



Digital Trunked Radio System Statewide Needs Assessment and Business Plan

Executive Summary

June 30, 2015

Executive Summary

The state of Colorado (State) recognizes that it is critical for state, local, tribal, and federal public safety personnel across Colorado to have radio communications systems that meet their needs for daily and emergency operations. The current landscape of public safety radio communications includes the statewide Digital Trunked Radio System (DTRS) as well as numerous other radio systems that serve regional or local areas.

In accordance with the provisions of SB 14-127, the Division of Homeland Security and Emergency Management (DHSEM), entered into a contract with Federal Engineering, Inc. (FE) to conduct a needs assessment of the Digital Trunked Radio System, as well as various other systems in the state. The purpose of the study was to determine current *and future* public safety communications needs in Colorado and how they may impact the DTRS network, interoperability, and other non-DTRS systems operating in Colorado. In addition, the contractor was asked to present a second report that is a business plan for sustainability of the DTRS and interoperable systems.

In addition to the voluminous background information and supporting documentation, both reports include number of recommendations for the State as well as other stakeholders including Public Safety Communications Subcommittee (PSCS) and the Consolidated Communications Network of Colorado (CCNC).

DTRS Overview

DTRS is the statewide, public safety, voice radio system that enables direct communications between public safety agencies across jurisdictional and regional boundaries. DTRS encompasses 215 radio tower sites distributed across the state. These sites connect to one of five distributed cores via approximately 300 backhaul links (microwave or other telecommunications circuits). The system uses frequencies in the 700 MHz and 800 MHz bands and employs Association of Public Safety Communications Officials (APCO) Project 25 (P25) standards, which define a common set of signaling interfaces and user features.

More than 1,000 local, regional, tribal, state and federal agencies use DTRS and the system supports over 75,000 subscriber radios. Approximately 18% of these users are from state government. The remaining 82% are local, regional, tribal and federal government agency users. The ownership of the DTRS is diverse. The state of Colorado Governor's Office of Information Technology (OIT) owns a significant portion of the equipment used in the network, as do numerous municipalities and regional partnerships.

DTRS Issues and Needs

The term "operability" describes the ability of a radio system to meet the operational needs of those who use it on a daily basis. Based on the results of the user surveys, DTRS currently meets most of the needs for operability of its users including those for capacity, features, and reliability.

State and local radio users raised concerns about the mobile radio coverage DTRS provides including significant gaps along Colorado highways.

FE's analysis found estimated current mobile radio highway coverage to be 79% across the entire state (with approximately 73% coverage in the western portion of the state and 84% in the eastern portion.¹) Users from across the state substantiated this critical need for additional coverage through a series of coverage workshops conducted by FE as part of the development of this report.

The following list describes other critical needs identified through the user survey and interview process:

- Replace soon-to-be unsupported radio repeater stations (which operate at sites and provide radio coverage to users) and dispatcher console equipment (which allows 9-1-1 centers to communicate with field users) over the next 3 to 5 years.
- Keep the system's overall platform up to date through the application of the new system software releases within the next 1 to 4 years.
- Replace the aging and unreliable microwave backhaul system that provides links between DTRS sites and zone controllers.

DTRS Recommendations and Cost Estimates

In order to address each of the critical needs identified by the users: coverage, equipment lifecycle, system platform upgrade, and microwave backhaul replacement, FE developed a set of recommendations for the State's consideration.

Enhancing DTRS coverage is the most critical user need based on feedback from the user surveys and coverage workshops. Coverage in the western portion of the state requires the most improvement. Due to the radio engineering challenges posed by the Rocky Mountains, enhancing the mobile radio coverage in the gaps identified by users (through surveys and coverage workshops) requires the addition of approximately 109 new radio sites with the majority of them being located in the western portion of the state. These additional sites raise the predicted statewide mobile radio coverage on state highways from the estimated 79% to approximately 90% (with predicted increases from 73% to 87% in the western portion of the state and from 84% to 93% in the eastern portion).

The estimated cost to add these 109 new radio sites is \$115,976,000. The cost estimate is conservative in that it includes the development of new radio sites, which require items such as access roads, communications equipment shelters, towers, and main and backup power. If the State identifies and uses existing sites, a reduction in the overall cost is possible.

¹ For the purposes of this analysis, the "western portion of the state" includes the following Counties; Alamosa, Archuleta, Delta, Dolores, Eagle, Garfield, Grand, Gunnison, Hinsdale, Jackson, La Plata, Mesa, Mineral, Moffat, Montezuma, Montrose, Ouray, Pitkin, Rio Blanco, Rio Grande, Routt, Saguache, San Juan, San Miguel, and Summit. The "eastern portion of the state" includes all other Counties.

Table ES-1 describes the recommendations and estimated costs to address the remaining critical improvements to DTRS: equipment lifecycle, system platform upgrade, and microwave backhaul.

Table ES1 – Critical Improvements - Recommendations and cost summary

Recommendation	Action Plan	Estimated Cost and Funding Status
<i>Topic: Equipment Lifecycle</i>		
Continue replacement of legacy DTRS equipment	Replace existing Gold Elite consoles and Quantar [®] repeaters before the end of lifecycle in 2018 and 2020, respectively.	Approximately \$12,504,000 to replace state-owned equipment. House Bill 14-1203 will address this funding. Approximately \$17,527,000 to replace locally owned and funded equipment.
<i>Topic: System Platform Upgrade</i>		
Keep the DTRS platform up to date in order to continue to receive vendor support	State and local stakeholders collaboratively develop a plan for statewide “system release” upgrade to be performed within the next 1 to 5 years	A plan and related costs have yet to be determined. However, funding will be available for state-owned assets starting in 2017 via House Bill 14-1203.
<i>Topic: Microwave Backhaul</i>		
Replace the aging and unreliable microwave backhaul system	Implement a new microwave system using MPLS technology in a fault-tolerant topology (a design of five interconnected rings)	According to OIT, the total project cost estimate is between \$44.5M and \$55.9M. Budget requests have been made by OIT

Section 6 of the Needs Assessment Report contains the following table with recommendations for addressing the high and medium priority needs, page 128.

Table 18 – Summary of DTRS requirements

DTRS Requirements	
DTRS Attribute	Identified Need
Critical Priority	
Coverage	DTRS' coverage requirement should be developed and the system should be expanded with additional sites to address the user-identified coverage gaps, mainly in the western part of the state.
Backhaul	Improvements to the backhaul network of DTRS are essential. These include the replacement of the current topology, technology, and equipment with highly reliable modern technology that incorporates ring architecture (not spurs), and has the bandwidth necessary to meet anticipated growth.
Equipment and System Lifecycle	DTRS should be kept up-to-date with Motorola's equipment and system-release lifecycle plan. This involves replacing existing Gold Elite consoles by 2018, Quantar® repeaters as possible (before end –of-support in 2020), and completing a further platform upgrade within the next 1 to 4 years.
High Priority	
Interoperability	DTRS should continue to provide the same high-level of interoperability available to users for daily communications. The methods to provide interoperability between DTRS and other systems (mainly ISSI) should be further developed to meet specified operational needs through supportive governance and, as needed, funding.
Ownership	As DTRS is changed and expanded, the detailed listing of the ownership of infrastructure assets should be updated on an annual basis.
Features	Users of DTRS, including field users and dispatchers, should be made more aware of the features of DTRS. This can be accomplished through a combination of training, exercise, and usage. Additionally, the specific features of GPS, authentication, and encryption should be explored to determine if DTRS should be enhanced in order to provide them at a local or statewide level.
Reliability	DTRS should be equipped with a software package that records, and is capable of producing reports on, system reliability. Additionally, the specific concerns about backhaul reliability should be addressed.
Medium Priority	
Capacity	DTRS should continue to be monitored for its traffic loading including the continuation of the current process for predicting effects of the anticipated traffic from new user agencies. Channels should be added at sites or the system should be migrated to P25 Phase 2, which effectively doubles the capacity and should be employed when such predictions show the need for increased capacity.
Maintenance	Existing standards for infrastructure and subscriber maintenance should be reviewed to ensure that they completely and accurately describe the requirements for the type and frequency of maintenance to be performed for the various components. If none

DTRS Requirements	
	is found to exist, new maintenance standards should be developed. Radio sites should continue to be maintained and funding for the replacement of towers as requested by OIT should be provided.
Training and Exercises	DTRS training should continue at its current levels and a statewide governance organization (such as PSCS or CCNC) should consider revising the online training material to reflect recent system developments. Exercises should be expanded to include communications (both field users and dispatchers) and exercises should be held more frequently.

The most critical need among those identified above is coverage. Responses from surveys and input from interviews resoundingly stressed the need for improved coverage. As described, the initial phases of the build-out of DTRS (Phases 1 - 4) were in the eastern part of the state and fully funded. The later phases (Phases 5 - 7) in the western parts of the state were not funded to the same level as the earlier phases; therefore, coverage in those areas does not meet user requirements.

FE conducted a thorough analysis of the existing DTRS coverage gaps from our coverage workshops, which included feedback from the user community. The majority of the analysis focused on enhancing coverage on major roadways on which public safety radio users often travel. FE conducted a high-level coverage analysis to identify the approximate location of additional sites required to address the coverage gaps.

Based on this analysis, FE estimates that enhancing the mobile radio coverage in the gaps identified by users (through surveys and coverage workshops) requires the addition of approximately 109 new radio sites with the majority of them being located in the western portion of the state. These additional sites raise the predicted statewide mobile radio coverage on state highways from the estimated 79% to approximately 90% (with predicted increases from 73% to 87% in the western portion of the state and from 84% to 93% in the eastern portion). A total of 89 (or approximately 81%) of the 109 additional sites required to enhance coverage would be located in the western half of the state.

Current Status of Public Safety Communications Governance in Colorado

Governance of public safety communications involves the collaborative planning and management by the various systems administrators of an overall interoperability strategy. Within the state of Colorado, there are several groups currently involved in that effort.

A key group is the newly formed Public Safety Communications Subcommittee (PSCS), established by Senate Bill 14-127 as an advisory subcommittee to the Homeland Security and All-Hazards Senior Advisory Committee (HSAC). The HSAC is part of the Colorado Department of Public Safety's (DPS) Division of Homeland Security and Emergency Management (DHSEM). The PSCS has representative membership from across the State as well as many duties, but its primary purpose is promotion of interoperable communications among

public safety organizations throughout the state. In Colorado, the PSCS holds the duties and responsibilities of a Statewide Interoperable Executive Council (SIEC).

Supporting PSCS is the Office of the Statewide Interoperability Coordinator (SWIC), which manages the policies and programs of statewide communications interoperability as set by the PSCS and as documented in a Statewide Communications Interoperability Plan (SCIP).

The HSAC also supports nine Regions across the State for the purpose of regional emergency management planning. Each of these nine Regions has a public safety communications subcommittee tasked with coordinating local communications issues. The level of commitment to, and activity by, these HSAC regional communications subcommittees varies across the state.

The mission of the Consolidated Communications Network of Colorado (CCNC), a private 501(c)(3) corporation, is the management of the DTRS for public safety radio operability and interoperability among first responders across Colorado to better serve the State’s citizens. When formed in 2002, the CCNC was the only statewide public safety communications governance organization. The State now recognizes that while CCNC members are dedicated and its efforts have had positive effects, its purposes, duties, and membership significantly overlap those of PSCS.

Effective governance of public safety communications requires the attainment of several criteria including balanced membership, formal authorization, focus on public safety communications, regional input, effective leadership, funding, and other criteria. These criteria are described further in the *Business Plan*, but as demonstrated below in Table 1, there is no public safety communications governance organization in Colorado that currently meets all criteria and there is a significant level of overlap between the existing organizations.

Table 1 – Criteria of effective governance and existing public safety communications governance organizations in Colorado

Governance Criteria	HSAC Regions	PSCS	CCNC
Balanced Membership		✓	✓
Formal Authorization	✓	✓	
Charter		✓	
Public Safety Communications Focus		✓	✓
Shared Decision Making and Goals		✓	✓
Effective Leadership	✓	✓	✓
Regional Communications Boards	✓		✓
Transparency	✓	✓	✓
Outreach and Information Sharing		✓	
Funding			

The PSCS is the group that is closest to having all identified criteria but lacks:

- Its own regional boards (although it does leverage the HSAC Regional Committees' Communications Subcommittees for the purpose).
- The availability of and control over funding at a level that is sufficient to promote and enhance statewide interoperability.

The *Business Plan* also provides examples of how effective governance is implemented in other states.

Recommendations for Colorado's Public Safety Communications Governance

In order to provide Colorado with an effective public safety communications governance structure that collaboratively defines and plans statewide interoperability requirements and solutions, FE provided several recommendations detailed in Section 9 of the report, summarized here:

- The PSCS and the full Colorado public safety communications governance structure should be independently established legislatively in Colorado code and they should not be a subcommittee of the HSAC. Furthermore, the existing "sunset" date of the PSCS should be eliminated and the role of PSCS should be expanded to incorporate new technologies (specifically public safety broadband wireless networks and Next Generation 9-1-1 services).
- The PSCS should have ownership of both the development of the SCIP and the overall plan for the technology roadmap for expansion or upgrades of the DTRS.
- The Office of the SWIC should continue in its role as the main interface between the PSCS and state, local, tribal and federal agencies.
- The PSCS should develop formal agreements that define the roles and responsibilities for the various state and local owners with regard to existing and new interconnections of equipment within DTRS.

Current Status of Funding of Public Safety Communications in Colorado

Just as there are numerous owners of DTRS infrastructure and numerous systems other than DTRS, there are numerous sources of funding for public safety communications systems and interoperability in Colorado.

The state of Colorado, through the Governor's Office of Information Technology's (OIT) Public Safety Communications Network (PSCN) team, performs a significant amount of day-to-day management of DTRS. Likewise, they provide a significant amount of funding to deploy, maintain, upgrade and replace the DTRS infrastructure assets owned by the state of Colorado.

Funding of the PSCN team is predominantly through user fees charged to State agencies (and only State agencies) for their use of DTRS as well as other State-owned radio systems.

PSCN has also received funding for specific projects from the State's general fund, including capital improvement and controlled maintenance projects, as well as through legislative initiatives such as House Bill 14-1203. The latter will provide significant monies toward the replacement of outdated infrastructure equipment and the upgrade of DTRS' entire software platform.

PSCN requested \$55 million in general fund allocations over 5 years for replacement of the DTRS microwave network (which interconnects radio sites to each other) and, as described in the *Needs Assessment*, FE recommends a request for another approximately \$115 million to improve coverage to the level identified as a requirement by users.

Local agencies fund the operation, maintenance, and replacement of the DTRS infrastructure assets they own via a number of sources including bonds, local general funds, 9-1-1 fees, usage fees, and grants. Owners and operators of other public safety communications systems ("non-DTRS systems") use these same varied sources.

Recommendations for Colorado's Public Safety Communications Funding

Establishing the balance between expending funds to solve problems and tolerating some existence of those problems is a challenge of government that certainly extends to public safety communications. The *Needs Assessment* describes many of these technical risks and the costs associated with addressing them. This *Business Plan* reaffirms those areas of risks and identifies several others, including:

Coverage Risk – Additional funding (beyond the levels those already requested by OIT/PSCN for identified projects) of approximately \$115 million is needed to meet the needs of users as identified through surveys and coverage workshops. Additionally, FE recommends that the PSCS should first work with its statewide users of DTRS to formally define the system's coverage requirement.

Sustainability Risks – Some user agencies have left DTRS due to their uncertainty about the system's overall financial and governance stability and FE recommends that the state of Colorado reaffirms its commitment to DTRS by addressing the governance and funding recommendations included in the report. FE also recommends that PSCS minimize uncertainty in DTRS ownership by annually updating the DTRS infrastructure ownership list as discussed in the *Needs Assessment* and establish formal agreements to define the roles and responsibilities associated with ownership. Finally, some user agencies are considering leaving DTRS because of the high cost to replace DTRS-compatible subscriber radios and FE recommends the State establish a grant program to assist users (only those who can demonstrate an appropriate level of need) with the replacement of their DTRS-compatible subscriber radios.

Interoperability Risk – As new systems other than DTRS are deployed and as the need for cross-jurisdictional and cross-discipline communications becomes more urgent, there is the risk that the necessary interconnections between DTRS and those other systems will not meet user needs. FE recommends PSCS confirm those user needs and that the state of Colorado establish a fund

available to agencies to support interoperability initiatives that are consistent with the goals of the SCIP.

Governance Risk – Without funding for the governance structure, staff, and initiatives described in this report, the PSCS and the entire future of public safety communications governance may be unable to deliver on its mission. FE recommends that DPS continues to provide administrative support for PSCS and that the legislature provides the PSCS with an annual line item appropriation.

FE identifies numerous alternatives for funding to complete these recommendations. These include methods to pay for capital and operational expenses such as grants, certificates of participation, bonds, 9-1-1 fees, other surcharges (tickets, tourism, vehicles, etc.), public-private partnerships, usage fees, and the leasing of unused tower space.

A comprehensive funding strategy is not something a third-party reviewer such as FE can recommend with any level of confidence. Agencies from across the State must determine their needs for the levels of improvement to DTRS and overall statewide interoperability. Once that is determined, FE recommends the PSCS and SWIC work with the Office of State Planning and Budget to determine how much funding each strategy can raise.

Interoperability Overview

The term “interoperability” refers to the ability to provide communications between disparate systems when needed and when authorized. This allows users of those systems to communicate with each other during emergencies or planned major events. There are various ways to achieve interoperability, such as simply sharing radios or by using technology and/or operational procedures to interconnect different systems.

Within Colorado, there are many methods used to provide interoperability. These include the provision of shared Mutual Aid talk-groups (the equivalent of a dedicated radio channel in a trunked radio system) within DTRS as well as various interconnections between systems.

Interoperability has been implemented at the local level to support local interoperability needs. Users expressed that these methods met a majority of their interoperability needs but room for improvement exists.

Interoperability Issues and Recommendations

In order to enhance interoperability, it is essential to improve operability. Therefore, it is critical to address system issues such as coverage and equipment replacement.

FE recommends that the State address its interoperability issues at the local agency level and work with planning groups such as the State Homeland Security and All-Hazards Senior

Advisory Committee (HSAC) Communications Committees to establish effective governance structures and provide the funding support they require².

The needs for interoperability at the regional and statewide levels continue to grow due to the higher degree of cross-discipline and cross-jurisdiction cooperation for public safety services. Implementations of new radio systems in Colorado that are not part of DTRS have created new requirements for improved interoperability. In addition, collaborative public safety interactions across state borders have increased the need for interstate interoperability.

The technical method most likely to address these regional, statewide, and interstate needs for interoperability is a new capability called the Inter-RF-Subsystem Interface (ISSI). The deployment of ISSI is just beginning in Colorado and neighboring states. This deployment should continue but it should do so:

- Only to meet specifically-identified operational needs.
- Without negative consequences to the capacity or other aspects of individual systems that will be interconnected.
- In a design/topology that meets needs while minimizing deployment and on-going costs.
- Within the collaborative planning and governance purview of the Public Safety Communications Subcommittee.

Conclusion

The findings of FE's State-wide Needs Assessment and Business Plan reports demonstrate that public safety communications in Colorado has four critical needs. They are:

- Coverage improvement
- Governance
- Sustainability
- Interoperable communications

By addressing these four critical needs, the State mitigates a significant amount of risk to the continued success of the Digital Trunked Radio System and public safety communications in general, thus helping Colorado remain a great and safe place to live, work, and play.

² Issues related to funding and governance are addressed in the *Business Plan* report, which is described later as a companion to this Needs Assessment report.