Development of Interface Specifications for Mobile Data Platforms on DOT Vehicles

Thompson Engineering Company

CLEAR ROADS

research for winter highway maintenance

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NOTICE:

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16. Abstract

AVL/GPS/Sensor Data Collection Systems are typically deployed within transportation maintenance fleets. All too often, highway maintenance engineers invest resources into AVL & GPS along with several types of sensors, only to find that the systems are proprietary and find it difficult incorporate new technology. Developing a set of standards to develop interoperable components becomes essential. This Clear Roads project developed a set of generic specifications and proposes an implementation plan to standardize them at the national level. The specification designates a standard modem/GPS unit that employs cellular and Wi-Fi communications to transmit to a web based server. In-vehicle, the modem/GPS unit connects to the engine bus of each transportation vehicle using the SAE J1939 interface. All onboard sensors are connected to the engine bus and the modem/GPS unit listens for sensor data. It is remotely programmed to collect and transmit the desired information for each unique user community to a transportation database. The implementation plan is built upon petitioning a standard granting organization such as SAE or IEEE through the use of a national sponsor such as APWA or FHWA with the Clear Roads proposed specification. By adopting a standard interface, vendors can remain competitive, offer unique services, yet provide a wide range of interoperable products for the transportation industry.

17. Key Words GPS, AVL, specifications, road maintenance, sensors, salt spreaders, Clear Roads, SAE J1939, NTCIP, pavement temperature, winter maintenance, modem, wireless network, CANbus, engine data, mobile data collection	Distribution Statement No restriction. This document is available to the public through the Clear Roads Organization and the Wisconsin Department of Transportation 4802 Sheboygan Avenue Madison, WI 53707

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Wilfrid Nixon of the University of Iowa who assisted with the literature search, which helped us identify current research on our topic and strategies that might be worth investigating.

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Finally, the many individuals, both in management and in the field, who completed our surveys allowed us to provide substantive findings and recommendations in this report. Our sincerest thanks go to all who shared their road maintenance experiences with us.

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I. EXECUTIVE SUMMARY

A. General. AVL/GPS/Sensor Data Collection Systems are typically deployed within transportation maintenance fleets but any public works fleet is a candidate for these types of systems. The work completed on specifications from this project will benefit highway maintenance engineers significantly. Recent events have shaped the world's approach to transportation safety and the marshalling of resources to respond to several challenging (potentially damaging) scenarios. Paramount to successfully managing these situations is the ability to react in real-time over a wide geographic area using a variety of communications means and a host of emergency and environmental services.

All too often, highway maintenance engineers invest resources into automatic vehicle location and global positioning systems along with several types of sensors, only to find that the systems are proprietary, they are stuck with one type of system, they can't incorporate new technology, etc. In addition, the calculated uniqueness of various sensors such as salt spreaders, temperature sensors, plow indicators, hydraulic systems, tilt meters, etc. makes them inflexible to change and integration. The highway maintenance engineer is faced with one system, no way to compete amongst vendors, for all of these pieces of equipment. The key is for vendors to be directed to develop interoperable components that can work with other vendor's equipment. Developing a set of standards becomes essential for the success of these types of systems and the place to start is with the vehicle hardware.

When new cameras and printers can be plugged into standard personal computers and be functional in a matter of minutes or seconds, the concept of interoperable or "plug and play" is a common concept in the consumer world. This sort of convenience and cooperation in the marketplace is possible because of standards to which these devices conform. In the AVL/GPS market as applied to road maintenance, the situation is complex encompassing many facets of technology implementation and user expectation; however, the need is clear – that is, standardization of the equipment, processes, and interfaces is required in order to leverage the competitive nature of the marketplace, to allow users to build on previous inventories without unnecessary trade-ins or scrapping previous systems and to insure the data gathered and stored is useful far into the future.

B. Specification. The concept of operations and the specification (completed late 2009 & early 2010) have captured an innovative approach and solution to meeting this challenge. This approach builds on previous standardization efforts in process at the Society of Automotive Engineers (SAE) and National Transportation Communications for ITS Protocol (NTCIP). In essence, the specification that follows views the "vehicle as a hub" encompassing several levels of sophistication. This methodology embraces the existing trends in vehicle communication from vehicle to vehicle and vehicle to roadside.

It also takes advantage of the attendant technologies that continue to become faster and more ubiquitous, have increased range, and have the ability to employ "there's an app for that". The internet, cellular networks, and wireless networks continue to improve their coverage areas, speed, throughput, and versatility. This specification takes advantage of these major industry improvements over time. In addition, the specification capitalizes

on growing use of the engine bus as the central hub for vehicle data. The future vision of the "vehicle as a hub" methodology will encourage stakeholders to "buy-in" to this approach.

Thus, the specification seeks to integrate with existing vehicle data specifications from SAE and NTCIP. It also employs the engine bus from late model vehicles as the entry point for all vehicle sensors (data stream, discrete, triggers, etc.). It proposes two types of wireless connectivity to link the vehicle to existing networks; that is Wi-Fi and cellular. The on-board modem/GPS unit is remotely programmable and configured generically to communicate on all networks to tailored or customized web sites. Data fields are uniquely tagged with specification determined identifiers to parse and deliver each data item or datum to the appropriate record.

The proposed solution requires that standardization occur at the database and graphical user interface levels in order to receive and transmit data and information to/from the vehicle. The establishment of a "Transportation" database will be useful in several legacy and related applications including fuel management, repair or work order systems, and cost accounting modules.

There has also been significant movement in standardizing transportation on-board data communications and vehicle health monitoring systems using FHWA best practices documents, NTCIP and SAE standards. These references are also employed in this document and the specification is meant to join with these documents to better standardize these technologies and their implementation in the transportation community as a first step. The actual formatting and integration with these documents will require coordination with other state and federal agencies, technical advisory committees, and certain vendor communities.

C. Implementation Plan. This document provides a recommended implementation plan to begin the task of formally standardizing the in-vehicle data collection systems to interface with a broad range of products. The implementation plan is characterized by the following features:

1. Develop specifications for a transportation database and the web-based graphical user interface and database query methodology
2. Seek a sponsoring organization at the national level to champion this effort
3. Convene a technical committee of stakeholders to provide consensus on integration and interfaces
4. Petition existing standardization agencies for inclusion, i.e. SAE & IEEE
5. Prepare specifications in NTCIP format and receive stakeholder "buy-in"
6. Conduct testing, gain final approval, and begin implementation

The project proved to be more complex than originally anticipated; however, the project manager and committee members contributed several ideas that became part of the approved plan. This results in an innovative, forward vision, proposed solution that is achievable and conforms to emerging best practices and technologies. Attachment F provides the proposed PowerPoint slides for presenting the project results.

II. INTRODUCTION

A. Background. The Clear Roads pooled fund research program (www.clearroads.org), in coordination with the Wisconsin Department of Transportation, seeks to develop communication and data format specifications to support mobile data platforms used by State DOT's. The mobile data platforms may be comprised of equipment such as, snow plows, end-loaders, supervisor trucks, paint trucks, herbicide sprayers, trailers, oil distributors and other similar equipment used in roadway maintenance operations**.** Agencies that are considering adding GPS/AVL to support the mobile data platform need a set of specifications that will allow them to purchase a variety of different sensors that all use a common communication protocol and data format. This document comprises the final report for this project.

B. Attachments. The following attachments are included as part of the final report and represent the compendium of deliverables for this project. Attachments A - E were previously provided during the period of contract performance.

Attachment A: Literature Search (separately distributed) dated Mar 2009
Attachment B: Survey Report (separately distributed) dated Jul 2009
Attachment C: Survey Report (separately distributed) dated Aug 2009
Attachment D: Concept of Operations (separately distributed) dated Jan 2010
Attachment E: Specification Set (separately distributed) dated Feb 2010
Attachment F: PowerPoint Presentation Slides dated Mar 2010

C. General. The document is organized to provide a brief review of the previous tasks of the project and to list their findings or main results (sections III – V) as it relates to the Implementation Plan (section VI) which follows. The presentation slides are also included in Attachment F.

D. Project Task Organization. The task flow chart is shown in Figure 1. The main deliverables (shown in green) were the literature search, survey results, specification, and recommendations and implementation plan (consolidated as one in the final report). The subtasks (colored in blue) are also shown in Figure 1.

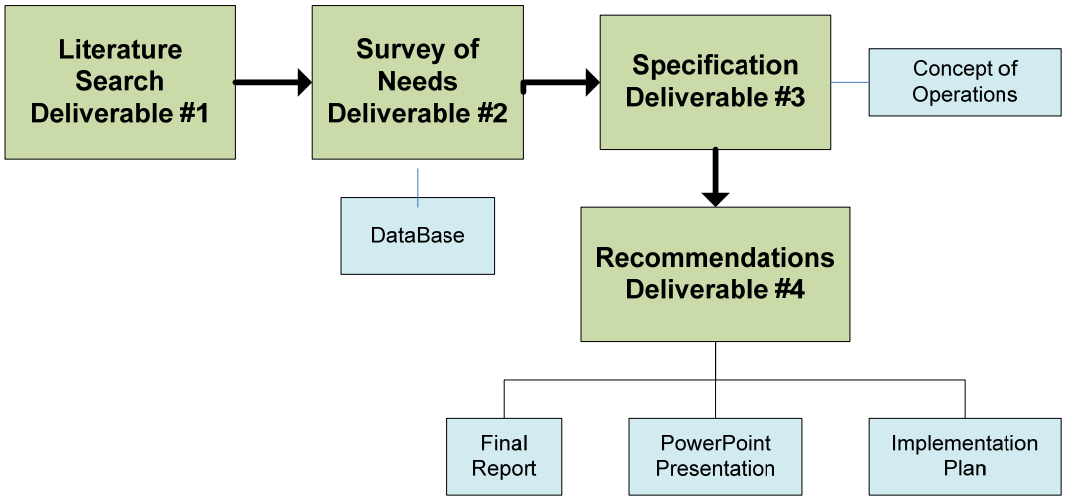


Figure 1: Project Organization

E. Project Schedule. The original project schedule is illustrated in Figure 2. The project finished on schedule and will conclude at the end of first quarter of calendar year 2010 (March 31, 2010).

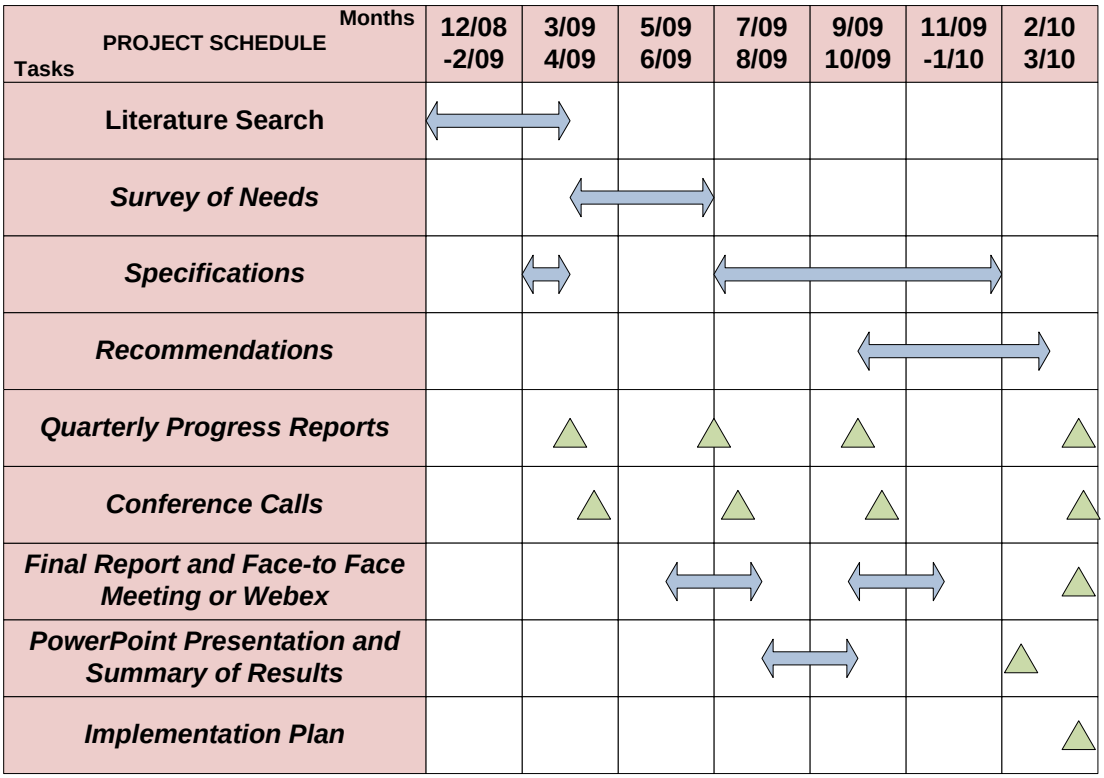


Figure 2: Project Schedule

F. Project Highlights. The project highlights are listed below.

- Conduct a literature search to seek information from other sources and/or leverage previous research to accomplish the project goals.
- Survey stakeholders and provide a forum for government agencies, vendors & manufacturers, & researchers to participate in the discussion.
- Create a common set of standards or specifications in order to improve overall interoperability to meet the requirements of collecting relevant information while still taking advantage of a competitive marketplace.
- Develop a set of recommendations & final report for Clear Roads Organization.

III. LITERATURE SEARCH

A. Purpose. The purpose of the literature review was to find references that provided information regarding the development of specifications, functional requirements, and/or interface descriptions for salt spreader controllers, onboard surface temperature sensors, engine bus, and other data gathering equipment to include communications and other onboard electronic equipment. The focus of the review was directed towards foreign countries first, in particular, progressive snow fighting countries. Second, examine and identify the related literature in North America.

B. Scope. In conducting this review, the TRIS database was used, in conjunction with a detailed review of Permanent International Association of Road Congresses (PIARC) winter road congress publications, the proceedings of Standing International Road Weather Commission (SIRWEC) meetings, and of the Transportation Research Board (TRB) Annual Meeting publications over the past ten years. The time period limit, although somewhat arbitrary, recognizes that while there may well have been studies on these matters prior to this time, the rapid development of electronics and communications would likely render any such earlier publications or studies obsolete by now. Note also that in many cases, the studies in the references were not specifically about the topics considered in this current study, but in order for the study in the reference to have been done, some of the topics in this current study must have been addressed.

C. Literature Search Findings. The findings from the literature search were provided in two main categories; foreign countries and North America. The literature search uncovered several interesting documents related to subjects that were discussed in this project, however, no one document or study addressed the topic directly or from the focused scope required to provide specifications that would allow agencies to purchase a variety of different sensors that all use a common communication protocol and data format.

IV. SURVEY RESULTS

A. Purpose. The purpose of the survey instruments was to provide a forum for government agencies, vendors & manufacturers, and researchers to participate in the discussion regarding the development of specifications, functional requirements, and/or interface descriptions for salt spreader controllers, onboard surface temperature sensors, engine bus, and other data gathering equipment to include communications and other onboard electronic equipment. There is a lot of expertise in this industry and many projects have been implemented, tested, and analyzed. These projects provide a rich source knowledge comprised of best practices, tried & true procedures, and areas to avoid. The survey instruments were one method to canvas the stakeholders for their opinions, requirements, and knowledge of what works.

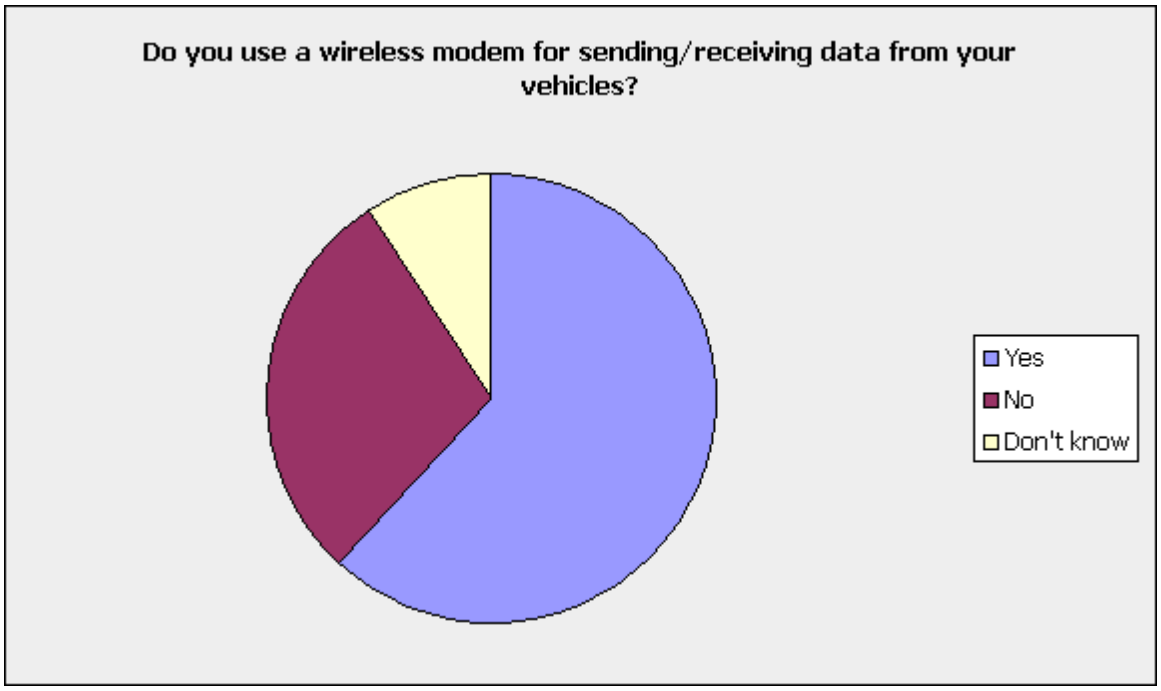
B. Approach. The surveys focused on three perspectives: government agencies, vendors, and academics. Each group was provided a forum to contribute their current data gathering methods and future information collection needs. The survey queried each group about ideas for specifications and standards for gathering information from mobile data platforms using on-board sensors. Thus, three survey instruments were created, one for each group of potential respondents.

C. Scope. In conducting the survey, experts and stakeholders were contacted and offered to participate. It was not feasible to gather random data or conduct an opinion poll. However, all interested parties were invited to participate, the survey was offered online without any proprietary identification or password required. It was announced on the electronic bulletin board for snow and ice professionals (listserv) and distributed to organizations such as American Public Works Association (APWA) members, American Association of State Highway & Transportation Officials (AASHTO) members, and Transportation Research Board (TRB) Winter Maintenance Subcommittee members.

D. Example Survey Results. The following examples include sample questions and responses that provide an overview of the survey methodology. These examples are from the government agency survey. These examples illustrate how the results from the survey were presented and the variety of answers and level of interest from the responders.

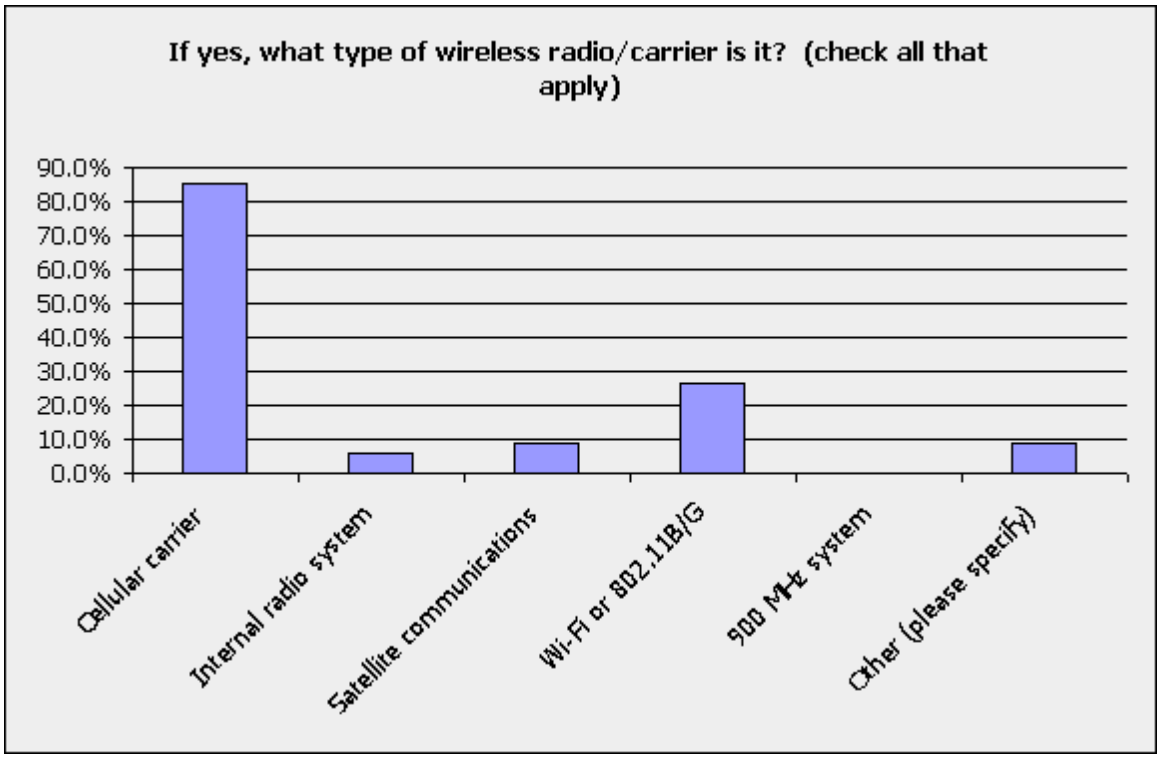
1. Mobile Data Collection Usage

Do you use a wireless modem for sending/receiving data from your vehicles?		
Answer Options	**Response Percent**	**Response Count**
Yes	61.8%	34
No	29.1%	16
Don't know	9.1%	5



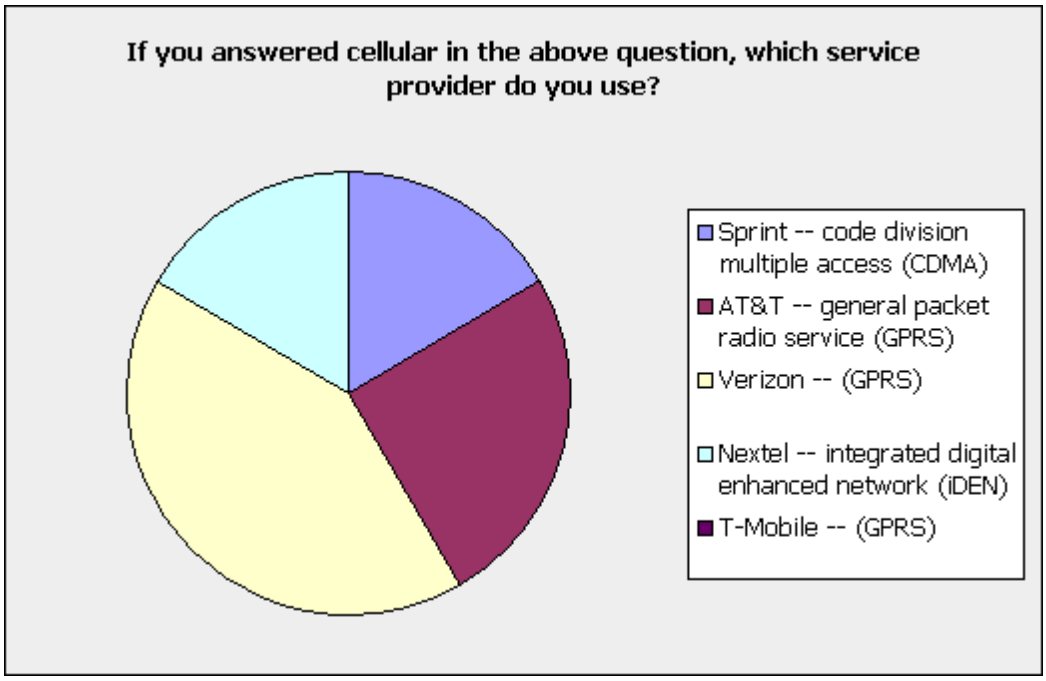
2. Wireless Networks

If yes, what type of wireless radio/carrier is it? (check all that apply)		
Answer Options	**Response Percent**	**Response Count**
Cellular carrier	85.3%	29
Internal radio system	5.9%	2
Satellite communications	8.8%	3
Wi-Fi or 802.11B/G	26.5%	9
900 MHz system	0.0%	0
Other (please specify)	8.8%	3



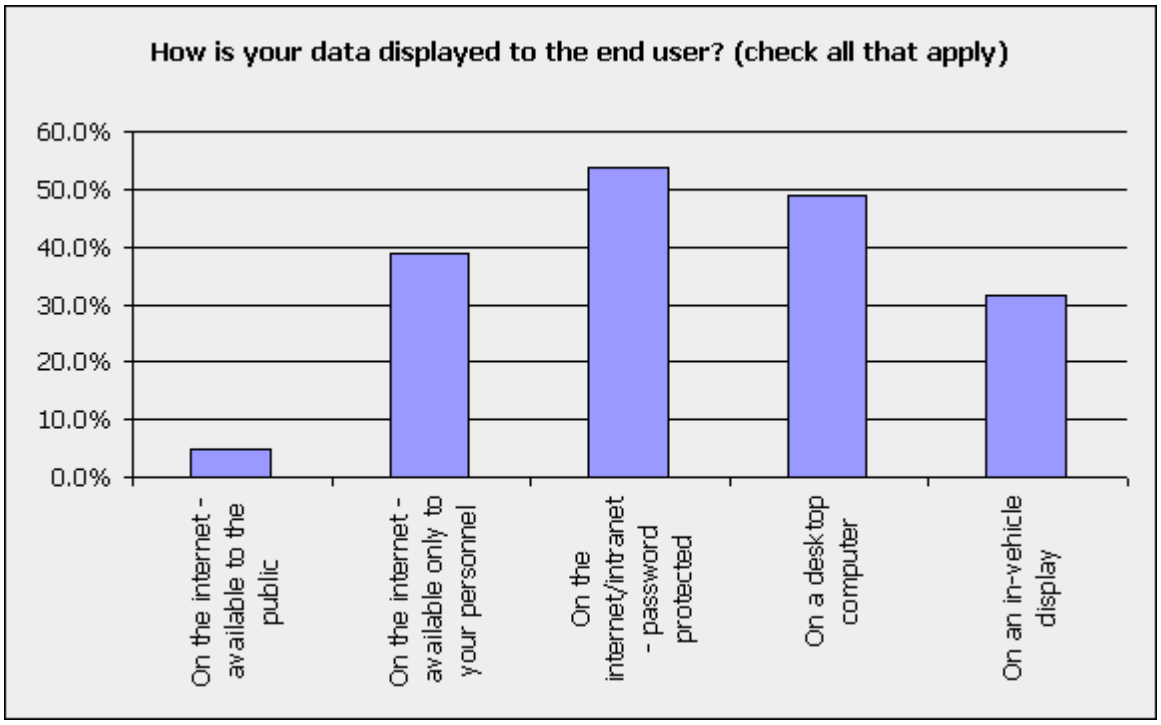
3. Cellular Service Provider

If you answered cellular in the above question, which service provider do you use?		
Answer Options	**Response Percent**	**Response Count**
Sprint -- code division multiple access (CDMA)	16.7%	4
AT&T -- general packet radio service (GPRS)	25.0%	6
Verizon -- (GPRS)	41.7%	10
Nextel -- integrated digital enhanced network (iDEN)	16.7%	4
T-Mobile -- (GPRS)	0.0%	0
Other (please specify)		6



4. Data Display

How is your data displayed to the end user? (check all that apply)		
Answer Options	**Response Percent**	**Response Count**
On the internet - available to the public	4.9%	2
On the internet - available only to your personnel	39.0%	16
On the internet/intranet - password protected	53.7%	22
On a desktop computer	48.8%	20
On an in-vehicle display	31.7%	13
other/comment		2



E. Features & Findings. The relevant findings from the surveys are provided below. Attachments B and C provide a complete transcript of the three surveys and their detailed responses.

1. **Who took the survey, did it represent the views of the industry?** 97 people took the survey; 72 from government agencies, 17 from vendors and 8 researchers. Of the government agency respondents 85% were from state government.

2. **What is variety of vehicles from which people collect data?** In the government survey respondents were asked what type(s) of vehicles do they gather data electronically? (check all that apply) Vendors were asked for what types they sell equipment. Researchers were asked for on what types they do research. The results of this question are included table 1.

Vehicles	Government	Vendors	Researchers
Snow plows	87.70%	85.70%	100.00%
Paint trucks	38.60%	35.70%	0.00%
Sweepers	29.80%	21.40%	42.90%
Gravel trucks	17.50%	14.30%	28.60%
Graders	7.00%	7.10%	28.60%
Delivery and routing	1.80%	7.10%	14.30%
Waste management	0.00%	14.30%	28.60%

Table 1: Types of Vehicles that Agencies Use to Collect Data

Other vehicles mentioned include: Concrete pumpers, patrol trucks, weed sprayers, mowers, tractors, snow blowers, and motorcycles.

3. **Is the development of standards a good idea?** The survey(s) asked the question, "The goal of this study is to develop a set of interface specifications for on-board sensors and devices used on maintenance vehicles. This would allow them to be plugged in and instantly recognized for immediate utilization. Would this specification be helpful to your agency or organization?" The answer was definitive. **Government, 83.5% affirmative and vendors, 80.0% affirmative.** A typical comment made by one respondent was "We are currently collecting data from 3 different vendors and bringing it into DOT command center. A standard protocol would make the hardware connection and data collection easier."

4. **What is the breadth of interest now and in the future?** The question about future use of sensors indicates increased interest in more data gathering of all kinds. One respondent when asked, "What types of data do you think it would be best to gather in future?" commented, "GPS for all maintenance vehicles, along with applicable production data (e.g. material application). In addition, environmental sensors (pavement and air temperature, etc.). Real-time communication and/or batch data transfer, and management interfaces to use this information in a decision-support tool."

F. Additional Features & Findings. The following conclusions were also drawn from the survey responses.

1. There is interest in a wide variety of sensors/devices.
2. The amount and type of data collected will be increasing in the future.
3. Though not in wide spread use now; there is a keen interest in sensing liquid and dry material that remains in the truck.
4. There are interesting technical questions for the future like how to sense the salt concentration of the pavement.
5. There is a great deal of interest in discrete sensors (up/down, on/off, open/closed).
6. Not surprisingly with the explosion of video there is interest in mounted cameras for the future.
7. Two-way data messaging is increasing.
8. Safety features are a concern with respondents seeking to sense seat belt usage, tilt sensors, and safety lights.
9. Over 80% of Government agencies and vendors think this is a good idea.
10. There is a significant interest in more data gathering of all kinds in the future.
11. Data and information gathering is important for decision making and that the absence of common specifications, ability to "plug and play" sensors & modems inhibits this process.
12. All three groups had responders that acknowledged that this would not be "easy" or anticipated that one solution would not fit all stakeholders.
13. Responders came from 18 different states, three countries, several counties, and 15 different vendors.

V. SPECIFICATION

A. General. The specification set is based on an innovative approach that builds upon the concept of the "vehicle as a hub". In other words, in the near future each vehicle can be viewed as a sensor probe and a communications node for collecting information and transmitting & receiving data throughout the road and highway networks. A concept of operations was created to illustrate this hypothesis.

B. Concept of Operations. The specification addresses the on-board data collection and communications equipment for road maintenance vehicles. It describes the interface between a host end server application or graphical user interface and the modem/GPS unit on-board the vehicle. This relationship is described in Figures 3, 4, and 5. Figure 3 provides a block diagram linking the vehicle to the user.

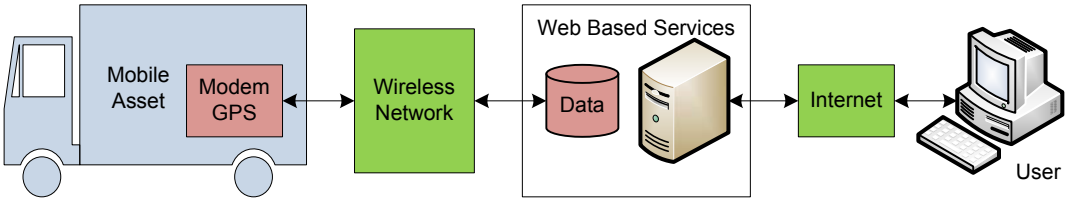


Figure 3: Block Diagram Illustrating Vehicle to User

Figure 3 shows the basic building blocks of an AVL/GPS data collection system. The modem/GPS unit on board the vehicle provides the communications connection for exporting the information off the road maintenance vehicle.

Figure 4 provides the next level of detail in showing how each component connects to gather data at the sensor and send the information to the user. All of the sensors are connected to the engine bus. The engine bus is connected to the modem/GPS unit via a standard J1939 connector. The unit is programmed to collect the user defined data and transmit at user determined intervals. The wireless network functions as the link from the vehicle to the host end server.

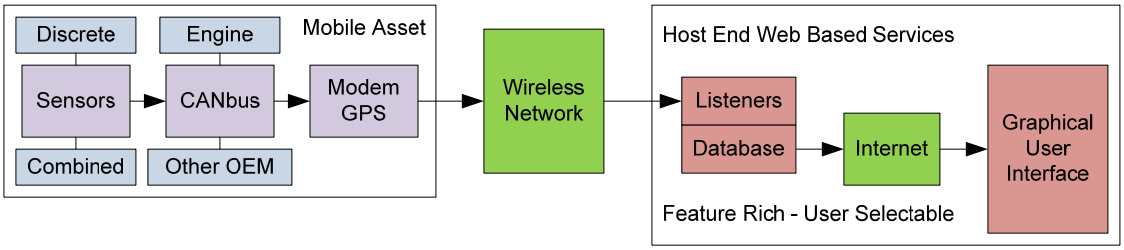


Figure 4: Block Diagram of On-board Equipment & Host End Services

The modem/GPS unit needs to employ firmware that is intelligent in two ways. It requires an intelligent agent that provides system recognition and interface data when queried by the host end. Secondly, the modem/GPS unit must possess an intelligent agent that can be remotely programmed to configure the unit for functional features. Figure 5 illustrates the data gathering system at the functional level. The boxes colored in green are example sensors that could be used for road maintenance vehicles. The modem/GPS unit is programmed to "listen" for desired data on the CANbus; extract it

and tag it with date, time, latitude, longitude, speed, heading, etc. and other sensor information. Then it is packaged for transmission or on-board data storage. These features are the heart of the "plug and play" aspect of this concept or hypothesis.

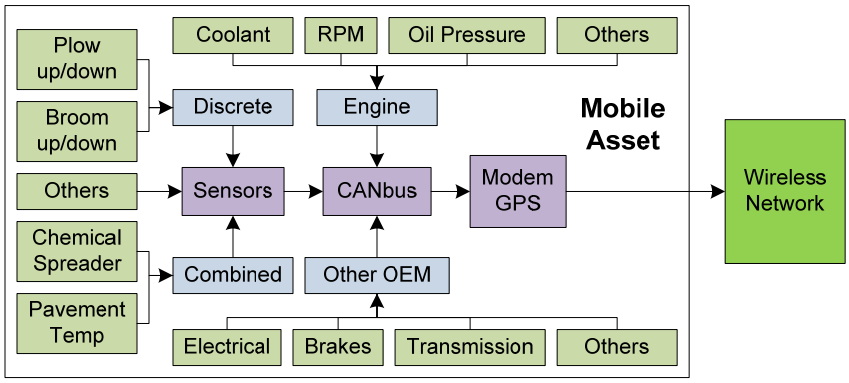


Figure 5: Functional Level Block Diagram

One of the facts learned in the literature search and survey portions of this study is that no two customers or users want the exact same data. Thus, the on-board modem/GPS unit needs to be configurable or customizable. See figure 6 below.

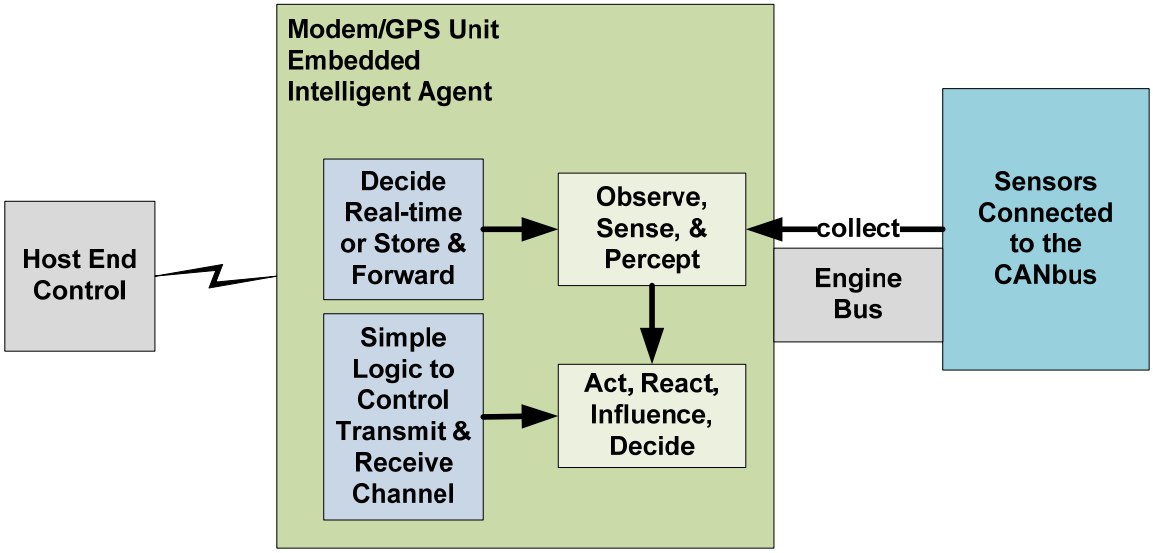


Figure 6: Intelligent Agent Example for Modem/GPS

C. Specification Methodology. The specification methodology was based on several premises that are briefly outlined below. The concept is to conform to existing standardization efforts and to employ the advances in attendant technologies as a means to adopt this concept industry and agency wide. A brief summary of methodology and basic assumptions are provided below.

1. Users desire to collect engine data as well as vehicle activity. This data provides vehicle health information when combined with vehicle activity or performance enables supervisors to influence the road maintenance response based on a current, accurate snap shot of the situation.

2. The specification provides for the communications modem to be standardized and focused on two methods of wireless communications; cellular and wireless network (e.g. wi-fi, 802.11B/G). This provides a real-time communication method and maintains a store and forward communication method for transmitting/downloading time-sensitive, perishable information as well as retaining valuable summary information for end of day, end of week larger transmissions. One or both methods may be used.

3. All sensors are connected to the CANbus; this provides a standard, systematic approach for a variety of third party vehicle subsystems, such as salt spreaders, pavement temperature sensors, hydraulic systems, and discrete sensors that signal plow up/down, broom up/down, doors open/closed, etc.

4. The in-vehicle modem will connect to the CANbus. This will standardize all data gathering accomplished by the vehicle. It provides one common source for vehicle data. Location information is only valuable when tied to vehicle performance or vehicle health information.

5. As new sensors are introduced or as users desire to collect more information, the SAE J1939 specification has place-holders for additional data fields. This feature allows users to switch sensor providers or to mix and match vendor products to maximize their performance cost effectively.

6. The standards in this set of specifications apply only to those host end server applications that are web based. They must be browser based and password secure and be able to query a standardized transportation database. It allows the user to employ vendor specific, yet competitive products that can still customize the “look and feel” to meet unique user requirements.

7. The modem/GPS unit that will be installed in-vehicle must be simple, self contained, yet possess a certain amount of intelligence. It must have the ability to be remotely controlled and configured via wireless communications.

The above methodology seeks to support several trends in the transportation, communications, web services, and information collection industries and technologies. Viewing the vehicle as a hub is going to expand over the next few years and this specification seeks to be consistent with those types of developments. The internet, cellular networks, wireless communications, and database backed web services will get faster; and more secure, ubiquitous, and sophisticated. The vehicle hub centric outlook is the key to mesh networks, vehicle to roadside, traffic control, and a host of other enhancements to the motoring public and transportation industries.

VI. IMPLEMENTATION PLAN

A. General. The results and findings of this project are valuable but require additional effort to be implemented. The host end and data storage elements that comprise an overall data and information gathering system also require some standardization. The process is complicated because of the wide usage of numerous vendor products throughout the agencies. Yet this massive implementation at all government levels confirms the need for a common set of standards. Combine this with the constant influx of new products and technologies and the myriad of industries that the transportation professional must harness to provide road maintenance to the traveling public and you have a complex system.

B. Proposed Tasks. The proposed tasks for the implementation plan are illustrated in Figure 7. The tasks are presented in a task flow diagram, yet several of the efforts can be accomplished in parallel. The goal is to publish a mandated detailed specification applicable to all stakeholders that can be used in the procurement of in-vehicle data gathering systems. This specification must be peer reviewed and approved by international governing associations such as SAE and IEEE. The proposed tasks described below and shown in Figure 7 comprise a dynamic process that will require considerable attention. Each of the colored boxes shown in Figure 7 is significant and will require coordination.

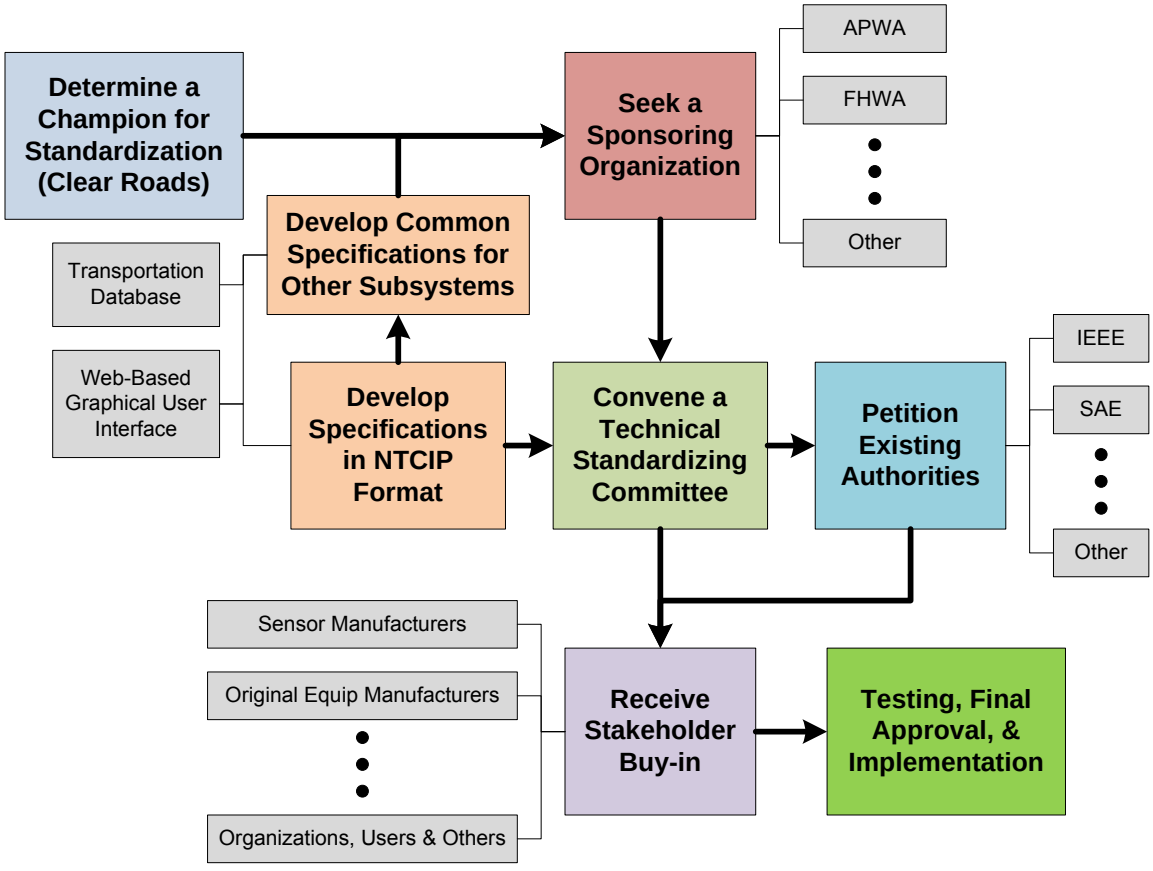


Figure 7: Implementation Plan

1. Determine a Champion for Standardization. Presently Clear Roads has assumed this role, funded the initial effort, and has a large stake in the outcome. This task is mentioned to attract a champion at the national or international level and/or team with similar organizations. Candidates are subcommittees at the transportation research board, like organizations that are not snow belt states, regional subchapters of American Public Works Association (APWA) or Intelligent Transportation Society (ITS).

2. Develop Common Specifications for Other Subsystems; Develop Specifications in NTCIP Format. *It is important to develop standardized specification sets for the related systems; e.g. database & user interface. See Figure 8. These two systems are key to overall assistance to the decision makers because they will interface with multiple legacy systems. These could include fuel, repair order, hazardous material handling,* weather, traffic, dynamic message signs, time card, supply parts, etc. By using the NTCIP format, the specifications will conform to the ongoing research and interface requirements being developed for vehicle to vehicle and vehicle to/from roadside communication links.

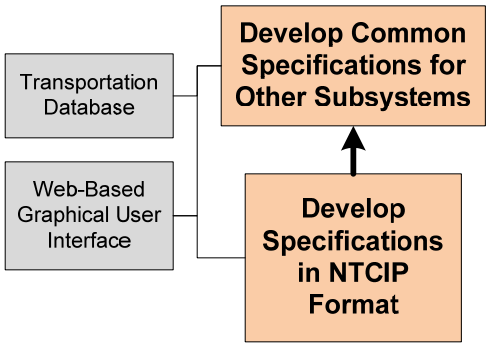


Figure 8: Other Specifications

Seek a Sponsoring Organization. *It is important to find a sponsoring organization at the national level to introduce the requirement, provide funding and other resources, and to coordinate stakeholder involvement. See Figure 9 for a couple of recommendations. The sponsoring organization becomes the conduit for international cooperation and can prepare* and present appropriate publishable documents. The sponsor needs to be at the national level with ties to the international community in order to standardize these specifications throughout the road maintenance community. They also become a central clearinghouse for emerging technologies and innovations in related industries. Finally, they assume the role of a sounding board and rallying point for negotiating various hurdles that may present themselves during the process.

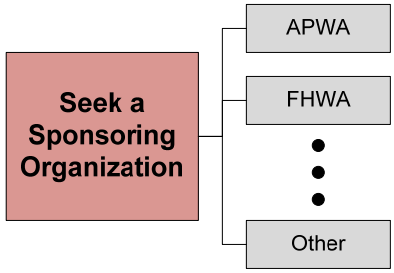


Figure 9: Sponsorship

Convene a Technical Standardizing Committee. The sponsoring organization will need to form a technical advisory committee that includes representatives from each stakeholder community and interfacing organizations, such as, SAE, ITS, IEEE, vendors, transportation consultants, university professors, professional society experts, sensor makers, and original equipment manufacturers. The most promising near term solution for this step is to have an existing technical committee adopt this issue as it is similar to several sitting committees in session at this time, e.g. winter maintenance, vehicle to roadside, NTCIP, and others.

Petition Existing Authorities. *The broad aspects of this project demanded that several of the required technologies interface existing standards and specifications. For example, to enforce the requirement that all sensors interface with the engine bus and identifies the engine bus as the central information source for the vehicle data gathering efforts; the data* and connections must conform to SAE J1939. This spec had the foresight to provide placeholders for additional sensors uncovered in this study, however, the board of advisors must be petitioned to standardize the data field identifiers and agree to the integration of information introduced to the engine bus.

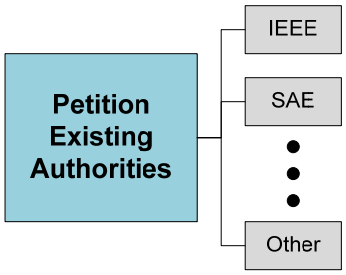


Figure 10: Required Interfaces

Receive Stakeholder Buy-in. *The stakeholder community may participate and/or approve these standards as appropriate. One hundred percent consensus will be difficult to achieve, yet open forum discussions, posting of committee deliberations, and informative canvassing of these matters is important. It should be emphasized that maintaining* competitive performance and cost aspects amongst various vendors is a vital piece to the road maintenance community.

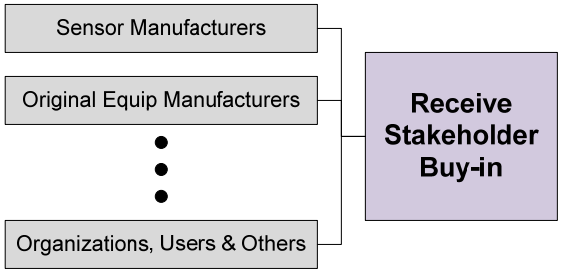


Figure 11: Stakeholder Buy-in

Testing, Final Approval, & Implementation. There will need to be a testing phase for the standards as well as a formal approval process prior to full implementation. The sponsoring organization will host this effort ensuring that the initial prototype demonstrations and testing is well planned, laboriously recorded in detail, and that action items are created for each fault, issue, and/or failure.

VII. SUMMARY

Clear Roads has reached a milestone in this process by contracting for specifications that are generic for the in-vehicle equipment and allow several vendors to compete price-wise and performance-wise. The Clear Roads members have expressed a desire to incorporate a “Plug & Play” methodology for their road maintenance vehicle fleets.

The initial literature search and industry survey (conducted in 2009 as part of this project) has demonstrated that it is not feasible to create a set of specifications that encompasses all vehicles, situations, and previous implementations. Retro-fitting previous installed modem/GPS units, discrete and combined sensors, and older model OEM equipment is not feasible.

The proposed solution requires that standardization also occur at the database and graphical user interface levels in order to receive and transmit data and information to/from the vehicle. This project is an excellent starting off point to gain national acceptance for road maintenance vehicles equipped with mobile data collection systems.

Presentation on Development of Interface Specifications for Mobile Data Platforms on DOT Vehicles

In cooperation with & funded by:

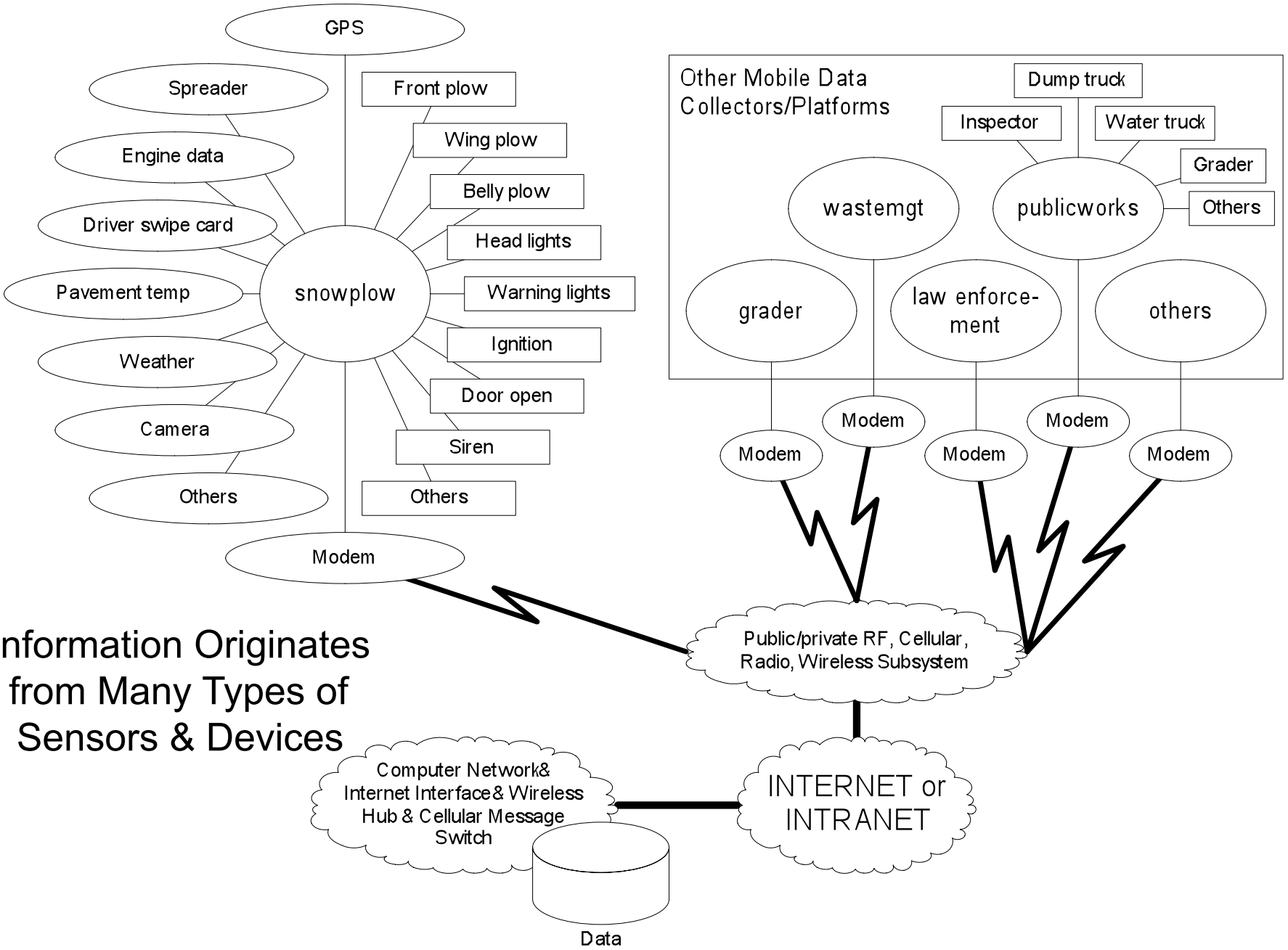
April 2010

Prepared by:
Thompson Engineering Company

Table of Contents

Project Purpose

- The Clear Roads pooled fund research program (www.clearroads.org), in coordination with the Wisconsin Department of Transportation, seeks to develop communication & data format specifications to support mobile data platforms used by State DOT's.
- The mobile data platforms could be equipment such as, snow plows, end-loaders, supervisor trucks, paint trucks, herbicide sprayers, trailers, oil distributors & other similar equipment used in roadway maintenance operations.
- Agencies that are considering adding GPS/AVL to support the mobile data platform need a set of specifications that will allow them to purchase a variety of different sensors that all use a common communication protocol & data format.

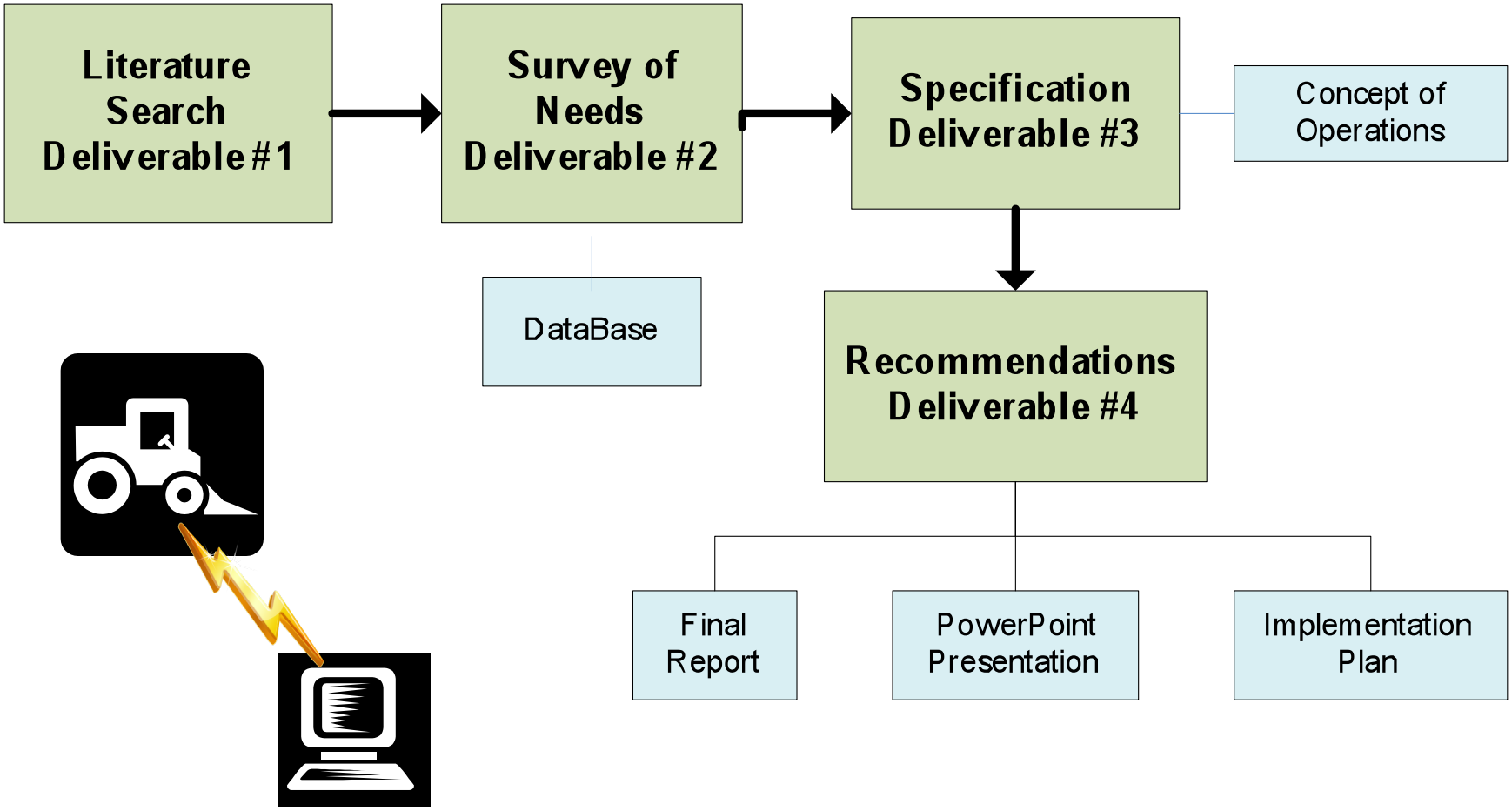


Information Originates from Many Types of Sensors & Devices

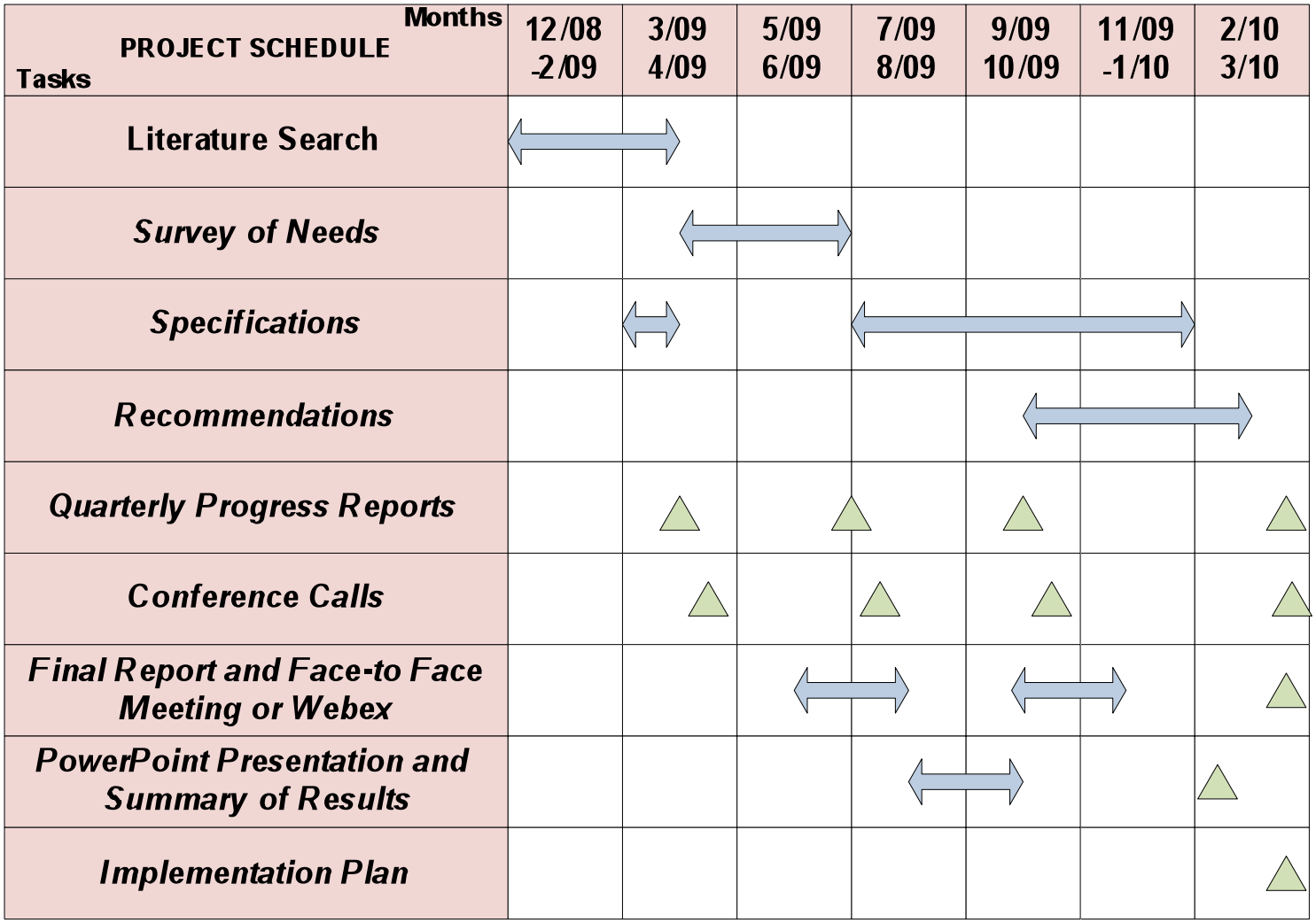
Project Tasks

- Literature Search
- Survey of Needs
  - Survey data & information
  - Survey results report
- Specification
  - Concept of operations
  - Detailed specifications
- Final Report
  - Recommendations
  - Presentation slides

Project Organization – Task Flow



Project Schedule (Dec 2008 – Mar 2010)



Literature Search

- The focus of the review was directed towards foreign countries first, in particular, progressive snow fighting countries.
- Second, examine and identify the related literature in North America.
- Results – uncovered several interesting documents related to the project subjects.
- No one document or study addressed the topic directly or from the focused scope required to provide specifications.

Survey of Stakeholders

- Created three surveys
  - Government agencies
  - Vendors
  - Academic institutions
- Queried each group for ideas on specifications and standards for gathering information from mobile data platforms using on-board sensors.
- Survey was on-line for 7 weeks.
- Canvassed several organizations seeking responders; AASHTO, APWA, TRB, state DOTs

Survey Results – from Responders

- Interoperability & interchangeability are very important
- Focus on operational criteria not technology & design features
- Get as much “buy in” from players in the field as possible
- Keep implementation of the standards in mind from the beginning & throughout this process
- Challenge - all responders acknowledged that this would not be “easy” or anticipated that one solution would not fit all stakeholders.

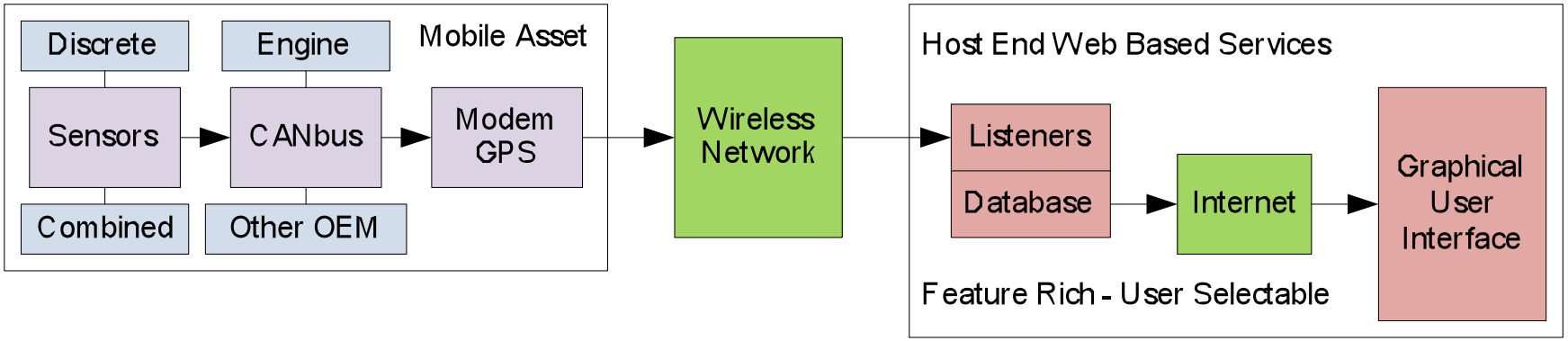
Survey Results from Responders (Cont.)

- over 80% thought this project was a good idea
- There was a wide array of sensors in use or desired to be employed
- Most responders wanted to collect engine data
- One stakeholder says “Back this up with deployment & we have power.” This emphasizes the issues surrounding approval & acceptance.
- Interface with existing standards (i.e. SAE, NTCIP, IEEE GPS, & wireless are important considerations

Specifications

- View each vehicle as a communications hub.
- Require all sensors connect to engine bus.
- Limit the standardized communications networks to cellular and Wi-Fi. Connect to engine bus.
- Introduce on-board intelligent agents to customize and tailor data collection requirement to each customer. Use J1939 data identifiers.
- Maintain vendors ability to remain competitive and be rewarded for performance
- Standardize database and web based GUI

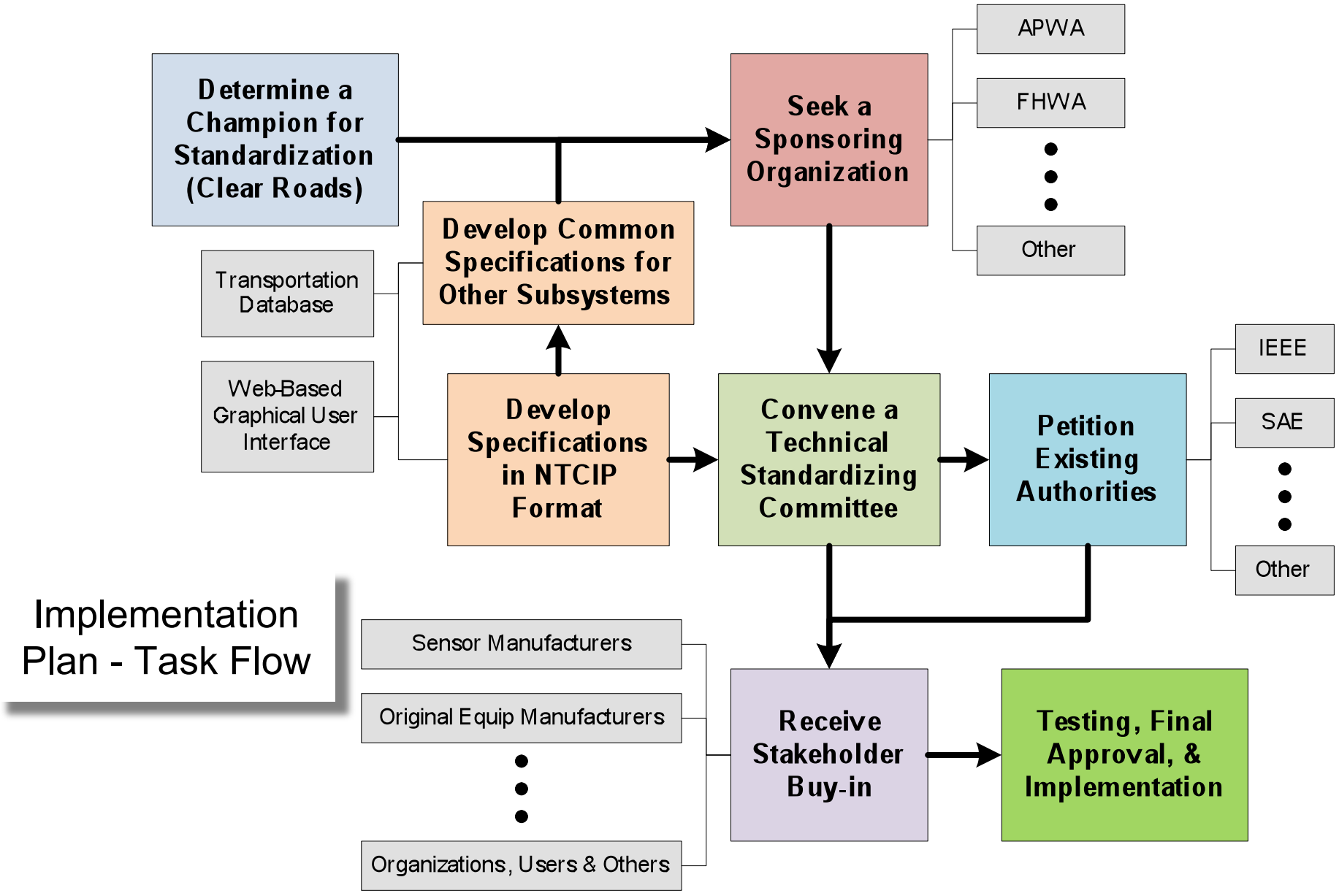
Concept of Operations



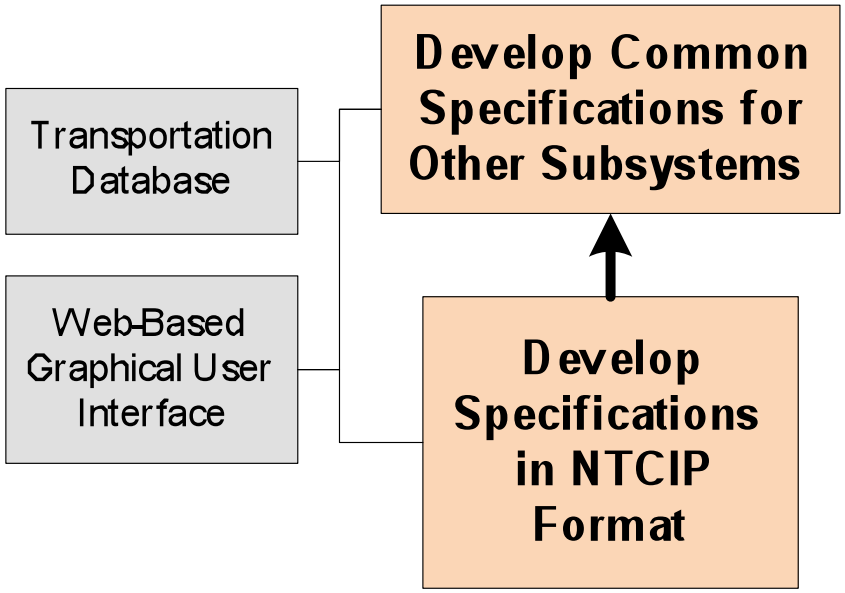
On-board Equipment & Host End Services

Implementation Plan

- Develop specifications for a transportation database and the web-based graphical user interface and database query methodology
- Seek a sponsoring organization at the national level to champion this effort
- Convene a technical committee of stakeholders to provide consensus on integration and interfaces
- Petition existing standardization agencies for inclusion, i.e. SAE & IEEE
- Prepare specifications in NTCIP format and receive stakeholder “buy-in”
- Conduct testing, gain final approval, and begin implementation

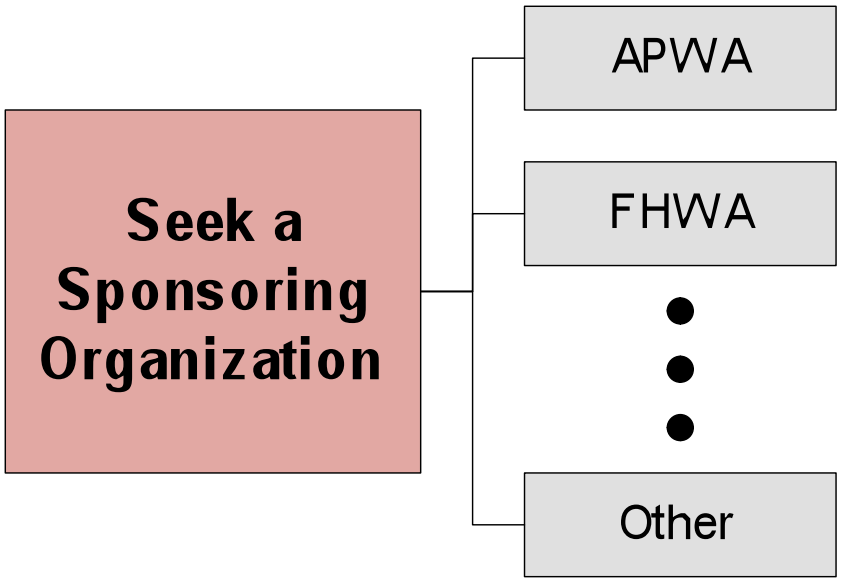

Implementation Plan - Task Flow
Determine a Champion for Standardization (Clear Roads)
Seek a Sponsoring Organization
APWA
FHWA
Other
Develop Common Specifications for Other Subsystems
Transportation Database
Web-Based Graphical User Interface
Develop Specifications in NTCIP Format
Convene a Technical Standardizing Committee
Petition Existing Authorities
IEEE
SAE
Other
Sensor Manufacturers
Original Equip Manufacturers
Organizations, Users & Others
Receive Stakeholder Buy-in
Testing, Final Approval, & Implementation

Standardize Database & Web Based GUI



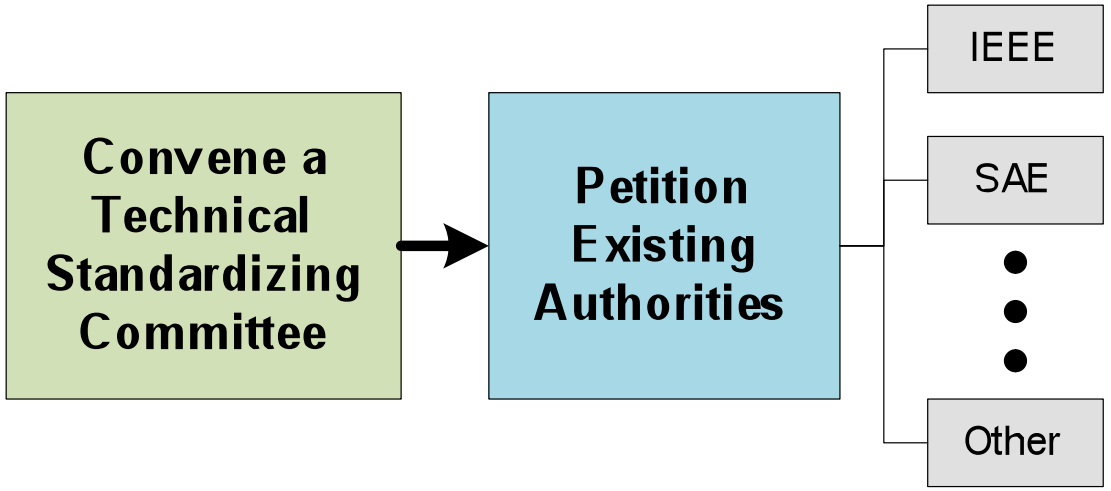
- Project Champion
- Common specs
  - Database
  - Web based GUI
- Develop using NTCIP formats for consistency
- Allows a plug and play style for host end.
- Maintain marketplace competition and performance rewards.

Seek Sponsor



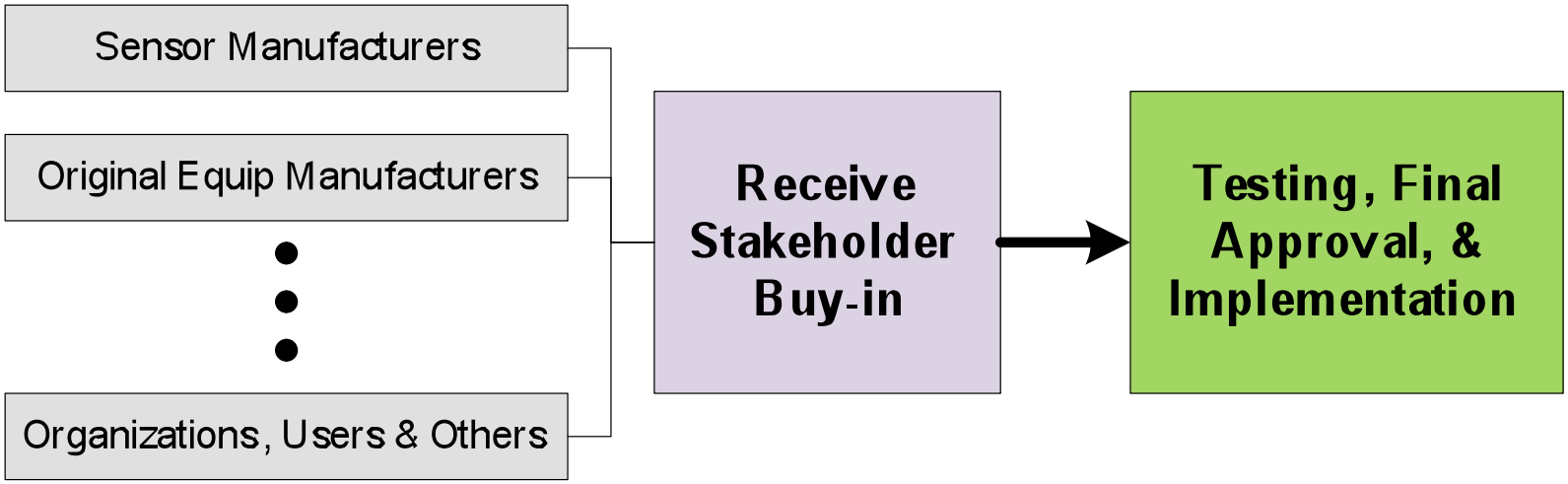
- National level
  - Stakeholder Coordination
  - International Cooperation
- Consolidate resources
- Funding
- Central clearinghouse for new ideas & emerging technology
- Sounding board & rallying point for negotiating hurdles during the process

Conforming to Existing Standards



- Specifications must conform to related standards
- Capitalize on previous standards for similar information
- By coordinating with existing standards the approval process is less complicated
- Standards have placeholders for emerging requirements

Acceptance, Approval, & Implementation



- 100% consensus is difficult
- Maintain competitive marketplace for price & performance
- Build in flexibility, allow levels of sophistication
- Plan for a testing & tweaking period

Summary

- Literature search
- Stakeholder surveys
- Concept of operations
- Specifications
- Implementation plan & recommendations
- Key points
  - Vehicle as communications hub
  - Sensor data consolidated at engine bus
  - Programmable modem & GPS to customize data collection & transmission/storage
  - Standardize database & host end subsystems

Questions?

Questions?

Thompson Engineering Company

Contact :

Thompson Engineering
3830 Rustic Place
Saint Paul, MN 55126
Tel: 651 260-0116
Email & Website:
greg@statisticsinc.com
www.statisticsinc.com

research for winter highway maintenance

Lead state:
Wisconsin Department of Transportation
4802 Sheboygan Ave.
P.O. Box 7965
Madison, WI 53707-7965