each other to affect the quality of radio system performance. An adjustment to one BDA will impact the noise and signal level of another BDA. Therefore, maintenance crews are frequently making changes to amplifier levels and other reconfigurations that affect noise levels. Maintenance crews have no resource that provides a centralized log of these adjustments, nor any information references as to how those changes may impact other portions of the system.

**Recommendation #8 (Near-Term):** *WMATA should develop a change management system to record and track changes of communication systems noise and signal levels, BDA parameters, and asset locations.*

- Failure rates of Metrorail communications system components have at times exceeded the maintenance teams’ capacity to effect repairs in a timely fashion. Repairs of known system failures were often delayed due to lack of adequate spare parts.**

**Recommendation #9 (Near-Term):** *WMATA should ensure a sufficient spare-parts inventory is maintained and available to work crews to avoid outages associated with insufficient spare parts. WMATA should track repairs delayed by lack of spare parts or equipment shortages. In addition, WMATA should closely monitor the maintenance-crew work load to ensure adequate staffing is available to maintain the PSRS radio systems.*

Radio Systems Operations and Maintenance Findings and Recommendations Summary			
No.	Finding	Recommendation	Timing
6	The current method of voice-quality testing, despite recent enhancements and ongoing improvements, still lacks the precision and specificity to reliably identify individual BDA failures.	WMATA should conduct detailed uplink, downlink, and noise signal-level testing throughout the underground tunnel system on a routine basis. At a minimum, these tests should be conducted weekly. However, daily testing is recommended.	Near-Term
7	WMATA did not routinely inform Metrorail jurisdictions of Public Safety Radio System (PSRS) failures prior to January 2015, but this has been corrected.	WMATA should enhance its online radio outage display to provide information on all known problem areas.	Near-Term
8	There is no central database of PSRS and CRCS radio systems configuration data that would enable maintenance crews’ to coordinated and understand work effort between the multiple radio maintenance crews.	WMATA should develop a change management system to record and track changes of communication systems noise and signal levels, BDA parameters, and asset locations.	Near-Term
9	Failure rates of Metrorail communications system components have at times exceeded the maintenance teams’ capacity to effect repairs in a timely fashion. Repairs of known system failures were often delayed due to lack of adequate spare parts.	WMATA should ensure a sufficient spare-parts inventory is maintained and available to work crews to avoid outages associated with insufficient spare parts. WMATA should track repairs delayed by lack of spare parts or equipment shortages.	Near-Term

*Table 2: Summary of Radio Systems Operations and Maintenance Recommendations*

### 9-1-1 Service

- **9-1-1 calling is inaccessible to many passengers.** Field testing by the communications Committee, as well as testing conducted by the MWCOG 9-1-1 Directors Committee, revealed substantial connectivity problems with commercial cellular service in most Metrorail tunnels between stations. Tunnel cellular service is provided exclusively by Verizon Wireless, but only to its own subscribers and those of its roaming partner, Sprint. This infrastructure was installed ten to twenty years ago and is near its end of life. Service in the stations is the result of a new Neutral Host infrastructure implemented under a WMATA contract to a Cellular Carrier Team<sup>21</sup> consortium between 2009 and 2013. This Neutral Host system provides service for all wireless carriers.

**Recommendation #10 (Near-Term):** *MWCOG, Metrorail jurisdictions, and WMATA should encourage Verizon Wireless to repair and maintain its legacy system to restore original 9-1-1 service in the tunnels for Verizon and Sprint customers. In addition, the parties should encourage the other carriers to correct any deficiencies in 9-1-1 calling capabilities.*

**Recommendation #11 (Long-Term):** *MWCOG and Metrorail jurisdictions should work with WMATA and the Cellular Carrier Team to pursue rapid reinstatement and an accelerated build of the Neutral Host system.*

- **There is an appearance of no viable, near-term plan in place to ensure 9-1-1 service is accessible to all Metrorail passengers.** As is the case for the signal amplification improvements, new cable is required along the tunnel walls to correct the 9-1-1 shortfalls and will require several years for completion. The Cellular Carrier Team's primary implementation vendor declared bankruptcy in 2013, stalling the project. Currently, no work is underway to secure universal tunnel coverage for 9-1-1 service throughout the system. As a result, subscribers on the AT&T and T-Mobile wireless networks do not have access to 9-1-1 calling in the Metrorail tunnels. The current WMATA plan is to install a specialized cable mounting apparatus that should facilitate installation of the Cellular Carrier Team's Neutral Host cable sometime in the future.

**Recommendation #12 (Near-Term):** *WMATA should prioritize the installation of radiating-cable supporting apparatus in areas where Verizon Wireless tunnel service is poor. In the interest of public safety, WMATA should also request the Cellular Carrier Team to build in these areas first.*

- **When a 9-1-1 call is successfully placed within the Metrorail tunnel system, there is no automated capability to determine the location of the call's origin.** Global Positioning System (GPS) signals are not available underground within Metrorail tunnels and stations and, as a result, the precise location of a 9-1-1 caller is not known. If the location of a caller or an incident is not known at dispatch, substantial lost time may result in the response. Additionally, the current 9-1-1 system does not support text or image transmission.

**Recommendation #13 (Long-Term):** *The MWCOG 9-1-1 Directors should continue to monitor the Federal Communications Commission (FCC) proceedings on location accuracy requirements and the relevant test-bed systems to determine if industry solutions will provide*

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<sup>21</sup> The Cellular Carrier Team comprises Verizon Wireless, Sprint, AT&T, and T-Mobile.



*the needed improvements for Metrorail underground location positioning. The findings should be reported to the MWCOG communication study working committee or the Interoperability Working Group, as needed.*

**Recommendation #14 (Long-Term):** *The MWCOG 9-1-1 Directors should review with the wireless carriers all possibilities to provide wireless services within the Metrorail system that support the known features of Next Generation 9-1-1, including text-to-9-1-1. The 9-1-1 Directors should report their findings to the MWCOG Board of Directors and/or MWCOG Interoperability Working Group, as needed.*

9-1-1 Service Findings and Recommendations Summary			
No.	Finding	Recommendation	Timing
10	9-1-1 calling is inaccessible to many passengers.	MWCOG, Metrorail jurisdictions, and WMATA should encourage Verizon Wireless to repair and maintain its legacy system to restore original 9-1-1 service in the tunnels for Verizon and Sprint customers. In addition, the parties should encourage the other carriers to correct any deficiencies in 9-1-1 calling capabilities.	Near-Term
11	Ibid.	MWCOG and Metrorail jurisdictions should work with WMATA and the Cellular Carrier Team to pursue rapid reinstatement and an accelerated build of the Neutral Host system.	Long-Term
12	There is an appearance of no viable, near-term plan in place to ensure 9-1-1 service is accessible to all Metrorail passengers.	WMATA should prioritize the installation of radiating-cable supporting apparatus in areas where Verizon Wireless tunnel service is poor. In the interest of public safety, WMATA should also request the Cellular Carrier Team to build in these areas first.	Near-Term
13	When a 9-1-1 call is successfully placed within the Metrorail tunnel system, there is no automated capability to determine the location of the call's origin	The MWCOG 9-1-1 Directors should continue to monitor the Federal Communications Commission (FCC) proceedings on location accuracy requirements and the relevant test-bed systems to determine if industry solutions will provide the needed improvements for Metrorail underground location positioning.	Long-Term
14	Ibid.	The MWCOG 9-1-1 Directors should review with the wireless carriers all possibilities to provide wireless services within the Metrorail system that support the known features of Next Generation 9-1-1, including text-to-9-1-1.	Long-Term

Table 3: 9-1-1 Service Findings and Recommendations

*Policy and Procedures*

- Reliable, efficient communication between WMATA’s Rail Operations Control Center (ROCC), Metro Transit Police Department, and the multiple emergency 9-1-1 call centers is critical to an effective incident response.** The ROCC is the Metrorail central nervous system. It is where major decisions are made regarding train movement, shutdowns, and passenger management. All information from the communications system flows into the ROCC. In dealing with a major incident, the ROCC faces challenges when sharing timely information with public safety personnel in the field or with other agencies.

**Recommendation #15 (Near-Term):** *The MWCOG 9-1-1 Directors and WMATA should adopt a standardized approach across all jurisdictions for interagency information sharing*

for Metrorail emergencies. This study's recommendations should be coordinated through all of the response-related committees, such as police, emergency managers, and fire and EMS for formal adoption during events. The non-sensitive information could be shared and possibly be used by 9-1-1 facilities to identify in the CAD key address locations of critical infrastructure locations. This will provide first responders the exact location of any incident. The parties should meet periodically to review incidents and continually refine and improve underground incident response.

**Recommendation #16 (Long-Term):** WMATA and Metrorail jurisdictions should initiate a study on the merit and feasibility of a CAD-to-CAD interface to facilitate information flow on Metrorail-related incidents.

**Recommendation #17 (Near-Term):** Metrorail jurisdictions should staff a permanent public safety liaison during all operating hours at the ROCC and WMATA should work to integrate this liaison into its emergency operations.<sup>22</sup>

- **In some cases, local first responders are not aware of existing backup communications options.** When primary underground communication systems fail, backup communications options must be used to quickly establish and maintain communications. Among Metrorail and regional responders, there is a systematic lack of understanding of what backup communication resources are available, how they are to be deployed, and under what circumstances they should be activated. Limited access to underground Metrorail stations and tunnels for real-life training is a contributing factor to this lack of understanding.

**Recommendation #18 (Near-Term):** Metrorail jurisdictions should anticipate radio communication problems for all Metrorail underground events and should always be prepared to deploy backup communications solutions, such as a tactical BDA<sup>23</sup>. The Metrorail jurisdictions should ensure a sufficient quantity of tactical BDAs are deployed. The MWCOG Police-Fire Communications Committee should determine the specific number of tactical BDAs that are needed. They should develop plans regarding the use of these backup communication systems to include communications team staffing levels, pre-plans for various scenarios, and training plans for deploying backup solutions. WMATA should provide more access to its system to allow jurisdictions to test and train as needed to refine these plans. This recommendation should be led by the MWCOG Police-Fire Communications Committee.

- **Several partner agencies have limited-to-no remote access to Metrorail video camera feeds.** Local first responders indicated that they require remote access to Metrorail's video camera images, both in their command centers as well as for responding units in the field. During an incident, live video images provide a critical situational awareness tool for the first responders prior to entering the underground. Furthermore, the first responders command center could monitor video images during an active incident and provide assistance to the on-scene first responders if radio communications were to fail. Almost all surveyed first responders unanimously favored an expansion of CCTV coverage into the tunnels and requested real-time access to WMATA video feeds.

**Recommendation #19 (Near-Term):** WMATA and Metrorail jurisdictions should collaborate to increase the number of video feeds monitoring the underground tunnels and provide first responders (and associated command centers) with real-time access to these

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<sup>22</sup> This measure has been approved and staffed on a temporary basis. The fire liaison is now posted in the ROCC as of late July.

<sup>23</sup> A tactical bi-directional amplifier (BDA) is a portal BDA that can be setup to establish and extend radio communications.

video feeds. In addition, closed-circuit television (CCTV) coverage would ideally be expanded beyond stations to include inside tunnel locations such as shaft entry points.

- **At-Large Recommendations.** The following recommendations are offered for the general benefit of the Metrorail underground communications system but are not necessarily derived from any one formal finding:

**Recommendation #20 (Near-Term):** WMATA and Metrorail jurisdictions should engage in a systematic preparedness planning process that includes a comprehensive training and exercise program for communications.

**Recommendation #21 (Near-Term):** MWCOG should continue sponsoring the Metro Communications Study Committee to provide oversight for the implementation of accepted recommendations of this study. This Committee could assist other MWCOG committees on interoperability issues.

Policy and Procedures Findings and Recommendations Summary			
No.	Finding	Recommendation	Timing
15	Reliable, efficient communication between WMATA’s Rail Operations Control Center (ROCC), Metro Transit Police Department, and the multiple emergency 9-1-1 call centers is critical to an effective incident response.	The MWCOG 9-1-1 Directors and WMATA should adopt a standardized approach across all jurisdictions for interagency information sharing for Metrorail emergencies.	Near-Term
16	Ibid.	WMATA and Metrorail jurisdictions should initiate a study on the merit and feasibility of a CAD-to-CAD interface to facilitate information flow on Metrorail-related incidents.	Long-Term
17	Ibid.	The NCR should staff a permanent public safety liaison during all operating hours at the ROCC and WMATA should work to integrate this liaison into its emergency operations.	Near-Term
18	In some cases, local first responders are not aware of existing backup communications options.	Metrorail jurisdictions should anticipate radio communication problems for all Metrorail underground events and should always be prepared to deploy backup communications solutions such as a tactical BDA.	Near-Term
19	Several partner agencies have limited-to-no remote access to Metrorail video camera feeds.	WMATA and Metrorail jurisdictions should collaborate to increase the number of video feeds monitoring the underground tunnels and provide first responders (and associated command centers) with real-time access to these video feeds.	Near-Term
20	At-Large Recommendation	WMATA and Metrorail jurisdictions should engage in a systematic preparedness planning process that includes a comprehensive training and exercise program.	Near-Term
21	At-Large Recommendation	MWCOG should continue sponsoring the Metro Communications Study Committee to provide oversight for the implementation of accepted recommendations of this study.	Near-Term

Table 4: Summary of Policy and Procedures Recommendations

## Terms and Acronyms

Acronym	Term
BAMS	Bell Atlantic Mobile Services
BART	Bay Area Rapid Transit
BDA	bi-directional amplifiers
CCTV	closed-circuit television
COML	communications unit leader
COMT	communications unit technician
CRCS	comprehensive radio communications system
DAS	distributed antenna system
EMS	emergency medical service
ETS	emergency telephone system
FCC	Federal Communications Commission
GPS	Global Positioning System
IDLH	immediately dangerous to life or health
ISSI	Inter RF Subsystem Interface
HSEMA	Homeland Security and Emergency Management Agency (DC)
LMRS	land mobile radio system
MPD	Metropolitan Police Department (DC)
MTA	Metropolitan Transportation Authority (NYC)
MTPD	Metro Transit Police Department
MWCOG	Metropolitan Washington Council of Governments
NIMS	National Incident Management System
NCR	National Capital Region
O&M	operations and maintenance
OUC	Office of Unified Communication (DC)
PA	public address
PSAP	public safety answering point
PSRS	public safety radio system
RF	radio frequency
RFP	request for proposals
RIZ	radio interoperability zone
R&O	Report and Order
ROCC	Rail Operations Control Center
SOP	standard operating procedure
WMATA	Washington Metropolitan Area Transit Authority

## **MWCOG Metro Communications Study Committee**

The MWCOG Metro Communications Study Committee comprised representatives from the following jurisdictions and organizations:

### **DC HSEMA**

Jeff Wobbleton, Technical Project Manager

Chris Geldart, Director

### **MWCOG**

Public Safety Communications Subcommittee

Chief Scott Boggs, Prince William County

Fire Chiefs Committee, on behalf of Chairman Bashoor

Wayne McBride, Prince George's County

9-1-1 Directors Committee

Steve Souder, Fairfax County (Chairman)

### COG Staff

Stuart Freudberg

Dave McMillion, Administrative Project Manager

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### **WMATA**

Chief Ron Pavlik, MTP

Marshall Epler

### **Consulting Team**

Obsidian Analysis, Inc.

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