SOUTHEAST MICHIGAN SNOW AND ICE MANAGEMENT (SEMSIM)

Final Evaluation at End of Winter Season Year 2004

Road Commission for Oakland County

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16. Abstract

In the early spring of 1999, the Detroit Department of Public Works, the Road Commission of Macomb Country, the Road Commission for Oakland County, and the Wayne County Department of Public Services formed the Southeast Michigan Snow and Ice Management partnership, naming themselves the SEMSIM Partners. The purpose of the partnership was to develop an AVL (Automatic Vehicle Location) system that would allow the Partners to fight a snowstorm in a cooperative effort.

There have been three phases of the program. The first phase consisted of 40 vehicles (10 each partner) based on a standard application designed by Orbital Sciences Transportation Management Systems (TMS) out of Columbia, Maryland. The second phase was developed by Orbital Sciences from a suggested improvement by the SEMSIM Partners to create an Internet web-based system. This Phase II system that consisted of a mini-fleet of 40 vehicles that could be viewed from any PC computer that was able to access the Internet. After a trial period, the remaining fleet was expanded to the present 292-vehicle Phase III system.

This report provides an evaluation of the fifth season, the winter of 2003–2004. The evaluation centered on determining if the system (1) provided the tracking and reporting tools that the SEMSIM Partners wanted and (2) had the potential to provide improved efficiency and impacted standard ITS measures in a positive way.

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Executive Summary

In the early spring of 1999, the Detroit Department of Public Works, the Road Commission of Macomb Country, the Road Commission for Oakland County, and the Wayne County Department of Public Services formed the Southeast Michigan Snow and Ice Management partnership, naming them the SEMSIM Partners. The purpose of the partnership was to develop an AVL (Automatic Vehicle Location) system that would allow the Partners to track their vehicles and fight a snowstorm in a cooperative effort.

The SEMSIM system is a complex AVL system utilizing the Detroit area regional public bus system's SMART (Suburban Mobility Authority for Regional Transportation) 900 MHz radio system to provide communication between vehicles and computer terminals located at dispatch locations owned by the SEMSIM Partners. There have been three phases of the program. The first phase consisted of 40 vehicles (ten for each partner) based on a standard application designed by Orbital Sciences Transportation Management Systems (TMS) out of Columbia, Maryland. After evaluation of this system, the SEMSIM Partners suggested an improved Internet web-based system to Orbital Sciences. Orbital responded and developed a Phase II system that consisted of a mini-fleet of 40 vehicles that could be viewed from any PC computer that was able to access the Internet. After a trial period, the remaining fleet was expanded to the present 292-vehicle Phase III system.

This report provides an evaluation of the fifth season, the winter of 2003–2004. The evaluation effort consisted of numerous discussions with the SEMSIM Partners throughout the year and post-season interviews with the supervisors of the 16 of the 18 garages that have had the SEMSIM system installed. In addition, an interview was conducted with SMART personnel who will use the system to help schedule buses during winter months. Finally, other governmental agencies across the United States that are using AVL technology to track vehicles were contacted to see how they are using the technology in their states and cities. The evaluation centered on determining if the system (1) provided the tracking and reporting tools that the SEMSIM Partners wanted and (2) had the potential to provide improved efficiency and impacted standard ITS measures in a positive way.

AVL systems are expected to greatly facilitate early twenty-first century services. But just like any of the innovations of the past, it's going to take considerable work, experience, and time to utilize these systems in the most productive ways possible. The following recommendations highlight issues that need to be carefully considered as SEMSIM continues to evolve and moves into the next phase. These recommendations are more completely discussed in the full report.

- Review all vehicle installations and make sure they are operational.
- Have the system performance analyzed and determine where improvements can be made.
- Complete the installations of the remaining fleet vehicles.
- Host the SEMSIM system by a full-time Internet hosting service.
- Contract with Orbital Sciences to support the SEMSIM system beyond the initial warranty period. This support should include further training for all SEMSIM users and application enhancements when they are identified.

- Install a dedicated terminal for SEMSIM at each dispatch location for everyone's use so the vehicle status can be observed at any time without interrupting another task or having to launch the SEMSIM application.
- Ensure system operation through a preventive maintenance program.
- Spend time with the supervisors to ascertain what kind of information would be most useful to their operations.
- Consider installing laptop computers in the vehicles of those supervisors who have expressed interest in this means of accessibility.
- Conduct a mock run of a snow-incident observation.

1.0 Introduction

In early spring of 1999, the Detroit Department of Public Works, the Road Commission of Macomb Country, the Road Commission for Oakland County, and the Wayne County Department of Public Services formed the Southeast Michigan Snow and Ice Management partnership, naming them the SEMSIM Partners. This partnership was formed to develop an AVL (Automatic Vehicle Location) system that would allow the partnership to fight a snowstorm in a cooperative effort.

The installation of the expanded SEMSIM system to the 292 vehicles began in the second week of October 2003 and was completed by the second week of December 2003. In the second and third week of December, a series of meetings was held with each of the maintenance departments of the SEMSIM Partners to review the maintenance training that they received to support the system, determine if they felt they were ready to support the system and to review the installation of the SEMSIM equipment on their vehicles.

1.2 Objective of SEMSIM

The SEMSIM system is a complex AVL system utilizing the SMART (Suburban Mobility Authority for Regional Transportation) 900 MHz radio system to provide communication between vehicles and computer terminals located at dispatch locations owned by the SEMSIM Partners.

SMART is the regional public bus system in the Detroit area. Since the SMART bus system had additional capacity on their 900 MHz radio communication system, they agreed to allow the SEMSIM Partners co-use of their antenna and backbone system. In choosing Orbital as the vendor, the Partners gained an advantage in that the SMART AVL transient system and its communication system were also installed by Orbital Sciences, negating effort to bring a vendor up to speed on the communication system to be used.

The system consists of 900 MHz radio transmission from the trucks to an antenna in the Renaissance Center in downtown Detroit, an antenna in Clarkston, Michigan or an antenna at Omo Road in Macomb County. The system utilizes an asymmetric, non-simulcast architecture. Three frequencies are used with channels “A” and “C” from the Renaissance Center, “B” from Clarkston and “C” again from Omo Road. The frequency that each Partner’s vehicle uses is chosen based on its geographic operating area relative to the transmission towers.

Transmission from these three locations goes to the SMART center in Troy using a wide area network (WAN) system and from there is sent to a server system at Orbital headquarters in Columbia, Maryland. The server system is connected to the Internet that makes available all the services of the SEMSIM system to any computer connected to the Internet.

1.3 Project History

Below is an overview of the history of the SEMSIM project. The overview shows the considerable progress that has been made over the last five years in cooperation between the counties of Southeastern Michigan and the City of Detroit as well as the technical advances made and the large number of vehicles installed with AVL equipment. The web-based application allows any computer with Internet access to observe the operation of winter maintenance vehicles of the SEMSIM Partners.

1999–2000

Application based Orbtrac 100 installed on 40 trucks.

2000–2001

Second year of application based Orbtrac 100.

New web-based SEMSIM system proposed and approved.

2001–2002

New web-based SEMSIM system (based on Orbtrac 120) installed in 40 mini-fleet trucks.

Communication problems found.

2002–2003

Orbital provides additional enhancements and modifications to the truck-based hardware and web-based software to correct initial problems found.

Communication problems persist.

2003–2004

Solutions to communication problems are found and implemented.

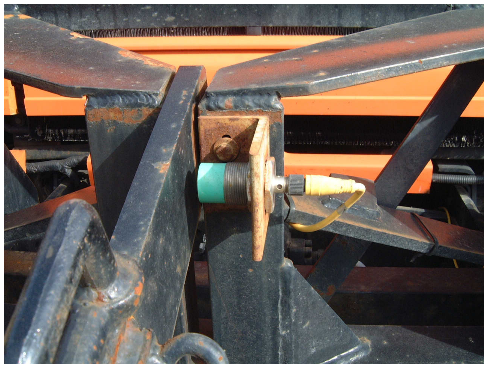
SEMSIM system is expanded to approximately 300 vehicles.

1.3.1 System Improvements

The SEMSIM AVL system has gone through many improvements over the last five years of operation. High speed and readily available Internet service to distribute the data to the garage service centers, improved ways of sensing plow positions, a much cleaner and reliable vehicle installation and easier to use equipment in the vehicle have made the system easier to use, more reliable and easier to maintain.

After the first year of operation, the Partners realized that a web-based application, which could be operated from any computer on the Internet, would provide the advantages of easily providing the data to the garage service centers using a high speed, publicly available Internet connection and would allow the use of a low cost computer dedicated to SEMSIM. The SEMSIM Partners worked with Orbital Sciences to develop an Internet based application that has the same features as the previous application that had to be loaded on each computer that ran SEMSIM. Where a dedicated LAN line or slow dialup connection was used previously to connect each SEMSIM terminal directly to the host system, the new design can use any public or privately available high speed Internet service. This makes support of the SEMSIM system much easier.

A mercury switch replaced the pressure switch to sense the belly (or blade under the center of the vehicle) and front plow positions. The proximity switch originally used for the front plow was expensive and was subject to damage. The belly plow used a pressure switch to detect the hydraulic pressure holding the blade to the pavement. The mercury switch is smaller, more protected and provides a much more accurate way to sense various positions of a plow being down than the pressure switch that was used to detect the hydraulic pressure holding the plow to the pavement. The pressure switch seemed like a good idea since it was a clean installation and could be mounted in a more protected area of the vehicle because it just sensed pressure of the hydraulic fluid going to the plow. Unfortunately, it was found during discussions with drivers that the blade was not always forced against the pavement, but sometimes held slightly above the surface in order not to damage shoulders. The mercury switch could be set to indicate plow down when the plow was held slightly above the road surface. Figure 1 shows the proximity sensor used in the first front plow installations for Phase 1 and Figure 2 shows the mercury sensor that is used today.


a

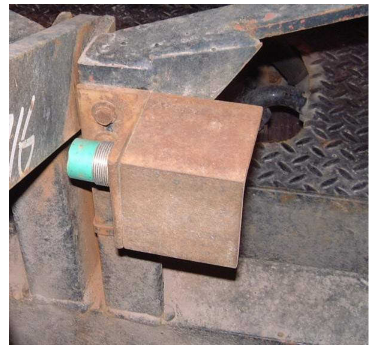

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Figure 1. Proximity Sensor on Plow Used in Phase 1
(a. Unprotected b. Shield to Protect Sensor)

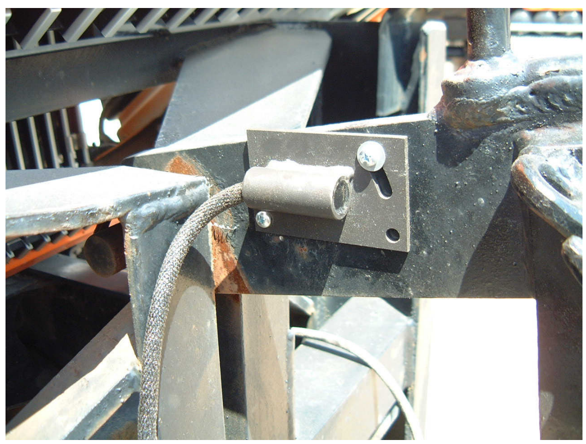


Figure 2. Mercury Sensor on Front Plow

The installation into the first 40 vehicles in 1999 found that providing a clean and protected installation would be better done with a simpler, more rugged connector system and a single housing for the radio, the Orbital VLU (vehicle logic unit), charge guard (that maintains power to the system for a period of time after the vehicle is shut down) and the cable termination block. Figure 3 shows the internal components of the single housing that protects the vehicle electronics. Figure 4 shows the old MDT (mobile data terminal) with three connectors (which often broke and fell off) and the new MDT with a single, more rugged connector that locks securely onto the MDT.

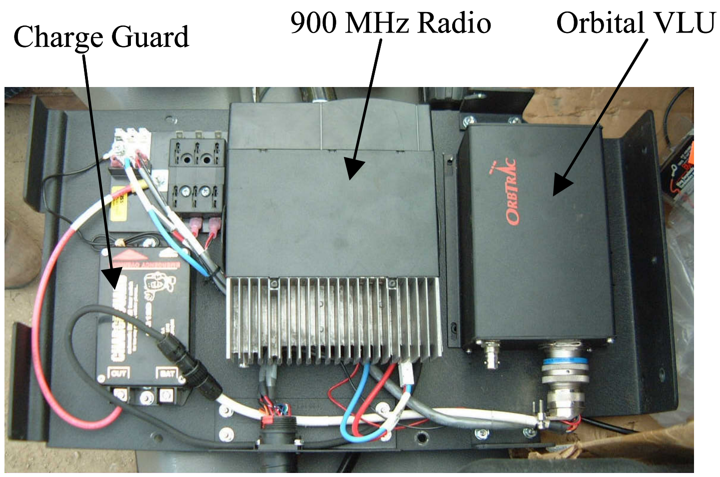


Figure 3. Single Housing for the Vehicle Electronics

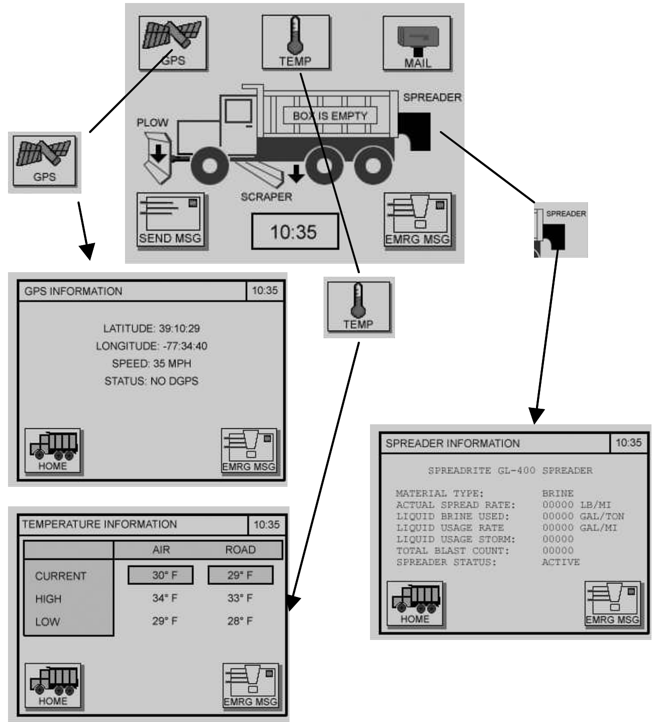
a

b

Figure 4. Connector System for Old (a) and New (b) MDT (Mobile Data Terminal)

The new Orbtrac 120 is an easier system to use. The display (MDT) shows a picture of a truck and visually shows the things on the truck that can be displayed. The MDT uses a touch screen to access the information. Figure 5 shows a picture of the MDT and the information displayed on its screen. From the home screen (Figure 5b), you can access information about GPS position, road and air temperature and material being spread. From this screen you can also send and receive messages.

a



b

Figure 5. Mobile Data Terminal (MDT)
(a) MDT with the VLU
(b) Display Showing Three of the Information Screens

1.4 Evaluator's Role

1.4.1 Tasks

The evaluator was given seven tasks as follows:

- Work with the SEMSIM Partners to review, and modify if appropriate, SEMSIM goals and objectives and the methodology as well as the measures for the evaluation.
- Work with the SEMSIM Partners to understand the system to be deployed and determine the extent to which the deployed system achieves project goals.
- Collect sufficient objective data to allow for the quantitative measurement of the effects of the project on snow and ice management operations.
- Document technical and institutional issues that impact the project and winter storm management decision making by the SEMSIM Partners. Characterize the activities and decisions of managers and vehicle operators in terms of their need for and use of information.
- Evaluate the level of integration with current or planned (for deployment within approximately three years) regional transportation or transportation-impacting programs that may influence the outcome of SEMSIM. Evaluate the degree of consistency with the regional

ITS Architecture that exists in Southeastern Michigan and the National ITS Architecture and any applicable standards.

- Provide periodic updates to the SEMSIM Partners of evaluation issues and results.
- Prepare and present a Final Evaluation Report to the SEMSIM Partners.

1.4.2 Objective of the SEMSIM evaluation

This project called for evaluation of how the Partners used the SEMSIM system. Evaluation goals were to assess the integrated system in terms of capability, acceptability, and impact, and to evaluate the project's value as a role model for other areas of the country.

General Dynamic's plan to conduct scheduled working sessions at four of the SEMSIM Partner garages and working sessions during snow incidents was delayed by the installation procedure, which went into January 2004. The installation procedure was followed-up by training sessions for the mechanics, administrators, garage superintendents, foremen and the drivers of the snowplow vehicles which were still in process into April 2004.

Because the users of the SEMSIM system were not able to use the system during the snow season, it was decided to modify the working sessions into interviews with 16 of the garages and the SMART bus dispatch terminal that are using the SEMSIM equipment. It was felt that this would do three things: Determine how the SEMSIM Partners will implement the SEMSIM system for both winter and non-winter operations, gather concerns that need to be addressed and are not being communicated to the SEMSIM management and demonstrate to the field supervisors that the SEMSIM Partner's management was proactive and interested in how the SEMSIM system is being received and what suggestions the field supervisors have for the SEMSIM system.

2.0 Status for 2003–2004 Season

Considerable progress was made in the 2003–2004 season. Many of the problems were solved. The communication problem between the trucks and the radio towers that has plagued the project for two years was solved by implementing advanced communication error correction protocols and redesigning the modem circuitry. The mini-fleet of 40 test vehicles was expanded to nearly 300 vehicles and training of maintenance, driver and supervisory personnel was accomplished.

2.1 Installation

Installation of the expanded SEMSIM system to 292 vehicles began in the second week of October 2003 and was completed by the second week of December 2003. A local company hired and supervised by Orbital Sciences did the installation.

The installation was to follow configuration drawings that were developed by Orbital with consultation from the SEMSIM mechanics and supervisors the previous year.

2.1.1 Installation issues

Between the time that the configuration drawings were made and the installation was started, new vehicles were purchased and put into service. The installation into these new vehicles complicated the configuration somewhat since these vehicles were different than the older vehicles they replaced. These new vehicles required changes to be made at the time of the installation.

The installation schedule was tight and required coordination of vehicles by both the SEMSIM Partners and the Orbital installers. Some of the installations took longer than Orbital had first envisioned and therefore held up the availability of the vehicles for which SEMSIM Partners had scheduled jobs. There were some liberties taken by the installers where they did not always follow the installation configuration drawings agreed to with the Partners. Some of the Partners felt that the displays (Mobile Data Terminal) were not installed in the positions agreed upon—where a driver could easily see them—but in places convenient to the installers. Some of the brackets had very narrow attachment areas and could be bent with very little pressure (see the photo in Figure 6). Instead of using a bolt and nut attachment, the bracket was mounted using two sheet metal screws into a relatively thin piece of sheet metal on the truck. In other cases the display was placed in the way of controls that resulted in them being pushed out of the way. During the interviews, several were found on the floor of truck cabs.

Sealing wire entrances and exits from the cab were not always done in a workmanlike manner and some of the vehicle's wiring seals were violated in order to pass the wiring for the SEMSIM system into and out of the vehicle cab. These had to be repaired later by a garage mechanic.

Figure 6. Mobile Data Terminal (MDT) Showing Fragile Mounting Attachment Using Sheet Metal Screws into a Sheet Metal Bracket

A number of the Partner's trucks have manual spreaders that don't provide spread rate information to external equipment. In other cases, the spreader may have the capability of providing external spread rate information, but the interface is not compatible with the Orbital AVL equipment. Some of the manual spreaders have been outfitted with manual spreader sensors. The Partners do not feel that this is a lasting solution and have had several of the manual spreader sensors knocked off because they project beyond the safety of the outer periphery of the side of the vehicle.

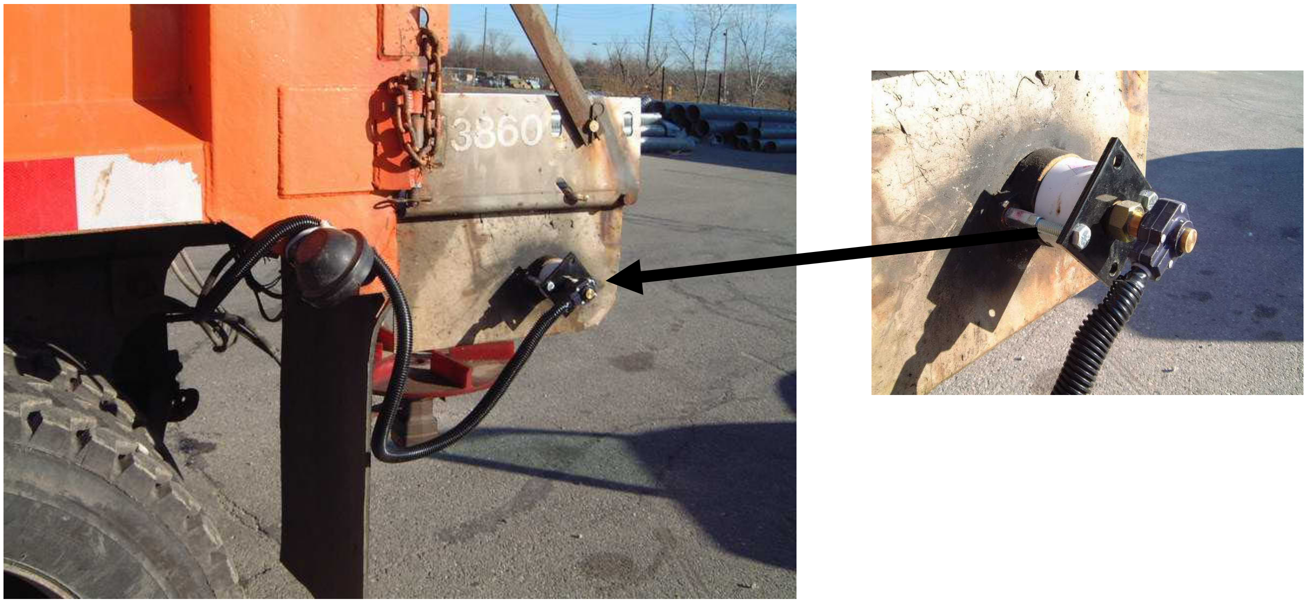


Figure 7. Manual Spreader Sensor

An effort should be made in future installations to make the installation as generic as possible by using standard wiring lengths and standard but adjustable mounts for the display (MDT). Ordering standard cable assemblies in volume would keep the cost of the cabling to a minimum. The unused cable length can always be tie-wrapped under the dash or in some other out-of-the-way place. Connectors should never be crimped in the field. Crimping of connector pins usually requires specialized training and the use of custom crimping tools that are not available in the field. Adjustable mounts might be more expensive than some of the fixed mounts, but the vehicle system could be transferred to a new truck more easily and adjusted during installation without a bracket design being required.

2.1.2 Sensor issues

The three types of sensors being used are spread rate, blade position and temperature. The preferred way to obtain spread rate is from an automatic spreader controller in cases where a compatible interface exists. Blade position for the SEMSIM AVL system is obtained by detecting the closure of a mercury switch that senses the tilt of a mechanical blade positioning member for both the front plow and the belly (or under-blade) plow. The temperature is obtained from a J1708 interface from a Commercial Vehicle Systems model no. 849-0039-000 Air/Road Temperature sensor.

None of these interfaces are considered standard for their specific application; however, the only one that is of great concern is the spreader interface because there are many spreader controller manufacturers. Unfortunately, spreaders do not have identical communication protocols and electrical interfaces. This makes interfacing them to the Orbital Orbtrac 120 problematic. It would be beneficial if these interfaces were made a standard. This interface compatibility problem is discussed further on page 19 and in Appendix B, page B-26.

2.2 Training

The training for SEMSIM consisted of driver training, maintenance training, web-based training (use of the application) and administrator training (training the managers on how to set up and maintain the system). The maintenance, web and administrator training were given to a limited number of representatives for each of the SEMSIM Partners with the intention of these representatives training the remaining users in their group. The drivers were given an abbreviated demonstration of how the vehicle system worked when they picked up their vehicle after installation.

The maintenance, web and administrator training consisted of about one-half day of instruction. The maintenance manual used for the maintenance training was excellent and provided a clear approach to debugging a system. The maintenance personnel felt that the training itself was much too short for a system as complex as SEMSIM. There was no hands-on instruction and many of the maintenance personnel had never really worked with the SEMSIM system prior to being trained.

The web and administrator training suffered from the same problem. The training was not sufficient for a clear understanding of the system. This training had the additional problem that the actual web-based application was used for training. The application used LANs (local area networks) at customer sites that were not yet tuned to running the application reliably. The result was that the application ran slowly and had interruptions resulting in training sessions with many distractions.

The SEMSIM Partners negotiated with Orbital to include additional maintenance training with the SEMSIM Partners at a designated time in the future using vehicles with known problems so a hands-on training session fixing real problems could be conducted.

The SEMSIM Partners also will be requesting additional web and administrator training from Orbital to improve their knowledge of the system.

2.3 Support

2.3.1 Warranty

The original approach to warranty was that Orbital would supply both labor and materials for one year after system approval by the SEMSIM Partners. The concern with this approach was that the SEMSIM Partners would have to deal with maintaining a system that they did not understand after the warranty period was done. It also appeared that Orbital was not prepared to maintain a large system such as SEMSIM. The Partners decided that using their own maintenance personnel and sending failures back to Orbital for depot repair was the approach they preferred to take. The Partners agreed to accept a maintenance training course for their maintenance departments in lieu of the on-site service originally proposed. Having the ability for each Partner to support the system, and the availability of spare parts being stored at one of the Partners locations, made SEMSIM self-supporting. With this change, Orbital agreed to provide further training for the Partners in order for them to have the proper knowledge to repair the system. In a meeting held in late July 2004, there was some reluctance by the maintenance departments of the SEMSIM Partners to handle the extra maintenance effort required by SEMSIM. Because of this, it may be necessary to fund maintenance through the SEMSIM program until the SEMSIM system is running smoothly and is considered an important part of the standard vehicle equipment.

2.3.2 Spare parts

Orbital does not keep a stock of spare parts for their Orbtrac 120 winter maintenance AVL product. They quote to a requested quantity of spare parts from the customer. This means that the SEMSIM Partners have to stock their own spare parts at a location yet to be determined. Some spare parts are being stored at Oakland County. A spare parts list has been generated by the SEMSIM Partners and quantities of each spare part to keep on hand are going to be determined during meetings held prior to the 2004–2005 winter season.

2.4 Winter Maintenance Cost Reduction

An automatic vehicle location (AVL) system can improve the efficiency of providing winter maintenance services through better use of supervision, service, material usage, and communication. There are several reasons why it is too early to expect these to be observable in SEMSIM. It takes time to ensure that the SEMSIM AVL system is tuned to gain these efficiencies and for the personnel to have the confidence in the system to believe the data they obtain. Nonetheless, it is good to review what are believed to be reasonable expectations from the system.

2.4.1 Supervisor efficiency

Supervisors are often out on the road during a snow emergency examining the conditions and determining the effectiveness of the snow clearing operation. Most supervisors believe that there will be some advantage using the system to track how a snowstorm is being cleared, but they do not believe that it will eliminate the trips they take to examine conditions. Some of the supervisors hope it will free up some of their time to get their office work done. Being able to view the big picture from a terminal showing the entire snow-clearing operation should enhance the supervisor's effectiveness as soon as they have all their vehicles installed and gain confidence in the system.

Knowing where the vehicles are, what part of their route they are working and how much salt they have left can help a supervisor determine which vehicle can be pulled from the job it is doing to handle a new route or problem without calling a number of vehicles to make that determination.

2.4.2 Material efficiencies

With the SEMSIM system, the amount of salt and other materials being applied can be monitored and controlled closely because the system displays what the driver is applying. Fuel efficiency can be improved by knowing what vehicle is closest to an area that needs attention and a driver can monitor the salt remaining without guessing or the danger of stopping the vehicle in traffic and getting out to check.

2.4.3 Goal setting

Because the SEMSIM system shows and records the details of a storm fighting operation, a supervisor can compare how one storm was handled as compared to another one. This allows a change of strategies to be made and then analyzed to see how the snow clearing operation can be improved. Goals can be set for drivers and groups to encourage improvement.

2.5 Better Communication

The primary communication used between a vehicle and the dispatcher is the private mobile radio system. This is the preferred communication method and works well when a driver and dispatcher need to have a live conversation, but is difficult to use during high traffic periods such as during a severe storm—the most critical time of usage. A dispatcher's time is critical during this period and non-emergency messages can take an important toll on a dispatcher's work schedule.

The Orbtrac 120 system has a text messaging capability that allows a dispatcher or driver to send a message (in a way similar to email) without having to have live communication. In other words, the message can be sent and then received by the other party at a later time. For non-critical messages, this can be a great time saver. Because there is a delay (up to several minutes) for the message to be handled by the SEMSIM system, it is not useful for interactive communication. It would be ideal, however, to reschedule a driver for a job that will happen, say, in an hour or so.

This messaging feature did not work well with the truck to tower communication problems that were experienced in the last couple of years, but now appears to work reliably. Because of the potential for distraction while driving, a procedure for making the best use of this communication feature has yet to be determined. An audible alarm indicating when a message has been received would be an improvement and has been suggested by the field supervisors and drivers.

2.6 Increasing the Safety of Winter Maintenance

As part of its communication feature, the SEMSIM system has an emergency alarm message that can be sent by a driver. This message differs from other messages in that it must cleared intentionally by a person at the office terminal. This message also provides for an audible alarm from the computer terminal. The fact that a person does not have to be at the terminal when the message is received is an additional security benefit.

2.7 Providing Better Response

The SEMSIM system allows the operator to determine the closest vehicle to an area that needs attention. This might be a bridge or a street that is slippery. A feature in the SEMSIM system allows the operator to find three vehicles that are close to the problem and dispatch one to that location. The system also points up areas that have not been covered or that has not been covered for a few hours and may need some additional treatment.

2.8 Reducing the Barriers between Agencies

In the past, communication between highway maintenance departments of the Southeastern Michigan counties and with the City of Detroit happened rarely, so ideas and approaches to solving problems were almost never discussed between these groups. The SEMSIM project has changed this dramatically. Since 1999 there have been regularly scheduled meetings between the maintenance departments of Southeastern Michigan governments, often once a month, to develop SEMSIM. But, other topics and solutions to problems are also discussed. SEMSIM has introduced people in the various governmental maintenance departments that may have never met otherwise. There has been discussion of potential cooperation in winter maintenance between governmental maintenance departments that would never have been considered it if it had not been for SEMSIM.

2.9 Providing Integration with Existing Systems

The original RFP required that there be an ability to integrate other services into the SEMSIM system. As discussed in Appendix B, page B-26, the SEMSIM system uses many industry standards: standard ESRI map objects for mapping information, a Microsoft SQL database with the Open Database Connectivity standard (ODBC) to store information, J1708/1587 vehicle communication standards and RS232 serial communication are some examples. No effort has been made to perform these interfaces yet, but the capability exists.

2.10 Providing Data to SMART

SMART is an active partner in the SEMSIM project. They have provided the 900 MHz communication towers and have attended many of the SEMSIM meetings. They have started working with the SEMSIM system and view the data as pivotal in making operational decisions about routing buses in the winter season. They also view the knowledge of where summer maintenance crews (repairing highways) are as important information to determine how close to schedule a bus can run. Additionally, highway maintenance can affect the ability for a bus to pull to the side of the road to board passengers. The knowledge of maintenance crew movement can allow SMART to determine if changes to their route might be necessary.

2.11 Creating a Model for Other States

The SEMSIM system is the largest winter maintenance AVL system in the United States. The SEMSIM members have been actively cooperating for five years to make the SEMSIM system a success. Members of the SEMSIM Partners have been active in giving presentations of the SEMSIM system.

Dennis Kolar (Director of Central Operations for the Road Commission for Oakland County and the Program Manager for SEMSIM) has spoken at the Arizona LTAP Winter Workshop in Pinetop, Arizona, Michigan's Annual Conference of the County Road Association, the Annual Meeting of the Michigan Chapter of the International Right of Way Association and the Michigan ITS annual meeting.

Brent Bair (Managing Director for the Road Commission for Oakland County) has given a presentation at the Snow Conference in Traverse City and has also included updates in his ITS presentations.

Pat Hogan (Director of Roads for Wayne County) gave a presentation last fall in San Diego at the National APWA meeting.

General Dynamics has discussed SEMSIM with many city and state organizations, some of which are part of the discussion about other state's use of AVL for winter maintenance (see Section 5, page 19).

The news organizations for the local television stations have provided over an hour of total coverage of SEMSIM during their normal newscasts.

These presentations and discussions have made SEMSIM highly visible to other governments across the United States. It is also recognized that SEMSIM, although not perfect, has been successful in making a large AVL system work.

3.0 Interviews

The installation and training for the new web-based SEMSIM system was not complete until after the 2003–2004 winter season. The first 40 vehicles installed with AVL equipment—the mini-fleet—consisted of ten vehicles at a single garage for each SEMSIM Partner. The expanded system, consisting of nearly 300 vehicles, involved 18 garage service centers. Since winter was over, the approach of viewing how the four sample garages of the SEMSIM Partners used the system for winter maintenance was no longer valid. General Dynamics suggested that a large number of the supervisors of the garages with SEMSIM systems be interviewed. By interviewing as many of the supervisors and some of the drivers of these garages that had the new SEMSIM AVL system, it was felt that we could understand how they were going to use this new tool they were provided.

Supervisors and drivers at 16 garages were interviewed. An interview with Steve Fern (Manager of Electronics and Communications of SMART) and with Phineas Williams (head dispatcher at SMART) was also done. These interviews were held from the middle of April 2004 through June 2004. Details of these interviews are in Appendix A.

From these interviews, a number of additional uses of SEMSIM were brought out, improvements were suggested and concerns about system issues discussed.

3.1 Non-winter Applications for SEMSIM

3.1.1 Locating/tracking all vehicles

The SEMSIM system is useful in tracking vehicles of all types in every season. There may be cost issues and many of the vehicles tracked could be done with equipment that does not detect any on-board equipment status. If equipment status (such as temperature, blade position, spread rate) is not required, the tracking alone can be done with much lower cost equipment including cell phone GPS devices that are on the market today.

3.1.2 Emergency response time reduction

Dispatchers can direct vehicles, which are being tracked with GPS equipment, to a site where they are needed. This is not limited to winter maintenance vehicles, but other emergency vehicles such as police cars, fire trucks and ambulances.

3.1.3 Recording curb-miles of sweeping

Aurora, Colorado equipped street sweepers with AVL equipment and has found it useful to track the status of their street sweeping operation.

3.1.4 Recording footage cut on vacant lots

Mary Richardson of the Detroit Southfield garage mentioned that they get reimbursed for cutting the grass in vacant lots. Many groups that work as cost centers and get paid for jobs done based on area covered could track the work using AVL equipment.

3.1.5 Pothole repairs

AVL equipment could be used to target potholes and dispatch patching crews to these areas using AVL equipment. Further, the holes could be tracked from the time they are identified until the time they are filled using a geographic information system (GIS) database. This would be a useful way to establish repair costs in order to determine when economics implies that road rebuilding would be more feasible than continued repair of a road surface.

3.1.6 Verification of any truck-related incident claims

Claims are often made of damage caused by plow trucks and other equipment to private property. The use of AVL equipment can verify or dispute these claims by reviewing the time period and the area where the claim was made.

3.1.7 Shoulder grading and liquid chloride application used for dust control on dirt roads

Shoulder grading and liquid chloride applications are some of the more popular non-winter AVL applications discussed by highway maintenance crews. Tracking where these operations are being done and storing the times they are done in a database would be useful for determining the progress of these summer maintenance jobs and provide the ability to easily schedule when they should be repeated.

3.1.8 Vactor drain cleaning

Drain cleaning is another application that is ideal for AVL. A GIS database of drains displayed on a map could be displayed showing which ones have been done recently. When a vactor completed the cleaning of a drain, it could acknowledge the completion by sending a message that would result in the map being updated and showing the date and time the cleaning was done. The vactor trucks could be tracked in the same way as the other maintenance vehicles.

3.1.9 Forestry issues

Tracking forestry crews would have similar advantages that tracking other crews would have. Knowing where a specific crew is working would allow them to be summoned to a location where they were needed

3.1.10 Locate and inventory culverts, light poles, fireplugs and other distributed capital equipment

Culverts can be buried over time and prove hard to find. A handheld GPS receiver (most likely one of the new GPS cell phones) coupled with an AVL application and a GIS database would allow the inventorying of culverts and other distributed equipment.

3.2 Improvements Suggested by Interviewees

3.2.1 Add an audible alert to messaging system

The flashing display is not felt to be enough to warn that a message has been received. An audible warning is suggested.

3.2.2 Develop "SEMSIM-on-a-Laptop" for supervisors on the road

Supervisors spend a lot of time on the road. Having an application tailored for the supervisor on the road would make it convenient for a supervisor to follow the progress of his fleet while he is looking at the condition of the roads.

3.2.3 Check maps for updates and accuracy

Supervisors have noticed that there are some errors in the SEMSIM maps. These errors are minor, but should be examined to see if they are in the map data or are due to the Orbital application misinterpreting the data.

3.2.4 Change emergency message button so it cannot be activated when cleaning screen

When the screen is being cleaned, it is too easy to activate the emergency message and then acknowledge that it should be sent during normal cleaning of the display. When use of emergency messaging is implemented, this could create a situation where emergency messages are not reliable and are therefore not taken seriously.

3.2.5 Conduct a mock snowstorm trial run

Performing a mock snowstorm will enable everyone to shake out the system and make sure that there is no problem when everyone is using it. The state of Virginia found that there was a problem with the speed of their Orbital system when all 80 of their trucks were operational. Testing the system during a snowstorm is not satisfactory. If a problem is found, no one has the time to debug and research what the problem might be. This was a suggestion by Floyd Drouillard, a Wayne County supervisor.

3.2.6 Review snowstorms after a storm incident to determine improvements and efficiencies

No one clearing a snowstorm has the time to perform an analysis of the snowstorm while it is being cleared. The SEMSIM system has playback features that allow analysis of the snow-storm clearing operation in real-time as well as the ability to run through it at high speed. This allows detailed analysis of what was done and how improvements might be implemented in future snow fighting efforts.

3.2.7 Schedule preventative maintenance

The system should not require much preventative maintenance, however, tracking areas where the system might experience heavy wear or deterioration might ensure that an expensive overall system repair is avoided. One example might be the touch screen display. Commercial applications of touch screen displays demonstrate that these are areas where high wear situations occur. A preventative maintenance procedure noting problem areas might find things that could be corrected before they become costly. For example, a screen protector could extend the life of the touch screen and keep a costly screen replacement from being necessary.

3.3 Key Concerns

3.3.1 Installations sloppy and deviated from original drawings

Some of the vehicle installations had cable egresses into the vehicle interior that left holes where water and road debris could enter the vehicle interior. MDT displays and cable routing were not done according to the original drawings. Some of these problems might be the result of new vehicles being introduced during the installation process.

3.3.2 Inadequate training—both when and how to use it

Both supervisors and drivers felt that they needed more training. The supervisors that attended the Orbital training sessions felt that the training was hampered by the operation of the system that was used to perform the training since it was still in the process of being updated. Some of the drivers felt that they really got no training since at best they received an overview at the time they picked up their vehicle.

No written procedures exist as to how the system is to be used and no real policy exists as to how it is to be integrated into the supervisor or dispatcher’s job.

3.3.3 System experiences too much delay

Most everyone expects snappier operation from the system both in screen updates and the vehicle position updates.

3.3.4 Messaging system too slow and impractical compared to radios

The people operating the SEMSIM system would like to see the messaging update more quickly. It is not unusual for a message to take five minutes to be received. This is most likely to be worse as more vehicles are added to the system. It should be noted that the text messaging system is not designed to be used as a real-time communication system. It’s most practical use is to send a message when it is difficult to contact someone because of overcrowding of the voice radio system or the person to be contacted is not personally available and the message is to be left for reading by him when he is free to check messages.

3.3.5 SEMSIM terminals are often shared with other users and applications

Having a dedicated computer in a convenient area in the garage office that is always on and running the SEMSIM application could go a long way to reduce the complaint of the SEMSIM application being slow.

If the system was always up and the information displayed so the application would not have to be launched, it could be used to obtain information quickly. The time to launch the system can take a minute or more and can take up to five minutes to log onto the computer, find the application, sign on to the SEMSIM application, launch the application and zoom into the area or find a vehicle in the list. This delay can be completely eliminated if the system is on and operational with the vehicles of interest pre-selected.

3.3.6 The SEMSIM system isn't being used and it remains unfamiliar

The supervisors need to clearly understand what is expected of them in using the SEMSIM system. It should be generally understood what efficiencies the management feels the SEMSIM system is going to provide.

3.3.7 The SEMSIM system isn't reliable enough to be counted on as a tool for everyday use

The perception is that the SEMSIM system is unreliable. This concern should be removed if a computer is provided for use specifically for SEMSIM, the supervisors are properly trained and any operational issues regarding the Internet connections resolved.

4.0 National and Local ITS Architecture

Mr. J. Richard Bishop, a national expert in the field of ITS, researched the national ITS requirements and contributed material for this section and Appendix B.

In the initial evaluation of SEMSIM relative to the National ITS Architecture, winter maintenance functions did not exist in that version of the architecture and surrogates were used for the evaluation. In the current version of the architecture (October 2003), Maintenance and Construction Management services have been added.

As before, it is clear that the SEMSIM design is compliant with the ITS architectural approach, based on a review of the national architecture philosophy, relevant user services within the national architecture, market package design options, physical architecture aspects, and the SEMCOG regional architecture. In no cases have areas of non-compliance been identified.

One area of concern, not directly related to the National Architecture, is the proliferation of diverse physical interconnects and data formats as new generations of instrumentation are released. Currently, there is not a standard interface for components of a system such as the SEMSIM system. Since the ITS National Architecture does not address these types of interfaces, it is recommended that SEMSIM and similar activities nationwide initiate an interface standardization effort. This effort could reflect standardized interfaces adhered to in the computer industry (parallel port, serial port, USB, firewire, etc.) and the automotive industry (CAN, J1939, J1708/1587). Economical and efficient deployment of winter maintenance management systems nationwide would benefit greatly from such an effort, which might be centered within an AASHTO (American Association of State Highway and Transportation Officials) committee or ITE (Institute of Transportation Engineers). The AASHTO Sub-Committee on Maintenance within the Highway Committee is a recommended starting point.

5.0 Experiences of Other Winter Maintenance AVL Users

5.1 Virginia DOT

Dan Roosevelt, a research scientist of Virginia DOT, and Virginia's consultant, Bill Campenni of Stuart AVL Technology, were interviewed several times over the last few years about the Orbtrac 100 AVL system that Virginia installed in 1997 for use on their winter maintenance program. Approximately three quarters of their fleet is made up of contract operators that bid for the business each year. Because of this, they often have operators that are unfamiliar with their routes. The primary use of their AVL system was to ensure that their operators were on the proper route and providing the service they are paid to perform. The fleet was made up of 80 vehicle-based systems transmitting to a base station using CDPD (Cellular Digital Packet Data). CDPD is a digital packet messaging protocol developed for the analog cell phone technology (AMPS) that is now obsolete and being discontinued by the cellular phone company suppliers. The system had sensors that indicated when salt was being spread (rate of salt flow was not provided), plow was down, and ignition was on. They also had messaging capability, but it was not used except for occasionally sending emergency calls back to the base station.

About two years ago the system was removed from the vehicles and put in storage. About a year or so ago, Robert Driscoll, Resident Engineer of Maintenance Operations, tried to use the equipment and found that the Orbtrac 100 system was obsolete and that the CDPD provided by AT&T was going to be discontinued. He decided to look for other ways to provide AVL for the dump trucks, plow vehicles, inspectors, sweep trucks, and for the pothole filling operation. He found that the new GPS cell phones, available from Nextel, could provide the position information and that software to provide a Internet map and reporting system was available from ActSoft. He is very happy with this solution that costs about $23 per month over the standard cell phone communication rates.

5.2 Minnesota DOT

Minnesota DOT installed their first AVL system in the summer of 1997. The system started with 15 transit buses, one sign truck, four state patrol cars, one DNR aircraft, and one state patrol aircraft. However, the equipment was removed from the transit buses because of problems with the bus management software. The system at that time utilized satellite communication for the rural areas and CDPD where it was available.

This year their supplier, Thomtech, is installing 60 AVL systems in snowplow vehicles using IDEN (Nextel) high speed communication. They no longer use satellite communication because of its high cost.

The AVL system monitors plow position, road temperature (using a Commercial Vehicle Systems—formerly Sprague—infrared sensor), and rate of salt being spread from a Force America or Dickey-John 2000 spreader controller. Thomtech, through a combination of phone support and occasional on-site service, performs system maintenance. Other maintenance applications that Minnesota DOT is considering for AVL are street sweepers, supervisor trucks, pothole-filling trucks, mower and vegetation control vehicles, and dead-deer pickup.

5.3 Iowa DOT

Dennis Burkheimmer, the Winter Maintenance Administrator for the Iowa DOT, provided an update on the status of the Iowa Orbital Orbtrac 100 AVL systems that were installed on 18 winter maintenance trucks for the 1998 winter season. The system used a 900 MHz digital two-way radio system built on top of a digital voice system. The trucks were equipped with front, wing and belly plows as well as an automatic Raven salt spreader with pre-wetter and a 900-gallon anti-icing spray system. The software included the Aspire reporting package. All the users were happy with the system and the information it provided, but funding ran out and they were not able to obtain the funding that would equip the entire fleet of 880 vehicles. The original contract called for an additional 150 vehicles to be installed, but due to lack of funding, Iowa had to pull out of the contract. Because they were unable to complete installation on the remaining vehicles, the Iowa DOT decided to remove the Orbtrac equipment and shut the AVL system down. The rational was that the system was only going to be useful if all vehicles could be tracked.

Iowa found that they were more interested in using the system for analysis after a storm to measure results and review where efficiencies could be improved. They are convinced that an AVL system is going to have to be used for year round operations in order for it to be available for winter uses and to justify its cost.

5.4 City of Aurora, Colorado

Lynne Center is the project manager of the AVL system for the City of Aurora, Colorado. Originally Orbital Sciences supplied and installed Aurora's AVL equipment in August of 1998. The installation consisted of 26 vehicles, 20 of which were winter maintenance vehicles. The system used differential GPS and CDPD communications supplied by AT&T. They chose CDPD because they have areas where their radio system does not adequately cover the winter maintenance area. Also, for safety and emergency use, they wanted to ensure adequate coverage. This vehicle AVL system collected position information every two seconds and sent position data every 20 seconds to the base computer. Orbital did not provide a way to detect the spreading rate for the Muncie and Component Tech spreaders they used.

When Lynne was interviewed on March 22, 2004, she said that Aurora had changed vendors to CompassCom out of Centennial, Colorado. There were several reasons for this change. The first was that Orbital no longer was supporting the Orbtrac 100. Secondly, CDPD (which uses analog cell phone technology) was going to be turned off in their area in July 2004 and they were going to have to switch to the GPRS GSM network. Lastly, CompassCom had reporting modules Aurora was interested in that were not available from Orbital. At the time of our conversation, Aurora was in the process of installing 40 vehicles and expected to have a total of 80 when the system was fully outfitted. The largest number of vehicles with the AVL system was to be their snowplows followed by sweepers, pavers and graders.

5.5 City of Baltimore, Maryland

The City of Baltimore installed Orbital Orbtrac 100 AVL systems in 75 snowplow vehicles in the summer of 2001. At that time, Paul Manik was the project manager for the AVL system. Over the last year, Bill Colbert, the transportation manager, has been managing the system. The system uses a 450 MHz Motorola data radio system transmitting out of four towers at a data rate of 19.2 kilobytes per second. The system is able to transmit plow position. They have Dickey-John manual spreaders. These spreaders are not capable of transmitting spread rate. Some spreaders have been modified to allow the Orbital system to indicate that salt is being spread, but no attempt has been made to transmit the spread rate. They use a mercury switch for their plow position. Baltimore hosts the system themselves. The system has been fairly reliable, but an incompatibility between the Motorola radio and the Orbital software results in the database having to be reset at times.

Lately, Robert Marsili has been managing the system. Because Orbital considers the system obsolete, Mr. Marsili is faced with having to upgrade the system entirely before expanding the system. He has visited New York, Washington and Philadelphia who have AVL systems that he is considering. Besides tracking winter maintenance vehicles, Mr. Marsili is interested in tracking road maintenance, lighting crews and pothole patching crews.

5.6 County of Waukesha, Wisconsin

Richard Bolte, Director of Pubic Works and Randy Schulz, Patrol Superintendent, for the County of Waukesha, Wisconsin said that they installed Orbital, Orbtrac 120 AVL systems on six test vehicles in March, 2003. The communication from the plow vehicles used a 150 MHz radio system originally used for voice radio communications for the county. The voice radio communications was moved to 900 MHz and the 150 MHz system was solely used for the Orbital AVL system.

The test vehicles were configured to provide blade position, salt spreading rate, ground and air temperature and vehicle speed.

They had planned on expanding the equipment to the total fleet of 70 snowplow vehicles and eventually other vehicles such as mowers and graders after the test period. In the first week or so, the system worked very well. Then they started to have server problems that resulted in polling updates from the vehicles going from two minutes to between 30 and 45 minutes. There were also several shutdowns of the server. Because of the poor experience during this test phase, they removed the test units in September of 2003 and have no further plans on expanding AVL into their snowplow vehicles. Unfortunately, this was the period when Orbital was still developing their web-based application and they were having problems that were corrected later that year.

6.0 Conclusions and Recommendations

6.1 Conclusions

The SEMSIM system is the largest, most sophisticated winter maintenance AVL system in the United States. It has the potential to provide detailed information about each winter maintenance vehicle that is owned by the three largest counties in Southeastern Michigan and the City of Detroit and present it to anyone that has a computer with an Internet connection. This is a powerful tool. It makes it possible to direct the winter maintenance operation from a computer terminal. In the future it is entirely possible that it will be unthinkable that such an operation, as clearing snow in a 5,000 square mile area, would be done without an AVL system such as SEMSIM.

SEMSIM has proven that a large, complex AVL system can be made to work. The SEMSIM system has improved greatly in the last six months when Orbital Sciences redesigned the error correction and the modem design for the wireless communication between the trucks and the transmitting towers. There are still major problems to overcome. The garage/service center personnel do not have the application readily available for their use. Secretaries and supervisors use the available computers at the garage/service centers to do critical jobs, such as payroll, that would have to be interrupted if SEMSIM was to be used. If the SEMSIM system is not up and operational, it tends to be ignored. Computers are scheduled to be installed for the garage/service centers for Macomb and Oakland Counties during the coming year; however, there is no assurance that they will be available for the coming winter.

The vehicle maintenance groups are not strongly supporting the maintenance of the SEMSIM system. They will not interrupt the use of a vehicle to repair a system that they do not feel is critical to the functional operation of the vehicle.

The speed of the application is not up to expectations. It is not clear where the speed problem exists. Orbital feels that it is the Internet connections at the SEMSIM Partner locations. The SEMSIM Partners feel that the application design has a lot to do with the lack of system responsiveness.

The server has been fairly reliable, but goes down for days at a time with no one at Orbital is aware that it has happened unless the SEMSIM Partners make them aware of the problem.

The SEMSIM Partners had a limited amount of training. Further training is being arranged and this should improve the ability of the supervisors, drivers and vehicle mechanics to use and service the system.

The SEMSIM management should be aware of suggested new uses for SEMSIM. The SEMSIM Internet program should allow Orbital or other software developers to build on the Orbital Sciences application and provide enhancements to the SEMSIM system when they become apparent. One potential application already suggested is a laptop version of the Orbtrac application usable by a supervisor in a vehicle examining the road conditions.

6.2 Recommendations

Our recommendations are based not only on the experience of SEMSIM managers, supervisors, and drivers but also on the experience of other states that have used an AVL winter maintenance system. In addition, we include recommendations that resulted from our discussions with SMART personnel.

Review all vehicle installations and make sure they are operational. Each of the 18 garage/service centers that have SEMSIM systems should be reviewed and the condition of each SEMSIM system should be noted. Parts needed to make the system operational or modified to make the display usable by the driver should be determined. Parts then need to be ordered from their suppliers and the vehicles repaired before the winter season.

Have the system performance analyzed and determine where improvements can be made. The SEMSIM Partners have questioned several areas of performance such as the speed of the application, the quality of the Internet connection and the coverage of the wireless communication. The SEMSIM Partners should have an independent analysis done of these performance issues.

Complete the installations of the remaining fleet vehicles. Use of the system will depend on being able to track and monitor the performance of all the vehicles in the fleet. The percent of vehicles installed at Partner sites vary from about 50 percent to over 90 percent. There are approximately 200 more trucks that need SEMSIM equipment to be installed to insure that the entire Partner fleets have SEMSIM AVL systems installed.

Host the SEMSIM system by a full-time Internet hosting service. Orbital Sciences is a system developer, but is not a hosting service with the experience and equipment to ensure nearly 100 percent system up time such as advertised by a professional, full-time hosting service.

Additionally, the equipment on which the system is being hosted was originally supplied by the SEMSIM Partners and is several years old. A professional hosting service would maintain up-to-date equipment.

Contract with Orbital Sciences to support the SEMSIM system beyond the initial warranty period. SEMSIM needs the engineering support from Orbital Sciences to provide further training for the mechanics, application users, drivers and administrators. Additionally, spare parts and equipment repair, additional equipment for new installations, engineering sustaining support (to correct engineering problems found in field use), application support for the Internet application and support for system enhancements that the Partners find valuable from their experience with the SEMSIM application over the next several months will be needed.

Provide a dedicated computer for SEMSIM at each dispatch location. Some supervisors in the garage/service centers are scheduled to receive computers in the coming year. Because many of these are to be ordered after the beginning of the next fiscal year, the danger is that they will not be available until well into or possibly after the winter season. The performance requirements of the computer for SEMSIM are modest and older computers—obsolete for other purposes—could be used for the SEMSIM application. Apparently the Partners have a number of these computers available. Obtaining these computers solely for SEMSIM would allow the SEMSIM application to be used by anyone in the garage/service center—including drivers that could view their daily performance. During our interviews it was apparent that the person that would use SEMSIM might not necessarily be the supervisor that is to get the new computer scheduled for the next year. If the computer used solely for SEMSIM were generally available to all personnel, its value would be greatly enhanced and might not be viewed so strongly as an intrusive monitoring device.

Ensure system operation through preventive maintenance. Not everyone views the SEMSIM system as an essential tool. Because of this, SEMSIM is faced with a chicken/egg scenario. It will not be used if it is not in good repair and it will not be maintained in good repair if it is not viewed as an essential tool and used consistently. The vehicle maintenance personnel and the computer support personnel of the SEMSIM Partners are not yet committed to maintaining the system. Therefore, it is suggested that a portion of SEMSIM funds be used to contract a third party to help maintain and support the system until the SEMSIM Partnership personnel are familiar with the system, understand its value and can support it themselves. It is suggested that this maintenance organization be contracted locally to ensure that they will be available to provide service on full time basis.

Spend time with the supervisors to ascertain what kind of information would be most useful to their operations. As users become more familiar with the SEMSIM system, new ideas for use of the information will become apparent. These ideas will come from the users operating the system every day—the supervisors, dispatchers and drivers. Meetings with these people should be conducted after they have had several months to use the system consistently to see what additional benefits can be discovered from SEMSIM.

Consider installing laptop computers in the vehicles of those supervisors who have expressed interest in this means of accessibility. Starting with those supervisors who are already asking for this feature would be a good trial to determine if all supervisor vehicles should have a laptop and what special needs are required to make it most usable and useful. A laptop application would need to be modified for ease of use in a vehicular application, keeping in mind that this environment would require something different than a desktop mouse-driven application.

Conduct a mock run of a snow-incident observation. The very limited experience of the partial storm observation last season points out the need to conduct a mock run to prepare all participants: observers, personnel responsible for the base station terminal, and drivers. Because a snowstorm is such an intense operation, any problem with the SEMSIM system will result in the SEMSIM being abandoned. A mock run will point out any problems that can possibly be corrected before the snow season. Also questions about how the SEMSIM system operates can be answered before an intense snow clearing operation distracts everyone. We recommend a pre-snow-season mock run.

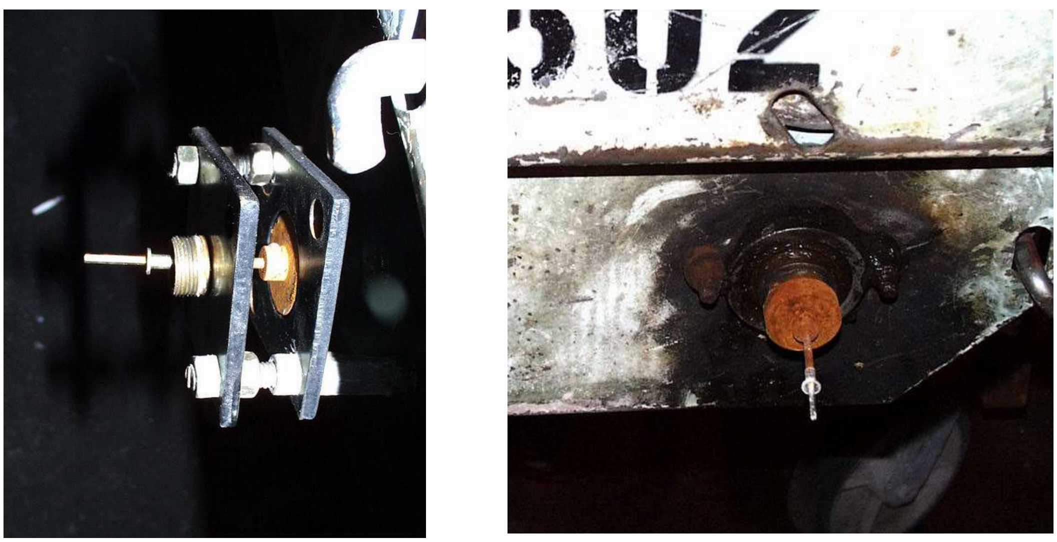
Appendix A: Interviews with District Supervisors

Each of the SEMSIM Partners has a number of facilities over their areas staffed by drivers, vehicle maintenance personnel and supervisors that maintain the roads assigned to them. Eighteen of the SEMSIM Partner's facilities have been outfitted with SEMSIM AVL systems. After the SEMSIM systems were installed on vehicles at each of these facilities and the supervisors had had time to be trained, interviews were conducted with 16 of them to determine how they planned on using the systems. An interview with Steve Fern (Manager of Electronics and Communication) and Phineas Williams (head dispatcher at SMART) was also done to determine how SEMSIM was going to aid the SMART regional transit system.

City of Detroit
Russell Street Facility

5800 Russell St.
Detroit, MI 48211
April 13, 2004
Interviewees: Tywania Compton (Supervisor) and William Ruth (Mechanic)

Twelve spreader auger sensors are going to be installed. Ten have been completely installed, but only two of those are working. The other two still haven't been installed yet (see Figure A1). Since Orbital's on-site installation representative is now gone, who will complete the installations?



a b

Figure A1. Uninstalled Sensors

At least ten trucks have never reported to the SEMSIM system. Another dozen or so have last reported much further in the past than they should have.

Ms. Compton and the other Supervisor are the two main station users of the system.

Ms. Compton thinks the training was rushed and very inadequate. She still does not know how to do reports correctly, and has nobody to learn it from. When Orbital did the training, they did not make the trainees go through the steps and be sure they knew how to do everything; they simply explained how to do it.

The only real summer uses the system seems to have is tracking to make sure trucks are where they are supposed to be.

Detroit spreaders are put on and removed from the trucks nearly every day during winter. They use the same trucks for daily bulk trash removal so they remove the spreaders to prevent damage from large heavy items. This makes damage to the sensors much more likely from constant handling.

The front plow sensor was not on truck 007600 and the wiring to the plug was cut (see Figure A2).

Figure A2. Uninstalled Plow Sensor

The MDT had pulled the screws out of the spreader control box it was mounted on top of, and was laying on the floor of the cab (Figure A3). The metal thickness of the top and the screw type appears to be too weak. This has happened on several trucks (most trucks have them mounted this way).

Figure A3. MDT broken from mounts

The trucks with Panavice MDT mountings have loosened up from vibration, but simply need retightening.

Mr. Ruth worked on the spreader mountings with the Orbital representative before he left Orbital. He felt the representative was very computer/electrical savvy but did not have much mechanical know-how or experience, especially with this size of equipment. He somewhat assisted the representative with the mounting system for the spreader sensors. Mr. Ruth noted many of the following observations.

The spreader mountings require a welded on spindle to the auger shaft opposite the gearbox area, they are not mounted to the gearbox as in the old Phase I system. There are several reservations about this mounting as follows: a chopped-together system of somewhat nonstandard parts, the unit is unprotected and sticks out from the side of the truck, liability concerns because it sticks out, mechanical speedometer wires and components are already rusting.

Who is the supplier if/when these components start to rust out and fail in a year or two? Spare parts in stock?

The tapered-fit 3/8-inch threaded rod along with the PVC spacer can be seen in Figure A4. The rods were left long to offer some protection for the sensor and to possibly use for some sort of guard mount in the future. Also, in Figure A5, the speedometer cable can be seen—these are all different custom lengths among the different spreaders.

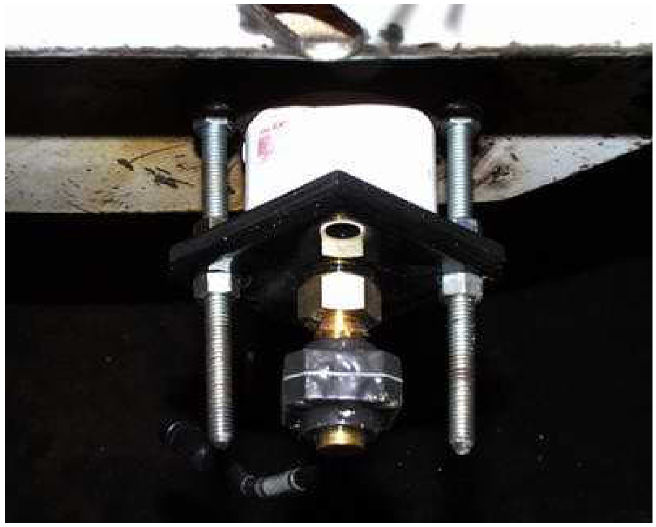


Figure A4. Manual Spreader Sensor

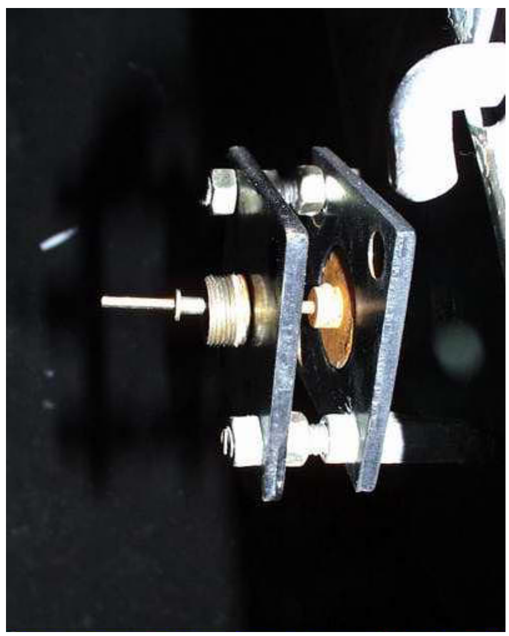


Figure A5. Spreader Sensor with Speedometer Cable

There was a question as to why a Hall effect sensor wasn't used on the hydraulic motor since there is already a protected input port right there and the components to do it would probably be more rugged. Mr. Ruth feels the mechanical system was a thrown-together afterthought type of solution.

There was a question as to why the sensor wasn't installed on the gearbox, as it was in the Phase I system (Figure A6). Mr. Ruth feels this is a much more protected and environmentally hospitable location (Figure A7).

Figure A6. Spreader Sensor Mounting as Done in SEMSIM Phase I

a

b

Figure A7. Spreader Gearbox With (a) and Without (b) Cover

The connector used for the spreader is a hybrid 2-male, 1-female pin type. These are custom and difficult to work on, if they had a simple Weatherpack style of plug they would be much easier for the mechanics to service since they are already outfitted to deal with that type of connector.

There was one connector with miswired pinouts, Mr. Ruth found the problem and rewired it the correct way, then it worked properly. They are in process of fixing all of them.

For the new chemical de-icing specific trucks (refitted with federal grant money, so they will never be used again for bulk pickup or salting), Mr. Ruth proposed an in-line flow rate sensor to use with the SEMSIM system. There is already a similar sensor installed in the main line as shown in Figure A8.

Figure A8. In-line Flow Sensor

The front plow hydraulic is a gravity-drop system, not a power-up and power-down type. If it is left up, it sticks and cannot be made to drop again without mechanical assistance. Therefore, they are usually left in the down position even when no plow is attached. This could cause false "front plow down" readings in SEMSIM which would not be easily remembered without additional record keeping for when the plow was attached or removed.

There are rumors going around among the drivers about ways to defeat the SEMSIM system. One of these is that smacking the MDT will disrupt it. Some have apparently been hit so hard they have cracked screens or are completely broken. These rumored methods are incorrect, and Mr. Ruth believes people will get caught trying it. Also, Mr. Ruth feels that the system is much easier to defeat for real than the rumored methods that are going around.

City of Detroit
Southfield Yard

12255 Southfield Fwy.
Detroit, MI 48228
May 4, 2004
Interviewees: Will Malone (Supervisor) and Mary Richardson (Office Foreman)

Neither have had any formal training with the system, nor have any people on the other shifts who might end up using the system. They just got a walk-through from Ms. Compton. Ms. Richardson probably knows more about it and has used it more than Mr. Malone has.

There is no directive on when or where to use the system, other than it can be used for snow and ice removal.

Mr. Malone hasn't used the system much, only a little during the snow/ice season, and most of that time it was down. They barely had eight hours of real time to use it.

Mr. Malone remembers that the systems were installed two to three months ago. He sent trucks to Detroit to have it done.

Detroit spreaders are put on and removed from the trucks nearly every day during winter. They use the same trucks for daily bulk trash removal so they remove the spreaders to prevent damage from large heavy items. Only a couple spreaders have the spread rate sensors on them. Most of their spreaders did not have a compatible interface to the SEMSIM Orbtrac system.

Summer activities are bulk trash collection and street sweeping. System could be good for locating all vehicles quickly on the map in a non-winter application.

Mr. Malone thinks some summer use of it would be good to get familiar and to keep equipment up to date. Sometimes drivers don't report when MDT's fall off in the cab and other problems.

He hasn't used information from any of the sensors—road/air temp or spreader.

On the day of the interview he could not log into the system, he was using www.semsim-avl.net, and got an error message: Information Alert, 502 Bad Gateway, DNS name server is unreachable, etc. It could have been that their building system was down.

The drivers haven't had any training on it and don't use it as far as he knew. There were no drivers available to talk to at the time of the interview because all were out doing trash collecting.

This year was the first time they used the system at this location. Mr. Malone indicated that it was totally new to him and they hadn't had a prior test system as others had had about five years ago. Mr. Malone thought the east side was going to be getting it earlier, and then it would migrate over to the west side.

The MDTs have rattled the screws out of the spreader control box they were mounted to and have been found laying on the floor of the cab. Truck 007614 has one that way right now. The metal thickness of the top and the screw type appears to be too weak. This has happened on several trucks (most trucks have them mounted this way), but some have been remounted and have not fallen off again.

Some belly plow style trucks like 027604 with Panavice MDT mountings have loosened up from vibration, but simply need retightening. Also, the MDT's are in the way of the "hoist" knob, and are at a little worse angle and farther away than the ones hard-mounted on the spreader control boxes.

General Dynamics noted that all sensors and MDTs on the inspected trucks looked good. Trucks 0718 and 007620 were quickly checked over and looked to be in good condition.

Ms. Richardson believes that creating her own lists of trucks should be unnecessary.

She finds that map sizes won't increase or resize easily, also it always comes up to the tri-county area instead of just the western district and City of Detroit.

She hasn't used the messaging feature, but she knows Ms. Compton has tried it out.

She noted that no salting info for the trucks was being shown (this is probably because almost no trucks have salt spreader sensors installed).

She thinks a good summer use of the system would be for sweeping (tracking swept curb miles—they get reimbursed) and also for recording footage that is cut on vacant lots.

The system has usually been down a lot, especially last winter.

They both usually give feedback to Ms. Compton about the system.

City of Detroit
Street Maintenance Garage

2633 Michigan Ave
Detroit, MI
5/13/04
Interviewees: Wendall Edwards and Ernest Owens

Mr. Edwards and Mr. Owens said that they had at least six computers that were capable of being used for SEMSIM.

Mr. Owens said that they were not using the system at the present time and its only anticipated its use for winter maintenance. They felt that it could be used for pothole repairs and finding and contacting other county's trucks that might be closer to an area that needed to be cleared during winter maintenance.

When asked about the use of the vehicle mapping, Messrs. Edwards and Owens felt that it was a good thing to use to check where certain trucks were when they were not where they expected them to be.

An example that was given was if the driver is supposed to be on Michigan Avenue and he is found to be two miles down I-94, he can be asked what he is doing there.

Messrs. Edwards and Owens felt that the spreader information would be used to determine how much salt is being spread during a winter season.

At this time neither have used the messaging capability. They felt that maintenance of the system was not being handled well because the system is often down and they have not been able to consistently use the system. They felt that if it was available more often, they could use it to locate a driver when they could not reach him by radio.

In summary, both Mr. Edwards and Mr. Owens felt they needed more training on the system for both the drivers and supervisors. They felt the training they received was not good enough to know the system thoroughly. They felt that the information provided in the manuals was good.

Macomb County
Washington Service Center (SC1)

12990 31-Mile Rd.
Washington, MI 48095
April 14, 2004
Interviewee: Ken McCarthy (Supervisor)

The terminal was located in the central office. Mr. McCarthy was the main user of this terminal. The one problem they were encountering was the fact that they only have the one computer for everyone, so during the day when the office staff is working it is hard to gain access to the system.

The screen was up and tracking all the trucks. The tracking system however was extremely slow. For instance, when Mr. Roberts (a Technology Ventures interviewer) went out in truck number 1509, he was tracked sitting at an intersection for over ten minutes. But, when Mr. McCarthy called him on the radio to verify his position, it turned out that 1509 was actually moving the whole time.

Mr. McCarthy only uses the system to see where his trucks are every now and then. He said it was much quicker to reach the drivers by phone then to text them. The drivers are concentrating on their driving and find it difficult to try and send text to the main terminal while doing so. Also, the text messaging is delayed far too long. Mr. McCarthy sent a message and then called the driver to let us know when he received it. It took five minutes for the driver to receive the message.

Mr. McCarthy said he had problems customizing the colors for tracing. He eventually figured out how to just put his fleet of trucks in. He said the training was not sufficient, and he would appreciate a refresher course in using the system.

Mr. McCarthy stated he had a hard time locating the vehicles on the map when he zooms in. The mapping system does not stay in the Washington area when zoomed in, it encompasses a much larger area and he stated that it is hard for him to follow.

Mr. McCarthy said he did not use the system for much record keeping. The only use he could see for record keeping would be in the event of an accident. He could then pull up the records and show when and how many times the intersection had been salted.

He felt the truck box gauge was not accurate. When Mr. Roberts went out in truck 1509 they had a load of gravel. The gauge stated they had a full load when they left. They went out in the truck and spread the entire load of salt. When they returned, the gauge was still showing a full load. The driver stated that was the way it always worked for him. This also points to a lack of training about how the system detects and measures the box level.

One of the other gauge problems was that when the plow was down the system was still saying it was up. We radioed the driver and asked him to put it up and down on the gravel road and the reading at the main terminal never did change.

Mr. McCarthy noted that the way the monitor was mounted in the truck it took a real beating. When Mr. Roberts was in the truck he stated the system was bouncing up and down while on the gravel roads. Mr. McCarthy said he also did not approve of the way the box was bracketed to the rear of the truck. It did not seem to be stable enough.

Mr. McCarthy said he felt there was still a lot of questions he needed answers to regarding the system. He felt the training class was not as informative as he needed. He stated again the main problem was that there was only one computer in the office, and the office staff had to use the computer most of the day, so they would have to be kicked off for him to utilize the system. He still felt it was quicker to radio the drivers then to text them. And he felt some of the system's problems stemmed from the fact that the equipment took a beating in the trucks. Mr. Roberts noted the vibration was extreme when the truck was going down the gravel roads.

Macomb County
New Haven Service Center (SC2)

58270 William St.
New Haven, MI 48048
April 28, 2004
Interviewees: Cindy McNamara (Supervisor) and Mark Rowe (Driver)

They didn't use the system during the winter.

There is only one terminal in use for the Orbtrac application. The location of the terminal is at the front desk.

The system hasn't really been used at all. It hasn't been launched and minimized while using other applications, but they could start launching it, so they can check it from time to time.

Ms. McNamara said the mapping system would be good once they get used to the system, but also mentioned that it would be good to have more training and more hands-on use first.

They haven't used the record keeping option. Ms. McNamara thought they did not have enough training yet from the limited amount conducted in February and March.

Ms. McNamara thinks it is quicker to use the County Radio or cell phone than the messaging system. A test was conducted to try and message a truck on-site, but the message was never received from the base terminal – although the terminal had received our message from the truck. When the base terminal tried to send back a message to the truck, they got an error message "URL not working". The web page wasn't resetting, but once the web page was restarted the maps and messaging came back up.

She noted that they didn't have a chance to use the salt spreading feature in the winter season.

The truck installations and equipment demonstrated a variety of different problems. A couple of the MDT's were burnt out and they had to be sent out for repairs. Some AVL systems must be staying on all night because when drivers are ready to first go out on shift the voltage of the battery is very low. Ms. McNamara showed one truck where the MDT was turned away so much that the driver would have had to lean almost over to the passenger side to see the screen. One driver (of truck 151202) said that there is static in the County Radio when the MDT is working, but when the MDT's screen is black and not working there is no static. In another instance, wires are coming loose on the MDT's and should be fixed. One MDT freezes up to the point that you can see the clock on it doesn't change and it continues to show the clock even when the unit is supposed to be in an off state. The power unit on the back wall of the truck seems to be a little loose as well.

Mr. Rowe said that he thinks the system in general is a good idea. They can use the temperature reading for salting the roads. He would like to have a manual for the drivers so they can read it and get to know how the system works. Mr. Rowe also mentioned that more training would be a good thing for both the drivers and supervisors.

Macomb County
Clinton Township Service Center (SC3)

34592 Nova St.
Clinton Township, MI 48035
April 22, 2004
Interviewee: Jim Rogers (Acting Supervisor)

Mr. Rogers noted that the SEMSIM terminals are at the front desk where the office staff are working. He would like to see one in his office so he doesn't have to interrupt them while they are working. They leave the Orbtrac system on throughout the day.

Mr. Rogers also said he has only been in this position for about three months so he hasn't had a chance to use the SEMSIM system that much.

The system is on terminals where there are people working all day, but it is only used if they want to use it and check for a location of a truck. They try to use it daily for updates on the trucks that are out for the day.

There is nothing wrong with the map if it works properly. It will work for about 20 minutes and then slow down and continually slows down throughout the day. He guesses it's because the information has to come from a long distance, Maryland.

Mr. Rogers stated he did not use the system for record keeping. He had classes on it about month before but feels they need some more training on the system. He also stated that they have had some problems with the website.

Mr. Rogers mentioned that he felt the radios were a much better way of communicating with the drivers than the messaging portion of the system. He also stated that they would like to have more training on the messaging ability. Mr. Rogers also said that when their system is up they get other emergency messages from other counties and he would only like to see those messages just from their area.

Mr. Rogers remarked that they didn't get a chance during the times of snow to use the salt spreading information.

He stated that overall he thinks the maintenance of the system in the trucks is good. But he believes that it takes too long for the data transfer from Maryland back to the terminals. Mr. Rogers showed me some of the trucks and the MDT's were all on their pedestals—nothing looked to be abused.

Mr. Rogers said he felt the training class was not as informative as he needed. He stated again the main problem was that there were two computers in the office, and the office staff had to use those computers most of the day, so they would have to interrupt their work for him to utilize the system. He still felt it was quicker to radio the drivers than to text them.

Macomb County
Shelby Service Center (SC4)

51235 Napi Dr.
Shelby Township, MI 48315
April 28, 2004
Interviewee: Ken Welsh (Supervisor)

Mr. Welsh said they didn't use the system all winter. The normal clerk was out on maternity leave and didn't get back until around Good Friday, while the temporary clerk didn't know anything about the system.

He said they had one terminal at the front desk, and they would have to interrupt the clerk in order to check the website, which would take the clerk away from her daily duties. Mr. Welsh also said he could put an item in his budget to obtain another computer terminal specifically for the Orbtrac application.

The main problem they had in using SEMSIM was that they needed more training than what they had been given, for both the drivers and supervisors. Mr. Welsh said he has been to a two hour training and presentation but it wasn't a good demonstration because they could hardly see the small screen that it was shown on.

Mr. Welsh said that the GPS Mapping is a good idea, because if they can't find a truck at night they could pull it up on the system and locate it and go to where the truck is. The night shift doesn't have a clerk so they are free to use the system at any time for those hours.

He stated he did not use the system for record keeping. He had classes on it about month ago and feels they need some more training on the system before he could use it correctly.

Mr. Welsh doesn't feel the messaging system is helpful, because it only has a set amount of preprogrammed messages. Also, the messaging is too slow—it has a very long delay. It is much faster to use the radio, a cell phone, or Nextel walkie-talkie to communicate with a driver.

He didn't have a chance to use the salt spreading feature in the winter season.

Mr. Welsh demonstrated one of the in-truck AVL systems. He started the truck and the unit wouldn't come on, it simply had a black blank screen. He also said he didn't think the system was calibrated properly. There were some problems with the installations of the AVLs here too, such as hanging wires on the bottom of the truck. One installer drilled through the dashboard and hit a Ni-Cad battery. They had to take the truck to another division's garage to make the repairs instead of being able to fix it in their own garage.

Mr. Welsh said he felt the training class was not nearly as informative as he needed. He stated again, the main problem was there is only one computer in the office, and the office staff has to use the computer most of the day, so he would have to interrupt their work in order for him to utilize the system. He still felt it was quicker to radio the drivers than to bother trying to text them.

Oakland County
District 1 (Milford Garage)

4353 Duck Lake Road
Milford, MI 48381
April 15, 2004
Interviewees: Mark Pohl (Garage Supervisor) and Sherri Parker (Driver)

Milford District 1 has 25 vehicles and 40 employees. Five of the vehicles have SEMSIM equipment.

Mr. Pohl hoped to use the system to determine areas that have been salted and confirm that critical areas have been treated when asked without having to have contact with the driver. He was not able to use the system for winter maintenance due to the system's late installation and late training. He has not had any real hands-on experience yet.

Mr. Pohl said Oakland County has been cutting edge on many technologies. He indicated that he did not know if there was ever going to be cross-county cooperation and if there is, a way to share costs must be determined.

Mr. Pohl does not have a night shift in District 1. A Road-Weather Information System (RWIS) is at his location. There are three in Oakland County: one in Davisburg, one in Orion and one in Milford.

Chatter on the radio system is so great that the operator sometimes turns it off. (Note: The text messaging system could be used in this case to overcome the high message traffic on the radio during snow clearing operations.) The SEMSIM system could be used to find the vehicle if the operator did turn off the radio.

One potential use for the SEMSIM system could be to locate and inventory culverts. This may not be practical since the truck could not move directly over the culvert. Culverts are hard to find. Some have been flattened and buried.

The SEMSIM system could be used to catalog the condition of the road. There is a pavement management system that Mr. Pohl used in the past. It was tedious to use and possibly SEMSIM could be used to store pavement information. (Note: Possibly the messaging system could be modified in the future to provide this feature.)

Drivers have not been trained. Mr. Pohl is retiring in December 2004. No replacement has been selected. There are also two foremen leaving. This will probably create a transition problem in many areas, SEMSIM included.

Ms. Parker drives truck A0671. She likes the salt remaining indicator. She feels that it is pretty accurate. She likes the temperature sensor and feels it is accurate also.

Ms. Parker's MDT is the one that banged against the dash, fell off and has loose parts rattling around inside. Ms. Parker is short and it was hard for her to see the display since it was mounted on a fixed bracket.

Oakland County
District 2 (Davisburg Garage)

10275 Dixie Highway
Davisburg, MI 48350
April 15, 2004
Interviewees: Richard Wood (Superintendent) Neil Farner and Willis Greer (Foremen), two drivers

This location had a garage fire during winter. They lost four SEMSIM trucks in the fire. There are four trucks with SEMSIM now, two of which came from Southfield (A0596 and A0627, A0665 and A0703).

They indicated that the MDT's are not mounted in the trucks well.

During the interview the Orbital system was down. Mr. Wood was to get training on the day of this interview, but since the system was down the training was delayed.

Mr. Wood notes that using the normal radio gets noisy. There are two frequencies. On his frequency there are six districts or 250 people. On second frequency there is traffic safety, electrical, guardrail, engineering, and sign shop. The messaging system could take traffic off the radio and provide supplemental service.

They believe that they have had Internet problems with speed, but could not distinguish between whether the problem was a slow SEMSIM system or a slow Internet communication problem.

They have been told that the operating system that is going to be installed is Windows 98. We told them that they will need a newer operating system than that, because the required Internet Explorer 6.0 will not load on Windows 98.

They often get calls about areas that need attention and find that the information is incorrect—even when called in by police. The tracing feature could improve information about this situation. They misunderstood the tracing feature and thought that they had to clear the trace manually.

Implementing a "nearest truck" feature would be a good addition. It could provide quicker information as to what truck could provide service to a critical area.

The salt remaining sensor is considered to be a nice feature. If the amount of salt that a driver had loaded in a day is recorded and reported, then that should reduce a lot of the salt usage inaccuracies. The drivers are not very good at estimating the amount of salt they use. It would be nice to have it accumulated on the display for the driver to see.

Mr. Wood is going to check vehicle systems to see that they are working properly. They felt that they would use the messaging system when they could not reach the driver through the normal radio system.

Drivers have been using the temperature sensors and feel that they are accurate. Mr. Wood has gotten no negative feedback about them. The foremen would like to have the temperature sensors for evaluation of the road condition.

They feel they can use the system to see how far the shoulders have been graded without going out and checking or taking the driver's word for it.

Drivers were put through an informal "crash course" when they picked up their trucks.

Drivers said that they have gotten no training. They were not aware of the full box button. They were skeptical of the usefulness of the messaging system. They can talk on the radio while going down road at 35 MPH, but they could not use the message system under those circumstances.

Oakland County
District 4 (Pontiac Garage)

2420 Pontiac Lake Road
Waterford, MI 48328
April 14, 2004
Interviewees: Michael Stevens (Supervisor), Dennis Kolar (Director of Central Operations), Mark Hirt, Gordon Morris, and David Kemp (foremen)

District 4 has 35 plow trucks of which 15 have the SEMSIM equipment.

Michael Stevens and his foremen are expecting that the system will be on all the time and the color-coded traces will provide quick feedback as to what has been covered. They hope it will confirm what the driver says he has covered and provide a record as to what one shift has covered so that the next shift knows where to start. There are times that a complaint comes in about a crew sitting at a location for two hours. The SEMSIM system could support or refute the claim.

Oakland has the Compuspread automatic spreader. One of the foremen felt that he had the best luck by using the system on manual for more precise control. He felt that, when the system was on automatic, the Compuspread might allow the vehicle to travel 20 feet or so before salt would start to flow. They do not feel that they have a salt clogging or flow problem with their spreaders.

The foremen felt that there was a problem with the drivers pushing the "full box" button. If they forget, the unit does not provide the proper information back to the system.

The foremen felt that it was valuable being able to identify if a vehicle was at a location at a certain time. They get many calls from people saying that something was not done or that something was damaged at a certain time. Having knowledge if a vehicle was at a location at a certain time would allow a foreman to discuss the incident knowledgably.

One of the foremen pointed out that some of the drivers will try to defeat the system. Once a driver finds out that he can put the plow at a position that looks like it is down, but is not, he will try to position the plow to take advantage of that.

There were discussions about how to motivate drivers to use the system properly and not try to defeat it either by getting around its reporting proper information or sabotaging the system. The foremen did not feel that promoting a competitive atmosphere was advantageous. They felt that the drivers were just going to have to accept it, that it was the way things will be done and that was it.

It was asked if it would be valuable to provide a SEMSIM website that would allow residents to see what was plowed so that they would not have to call in to see what had been covered. The foremen felt that this would be a big problem; because the average citizen does not understand priorities and the order that plowing is to be done. When their area is not done and a plow vehicle is seen to be close-by, they don't understand that the vehicle has higher priorities than doing their subdivision. Often there may be a reduced crew on the road in off-hours, when it is snowing, in order to give plow drivers a needed period of rest before they come on the job prior to a morning rush hour. The foremen's fear is that their decisions would be second-guessed by people that do not have the experience or knowledge of what resources are available.

Other uses for SEMSIM were discussed. Non-winter uses include shoulder grading, tracking mowers and liquid chloride dispensing vehicles that are used on gravel roads for dust control. Oakland has 18 graders, three swath mowers that mow the edge of the road and four boulevard mowers. There are nine vehicles that can dispense liquid chloride. The townships are charged for liquid chloride applications. There are four applications per year. Being able to see that the chloride has been done would help the billing process. Oakland County has six Vactor trucks that clean out drains. SEMSIM equipment could be used to know where a sewer cleaner was and whether a drain in question was cleaned. Another use is to track the patching crews and be able to monitor if the barricade equipment is positioned properly. Forestry crews could be tracked to see where they are and be notified about a fallen tree that needs attention.

There was some concern about the security of the SEMSIM system. It was feared that someone with unfavorable intentions could obtain a user name and password. A news organization could use the information to write an unfavorable news article.

A question came up as to whether a Nextel walkie-talkie type of voice communication could be done with the messaging system to enhance contacting a truck. It was pointed out that the system was not that interactive at this time.

There was interest that some foremen might want to use the SEMSIM system from home. Some of them have Windows 98. Windows 98 will only allow the use of Internet Explorer up through version 5.5. Orbital recommends Explorer 6.0.

One of the foremen felt that it would be valuable to have a version of SEMSIM that could be put on a laptop and taken with them on the road.

Oakland County
District 4S (Southfield Garage)

27900 Franklin Road
Southfield, MI 48034
May 13, 2004
Interviewee: Jack Brown (Superintendent)

Mr. Brown was asked how many terminals they had at their department for use of Orbtrac and he stated that there was only the one computer that was capable of viewing the web page, and that it was in his office.

Mr. Brown said that the system was in use all winter. It was used to track the trucks, and the use of salt. He also said that he used it from home to help the supervisors locate trucks at night.

When asked about the mapping capabilities Mr. Brown said it uses too much unnecessary data to send back and forth and it also takes too long to get info back. It runs about 10 to 15 minutes behind.

They don't use the system for record keeping.

The messaging system was only used to let the drivers know when the storm was letting up, so they knew when to come in.

The salt spreading feature wasn't used this past winter, but will be used next year.

Mr. Brown felt the system was too new to know anything concrete about the maintenance aspects yet.

Mr. Brown feels the system is a great idea but would like to see some other uses for the system such as sweepers, mowers and vactor trucks. Prior to winter, he would also like to see a refresher-training course on the system for supervisors and drivers.

Oakland County
District 4T (Troy Garage)

1930 Stephenson Highway
Troy, MI 48083
April 14, 2004
Interviewee: Curtis Cooley (Superintendent)

He said they only got around to using the system at the end of winter.

The whole SEMSIM system needs to be simplified. Mr. Cooley also mentioned that he liked the old system better than the one now that is on the Internet. His concern was the lack of responsiveness and the difficulty in negotiating the maps.

He is concerned that there are no safeguards on the computers. For example, he can view other people's folders on his computer.

They have one terminal at the front desk. They would have to interrupt the clerk in order to check the website, which would interfere with the clerk's duties.

Mr. Cooley stated that they needed more training than what they had been given, for both the drivers and supervisors. He said he went for a two hour training and presentation, but it wasn't a good one because they couldn't see the small screen that Orbtrac was being demonstrated on.

The system should be good for tracking the trucks when it is snowing. Also, when the trucks are in a convoy, it could be used to space out the trucks properly.

When asked about the mapping abilities Mr. Cooley said there was a problem with zooming in on vehicles, and also there seems to be no way to put labels over the trucks. The green circle with the arrow in it (to tell which way the truck is traveling) is a good feature. Mr. Cooley also noted that the traces are very slow. He is not able to trace some trucks on the map and yet others are able to be traced.

Mr. Cooley stated he did not use the system for record keeping. Mr. Cooley recommended that they have refresher course on using the system.

Mr. Cooley doesn't feel that the messaging option is good, because it is quicker to pick up the county radio or cell phone. He hasn't used the messaging capabilities very much.

They didn't have a chance to use the salt spreading feature in the winter season.

Mr. Cooley said that the maintenance of the system is good. He feels the data stream delays are the biggest hassle because it seems to take too long for the information to be sent over the Internet connection. It appears to him that the more trucks that are on the system, the slower the reporting gets.

Mr. Cooley said he felt that one of the two main problems where that the training class was not as informative as he needed. The other was that there is only one computer in the office, and the office staff has to use the computer most of the day, so he would have to kick them off in order for him to utilize the system.

SMART (Suburban Mobility Authority for Regional Transportation)
Oakland Terminal

2021 Barrett St.
Troy, MI 48084
April 16, 2004
Interviewees: Steve Fern (Manager Electronics and Communications), Phineas Williams (Head Dispatcher)

Steve Fern was not given a user name or password until a week before this interview. Since he has not been in our technical meetings lately, it was forgotten to provide him with use of the SEMSIM system.

The discussion with Messrs. Fern and Williams was primarily to determine what benefit SMART can obtain from the SEMSIM system. Mr. Fern indicated that the SMART bus system covers the three county areas of Macomb, Oakland and Wayne. Weather is highly variable over these counties. He gave an example that Big Beaver Road is a weather boundary and North of Big Beaver it can be raining or snowing and south the sun can be shining. SMART runs both linehaul regular scheduled bus service and paratransit services that are dispatched separately. Paratransit services provide point-to-point service using smaller buses, whereas the regular scheduled routes use large 35-foot passenger buses. During a snow incident, at 2:00 A.M., the decision is made if they are going to run Paratransit, if they are going to run linehaul scheduled routes, run on standard bus routes or run on snow routes. Buses can be treacherous in snow. The front of a bus is light in comparison to the rear and Steve describes them as a 35-foot stretch Volkswagen beetle. A bus has a wide footprint on the rear since it has dual tires. A bus can be stuck if it is run on a route that is not adequately cleared of snow.

On a regular day, the customer service information office gets just under 1,000 calls. On a snow day they can get 3,000 calls a day. They have an automated attendant that tells a customer that they are running or not and whether it is a snow route or not. The automated system typically takes care of two-thirds of the calls. The remaining one-third is handled by an operator. In order to route the buses properly and inform the customers how the routing is to be done, they need two critical pieces of information. One: how bad is it snowing and accumulating and two: how are the snowplow trucks doing in clearing the roads? Once on snow routes, you stay on them the whole day to eliminate confusion.

Right now they have no information about what road clearing is being done. They subscribe to a weather reporting system, but it is for metropolitan Detroit and provides them a limited amount of critical information. They make a decision by county as to how they run for a day. The decision is made countywide in order not to confuse customers. It is easier to say that buses will run a certain way in a county than by route.

If they can view the plow trucks clearing streets, they can make a decision as to whether they can provide paratransit services to an area. Right now, they have to make the decision when they arrive at a customer's location. Mr. Williams explained that two days with the same snowfall could create entirely different driving conditions for buses. If the temperature is near 32°F, and you get a salt truck out there one time, you don't have any problems the rest of the day. If the temperature is 22°F, the snow is not removed or salted often; it may be impassable by a bus.

Mr. Williams hopes that he can also obtain construction information through SEMSIM. Mr. Fern and Mr. Williams point out that pullout areas for buses are often not considered in the construction process. Often there is no way for a bus to pull off to pickup passengers. Viewing construction crews on the SEMSIM system would provide valuable scheduling information to the dispatcher.

Discussions turned to how to ensure SEMSIM will survive in the future. We discussed the importance of providing benefits to every person that a system, such as SEMSIM, relies on. Mr. Fern points out that he has found that an employee must hear the importance of something on a regular basis. If it is just mentioned casually, it is not perceived as important. He had a painful example in his experience of a system that dispensed fuel automatically. It never worked reliably because the maintenance department never took ownership in the project and therefore the fuel dispensing system failed. Steve had numerous examples of system failures that did not provide benefit to a key contributor to the system.

For decades Mr. Fern has been interested in having a conduit of communication to the road commissions, but for various reasons, it just never happened. He feels that by involving himself in the radio communication system for SEMSIM, regular communication with the road commissions in Southeastern Michigan will happen.

Wayne County
Goddard Yard

15645 Goddard Rd.
Southgate, MI 48195
April 16, 2004
Interviewees: William Bantom (Department Manager), Floyd Drouillard (Yard Foreman)

Bill Bantom wasn't available, so Floyd Drouillard was interviewed. He felt that he would probably be using the system the most. He has had training on the system. He is usually in the office, or sometimes out with the crews on the road in a storm. Mr. Bantom and Jeff Bowdler (Supervisor) usually drive around and assess the roads. Mr. Bantom or another yard forman may use the system during a storm if Mr. Drouillard is on the road.

Mr. Drouillard said he hasn't used the system much. He has been too busy with paperwork backlogs and computer upgrades. He said that there has been no mandate, guidelines, or policies on using the system, other than it's understood that only the foremen or the managers are to use the system—not employees.

He felt that the system has frozen up on him too often in the past or would take forever to do something. This was especially true if the request was a more complex task such as mapping the track of a truck. He feels there are still a few bugs left to fix.

Some uses of the system so far have been to look up truck routes if there are complaints, or using SEMSIM to track drivers and catch them if they're somewhere out of the area where they are supposed to be.

Mr. Drouillard felt that training needed to be expanded and more in-depth—especially for the detailed map features. Also, he felt that just spending more time on the system would increase familiarity.

Mr. Drouillard had some problems logging into the system. He called Bob Conrad for help (Wayne County area engineer) and finally got in with a different user/password. He is not using his own user/password to get into the system due to upgrades/problems etc.

Mr. Drouillard mentioned that some of the roads are either not on the map (including some smaller ones right near the yard), or are coded in such a way as to confuse him when looking at the map. For example, Champaign and Dix are both listed as dark blue roads, but Champaign is a two-lane stop and go type road, whereas Dix is a five lane major thoroughfare. Dix should have a bigger highlight on it. Fort Street is another undersized road as well. The maps should be updated and proofed for more accuracy, and made so it is easier to identify the semi-major roads.

They have tried text messaging a few times just to see if it works—which it did—but otherwise they have not used it much.

Mr. Drouillard mentioned that emergency messages sometimes get sent accidentally. This happens when the driver cleans the screen of the MDT, and the emergency button is accidentally hit. The OK button, which pops up for confirmation, is close to the emergency button, so a swipe back and forth with a cloth can hit the emergency and then the OK. These should be spaced out more or changed in such a way to ensure that this could not occur.

Mr. Drouillard felt that non-winter uses for the system could include checking the location of a down vehicle if there is no radio response, providing the fastest emergency response by locating the vehicle closest to a called-in emergency and routing it there, and finally for punitive measures to check and see if people are where they are supposed to be. He doesn't know if the system information would be court-admissible or not.

Mr. Drouillard pointed out that a couple of the trucks on the map, which were parked in the garage at the time, were showing on the SEMSIM system to be one/eighth to one-quarter mile away from their actual real position with time/date stamps that were old (for example, Truck 90030 had a time stamp of 4:43 A.M., when it was really 11:36 A.M. and parked in a location it never would be parked.) (Note: This could be caused by a radio coverage problem. Testing radio coverage in areas suspected of having poor coverage should be on the list of projects to be done.)

One driver has bragged that his truck will never show up on the system, supposedly thanks to a magnet he puts somewhere. Mr. Drouillard wonders if the system can be defeated by a magnet, or by unplugging the wire bundle going into the box. What happens if this large wire is unplugged? (Note: The system does not have to be plugged into the MDT display in order to function and a magnet cannot defeat the operation of the system.)

Mr. Drouillard could see where, during a winter storm, a dispatcher could take complaint calls and reroute the closest truck to deal with it. If a driver was taking a long time to plow an area, the position of his truck could be checked on a map to find out why and disciplinary action could be taken if needed. If the supervisor is driving the roads all night doing road checks and getting tired, he could use the system in lieu of more driving to keep tabs on things from the office.

Mr. Drouillard suggested that a mock snowstorm trial might be a good idea to test the system. Bob Conrad was working on a mock Fermi nuclear disaster in which the trucks were supposed in the project. He suggested that Mr. Conrad be contacted to see if/when this exercise might take place.

(Note: When contacted about this, Bob Conrad said that every two years Fermi is required by FEMA to have mock disaster with the State, Monroe and Wayne Emergency Management groups. This took place on March 23, 2004. He and Bob Verardi (another Wayne County employee) did bring up the SEMSIM program at their desktops, but it was mainly to see if it worked. He felt that it appeared there would be a benefit of having real-time information for an actual disaster.)

There are 22 trucks outfitted with system at this garage—all with the big dump boxes. Vehicle number 70014 has never worked properly, and still isn't fixed. Vehicle 79539 is also suddenly not working, but the truck had a transmission go out and so was out for repairs and the system might have been disconnected. Mr. Drouillard doesn't think the drivers have had any training on the system. The drivers don't like the full box feature, because they feel that the chunks of salt change auger flow rate enough to make the system inaccurate and undependable. He and drivers really like the road/air temperature feature for determining conditions that help determine salt effectiveness, road temperatures high enough to do cold patch operations, etc. He feels the sensors are at least somewhat accurate, but does not have any way to determine how accurate. Mr. Drouillard feels the road/air sensor system continually comes up as helpful and effective, so it should be tested for accuracy since it is seeing widespread use and being heavily relied on.

Most of the trucks are in very good shape mechanically with regard to the SEMSIM system. General Dynamics checked belly and front plow sensors, and the MDT mountings and condition of the in-cab equipment. The only really bad one that was found was the mounting for the MDT display in the crew cab truck—shown in Figure A9. Otherwise the ones seen seem to be quite acceptable.

Figure A9. Display or Mobile Data Terminal (MDT) in Crew Cab

On cold days, the MDT screen will go gray or very light and won't show up well until warmed up. This yard has to park all their trucks outside so they end up getting really cold at night compared to most other yards. They plug engine heaters in to keep them warm so they will start.

Wayne County
Norton Yard

27900 Grantland Road
Livonia, MI 48154
April 20, 2004
Interviewees: Paul Kinville (Supervisor-Norton Yard), Tom Palazzolo (Supervisor-Phoenix Yard)

Both have had the SEMSIM training.

One of the biggest questions is when/how/where are they supposed to use the system. There is no directive, and they don't know what the system is best used for.

Mr. Kinville notes that the drivers use the road/air temp monitors a lot. They seem to be pretty accurate, and they like this feature.

He hasn't used the system to track people yet.

Mr. Kinville found that some trucks with Panavice MDT mountings have loosened up, while others are in the way of levers.

Mr. Palazzolo thinks the training was terrible. It was basically a talk about things that didn't work yet, might work in the future, or still had bugs to fix, and the system was often down.

He finds the program itself is very slow to react.

He also can't get into the system right now. He isn't sure if he's using the right user/ password or not.

Mr. Palazzolo doesn't know if the spreaders have sensors on them or not, he hasn't checked that feature yet.

The program is not very practical for either Mr. Kinville or him to use during a snowstorm, as they spend most of their time on the roads. The Yard Foreman (like Simone Coleman) may be able to use it more, such as to check and see when a road was last salted.

Mr. Palazzolo feels the system will be too slow for winter storms. Why log into the system, get the right map up, and check someone's position when a quick radio or cell call can accomplish the same thing much faster and while on the move?

The best uses of the system are probably not down at this level, but are more geared towards upper management, for things such as proving which roads have been done when, or for 'Monday Morning Quarterbacking' after a storm in order to find places to improve operations.

Also, using the system for disciplinary measures was brought up. Many drivers hate the system for the GPS capability, they think it is 'big brother' watching them and hence do not care about the system and do not report if it is not working. Some may try to disable the system on their own.

One repeated system use was in the event of an emergency; the system could locate the closest truck and have it respond. It was also noted that the driver routes are logged on a crew assignment sheet, and this could be checked for the same purpose, although it may not be quite as accurate. Also, a simple cell call or radio call could be used too.

Another repeated use was to check on drivers if they aren't responding to the radio. The system can be used to find their location and send someone to check on them.

Also, it may be able to be used for preventative maintenance scheduling on a per-truck basis, or just for collecting information that may be useful later for some unforeseen purpose.

A few of the drivers had some training on the in-cab system last year.

Emergency alarms are accidentally being activated. I notified them that this might be due to people cleaning their screens and inadvertently confirming an emergency message send.

Drivers need some sort of audible alarm that they have an incoming message from base. Unless they look right at the MDT screen, there is no way for them to know that they have one. Sometimes the screens are knocked onto the floor, poorly aligned, or drivers are out of the cab and busy with other items.

The MDT's need a more solid mounting system, and some need relocating to better positions.

Mr. Palazzolo sees just as many bad points about the system as good points. He does not think they will help in the field. Both Mr. Palazzolo and Mr. Kinville see it as more work and more behind-desk time with no payoff at their level. They would rather not have it.

Also, Mr. Palazzolo thinks that all the electronic systems in those rough riding trucks are a bad idea, prone to multiple and hard-to-track failures. Simple and robust is the best way. Same thing with the old Compuspreads (95) they got, the systems weren't set up quite right, and when they'd go down they convert them to manual operation and send them back on the road. The best spreader system ever was the hydraulic-manual, one lever and 2 knobs, and all the driver had to remember was to shut it off at an intersection so it didn't leave a pile of salt in one place.

They don't do any resource sharing at all across any county lines, except where they overlap as a courtesy. He thinks the idea of resource sharing is a bureaucratic fantasy attempt at cost savings.

Mr. Palazzolo knows there are 40 canned messages he can send out, but has no idea what any of them are. He can and has typed messages into it, one he sent out to alert drivers to take a break without using the airwaves, but isn't sure if everyone got it or not.

The first two hours or so of a storm is spent at the desk while crews arrive and routes are planned out. The rest is usually out on the road.

Wayne County maintains a "bare pavement" philosophy and will work 24/7 to ensure all roads are wet and clean and stay that way. This is not like the other counties, and may not fit in with some of the upper management goals for this system such as improving efficiency.

Mr. Palazzolo thinks that a broken MDT he was aware of was fixed, but there are still several loose or poorly mounted ones, and he doesn't know the status of those.

Wayne County
Phoenix Yard

14973 Northville Road
Northville, MI 48170
April 8, 2004
Interviewees: Tom Palazzolo (Supervisor-Phoenix Yard) and Simone Coleman (Foreman-Norton Yard)

This interview was conducted at the Norton Yard, as Mr. Palazzolo was subbing for Paul Kinville (who was on vacation at the time) in that location.

Mr. Palazzolo felt that the training session brought out much of what the application could not do and was left with the impression that the system still had a lot of problems. He noted that they sat around a lot waiting for the Orbital home office to fix the system so they could continue with the training.

He felt that the communication system was slow and that that might affect performance. Simone's computer, however, came up very quickly and the application appeared to be quite responsive. The computer that Paul Kinville had was quite old (a Compaq Deskpro with Windows 2000 on it).

Both Mr. Palazzolo and Ms. Coleman were trained on the SEMSIM system, but they were not trained on the vehicle systems and have never used them. They indicated that the drivers were not trained on the vehicle systems and in asking one of the drivers, he indicated that he was not trained. The equipment was simply installed with no real explanation.

They have not used the SEMSIM application. When asked why, it appeared that they are not convinced that the system will provide any more information than using the radio to call the trucks. The training was short and the application appears complicated. Additionally, they are concerned that if they are on the computer, they will be asked by their supervisors why they are spending time there and not on the road. Mr. Palazzolo does not spend a lot of time on the road feeling that if the drivers are doing their job, he does not have to be on the road.

The web training was Mr. Palazzolo's first introduction to the SEMSIM system.

Mr. Palazzolo felt that the system could be used for some non-winter applications such as finding the nearest patching or maintenance crew to an emergency situation. He points out, however, that most of the time a foreman or supervisor knows where the crews are working, but if the area is large, the SEMSIM system could point out where in the area they are at the present time. He thought that the messaging system could be used to relay new instructions to a driver as to an area to cover (blading a gravel road, for example) when someone complains that it was missed. This is especially useful if a driver cannot be reached by calling on the radio for some reason.

Mr. Palazzolo suggested that a scheduled exercise could be conducted to get everyone started using the system.

There appears to be a mounting problem with these vehicles. Two vehicles numbered 803 70216 and 803 70219 were personally inspected. The display was mounted very close to the hydraulic controls and interferes with the use of these levers. The mounts are both Panavice flex mounts. The mount holding the MDT in 803 70216 was loose where it mounted to the vehicle. The stalk was disconnected from the mount in 803 70219 and was flopping around on its connecting cable (see Figure A10).

Figure A10. Display (MDT) Stalk Disconnected from Mount

Wayne County
Wayne Yard

3825 Howe Rd.
Wayne, MI 48184
April 15, 2004
Interviewees: Ralph Zajac (Head Supervisor), Joe Krystyniak (Supervisor), Tom Popek (Yard Foreman)

They only have four trucks outfitted with the SEMSIM system, out of the 25 total at the yard. They thought that more trucks were supposed to be outfitted as of March 1, but it hasn't happened yet. It appears that percentage of trucks outfitted in this location is not enough to make the system very worthwhile to use.

The in-truck MDT was set at a very funny angle and still has plastic on the screen.

The front plow sensor is in a very well protected location.

Joe Krystyniak spends most of his time out on the road, checking areas and weather and making the decisions.

Mr. Krystyniak heard the system still wasn't working, and has never worked yet, so he has never used it. He does not have much interest in it.

Mr. Krystyniak questions the usefulness and purpose of the system. He feels it is a tool for the upper management and politicians to use in a punitive way and assign blame. He feels especially this way because of the ability of the system to locate vehicles.

Since he spends so much time on the road, he probably wouldn't be the main user of the system, Mr. Popek would be.

Mr. Krystyniak believes that road conditions and response is more of an art of balancing multiple variables and experience, not something a relatively simple system can help much on, other than to see where people have been or if they're where they are supposed to be. Many items to note were listed such as ground temperature, road temperature, winds, storm speed, duration, type of snow falling, wet/icy level on roads, etc. He feels the old-fashioned driving way lets him make the best assessments and educated guesses.

Mr. Krystyniak usually keeps track of people by driving around and listening to the radio. If someone hasn't been heard from in a couple hours then they start calling and searching the usual spots, to see if it's a breakdown or if it's someone hiding behind a strip mall and not doing their job.

Mr. Krystyniak noted that they had a wiring problem in one of their trucks, but it was fixed. Other than this, he doesn't know about any mechanical malfunctions because he hasn't used the system.

The drivers have had no training on system.

Vibration of the units is a big problem; things loosen up due to the diesel engine harmonics. Also, there is no real suspension on the trucks at all; most of it is done through the driver's air seat.

Mr. Krystyniak thinks the plug on the side of the box can be easily unplugged for drivers to defeat the system.

Mr. Krystyniak really likes having the road/air temperature on the trucks. He has called drivers last winter to get readings from these instruments. One thing they are good for is checking the bridge deck temperatures since they are trouble spots. He doesn't know how accurate they are, he just uses the readings without question.

Mr. Krystyniak stated that the real snow work starts once the snow stops falling, until that time they just keep the roads salted and largely wait for the end of the storm. There is no way to keep ahead of it if it's still falling more than one-half inch an hour.

Mr. Krystyniak has had little to no information about the system passed to him over the past five years or so other than what he has heard on the news or in the paper.

Mr. Popek is very engineering-minded and more open to the system. He spends most of his time in the office, so he is the most likely daily user of the system in this location. He feels he needs further training on using it.

Mr. Popek remembered that Bob Conrad came over about a month ago (in March) and they tried doing things on the system a few times. Then for some reason Mr. Popek's logon wouldn't work even though Bob Conrad's did. He hasn't used it since then.

Mr. Popek thinks they probably can't utilize the system to its fullest extent, he feels many drivers have their hands full just dealing with traffic, driving, and doing their plowing/salting job.

Counties rarely need added help from other counties. Mr. Popek has not crossed county lines in 20 years. Bob Conrad usually makes those decisions if certain areas are being hit hard.

Appendix B: National and Local ITS Architecture

I. Background / Description of the National ITS Architecture

I.A. Overview

The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS
- The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).
- The information flows that connect these functions and physical subsystems together into an integrated system.

This evaluation is based upon the October 2003 version of the National ITS Architecture, downloaded from www.its.dot.gov and related websites.

Use of the National ITS Architecture also helps states save time and money because regional and statewide architectures do not have to be developed from scratch. In addition, using the National ITS Architecture helps ensure that state and regional ITS architectures will be able to incorporate key elements needed for future expansion. This means that systems can evolve over time and in accordance with local priorities and available resources. As states and regions expand their use of the National ITS Architecture, the power of integrated ITS systems will be magnified.

Using the National ITS Architecture facilitates planning for an entire system up-front, while eliminating the possibility of "gaps" in system definition and integration. This allows systems to be implemented in stages, while reducing the possibility of future costly changes to hardware or software that can be common as systems are upgraded over time

The National ITS Architecture provides a common structure for the design of intelligent transportation systems. It is not a system design nor is it a design concept. It is the framework around which multiple design approaches can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common architecture noted above. The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement a given user service, the physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle), the interfaces/information flows between the physical subsystems, and the communication requirements for the information flows (e.g., fixed-point to fixed-point or wide area wireless). In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale considerations in deployment.

The National Architecture is therefore not prescriptive. In actual deployments, the character of a subsystem deployment is determined by the specific equipment packages chosen.

I.B. ITS User Services

The user services within the National Architecture are grouped into eight "bundles" as shown below; new or updated user services may be added to the National ITS Architecture over time.

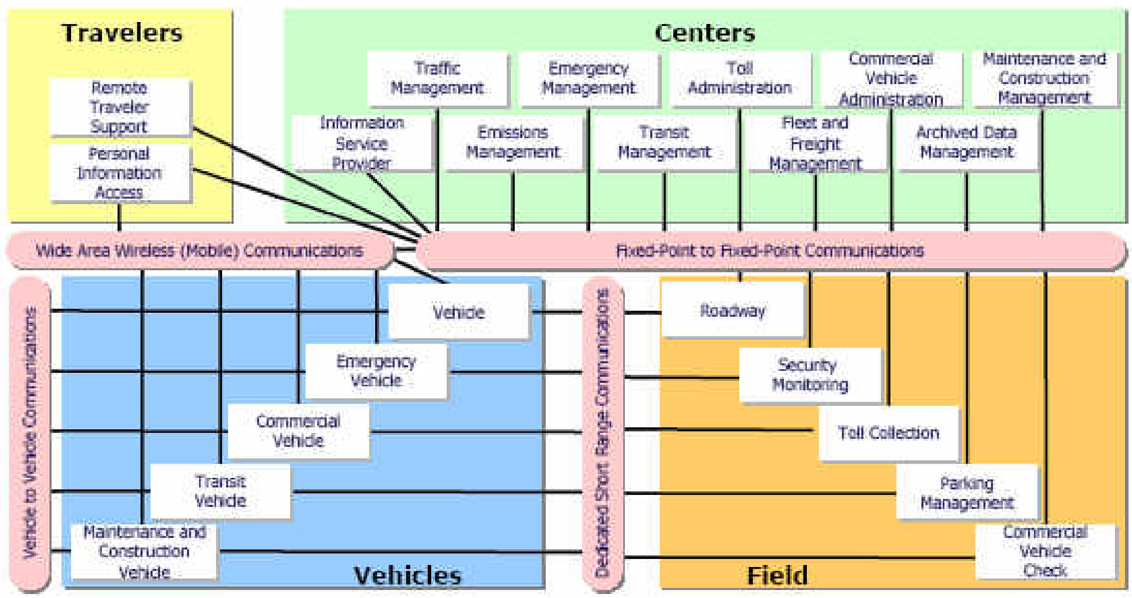
Note that Maintenance and Construction Management services is the eighth bundle. MCMS will be the focus for this evaluation of SEMSIM.

Table 1. ITS User Services

User Service Bundle	User Service
Travel and Traffic Management	Pre-Trip Travel Information En-Route Driver Information Route Guidance Ride Matching and Reservation Traveler Services Information Traffic Control Incident Management Travel Demand Management Emissions Testing and Mitigation Highway-Rail Intersection
Public Transportation Management	Public Transportation Management En-Route Transit Information Personalized Public Transit Public Travel Security
Electronic Payment	Electronic Payment Services
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection On-Board Safety and Security Monitoring Commercial Vehicle Administrative Processes Hazardous Material Security and Incident Response Freight Mobility
Emergency Management	Emergency Notification and Personal Security Emergency Vehicle Management Disaster Response and Evacuation
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance Lateral Collision Avoidance Intersection Collision Avoidance Vision Enhancement for Crash Avoidance Safety Readiness Pre-Crash Restraint Deployment Automated Vehicle Operation
Information Management	Archived Data Function
Maintenance and Construction Management	Maintenance and Construction Operations

I.C. Transportation Subsystems and Communication Links

The following figure from the Architecture shows the 19 transportation subsystems (white rectangles) and the four general communication links (ovals) used to exchange information between subsystems. This figure represents the highest level view of the transportation and communications layers of the physical architecture. The subsystems roughly correspond to physical elements of transportation management systems and are grouped into four classes (gray rectangles): Centers, Roadside, Vehicles and Travelers.



I.D. Architecture Subsystems

Architecture subsystems are divided into Center Subsystems, Field Subsystems, Vehicle Subsystems, and Traveler Subsystems.

I.D.i. Center Subsystems

- Commercial Vehicle Administration - Sells credentials and administers taxes, keeps records of safety and credential check data, and participates in information exchange with other commercial vehicle administration subsystems and CVO Information Requesters.

- Fleet and Freight Management - Monitors and coordinates vehicle fleets including coordination with intermodal freight depots or shippers.

- Toll Administration - Provides general payment administration capabilities to support electronic assessment of tolls and other transportation usage fees.

- Transit Management - Collects operational data from transit vehicles and performs strategic and tactical planning for drivers and vehicles.

- Emergency Management - Coordinates response to incidents, including those involving hazardous materials (HAZMAT).

- Emissions Management - Collects and processes pollution data and provides demand management input to Traffic Management.

- Archived Data Management - Collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications

- Traffic Management - Processes traffic data and provides basic traffic and incident management services through the Roadside and other subsystems. The Traffic Management Subsystem may share traffic data with Information Service Providers. Different equipment packages provide a focus on surface streets or highways (freeways and interstates) or both. It also coordinates transit signal priority and emergency vehicle signal preemption.

- Information Service Provider - ISPs can collect and process transportation data from the aforementioned centers, and broadcast general information products (e.g., link times), or deliver personalized information products (e.g., personalized or optimized routing) in response to individual information requests. This subsystem may be deployed alone (to generally serve drivers and/or travelers) or be combined with Transit Management (to specifically benefit transit travelers), Traffic Management (to specifically benefit drivers and their passengers) deployments. The ISP is a key element of pre-trip travel information, infrastructure based route guidance, brokering demand-responsive transit and ridematching, and other traveler information services.

- Maintenance and Construction Management – This subsystem monitors and manages roadway infrastructure construction and maintenance activities. Representing both public agencies and private contractors that provide these functions, this subsystem manages fleets of maintenance, construction, or special service vehicles (e.g., snow and ice control equipment) and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment.

I.D.ii. Field Subsystems

These subsystems include functions that require convenient access to a roadside location for the deployment of sensors, signals, programmable signs, or other interfaces with travelers and vehicles of all types. The five Field Subsystems are described below:

- Roadway - Provides traffic management surveillance, signals, and signage for traveler information. This subsystem also includes the devices at roadway intersections and multi-modal intersections to control traffic.

- Toll Collection - Interacts with vehicle toll tags to collect tolls and identify violators.

- Parking Management - Collects parking fees and manages parking lot occupancy/availability.

- Commercial Vehicle Check - Collects credential and safety data from vehicle tags, determines conformance to requirements, posts results to the driver (and in some safety exception cases, the carrier), and records the results for the Commercial Vehicle Administration Subsystem.

- Security Monitoring - Includes surveillance and sensor equipment used to provide enhanced security and safety for transportation facilities or infrastructure.

I.D.iii. Vehicle Subsystems

These subsystems are installed in a vehicle. The five Vehicle Subsystems are described below:

- Vehicle - Functions that may be common across all vehicle types are located here (e.g. navigation, tolls, etc.) so that specific vehicle deployments may include aggregations of this subsystem with one of the other three specialized vehicle subsystems types. The Vehicle Subsystem includes the user services of the Advanced Vehicle Control and Safety Systems user services bundle.

- Transit Vehicle - Provides operational data to the Transit Management Center, receives transit network status, provides en-route traveler information to travelers, and provides passenger and driver security functions.

- Commercial Vehicle - Stores safety data, identification numbers (driver, vehicle, and carrier), last check event data, and supports in-vehicle signage for driver pass/pull-in messages.

- Emergency Vehicle - Provides vehicle and incident status to the Emergency Management Subsystem.

- Maintenance and Construction Vehicle - Provides the sensory, processing, storage, and communications functions necessary to support highway maintenance and construction. All types of maintenance and construction vehicles are covered, including heavy equipment and supervisory vehicles.

I.D.iv. Traveler Subsystems

These subsystems represent platforms for ITS functions of interest to travelers or carriers (e.g., commercial vehicle operators) in support of multimodal traveling. They may be fixed (e.g., kiosks or home/office computers) or portable (e.g., a palm-top computer), and may be accessed by the public (e.g., through kiosks) or by individuals (e.g., through cellular phones or personal computers). The two Traveler Subsystems are described below:

- Remote Traveler Support - Provides traveler information at public kiosks. This subsystem includes traveler security functions.

- Personal Information Access - Provides traveler information and supports emergency requests for travelers using personal computers/telecommunication equipment at the home, office, or while on travel.

I.E. Market Packages

The National ITS Architecture developers maintain a set of “market packages” that reflect the current definition of ITS and the evolving technology market. The following table contains a complete listing of these, grouped according to their respective major application areas. The specific set of market packages defined is merely illustrative and does not represent the only way to combine the functions and equipment in order to provide ITS services.

A given market package may provide only part of the functionality of a user service (supporting multiple service levels), but often serves as a building block by allowing more advanced packages to use its components. Market packages also allow early deployments to be separated form higher risk services and can specifically address varied regional needs.

Market packages are not intended to be tied to specific technologies, but of course depend on the current technology and product market in order to actually be implemented. As transportation needs evolve, technology advances, and new devices are developed, market packages may change and new market packages may be defined.

ITS Market Packages

AD1	ITS Data Mart
AD2	ITS Data Warehouse
AD3	ITS Virtual Data Warehouse
APTS1	Transit Vehicle Tracking
APTS2	Transit Fixed-Route Operations

APTS3	Demand Response Transit Operations
APTS4	Transit Passenger and Fare Management
APTS5	Transit Security
APTS6	Transit Maintenance
APTS7	Multi-modal Coordination
APTS8	Transit Traveler Information
ATIS1	Broadcast Traveler Information
ATIS2	Interactive Traveler Information
ATIS3	Autonomous Route Guidance
ATIS4	Dynamic Route Guidance
ATIS5	ISP Based Route Guidance
ATIS6	Integrated Transportation Management/Route Guidance
ATIS7	Yellow Pages and Reservation
ATIS8	Dynamic Ridesharing
ATIS9	In Vehicle Signing
ATMS01	Network Surveillance
ATMS02	Probe Surveillance
ATMS03	Surface Street Control
ATMS04	Freeway Control
ATMS05	HOV Lane Management
ATMS06	Traffic Information Dissemination
ATMS07	Regional Traffic Control
ATMS08	Traffic Incident Management System
ATMS09	Traffic Forecast and Demand Management
ATMS10	Electronic Toll Collection
ATMS11	Emissions Monitoring and Management
ATMS12	Virtual TMC and Smart Probe Data
ATMS13	Standard Railroad Grade Crossing
ATMS14	Advanced Railroad Grade Crossing

ATMS15	Railroad Operations Coordination
ATMS16	Parking Facility Management
ATMS17	Regional Parking Management
ATMS18	Reversible Lane Management
ATMS19	Speed Monitoring
ATMS20	Drawbridge Management
ATMS21	Roadway Closure Management
AVSS01	Vehicle Safety Monitoring
AVSS02	Driver Safety Monitoring
AVSS03	Longitudinal Safety Warning
AVSS04	Lateral Safety Warning
AVSS05	Intersection Safety Warning
AVSS06	Pre-Crash Restraint Deployment
AVSS07	Driver Visibility Improvement
AVSS08	Advanced Vehicle Longitudinal Control
AVSS09	Advanced Vehicle Lateral Control
AVSS10	Intersection Collision Avoidance
AVSS11	Automated Highway System
CVO01	Fleet Administration
CVO02	Freight Administration
CVO03	Electronic Clearance
CVO04	CV Administrative Processes
CVO05	International Border Electronic Clearance
CVO06	Weigh-In-Motion
CVO07	Roadside CVO Safety
CVO08	On-board CVO and Freight Safety & Security
CVO09	CVO Fleet Maintenance
CVO10	HAZMAT Management
CVO11	Roadside HAZMAT Security Detection and Mitigation

CVO12	CV Driver Security Authentication
CVO13	Freight Assignment Tracking
EM01	Emergency Call-Taking and Dispatch
EM02	Emergency Routing
EM03	Mayday Support
EM04	Roadway Service Patrols
EM05	Transportation Infrastructure Protection
EM06	Wide-Area Alert
EM07	Early Warning System
EM08	Disaster Response and Recovery
EM09	Evacuation and Reentry Management
EM10	Disaster Traveler Information
MC01	Maintenance and Construction Vehicle and Equipment Tracking
MC02	Maintenance and Construction Vehicle Maintenance
MC03	Road Weather Data Collection
MC04	Weather Information Processing and Distribution
MC05	Roadway Automated Treatment
MC06	Winter Maintenance
MC07	Roadway Maintenance and Construction
MC08	Work Zone Management
MC09	Work Zone Safety Monitoring
MC10	Maintenance and Construction Activity Coordination

I.F. Communications

The National ITS Architecture provides the framework that ties the transportation and telecommunication worlds together to enable the development and effective implementation of the broad range of ITS user services. There are multiple communications options available to the system designer. The flexibility in choosing between various options allows each implementer the ability to select the specific technology that meets the local needs. The architecture identifies and assesses the capabilities of candidate communications technologies, but it does not select or recommend "winning" systems and technologies.

Architecture developers have identified four communication media types to support the communications requirements between the twenty two subsystems in the National Architecture. They are fixed-point to fixed-point, wide area wireless, dedicated short-range, and vehicle-to-vehicle communications. The four communication types are shown as ovals on the High-Level

Architecture diagram. According to National Architecture documents, "the conclusion that can be drawn from previous technology assessments and data loading and communication system performance analyses, is that the commercially available wide area wireless (including broadcast) and fixed-point to fixed-point infrastructures, adequately meet the near term technical requirements of ITS."

II. SEMCOG Regional Architecture

The ***Southeast Michigan Regional ITS Architecture*** is a roadmap for transportation systems integration in Southeast Michigan over the next 20 years. According to the Southeast Michigan Council of Governments website (www.semcog.org), the architecture was developed through a cooperative effort by the region's transportation agencies, covering all modes and all roads in Southeast Michigan. It represents a shared vision of how each agency's systems will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the region.

The architecture is an important new tool that is used by:

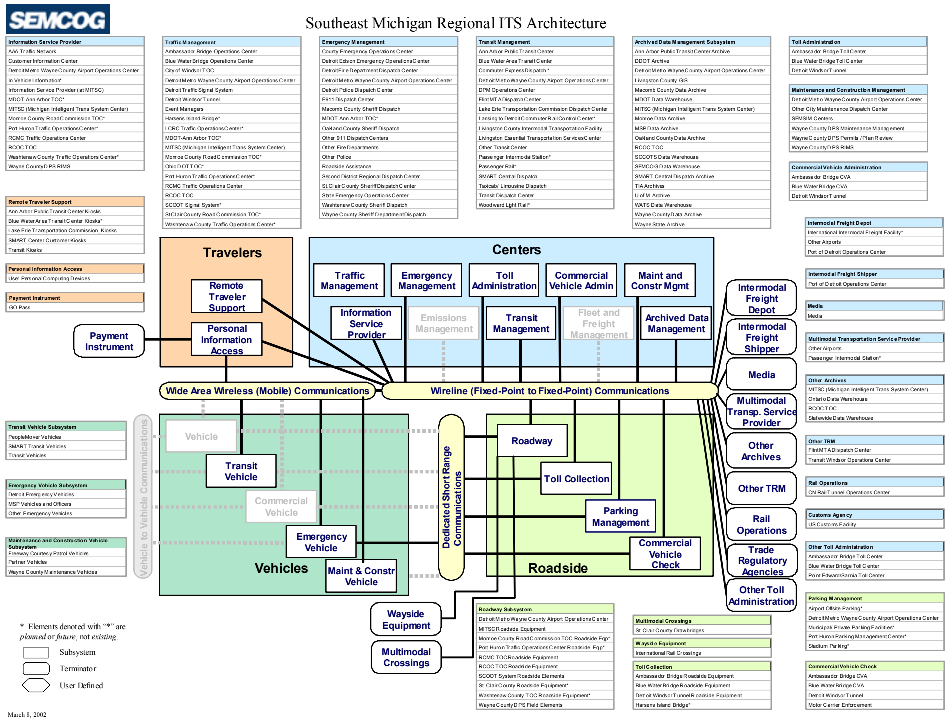
- SEMCOG to better reflect integration opportunities and operational needs into the transportation planning process.
- Operating Agencies to recognize and plan for transportation integration opportunities in the region.
- Other organizations and individuals that use the transportation system in Southeast Michigan.

The architecture provides an overarching framework that spans all of these organizations and individual transportation projects. Using the architecture, each transportation project can be viewed as an element of the overall transportation system, providing visibility into the relationship between individual transportation projects and ways to cost-effectively build an integrated transportation system over time.

Aspects of the SEMCOG regional architecture relevant to SEMSIM will be described in this section.

II.A. SEMCOG Regional Architecture "Sausage Diagram"

The Regional Architecture "sausage diagram" is reproduced below for illustrative purposes to indicate the extensive degree to which architecture components are inter-related and documented in a format consistent with the National Architecture. SEMSIM Centers are shown residing within the Maintenance and Construction Centers segment, with communications connectivity to vehicles indicated by Wireline (fixed point-point) communications connecting to Wide Area Wireless (Mobile) communications.



II.B. Interfaces

A primary purpose of the architecture is to identify the connectivity between transportation systems in the Southeast Michigan region. An extensive interfaces table in the regional architecture identifies every interface identified for the region. SEMSIM interfaces to the following nodes in the architecture:

- County Emergency Operations Center
- DDOT Archive
- Detroit Edison Emergency Operations Center
- Detroit Fire Department Dispatch Center
- Detroit Metro Wayne County Airport Operations Center
- Detroit Police Dispatch Center
- E911 Dispatch Centere
- Event Managers
- Freeway Courtesy Patrol Vehicles
- LCRC Traffic Operations Center
- Macomb County Data Archive
- MDOT Data Warehouse
- MDOT – Ann Arbor TOC
- Michigan ITS Center
- Monroe County Road Commission Traffic Operations Center

- Oakland County Data Archive
- Other 911 Dispatch Centers
- Other Police
- Partner Vehicles
- RCMC Traffic Operations Center
- RCOC TOC
- Roadside Assistance
- SEMCOG Data Warehouse
- SMART Central Dispatch Archive
- U of M Archive
- Washtenaw County Traffic Operations Center
- Wayne County Data Archive
- Wayne County Maintenance Vehicles
- Wayne State Archive

II.C. MCMS Equipment Packages

MCMS equipment packages detailed in the regional architecture are;

- MCM Environmental Information Processing
- MCM Incident Management

II.C.i. MCM Environmental Information Processing Equipment Package

The Environmental Information Processing equipment package processes current and forecast weather data, road condition information, local environmental data, and uses internal models to develop specialized detailed forecasts of local weather and surface conditions. The processed environmental information products are presented to the user.

User Service Requirements (fully or partially addressed) (extracted from Regional Architecture website):

8.0	MAINTENANCE AND CONSTRUCTION MANAGEMENT
8.1	MAINTENANCE AND CONSTRUCTION OPERATIONS
8.1.1	Maintenance and Construction Operations shall provide a Maintenance Vehicle Fleet Management (MVFM) function to schedule and dispatch, monitor and track location, and monitor operational condition and maintenance requirements of public and contracted fleets of maintenance, construction, and specialized service vehicles. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Vehicle Maintenance Crews, Equipment Maintenance Crews, Weather Services

	Organizations, and Information Service Providers.
8.1.1.6	MVFM shall be capable of providing dispatchers and operators of maintenance, construction, and specialized service vehicles with information regarding potential and actual roadway problems.
8.1.1.6.1	MVFM shall provide information to dispatchers and vehicle operators, including but not limited to:
8.1.1.6.1(d)	Environmental conditions
8.1.1.6.2	MVFM shall be capable of filtering, fusing, processing, and presenting data from multiple weather and environmental sources.
8.1.1.6.3	MVFM shall be capable of receiving fused weather and roadway information from external sources, including but not limited to:
8.1.1.6.3(a)	Surface transportation sources
8.1.1.6.3(b)	Weather service organizations
8.1.1.6.6	MVFM shall support transmission of fleet operations data to other Operations centers.
8.1.1.6.7	MVFM shall support transmission of fleet operations data to archives.
8.1.2	Maintenance and Construction Operations shall provide a Roadway Management (RWM) function to monitor traffic, road surface, and environmental conditions and forecast traffic and road surface conditions to support management of routine and hazardous road condition remediation and to communicate changes in conditions. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Asset Managers, Planning Agencies, and Weather Services Organizations.
8.1.2.1	RWM shall support a number of different services, including but not limited to:
8.1.2.1(a)	Winter maintenance (plowing, treating, anti-icing, de-icing, etc.)
8.1.2.1(b)	Hazard removal (removing trash, animals, etc.)
8.1.2.1(c)	Emergency activities (incident response, planning, alternate routing, etc.)
8.1.2.1(d)	Routine maintenance activities (cleaning, cutting, etc.)
8.1.2.1(e)	Repair activities
8.1.2.1(f)	Other weather related activities (fog dispersion, etc.)

8.1.2.4	RWM shall determine the need for forecasted and scheduled roadway treatment.
8.1.2.4.1	RWM shall be capable of filtering, fusing, processing and presenting data from multiple weather and environmental sources.
8.1.2.4.2	RWM shall be capable of receiving and fusing weather and roadway information from external sources, including but not limited to:
8.1.2.4.2(a)	Surface transportation sources
8.1.2.4.2(b)	Weather service organizations
8.1.2.4.5	RWM shall support short-term weather prediction for winter maintenance.
8.1.2.6	RWM shall track the amount of materials applied to the roadway for comparison to planned / forecasted requirements.
8.1.2.7	RWM shall monitor the amount and availability of materials at storage facilities.
8.1.3	Maintenance and Construction Operations shall provide a Work Zone Management and Safety (WZMS) function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Public Safety Organizations, Information Service Providers, and Travelers.
8.1.3.1	WZMS shall monitor, control, and direct activity in the vicinity of work zones.
8.1.3.1.1	WZMS shall provide information about work zones, including but not limited to:
8.1.3.1.1(a)	Anticipated delays
8.1.3.1.1(b)	Alternate routes
8.1.3.1.1(c)	Suggested speed limit
8.1.3.2	WZMS shall support the management of data about work zones.
8.1.3.2.1	WZMS shall collect information concerning work zone activities, including but not limited to:
8.1.3.2.1(a)	Location
8.1.3.2.1(b)	Nature / type

8.1.3.2.1(c)	Scheduled start time
8.1.3.2.1(d)	Duration
8.1.3.2.1(e)	Lane shifts
8.1.3.2.1(f)	Staging areas
8.1.3.2.1(g)	Length of work zone
8.1.3.2.1(h)	Scheduled phases of work zone configuration
8.1.3.2.1(i)	Alternate routes
8.1.3.2.1(j)	Anticipated delays for travel route
8.1.3.2.1(k)	Anticipated delays for diversion route
8.1.4	Maintenance and Construction Operations shall provide a Roadway Maintenance Conditions and Work Plan Dissemination (RMCWPD) function to provide Intra- and Inter-agency coordination of work plans. This function includes interactions among Traffic Managers, Supervisors, Planning Agencies, Public Safety Organizations, and Information Service Providers.
8.1.4.1	RMCWPD shall coordinate information on planned maintenance and construction activities, including work zone information, and unplanned remediation activities, such as inclement weather responses, so that routing, scheduling, and resource allocation can be accomplished.
8.1.4.3	RMCWPD shall coordinate information with other transportation agencies, including but not limited to:
8.1.4.3(a)	Public Safety
8.1.4.3(b)	Emergency Medical Management
8.1.4.3(c)	Transit
8.1.4.3(d)	Traffic Management
8.1.4.3(g)	Information Service Providers

II.C.ii. MCM Incident Management Equipment Package

The MCM Incident Management equipment package supports coordinated response to highway incidents. Incident notifications are shared, incident response resources are managed, and the overall incident situation and incident response is coordinated among allied response organizations.

User Service Requirements (fully or partially addressed) (extracted from Regional Architecture website):

8.0	MAINTENANCE AND CONSTRUCTION MANAGEMENT
8.1	MAINTENANCE AND CONSTRUCTION OPERATIONS
8.1.1	Maintenance and Construction Operations shall provide a Maintenance Vehicle Fleet Management (MVFM) function to schedule and dispatch, monitor and track location, and monitor operational condition and maintenance requirements of public and contracted fleets of maintenance, construction, and specialized service vehicles. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Vehicle Maintenance Crews, Equipment Maintenance Crews, Weather Services Organizations, and Information Service Providers.
8.1.1.2	MVFM shall be capable of supporting route scheduling and dispatching of public and contracted fleets of maintenance, construction, and specialized service vehicles.
8.1.1.3	MVFM shall be capable of supporting interactive data communications between dispatchers and operators of public and contracted maintenance, construction, and specialized service vehicles.
8.1.1.3.1	MVFM shall be capable of communicating information to vehicle operators, including but not limited to:
8.1.1.3.1(a)	Routing information
8.1.1.3.1(b)	Scheduling data
8.1.1.3.1(c)	Dispatch instructions
8.1.1.3.1(d)	Corrective actions
8.1.1.3.1(e)	Environmental information (road and weather conditions)
8.1.1.6	MVFM shall be capable of providing dispatchers and operators of maintenance, construction, and specialized service vehicles with information regarding potential and actual roadway problems.
8.1.1.6.1	MVFM shall provide information to dispatchers and vehicle operators, including but not limited to:

8.1.1.6.1(a)	Congestion
8.1.1.6.1(b)	Incidents
8.1.1.6.1(c)	Roadway restrictions
8.1.1.6.5	MVFM shall provide information to the vehicle operators concerning roadway problem spots and alternate routes because of potential or actual roadway problems.
8.1.1.6.6	MVFM shall support transmission of fleet operations data to other Operations centers.
8.1.1.6.7	MVFM shall support transmission of fleet operations data to archives.
8.1.2	Maintenance and Construction Operations shall provide a Roadway Management (RWM) function to monitor traffic, road surface, and environmental conditions and forecast traffic and road surface conditions to support management of routine and hazardous road condition remediation and to communicate changes in conditions. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Asset Managers, Planning Agencies, and Weather Services Organizations.
8.1.2.1	RWM shall support a number of different services, including but not limited to:
8.1.2.1(a)	Winter maintenance (plowing, treating, anti-icing, de-icing, etc.)
8.1.2.1(b)	Hazard removal (removing trash, animals, etc.)
8.1.2.1(c)	Emergency activities (incident response, planning, alternate routing, etc.)
8.1.2.1(d)	Routine maintenance activities (cleaning, cutting, etc.)
8.1.2.1(e)	Repair activities
8.1.2.1(f)	Other weather related activities (fog dispersion, etc.)
8.1.2.4	RWM shall determine the need for forecasted and scheduled roadway treatment.
8.1.2.4.4	RWM shall make use of information on usage of treatments and materials.
8.1.2.5	RWM shall support management of resources to perform hazardous road condition remediation.
8.1.2.5.1	RWM shall support application of materials, plowing, and other means to counteract adverse winter weather conditions.
8.1.2.5.2	RWM shall support appropriate responses to other environmental conditions that effect travel.
8.1.2.6	RWM shall track the amount of materials applied to the roadway for comparison

	to planned / forecasted requirements.
8.1.2.7	RWM shall monitor the amount and availability of materials at storage facilities.
8.1.2.9	RWM shall monitor, manage, and control remotely located, automated systems that affect the roadway surface (e.g. de-icing/anti-icing applications).
8.1.3	Maintenance and Construction Operations shall provide a Work Zone Management and Safety (WZMS) function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Public Safety Organizations, Information Service Providers, and Travelers.
8.1.3.1	WZMS shall monitor, control, and direct activity in the vicinity of work zones.
8.1.3.1.1	WZMS shall provide information about work zones, including but not limited to:
8.1.3.1.1(a)	Anticipated delays
8.1.3.1.1(b)	Alternate routes
8.1.3.1.1(c)	Suggested speed limit
8.1.3.2	WZMS shall support the management of data about work zones.
8.1.3.2.1	WZMS shall collect information concerning work zone activities, including but not limited to:
8.1.3.2.1(a)	Location
8.1.3.2.1(b)	Nature / type
8.1.3.2.1(c)	Scheduled start time
8.1.3.2.1(d)	Duration
8.1.3.2.1(e)	Lane shifts
8.1.3.2.1(f)	Staging areas
8.1.3.2.1(g)	Length of work zone
8.1.3.2.1(h)	Scheduled phases of work zone configuration
8.1.3.2.1(i)	Alternate routes
8.1.3.2.1(j)	Anticipated delays for travel route
8.1.3.2.1(k)	Anticipated delays for diversion route

8.1.4	Maintenance and Construction Operations shall provide a Roadway Maintenance Conditions and Work Plan Dissemination (RMCWPD) function to provide Intra- and Inter-agency coordination of work plans. This function includes interactions among Traffic Managers, Supervisors, Planning Agencies, Public Safety Organizations, and Information Service Providers.
8.1.4.1	RMCWPD shall coordinate information on planned maintenance and construction activities, including work zone information, and unplanned remediation activities, such as inclement weather responses, so that routing, scheduling, and resource allocation can be accomplished.
8.1.4.2	RMCWP shall support inter-agency coordination of response and scheduling of resources for significant events with broad impact, like natural disasters, major incidents, and large planned or seasonal events.
8.1.4.3	RMCWPD shall coordinate information with other transportation agencies, including but not limited to:
8.1.4.3(a)	Public Safety
8.1.4.3(b)	Emergency Medical Management
8.1.4.3(c)	Transit
8.1.4.3(d)	Traffic Management
8.1.4.3(g)	Information Service Providers
8.1.4.3(h)	Transportation Asset Management (Pavement management, bridge management, etc)

III. Architecture Analysis Specific to SEMSIM

III.A. SEMSIM-relevant Areas of the National Architecture

Based on the above overview of the National Architecture, it is apparent that the Maintenance and Construction Management User Service directly applies to SEMSIM.

Extracting from the architecture documentation, subsystems relevant to this evaluation are:

- Maintenance and Construction Management -- monitors and manages roadway infrastructure construction and maintenance activities; manages fleets of maintenance, construction, or special service vehicles (e.g., snow and ice control equipment); performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment.

- Maintenance and Construction Vehicle - provides the sensory, processing, storage, and communications functions necessary to support highway maintenance and construction.

Market packages most relevant to SEMSIM are:
MC01: Maintenance and Construction Vehicle and Equipment Tracking
MC02: Maintenance and Construction Vehicle Maintenance
MC03: Road Weather Data Collection
MC05: Roadway Automated Treatment
MC06: Winter Maintenance

MC07: Roadway Maintenance and Construction
MC10: Maintenance and Construction Activity Coordination

Regarding communications options, the architecture program has examined the fixed point to mobile communications approach in SEMSIM and determined that this is one of several viable communications approaches.

The following section will analyze the SEMSIM approach relative to design options specified in the Architecture Market Package document.

III.B. Analysis of SEMSIM approach Relative to the National Architecture

III.B.i. Market Packages

Section 6.1.12 of the Architecture Market Package document is entitled Maintenance and Construction Operations Management Design Options. The Market Packages related to Maintenance and Construction Operations were designed to accommodate a broad array of implementation options and scenarios. Table 6.3.7-1 within the document identifies some of the major design options with Maintenance and Construction Market Packages and is reproduced below.

Table 6.3.7-1: Maintenance and Construction Design Options

Market Package	Major Options Consistent with the National ITS Architecture
Maintenance and Construction Vehicle and Equipment Tracking	• Technologies for vehicle location: signpost or wayside beacons, global positioning system (GPS), differential GPS, radio signal trilateration (e.g. Loran-C), dead reckoning. • Wide-area communications: cell-based, specialized mobile radio (SMR), trunked radio, other conventional two-way radio, wayside beacons. • Real-time information: may be provided directly by the maintenance and construction agency and/or through a third-party information provider. Wide variety of possible communications technologies
Maintenance and Construction Vehicle Maintenance	• Vehicle condition data may be held on the maintenance and construction vehicle and down-loaded off line, or may be communicated real-time to operations center
Road Weather Data Collection	• Approaches: Electronically sense weather and environmental conditions • Types of data used/provided: Weather information, environmental hazards such as icy/fogy road condition. Weather information could include climatology, observations and forecasts of the atmosphere, and of pavement/ground conditions. • Automation: fully automated • Intelligence of process: Capabilities of field processors to filter sensor measurement • Communication: Wireline or wireless communication between sensors and weather center
Weather Information Processing and Distribution	• Information delivery mechanisms: AM, FM or HAR subcarriers. Messages could either be provided to travelers using roadside DMS or in-vehicle devices. Weather information is also shared with other centers to aid the decision processing systems.
Roadway Automated Treatment	• Approaches: fixed instrumentation • Types of data collected: environmental conditions of the pavement • Automation: fully automatic, require operator interpretation. • Intelligence: field processors filter raw data, raw data transmitted to TMC • Technologies: environmental sensors are used to determine when to spray chemicals on roadway surfaces to prevent unsafe driving conditions.
Winter Maintenance	• Environmental sensors in the pavement and on-board sensors are used to aid decision support systems in determining when to deploy operations.
Roadway Maintenance and Construction	• Weather agencies can provide maintenance and construction agencies with information that will aid them in scheduling certain activities (e.g., mowing, pesticide applications, construction projects).
Work Zone Management	• Vehicle detectors and DMS are used to control traffic conditions in the work zone and also warn motorist sufficiently upstream of the work zone of activity ahead.
Work Zone Safety Monitoring	• Sensors are used to monitor activity in the work zone and warn maintenance and construction crews of vehicles that enter the work area.
Maintenance and Construction Activity Coordination	• Systems could be in place to numerous centers to share information regarding maintenance and construction activity. Information can be used to allow transit agencies to modify their bus schedules, etc.

Below, each of the sections in the table above is compared to the SEMSIM approach:

Maintenance and Construction Market Package Design Options Compared to SEMSIM Attributes	
Design Option Category	**SEMSIM Attributes**
M&C Vehicle and Equipment Tracking	Vehicle location via GPS Vehicle tracking via mobile communications to SEMSIM Center Information transmitted in real-time as needed
M&C Vehicle Maintenance	Selected vehicle condition data, in particular plow and spreader status, is communicated real-time to SEMSIM Center.
Road Weather Data Collection	Measurement of road and air temperature from plow trucks.
Weather Information Processing and Distribution	Not directly applicable to SEMSIM. Road condition data is disseminated to local traffic management centers, as well as the media and the public (via Internet).
Roadway Automated Treatment	As roadway automated treatment applies to roadside instrumentation, this is not applicable to SEMSIM.
Winter Maintenance	Instrumentation to monitor air temperature, road temperature, plow status (belly and front), box loading, and spreader (status and salt rate).
Roadway Maintenance and Construction	Not applicable to SEMSIM.
Work Zone Management	Not applicable to SEMSIM.
Work Zone Safety Monitoring	Not applicable to SEMSIM.
M&C Activity Coordination	Not applicable to SEMSIM.

III.B.ii. Physical Architecture

In the Physical Architecture documents, the Maintenance and Construction Management and Maintenance and Construction Vehicle subsystem descriptions are elaborated upon further. These descriptions are reproduced below and then decomposed into a table which contrasts these functions with the SEMSIM approach.

Maintenance and Construction Management Subsystem

The Maintenance and Construction Management Subsystem monitors and manages roadway infrastructure construction and maintenance activities. Representing both public agencies and private contractors that provide these functions, this subsystem manages fleets of maintenance, construction, or special service vehicles (e.g., snow and ice control equipment). The subsystem receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. The subsystem participates in incident response by deploying maintenance and construction resources to an incident scene, in coordination with other center subsystems. The subsystem manages equipment at the roadside, including environmental sensors and automated systems that monitor and mitigate adverse road and surface weather conditions. The subsystem manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of maintenance and construction operations. The subsystem remotely monitors and manages ITS capabilities in work zones, gathering, storing, and disseminating work zone information to other systems. It manages traffic in the vicinity of the work zone and advises drivers of work zone status (either directly at the roadside or through an interface with the Information Service Provider or Traffic Management subsystems.) It schedules and manages the location and usage of maintenance assets (such as portable dynamic message signs). Construction and maintenance activities are tracked and coordinated with other systems, improving the quality and accuracy of information available regarding closures and other roadway construction and maintenance activities.

National Architecture Maintenance and Construction Management Subsystem Contrasted with SEMSIM Approach		
MCMS Sub-function	**SEMSIM Sub-function**	**Compliance / Relevance**
Monitors and manages roadway infrastructure construction and maintenance activities	Central management and tracking of winter maintenance vehicles, to include plow and spreader status on a geographic basis	Compliant
Manages fleets of maintenance, construction, or special service vehicles	Central management of winter maintenance vehicles	Compliant
Receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment.	Received includes vehicle location (and track history, plow status, spreader status, box loading, air and road temperature; communications system supports vehicle dispatch and overall resource management	Compliant

National Architecture Maintenance and Construction Management Subsystem Contrasted with SEMSIM Approach (Continued)		
MCMS Sub-function	**SEMSIM Sub-function**	**Compliance / Relevance**
Participates in incident response by deploying maintenance and construction resources to an incident scene, in coordination with other center subsystems.	For winter weather incidents, plow vehicles are dispatched in coordination with local traffic centers	Compliant
Subsystem manages equipment at the roadside, including environmental sensors and automated systems that monitor and mitigate adverse road and surface weather conditions		Not relevant
Subsystem manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure.		Not relevant
Interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of maintenance and construction operations.		Not relevant
Subsystem remotely monitors and manages ITS capabilities in work zones, gathering, storing, and disseminating work zone information to other systems		Not relevant
Manages traffic in the vicinity of the work zone and advises drivers of work zone status (either directly at the roadside or through an interface with the Information Service Provider or Traffic Management subsystems.)		Not relevant
Schedules and manages the location and usage of maintenance assets	Tracking of vehicle location, track, and plow/spreader status	Compliant
Construction and maintenance activities are tracked and coordinated with other systems, improving the quality and accuracy of information available regarding closures and other roadway construction and maintenance activities.	Winter maintenance activities, including which roads have been treated and when, are coordinated with local traffic operations centers	Compliant

Maintenance and Construction Vehicle Subsystem

This subsystem resides in a maintenance, construction, or other specialized service vehicle or equipment and provides the sensory, processing, storage, and communications functions necessary to support highway maintenance and construction. All types of maintenance and construction vehicles are covered, including heavy equipment and supervisory vehicles. The subsystem provides two-way communications between drivers/operators and dispatchers and maintains and communicates current location and status information. A wide range of operational status is monitored, measured, and made available, depending on the specific type of vehicle or equipment. For example, for a snow plow, the information would include whether the plow is up or down and material usage information. The subsystem may also contain capabilities to monitor vehicle systems to support maintenance of the vehicle itself and other sensors that monitor environmental conditions including the road condition and surface weather information. This subsystem can represent a diverse set of mobile environmental sensing platforms, including wheeled vehicles and any other vehicle that collects and reports environmental information.

National Architecture Maintenance and Construction Vehicle Subsystem Contrasted with SEMSIM Approach		
MCVS Sub-function	**SEMSIM Sub-function**	**Compliance / Relevance**
Provides the sensory, processing, storage, and communications functions necessary to support highway maintenance and construction	On-board equipment collects and transmits relevant winter maintenance data including vehicle location (and track history, plow status, spreader status, box loading, air and road temperature; communications system supports vehicle dispatch and overall resource management	Compliant
Provides two-way communications between drivers/operators and dispatchers	SEMSIM uses text messaging between these entities (a feature of the Orbtrac system). Two-way communications provided via SMART 900 MHz wide-area wireless communications system	Compliant

National Architecture Maintenance and Construction Vehicle Subsystem Contrasted with SEMSIM Approach (Continued)		
MCVS Sub-function	**SEMSIM Sub-function**	**Compliance / Relevance**
Maintains and communicates current location and status information	Vehicles equipped with GPS; subsystems monitor key functions; location and subsystem status communicated to SEMSIM center	Compliant
May also contain capabilities to monitor vehicle systems to support maintenance of the vehicle itself and other sensors that monitor environmental conditions including the road condition and surface weather information	Environmental conditions monitored include air temperature and road temperature	Compliant
This subsystem can represent a diverse set of mobile environmental sensing platforms, including wheeled vehicles and any other vehicle that collects and reports environmental information	SEMSIM fundamentally focuses on plow trucks. Broader system usage is being explored, as these trucks perform other maintenance duties in warm weather.	SEMSIM supports extended functions for sensing and maintenance operations management; this capability is not currently employed.

SEMSIM is also compliant with relevant physical architecture aspects of the SEMCOG regional architecture.

III.C. Architecture Philosophy

In additional to functional analysis, the philosophy of the architecture can be usefully applied to gain a sense of the degree to which SEMSIM is in alignment with architecture principles. The intent of the architecture is to provide linkages or "hooks" within and between ITS components within a region, as appropriate. Not all linkages need to be actualized; however the ideal is for inherent compatibility so that future upgrades may implement desired linkages. Many times, this simply translates to avoidance of inherent in-compatibility.

The SEMSIM system relies on in-vehicle data collection/processing, communication links to a data center (SMART), and management workstations at the individual localities, all supported by custom software. As is typical with today's modular computer technology, the ability to upgrade the system to add links to, say, traveler information systems, is a matter of software modifications and possibly hardware upgrades -- thus, there is no fundamental impediment to adding increased system capability throughout the suite of ITS services defined by the architecture. If and when this is done, the architecture provides a comprehensive data flow diagramming to guide such efforts.

Thus, the SEMSIM system design is compliant with the intent and spirit of the national ITS architecture.

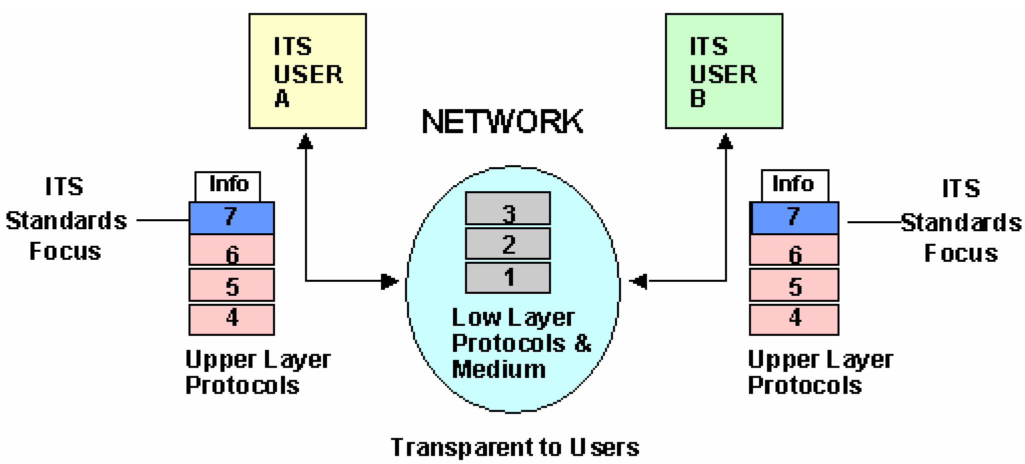
IV. Standards and Interoperability

It is useful to note that the national architecture does not define data formats or protocols, nor does it define standard hardware or software approaches. These decisions are left to individual implementers; vendors are motivated to use industry standards to gain national market share. A brief discussion of standards and interoperability is provided here.

IV.A. Standards Issues relating to the SEMSIM System Approach

As a companion effort with the architecture, USDOT is defining a set of specific data standards which can offer inter-operability. These are ITS-specific standards that complement standards already in place within the computer and communications industry.

Standards generally address the communications layer, one of three layers (along with the transportation and institutional layers) defined by the Architecture. The communications layer includes all of the communications equipment (e.g., wireline and wireless transmitters and receivers) and the information management and transport capabilities necessary to transfer information among entities in the transportation layer. The application data content and the transportation application requirements are generally transparent to the communications layer. The communication layer's view of ITS is that of many distributed users, some of them mobile, which require communication services.



It can be seen from the above diagram that low layer protocols and communications mediums are left to industry standards, such as CDPD and 900 MHz systems. Upper layer protocols, unique to ITS, are addressed by USDOT standards efforts.

IV.A.i. High Layer ITS Standards

Within an extensive standards effort, only two standards items emerged from the research within this task which are potentially applicable to SEMSIM. They are:

> Information Service Provider (ISP) Vehicle Location Referencing Standard (J1746) approved in late 1999 and scheduled for publication by SAE in May 2000. J1746 standardizes the way information is conveyed between vehicles, ISPs, and traffic management centers in describing the exact location of a vehicle or incident.

> The Location Referencing Message Specification (LRMS) Information Report (SAE J2374) describes a set of standard interfaces for the transmission of location references among various ITS components. The report was published by SAE in fall of 1999.

IV.A.ii. Low Layer Industry Standards

The Orbital design encompasses a wide array of standard industry interfaces and standards, which enhances interoperability and simplifies support.

Communications: standard commercial components and protocols are used, including high-speed TCP-IP interfacing and a 900 MHz radio wireless system. The communications system uses Asymmetric Non-Simulcast transmission. This approach uses a transmitter in the Renaissance building in Detroit, a transmitter at Omo Road in Macomb Co. and a transmitter in Clarkston that is in Northern Oakland Co. .

Database: Fixed end databases are compliant with Microsoft Access SQL and ODB-C standards. This is a common open industry standard that virtually all databases support.

Location Referencing: AVL data is stored in open formats and runs on Microsoft Windows NT. The commercial product ESRI MapObjects is used. For future phases, the SEMSIM system can read any map data supplied in shape file format (shp).

Data Communications: A fully networked client /server system architecture is used, and redundant components are employed. Standard RS232 data interfaces are used. Open Database Connectivity standard (ODBC) used between system components.

Vehicle: Standard data communication protocols (J1708, J1589) are used. Physical interface to engine is compatible with existing Orbcomm IVU-120 vehicle equipment.

User Terminal: The Orbcomm system software within SEMSIM can run on any PC running Internet Explorer 6 or later.

IV.B. Interoperability & Interfaces

Because ITS Standards focus on higher layers, a particular system implementation may not be compatible, in terms of data formats, with a system in an adjoining jurisdiction, for example -- and both systems could still be compliant with the national architecture. Also, one vendor's approach may differ from another's approach, so that for Vendor A to perform an upgrade to a system designed by Vendor B may not be a simple matter. At the same time, vendors are motivated to use current industry standards for data exchange and standardized hardware, as this simplifies their design and support activities; some commonality among different vendor approaches can generally be expected. For example, the Orbital approach uses industry standard 900 MHz radio communications and ODB-C compliant data base approaches.

Further, there are concerns re physical interconnects as new generations of instrumentation are released. Currently, there is not a standard interface for components of a system such as the SEMSIM system. New models of spreaders have different interfaces than previous models. Additionally, new brands of spreaders are being purchased that require customized interfaces. This situation also exists for temperature sensors and other components.

Since the ITS National Architecture does not address these types of interfaces, it is recommended that SEMSIM and similar activities nationwide initiate an interface standardization effort. This effort could reflect standardized interfaces adhered to in the computer industry (parallel port, serial port, USB, firewire, etc.) and the automotive industry (CAN, J1939, J1708/1587). Economical and efficient deployment of winter maintenance management systems nationwide would benefit greatly from such an effort, which might be centered within an AASHTO committee or ITE.

Within AASHTO in particular, the Subcommittee on Maintenance within the Standing Committee on Highways may be an appropriate focal point. The Sub-Committee’s mission is “to provide guidance and direction to AASHTO that facilitates continuous improvement and safety in highway system preservation, maintenance, and operations." The Sub-Committee tasks, as noted on the AASHTO website (www.aashto.org) are to prepare, publish and keep current:

- general maintenance specifications for contract or force account work involving the preservation of all classes of highways under the jurisdiction of the Member Departments;
- a comprehensive manual of recommended maintenance methods and practices;
- a manual of instructions for inspectors of maintenance work;
- information on new and improved maintenance equipment and practices;
- data on new types of equipment that will further mechanize and reduce the costs of maintenance operations and encourage maintenance performance records and reports that will: (a) identify design features that should be corrected as disclosed through maintenance problems and operation; (b) promote efficient and effective maintenance through improved management practices; (c) protect and enhance the quality of environment; and (d) develop instructional recommendations for inclusion in a manual relating to roadside development and the preservation of the roadside.

Within this Sub-Committee is the **Snow & Ice Task Force,** whose purpose is to enhance and promote winter operations as it relates to highway maintenance activities. The Task Force focuses on the following:

- Exchange of information between its members and other groups with shared interests;
- Encourage focus and increased awareness of winter operations related issues and concerns;
- Develop resolutions and research problem statements, and submit them to the AASHTO Subcommittee on Maintenance; and
- Identify and share new technology and best practices.

All states have members on the Maintenance Sub-Committee and those states with major winter operations are participating, or can participate, in the Snow and Ice Task Force. Therefore, this appears to be a prime starting point for national-level discussions on interoperability and interfaces.