June 2025 | Prepared by: Athey Creek Consultants

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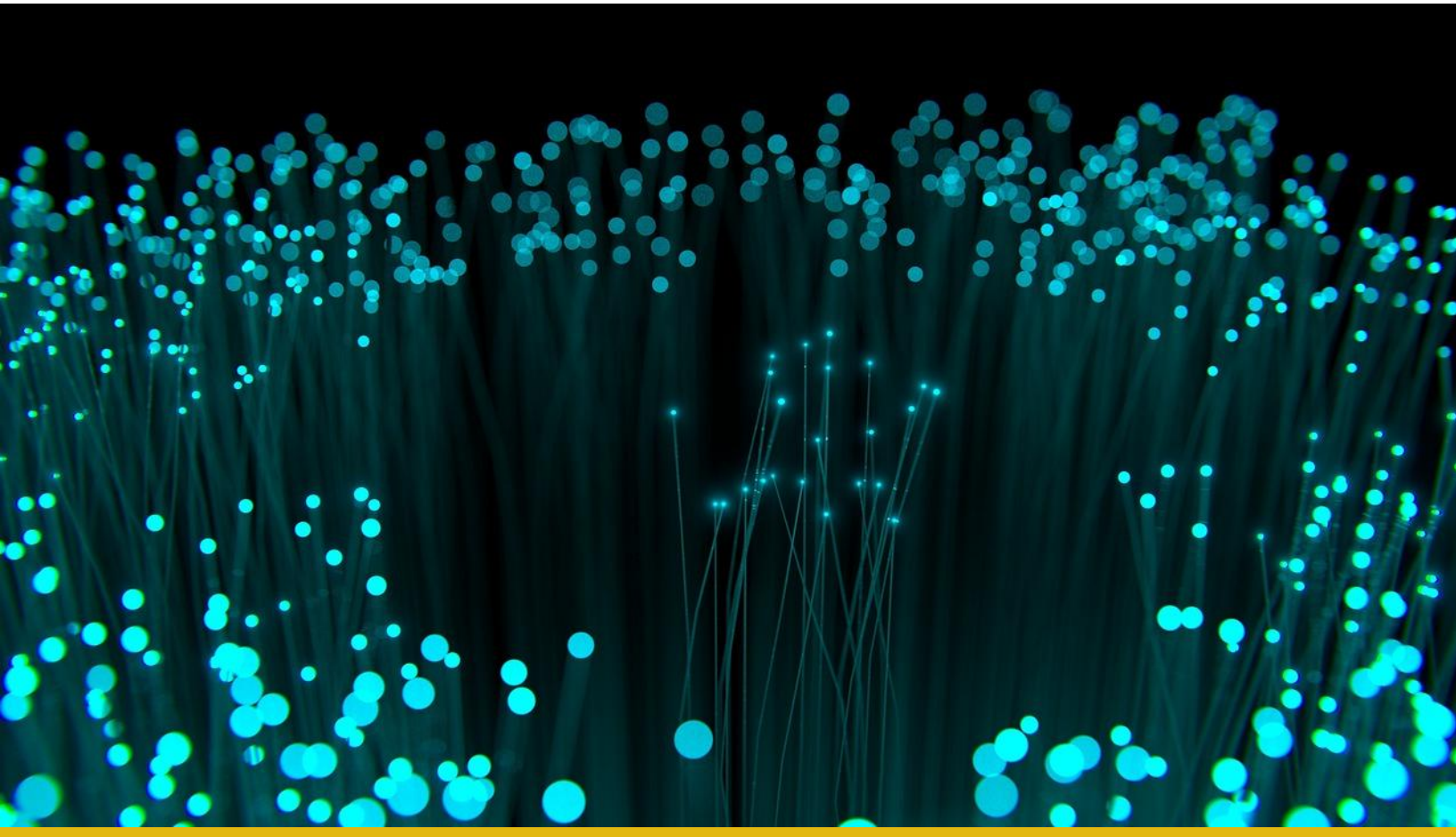

Administration of Communications

ENTERPRISE TRANSPORTATION POOLED FUND STUDY TPF-5(490)

FINAL REPORT – June 2025

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16. Abstract

State departments of transportation (DOTs) have various models for deploying and administering communications infrastructure to support intelligent transportation systems (ITS) networks and other operations functions -- some utilizing public-private partnerships, leasing, asset sharing, resource trading, or other approaches. This ENTERPRISE Pooled Fund Study (PFS) project documented state DOT models for administration of communications and gathered examples of efficiencies that state DOTs are achieving due to these models and practices. The state DOTs interviewed for this research noted efficiencies and cost savings with the use of resource trades (with other public agencies and private sector broadband providers), leasing fiber, asset sharing, and leveraging federal broadband grant funding to expand communications for ITS networks.

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The cover page image is provided courtesy of Joshua Kimsey at Pixabay.

Project Champion

Kevin Price from the Illinois Department of Transportation was the ENTERPRISE Project Champion for this effort. The Project Champion served as the overall lead for the project.

ENTERPRISE Members

The ENTERPRISE Board consists of a representative from each of the following member entities.

- Illinois Department of Transportation
- Iowa Department of Transportation
- Kansas Department of Transportation
- Michigan Department of Transportation
- Minnesota Department of Transportation
- Ontario Ministry of Transportation
- Texas Department of Transportation
- Wisconsin Department of Transportation

Project Input

ENTERPRISE would like to thank the following state transportation agencies that provided input to the project through interviews.

- Arizona Department of Transportation
- California Department of Transportation
- Illinois Department of Transportation
- Indiana Department of Transportation
- Kansas Department of Transportation
- New Hampshire Department of Transportation
- Utah Department of Transportation

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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACA	Arizona Commerce Authority
ARPA	American Rescue Plan Act
ATCMD	Advanced Transportation and Congestion Management Technologies Deployment
Caltrans	California DOT
CMAQ	Congestion Mitigation and Air Quality Improvement Program
Comms	Communication
DCEO	Department of Commerce and Economic Opportunity
DoIT	Department of Information Technology
DOT	Department of Transportation
DTS	Department of Technical Services
ENTERPRISE	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency
FHWA	Federal Highway Administration
IIJA	Infrastructure Investment and Jobs Act
ISP	Internet Service Providers
IT	Information Technology
ITS	Intelligent Transportation Systems
JULIE	Joint Utility Locating Information for Excavators
LAN	Local Area Network
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
OMC	Operate, Maintain, and Commercialize
PFS	Pooled Fund Study
ROW	Right-of-Way
SLFRF	State and Local Fiscal Recovery Funds
STIP	State Transportation Improvement Plan
TID	Trade Identification Number
TMC	Transportation Management Center
TSMO	Transportation System Management and Operations
UDOT	Utah DOT
UIC	University of Illinois-Chicago

Executive Summary

State departments of transportation (DOTs) have various models for administering communications infrastructure to support intelligent transportation systems (ITS) networks and other operations functions – some utilizing public-private partnerships, leasing, asset sharing, resource trading, or other approaches. The research completed a literature search and conducted interviews with seven (7) state DOTs (Arizona, California, Illinois, Indiana, Kansas, New Hampshire, and Utah) to gather information about key practices associated with administering communications infrastructure.

Key findings from the research include:

- **Communications Mediums:** Fiber is prevalent in urban areas with higher densities of ITS field devices, while cellular continues to be utilized to support ITS devices in rural areas. Several agencies reported they are phasing out or have decommissioned microwave communications.
- **Construction, Maintenance, and Ownership:** Most agencies build, own, operate, and maintain communications infrastructure, along with purchasing cellular services. Kansas DOT has a statewide maintenance contractor for ITS and the California DOT (Caltrans) uses overflow contracts to augment agency staff.
- **Funding:** State funds, federal program funds, and federal grants are utilized by state DOTs for communications infrastructure. Funding partnerships (e.g., funding from other state agencies or local entities) can be an efficient use of funds and staff resources.
- **Information Technology (IT) Support Models:** Many different models for IT support for ITS network communications were reported. Advantages and disadvantages exist with each model. Agencies with statewide IT support reported advantages with price discounts as part of a larger IT group and benefits from standardized equipment, though with this model the statewide vision for IT may not align with the ITS network needs. ITS groups with dedicated IT staff noted efficiencies due to familiarity with the network.
- **Broadband Grants:** Arizona DOT and Kansas DOT reported that federal grant funding for "middle mile" broadband development (i.e., connecting local communities to robust, high-capacity national and regional networks) is being leveraged to expand service to the DOT's ITS network. In both states, plans to allow use of the built infrastructure (e.g., conduit/ducts) by private sector entities are underway. Both agencies reported efficiencies to the agency due to these practices.
- **Fiber Leasing:** Illinois DOT actively advertises some fiber and conduit for lease. Arizona DOT has recently developed a model for leasing fiber. In Arizona, revenues from leased fiber must be used to operate, maintain, and expand the built network, or for building future broadband projects, presenting efficiencies for growing the network and further expanding ITS services.
- **Resource Trading:** The practice of resource trading (e.g., waiving the right-of-way (ROW) fee in exchange for use of fiber assets, swapping fiber strands) was reported by some agencies, resulting in cost savings to the agency. Utah DOT's resource trading program with broadband providers has

saved over $100 million in trade value alone, plus additional savings by avoiding leased services (e.g., camera data transfer fees) that would otherwise be incurred without fiber.

- **Implementation of Federal Highway Administration (FHWA) Final Rule on Broadband Infrastructure Deployment:** Most agencies indicated they have implemented the Final Rule, but none reported new opportunities to partner with private sector broadband providers attributed to the rule. Reasons include long-standing similar efforts already in place, DOT project locations that may not match up with providers' needs, and the need for more time to see benefits.

In total, more than 20 examples of efficiencies and cost savings due to various communications administration practices were reported by agencies interviewed for this project.

Chapter 1: Introduction

State departments of transportation (DOTs) have various models for deploying and administering communications infrastructure to support intelligent transportation systems (ITS) networks and other operations functions -- some utilizing public-private partnerships, leasing, asset sharing, resource trading, or other approaches. In addition, agencies have experienced cost savings or other efficiencies through practices, arrangements, and activities for administering communications infrastructure networks.

The objectives of this ENTERPRISE Pooled Fund Study (PFS) research project were to document state DOT models for administration of communications and investigate how state DOTs may reduce costs and increase efficiencies when installing and managing communications infrastructure.

Project Objectives

- Document state DOT models for administration of communications infrastructure.
- Investigate how DOTs may reduce costs and increase efficiencies.

The research documented various models for DOT administration of communications (e.g., communications infrastructure mediums, funding, innovative partnerships, information technology (IT) support, efficiencies, and challenges) and exploring how agencies are implementing the provisions of the Federal Highway Administration (FHWA) Final Rule on Broadband Infrastructure Deployment.

1.1 Project Approach

The project began with an online search to gather examples of agency communications administration models, with a focus on identifying state DOTs that have achieved efficiencies or cost savings. An online scan was also conducted to identify examples of how agencies have implemented the FHWA Final Rule on Broadband Infrastructure Deployment, such as information posted to agency websites or modifications to agency policies.

Next, interviews were conducted with selected state DOTs, to gather information about their communications infrastructure administration models, related arrangements, efficiencies, and challenges. Summaries were documented to highlight each agency's practices. After gathering agency examples and conducting agency interviews, a summary of agency practices was completed.

Finally, key findings were summarized, and an implementation plan was prepared to outline steps agencies can consider for implementation.

See Figure 1.1 for an overview of the project approach.

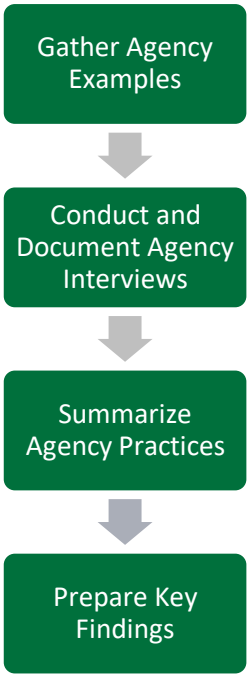

Figure 1.1 Project Approach

1.2 Report Organization

This report summarizes the research findings and is organized as follows:

- Chapter 2: Gather Agency Examples – Summarizes results from an online search that identified various state DOT models for communications administration and examples of how agencies have implemented the FHWA Final Rule on Broadband Infrastructure Deployment.
- Chapter 3: Agency Interviews – Describes the state DOTs interviewed, the approach to gathering information through agency interviews.
- Chapter 4: Communications Administration Models and Practices – Provides an overview of state DOT models for administering communications infrastructure and key practices as gathered during agency interviews.
- Chapter 5: Agency Reported Efficiencies and Cost Savings – Details efficiencies and costs savings experienced by agencies through their communications infrastructure models and practices.
- Chapter 6: Agency Reported Challenges and Barriers – Provides an overview of challenges and barriers that agencies encounter with administering communications networks.
- Chapter 7: Findings and Implementation Plan – Summarizes key findings from the research and outlines an implementation plan for ENTERPRISE agencies to consider based on project findings.

Chapter 2: Gather Agency Examples

An online search was conducted to gather examples of communications administration models and practices, identifying state DOTs that have achieved efficiencies or cost savings with administering communications assets for ITS and operations. For example, successful models for IT support and strategies for building and maintaining communications infrastructure such as federal grants, public-private partnerships, leasing, asset sharing, and resource trading with public or private sector entities. This also included an online scan to identify examples of how state DOTs have implemented the FHWA Final Rule on Broadband Infrastructure Deployment, which allows for the installation of broadband facilities during state DOT road construction projects.

Findings from the online search, along with input from ENTERPRISE Board members, were used to select state DOTs to participate in interviews to gather additional information for this project.

2.1 Identifying Models for Communications Administration

The online search identified several examples of agency practices for administering communications infrastructure. While some of the resources were specific to communications infrastructure, one reference document related to IT support focused on coordinating IT with overall transportation systems management and operations (TSMO) activities.

Review of these resources indicates that many state DOTs have a strong history of participating in innovative arrangements for building and managing communications infrastructure, utilizing strategies such as fiber sharing (e.g., with public and private sector entities) and resource trading (e.g., use of right-of-way in exchange for related assets). Emerging strategies include increased use of public-private partnerships and leveraging 'middle-mile' broadband buildout efforts that increase connectivity to underserved and unserved communities, such as federal grant funding, to also support ITS networks.

Table 2.1 provides an overview of resources reviewed for this project that discuss agency models and various practices for administration of communications and the agencies featured in each resource.

Table 2.1 Resources Discussing Agency Models for Administration of Communications

Resource	Overview
AASHTO Response to Notice, Request for Comment, Infrastructure Investment and U.S. Dept of Commerce (Tymon, 2022)	Communicates state DOTs' recommendations for flexibility for the deployment of broadband projects in state-owned right-of-way and promotes public-private partnerships between state agencies and broadband providers to expand future deployments.

Resource	Overview
State DOTs Expand Support for Broadband Projects (AASHTO, 2022)	Describes a partnership between the Arizona Commerce Authority (ACA) and the Arizona DOT that supports broadband expansion efforts on Interstate 17 and Interstate 19.
Arizona Broadband Middle-Mile Strategic Plan (Arizona Commerce Authority, 2022)	Identifies key middle-mile broadband infrastructure to address the connectivity needs of unserved and underserved communities in Arizona. As one of many benefits, the plan indicates "The robust 'middle-mile' network will address Arizona DOT and other public agencies' connectivity needs, while preparing for future technology platforms (connected and automated vehicles, modern ITS, artificial intelligence, virtual reality, etc.)." Outlines key partnerships and roles, including Arizona DOT's role in leading the procurement process for all interstate corridors development.
Case Study: UDOT Takes Active Role in Facilitating Broadband Development (FHWA, 2022)	Describes Utah DOT's practices for streamlining fiber installation, leading to faster installations and cost efficiencies. Utah DOT has a dedicated fiber optics office that coordinates fiber optics requests and activities. Utah DOT communicates regularly with regional telecommunications providers to coordinate opportunities for including fiber in road construction projects. Utah DOT enters into resource sharing and trading arrangements with telecommunications providers, allowing the agency to increase connectivity to ITS devices.
Practices for Improving the Coordination of Information Technology and Transportation Systems Management and Operations Resources: A Reference Document (Jacobson et al., 2022)	Discusses various models for IT supporting TSMO activities at state DOTs. Produced a series of fact sheets on the following topics: 1. Project Executive Summary 2. Common Understanding 3. Agency Successes 4. Staffing Practices 5. Cybersecurity Practices Project materials are posted at the FHWA's Coordination of Information Technology and TSMO website. Featured DOTs include Louisiana, Michigan, Florida, Pennsylvania, Connecticut, Maryland, California, Tennessee, and New Hampshire. Other agencies included the Pennsylvania Turnpike Commission and Maricopa County, Arizona.
Emerging Practices for Communications Infrastructure (Preisen & Roelofs, 2020)	Documents emerging practices for ITS communications infrastructure, including state transportation agency practices related to fiber sharing, resource trading, and public-private partnerships. Relevant practices: • Wisconsin DOT: Obtains fiber assets from broadband providers in exchange for access to install fiber in DOT right-of-way. • Minnesota DOT: Shares fiber with Minnesota IT Services which provides connectivity to state, county, and city entities.

Resource	Overview
	• Utah DOT: Enters into resource trading arrangements with private sector telecommunications providers. • Georgia DOT: Aiming to establish a public-private partnership model for broadband development with a combination of agency-owned and privately-owned fiber along interstates. • Arizona DOT: Exploring public-private partnerships and sharing partnerships for broadband connectivity in rural communities.
Policies, Laws, and Agreements for the Use of Fiber Communications (Athey Creek Consultants, 2016)	Provides a summary of resources (e.g., policies, laws, agreements) on the use of fiber communications by transportation agencies and highlights practices for sharing fiber infrastructure. Documented fiber sharing practices for Iowa DOT, Utah DOT, Virginia DOT, and Wisconsin DOT. Gathered and posted example fiber sharing agreements at the ENTERPRISE Policies, Laws, and Agreements for the Use of Fiber Communications project web page.
Shared Communications: Volume I. A Summary and Literature Review (Franzese, 2004) and Shared Communications: Volume II. In-Depth Systems Research (Truett & Chang, 2004)	Documents benefits and challenges with implementing shared communications infrastructure and resources, with a focus on rural ITS involving transit. Selected state DOT examples: Virgina DOT use of right-of way in exchange for in-kind telecommunications hardware and services and sharing fiber with the Army Corps of Engineers. The Capital Wireless Integrated Network – public safety and transportation agencies in Virginia, Maryland, and the District of Columbia planned to build a public safety data communications network for the Washington, D.C., area.

2.2 Examples of Implementing the FHWA Final Rule on Broadband Infrastructure Deployment

An online scan focused on identifying selected examples of how state DOTs have implemented the FHWA Final Rule on Broadband Infrastructure Deployment. This final rule, often referred to as "Dig Once," allows for the installation of broadband during road construction projects, alongside other utilities, to avoid the need for further excavation in the future (FHWA, 2021b). The rule requires state DOTs to:

1. Identify a broadband utility coordinator responsible for facilitating infrastructure right-of-way (ROW) efforts within the state.
2. Establish a registration process for broadband entities that seek to be included.
3. Establish a process for electronically notifying broadband infrastructure entities of the agency's statewide transportation improvement plan (STIP).
4. Coordinate state and local plans to minimize repeated excavations that involved broadband infrastructure in the ROW (FHWA, 2021a).

The online scan identified examples of how state DOTs have implemented the rule through public-facing documentation and resources. While this was not an exhaustive search of all state DOT websites, an effort was made to gather diverse examples. The examples include a wide range of implementation approaches, each meeting the minimum requirements of the rule, with some agencies also modifying existing policies (e.g., utility policies) or connecting to relevant broadband development efforts.

See Table 2.2 for selected examples of state DOT implementation of the FHWA Final Rule on Broadband Infrastructure Deployment and related broadband deployment resources.

Table 2.2 Examples of State DOT Broadband Deployment Resources

Agency	Broadband Deployment Resources
Mississippi DOT	• Mississippi DOT Broadband Infrastructure Coordination web page. • Registration page, "Frequently Asked Questions," and link to STIP documents.
Wisconsin DOT	• Wisconsin DOT Broadband Deployment on State Highways web page. • Broadband utility coordinator, registration portal to sign up to receive annual notification of the Wisconsin DOT highway improvement program. • Broadband Deployment Program Policy: 2-page policy that provides definitions, details, and links to other applicable DOT policies. • Link to the Public Service Commission of Wisconsin Broadband Grant Programs.
Indiana DOT	• Indiana DOT Broadband Corridors web page. • Indiana DOT broadband contacts, registration link, and link to STIP documents. • ROW access rates for fiber, macro cell, and small cell installations. • Indiana DOT "Dig Once" Rule – Outlines requirements and criteria for broadband installations such as when conduit installation is allowed, types of installations, permit application content, access agreement conditions, bond requirements, installation of conduit and fiber optic cable, trenching, directional drilling, conduit splicing, installation of components (e.g., handholes, vaults, tracer wire, cable duct markers), locator posts, as-built documentation, and relocations. • Indiana DOT Broadband Corridors Map – provides a map display of designated broadband corridors and candidate broadband coordinators.
California DOT (Caltrans)	• Caltrans Wired Broadband Facilities on State Highway Right of Way web page. • Provides regional contacts, a user guide, frequently asked questions, a facility co-location information video, and information about encroachment permits that are required for broadband installations. • Caltrans Broadband Partnership Opportunity Map – displays proposed transportation projects on the state highway system to help determine where there may be opportunities to install broadband conduit.

Chapter 3: Agency Interviews

After gathering agency examples and in consultation with ENTERPRISE Board members, seven agencies were selected to participate in interviews to provide information about their practices:

- Arizona DOT
- Caltrans
- Illinois DOT
- Indiana DOT
- Kansas DOT
- New Hampshire DOT
- Utah DOT

The State DOTs interviewed were chosen based on practices that appeared to be resulting in cost savings or other efficiencies to the agency. The agencies represent diverse geographic locations and conditions, various sizes, and a combination of urban and rural contexts. See Figure 3.1.

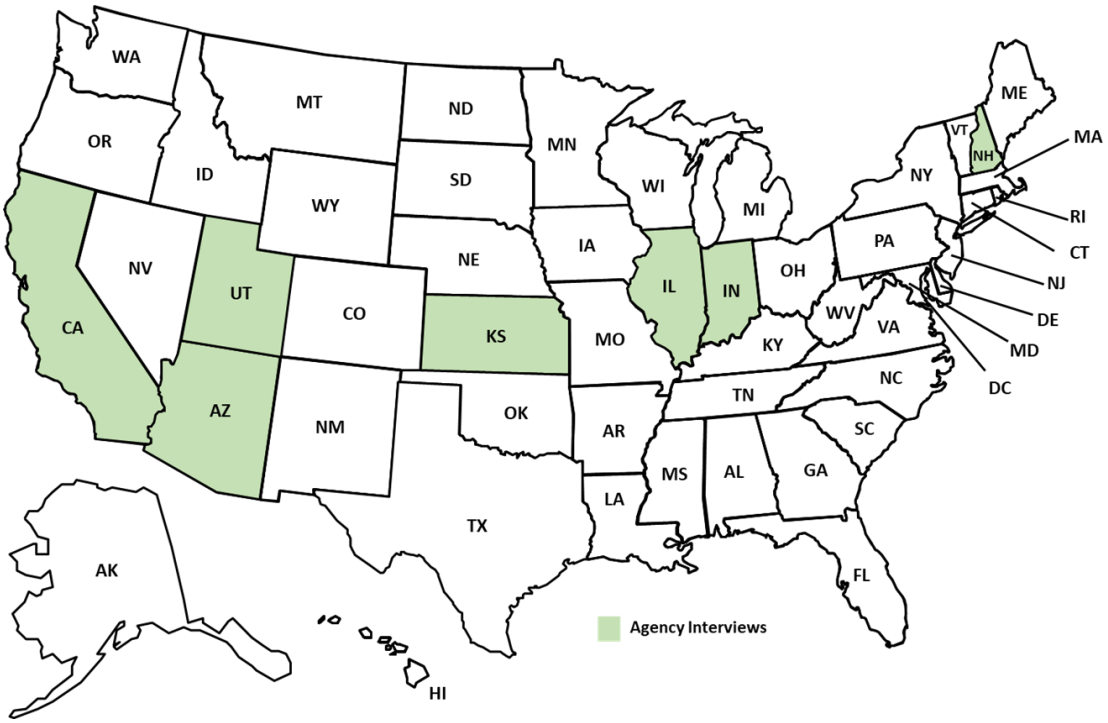

Figure 3.1 Locations of Agencies Interviewed

The interviews gathered details about each agency's communications administration practices, arrangements, efficiencies, and challenges or barriers. An interview question guide (see Appendix A) was prepared to facilitate input. Areas of questioning included:

- What types of communications mediums are used for ITS networks?
- How is your agency's communications infrastructure administered?

  - Who builds, maintains, and owns the communications assets?
  - What types of funding are used (e.g., federal, state, grants)?
  - Is your agency utilizing leasing, public-private partnerships, asset sharing, resource trading, or similar strategies? How are these arrangements initiated and administered?
  - What, if any, state laws govern how the agency can administer communications infrastructure assets?
  - How is security handled with shared facilities or resources?
  - How is IT support provided?
- How has your agency's communications administration model resulted in efficiencies or cost savings to the DOT? What are some challenges or barriers?
- How has your agency modified its policies to reflect the FHWA Final Rule on Broadband Infrastructure Deployment? Has this presented opportunities for sharing resources or new partnerships? How has it been implemented in smaller communities?

Because some background information was known about these agencies based on information gathered and described in Chapter 2, special attention was given to key practices for each agency during the interviews. Figure 3.1 provides a brief overview of key practices highlighted during each agency interview.

Table 3.1 Key Practices Highlighted in Agency Interviews

Agency	Key Practices
Arizona DOT	• Use of federal grant funds for fiber buildouts. Planned leasing of fiber assets.
Caltrans	• "Dig Smart" policy. Web-based map display of upcoming construction projects to promote partnerships with broadband companies.
Illinois DOT	• Leasing DOT-owned fiber. Arrangements with other state agencies for administration of communications infrastructure. Centralized IT support.
Indiana DOT	• Closed, secure ITS network. IT staff support specific to the ITS network.
Kansas DOT	• Use of federal grant funds for fiber infrastructure buildouts. Fiber sharing with public and private sector entities.
New Hampshire DOT	• State-level IT support, with dedicated staff in the traffic management center (TMC). TSMO division reviews all design and construction plans to identify needs and opportunities for ITS and communications infrastructure.
Utah DOT	• Trades resources with telecommunications companies. Provides a web-based map display showing existing and planned fiber infrastructure to coordinate with telecommunications companies.

See Appendix B for the agency interview summaries which provide a comprehensive overview of each agency's practices. Information gathered during agency interviews was used to summarize key practices in Chapter 4: Communications Administration Models and Practices; Chapter 5: Agency Reported Efficiencies and Cost Savings; and Chapter 6: Agency Reported Challenges and Barriers.

Chapter 4: Communications Administration Models and Practices

This section provides a summary of communications models and practices, as drawn from agency interviews. This section focuses on the following topics:

- Communications Mediums
- Construction, Maintenance, and Ownership
- Funding
- Information Technology Support
- Broadband Grants with Future Use by Private Sector
- Fiber Leasing
- Resource Trading
- Asset Sharing and Other Partnerships
- Security with Shared Facilities

See Appendix B for interview summaries for each agency that participated in interviews: Arizona DOT, Caltrans, Illinois DOT, Indiana DOT, Kansas DOT, New Hampshire DOT, and Utah DOT.

4.1 Communications Mediums

The agencies interviewed have utilized diverse types of communications mediums to support their ITS networks. Notable observations include:

- Fiber is prevalent in urban areas with higher densities of ITS field devices.
- Cellular continues to be utilized, with fiber as available, to support ITS devices in rural areas.
- Several agencies noted that they are phasing out or have decommissioned microwave. However, 40% of New Hampshire DOT connectivity utilizes microwave technology through the use of a microwave network shared among several state agencies and managed by the New Hampshire Department of Safety.

See Table 4.1 Table 2.1for communications (comms) mediums and approximate usage for ITS networks.

Table 4.1 Communications Mediums

Comms Mediums	Approximate Usage for ITS Networks by DOT						
	Arizona	Caltrans	Kansas	Illinois	Indiana	New Hampshire	Utah
Fiber	70%	6 (larger) districts	75%	Urban: 80% Rural: 9%	40% (urban)	30%	90%
Cellular	25%	All 12 districts	20%	Urban: 15% Rural: 90%	59% (remote)	30%	8%

Comms Mediums	Approximate Usage for ITS Networks by DOT						
	Arizona	Caltrans	Kansas	Illinois	Indiana	New Hampshire	Utah
Microwave	-	Some districts	2%*	Rural: 1%*	0%**	40%	-
Satellite	-	Researching feasibility	0%	-	-	-	-
Radio	5% (point to point)	-	2%	-	1%	-	2% unlicensed frequencies
Bluetooth	-	-	1%	-	-	-	Secondary function
Wi-Fi	-	-	-	-	-	-	-
Other	-	AVPN (1 or 2 districts)	-	Urban: 5% microwave and copper*	-	-	-

*Phasing out; **Decommissioned

4.2 Construction, Maintenance, and Ownership

Observations regarding construction, maintenance, and ownership of communications infrastructure for the transportation agencies interviewed included the following:

- For the most part, the agencies build, own, operate, and maintain the communications infrastructure, with cellular services purchased from private cellular carriers.
- Maintenance of ITS and communications infrastructure is sometimes outsourced in full or in part. Kansas DOT utilizes a maintenance contractor for ITS network maintenance services statewide. Caltrans utilizes overflow contracts for maintenance as needed to augment agency staff.
- Shared communications facilities with other state or local public agencies are common for most agencies interviewed. In contrast, the Indiana DOT communications network is independent from other agencies and only supports ITS field devices, creating a highly secure network.

4.3 Funding

The construction and maintenance of ITS devices, systems, software, and supporting communications infrastructure assets is funded using a variety of mechanisms. Use of state funds, federal program funds (e.g., Congestion Mitigation and Air Quality Improvement Program (CMAQ)), and federal grant funding were reported. Federal grant programs appear to be an emerging source of funding for communications infrastructure in the agencies interviewed.

Highlights regarding funding communications infrastructure from the agencies interviewed included:

- **Arizona DOT:** Arizona DOT is leveraging grant funding from the American Rescue Plan Act (ARPA) Coronavirus State and Local Fiscal Recovery Funds (SLFRF) program for fiber to support ITS and has set up a model for leasing a portion of the built fiber to private sector entities. See Section 4.5 for details.
- **Caltrans:** Caltrans predominately utilizes capital funds for communications infrastructure. Some Metropolitan Planning Organizations (MPOs) partner with Caltrans to fund ITS devices, and Caltrans is also trying to obtain grant funding.
- **Illinois DOT:** Federal funding is preferred. Illinois has set aside ITS program funds for capital improvements, which is called out separately in state budget legislation. This is a lump sum amount that rolls over and does not expire as long as the required documentation is completed.
- **Indiana DOT:** Indiana DOT often uses standard federal-aid projects, for example federal CMAQ funds, to build the ITS and communications infrastructure.
- **Kansas DOT:** State and federal funds are used for ITS communications. Kansas DOT has also secured grant funding for fiber buildouts. Kansas DOT is developing policies and procedures to allow open access by the private sector to DOT-owned ducts. See Section 4.5 for details.
- **New Hampshire DOT:** The TSMO Bureau is allocated up to 1.5% of construction costs and can secure more than 1.5% if needed. All design and construction projects are reviewed by the TSMO Bureau to identify TSMO and ITS needs, solutions, and technologies. The New Hampshire Turnpike provides some funding to support the New Hampshire DOT TSMO Bureau.
- **Utah DOT:** A mixed funding approach is utilized for Utah DOT's communications network. There is a yearly state budget for operation and maintenance costs. Sources include grant funds, state funds, and federal funds (e.g., CMAQ funds).

Unique funding partnerships that have resulted in efficiencies include the following examples:

Caltrans Partnerships with MPOs for ITS Devices:

- In some cases, Caltrans partners with MPOs to deploy ITS assets, and some MPOs have funded ITS field devices.

Turnpike Funding for New Hampshire DOT TSMO Bureau:

- New Hampshire DOT has a memorandum of understanding (MOU) in place that provides New Hampshire Turnpike funding to support the New Hampshire DOT TSMO Bureau. A portion of the New Hampshire DOT TMSO budget is provided by the Turnpikes, and in turn New Hampshire DOT manages their networks, deployments, day-to-day operations, ITS devices, and ITS communications. This is a beneficial relationship for both parties. New Hampshire DOT has the expertise to deploy and operate the ITS network, and centralizing these ITS support functions is efficient since New Hampshire is a small state.

Funding Efficiencies

Funding partnerships at Caltrans and New Hampshire DOT have created efficiencies.

Efficiencies exist with utilizing staff expertise at New Hampshire DOT to support the New Hampshire Turnpike ITS network.

4.3.1 IT Support within the DOT

Caltrans and Indiana DOT noted that IT support for ITS and communications networks resides in the DOT, each reporting benefits and drawbacks.

- **Caltrans**: Caltrans has an IT group that supports ITS implementations, handling activities such as procurement and equipment management. While the ITS group does not have dedicated IT staff, they work closely with Caltrans IT staff who are familiar with the ITS network. Each district has an IT manager, and these staff are assigned to IT tasks as needed.
    - *Benefits:* The Caltrans IT group uses standardized software and equipment, which simplifies support for the ITS network. In addition, the IT group has developed equipment standards tailored to different IT user levels, reducing the guesswork for users.
    - *Challenge:* A challenge with this model is that the rigid, state-level IT guidelines don't always align with the more specific needs of the ITS network.
- **Indiana DOT:** At Indiana DOT, the IT function for the ITS network resides within the DOT and within the ITS group. The IT team includes three network positions, two database positions, an ITS director, and a dozen or so Local Area Network (LAN) technicians.
    - *Benefits:* From a security standpoint, the ITS network is isolated from other Indiana DOT systems, reducing vulnerability. The network uses secure servers, and data is regularly backed up. If an attack occurred, recovery would be quick. The network's closed system minimizes overall risk. This model also provides focused IT resources for the ITS network.
    - *Challenge:* With a closed network, the ITS group must operate with its own IT resources and staff. Limited flexibility exists to absorb workload when there are unfilled positions, and qualified staff are difficult to hire. However, with in-house expertise, the ITS group can be nimble without the need to hire external expertise.
- **Illinois DOT:** The IT function and day-to-day support of the ITS network resides in each district's operations group, which could include traffic engineers or electrical staff. Illinois DOT also contracts out maintenance, for example electrical maintenance contractors are required to hire a specialty subcontractor for the ITS network. Illinois DOT also has IT staff within the administration section of the DOT, but their support for the ITS network is limited (e.g., to review specs). Currently only a few agencies are allowed to have their own IT staff. This may change in the future, especially with recent cybersecurity issues, as the state may want to consolidate IT into a single statewide function.

Efficiencies from IT Support within the DOT
Use of standardized software and equipment simplifies IT support for the ITS network at Caltrans.
Efficiencies and security advantages exist with Indiana DOT's closed communications network.
Dedicated IT staff in the Indiana DOT ITS group allows staff to efficiently focus on ITS devices and network communications.

Advantages of having IT support within the DOT include standardized equipment and software, as well as the ability to have specialized IT staff focused on ITS network operations. Even with IT support within the agency, Caltrans reported that state-level IT guidelines may not align with specific ITS network needs.

4.4 Information Technology Support

For transportation agencies, IT support is a key component of administering communications infrastructure and assets. This support includes a growing need to mitigate security risks and maximize efficiency. The agency interviews revealed a range of models for IT support of ITS networks and communications infrastructure. Models included IT support within the DOT (in some cases dedicated IT staff in the ITS group), statewide IT support, and mixed approaches.

4.4.1 Statewide/Centralized IT Support with Embedded Staff

New Hampshire DOT reported statewide/centralized IT support for ITS and communications networks.

- **New Hampshire DOT:** The central IT function exists under the New Hampshire Department of Information Technology (referred to as "State IT"), which consolidates IT services for all New Hampshire state agencies under a single department. Within this structure, New Hampshire DOT has a dedicated IT team for DOT support. Additionally, New Hampshire DOT's TSMO function is supported by three IT staff embedded at the TMC, who are primarily responsible for managing and supporting the ITS network.
    - *Benefits:* This organizational model is highly effective. The TMC's IT staff are directly responsible for the ITS network. These staff have the same training and purchasing capabilities as the broader State IT system. NHDOT also benefits from more favorable pricing and purchasing terms as part of the larger State IT system.
    - *Challenges:* Because the New Hampshire DOT network is not connected to the State IT system, State IT has limited awareness and understanding of the DOT ITS network. In addition, because New Hampshire DOT is not on the State IT network, the DOT does not have IT staff support on weekends.

Cost Savings from Statewide/Centralized IT Support with Embedded Staff
Cost savings are achieved by New Hampshire DOT through discounts the agency receives with IT staff who are part of the broader State IT system.

The expertise and purchasing power of being part of the broader State IT network, with dedicated IT staff within the TMC, is a highly effective model for IT support at New Hampshire DOT.

4.4.2 Mixed Approach for IT Support

Kansas DOT and Utah DOT reported a mixed approach for IT support, including support at the DOT as well as support from a centralized (state-level) IT department.

- **Kansas DOT:** Kansas DOT noted that the agency has IT staff to support ITS operations, and there are also IT staff within the state's IT department.
- **Utah DOT:** The Utah Department of Technical Services (Utah DTS) provides statewide IT support for internet, computers, and related services. UDOT's traffic network operates on a separate, closed fiber infrastructure, separate from the DTS network. Utah DOT augments with DTS staff to support the ITS traffic network and collaborates with DTS on fiber deployment projects.
    - *Benefits:* The consolidation of staff within Utah DTS allows for greater support across the state. The use of standardized equipment, such as network switches, ensures that staff are familiar with necessary maintenance tasks.
    - *Challenges:* At times, DTS and Utah DOT traffic operations have different visions. Additionally, Utah DOT's traffic operations may require specialized equipment specific to the traffic network, which may not align with the standard equipment put forth by DTS.

A mixed approach for IT support (DOT support with state IT support) offers benefits and drawbacks specific to an agency's organizational structure and communications infrastructure support needs.

4.5 Broadband Grants and Future Use by Private Sector

Arizona DOT and Kansas DOT are utilizing funds from a variety of federal grant programs to build fiber and leverage these new assets for ITS communications.

Arizona DOT Fiber Installation for ITS and Leasing:

Arizona DOT is constructing 400 miles of broadband fiber using grant funds from the ARPA Coronavirus SLFRF. The funding, administered through the Arizona Commerce Authority, is constructing "middle-mile" fiber infrastructure to provide broadband access to underserved and unserved communities. The corridors being constructed have been prioritized for the grant purpose of providing broadband access to underserved and unserved communities. However, leveraging this new communications infrastructure to support ITS network operations is an added benefit to Arizona DOT.

Arizona DOT is the owner of the fiber infrastructure and plans to lease a portion of the built fiber. Arizona Revised State Statute 28-7383: Management of state-owned telecommunication facilities stipulates that "The department may enter into an agreement with a public or private entity for the purpose of using, managing or operating state-owned telecommunication facilities and coordinating activities in this state relating to planning, mapping and procuring broadband service" (Arizona State Legislature, 2023a).

Arizona DOT entered into an "Operate, Maintain, and Commercialize" (OMC) services agreement with a private sector partner to manage the leases. This model, which includes revenue sharing between Arizona DOT and its private sector partner, is self-sufficient for operations and maintenance of the network, and excess revenues will be used for additional network expansion. To this end, Arizona passed legislation (Arizona Revised Statute 28-7387: Smart highway corridor trust fund: purpose) stipulating that revenues from leases must go into the state's Smart Highway Corridor Trust Fund and can only be used for 1)

operations, maintenance, and expansion of the telecommunication facilities and services; and 2) building future broadband projects (Arizona State Legislature, 2023b).

Kansas DOT Fiber Buildouts and Future Use by the Private Sector:

Kansas DOT is utilizing funding through an Advanced Transportation and Congestion Management Technologies Deployment (ATCMD) grant to deploy advanced ITS technologies along I-83, including a connected vehicle test. As part of this US-83-Connected-Vehicle-Project, 70 miles of fiber will be installed as Kansas DOT's non-federal match contribution.

Funding from an Infrastructure Investment and Jobs Act (IIJA) Broadband Grant is supporting expansion of fiber to provide "middle-mile" broadband connections to underserved areas in Kansas. Multiple partners are involved in the project. Kansas DOT contributed a cash match but also contributed ROW for installing the multi-duct conduit and fiber. Kansas DOT's ITS devices and business network will be connected to the Kansas DOT-owned fiber in this new network. Kansas DOT is also developing policies and procedures to allow open access (by the private sector) to Kansas DOT-owned ducts. The need to modify state laws will be researched as policies and procedures are developed. The policies and procedures developed during the IIJA grant project (to allow open access to Kansas DOT-owned ducts) will be extended to future Kansas DOT-funded projects.

Kansas DOT's lessons learned from experiences to date regarding the IIJA grant buildout initiative include:

- It is important to vet the early procurement process. With significant interest from the private sector, vet the procurement processes even before submitting the grant application.
- Initiate policies and procedures early. This includes details such as open access to private internet service providers (ISPs) and determining if the backbone can handle it. In addition, there is a need to determine whether private sector entities will build their own supporting infrastructure (e.g., handholes, vault access, separate vaults, connections) and how security will be handled.

Additional information about the IIJA Broadband grant is available at the Kansas Commerce Freestate Middle Mile Network website.

Efficiencies and Cost Savings from Broadband Grants and Future Use by Private Sector

Arizona DOT is leveraging the "middle mile" grant-funded fiber to support ITS network operations.

Excess revenues from Arizona DOT's fiber leases will be used to operate, maintain, and expand the built fiber, and for future broadband projects.

Kansas DOT will benefit from new fiber installed using federal grant funding, to support the ITS network.

Cost savings to Kansas DOT will be seen as policies and procedures are finalized to define how to lease, license, or permit to Kansas DOT's open ducts/conduits.

4.6 Fiber Leasing

Arizona DOT and Illinois DOT have models in place to lease agency-owned fiber infrastructure. For both agencies, the management of lease agreements is outsourced, and the management services are self-funded through revenues collected through the leases.

Arizona DOT Leasing Model:

Arizona DOT has developed a model for leasing fiber infrastructure to private sector entities. This model includes contracting with a private sector partner to manage leases. All revenues from leases are required to be re-invested in the state's communications infrastructure. See Section 4.5 for details.

Illinois DOT Fiber Leasing:

Illinois DOT actively advertises some fiber and conduit for lease. Illinois DOT has entered into a services agreement with the Illinois Department of Information Technology (DoIT) by which DoIT performs advertising, maintenance, marketing, invoicing, and payment collection for Illinois DOT's fiber lease agreements. This services agreement is self-funded through revenue collected from the leases.

When Illinois DOT builds fiber that could potentially be leased, the agency attempts to use state only funds, due to restrictions and requirements on federal funds for purposes beyond transportation. Each federal program has its own rules and regulations, including the potential for leasing fiber. Because of this, resource trading is often prioritized over leasing to avoid accounting responsibilities and eligibility of federal funds.

Efficiencies from Fiber Leasing

Illinois DOT has a services agreement in place with the Illinois DoIT to coordinate and manage Illinois DOT's external lease agreements.

Revenue collected from Illinois DOT's external leases pays for the lease management services provided by Illinois DoIT.

4.7 Resource Trading

Practices for resource trading involving communications infrastructure were shared by Illinois DOT and Utah DOT.

Illinois DOT Resource Trades:

Illinois DOT conducts three types of resource trades, and agreements are initiated for each type:

- Illinois DOT's resource trading with Illinois DoIT began when the state's IT department at the time received a federal grant for interstate fiber buildout. Illinois DOT waived the ROW fee in exchange for access to some fiber. Additional resources and responsibilities trades have continued since then.
- Some Illinois DOT districts trade fiber (use of strands and/or conduit) with counties or local municipalities.
- Some Illinois DOT districts are working with private broadband providers (usually strand-for-strand trades) in areas where broadband needs exist. No money is exchanged.

Utah DOT Resource Trading:

Utah DOT utilizes resource trades with telecommunications (i.e., telecom) companies as a significant part of their overall communications infrastructure strategy. Cash or in-kind trades are conducted, including trades involving fiber strands, conduits, and other communications infrastructure assets. A running log tracks the value of all trades and ongoing balances with telecom providers. The Utah DOT Fiber Trade

Approval Committee reviews and approves the trades, and all trades are required to improve Utah DOT's ITS communications system.

A master agreement is established with each telecom provider, and a "trade identification number" (TID) is created under the master agreement for each trade. The resource trading process requires that Utah DOT builds trust with the providers and requires an easy and clear process. The Utah DOT Fiber Map serves as a valuable tool, displaying in-place fiber and locations where Utah DOT would like to have fiber installed, to see where gaps in coverage exist. Utah DOT acts as a neutral facilitator, meets with providers annually in a group setting, and does not sign exclusive agreements for ROW access.

Cost Savings from Resource Trading

Utah DOT has saved more than $100 million through resource trades with broadband providers.

Utah DOT sees a 2-to-1 return on their investments.

Installing extra conduit during road construction projects (for future use by Utah DOT and possible trades) is much less expensive than later re-construction.

Utah state legislation that was required to enable trade arrangements:

- Utah Code 72-7-108. Longitudinal telecommunication access in the interstate highway system
- Rule R907-64. Longitudinal and Wireless Access to Interstate System Rights-of-Way for Installation of Telecommunication Facilities
- Rule R907-65. Compensation Schedule for Longitudinal Access to Interstate Highway ROW for Installation of Telecommunications Facilities
- Rule R930-7. Utility Accommodation

See the Fiber Optic story link on Utah DOT's Strategic Vision web page for more information about Utah DOT's resource trading practices.

4.8 Asset Sharing and Other Partnerships

Many of the agencies interviewed indicated that they share assets (e.g., fiber) or have other types of partnerships in place with public or private sector entities. This section provides examples of these sharing arrangements and coordination approaches.

Arizona DOT Fiber Sharing and AZTech Partnership:

- Arizona DOT shares fiber (4-5 strands) with some municipalities in the Phoenix area. In some situations, Arizona DOT will allow local agencies to install conduit within the ROW.
- Arizona DOT participates in AZTech, a regional traffic management partnership in the Phoenix Metropolitan area that guides the application of ITS technologies for managing regional traffic. AZTech meets monthly, providing an opportunity to coordinate traffic operations in the region.

Kansas DOT Fiber Sharing:

- Kansas DOT's general policy is to share fiber with other government agencies and public entities such as universities.

- Kansas DOT has shared fiber with the city of Wichita. A fiber sharing plan is in place in Wichita and includes exchanging fiber resources, for example Kansas DOT provides a few strands to the city in exchange for use of city fiber resources.

Kansas DOT Coordination with Public Sector and Private Sector Entities:

- Kansas DOT coordinates with Kansas Turnpike Authority (public agency) and private sector companies on joint fiber facilities. Kansas DOT allows access to right-of-way and the fiber is co-located, ranging from sharing empty conduit to Kansas DOT owning fiber in private sector cable.
- Kansas DOT has allowed private sector entities to co-locate. In this situation, the fiber installed for Kansas DOT's use was at no cost to the DOT. In exchange, Kansas DOT allowed the company to install fiber in the ROW.
- On a few projects, Kansas DOT has entered into public-private-partnerships that allow multi-duct conduit and fiber to be placed along selected routes in Kansas by a private company. This has been done in a shared trench installation and sharing open conduit in a multi-duct installation. These installations have resulted in reduced construction costs for Kansas DOT.
- Kansas DOT is placing DOT office connections on their fiber network to eliminate service fees from other providers.
- Kansas DOT has provided a free internet connection to the Kanas Highway Patrol as a benefit to a sister agency, resulting in a cost savings to the state. Kansas DOT also provides fiber as backup communications for Kansas Highway Patrol radio traffic.

New Hampshire DOT Use of Shared Microwave Network:

- NHSafeNet is a shared microwave network shared with several state agencies. The network is owned and managed by the New Hampshire Department of Safety. New Hampshire DOT pays for maintenance and operations cost based on a percentage of bandwidth use and annual unscheduled maintenance.
- New Hampshire DOT has one run managed fiber network that is leased from the University System of New Hampshire iBeamNH network.

Cost Savings and Efficiencies from Asset Sharing and Other Partnerships

Kansas DOT's fiber sharing and multiple other arrangements with public and private entities have resulted in cost savings and efficiencies to the agency.

New Hampshire DOT pays for only a small portion of the NHSafeNET shared microwave network and is not responsible for maintaining it, which is a cost savings to New Hampshire DOT.

Utah DOT's fiber sharing with Utah DTS benefits both entities.

Utah DOT Fiber Sharing:

- Utah DOT and Utah DTS have some shared fiber facilities. This shared fiber benefits both entities.

4.9 Security with Shared Facilities

A variety of security measures are utilized by the agencies interviewed when the DOT shares communications facilities with public or private entities. Practices can include separate racks, separate keys, and separate pull boxes or handholes with each entity responsible for security and maintenance.

Security strategies for communications hubs/shelters include cameras, physical keys, access cards, and electronic intrusion detection with alerts to agency staff.

Details about security of shared facilities, as noted by the agencies interviewed, are shown in Table 4.2.

Table 4.2 Security Practices for Shared Facilities

Agency	Security Practices
Arizona DOT	• Security in the Phoenix area is coordinated through the AZTech group. For Arizona DOT-owned conduit, the local agencies and the DOT use the same conduit and pull boxes. For lateral connections, the locals install their own box to connect to their local connections. DOT boxes are secured with padlocks. • For leased fiber, the private sector entity that is managing the leases for Arizona DOT will be the only private sector entity in the ROW. Arizona DOT is working through security for the racks available for private sector providers.
Caltrans	• For Caltrans TMC facilities that are shared with Highway Patrol, Highway Patrol has security responsibility including sign-in and badging.
Kansas DOT	• Policies and procedures related to security of leased fiber facilities will be developed as part of implementing the fiber buildout for the IIJA Broadband grant. This may include separate racks and separate keys for each entity.
Illinois DOT	• Shared fiber or shared conduit results in two handholes for access. Each entity provides their own security and maintenance.
Indiana DOT	• N/A – No shared communications infrastructure assets.
New Hampshire DOT	• Physical access to the New Hampshire SafeNet shared microwave network is by personal identification for New Hampshire DOT staff and contractors. New Hampshire DOT only has access to the edge, via an edge router. • New Hampshire DOT follows American Tower / Crown Castle standard log on procedures for physical access to leased microwave tower space.
Utah DOT	• Hubs are secured with cameras, a physical key, and access cards. However, physical security is a challenge, as a crowbar can be used to break in. • Most sites have electronic intrusion detection with alerts to Utah DOT staff. • A copper theft deterrent used is labeling boxes with “Fiber Optics.”

4.10 Implementation of FHWA Rule on Broadband Infrastructure Deployment

The FHWA Final Rule on Broadband Infrastructure Deployment aims to facilitate the installation of broadband infrastructure. The rule requires state DOTs to identify a broadband utility coordinator, establish a registration process for broadband entities that seek to be included, establish a process for electronically notifying broadband infrastructure entities of the agency’s STIP, and coordinate state and local plans to minimize repeated excavations that involved broadband infrastructure in the ROW.

The interviews with state DOTs inquired about how the final rule has been implemented within their agency and whether it has resulted in new partnerships or efficiencies. Findings from interviews revealed that most DOTs have implemented the rule; however, the agencies have not experienced new opportunities to partner with broadband providers as a result of the rule. Some possible reasons cited for the lack of new partnerships included:

- The DOT has been coordinating with broadband for several years before the FHWA final rule was in place, therefore the rule did not specifically facilitate new partnerships.
- The agency's road construction project locations may not match up with the broadband providers' expansion needs.
- Broadband providers may not wish to share their expansion plans with the state DOT.
- It is too early, and time is needed to build partnerships as the rule is rolled out.

When asked about implementation of the Final Rule in local communities, the agencies interviewed had no tangible examples to share.

See Section 2.2 Examples of Implementing the FHWA Final Rule on Broadband Infrastructure Deployment for examples of how state DOTs have implemented the rule through public-facing documentation and resources such as websites and policies.

Chapter 5: Agency Reported Efficiencies and Cost Savings

The agencies interviewed for this research noted many examples of efficiencies and cost savings, based on their communications administration practices. See Chapter 4: Communications Administration Models and Practices for efficiencies and cost savings achieved through the models and practices highlighted. Table 5.1 provides an overview of the efficiencies and cost savings reported.

Table 5.1 Efficiencies and Cost Savings

Agency	DOT Reported Efficiencies and Cost Savings
Arizona DOT	• Federal grant funding for fiber buildout and future leasing: Leveraging the fiber infrastructure (built using grant funding) to also support ITS network operations is an added benefit to Arizona DOT. ITS infrastructure is now connected across the state along key Arizona DOT corridors and traffic signals, providing faster traffic operations response times and improved traveler information.
Caltrans	• Design flexibility: California is a big state with diverse population areas, therefore one size does not fit all. Districts have discretion to design their own communications systems to fit their needs, resulting in efficiencies. • Performance specifications: Traffic Operations in Caltrans headquarters provides performance specifications (e.g., device up-time, reliability, contract for delivery), reviews measures reported by the districts, and creates a baseline and guidance for performance including for contractors. • Consolidation of groups: In the past, Caltrans had separate groups for different ITS field elements (e.g., signals, cameras, DMS). Caltrans recently consolidated these groups under Maintenance, with shared efforts.
Kansas DOT	• Fiber sharing and resource exchanges: Cost savings to Kansas DOT occur through exchanging resources with the private sector. Public-private partnerships that allow multi-duct conduit and fiber to be placed along selected routes in Kansas by a private company have resulted in construction cost reductions to Kansas DOT. • Federal grant funding: Cost savings to Kansas DOT are seen from the IIJA grant, especially with future private sector partnerships, as policies and procedures are finalized to define how to lease, license, or permit to Kansas DOT's open conduits. • Fiber for DOT office connections: Kansas DOT is placing DOT office connections on their fiber network to eliminate service fees from other providers. • Efficiencies with Kansas Highway Patrol: Kansas DOT has provided a free internet connection to the Kansas Highway Patrol as a benefit to a sister agency, resulting in an overall cost savings to the state.

Agency	DOT Reported Efficiencies and Cost Savings
Illinois DOT	• Illinois DOT agreement with Illinois DoIT for managing fiber leases: This agreement has been very beneficial, as DoIT has the expertise to coordinate and manage Illinois DOT's external lease agreements. Revenue collected from the lease agreements pays for the services provided by DoIT. • Awareness of entities digging in the ROW through DoIT agreement: Illinois DOT is not part of the state's "OneDig" call system, Joint Utility Locating Information for Excavators (JULIE), because if an entity is digging in the ROW, they are supposed to obtain a permit, however this doesn't always happen. Illinois DoIT is on the OneDig call system, and because they are managing the Illinois DOT services agreement, they field and respond to all OneDig calls, helping to inform Illinois DOT of digging that occurs in the ROW. • Illinois DOT contract with the University of Illinois-Chicago (UIC) for traveler information systems: UIC administers Illinois DOT's traveler information systems. As such, Illinois DOT has leaned on UIC's expertise in networking, for example, when providing the districts with network connectivity.
Indiana DOT	• Closed ITS network: Efficiencies exist with having a closed ITS communications network (not connected to other Indiana DOT networks). The closed network approach reduces risk by reducing vulnerabilities to potential cyberattacks. • Dedicated IT Staff for ITS: Because the ITS group has dedicated IT staff, the ITS network does not compete for resources within or outside the agency. This allows the dedicated IT staff to focus on ITS communications and devices without being pulled into other tasks.
New Hampshire DOT	• State IT discounts: Cost savings are achieved through discounts New Hampshire DOT receives with staff as part of State IT. • Shared microwave: New Hampshire DOT pays for only a small portion of the NHSafeNET shared microwave network and is not responsible for maintaining it, which is a cost savings to New Hampshire DOT. • Standard specifications: Use of standard specifications (e.g., for ITS devices) has resulted in efficiencies, especially when going out to bid. When standards are followed, the devices are compatible and can be integrated easily.
Utah DOT	• Resource Trades: - The cost savings to Utah DOT attributed to resource trades with broadband providers is more than $100 million in trade value alone, with additional savings due to avoiding leased services (e.g., camera data transfer charges) that would be needed if fiber was not in place. Utah DOT receives a 2-to-1 benefit for their investments in fiber when they leverage resource trades. - Installing additional conduit (for future DOT use and possible trades) during road projects is much less expensive than re-constructing at a later date.

Agency	DOT Reported Efficiencies and Cost Savings
	- Constructing conduit and fiber helps connect communities (part of Utah DOT's Strategic Vision), thereby enhancing quality of life through transportation. • IT Support (statewide): Efficiency with consolidation of IT staff supporting ITS across the state. Standard equipment enables staff familiarity for maintenance. • Shared Fiber with Utah DTS: This arrangement benefits both entities.

Chapter 6: Agency Reported Challenges and Barriers

The agencies interviewed noted a wide range of challenges and barriers associated with administering communications networks. See Table 6.1 for an overview of challenges and barriers.

Table 6.1 Challenges and Barriers

Agency	DOT Reported Challenges and Barriers
Arizona DOT	• When installing fiber conduit, snow runoff filled the boxes with water. It became very important to secure and seal the fiber, splice enclosures, and other components during construction. • Marking fiber conduit has been a challenge. A lesson learned is to take the time and effort to adequately mark new conduit installations. This can be a heavy lift with many miles of installations.
Caltrans	• The availability of communications services varies by region. Multiple options are available in urban areas compared to rural areas. In some areas it is difficult to acquire permits due to environmental constraints or services are too expensive. Therefore, Caltrans may need to construct its own systems in areas where no service is available.
Kansas DOT	• When co-locating with public or private entities in the same trench, Kansas DOT needs to coordinate with these entities for re-locations, expansions, and construction. • Installing Kansas DOT fiber in railroad right-of-way can be a challenge in terms of permitting and policies near railroads. Each railroad is different. The railroads usually deal with commercial entities, so Kansas DOT needs to review and modify the railroads' standard agreement language to fit government needs.
Illinois DOT	• "Dig once" implementation has been a challenge, both at the federal and the state levels. Resolving the federal and state (Illinois Dig Once Act) requirements will take time and effort. For example, the FHWA regulation requires a statewide coordinator at the DOT and the Illinois Department of Commerce and Economic Opportunity (DCEO) is the state's lead for broadband development.
Indiana DOT	• If sharing and leasing were more utilized, the ITS communications system would need to be re-architected. Security would be a challenge since the agency is not set up to be connected to other networks.
New Hampshire DOT	• Purchases that don't follow standard specifications result in inefficiencies. • The cost of installing fiber in the New Hampshire DOT network is often cost prohibitive. As a result, New Hampshire DOT needs to lease additional tower space or pay for cellular service.

Agency	DOT Reported Challenges and Barriers
	• Challenges exist with different procurement models used by New Hampshire DOT versus the state purchasing system.
Utah DOT	• Ensure that the proper legal framework is in place for resource trades. If a resource is promised through an MOU rather than a contract, the trade could fall through leaving the agency without the infrastructure they counted on. • Utah DOT has experienced that smaller companies can often act faster and are more invested as a trading partner, compared to large companies.

Chapter 7: Findings and Implementation Plan

State DOTs have various models for constructing and administering communications infrastructure to support ITS networks and other operations functions – some utilizing public-private partnerships, leasing, asset sharing, resource trading, or other approaches. This research documented state DOT models for administration of communications and investigated how state DOTs may reduce costs and increase efficiencies when installing and managing communications infrastructure.

The research completed a literature search and conducted interviews with representatives from seven (7) state DOTs to gather information about key practices associated with administering communications infrastructure. The research also gathered information about how agencies are implementing the provisions of the FHWA Final Rule on Broadband Infrastructure Deployment.

7.1 Key Findings

Selected key findings from the research include the following:

- **Communications Mediums:** Fiber is prevalent in urban areas with higher densities of ITS field devices, while cellular continues to be utilized, with fiber as available, to support ITS devices in rural areas. Several agencies reported they are phasing out or have decommissioned microwave communications.
- **Construction, Maintenance, and Ownership:** Most agencies build, own, operate, and maintain communications infrastructure, along with purchasing cellular services. Kansas DOT has a statewide maintenance contractor for ITS and Caltrans uses overflow contracts to augment agency staff.
- **Funding:** State funds, federal program funds (e.g., CMAQ), and federal grants are utilized by state DOTs for communications infrastructure. Funding partnerships (e.g., funding from other state agencies or local entities) can be an efficient use of funds and staff resources.
- **IT Support Models:** Many different models for IT support for ITS network communications were reported. Benefits and challenges exist with each model. Agencies with statewide IT support reported advantages with price discounts as part of a larger IT group and benefits from standardized equipment, though with this model the statewide vision for IT may not align with the ITS network needs. ITS groups with dedicated IT staff noted efficiencies due to familiarity with the network.
- **Broadband Grants:** Arizona DOT and Kansas DOT reported that federal grant funding for "middle mile" broadband (i.e., connecting local communities to robust, high-capacity national and regional networks) is being leveraged to expand service to the DOT's ITS network. In both states, plans to allow use of the built infrastructure (e.g., conduit/ducts) by private sector entities are underway. Both agencies reported efficiencies to the agency due to these practices.
- **Fiber Leasing:** Illinois DOT actively advertises some fiber and conduit for lease. Arizona DOT has recently developed a model for leasing fiber. In Arizona, revenues from leased fiber must be used

to operate, maintain, and expand telecommunication facilities and services, or for building future broadband projects, presenting efficiencies for growing the network and further expanding ITS services.

- **Resource Trading:** The practice of resource trading (e.g., waiving the ROW fee in exchange for use of fiber assets, swapping fiber strands) was reported by some agencies, resulting in cost savings to the agency. Utah DOT's resource trading program with broadband providers has saved over $100 million in trade value alone, plus additional savings by avoiding leased services (e.g., camera data transfer fees) that would otherwise be incurred without fiber.
- **Implementation of FHWA Final Rule on Broadband Infrastructure Deployment:** Most agencies indicated they have implemented the Final Rule, but none reported new opportunities to partner with private sector broadband providers attributed to the rule. Reasons include long-standing similar efforts already in place, DOT project locations that may not match up with providers' needs, and the need for more time to see benefits.

In total, more than 20 examples of efficiencies and cost savings due to various communications administration practices were reported by agencies interviewed for this project.

7.2 Implementation Plan

Transportation agencies can implement the results of this research in several ways. Recommended implementation steps for ENTERPRISE agencies could include:

1. Distribute this report to agency staff responsible for planning, constructing, and maintaining communications infrastructure assets. Agency staff and groups who may benefit from the information in this report could include:
    - ITS managers
    - Traffic management center managers
    - District or regional managers responsible for ITS devices and communications infrastructure
    - Broadband development staff (e.g., broadband office or statewide broadband agency)
2. Review the practices documented in this report to identify strategies that could be implemented by your agency. Reference the efficiencies documented to build a case for implementing or expanding practices that could result in cost savings and efficiencies to the agency.
3. Consider pursuing funding through federal broadband development grant programs and leverage this built fiber infrastructure to support ITS network communications. Consider partnerships with the statewide broadband agency (as applicable) to pursue federal grant funding. Review relevant practices in Chapter 4.5 Broadband Grants and Future Use by Private Sector.
4. Review state legislation and agency policies to become familiar with requirements for fiber sharing, resource trading, and leasing. Reference state laws in states that have these practices in place, as documented in Chapter 4: Communications Administration Models and Practices.

References

American Association of State Highway and Transportation Officials (AASHTO). 2022. State DOTs Expand Support for Broadband Projects. Accessed April 7, 2025, from https://aashtojournal.transportation.org/state-dots-expand-support-for-broadband-projects/.

Arizona Commerce Authority (ACA). 2022. Arizona Broadband Statewide Middle-Mile Strategic Plan. https://www.azcommerce.com/media/vvslgr2e/aca-broadband-strategic-plan-final-2-2-22.pdf.

Arizona State Legislature. 2023a. Management of state-owned telecommunication facilities. Arizona Revised State Statute 28-7383, 56th Legislature, 1st Regular Session. Accessed April 7, 2025, from https://www.azleg.gov/viewdocument/?docName=https://www.azleg.gov/ars/28/07383.htm#:~:text=28%2D7383.%20Management%20of%20state%2Downed%20telecommunication%20facilities.

Arizona State Legislature. 2023b. Smart highway corridor trust fund; purpose. Arizona Revised State Statute 28-7387, 56th Legislature, 1st Regular Session. Accessed April 7, 2025, from https://www.azleg.gov/viewdocument/?docName=https://www.azleg.gov/ars/28/07387.htm.

Athey Creek Consultants. 2016. Policies, Laws, and Agreements for the Use of Fiber Communications. ENTERPRISE Pooled Fund Study. https://enterprise.prog.org/wp-content/uploads/ENT_Fiber_Communications_FINAL_Report_Dec2016.pdf.

Federal Highway Administration (FHWA). 2021a. Broadband Infrastructure Deployment. Federal Register, Vol. 86, No. 230. https://www.govinfo.gov/content/pkg/FR-2021-12-03/pdf/2021-26231.pdf.

Federal Highway Administration (FHWA). 2021b. FHWA Publishes Final Rule to Promote Broadband Access in Underserved Communities. Accessed April 7, 2025, from https://highways.dot.gov/newsroom/fhwa-publishes-final-rule-promote-broadband-access-underserved-communities#:~:text=WASHINGTON%20%E2%80%93%20The%20U.S.%20Department%20of,further%20excavation%20in%20the%20future.

Federal Highway Administration (FHWA). 2022. UDOT Takes Active Role in Facilitating Broadband Development. Case Study FHWA-HIF-22-040. https://www.fhwa.dot.gov/utilities/pdf/hif22040.pdf.

Franzese, O., Truett, T., and Chang, E.C.-P. 2004. Shared Communications: Volume I. A Summary and Literature Review. Federal Transit Administration. https://rosap.ntl.bts.gov/view/dot/3706.

Jacobson, L., Lockwood, S., and Beck, S. 2022. Practices for Improving the Coordination of Information Technology and Transportation Systems Management and Operations Resources: A Reference Document. Federal Highway Administration FHWA-HOP-21-008. https://ops.fhwa.dot.gov/publications/fhwahop21008/fhwahop21008.pdf.

Preisen, L. and Roelofs, T. 2020. Emerging Practices for Communications Infrastructure. ENTERPRISE Pooled Fund Study. https://enterprise.prog.org/wp-content/uploads/ENT-Emerg-Pracs-Communs-Infra-Final-Report.pdf.

Truett, T. and Chang, E.C.-P. 2004. Shared Communications: Volume II. In-Depth Systems Research. Federal Transit Administration. https://rosap.ntl.bts.gov/view/dot/3707.

Tymon, J. February 3, 2022. Letter to Evelyn Remaley Hasch, Acting Assistant Secretary for Communications and Information, U.S. Department of Commerce. *"AASHTO Response to Notice, Request for Comment, Infrastructure Investment and Jobs Act Implementation, National Telecommunications and Information Administration, U.S. Department of Commerce (National Telecommunications and Information Administration – Docket No. 220105-0002)."* https://transportation.org/policy/wp-content/uploads/sites/56/2023/03/AASHTO-Comments-to-NTIA-on-IIJA-Broadband-Program-1.pdf.

Appendix A:
Question Guide for Agency Interviews

ENTERPRISE

Administration of Communications

Question Guide for Agency Interviews (August 2024)

Project Overview:

State departments of transportation (DOTs) have various models for deploying and administering communications to support intelligent transportation systems (ITS) networks. Some agencies are utilizing public-private partnerships, leasing, asset sharing, resource trading, or other approaches. The ENTERPRISE Pooled Fund Study is investigating how State DOTs may reduce costs and increase efficiencies when installing and managing ITS communications infrastructure.

Question Guide:

1) We would like to understand some overall context for your agency's ITS network communications. What communications mediums does your agency use to support ITS networks? For each, what is the approximate share of usage in the agency's overall ITS network operations approach?

Mediums	Approximate % Usage
Fiber (%)	
Cellular (%)	
Microwave (%)	
Satellite (%)	
Radio (e.g., 4.9 GHz) (%)	
Bluetooth (%)	
Wi-Fi (%)	
Other (%) – *Please indicate type(s)*	
Total =	**100%**

Administration of ITS Communications Infrastructure:

2) How is your agency's communications infrastructure administered for ITS network operations?

   a. Who is responsible for building, maintaining, and owning the ITS communications assets? Is your agency utilizing public-private partnerships, leasing, asset sharing, resource trading, or other similar approaches? What agencies or private sector entities are involved?

   b. How is information technology (IT) support handled for your agency's ITS communications network?

   c. What types of funding is utilized to build and maintain the ITS communications assets? Are there any restrictions on federal funds? Are grants utilized?

d. How are various arrangements (e.g., construction, ownership, maintenance, funding) initiated and administered?

e. How is security handled with shared facilities or resources?

f. What, if any, state laws govern how the DOT can administer ITS communications resources?

Efficiencies and Challenges:

3) How has your agency's ITS communications administration model resulted in efficiencies or cost savings to the DOT?

4) What challenges or barriers exist in terms of efficiently administering communications for ITS networks?

FHWA Broadband Infrastructure Deployment Rule:

5) How has your agency modified its policies for the FHWA Final Rule on Broadband Infrastructure Deployment (i.e., "Dig Once" rule)?

6) Has the rule presented opportunities for sharing communications resources or new partnerships?

7) How is the rule being implemented in smaller communities (e.g., traffic signal communications)?

Other:

8) Do you have any other relevant information to share?

Appendix B:
Agency Interview Summaries

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Administration of Communications

Arizona Department of Transportation (UDOT)

Interview Summary

Interview Participants:

- Brad Burgess, Arizona DOT
- Bruce Dressel, Arizona DOT

Interview Date: June 25, 2024 (and supplemental information provided via email 12/10/24)

<table>
<tr><td>Communications Mediums and Approximate Usage for ITS Networks</td><td>
<table>
<tr><th>Mediums</th><th>Approximate % Usage</th></tr>
<tr><td>Fiber (%)</td><td>70%</td></tr>
<tr><td>Cellular (%)</td><td>25%</td></tr>
<tr><td>Microwave (%)</td><td>-</td></tr>
<tr><td>Satellite (%)</td><td>-</td></tr>
<tr><td>Radio (e.g., 4.9 GHz) (%)</td><td>5% point to point radio</td></tr>
<tr><td>Bluetooth (%)</td><td>-</td></tr>
<tr><td>Wi-Fi (%)</td><td>-</td></tr>
<tr><td>Total =</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Construction, Maintenance and Ownership</td><td>• Not discussed. (See “public-private partnerships, leasing, asset sharing, or resource trading” section below for related information.)</td></tr>
<tr><td>Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading</td><td><u>Public-Private Partnerships:</u>
• The ADOT Broadband Office is leading initiatives related to future public-private partnerships.
• Though not a traditional public-private partnership, ADOT recently entered into an “operate, maintain, and commercialize” (OMC) services agreement with a private sector company to manage fiber leasing for a 400-mile network buildout (described below), which includes a revenue split between ADOT and the company.

<u>ADOT Broadband Development (grant funds) and Leasing to Broadband Providers:</u>
• ADOT is constructing 400 miles of broadband fiber, using American Rescue Plan Act (ARPA) Coronavirus State and Local Fiscal Recovery Funds (SLFRF) federal grant funding. ADOT received this funding from the Governor’s</td></tr>
</table>

	office (Arizona Commerce Authority) to build middle mile fiber to provide broadband connection to underserved and unserved communities.
	• Of the 400 total planned miles, 200 miles has been built, including I-17 Phoenix to Flagstaff and I-19 Tucson to Nogales. The next 200 miles will be constructed along I-40 from the California border to Flagstaff.
	• ADOT is not able to operate and maintain the full 400-mile network with current staff, so the agency will lease fiber. To manage this, ADOT issued an RFP for OMC (operate, maintain, and commercialize) services and recently procured eX^2 Technology to provide these services. This is a revenue-based arrangement, with a revenue split of the leases between ADOT and their private sector partner (eX^2). The model is self-sufficient for operations and maintenance of the network, and excess revenues will be used for additional build out.
	• Arizona passed legislation (AZ Revised Statute 28-7387: Smart highway corridor trust fund: purpose) that revenue from leasing conduit/fiber must go into the state's Smart Highway Corridor Trust Fund and can only be used for 1) operations, maintenance and expansion of the telecommunication facilities and services; and 2) building future broadband projects.[1]
	• ADOT is the owner. 288 fiber cable was installed, which includes 144 strands for ADOT's ITS network and 144 strands available for leasing. The first lease will soon be finalized.
	• Use of this new fiber network for ITS purposes:
	  ○ Currently ADOT has a project in design to connect all dynamic message signs (DMS), cameras, and other ITS devices along the corridors.
	  ○ ADOT's ITS communications infrastructure needs extend well beyond the fiber corridors that are being built. Gaps exist where there are large concentrations of traffic, for example along managed corridors. The funding is dedicated to connecting underserved and unserved communities, so those locations have prioritized for the buildout.
	
	ADOT Leasing from AZNet:
	• ADOT leases some fiber connections from AZNet (in Arizona Department of Administration), for example to provide connections to Tucson.
	
	Fiber Sharing:
	• ADOT shares fiber (4-5 strands) with some municipalities in the Phoenix area. In some situations, ADOT will allow local agencies to install their conduit within ADOT's ROW.
	• ADOT participates in AZTech, a regional traffic management partnership in the Phoenix Metropolitan area that guides the application of ITS technologies for managing regional traffic. AZTech meets monthly,

[1] Supplemental information provided by ADOT via email 12/10/24.

	providing an opportunity to coordinate traffic operations in the region including ITS communications.
Information Technology (IT) Support	• Not discussed.
Funding for ITS Communications	• Not discussed specifically. (ARPA federal grant funding discussed in other sections.)
Security with Shared Facilities	• Security in the Phoenix area is coordinated through the AZTech group. For ADOT-owned conduit, the local agencies and ADOT use the same conduit and pull boxes. For lateral connections, the locals install their own box to connect to their local connections. ADOT boxes are secured with padlocks. • The biggest issue is wire theft, as fiber is removed while looking for copper. • For the new fiber network, eX^2 will be the only private sector owner/operator in the right-of-way since they are managing the leases. Racks are available for private sector providers, and ADOT is working through the associated security measures.
Applicable State Laws	• Arizona revised state statute to allow public-private partnerships. ADOT identified the gaps and identified statute revisions. The agency looked at Utah and Nevada state statute for example language. • AZ Revised State Statute 28-7383. Management of state-owned telecommunication facilities: "The department may enter into an agreement with a public or private entity for the purpose of using, managing or operating state-owned telecommunication facilities and coordinating activities in this state relating to planning, mapping and procuring broadband service." • ADOT has received some pushback with charging a new permit fee for telecommunications, which began in January 2023.
Efficiencies or Cost Savings to the DOT	Federal Grant Funding: • The purpose of the fiber buildout with ARPA funding is to connect underserved and unserved communities. Leveraging this infrastructure to support ITS network operations is an added benefit to ADOT. • ITS infrastructure is now connected across the state, along key ADOT corridors and traffic signals. A significant amount of recreational traffic travels to Prescott and Flagstaff, and now ADOT is able to monitor the traffic signals and adjust as needed during high-traffic situations. • Because the Flagstaff, AZ area experiences high levels of snowfall, connecting to ADOT's snowplows is important. When fiber is available in this area, it will be very helpful to connect to the plows. • Other benefits of this increased fiber infrastructure supporting ITS networks: ○ Faster traffic operations response times: ADOT can view and assess situations quickly before emergency vehicles arrive on the scene, enabling a proactive response in terms of adjusting signal timings.

	○ Improved traveler information: ADOT provides travel times to several tourist locations currently but is not connected in many locations. Improving connectivity will improve traveler information to motorists.
Challenges or Barriers	• When installing fiber conduit, snow runoff filled the boxes with water. It became very important to secure and seal the fiber, splice enclosures, and other components during construction. • Marking the fiber conduit has been a challenge. Even ADOT construction projects have hit the in-place conduit. A lesson learned is to take the time and effort to adequately mark new conduit installations. ADOT's regional TSMO staff typically provide the locates but this can be a heavy lift with many miles of installations.
Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• ADOT has a broadband coordinator, created a distribution list and ability for broadband providers to sign up online, sends out 5-year construction plan, and coordinates with statewide broadband planning efforts. • To date, ADOT hasn't had any providers reach out. The ADOT projects occur at distinct locations that often do not match up to the providers' plans. • ADOT's fiber buildout has been more of a middle mile effort, not in smaller communities. It could be difficult to implement "dig once" in a smaller community. However, resource exchanges might be possible. For example, the city could allow the provider to put in larger conduit with no right-of-way cost to the provider, if they provide fiber to the city.
Other Relevant Information	ADOT coordinates with other nearby states in the west/southwest (e.g., Utah, Nevada, Colorado, Idaho, Oregon, Montana, New Mexico) through a small, informal, grassroots level broadband community called the Western Broadband Summit. These states' broadband coordinators convene annually to discuss issues and trends, identify coordination opportunities, and discuss redundancies to maintain connections in the future.

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Administration of Communications

California Department of Transportation (Caltrans)

Interview Summary

Interview Participant:

- Ferdinand Milanes, Caltrans

Interview Date: September 9, 2024

<table>
<tr><td>Communications Mediums and Approximate Usage for ITS Networks</td><td>
<table>
<tr><th>Mediums</th><th>Approximate % Usage</th></tr>
<tr><td>Fiber</td><td>6 districts (not all, but includes larger districts)</td></tr>
<tr><td>Cellular</td><td>All 12 districts (some districts migrating to FirstNet network)</td></tr>
<tr><td>Microwave Part 101 (e.g., 900 MHz, 4.9 GHz, 5.9 GHz)</td><td>Some districts (not all districts)</td></tr>
<tr><td>Satellite (%)</td><td>Researching feasibility</td></tr>
<tr><td>Radio: Part 90 (%)</td><td>-</td></tr>
<tr><td>Bluetooth (%)</td><td>-</td></tr>
<tr><td>Wi-Fi (%)</td><td>-</td></tr>
<tr><td>Other</td><td>AVPN (digital circuit replacing analog leased lines from telephone company) in 1 or 2 districts</td></tr>
</table>
</td></tr>
<tr><td>Construction, Maintenance and Ownership</td><td>• Caltrans builds (state forces and contracted) and owns its communications infrastructure.
• Caltrans is responsible for maintaining the communications infrastructure through state staff and overflow contracts. For example, Caltrans experiences staffing challenges and can only employ about half of the electricians they need, then overflow contracts are utilized for system maintenance services.</td></tr>
<tr><td>Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading</td><td>• In some cases, Caltrans partners with metropolitan planning organizations (MPOs) to deploy ITS assets, e.g., some MPOs have funded ITS field devices.
• Not aware of public-partnerships, leasing, asset sharing or resource trading for communications infrastructure.</td></tr>
<tr><td>Information Technology (IT) Support</td><td>• There is a dedicated IT group at Caltrans that assists with ITS implementations and controls all IT activities such as procurement, equipment, and other aspects of IT.</td></tr>
</table>

	• The ITS group does not have dedicated IT staff, but the Caltrans IT group is very familiar with the ITS network. Operations staff have regular meetings with IT staff. Each district has an IT manager, and staff are assigned as needed to the IT efforts in each district. • Benefits: The Caltrans IT group has standard software and equipment such as routers, which makes it easy for IT staff to support the ITS communications network and equipment after it's installed. Equipment standards for equipment, and for the various levels of IT users (e.g., power user, midgrade user, beginning user) have been developed from the IT user perspective which takes the guesswork out of the user. • Challenge: It can be difficult to fit the ITS network's needs into the IT model, which has rigid, state-level guidelines that don't always align to the needs of the ITS network.
Funding for ITS Communications	• Caltrans predominately utilizes capital funds. • MPOs partner with Caltrans to fund some ITS devices. • Slowly trying to obtain grant funding.
Security with Shared Facilities	• For Caltrans TMC facilities that are shared with Highway Patrol, Highway Patrol has security responsibility including sign-in and badging.
Applicable State Laws	• The California Office of Emergency Service (OES) has statutory authority over public safety radio and microwave radio communications systems. However, if Caltrans is using communications for other purposes not designated as public safety (such as traffic cameras for traffic management), Caltrans doesn't need approval from the state OES. • State funding (by statute) for maintenance doesn't include flexibility for upgrades or replacements. This requirement is restrictive given the maintenance needs for ITS once these networks are constructed.

Efficiencies or Cost Savings to the DOT	• Flexibility: California is a big state with diverse population areas, and therefore one size does not fit all. Districts have a lot of discretion to design their own communications systems to fit their needs. Headquarters does not dictate this.
	• Performance specifications:
	  ○ The traffic operations function in Caltrans headquarters sets up specifications for performance (e.g., for device up-time, reliability, contract for delivery, and funding). They review various measures reported by the districts and create a baseline and guidance for performance, including for contractors.
	  ○ California Senate Bill – 1 (SB-1) established the performance requirements that are intended to "ensure transportation needs are addressed, fairly distribute the economic impact of increased funding, and direct increased revenue to the state's highest transportation needs." The Establishment of Asset Class Performance Benchmarks memorandum establishes 10-year annual condition targets/benchmarks for transportation management system (TMS) elements such as dynamic message signs (DMS), ramp meters, and other ITS assets.

	• Consolidation of groups: In years past, Caltrans had separate groups for different ITS field elements (e.g., signals, cameras, DMS). Recently, Caltrans has consolidated these groups under Maintenance, and they now have shared efforts.
Challenges or Barriers	• The availability of communications services varies by region, which is a challenge. For example, multiple communications technologies are typically available in urban areas compared to rural areas, in certain areas it can be difficult to acquire permits (e.g. environmental constraints), or services can be too expensive. Because of this, Caltrans may need to construct its own system in areas where no service is available.

Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• A broadband council is in place to implement broadband development in the state.
	• The Caltrans Wired Broadband Facilities on State Highway Right of Way web page provides multiple resources for broadband providers:
	  ○ Includes links to regional contacts by district, a user guide, broadband installation FAQs, and permitting information.
	  ○ Includes: Map of Proposed Transportation Projects on the State Highway System
	  ○ Includes: Facility Co-location Informational Video
	• Caltrans also has a "Dig Smart" policy that was implemented in 2023. (See Chapter 600 – Utility and Broadband Permits Section 603.2A in the Caltrans Encroachment Permits Manual.) The Dig Smart policy presents an opportunity for lowering the capital cost of infrastructure deployment and minimizing disruptions caused by ongoing or duplicative construction, thus incentivizing and expediting new investment. The Dig Smart policy was established to promote opportunities for joint builds of broadband infrastructure. The policy outlines requirements for coordinating with Caltrans on broadband development in the right of way at any time, not just when Caltrans is doing work in an area. The policy indicates that broadband underground construction activities will be limited to once every five years and provides a process for requesting exceptions with proper justification.
	• Only a handful of broadband providers have reached out to Caltrans to coordinate.
	• Caltrans is currently building a middle mile broadband project, which is allowing broadband development. But it's early in the process and there hasn't been a chance to exercise the Dig Smart policy yet. See: State of California Middle-Mile Broadband Initiative.
	• If Caltrans can access dark fibers that are constructed in the future, it could result in cost savings and other benefits such as backup during emergency outages or used for connected vehicle backhaul, especially since the public safety spectrum is being taken away.

Other	It is important to keep the maintenance aspects in mind as communications infrastructure is designed and installed. Need to be sure that the staff and funding are in place to maintain systems and equipment over time, with a clear replacement plan when "end-of-life" is reached. Staff turnover is an issue, especially with retirements.

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Administration of Communications

Kansas Department of Transportation (KDOT)

Interview Summary

Interview Participants:

- Thomas Northup, KDOT (June 3, 2024)
- Mike Johnson, KDOT (June 3, 2024)
- Shari Hilliard, KDOT (June 3, 2024)
- Mitch Sothers, KDOT (June 17, 2024)

Interview Dates: June 3, 2024 and June 17, 2024

<table>
<tr><td>Communications Mediums and Approximate Usage for ITS Networks</td><td>
<table>
<tr><th>Mediums</th><th>Approximate % Usage</th></tr>
<tr><td>Fiber (%)</td><td>75%</td></tr>
<tr><td>Cellular (%)</td><td>20%</td></tr>
<tr><td>Microwave (%)</td><td>2%
(being phased out)</td></tr>
<tr><td>Satellite (%)</td><td>0%</td></tr>
<tr><td>Radio (e.g., 4.9 GHz) (%)</td><td>2%</td></tr>
<tr><td>Bluetooth (%)</td><td>1%</td></tr>
<tr><td>Wi-Fi (%)</td><td>0%</td></tr>
<tr><td>Total =</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Construction, Maintenance and Ownership</td><td>• KDOT is responsible for building, maintaining, and owning the ITS communications assets.
• A maintenance contractor provides ITS network maintenance services statewide.
• The Traffic Management Center (TMC) has contracted staff who assist in the administration of ITS infrastructure.</td></tr>
<tr><td>Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading</td><td>Fiber Sharing:
• KDOT has shared fiber with the city of Wichita. A fiber sharing plan is in place in Wichita and includes exchanging fiber resources – e.g., KDOT provides a few strands to the city in exchange for use of city fiber resources.
• KDOT general policy is to share fiber with other government agencies and public entities such as universities.

Coordination with Public Sector and Private Sector Entities:
• KDOT coordinates with Kansas Turnpike Authority (public agency) and Lumen and Zayo (private fiber companies) on joint fiber facilities. KDOT</td></tr>
</table>

	allows access to right-of-way and the fiber is co-located, ranging from sharing empty conduit to KDOT owning fiber in private sector cable. • KDOT originally allowed Lumen's predecessor to co-locate. The fiber installed for KDOT use was at no cost to the DOT. In exchange, KDOT allowed the company to install their own fiber in the right-of-way. • On a few projects, KDOT has entered into Public-Private-Partnerships that allows multi-duct conduit and fiber to be placed along selected routes in Kansas by a private company. This has been done in a shared trench installation, and also sharing of an open conduit in a multi-duct installation. This has resulted in construction cost reductions to KDOT.
Information Technology (IT) Support	• KDOT has IT staff to support ITS operations, and there are also IT staff within the state's IT Department.
Funding for ITS Communications	General: • State and federal funds are utilized for ITS communications assets. • There are no restrictions on federal funds specific to ITS communications, except Buy America. Grant Funding: • Advanced Transportation and Congestion Management Technologies Deployment (ATCMD) Grant: ○ This grant funding is being used for the installation of advanced ITS technologies along US-83 including a Connected Vehicle (CV) test. ○ As part of this project, 70 miles of fiber will be installed as KDOT's non-federal match contribution to the grant. ○ Project website is available at: US-83-Connected-Vehicle-Project • Infrastructure Investment and Jobs Act (IIJA) Broadband Grant: ○ This grant is supporting a fiber buildout to provide "middle-mile" broadband connections to underserved areas. The Kansas Department of Commerce obtained the grant. KDOT is a subrecipient and is responsible for contracting for the construction. ○ Multiple partners are involved in the project. KDOT contributed a cash match but also contributed right-of-way for installing the multi-duct conduit and fiber. ○ The buildout will include a seven (7) micro duct network, and KDOT will own fiber in one of the ducts. One (1) micro duct will be available for use by KDOT. One micro duct will be reserved for future use. Five (5) empty conduits will be available for use by private sector partners. ○ KDOT's ITS devices and the KDOT business network will be connected to the KDOT owned fiber in this new fiber network. ○ KDOT is developing policies and procedures for allowing open access to the available KDOT owned ducts. Dark and lit services will be offered by private partners. This will also address operations and maintenance. Prior to this grant, KDOT was undertaking efforts to build out fiber to increase connectivity to ITS assets. The policy and

	procedures developed for the grant will also be applied to other KDOT funded projects in the future. ○ The project will be completed in 4 years, and KDOT may start sharing some ducts prior to that. ○ Lesson Learned: ▪ Vet the early procurement process with the many partners involved. With significant interest from the private sector, it is important to ensure that the procurement processes are vetted even before submitting the grant application. ▪ Initiate policy and procedures early. The grant application was developed quickly, and now KDOT is working out several details such as open access to private internet service providers (ISPs) and determining if the backbone can handle it. In addition, will the private entities build their infrastructure later (handholes, vault access, separate vaults, connections)? How will security be handled (e.g., accompanying infrastructure such as communications buildings)? ○ Additional information about this IIJA Broadband grant is available at: www.kansascommerce.gov/program/challenge/middle-mile/
Security with Shared Facilities	• Security is being worked out but will possibly have separate racks for each entity and separate keys. • Policies and procedures related to security of leased fiber facilities will be developed as part of implementing the buildout for the IIJA Broadband grant.
Applicable State Laws	• No specific laws yet. The need for modification to state laws will be researched as policies and procedures are developed for the IIJA Broadband grant. As needed, language for new or revised legislation will be drafted to enable private partner access to KDOT-owned ducts/conduit.
Efficiencies or Cost Savings to the DOT	• Cost savings to the DOT has resulted when KDOT exchanges resources with the private sector, for example sharing fiber or conduit, or obtaining fiber for KDOT use in exchange for allowing a private company access to KDOT right-of-way. • Cost savings to KDOT are seen from the IIJA grant, especially with future private sector partnerships as the policies and procedures are finalized to define how to lease, license, or permit to KDOT's open conduits. • Public-Private-Partnerships that allow multi-duct conduit and fiber to be placed along selected routes in Kansas by a private company has resulted in construction cost reductions to KDOT. • KDOT has undertaken an effort to develop policies and procedures for enabling private sector access to KDOT-owned ducts/conduit; these policies and procedures will be used for future deployments. • KDOT is placing DOT office connections on their fiber network, to eliminate service fees from other providers. • KDOT has provided a free internet connection to the Kanas Highway Patrol as a benefit to a sister agency and results in overall cost savings to the state.

	KDOT also provides fiber as backup communications for Kansas Highway Patrol radio traffic.
Challenges or Barriers	• When co-locating with public agencies and/or private companies in the same trench, KDOT then needs to coordinate with these entities for re-locations, expansions, and construction. • Installing KDOT fiber in railroad right-of-way can be a challenge, in terms of permitting and policies near railroads. Each railroad is different. The railroads usually deal with commercial entities, so KDOT needs to review and modify the railroads' standard agreement language to fit government (i.e., KDOT) needs.
Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• The State Broadband Coordinator is the Kansas Department of Commerce. • KDOT has modified its utility accommodation guide and has adopted a Dig Once policy.

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Administration of Communications

Illinois Department of Transportation (IDOT)

Interview Summary

Interview Participant:

- Kevin Price, Illinois DOT

Interview Date: July 30, 2024

Communications Mediums and Approximate Usage for ITS Networks

Mediums	Approximate % Usage: Rural Areas	Approximate % Usage: Urban/Metro Areas
Fiber (%)	9%	80%
Cellular (%)	90%	15%
Microwave (%)	1% (phasing out)	
Satellite (%)	-	-
Radio (e.g., 4.9 GHz) (%)	-	-
Bluetooth (%)	-	-
Wi-Fi (%)	-	-
Other (%)		5% microwave and copper (both being phased out)
Total =	**100%**	**100%**

Notes:

- Varies from district to district.
- Adding more fiber, phasing out microwave and copper.
- In some districts, fiber backhaul exists from an urban area to the district headquarters.
- Automated Vehicle Location (AVL) system communications have been through dedicated 2-way radio system in the past, but now likely needed to move off radio due to high data volumes.

Construction, Maintenance and Ownership

- IDOT builds, owns, and maintains the ITS network, for the most part.
- Administration of the ITS communications networks occurs within the operations groups within the IDOT districts.

Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading

Resource Trading: IDOT conducts three types of resource trades, and agreements are initiated for each type.

- IDOT's resource trading with the Illinois Department of Innovation and Technology (DoIT) began when the state's central IT department at the time received a large grant through the American Recovery and

	Reinvestment Act (ARRA) and built fiber in the interstate right-of-way (ROW). IDOT waived the ROW fee in exchange for access to some fiber. Additional trades of resources and responsibilities have continued since that time. • Some IDOT districts trade fiber (use of strands and/or conduit) with counties or local municipalities. This is usually initiated during a construction project. If funded through a federal grant, IDOT will manage it. • Some IDOT districts are working with private broadband providers -- usually strand-for-strand trades – in areas where broadband needs exist. No money is exchanged. <u>Fiber Leasing:</u> • Background: IDOT has been tasked with considering how to build more fiber when construction is occurring, and funding is set aside for this. However, DoIT has also started building fiber, so IDOT is now coordinating with DoIT to determine the best locations to install fiber. IDOT has a mindset that the agency should use federal funding in as many projects as possible, including ITS. However, when IDOT builds fiber lines that could potentially be leased, the agency typically uses state only funding due to restrictions and requirements on use of federal funds for purposes beyond transportation. Because of this, trading deals have been prioritized over leasing to avoid accounting responsibilities and eligibility of federal funds. • Fiber leasing: IDOT actively advertises some fiber and conduit for lease. To accomplish this, IDOT has entered into a services agreement with DoIT to perform the advertising, maintenance, marketing, invoicing, and payment collection for IDOT's fiber lease agreements. IDOT is the owner, so each lease agreement is in IDOT's name. IDOT's services agreement with DoIT is self-funded through the revenue collected from the fiber leases. • Use of federal funds: If IDOT builds an asset with federal transportation dollars and is compensated for the use of that asset for non-transportation purpose, the revenue needs to go back into a federal "pot" to be used on a future federally approved, federal-funded project. Have so far avoided this funding logistics by utilizing trades-in-services agreements. Various federal programs (e.g., grants, other federal programs) have different rules, including the potential for leasing fiber.
Information Technology (IT) Support	• The IT function and day-to-day support of the ITS network resides in the IDOT districts in their operations group, which could include traffic engineers or electrical staff. • IDOT also contracts out maintenance, for example electrical maintenance contractors are required to hire a specialty subcontractor for the ITS network because it has grown and has become more complex. • IDOT also has IT staff within the administration section of IDOT, however their support for the ITS network is limited (e.g., to review specs). Currently there are only a few agencies that are allowed to have their own

	IT staff. This may change in the future especially with recent cybersecurity issues occurring, the state may want to consolidate all IT into a single statewide agency function. • DoIT provides statewide IT support for all other agencies, supporting "business network" (e.g., computers, printers, cell phones) needs but does not currently support ITS.
Funding for ITS Communications	• Federal funding is preferred. • Historically, Illinois has set aside ITS program funds for capital improvements. This is a set aside in state budget legislation, called out separately. It is a lump sum amount that rolls over and doesn't expire as long as the required documentation is completed. This state funding is also used for federal match on ITS projects. • This model has benefits and drawbacks. A benefit is that it provides flexibility for ITS expenditures and is not bound by the statewide process for transportation programming. A drawback is that more documentation on how projects are selected is required. To help with this, the statewide and urban/regional ITS architectures were updated a few years ago and an ITS plan was created. The ITS plan developed a repeatable, documentable process for ITS project selection, which has been helpful.
Security with Shared Facilities	Shared fiber or shared conduit results in two handholes (IDOT and the other entity) for access. Each entity handles their own security and maintenance.
Applicable State Laws	• Federal and state funding have different rules and regulations. • In Illinois, the length of an IDOT fiber lease was originally limited to 10 years based on procurement law (where state is purchaser.) However, it was later determined that the lease agreements can be 20 years because IDOT owns the fiber they are leasing.
Efficiencies or Cost Savings to the DOT	• IDOT agreement with DoIT for advertising, management, and marketing fiber leasing: This agreement has been very beneficial, as they have the expertise to coordinate and manage the external lease agreements. Revenue collected from the external lease agreements pays for the services provided by DoIT. With this model, IDOT is well positioned to pursue additional fiber leasing in the future. • Awareness of entities digging in the ROW through DoIT agreement: IDOT is not part of the state's "OneDig" call system (JULIE), because if an entity is digging in the ROW, they are supposed to obtain a permit, however this doesn't always happen. DoIT is on the OneDig call system, and because they are managing the IDOT services agreement, they field and respond to all OneDig calls. This helps to inform IDOT of digging that occurs in the ROW, even if it's not permitted. • IDOT's contract with University of Illinois-Chicago (UIC) for traveler information systems: UIC administers IDOT's traveler information systems. As such, IDOT has leaned on UIC's expertise in networking, for example when providing the districts with network connectivity and for other general advice and recommendations.

Challenges or Barriers	• "Dig once" implementation has been a challenge, at both the FHWA and state levels. Meetings are underway to review and revise state policies as needed. At the DOT level, the federal rule/regulation came from USDOT FHWA. At the state level, the lead is the State Department of Commerce and Economic Opportunity (DCEO). Illinois DCEO is focused on broadband development, and they administer the state and federal broadband grants. DCEO is the committee lead for "dig once" implementation, IDOT is a participant. DCEO is familiar with current FCC rules, which is helpful. IDOT's interest is rooted in helping to determine where fiber infrastructure should be built. • Resolving state and federal requirements will take some effort. For example, the FHWA regulation requires a statewide coordinator at the DOT, whereas state legislation named DCEO as the state's lead for broadband development. • Illinois State Dig Once Act: 605 ILCS 145/ Illinois Dig Once Act. (ilga.gov)
Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• The FHWA rule is not yet fully implemented, and IDOT is working with DCEO on this. (See "Challenges or Barriers" section above.) • No new opportunities with broadband providers have resulted from the rulemaking yet. However, the coordination occurring currently may lead to an opportunity to develop a better broadband infrastructure map showing in-place fiber throughout the state.

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Administration of Communications

Indiana Department of Transportation (Indiana DOT)

Interview Summary

Interview Participant:

- Jim Sturdevant, Indian DOT

Interview Date: June 25, 2024

Communications Mediums and Approximate Usage for ITS Networks

Mediums	Approximate % Usage*
Fiber (%)	40% Urban sites with high density of ITS devices – 250 miles of fiber
Cellular (%)	59% Includes all remote sites (e.g., rural ITS and rural signals.) 5000 cellular modems (2500 ITS devices and 2500 signals.)
Microwave (%)	0% - decommissioned
Satellite (%)	0
Radio (e.g., 4.9 GHz) (%)	1%
Bluetooth (%)	0
Wi-Fi (%)	0
Total =	**100%**

Construction, Maintenance and Ownership

- Fiber is owned by INDOT.
- Cellular services are purchased (on a private cellular network.)
- A few local agency signals are on INDOT's communications system, but this is not common.
- INDOT owns and operates its own ITS network, which is independent of other state agencies. The ITS communications network only supports the ITS field devices, it is not connected to the Indiana Office of Technology's state network which provides email and websites for the state.

Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading

Sharing and Leasing:

- INDOT can lease space on public right-of-way for privately operated cellular towers, but not space on INDOT towers. This might become more popular when 5G comes online.
- Dark fibers exist for the INDOT Broadband group and the INDOT ITS group. The agency does not run anyone else's data through INDOT's fiber.

Right-of-way Access:

	• See Doing Business with INDOT: Broadband Corridors for designated INDOT Broadband Corridors and right-of-way access rates (i.e., fee schedule).

Information Technology (IT) Support	• The IT function for the ITS network resides within INDOT and within the ITS group. The IT team includes three (3) network positions, two (2) database positions, one (1) ITS director, and a dozen or so LAN technicians.
	• Advantages of IT support within INDOT's ITS function:
	  ○ From a security standpoint, the agency does not have significant vulnerability factors. A small number of users have access to the ITS network, and the ITS network is not connected to other INDOT systems such as email. The ITS network operates with secure LINIX servers, and the data is archived and backed up regularly. The ITS network is a relatively low-level "target" for malicious attacks. If an attack did occur, the network could be up and running within a day or two. This closed network approach for ITS systems reduces risk to the agency. For example, if a breach occurred at a field cabinet this would not impact the entire agency.
	  ○ The ITS network doesn't need to compete for resources, for example with other agencies or with other entities in the agency (e.g., planning.)
	  ○ This allows the IT group to focus on ITS, with dedicated staff that specialize in ITS communications and devices and not being pulled into other tasks.
	• Challenges with IT support within INDOT's ITS function:
	  ○ With a closed approach, need to make do with your own resources and staffing. There is limited flexibility to absorb the work when there are gaps in staffing (i.e., when positions are vacant.) Some agencies procure outside services but with in-house expertise, the INDOT ITS group can be nimble without needing to go out to bid to hire outside expertise.
	  ○ Hiring qualified technical staff is a challenge, especially with evolving field technologies and needs (e.g., civil engineers not trained for ITS/IT.) Training and institutional knowledge transfer can be challenging.

Funding for ITS Communications	• Dedicated funding and resources have built up over time. Initially, the agency purchased and deployed new devices, systems, and the traffic management center. Now, focusing on enhancing, maintaining, and upgrading. For example, initially the agency deployed all microwave, but over time has upgraded to fiber and cellular. • The communications network has evolved and been modernized over time, leveraging capital expansion with maintenance and asset management. • INDOT often uses standard federal-aid (80/20match) projects, for example federal CMAQ funds, to build the ITS and communications infrastructure. • The agency has not been successful in securing much grant funding.
Security with Shared Facilities	• N/A

Applicable State Laws	• None noted.
Efficiencies or Cost Savings to the DOT	• Efficiencies exist with having a closed ITS communications network (not connected to other INDOT networks) and with having dedicated IT staff for ITS systems. • From a security standpoint, the closed network approach for ITS systems reduces risk to the agency in terms of reducing vulnerabilities from potential cyberattacks. • Because the ITS group has dedicated IT staff, the ITS network does not compete for resources within or outside the agency. This allows the dedicated IT staff to focus on ITS communications and devices without being pulled into other tasks.
Challenges or Barriers	• No significant barriers noted. • If sharing and leasing were more utilized, the ITS communications system would need to be re-architected. Security would be a challenge, as this would require being connected to other networks which the agency is not currently set up to do. • Currently, the use of agency owned right-of way (ROW) is the most significant asset INDOT has to offer. INDOT may be able to allow installation of private broadband facilities in the ROW in exchange for a facility provided to the DOT.
Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• Details describing the FHWA "Dig Once" rule are outlined on INDOT's website at: Doing Business with INDOT: Broadband Corridors. • Details of INDOT's Dig Once Rule (Article 16 Broadband Requirements and Criteria) can be found at: https://www.in.gov/indot/doing-business-with-indot/files/INDOT-Dig-Once-Rule.pdf. • No opportunities or partnerships specific to building out the ITS communications network have been experienced as a result of the rulemaking.

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Administration of Communications

New Hampshire DOT (NHDOT)

Interview Summary

Interview Participants:

- Susan Klasen, New Hampshire DOT
- David Chase, New Hampshire DOT
- Nicholas King, New Hampshire DOT

Interview Date: June 25, 2024

<table>
<tr><td>Communications Mediums and Approximate Usage for ITS Networks</td><td>
<table>
<tr><th>Mediums</th><th>Approximate % Usage</th></tr>
<tr><td>Fiber (%)</td><td>30%</td></tr>
<tr><td>Cellular (%)</td><td>30%</td></tr>
<tr><td>Microwave (%)</td><td>40%
(4.9 GHz for last mile and Part 101 Microwave for backhaul)</td></tr>
<tr><td>Satellite (%)</td><td>0%</td></tr>
<tr><td>Bluetooth (%)</td><td>0%</td></tr>
<tr><td>Wi-Fi (%)</td><td>0%</td></tr>
<tr><td>Total =</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Construction, Maintenance and Ownership</td><td>• NHDOT owns and manages its fiber and private microwave networks.
• NHDOT also owns most of the microwave, and leases tower space.</td></tr>
<tr><td>Public-private Partnerships, Leasing, Asset sharing, or Resource Trading</td><td>• NHSafeNet is a shared microwave network shared with several state agencies (e.g., NH Department of Safety, NHDOT, NH Department of Natural and Cultural Resources, and a non-profit (NH Public TV.) The network is owned and managed by the NH Department of Safety. NHDOT pays for maintenance and operations cost based on percent of bandwidth use and annual unscheduled maintenance.
• NHDOT has one run managed fiber network that is leased from the University System of New Hampshire’s iBeamNH network. NHDOT leases this run from the University System.
• No public-private partnerships for communications networks currently.</td></tr>
<tr><td>Information Technology (IT) Support</td><td>• The central IT function exists under the NH Department of Information Technology (a.k.a. “State IT”) and is consolidated into one department for all state agencies. Within this structure, the NHDOT has a designated group of IT staff for DOT. Further, the NHDOT TSMO function is assigned three IT</td></tr>
</table>

	staff embedded at the traffic management center (TMC), and their main job is to support the ITS network.
	• Benefits:
	  ○ Overall, this model works very well. The TMC IT staff are responsible for the ITS network, which is beneficial. These staff have the same training and purchasing power as the larger State IT system.
	  ○ NHDOT receives more reasonable purchasing/pricing because they are part of the larger State IT network.
	• Challenges:
	  ○ The NHDOT network is not connected to the overall state network. Overall, the State IT lacks awareness and understanding of the DOT's ITS network. Because of this, NHDOT has identified a need to advocate for additional funds toward the DOT's IT initiatives.
	  ○ Because NHDOT is not on the state network, they don't have paid IT staff on weekends for the ITS network. The agency is planning to conduct some exercises to demonstrate gaps in IT coverage.

Funding for ITS Communications	• A continuity of operations plan is under development, and federal programmatic funding within the TSMO Bureau is being utilized for this effort. The focus of the plan is improving and enhancing the reliability of the TMC. The scope of work developed with FHWA outlines that the funds will be used to optimize performance, enhance reliability, and improve traffic management, safety, and security (rather than "repair and replace.") • All design and construction projects are reviewed by the TSMO Bureau, to identify TSMO and ITS needs, solutions, and technologies. The TSMO Bureau is allocated up to 1.5% of construction costs and can secure more than this 1.5% if needed; this practice began in 2016. Other bureaus are also interested in deploying ITS solutions, indicating that TSMO is well integrated and considered throughout the agency. • NHDOT has recently applied for a grant to expand road weather information system (RWIS) stations, which would include communications upgrades since many are proposed are in remote locations.
Arrangements and Agreements	• NHDOT has a memorandum of understanding (MOU) in place which provides Turnpike funding to support the TSMO Bureau. A portion of the TMSO budget is provided by the Turnpikes, and in turn NHDOT manages their networks, deployments, day to day operations, ITS devices and ITS communications. Roughly 45% of the ITS devices in NH are Turnpike devices. • This is a beneficial relationship for both parties. The Turnpikes provide funding, and NHDOT has the expertise to deploy and operate the entire ITS network. An overall challenge is staffing, with a very small staff (4 people) to manage all ITS devices and communications networks. However, centralizing these ITS support functions is efficient since NH is a small state.

Security with Shared Facilities	• NH SafeNet shared microwave: Physical access is by personal identification (ID) for NHDOT staff and contractors. NHDOT only has access to the edge, via an edge router. • ITS cabinet security: NHDOT is pursuing a grant for enhancing cabinet access, monitoring cabinets and equipment, remote access, and sharing access with the Bureau of Traffic signals section. • Leased microwave tower space: NHDOT follow American Tower / Crown Castle standard log on procedures for physical access. • Co-location on state fire towers: In the past, NHDOT has occupied another state agency's fire towers at no cost but now needs to vacate these towers due to policies that don't allow communications on facilities that were constructed for fire control purposes. A lesson learned is to always have a lease agreement in place for co-location and sharing, even if it's at no cost.
Applicable State Laws	• No public law in New Hampshire addresses the use of public-private partnerships for ITS and communications infrastructure. • Some definitions for toll collections exist. These funds need to be spent on the road the toll is collected on, even for ITS/communications. • Can't record footage from highway cameras. Recording is only allowed for specific bridges, some transit centers, and tolling (EZ Pass).
Efficiencies or Cost Savings to the DOT	• Cost savings are primarily from discounts NHDOT receives as part of State IT. • NHDOT pays for only a small portion of the SafeNET shared microwave network maintenance and is not responsible for maintaining it (NH Department of Safety maintains) which is an overall cost savings to NHDOT. • The use of standard specifications (e.g., for portable devices) has resulted in efficiencies, especially when going out to bid. When standards are followed, the devices are compatible and can be integrated easily.
Challenges or Barriers	• Purchases that don't follow NHDOT's standard specifications result in inefficiencies. • The cost of installing fiber in the NHDOT network is often cost prohibitive. As a result, NHDOT needs to lease additional tower space or pay for cellular service to support ITS network operations. • Challenges exist with different procurement models used by NHDOT versus the state purchasing system. NHDOT builds much of its ITS infrastructure that is procured under low bid project contracting. If NHDOT needs to obtain products or services through the state purchasing system, a challenge may exist if initially it was procured using sole source versus low bid or vice versa. In addition, suppliers have regions based on where the manufacturer is located. State purchasing doesn't recognize all available National Association of State Procurement Officials (NASPO) ValuePoint™ contractors. However, NHDOT purchases major "systems" through an RFP process and bases more weight on technical than cost, and uses the DoIT template to expedite this process.

Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• NHDOT hasn't modified their policies per say, however the agency does try to include additional empty conduit on new bridge crossings or bridge repair/replacement projects. • No opportunities for sharing resources or new partnerships yet, however NHDOT doesn't currently have a process for this type of agreement. It is something that NHDOT is actively trying to resolve.

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Administration of Communications

Utah Department of Transportation (UDOT)

Interview Summary

Interview Participant:

- Lynne Yocom, Utah DOT

Interview Date: September 16, 2024, with additional information via 12/15/24 email.

<table>
<tr><td>Communications Mediums and Approximate Usage for ITS Networks</td><td>
<table>
<tr><th>Mediums</th><th>Approximate % Usage</th></tr>
<tr><td>Fiber (%)</td><td>87%</td></tr>
<tr><td>Cellular (%)</td><td>6%</td></tr>
<tr><td>Microwave (%)</td><td>1%</td></tr>
<tr><td>Satellite (%)</td><td>1%</td></tr>
<tr><td>Radio (Unlicensed Frequencies) (%)</td><td>5%</td></tr>
<tr><td>Bluetooth (%)</td><td>Secondary function of the network</td></tr>
<tr><td>Wi-Fi (%) (Part of Radio)</td><td>Secondary function of the network</td></tr>
<tr><td>Total =</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Construction, Maintenance and Ownership</td><td>• UDOT owns and manages its communications network for ITS.
• UDOT also partners with cities and counties and Public Safety.</td></tr>
<tr><td>Public-private Partnerships, Leasing, Asset Sharing, or Resource Trading</td><td>Resource Trading with Telecommunication/Broadband Providers:
• UDOT enters into resource trade arrangements with telecommunication (i.e., telecom)/broadband providers. This includes cash or in-kind trades, including trades involving fiber strands, conduits, and other communications infrastructure.
• A running log is maintained to track the value of all trades and ongoing balances with each telecommunication/broadband provider.
• The UDOT Fiber Trade Approval Committee reviews and agrees on trades. All trades are required to improve the UDOT ITS communications system.
• A formal “master” agreement is in place with each telecommunication/broadband provider, and a “trade identification number” (TID) under the master agreement is created for each trade.
• The process requires building trust with the providers. It also requires an easy and clear process, and companies need to know where to go to find out about the process.</td></tr>
</table>

	• State legislation was required to enable trade arrangements. (See Section below on "Applicable State Laws." • The 2002 Olympics in Utah was the initial reason to initiate resource trading, as the agency needed cameras with fiber communications back to UDOT Traffic Operations Center (TOC) which prompted the initial fiber buildout. • UDOT Fiber Map: Shows in-place fiber and locations where UDOT would like to have fiber installed, then the companies can see where there are gaps. • UDOT acts as a neutral facilitator, meets with providers annually in a group setting, and does not sign exclusive agreements for right-of-way (ROW) access. ROW access is by permit. • See the Fiber Optic story link on UDOT's Strategic Vision web page. Asset Sharing: • UDOT and the Utah Department of Technical Services (Utah DTS) have some shared fiber facilities. Use of Federal Funds: • UDOT uses any betterment from the fiber and conduit trades to grow the fiber and conduit system. That way the federal dollars are used in accordance with the original intent. (Example: I-15 has 16 conduits. UDOT is currently using 3 conduits and reserving one for future growth. That leaves 12 available conduits to trade to help expand the conduit system in other locations in the state. It is a good use of federal dollars to install additional conduit when the road is being rehabbed because additional conduit placed when the road is opened up is much less expensive than coming back and trying to add it in as growth occurs.) • For every additional foot of conduit UDOT installs it trades it back to the telecoms in a 2 to 1 ratio. The UDOT network is approximately 3,400 road miles. 1,300 miles is UDOT installed and 2,100 miles has been installed and is maintained by a telecom partner. Therefore, for every $1 dollar spent in additional conduit capacity UDOT will see an additional $2 dollars in benefit in another location. This is how UDOT expanded into the rural areas. UDOT traded I-15 conduit for 24 strands of dark fiber from Salt Lake City to Monument Valley. This would have taken years, or it might not ever have been built. • It is also important to note that while transportation is UDOT's main purpose this conduit and fiber also helps connect communities. That is part of UDOT's Strategic Vision to Connect Communities by enhancing the quality of life through transportation.
Information Technology (IT) Support	• The Utah Department of Technical Services (Utah DTS) provides statewide IT support for internet, computers, and related services. • The UDOT traffic network is a closed network on separate fibers from the DTS network. • UDOT augments with DTS staff for the ITS traffic network. • UDOT will collaborate with DTS for fiber deployments.

	• DTS and UDOT are in the same racks and buildings, for the most part. UDOT coordinates with DTS on call before you dig markings even if it's a drop on a state building. • Drawbacks: - DTS and UDOT traffic operations sometimes have different visions. - At times, traffic operations will need a different type of equipment specific to the traffic network versus what DTS puts forth as a standard. • Benefits/Efficiencies: - Staff consolidation within the Utah DTS function and other efficiencies, for example DTS has more network techs spread across the state. - Standard equipment (e.g., network switches) is mostly used, so staff are familiar with the needed maintenance. - Shared fiber benefits both entities.
Funding for ITS Communications	• A mixed funding approach is utilized for the communications network. Yearly state budget for operation and maintenance costs. Grant funds that include Broadband Capital Projects Fund (CPF) grants, state funds, and federal funds (e.g., CMAQ funds for signal coordination as it reduces idling times, snowplow preemption increases efficiency.) Fiber projects are also included in road projects where it makes sense. Current example SR-162/262 fiber and conduit is being installed with the road improvement project. This project is on Navajo Nation and will greatly improve broadband communications for the tribal members.
Security with Shared Facilities	• Hubs are secured with cameras, physical key, and access cards. However physical security is a challenge, as a crowbar can be used to break in. • Most sites have electronic intrusion detection with alerts to UDOT staff. • A copper theft deterrent is labeling boxes with "Fiber Optics."
Applicable State Laws	• Utah Code 72-7-108. Longitudinal telecommunication access in the interstate highway system: https://le.utah.gov/xcode/Title72/Chapter7/72-7-S108.html?v=C72-7-S108_1800010118000101 • Rule R907-64. Longitudinal and Wireless Access to Interstate System Rights-of-Way for Installation of Telecommunication Facilities: https://rules.utah.gov/publicat/code/r907/r907-064.htm • Rule R907-65. Compensation Schedule for Longitudinal Access to Interstate Highway Rights-of-Way for Installation of Telecommunications Facilities: https://rules.utah.gov/publicat/code/r907/r907-065.htm • Rule R930-7. Utility Accommodation: https://rules.utah.gov/publicat/code/r930/r930-007.htm
Efficiencies or Cost Savings to the DOT	Resource Trades: • The savings to UDOT attributed to resource trades with broadband providers is more than $100 million in trade value alone, with additional savings due to avoiding leased services (e.g., camera data transfer charges) that would be needed if fiber was not in place.

	• UDOT receives a 2 to 1 benefit for their investments in fiber when they leverage resource trades. UDOT now has 3400 miles of fiber in place, supporting a very large traffic management network. • The map of in-place and planned fiber (UDOT Fiber Map) shows where UDOT would like to have fiber installed, so broadband companies can see where there are gaps and opportunities to partner. Tribal partnerships and grants are also shown on the map. • It is more efficient to install additional conduit (e.g., for future use and possible resources trades) when the road is being rehabbed because additional conduit placed when the road is opened up is much less expensive than re-constructing at a later date. • The addition of conduit and fiber helps to connect communities (part of UDOT's Strategic Vision), thereby enhancing quality of life through transportation. IT Support Model (statewide Utah DTS): • Efficiency with consolidation of staff in DTS supporting ITS network. • Standard equipment enables staff familiarity for maintenance. Shared Fiber with Utah DTS: • Shared fiber benefits both entities.
Challenges or Barriers	Resource Trades: • Ensure that the proper legal framework is in place. For example, if a resource is promised through an MOU (not a contract), the trade could fall through leaving the agency without the infrastructure they had counted on. • Smaller companies can often act faster and are more invested as a partner, compared to large companies.
Implementation of FHWA Final Rule on Broadband Infrastructure Deployment	• No changes at UDOT specific to this FHWA Rule. A "dig once" philosophy has been a best practice for UDOT for more than 25 years. If upgrading state roads, UDOT pays for 50% of the telecom re-location, which is an incentive for telecom companies to install in the right-of-way. • UDOT advertises projects through the Statewide Transportation Improvement Program (STIP). However, staff turnover at the telecom companies can result in lack of understanding the DOT process. • Two-way interactions occur. UDOT takes into consideration the telecom companies' input regarding where they want to deploy, so UDOT may consider this when creating the STIP. For example, UDOT tries to line up pavement projects with the needs of the telecom companies. UDOT goes to the telecom providers' annual meeting to share UDOT's plans and to listen, then UDOT develops their fiber buildout plan for the next year.