Appendix B

Maintenance and Construction Operations (MCO) User Service Detailed Documentation

MAINTENANCE & CONSTRUCTION OPERATIONS USER SERVICE

An Addendum to the
ITS Program Plan

Prepared for:
United States Department of Transportation

Prepared by:
SAIC & TransCore

January 26, 2001

TABLE OF CONTENTS

1. INTRODUCTION

1.1 OVERVIEW

The Maintenance and Construction Operations User Service describes the need for integrating key activities within these functional areas in the best possible manner. Generally, key Maintenance and Construction Operations (MCO) activities include monitoring, operating, maintaining, improving, and managing the physical condition of the roadway, associated infrastructure equipment on the roadway, and the available resources necessary to conduct these activities. The functional areas addressed in the Maintenance and Construction User Service are those that involve Intelligent Transportation System (ITS) technologies, integration with other transportation systems that are represented in the National ITS Architecture, and those that will benefit surface transportation efficiency and safety.

The MCO User Service seeks to address selected maintenance and construction operations, particularly as the use of various intelligent transportation systems (ITS) and technologies (e.g., graphical information systems, automation, robotics, computer-aided dispatching, etc.) become more commonplace. As ITS and other sensing and information systems are added to current maintenance and construction procedures, they can also provide detailed data of value to enhance traffic management, traveler information, fleet management, and planning activities.

The MCO User Service requires ITS-related systems and processes to have the capability to monitor, analyze, and disseminate roadway/infrastructure data for operational, maintenance, and managerial uses. It prescribes the need to coordinate and integrate MCO activities within diverse organizations in order to reduce costs, maintain or improve the efficiency and effectiveness of these activities, and increase the level of reusability of systems and technologies. The MCO User Service may be considered applicable to both urban and rural environments.

1.2 PURPOSE

The primary purpose of this User Service document is to address the needs of the relevant stakeholders within the maintenance and construction operations community. Based on these needs, the MCO User Service further describes the services it should provide, the operational concepts it should follow, the technologies that could be used, potential costs and benefits, and the organizational roles/responsibilities to make it all happen. Therefore, the MCO User Service provides a starting point for the United States Department of Transportation (U.S. DOT) to help the MCO community to keep up with current and future roadway and infrastructure investments.

In doing so, this MCO User Service document also provides the narrative necessary for inclusion into the National ITS Program Plan and the expansion of the National ITS Architecture. That is, based on this document, the necessary National ITS Architecture components (e.g., functional requirements, Market Packages, Architecture Flow Diagrams, Subsystems, etc.) will be developed/enhanced in order to more fully incorporate maintenance and construction operations.

1.3   USER SERVICE FOCUS

The focus for the MCO User Service will be on the following four (4) functional areas:

Maintenance Vehicle Fleet Management: Systems that monitor/track vehicle location, support enhanced routing, scheduling, and dispatching functions, and use on-board diagnostic systems to assist in vehicle operations and maintenance (O&M) activities.

Roadway Management: Systems that provide automated monitoring of traffic, road surface, and weather conditions (from both roadside components and vehicles), contain coordinated dispatching, perform hazardous road conditions remediation, and have the ability to alert public operating agencies of changes in these conditions.

Work Zone Management and Safety: Systems that ensure safe roadway operations during construction and other work zone activities and communicate with the traveler.

Roadway Maintenance Conditions and Work Plan Dissemination: Systems that disseminate/coordinate MCO work plans to affected personnel/staff within/between public agencies and private sector firms.

1.4   COORDINATION WITH OTHER USER SERVICES

Since the MCO User Service includes several different functional areas (above), it suggests coordination with a number of other previously defined User Services for successful inclusion into the National ITS Program Plan. The areas for coordination that are anticipated at this stage of the MCO User Service development process are presented in Table 1-1.

Table 1-1. MCO Functional Areas and Corresponding User Services

National ITS Architecture User Services	Maintenance. Vehicle Fleet Management.	Roadway Management.	Work Zone Management. & Safety	Roadway Maintenance Conditions and Work Plan Dissemination
Travel and Transportation Management				
• En-Route Driver Information	X	X	X	X
• Route Guidance	X		X	
• Traffic Control		X	X	X
• Incident Management	X	X	X	X
Travel Demand Management				
• Pre-Trip Traveler Information		X	X	
Public Transportation Operations				
• Public Transportation Management	X	X		
• En-Route Transit Information	X			
Commercial Vehicle Operations (CVO)				
• Hazardous Materials Incident Response	X	X		
Emergency Management				
• Emergency Vehicle Management	X	X		
Advanced Vehicle Control and Safety Systems				
• Lateral Collision Avoidance				
• Longitudinal Collision Avoidance	X	X	X	
• Vision Enhancement for Crash Avoidance	X	X	X	
• Safety Readiness	X	X	X	
• Automated Vehicle Operation	X	X	X	
	X	X	X	
Archived Data Systems	X	X	X	X

2. STAKEHOLDERS' NEEDS

2.1 OVERVIEW

Typically, responsibilities for MCO activities are divided between multiple public agencies at various levels of government (e.g., state, county, city, local municipalities, etc.). Consequently, there are disparities in the type and scale of resources and equipment available to provide the necessary level-of-service. Many of these specific MCO stakeholder groups previously had little or no involvement in the development of the National ITS Architecture. Therefore, these users' needs for MCO activities are outlined below with a partial list of their primary transportation-related tasks and user service objectives. The user needs listed below represent a comprehensive listing of needs identified by MCO stakeholders and are included herein for purposes of completeness. It should be noted, however, that not all of these needs will be addressed in the MCO User Service as many involve systems or components that are not covered in the National ITS Architecture.

2.2 TRANSPORTATION AGENCIES (PUBLIC SECTOR)

Please note that within this section, Transportation Agencies include the representative views held by staff within Traffic, Transit, and Emergency Services divisions/departments.

Field Crews (Maintenance and Construction)

Overall Needs

- Improve ability to perform routine, as-needed, and emergency maintenance activities on the transportation system

- Improve ability to perform construction activities on the roadway (e.g., rehabilitation and replacement of pavements, bridges, and roadside infrastructure, etc.)

- Reduce the amount of time and cost that it takes to respond to a MCO request/ incident

- Be better prepared to assess a MCO situation (e.g., type of problem encountered, correct tools in-hand, etc.)

- Improve ability to assess, inspect, maintain, install, repair, or replace infrastructure components

- Improve ability to incorporate ITS specifications and standards into MCO activities

- Improve ability to provide "just-in-time" maintenance support

- Provide adequate training to staff to perform MCO activities

On-Site Needs

- Obtain methods to better collect/maintain/report information on location, types, and condition of physical infrastructure

    - ITS components (e.g., traffic controllers, communications hubs, DMS, CCTV, surveillance stations, ramp meters, environmental sensors etc.)

    - Non-ITS components (e.g., pavement, bridges, signs, guardrails, etc.)

- Obtain methods to better collect/maintain/report work zone location, delay, and alternate route information

- Improve work zone safety (e.g., enforce speed limits, provide vehicle intrusion warnings, track individual crew movements, minimize potholes, etc.)

- Reduce the length of time that work zones are in place

- Provide reliable, accurate, and timely information to the motorists regarding the upcoming work zone and how best to navigate safely through

- Improve ability to predict "when" a work zone/lane closure may be necessary (e.g., flooding, landslide, etc.)

Vehicle Driver/Operator Needs

- Improve ability to drive and perform MCO activities on/with maintenance, construction, and special service vehicles (e.g., snowplows, Freeway Service Patrols, mowers, etc.)

- Obtain method to better receive routing and operating instructions, work plans/assignments, and roadway/weather information from dispatchers

- Have ability to track and report/view vehicle and salt/chemical locations, monitor vehicle status (e.g., conditions, tools on-board, salt/chemical levels, etc.) and generate operational/surveillance data

- Improve vehicle and personal safety (e.g., collision warning, personal security button, individual crew location system, etc.)

- Reduce stress, workload, and decision-making by automating the transmission of work data activity (e.g., plow up/down, location, herbicides, etc.)

Dispatchers

- Improve ability to monitor, schedule, and dispatch maintenance, construction, special service, or other public/community transportation fleet vehicles

- Obtain method to better disseminate routing and operating instructions, work plans/assignments, and roadway/weather information to vehicle operators/drivers

- Have the ability to "track" vehicles (i.e., know their location at any time) via a standard reference system/graphical display and obtain/generate operational data

- Improve ability to assess crew/driver status (e.g., assignments, qualifications, etc.)

- Reduce the amount of time needed to communicate/locate a driver

Vehicle Maintenance Crews (On-Site Facilities)

- Improve ability to maintain/repair vehicles and associated equipment, including on-board sensors, actuators, and electronics

- Obtain methods to better collect/maintain location, type, and physical condition of the entire vehicle fleet

- Reduce the amount of time that it takes to respond to a vehicle/equipment request/situation

- Be better prepared to assess a vehicle/equipment situation (e.g., type of problem encountered, correct tools in-hand, etc.)

- Obtain better method to monitor on-board, shop, and storage depot materials (e.g., snowplows, spreader vehicles, sealant trucks/melters, maintenance shop facility, etc.)

- Improve ability to diagnose on-board ITS equipment

- Improve staff training, or recruitment of new skill sets, to allow maintenance and troubleshooting of ITS equipment

Equipment Maintenance Crews (On-Site Facilities)

- Improve ability to maintain/repair roadway physical infrastructure equipment

    - ITS components (e.g., traffic controllers, communications hubs, DMS, CCTV, surveillance stations, ramp meters, environmental sensors etc.)

    - Non-ITS components (e.g., pavement, bridges, signs, guardrails, etc.)

- Obtain methods to better collect/maintain location, type, and physical condition of physical infrastructure components

- Reduce the amount of time that it takes to respond to an equipment request/situation

- Be better prepared to assess an equipment situation (e.g., type of problem encountered, correct tools in-hand, etc.)

Supervisors (Maintenance and Construction)

- Improve ability to monitor roadway conditions and/or events on the transportation system

- Enhance efficiency of operations when planning, scheduling, and allocating the necessary resources or responses [e.g., driver/vehicle status, assignments, resource availability (field and depot facilities), etc.]

- Obtain better methods to collect/maintain information on the MCO needs of the physical infrastructure, roadway closures, and restrictions (e.g., maintenance history, nature of problem, etc.)

- Obtain better method to monitor on-board, shop, and storage depot materials (e.g., snowplows, spreader vehicles, sealant trucks/melters, maintenance shop facility, etc.)

- Disseminate infrastructure inventory and condition, work zone, and portable asset status and location information (e.g., vehicles, DMS, roadway materials such as salt, chemicals, and herbicides, etc.) in a timely manner via electronic/computerized means

- Monitor/track contracting operations for those activities contracted-out to private sector (e.g., maintenance, construction, operations, etc.)

- Ensure resource availability [e.g., appropriately trained staff, inventory (spare parts, supplies, chemicals, etc.)]

- Connect inventory in depot facilities with assets in field with each work plan/assignment that is generated

- Receive traveler feedback (e.g., road not plowed, icy conditions/spots on roadway, etc.)

Asset Managers

- Improve ability to perform capital planning, manage equipment usage, and allocate other tangible resources (e.g., staff, funds, etc.)

- Ensure that MCO activities are an agency priority and ensure adequate funding

- Develop methods to better assess cost/benefits of new technology, justify their use, and evaluate their applicability

- Reduce costs and optimize maintenance schedules by receiving better MCO data on vehicle performance/status

- Obtain methods to better collect/maintain information on the type, use, location, failures, and maintenance requirements of portable assets, roadway system, vehicle fleet, etc.

- Disseminate portable asset, roadway system, vehicle fleet, and maintenance status and information in a timely manner via electronic/computerized means

Traffic Managers

- Improve ability to manage highway traffic, especially during incidents, road/lane closures, work zone activities, special events, and other situations

- Obtain method to better coordinate operational activities with maintenance and construction efforts, pass-along equipment status/failure reports, and use maintenance crews, vehicle drivers, and other fleet operators as surveillance inputs/probes

- Disseminate information on traffic, roadway, and weather conditions, roadway closures and restrictions, and other severe or unusual roadway conditions in a timely manner via electronic/computerized means

2.3   OTHER STAKEHOLDERS (PUBLIC AND/OR PRIVATE SECTOR)

Travelers

- Improve ability to receive reliable, accurate, and timely information on traffic (e.g., travel time estimates, expected delays, etc.), roadway and weather conditions, roadway closures and restrictions, work zones, snowplow activity, and other severe or unusual roadway conditions

- Minimize the disruption of MCO activities on travel movements

- Improve the ability to route motorists around maintenance and construction activity zones

- Types of travelers within this category include individual motorists (e.g., commuters, tourists, residents, etc.), transit agencies, commercial vehicle operators, emergency medical services, public safety, etc.

- Ability to provide feedback to MCO Supervisors (e.g., snowplows missed road, icy conditions, etc.)

Construction Crews (Private Company)

- Improve ability to perform construction activities on the roadway (e.g., rehabilitation and replacement of pavements, bridges, and roadside infrastructure, know when and where to conduct and coordinate maintenance as per the request of the public agency)

- Obtain methods to better collect/maintain/report work zone location, delay, and alternate route information

- Improve work zone safety (e.g., enforce speed limits, provide vehicle intrusion warnings, track individual crew movements, minimize potholes, etc.)

- Reduce the length of time that work zones are in place

- Provide reliable, accurate, and timely information to the motorists regarding the upcoming work zone and how best to navigate safely through

- Improve coordination of construction activity with maintenance and other activities.

Statewide and Metropolitan Planning Agencies

- Improve ability to identify short- and long-range MCO resources, equipment, and policies to enhance operational efficiency and operator and personnel safety

- Provide data/information for on-going MCO initiatives to justify their incorporation as an integral component of the statewide and regional transportation planning and budgeting processes

- Improve ability of various public agencies to create transportation policy

- Provide data/information for on-going MCO initiatives to justify their incorporation as an integral component of the transportation planning process

- Provide data/information to help determine future investment requirements of the nation's roadway system

- Facilitate inclusion of MCO activities in the overall planning process, including other components of a regional or statewide ITS architecture

Information Service Providers

- Improve ability to provide "value-added" information to roadway data obtained from internal and external resources.

- Disseminate reliable, accurate, and timely information on traffic, roadway, and weather conditions, roadway closures and restrictions, and other severe or unusual roadway conditions

Public Safety Agencies

- Improve ability to enforce, advise, and coordinate road/lane closures, work zone activities, and incident management activities

- Enhance roadway safety (especially during activities listed above)

Equipment Providers

- Improve ability to develop equipment that allow maintenance and construction crews to perform their job better

- Improve ability to incorporate ITS specifications and standards into MCO equipment

Weather Services and Environmental Organizations

- Improve ability to provide weather/environmental conditions data/information to transportation agencies to enhance scheduling/routing of MCO activities

- Improve ability to coordinate data/information collection and dissemination efforts with those of transportation agencies operating roadway/weather information systems (RWIS)

3. SERVICE DESCRIPTION

3.1 OVERVIEW

The MCO User Service will integrate key activities to ensure that roadways, associated infrastructure, and available resources are coordinated in the best possible manner. Generally, key MCO activities include monitoring, operating, maintaining, improving, and managing the physical condition of the roadway. The focus for the MCO User Service will be on the four (4) functional areas that follow:

- **Maintenance Vehicle Fleet Management**

- **Roadway Management**

- **Work Zone Management and Safety**

- **Roadway Maintenance Conditions and Work Plan Dissemination**

In the sections that follow, an initial indication of the services and/or functionalities that each of these MCO functional areas provides/contains will be described.

3.2 MAINTENANCE VEHICLE FLEET MANAGEMENT

Fleet operations, management, and maintenance is important to roadway operating agencies with fleets of maintenance, construction, and specialized service vehicles (e.g., snowplows, Freeway Service Patrols, bucket trucks, etc.). These vehicles are currently monitored, scheduled, routed, located, and maintained in an environment that generally creates high unit cost of operations. The Maintenance Vehicle Fleet Management functional area entails real-time tracking of all vehicle properties owned by a public agency along with the tracking of vehicles owned by organizations contracted by the public agency. The tracking of the rolling property may include monitoring of the on-board equipment and materials. The rolling property is observed to measure the effectiveness for remediating impediments to travel (e.g., snow/ice, rocks, dead animals).

Successfully meeting this functional aspect of the MCO User Service with ITS solutions has the potential to provide maintenance vehicle fleet management and operations with the following services/functionalities:

- Monitor/track the location of public vehicle fleets, fleets that are contracted by public agencies, construction vehicles, and specialized service vehicles in order to provide current location and status data/information to facilitate dispatch of the appropriate assets where needed

- Support enhanced routing, scheduling, dispatching functions including addressing applications that may further improve vehicle dispatching

- Improve communications, interactions, and fleet operations between dispatchers and drivers

- Use of on-board vehicle sensors to monitor vehicle diagnostics, operating conditions, etc. to ensure safe operations and maintain the working condition of said vehicle fleets

- Use of on-board vehicle sensors to monitor roadway conditions to obtain data/information about the roadway, materials usage, etc.

- Archive data for use in performance monitoring activities.

3.3   ROADWAY MANAGEMENT

Roadway management systems typically provide automated monitoring and forecasting of traffic, road surface, and weather conditions (from both roadside components and vehicles), contain coordinated dispatching, perform hazardous road conditions remediation (e.g., sand, salt, and de-icing chemical application, snowplowing, etc.), and have the ability to alert public operating agencies of changes in these conditions. This functional area therefore entails real-time observations of the roadway network to determine or infer the presence of materials that could obstruct the path of vehicles and that pose a threat of vehicle crashes. The Roadway Management functional area also accommodates the remediation of potential hazards through automated crew dispatch or devices that can remove the hazard without human intervention, and/or by coordinating with mobile crews already in the field. The hazard observations themselves may come from deployed sensors such as RWIS stations. For example, a rockslide occurs and obstructs several lanes. Because this area is prone to rockslides the public agency responsible for the roadway has deployed a video detection system to detect the presence of rocks in the roadway and automatically alert the local operations center and maintenance yard. Roadway Management supports a number of different services, operations, staff, and vehicle fleets as follows:

- Winter Road Maintenance: Activities include snowplowing, salt and sanding, application of de-icing chemicals, and storm clean up. *[Please note that all treatment of winter road maintenance and weather information needs should refer to the "Surface Transportation Weather Decision Support Requirements (STWDSR)", Versions 1.0 and 2.0 documents.]*

- Hazard Removal: Activities include removal of animals, objects, trash, washouts, sinks, slides, disabled vehicles, etc., and storm clean up.

- Emergency Preparedness: Activities include alternate routing, communications planning, pre-planning routes, and coordination with local public safety and law enforcement agencies.

All of these activities are performed in a coordinated manner in order to ensure safe roadway operations during normal and severe weather or adverse travel conditions. Successfully meeting this functional aspect of the MCO User Service with ITS solutions has the potential to provide roadway management with the following services/functionalities:

- Plan and forecast roadway management activities in proactive and reactive response situations (winter and summer)

- Determine the need for roadway treatment, both scheduled and forecasted (e.g., short-term weather prediction for winter maintenance, friction monitors, etc.)

- Perform hazardous road conditions remediation (e.g., sand, salt, snowplows, etc.)

- Monitor the level of chemicals on the roadway (e.g., salt, sand, de-icing chemicals, etc.)

- Monitor the amount and availability of chemicals on snowplows/spreader vehicles and at the maintenance shop facility (e.g., salt, sand, de-icing chemicals, etc.)

- Manage maintenance crew dispatching during road maintenance operations, hazard removal, and emergency preparedness activities

- Monitor, manage, and control, automated systems operating at remote locations that affect the roadway surface through treatment applications (e.g., de-icing applications underneath an overpass, etc.)

- Archive data for use in performance monitoring activities to track out-sourced contracting (private sector or to other public agencies)

3.4 WORK ZONE MANAGEMENT AND SAFETY

The services and/or functionalities that this MCO functional area provide are intended to ensure safe roadway operations and improve operational efficiencies during construction and other work zone activities. These services include the following at a minimum:

- Enact procedures and systems that cost-effectively manage work zone activities and communicate with the traveler

- Predict "when" a work zone/lane closure may be necessary (e.g., flooding, landslide, etc.)

- Collect/maintain/report work zone location, delay, and alternate route information

- Provide automated systems that enforce speed limits, provide vehicle intrusion warnings, and track individual crew movements

- Provide reliable, accurate, and timely information to the motorists regarding the upcoming work zone and how best to navigate safely through the area

3.5 ROADWAY MAINTENANCE CONDITIONS AND WORK PLAN DISSEMINATION

Roadway maintenance conditions and work plan dissemination systems are intended to disseminate/coordinate MCO assignments and work plans (e.g., type, routing, scheduling, resource allocation, etc.) to affected personnel/staff within and between public agencies (e.g., transportation, public safety, law enforcement, transit, construction, emergency service, etc.). They are meant to support resource allocation, routing, and scheduling, including the ability to provide this information in a real-time, accurate, and secure manner.

4. OPERATIONAL CONCEPT

4.1 OVERVIEW

In the sections that follow, the operational concepts for the MCO User Service will be further described by the functionality that each functional area will contain in order to support the MCO User Service. The focus for the MCO User Service will be on the four (4) MCO functional areas identified previously. Basically, an operational concept should be thought of in terms of "…what do we want the MCO User Service to accomplish…" and "…how will the MCO User Service actually accomplish/provide the functionality…".

It should be noted that these operational concepts are listed for reference purposes only and are not prescriptive. Furthermore, multiple listings of a specific functionality under different MCO User Service functional areas points out the potential for integration and cost-savings through delivery of the "same" function by a system/technology that can perform multiple jobs/tasks.

4.2 MAINTENANCE VEHICLE FLEET MANAGEMENT

The operational concepts and/or functionalities that this MCO functional area provides/contains includes the following at a minimum:

Vehicle Location and Operating Status

- Systems that provide information on vehicle location in order to track movements, enhance route scheduling, and improve dispatch functions

    - Typical data/information used primarily consists of vehicle positioning/location (lat/long coordinates), indication of vehicle moving vs. not moving, vehicle speed/rate, etc.

    - Typical processes include vehicle tracking (using data above), transmitting data to an operations center via standard formats, archiving said data, and graphical map display of vehicle location via user-friendly graphical user interface (GUI)

- Systems that provide/monitor information on vehicle conditions/status and on-board materials in order to enhance vehicle maintenance scheduling and improve vehicle operating performance

    - Typical data/information used primarily consists of on-board vehicle status and predicted failure rates (e.g., engine temperature, tire wear, brake wear, belt wear, etc.) and materials monitoring (e.g., temperature, quantity, flow-rate, etc. for sand, salt, sealant, and other materials)

    - Typical processes involved include monitoring/generating status data, transmitting said data to an operations center, archiving data, preparation of status reports/databases and/or GUI displays, and indication of a maintenance "alert"

- Systems should be capable of operating in various types of terrain such as mountains, valleys, canyons, etc.

- Other User Services to coordinate with include Route Guidance, Public Transportation Management, Emergency Vehicle Management, Archived Data Systems, and the entire Advanced Vehicle Control and Safety Systems User Service category

Contractor Monitoring (Private Sector and Public Agency)

- Systems that facilitate monitoring of the location, actions, and availability of private sector MCO services, equipment assets, and resources in order to optimize/manage scheduling, dispatching, and operations

    - Typical data/information includes firm, type/activity, location, status, maintenance schedules/work plans, equipment-in-use, infrastructure under repair, personnel involved, etc.

    - Typical uses include collecting performance and planning data for scheduling upcoming services, dispatching personnel and/or resources to other sites, reviewing contractor progress/status, quality-of-work, and personnel and/or resource reserves/conditions, etc

    - Typical processes include data collection/storage (manual and/or automatic), analysis of in-use vs. available assets, analysis of status vs. schedule, preparation of reports and/or graphical map displays, distribution to and communications with contractor, etc.

Traveler Information

- Systems that provide vehicle operators and dispatchers with routing information in order to direct vehicles around potential roadway problem spots

    - Typical data/information used to generate routing information is based on congestion, incidents, fixed or temporary roadway restrictions, weather conditions, etc.

    - Typical data/information sent to the vehicle includes type, location, duration, and severity of potential roadway problem spots (per data above) and alternate routing instructions

    - Typical processes include data surveillance/collection (per above), transmission of data in standard format to operations center, archiving data, comparison of incident data to scheduled routes, and information broadcast to vehicle of routing instructions

- Other User Services to coordinate with include Route Guidance, En-Route Driver Information, En-Route Transit Information, Incident Management, Archived Data Systems, and Hazardous Materials Incident Response

Computer-Aided Dispatching

- Systems that support route planning, scheduling and dispatching of vehicles in public fleets in order to optimize operations and provide enhanced communications between vehicle and dispatch facility

- Systems may be agency-specific or include inter-agency communications (e.g., highway patrol, EMS, maintenance vehicles, etc.)

- Typical data/information used includes vehicle positioning/location, incident location, scheduled route, and routing instructions

- Typical processes involved include vehicle tracking, transmitting data to an operations center, archiving data, graphical map display of vehicle location, comparison of vehicle location to scheduled route and known incident locations, and information broadcast to vehicle of routing instructions

- Other User Services to coordinate with include Route Guidance, Archived Data Systems, En-Route Driver Information, and En-Route Transit Information

4.3   ROADWAY MANAGEMENT

The operational concepts and/or functionalities that this MCO functional area provides/contains include the following (at a minimum):

Roadway Surface and Atmospheric Conditions

- Systems that monitor, detect, and forecast changes in roadway surface conditions and other weather and atmospheric conditions affecting travel in order to have a more up-to-date/accurate picture of roadway conditions so that dispatching of maintenance vehicles and use of salt/chemicals is optimized

    - Typical data/information includes ice, precipitation, fog, wind, blowing dust, air quality, roadway coefficient of friction, pavement temperature, avalanche detection, meteorological data, chemical levels, visibility, snow, etc.

    - Typical processes involve monitoring/generating conditions data, transmitting and/or storing data into a database system, archiving data, and preparation of reports and/or map displays to view results

    - Typical dissemination techniques include information/alerts to public agencies (potentially located in separate facility locations) via computer networks (or telephone), self-actuated components (e.g., DMS, HAR, etc.) that provide traveler warnings at spot-specific hazardous condition locations

    - Other User Services to coordinate with include Pre-Trip Traveler Information, En-Route Driver Information, and Archived Data Systems

Winter Maintenance

- Systems to enhance the efficiency and safety of roadway treatment and plowing operations before, during, and after winter storms

    - Typical data/information includes current, predicted, and archived information on weather and roadway surface conditions, location of nearest maintenance vehicle, time of last treatment per segment, type of treatment or chemicals applied, or last plowing per segment, automated environmental recordings (e.g., ice, snow, etc.), automated recording of operational data (e.g., spreader on/off, plow up/down, etc.), vehicle position on roadway, remotely-located automated roadway treatment system status

(e.g., on-line, chemical levels, roadway conditions, etc.), bridge-related hazards such as surface conditions, chemical and icing reports, etc.

- Typical processes involve monitoring/generating status data, transmitting and/or storing data into a database system, archiving data, preparation of reports and/or map displays to view results, optimizing vehicle and/or salt/chemical use, dispatching of appropriate vehicle, detecting roadway obstructions, and guiding the driver along the roadway lane

- Other User Service to coordinate with include Public Transportation Management, Emergency Vehicle Management, Traffic Control, Incident Management, Hazardous Materials Incident Response, and the entire Advanced Vehicle Control and Safety Systems User Service category

[Please note that all treatment of winter road maintenance and weather information needs should refer to the "Surface Transportation Weather Decision Support Requirements (STWDSR)", Versions 1.0 and 2.0 documents.]

Non-Winter Maintenance

- Systems to enhance the efficiency and safety of other (non-winter) maintenance activities

    - Typical activities include (as described in Section 3.3) hazard removal and emergency preparedness

    - Typical data/information includes current, predicted, and archived information on roadway conditions, location of nearest maintenance vehicle, time of last maintenance/treatment per segment, type of maintenance/treatment performed, automated environmental recordings (e.g., water levels), vehicle position on roadway, etc.

    - Typical processes involve monitoring/generating status data, transmitting and/or storing data into a database system, archiving data, preparing reports and/or map displays to view results, optimizing vehicle use, detecting roadway obstructions and providing driver guidance along roadway lanes for those activities addressed by the MCO User Service

    - Other User Service to coordinate with include Public Transportation Management, Emergency Vehicle Management, Traffic Control, Incident Management, Hazardous Materials Incident Response, and the entire Advanced Vehicle Control and Safety Systems User Service category

4.4   WORK ZONE MANAGEMENT AND SAFETY

The operational concepts and/or functionalities that this MCO functional area provides/contains includes the following at a minimum:

Work Zone Information

- Systems that gather, store, and disseminate information about work zones and construction activities (both short- and long-term activities) in order reduce the length of time that work zones are in place, reduce the frequency that work zones are established, and establish a more accurate picture of "where" activities are occurring and/or are planned

- Typical data/information includes location, nature/type, duration, lane shifts, staging areas, length, scheduled phases of work zone configuration, alternate route(s), and anticipated delays for both the travel route and the intended diversion route

- Typical processes include collecting up-to-date data (manual input and/or automatic), transmitting and/or storing data into a GIS database system, archiving data, correlating planned activities with actual work in the field, and preparation of reports and/or map displays to view results

- Typical uses of this data include supporting internal MCO needs, commercial and emergency vehicle routing activities, and providing input to traveler information systems and travel service organizations (for pre-trip, en-route, and at-site applications)

- Other User Services to coordinate with include En-Route Driver Information, Traffic Control, Route Guidance, Pre-Trip Traveler Information, Archived Data Systems, and Incident Management

Smart Work Zones

- Systems that monitor, control, and direct traffic activity in the vicinity of work zones in order to enhance operator (i.e., maintenance and construction crews) and public safety, minimize congestion delays, and provide relevant traveler information to motorists

  - Typical data/information includes volume, occupancy, speed, headway, recommended travel speed, video images, work zone intrusion detection

  - Typical processes include collection of field data, transmitting and/or storing data into a database system, archiving data, preparation of traveler information messages to broadcast in/around the work zone

  - Typical uses of this data is to advise/warn drivers as they approach work zones of anticipated delays, alternate routes, suggested travel speeds, etc.

  - Typical goals include to incorporate work zone set-up procedures without increasing the burden on the crews and to enact speed enforcement procedures (e.g., automated speed enforcement, equipped police officers for control/investigation, etc.)

- Systems that divert vehicles around work zones via automatic lane changing/merging techniques [i.e., Automated Highway System (AHS) techniques]

  - Typical data/information includes vehicle's AHS and roadway's AHS capabilities, roadway conditions (e.g., volume, occupancy, speed, headways, etc.), vehicle characteristics (e.g., class/type, position/location, etc.), merging distance, etc.

  - Typical processes include collection of field data, transmitting and/or storing data into a database system, archiving data, developing AHS-merging strategies, etc.

- Other User Services to coordinate with include En-Route Driver Information, Traffic Control, Incident Management, and the entire Advanced Vehicle Control and Safety Systems User Service Category

- Other User Services to coordinate with include Archived Data Systems

4.5 ROADWAY MAINTENANCE CONDITIONS AND WORK PLAN DISSEMINATION

The operational concepts and/or functionalities that this MCO functional area provides/contains includes the following at a minimum:

MCO Information Dissemination

- Systems to facilitate coordination of MCO activities within/between agencies in order to provide the ability to share information about affected roadways, anticipated duration, and sharing resources (see above for more details) as well as potential impacts caused by natural disasters such as hurricanes or blizzards

    - Typical data/information includes planned MCO activities, roadway management (especially winter maintenance) activities, equipment failures, etc.

    - Typical processes include data collection/storage (manual and/or automatic), archiving data, analysis of in-use vs. available assets, preparation of reports and/or graphical map displays, and distribution to other departments within agency, other agencies, and private sector

    - Typical agencies to disseminate information include public safety, emergency medical services, transit, TMCs, railroads, airports, and ISPs

- Other User Services to coordinate with include Archived Data Systems, En-Route Driver Information, and Pre-Trip Traveler Information

5. TECHNOLOGIES

5.1   OVERVIEW

The MCO User Service has several technological components including roadside equipment, on-board vehicle systems, communications networks, information management systems, and information dissemination devices. Therefore, a broad range of technologies applies to its development. System designers should make full use of these technologies when implementing the MCO User Service.

In the sections that follow, the four (4) MCO User Service functional areas are further described/broken-down by the systems/technologies that have the potential to meet the operational concepts (i.e., achieve the desired functionality). It should be noted that these systems/technologies are listed for reference purposes only; and are not prescriptive. Furthermore, it should be noted that multiple listings of a specific technology under different MCO functional areas points out the potential for integration and cost-savings through the use of the "same" piece of equipment to perform multiple tasks.

5.2   MAINTENANCE VEHICLE FLEET MANAGEMENT

Vehicle Location and Operating Status

- Automatic vehicle location (AVL) systems
    - Examples include global positioning systems (GPS), dead reckoning, low earth orbiting satellite (LEOs), cellular phone triangulation, radio frequency (RF) positioning, roadside RF beacon systems, inductive loop systems, etc.
- Fleet management systems
    - Incorporates AVL systems
    - Graphical information system (GIS) to manage/display data
        - Schedule adherence/tracking and route planning software
    - Computer-aided dispatching (CAD) systems
- On-board vehicle diagnostic systems
    - Critical system status reports (e.g., engine temperature, tire wear, brake wear, belt wear, etc.)
    - Includes software algorithms for preventive maintenance, failure predictions, and part replacement
- Robotics and mechanical equipment
- Activity tracking in-vehicle system (with on-board storage and immediate transmission)
- Vehicle operating information in-vehicle systems (with on-board storage, data management, access, and download capabilities)

- In-vehicle research system (e.g., permits prior work done, contracting other services

- Mayday-type systems/technologies

- Cellular telephones and paging systems for 2-way digital communications

- Web access and video image displays via in-vehicle devices/screens

Current Information

- Fleet management systems

- Route planning/guidance systems

- Roadway information/surveillance systems

    - Examples: inductive loops, CCTV, video imaging detection systems (VIDS), acoustic, radar, etc.

- Input from MCO information management system

Computer-Aided Dispatching

- Software applications

    - Examples include route planning/guidance, scheduling, vehicle tracking, graphical displays, storage, data retrieval, archiving, activity logging, etc.

    - For example, condition acquisition reporting system (CARS) software

- Fully-integrated real-time scheduling and activity reporting and voice/data communications

- Dedicated RF communications (e.g., center-to-vehicle, vehicle-to-vehicle, etc.)

- Dedicated inter-agency communications

    - Examples include dedicated RF communications, "trunked" radio systems, local area networks (LANs), bulletin board systems, Internet/web-sites, broadcast FAX system, e-mail system, pager systems, etc.

5.3   ROADWAY MANAGEMENT

Roadway Surface and Atmospheric Conditions

- Roadway surface condition monitoring and forecasting systems

    - Examples include ice, snow, water, roadway coefficient of friction, precipitation/moisture/flooding, pavement temperature, chemical concentrations, elevation, etc.

- Weather and atmospheric condition monitoring and forecasting systems

    - Examples include ice, precipitation, fog, wind, blowing dust, drifting snow, air quality, visibility, etc.

- Remote/robotic anti- and de-icing fluid and materials application and monitoring systems

- Disseminate information/alerts to public agencies

    - Examples include local area networks (LAN), bulletin board systems, Internet/web-sites, broadcast FAX system, e-mail system, pager systems, etc.

- Traveler warnings system (at spot-specific hazardous condition locations)

    - Examples include DMS, highway advisory radio (HAR), radio broadcasts (AM and/or FM subcarriers), in-vehicle displays (e.g., graphical, text, audible, etc.), flashing beacons coupled with a static sign message, stand-alone static warning signs, etc.

- Avalanche monitoring systems

- Variable speed limit systems (e.g., roadway and weather conditions data, DMS, loop detectors, software algorithms for speed estimates and correlation, etc.)

- Digital cameras and video surveillance via CCTV

- Palmtop and/or laptop computers

Winter Maintenance

- Same as "Roadway Surface and Atmospheric Conditions" (above)

- Computer-aided systems for planning efficient routes, monitoring progress of AVL-equipped vehicles, estimating completion of service vehicle activity (i.e., Smart Plows), and providing correct/accurate answers to questions from the public

- Fleet management systems

- Computerized database systems (with appropriate software applications)

    - Examples include time of last treatment per segment, type of treatment or chemicals applied, last plowing per segment, etc.

- On-board vehicle sensors

    - Examples include infrared sensors (e.g., pavement temperatures, etc.), automated recording of operational data (e.g., spreader on/off, plow up/down, etc.), roadway obstruction detection, lane guidance systems, etc.

- Roadway referencing systems

5.4   WORK ZONE MANAGEMENT AND SAFETY

Work Zone Information

- Palmtop, laptop, or notebook computers for "in-the-field" use

- GPS in tandem with field notebook computers (above)

- Computer workstations located at "central" facilities

- Computerized database systems

    - Examples include relational, distributed, object-oriented, etc.

- Sophisticated spreadsheet/worksheet applications

- GIS systems to manage/display data

- Communications to share information between public agencies

    - Examples include local area networks (LAN), bulletin board systems, Internet/web-sites, broadcast FAX system, e-mail system, pager systems, etc.

Smart Work Zones

- Roadway information/surveillance systems

    - Examples include inductive loops, CCTV, video imaging detection systems (VIDs), acoustic, radar, etc.

- Lane-drop smoothing systems (i.e., series of portable flashing beacon signs and electronic occupancy sensors)

- Traveler warnings system

    - Examples include DMS, highway advisory radio (HAR), radio broadcasts (AM and/or FM subcarriers), in-vehicle displays (e.g., graphical, text, audible, etc.), flashing beacons coupled with a static sign message, stand-alone static signs for warnings and/or diversion routes, etc.

- Personal warning devices/systems

    - Examples include a device (i.e., beeper) that a worker wears that provides an indication when a vehicle enters (i.e., machine vision video cameras) or worker leaves a "safe zone" and/or provides a message to motorists via roadside DMS and/or HAR Other examples include intrusion devices/alarms used for improving worker safety at work zones.

- Automated Highway Systems (AHS)

    - Examples include intelligent cruise control, intelligent braking, automated lane changing/merging, vehicle platooning, side/rear/front collision avoidance systems, etc.

- Decision-support systems (for congestion modeling)

- Moveable barrier systems

- Traffic control/signal timing systems

5.5 ROADWAY MAINTENANCE CONDITIONS AND WORK PLAN DISSEMINATION

Inter-Agency Coordination

- Communications to share information between public agencies

    - Examples include local area networks (LAN), bulletin board systems, Internet/web-sites, broadcast FAX system, e-mail system, pager systems, shared databases, telephone, RF broadcasts, etc.

Natural Events Management

- Coordinated use of ALL systems/technologies identified herein

Seasonal and Planned Events Management

- Coordinated use of ALL systems/technologies identified herein

Incident Management

- Coordinated use of ALL systems/technologies identified herein

MCO Information Dissemination

- Traveler information systems

    - Examples include DMS, highway advisory radio (HAR), RF broadcasts (AM and/or FM subcarriers), in-vehicle displays (e.g., graphical, text, audible, etc.), CB radios (per Caltrans study), flashing beacons coupled with a static sign message, stand-alone static warning signs, National Oceanic and Atmospheric Administration (NOAA) weather radio broadcasts, Internet/web-sites, telephone call-in systems, ISP-provided services, etc.

5.6 APPLICABLE STANDARDS

The MCO User Service should be standardized to at least a minimum level by following all existing data standards. Interfaces required for this User Service not currently defined within the National ITS Architecture or not falling under an existing standard (e.g., ANSI 20) should be considered for standardization.

5.7 PRIVACY CONCERNS

Permanent or temporary storage of data within the systems that support the MCO User Service should preclude the possibility of identifying or tracking either individual citizens or private firms and should follow the ITS Privacy Principles developed by ITS America ("Fair Information and Privacy Principles"). This means that even in the case where unprocessed data (i.e., data received directly from collection sources) are stored, privacy principles should be strictly followed. Identifiers of individual

citizens or private firms should be stripped from all data before archiving unless full disclosure of the intended use is made and informed consent is obtained. Unique system-developed identifiers that do not allow identification of individual citizens or private firms may be assigned to stored data.

5.8   LIABILITY CONCERNS

There are a few liability concerns to consider before contracting-out MCO services to the private sector. Many public agencies are concerned that their department may come under legal scrutiny if actions of a private sector firm under contract to them pose a risk/threat to the public or put an agency/individual at a disadvantage. The discussion below presents these topics/issues and potential remediation steps:

Topic: Data Sharing

- Concern that private sector firm will NOT share data/information that they obtain through the course of their MCO service contract
- Typical data includes pavement temperatures, speed/volume/occupancy, equipment failure rate, infrastructure inventory/status reports, etc.

Remediation:

- Incorporate language into contract that specifies that the private sector entity is responsible to share all data/information that they obtained through the course of their contract
- Language should specify all data/information types, frequency of data provision, accuracy of data/information provided, format of data, medium of data (e.g., paper, electronic file, graphical, etc.), to whom the data/information is to be provided, etc.

Topic: Cause of Accident

- Concern that an accident will occur involving the motoring public in an area for which the private sector firm is responsible
- Accident could be due to contractor negligence, contractor on-the-job accident, motorist at-fault, etc.

Remediation:

- Incorporate language into contract that specifies the conditions under which the private sector entity is responsible (and is not) if an accident should occur in area of their contractual service
- Language should specify the circumstances under which an accident is covered vs. not covered, financial obligation of firm, documentation of procedures that firms use to "prevent"/take-into-account such accidents, procedures to follow if an accident occurs, process to follow when contacting firm representatives, etc.