Alaska Department of Transportation
& Public Facilities

Land Mobile Radio System Phase II Deployment Report

Prepared for the Federal Highway Administration

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1 Preface

This report presents an executive summary, the project overview, Intelligent Transportation System standards and lessons learned for implementation of an Integrated Voice & Data, Land Mobile Radio System (ITS technologies) for the Alaska Department of Transportation and Public Facilities.

The project overview will cover the planning, research, testing, development, procurement and implementation processes used in completing the Land Mobile Radio Deployment Project.

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3 Executive Summary

In July 2004, the Alaska Department of Transportation and Public Facilities developed an integration methodology for Land Mobile Radio into the Department's Statewide Intelligent Transportation Systems Deployment Plan and the State Information Technology Plan.

After review of the Plans, the department determined the Project 25 integrated voice and data of the Alaska Land Mobile Radio project offered the best solution for the department's voice and data communications needs. This Federal, State and Local Government partnership project provided the funding mechanism to deploy the network of repeaters, gateways, zone controllers and switchers necessary to provide seamless radio network.

The department next conducted needs assessment to determine the number and type of radios for each Maintenance Station. Following the needs assessment, the department filed application to participate in the Federal Highway Administration Intelligent Transportation Systems Earmarks program.

The department, in partnership with Motorola Inc., developed the software to move data in the background and allow computing devices connected to the radio system to use the radio as if it were a modem. The Internet Protocol addresses used by the digital radio system provides for free movement of data to a server data repository.

Lessons Learned:
Permafrost presents special challenges to achieving a positive earth ground for digital communications. Several repeater sites required wells drilled where the well case contacted water to provide the positive earth ground. There are many places in Alaska where water is difficult to find. One site required four wells before finding water.

Multiple partners share the inherent risk of this type project. However not all partners will obtain funding in a timely manner and deployment plans will need to change to accommodate unfounded requirements. Working relations with all parties have remained professional and responsive throughout this project. However, deployment time lines remained fluid with delays ranging from materials, weather, permafrost to funding.

Each organization in the partnership experienced the challenge of re-education of the new funding policy makers for their organization. With any multiple year project, as new policy makers are elected or appointed they have concerns for both the cost and duration of a project of this scale.

4 Acronyms

ALMR	Alaska Land Mobile Radio is a repeater network managed by the Department of Administration
DOA	Department of Administration
DOD	Department of Defense
DOT&PF	State of Alaska Department of Transportation and Public Facilities
FCC	Federal Communications Commission
LMRS	Land Mobile Radio System is integrated digital voice and data subscriber equipment deployed to Maintenance Stations
FHWA	Federal Highway Administration
IP Address	Internet Protocol Address
ITS	Intelligent Transportation System
M&O	Maintenance & Operations
MMS	Maintenance Management System is software to manage highway assets
RF	Radio Frequency

5 Background

Land mobile radio repeaters have operated in Alaska for more than 30 years. The great distances between communities and mountainous terrain have always proven a challenge to low power out, line of sight communications. The existing radio systems proved inadequate with lost productivity and failure to provide the safety of life communications essential in Alaska.

In June 2000, the Department of Administration (DOA), in conjunction with the Department of Defense (DOD), conducted a statewide radio study in an effort to determine how to provide reliable radio communications. The Department of Transportation and Public Facilities (DOT&PF) user survey identified the many communications dead spots and the need for inter-operability with internal and external customers.

Responders to security, fire, medical, earthquake, flood and avalanche emergencies needed to coordinate mitigation efforts. A reliable, interoperable and expandable statewide network presented the best solution to Alaska's diverse communication needs. The DOT&PF research identified Project 25 compliant equipment with its integrated digital voice and data, VHF band, IP address and 16,000 talk group capability as the most viable of the solutions on the market.

The infrastructure necessary to provide the statewide network required multi partnerships and a mired of funding streams. The DOA and the DOD assumed the lead in developing the partnerships and accruing the majority of the funding necessary to build out the repeater systems.

The DOT&PF acquired Phase I funding for subscriber radio equipment through the Federal Highway Administration (FHWA) Intelligent Transportation Systems (ITS) Earmarks program. The Alaska FHWA as our partner, provided guidance through the application process and served as advisor for the Public Private Partnership Agreement with Motorola. The FHWA served as a technical advisor and provided research assistance throughout the life of the project.

The funding percentages for the Earmarks program are as follows:

ITS Earmark	50%
Other Federal Fund	30%
State General Fund	20%

6 Project Overview

6.1 Planning

In July 2001, the department began work with the DOA to plan system development, integration and deployment strategies. The integration strategy helped the department determine which components of the existing network and future systems would benefit from a digital voice and data capability. The department initiated a monthly news letter to keep personnel informed on new technologies and progress.

The department identified the need for near real time reporting to its' highway maintenance management system to collect needs assessment and quality assurance data. After user needs, the department developed the system requirements and mapped them to the National ITS Architecture. The Project 25 radios offered the opportunity to fulfill this data need as well as the ITS Standards.

During this time, the department developed the user needs for this and other ITS projects. By design, the development process for ITS projects encourages the interrelationships for the purpose of integration. The FHWA ITS program is an enabling process for enhanced performance and efficiency for Maintenance and Operations forces.

In the past the public and private sector were discouraged from partnership agreements. The Federal Government, recognizing the need to accelerate new technology development and deployment, now encourages partnerships.

6.2 Research

In September 2001, the department, FHWA and Motorola Inc. entered into partnership to develop and deploy the software to enable data transmission. At the time, all the manufactures of Project 25 equipment were three to four years from developing the software necessary to transmit data. Motorola was the only company willing to partner with the department to develop software which allows a computing device to use the radio as a wireless modem.

It was important for radio deployment to precede or coincide with the rollout of the department's MMS. The results from the Beta Test and final software for the radio were to serve as the primer for development of the Oracle Forms used to report highway maintenance needs and perform quality assessment surveys. The department presented research finding in the monthly news letter and at presentations to personnel.

6.3 Testing

In June 2003, the department, DOA and FHWA conducted Beta testing of the project software. Observers included DOD and Local Government. The Motorola development team completed the data software 30 days ahead of schedule.

The software performed better than expected with the integrated voice and data experiencing no delays or interruption of priority voice service. The data transmissions were quick and accurate. One observer from the DOD stated the text and graphics moved quicker over the LMRS than on their LAN.

For the test, one repeater in Fairbanks, two repeaters in Anchorage and one repeater in Juneau Alaska providing the communications to connect the three locations, covering a distance over nine hundred miles. The test validated the system as meeting the department's long distance communications needs.

Testing validated the system interoperability when radios moved from one talk group to another with a simple mouse click. The network of repeaters, switchers and gateways allowed the digital voice and data to move freely between the radio and T-1 telephone environments without delay or loss of data.

The ability to move data between these diverse environments will enable the department to provide assistance at one-man stations where a medical emergency went unassisted in the past. The ability to include one-man stations in a talk group with larger stations will insure there is someone to answer the call for help.

6.4 System Development

At the end of the testing, Motorola collected the new user needs and moved forward to modify the software to fulfill the functionality identified. From the lessons learned, the department realized the advantage of rethinking talk group organization.

The DOD and DOA worked in parallel to complete the repeater system build out and secure FCC approval of the statewide frequency plan. The repeater network along the highway would provide seamless radio travel allowing personnel to maintain communications with their highway maintenance station or other stations regardless of where they were on the state highway system. System build out provided safety of life communications to forty five of the eighty two State Maintenance Stations by the end of the 2008 construction season. The schedule to complete Phase III, a general funds project, is on hold while the State determines priorities.

6.5 Procurement

The department's procurement division helped develop the Public Private Partnership Agreement, which through a cost to benefit analysis allowed the department to purchase radios from Motorola without the competitive bid process. The department realized the benefits to this approach through reduced time lag and cost when compared to the normal competitive bid process.

Through the partnership, Motorola worked closely with the department to develop the software to move the integrated voice and data without requiring additional Motorola software on the attached computing device. This approach accelerated the

software development and enabled the department to be part of the development process. The remainder of Phase III radios will be purchased through the Western States Alliance Contract.

6.6 Implementation Process

The implementation process includes tasks to prepare the organization, people, vehicles and facilities for the arrival of the new radios.

- Establishing radio talk groups to support intended users proved to be a challenge. Having interoperability, adds a new dimension and special considerations to standard procedures of the past. Network operations, and having a possibility of 16 user-selectable channels on a portable radio leads to the question – what channel am I on or which one should I be on.
- Establishing maintenance support agreements is not unique, however with new equipment comes training requirements for internal maintainers and/or contractors.
- Receiving the purchased subscriber equipment and process them in through the responsible procurement/supply unit can add time to the implementation process.
- Programming the radios with talk groups is time consuming and the time for this task will depend on the number of radios involved. Thirty minutes per radio is a good rule of thumb for an experienced technician.
- Shipping radios to users can be a substantial part of a budget depending on the distance and mode of transportation.
- Installation cost for mobile, base station and console radios will vary widely based on availability of in-house/contractor staff and travel distances. Airfare in Alaska can be as mush as $2,500 for each installation technician.
- Providing essential user training requires participation at multiple levels in the organization and will require travel of the students or the instructor(s). User and refresher training can be by interactive CD available from Motorola.

The Motorola XTS5000 Model III portable radio has 350 functions available. All the manufactures of Project 25 equipment offer multi function radios. Training can be as simple as the instruction to wait for the radio to synchronize with the repeater before talking, or as complicated as programming and use of the programmable functions.

7 ITS Standards Applied

A list of the ITS standards are available on the FHWA website. The standards used for this project are:

- APCO Project 25 Standards for Public Safety Digital Radio
- NTCIP File Transfer Protocol Application Profile
- NTCIP Internet (TCP/IP and UDP/IP) Transport Profile
- NTCIP Point to Multi-Point Protocol using RS-232 Sub-network Profile
- IEEE P1455 - Standard For Message Sets for Vehicle to Roadside Communications
- 377-1980 (R1991, 2003) – IEEE Recommended Practice for Measurement of Spurious Emissions from Land-Mobile Communications Transmitters

During the Beta Test, the department validated system compliance for each of the above standards. Since there will be new capability in future versions of the LMRS software and transmitters, the department will continue the test process through future phases.

The Project 25 radios operate very much like the Internet and uses IP addressing to route both digital voice and data to the desired location(s). The digital voice, like other data, needs an intended recipient by address. This can be an individual radio or a talk group.

Data destined for a database server uses the same address methodology and the software supports multiple addresses messaging to radios, similar to Internet e-mail. During the movement of data from mobile computing devices, the department validated compliance with IEEE P1455 and 377-1980 (R1991, 2003) standards.

The concern and reason for measuring Spurious Emission was not as much the interference with other equipment as the health risk of high output transmitters and the antenna or source of RF radiation location. Antennas are typically mounts in the center of the cab, which is 4 - 6 inches from the operator's head. The radiation lobe from the base of the antenna when 100w VHF radios are used would pose a health risk to the eyes, brain, heart and lungs. The department elected to use the 50w version of the Motorola VHF XTL5000 mobile radio to reduce this health risk to our staff.

8 Lessons Learned

The implementation of a statewide system is not an easy undertaking, even for a multi-talented and disciplined team. The influence or impact of external forces will govern progress and often extend the timeline for events, which must take place in sequence. The installation of switchers, gateways and repeaters is essential to achieving area coverage. Repeater can only be installed in the summer months in Alaska due to the weather extremes when the work is on mountain tops.

ITS projects are relatively new to administrators. An administration change in the middle of a multi year ITS project can delay the schedule while the new administration feels out project worthiness and defines priorities. This process can add months to the timeline especially when multiple organization are involved. If one organization loses or fails to obtain its' funding, the entire project can be delayed or jeopardized.

Multiple partners share the inherent risk of this type project. One risk is that not all partners will secure funding in a timely manner and deployment plans will change due to unfounded requirements. Managing this risk requires creative thinking and a team effort to encourage other organizations to provide funding to keep the project on schedule.

Intuitional issues can also be barriers to progress. Each organization has to overcome the natural tendency to continue status quo. Not all members in the organization will want to embrace new technologies. Change management then becomes the most dynamic of the variables the project management team will have to control. Frequent information dissemination through newsletters, presentations and training are the best control mechanisms for change management.

Environmental issues: This project has proven to be common with respect to delays. With repeater systems, high ground is the optimum location and clouds are common around mountains. When a helicopter is the only way to get to the repeater site, weather can delay work for months.

Permafrost presents special challenges to achieving a positive earth ground for digital communications. Several sites required multiple wells drilled to find water to provide the ground. There are many places in Alaska where water is difficult to find. One site required four wells before finding water. Phase III of this project, the remote locations in the Northern, Eastern and Western parts of Alaska, water may be difficult to find. The DOA adjusted the final build out date for these areas from 2006 to 2008, in anticipation of the permafrost grounding issue.

When mounting mobile radios it is essential to have the radio install team, whither internal staff or a contractor, coordinate location for the radios, antennas and cabling with vehicle maintenance staff. Believe it or not drilling a hole, for the

antenna coax, through the vehicle air bag will disable this safety component. A mounting screw in the wrong place in the dash can also disable lights, light bars and other electronics. Even worse is when the screw causes an intermittent short which kills the battery (sometimes) when the vehicle is parked.