Concept of Operations for Mount Rainier National Park Intelligent Transportation Systems

Mount Rainier National Park

Natural Resource Report NPS/NRR—2013/04
NPS D-XXX/XXXXXX & PMIS 88348
ON THE COVER
Highway Advisory Radio Information Sign, Mount Rainier National Park
Photograph by: Steve Lawson
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Natural Resource Report NPS/NRR—2013/04
NPS D-XXX/XXXXX & PMIS 88348

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

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## Change History

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<td>Revised Draft RSG version 01.15 (added Appendices B and C) for NPS review</td>
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Foreword

This Foreword provides a guide to reading and reviewing the Concept of Operations Plan for Mount Rainier National Park Intelligent Transportation Systems (2013 MORA ConOps).

1. Mount Rainier National Park (MORA) is developing and intends to implement a comprehensive system to manage visitor travel to and within the park, and the 2013 MORA ConOps was developed as part of that effort. Mount Rainier National Park accommodates more than one million visitors annually and experiences intensive visitation during summer months. During peak periods of visitation, visitors must wait in long lines of traffic to enter the park and have difficulty finding places to park their cars once they enter the park. The park’s General Management Plan (GMP) calls for coordinated deployment of shuttle service, Intelligent Transportation Systems (ITS), and overflow parking management to improve transportation conditions in the park. The 2013 MORA ConOps was developed as a foundational step in the Systems Engineering process MORA is following for planning and deploying ITS in the park (Figure 1).

![Figure 1. Systems Engineering "V" Diagram.](image)

2. It is beyond the scope of the 2013 MORA ConOps to specify cost estimates for MORA ITS deployments. Subsequent phases of the MORA ITS Systems Engineering approach include specifying detailed system requirements, and ultimately developing detailed system design. Thus, the 2013 MORA ConOps does not include cost estimates for MORA ITS deployments, but rather provides a basis for MORA ITS stakeholders to specify and agree upon a concept for ITS deployment in MORA. Readers who are interested in additional information about the process of Systems Engineering for ITS, including information about sequencing of steps within the
Concept of Operations for MORA ITS

process, are encouraged to refer to the US Department of Transportation’s guide entitled *Systems Engineering for Intelligent Transportation Systems: An Introduction for Transportation Professionals* (a full citation is provided in the Resource Documents section on Page 3 of the 2013 MORA ConOps).

3. **The 2013 MORA ConOps is a collaborative document that is developed by the MORA ITS stakeholders who will deploy and use the next phase of technology for MORA Intelligent Transportation Systems (ITS).** The 2013 MORA ConOps is based on the US Department of Transportation (USDOT) guidelines for preparing a ConOps within a process of Systems Engineering for ITS. A question and answer piece is included to help define and explain technical terms for non-transportation professionals.

4. **While the stakeholders for the 2013 MORA ConOps include regional, statewide, and national agencies and individuals, none are more important than the stakeholders that work at MORA.** The 2013 MORA ConOps is the place for local (i.e., MORA) stakeholders to literally stake out their transportation technology needs and reasonable expectations for local outcomes.

5. **The 2013 MORA ConOps was developed with explicit recognition of the national significance of the Systems Engineering approach to the National ITS Architecture and the need for conformance to national standards, while still focusing on solving local (i.e., MORA) resource management and allocation issues.** The nation is building the transportation technology for the twenty-first century and it is essential that this is built from the outset as a connected system that is compatible from locality to locality, region to region, state to state and for manufacturers of transportation technology from country to country. The 2013 MORA ConOps uses the standards of the International Electronics and Electrical Engineers (IEEE) for conformance with national standards for Systems Engineering and the National ITS Architecture for conformance with ITS standards. The IEEE standard is used for upgrading or updating ITS Systems Engineering processes, and is therefore the correct approach for the MORA ConOps, which is an update to the 2007 MORA ITS Technical Report prepared for the National Park Service (NPS) by Science Applications International Corporation (SAIC) and Tom Crikelair Associates.

6. **The scale of the ITS Systems Engineering process at MORA should be commensurate with the scope of the ITS projects NPS chooses to pursue.** For example, the scale of the ITS Systems Engineering process would necessarily be more substantial if NPS chooses to pursue major interagency infrastructure capital improvements, such as extending the U.S. Department of Commerce’s Rural Broadband Initiative to MORA, than if NPS focuses on “local, stand-alone” projects only.

7. **As noted, the 2013 MORA ConOps follows guidelines for the IEEE standard format and its content and format are according to IEEE standards.** The following subsections provide an annotated outline of the 2013 MORA ConOps and are provided as a guide to reading and using
a. Change History. This is a table that documents the draft versions of the 2013 MORA ConOps development. The change history table provides documentation of changes during the process of the ConOps development. Initially, a consultant was the primary author of the 2013 MORA ConOps; as the review and revision process proceeds, local stakeholders become subsequent authors, approve the final document, and take the Systems Engineering process to the next stages, as needed.

b. Section 1, SCOPE. This section, as defined by the IEEE standard and Systems Engineering format, has four parts:
   i. Identification. This identifies that the 2013 MORA ConOps is an update to the 2007 Mount Rainier National Park ITS Technical Report.
   ii. Document Overview. This identifies the eight components of the IEEE standard for ConOps organization.
   iii. System Overview. This presents the key activities involved in the 2013 MORA ConOps development process.
   iv. Stakeholders. This identifies the individuals that comprise the MORA ITS stakeholder group that participated in a stakeholder workshop in MORA during October, 2012, as an initial step in the process to develop the 2013 MORA ConOps.

c. Section 2. DOCUMENTS. The IEEE ConOps standard provides for the identification of two types of documents: “Referenced Documents” and “Resource Documents.” Referenced Documents for the 2013 MORA ConOps include two legacy documents (the SAIC 2007 ITS Final Technical Report) and the MORA General Management Plan. Most importantly, the seminal reference document for the 2013 MORA ConOps was the “Summary of Workshop Notes” prepared by Ms. Laurie Miskimins of FHWA Central Federal Lands Highway Division (CFLHD) to document the Stakeholder Workshop conducted in MORA during October, 2012. Resource Documents include the principal documents used by the authors to help inform the development of the 2013 MORA ConOps. It is possible that the list of Referenced and/or Resource Documents for the 2013 MORA ConOps will grow as local stakeholders revise the document.

d. Section 3. THE CURRENT SYSTEM OR SITUATION. According to IEEE standard, the 2013 MORA ConOps documents the “current” MORA ITS situation in three parts:
   i. Background, Objectives, and Scope
   ii. Operational Policies and Constraints
   iii. Description of the Current System

This section of the 2013 MORA ConOps draws heavily from the 2007 MORA ITS Technical Report that documents MORA’s high priority needs, functional requirements, infrastructure support, and recommended ITS application areas, as indicated at the time the report was
developed. In describing the current system (as of March, 2013), the 2013 MORA ConOps presents the current status of deployment of ITS components recommended in the 2007 MORA ITS Technical Report.

e. **Section 4. JUSTIFICATION FOR AND NATURE OF CHANGES.** According to IEEE standard, the 2013 MORA ConOps provides five key provisions for updating ITS systems:
   i. *Justification for Changes*
   ii. *Description of Desired Changes*
   iii. *Priorities among Changes*
   iv. *Changes Considered but not Included*
   v. *Constraints and Assumptions*

As a result of the October, 2012 stakeholder workshop in MORA, this section of the 2013 MORA ConOps document focuses more on re-affirming the priority needs and operational policies identified in 2007, making organizational refinements, focusing on ITS applications in the Nisqually Corridor and particularly at Paradise.

f. **Section 5. CONCEPTS FOR PROPOSED SYSTEM.** According to the IEEE standard, this section proposes the essential updating of the MORA ITS system by providing a refocus of operational policies; and presenting a detailed description of the updated ITS system including hardware and software, staffing, modes of operation, user types, and the support environment envisioned. As with the other sections of the 2013 MORA ConOps, this section follows the IEEE standard format for organization; however, this is a section of the document where local MORA input and ownership is particularly important in the review and revision process for the document.

g. **Section 6. OPERATIONAL SCENARIOS.** There are five scenarios in this section that follow the IEEE standard to provide fictional examples of how the proposed MORA ITS would meet the high priority park needs and operational policies from the stakeholder and user perspectives.

h. **Section 7. SUMMARY OF IMPACTS.** According to the IEEE standard, this section of the 2013 MORA ConOps provides analysis of the impact of deploying the proposed MORA ITS components, including: 1) Operational Impacts; 2) Organizational Impacts; 3) Impacts during Development; and 4) Measuring the Impacts. This is another section of the 2013 MORA ConOps where local MORA input is particularly important in the review and revision process for the document.

i. **Section 8. ANALYSIS OF THE PROPOSED SYSTEM.** The IEEE ConOps standard specifies this section to: 1) summarize the improvements proposed by the ConOps process; 2) identify potential disadvantages and limitations raised through the 2013 MORA ConOps development process; and 3) note alternatives to the proposed system that may be considered.
Frequently Asked Questions

What is the Intelligent Transportation System? The USDOT’s ITS program “aims to bring connectivity to transportation through the application of advanced wireless technologies – powerful technologies that enable transformative change” -- a vision that includes the following features:

- A system in which highway crashes and their tragic consequences are rare because vehicles of all types can sense and communicate the events and hazards happening around them.
- A fully-connected, information-rich environment within which travelers, transit riders, freight managers, system operators, and other users are aware of all aspects of the system’s performance.
- Travelers who have comprehensive and accurate information on travel options – transit travel times, schedules, cost, and real-time locations; driving travel times, routes, and travel costs; parking costs, availability, and ability to reserve a space; and the environmental footprint of each trip.
- System operators who have full knowledge of the status of every transportation asset.
- Vehicles of all types that can communicate with traffic signals to eliminate unnecessary stops and help people drive in a more fuel efficient manner.
- Vehicles that can communicate the status of on-board systems and provide information that can be used by travelers and system operators to mitigate the vehicle’s impact on the environment or make more informed choices about travel modes.¹

What is Systems Engineering? Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem including: 1) operations; 2) costs and schedule; 3) performance; 4) training and support; 5) testing; 6) manufacturing; and 7) disposal.² Systems Engineering integrates all relevant disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

Why use Systems Engineering in ITS? The primary benefit of using a Systems Engineering approach for ITS is that it will reduce the risk of schedule and cost overruns and will provide a system of higher integrity. Other benefits include:

- Better system documentation
- Higher level of stakeholder participation
- System functionality that meets stakeholders’ expectation
- Potential for shorter project cycles


- Systems that can evolve with a minimum of redesign and cost
- Higher level of system reuse, and
- More predictable outcomes from projects.³

What is a Concept of Operations? A Concept of Operations (or ConOps) document results from a stakeholder view of the operations of the system being developed. A ConOps document will present each of the multiple views of the system corresponding to the various stakeholders. These stakeholders include operators, users, owners, developers, maintenance staff, and management personnel. A ConOps is intended to be easily reviewed by the stakeholders to facilitate agreement among stakeholders on the system description. A ConOps also provides the basis for user requirements for the system.⁴

How does the 2013 MORA ConOps relate to the existing MORA Intelligent Transportation Systems planning and deployment? In January of 2007, the Science Applications International Corporation (SAIC) and Tom Crikelair Associates completed a report entitled Mount Rainier National Park, Final Technical Report – Intelligent Transportation Systems. This document serves as the basis for the 2013 MORA ConOps and fulfills the requirements of the first two stages of Systems Engineering process for ITS: 1) Regional and National ITS Architecture; and 2) Feasibility Study/Concept Exploration (Figure 1). Technically, the 2007 MORA ITS Technical Report went beyond the first two steps of the Systems Engineering process, by beginning to address system requirements and design issues. However, the requisite documentation and approval processes required of a Systems Engineering approach were not addressed in the report or corresponding development process. Moreover, most of the recommendations in the 2007 MORA ITS Technical Report have not yet been implemented, and the 2013 MORA ConOps was commissioned to incorporate the seminal 2007 work into an ITS Systems Engineering framework and process for MORA.

What are the next steps in MORA ITS Planning and Deployment? Once the 2013 MORA ConOps is reviewed and adopted, NPS can proceed with subsequent steps in the Systems Engineering approach to ITS development, starting with specifying System Requirements (Figure 1). As noted, the scale of the ITS Systems Engineering process at MORA should be commensurate with the scope of the ITS projects NPS chooses to pursue.

³ Ibid.

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1. **Scope.** This section provides the Identification, Document Overview and System Overview.
   a. **Identification.** This concept of operations (ConOps), entitled “Concept of Operations for Mount Rainier National Park Intelligent Transportation Systems”, is an update to the Intelligent Transportation Systems (ITS) concept and recommendations presented in the 2007 Mount Rainier National Park (MORA) ITS Technical Report prepared for the National Park Service (NPS) by Science Applications International Corporation (SAIC) and Tom Crikelair Associates.
   b. **Document Overview.** The primary purpose of this document is to communicate the user needs and expectations for the continued deployment of the ITS systems and devices identified in the 2007 MORA ITS Technical Report. This ConOps document (hereafter referred to as the 2013 MORA ConOps) follows the Institute of Electrical and Electronics Engineers (IEEE) 1362-1998 standard that includes the following organization:
      i. Scope
      ii. Referenced Documents
      iii. The Current System or Situation
      iv. Justification for and Nature of Changes
      v. Concepts for the Proposed Systems
      vi. Operational Scenarios
      vii. Summary of Impacts
      viii. Analysis of the Proposed System
   c. **System Overview.** The 2013 MORA ConOps provides an opportunity to update previous MORA ITS concepts and plans (2002 General Management Plan [GMP] and SAIC 2007 MORA ITS Technical Report) that support improved visitor trip making decisions, traffic management capabilities, visitor use management, resource protection, and travel demand management (TDM) initiatives. The ConOps process includes the following key activities:
      i. The identification of external and internal MORA ITS stakeholders.
      ii. The identification of a core group responsible for preparing the 2013 MORA ConOps.
      iii. The development of an initial MORA ConOps document that is reviewed by a larger group of stakeholders and revised accordingly.
      iv. A final 2013 MORA ConOps document that is adopted and acted upon by MORA management and staff.
   d. **Stakeholders.** An ITS stakeholder workshop was held at MORA on October 10 and 11, 2012 for two reasons: 1) to familiarize the ITS consultants with existing ITS infrastructure at MORA; and 2) to meet with key MORA staff and technical representatives from FHWA and the Washington State Department of Transportation (WSDOT) to gather insight and information used to inform the development of this document. Attendees at the workshops are listed below and meeting notes from the workshop are included in Appendix A.
      i. Bryan Bowden, Community Planner, MORA
      ii. Roger Andrascik, Chief Natural and Cultural Resources, MORA
      iii. Lee Snook, Acting Chief of Interpretation, MORA
      iv. Kraig Snure, Wilderness District Ranger, MORA
      v. Chuck Young, Chief Ranger, MORA
vi. Lorant Veress, Operations Supervisor Protection, MORA
vii. Sueann Brown, Historical Architect, MORA
viii. Randy King, Superintendent, MORA
ix. Karen Thompson, Environmental Protection Specialist, MORA
x. Greg Burtchard, Archaeologist, MORA
xi. Darrin Swinney, IT/Telecom/GIS Program Manager, MORA
xii. Curt Jacquot, Interpreter – HAR Recordings Manager, MORA
xiii. Tracy Swartout, Deputy Superintendent, MORA
xiv. Patti Wold, Interpretive Media Specialist, MORA
xv. Kristyn Loving, Web and New Media Manager, MORA
xvi. Bill Legg, ITS Chair, Operations Division, Washington Department of Transportation
xvii. Steve Kim, Olympic Regional Traffic Engineer, Washington Department of Transportation
xviii. Nathaniel Price, ITS Operations Engineer, [Resource Center (RC)], Federal Highway Administration
xix. James Coylar, ITS Specialist, WA Division Office, Federal Highway Administration
xx. Laurie Miskimins, Transportation Planner, [CFLHD], Federal Highway Administration
xxi. Susan Law, Transportation Planner, [WFLHD], Federal Highway Administration
xxii. Barbara Samora, Biologist, MORA
xxiii. Daniel Camiccia, Park Ranger, MORA
xxiv. Geoff Walker, East District Park Ranger, MORA
xxv. Debbie Hannevig, Fee Operations Manager, MORA
2. Documents
   a. Referenced Documents.
   b. Resource Documents.
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3. **The Current System or Situation.** This section summarizes recommendations from the 2007 MORA ITS Technical Report and documents MORA’s current ITS system.

   a. **Background, Objectives and Scope.** The 2013 MORA ConOps provides an opportunity to update previous MORA ITS concepts and plans (GMP 2002 and SAIC 2007 MORA ITS Technical Report) that support improved visitor trip making decisions, traffic management capabilities, visitor use management, resource protection, and travel demand management (TDM) initiatives. The 2007 MORA ITS Technical Report identified intelligent transportation systems as “a means of alleviating congestion by providing Park visitors, employees, and gateway communities with real-time information on road, weather, parking conditions, and destination options in adjoining tourism corridors, thereby encouraging more informed travel choices and the reduction of demand at key resources.” In developing the 2007 MORA ITS Technical Report, SAIC applied a Systems Engineering process that conformed with National ITS Architecture according to the FHWA Final Rule for ITS. The Systems Engineering approach used in 2007 by the Park “... included identification and confirmation of Park needs, defining requirements, and identifying potential ITS Market Packages (now called ITS Service Packages) to address Park needs.” The scope of the 2007 ITS applications included three areas:

   i. Traffic monitoring applications
   ii. Information processing applications
   iii. Information distribution applications

   b. **Operational Policies and Constraints.** The 2007 MORA ITS Technical Report provided a detailed statement of NPS’ high priority park needs, as identified by park staff and stated in terms that could be considered operational policies (Table 1).

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5 SAIC 2007, p iii.
8 SAIC 2007, p iii.
9 *ibid*, p iv.
## Table 1. 2007 High Priority Park Needs/Operational Policies

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<tr>
<td>1</td>
<td>Get visitors to (voluntarily) visit popular places during less congested times (peak hour, day, weekend, and season).</td>
</tr>
<tr>
<td>2</td>
<td>Inform visitors of options and conditions “before they decide” to modify behavior patterns and moderate expectations.</td>
</tr>
<tr>
<td>3</td>
<td>Coordinate delivery of en-route driver information with timely suggestions for alternative activities (and increased information content about those activities) based on drivers’ geographic location.</td>
</tr>
<tr>
<td>4</td>
<td>Provide real-time information regarding weather, road conditions, parking availability, and the availability of services in the Park.</td>
</tr>
<tr>
<td>5</td>
<td>Provide timely and accurate information dissemination to support improved internal Park communications and operations.</td>
</tr>
<tr>
<td>6</td>
<td>Support alternative transportation strategies that mitigate limited vehicle access issues at popular locations (e.g. inter-city coach, shared-ride, park and ride schemes).</td>
</tr>
<tr>
<td>7</td>
<td>Provide reliable data to measure and determine congestion “threshold/standards” and to assist in the development of transportation system operations requirements.</td>
</tr>
<tr>
<td>8</td>
<td>Provide current information to welcome centers in gateway corridors.</td>
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Using the high priority park needs and operational policies identified by MORA staff through the 2007 System Engineering process, SAIC created a list of functional requirements for MORA ITS (Table 2).

---

Using the above high priority park needs and operational policies and corresponding functional requirements, SAIC assessed existing infrastructure and the feasibility of upgrading or installing new infrastructure required to support ITS systems. Table 3 presents the results of this assessment in an ITS infrastructure support matrix and Figure 2 provides a regional map of MORA for reference to specific areas noted in the infrastructure support matrix.

<table>
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<th>Need Identified by Design Team</th>
<th>System Functional Requirement</th>
</tr>
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<tr>
<td>Get visitors to (voluntarily) visit popular places during less congested times (peak hour, day, weekend, and season).</td>
<td>1a) System shall provide Park staff with ability to collect and disseminate information regarding real-time traffic conditions and construction, to include imagery, to visitors via the internet 511, TIS, etc.</td>
</tr>
<tr>
<td>Inform visitors of options and conditions “before they decide” to modify behavior patterns and moderate expectations.</td>
<td>2) System shall provide Park staff with ability to disseminate information regarding activities based on locations and duration to visitors via the internet and HAR.</td>
</tr>
<tr>
<td>Coordinate delivery of en-route driver information with timely suggestions for alternative activities (and increased information content about those activities) based on drivers’ geographic location.</td>
<td>3) Combination of requirements 1 and 2.</td>
</tr>
<tr>
<td>Provide real-time information regarding weather, road conditions, parking availability, and the availability of services in the Park.</td>
<td>4) System shall provide Park staff with ability to disseminate information regarding real-time weather conditions to visitors via the internet, 511, TIS, etc.</td>
</tr>
<tr>
<td>Provide timely and accurate information dissemination to support improved internal Park communications and operations.</td>
<td>5) System shall provide Park staff with ability to collect and disseminate information regarding real-time traffic conditions and construction, to include imagery, to visitors via internal Park communications (i.e. intranet).</td>
</tr>
<tr>
<td>Support alternative transportation strategies that mitigate limited vehicle access issues at popular locations (e.g. shuttles).</td>
<td>6) Combination of requirements 1a and 5.</td>
</tr>
<tr>
<td>Provide reliable data to measure and determine congestion “threshold/standards” and to assist in the development of transportation system operations requirements.</td>
<td>7) Combination of requirements 1a and 1b.</td>
</tr>
<tr>
<td>Provide current information to welcome centers in gateway corridors.</td>
<td>8) Combination of requirements 1a, 1b, and 4.</td>
</tr>
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</table>

Using the above high priority park needs and operational policies and corresponding functional requirements, SAIC assessed existing infrastructure and the feasibility of upgrading or installing new infrastructure required to support ITS systems. Table 3 presents the results of this assessment in an ITS infrastructure support matrix and Figure 2 provides a regional map of MORA for reference to specific areas noted in the infrastructure support matrix.

11 “Table 2 Functional Requirements for Mount Rainier ITS,” Ibid, 3.
### Table 3. 2007 Infrastructure Support for Mount Rainier ITS

<table>
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<tr>
<td>Nisqually Entrance Station</td>
<td>Power Available from nearby buildings. Support for real-time communications includes Ethernet (PTP-T1) and phone lines.</td>
<td>Connect to existing power and communications – preferably Ethernet unless distance &gt; 100m from device in which case phone lines can be used. Specific devices recommend by SAIC for this location include a real-time traffic counter (RTMS) and a highway advisory radio system (HAR).</td>
</tr>
<tr>
<td>Longmire Area</td>
<td>Power available from nearby buildings. Support for real-time communications includes Ethernet (PTP-T1) and phone lines (availability and reliability of phone lines in the area may be limited depending exact location). WiFi also available in the area. Antenna mounting options available on existing tower.</td>
<td>Connect to existing power and communications – preferably Ethernet unless distance &gt; 100m from device in which case phone lines can be evaluated. WiFi may be alternative if access to phone limited. Specific devices recommend by SAIC for this location include RTMS.</td>
</tr>
<tr>
<td>Carbon River</td>
<td>Communications not currently available. Power not readily available. Safety/security of devices at this location may be an issue. Most strategic location for ITS may be in Wilkeson, WA.</td>
<td>Real-time communications from this location not feasible. Placement of devices would be driven by lack of security. Specific devices recommend by SAIC for this location include RTMS.</td>
</tr>
<tr>
<td>Paradise Area</td>
<td>Power approaching Paradise available from sewage treatment plant on road leading to Paradise (just west of first entrance to the Picnic Area). Phone lines available at this location. Power in Paradise area available at Jackson Visitor Center (JVC) and various buildings as are Ethernet and Phones lines. Locations for traffic counters and other devices may not have easy access to power and communications. Power not available in upper parking lot exiting to Paradise Valley Road.</td>
<td>Connect to existing power where feasible. Devices such as traffic counters can be easily supported with small solar panel (1’ x 2’). Communications for devices located in the area can be supported by WiFi connection to the JVC (via small wireless access point at JVC). Devices located within 100m of the JVC can be connected via cable. Power and landline communication not available. Devices for real-time traffic monitoring can be supported using battery with solar back-up. Real-time communications can be supported using WiFi connection (site survey and wireless bridge may be required). Specific devices recommend by SAIC for the Paradise area include RTMS units on Paradise Road and Paradise Valley Road, HAR, and real-time network web cameras (web cameras).</td>
</tr>
</tbody>
</table>

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### Table 3. 2007 Infrastructure Support for Mount Rainier ITS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohanapecosh</td>
<td>Power available from nearby buildings. Phone lines also available at this location.</td>
<td>Connect to existing power and phone lines to support advisory radio. Specific devices recommend by SAIC for this location include HAR.</td>
</tr>
<tr>
<td>Sunrise Area</td>
<td>Power available from nearby buildings (generator). Communications via 128 Kbps satellite uplink.</td>
<td>Connect planned RTMS and network cameras to existing power (RTMS can be powered with battery/solar combination if necessary). Use existing satellite uplink to transmit data and imagery. Imagery limited to periodic screen captures to ensure adequate bandwidth for other Visitor Center Communications. Specific devices recommend by SAIC for this location include RTMS, HAR, and web cameras.</td>
</tr>
<tr>
<td>White River Entrance</td>
<td>Limited power available from nearby buildings (solar). Phone lines also available at this location. Connection to Park Intranet via T-1 line.</td>
<td>Connect to existing intranet to support real-time communications for planned RTMS. RTMS can be powered with battery/solar recharge combination. Specific devices recommend by SAIC for this location include RTMS.</td>
</tr>
<tr>
<td>White River Campground/Sunrise VC Road Junction</td>
<td>No telephone lines on-site. No utility service at this site. Limited solar power available.</td>
<td>RTMS would be powered using battery with solar panel recharging. Real-time communications from this location would be limited to low-power wireless communications link to the White River Entrance Station and may not be feasible due to line of sight requirements for these systems. Specific devices recommend by SAIC for this location include RTMS.</td>
</tr>
<tr>
<td>Stevens Canyon Entrance</td>
<td>There are telephone communication services at this location. No utility service at this site. Limited solar power available. (NOTE: Park staff have subsequently recommended that both power and telecommunication - i.e., fiber-optics - be extended along the roadway from Ohanapecosh).</td>
<td>Advisory radio for visitors approaching this location would be provided by focused transmission from Ohanapecosh. Other devices such as RTMS can be powered with battery/solar combination. Real-time communication from this location not feasible. Specific devices recommend by SAIC for this location include RTMS.</td>
</tr>
</tbody>
</table>
Figure 2. Regional access map, Mount Rainier National Park.
Concept of Operations for MORA ITS

Based on the above high priority park needs and operational policies, functional requirements, and infrastructure assessment, the 2007 MORA ITS Technical Report recommended the implementation of a set of specific ITS components, categorized into three ITS application areas (Table 4).

<table>
<thead>
<tr>
<th>Table 4. Recommended ITS Application Areas (2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Traffic Monitoring Applications</td>
</tr>
<tr>
<td>a. Real-time traffic counters (RTMS)</td>
</tr>
<tr>
<td>b. Real-time network Web cameras</td>
</tr>
<tr>
<td>2. Information Processing Applications</td>
</tr>
<tr>
<td>a. Software for MORA ITS Graphical User Interface (GUI)</td>
</tr>
<tr>
<td>3. Information Distribution Applications</td>
</tr>
<tr>
<td>a. Highway Advisory Radio systems (HAR)</td>
</tr>
<tr>
<td>b. Integration of MORA information with WSDOT 511</td>
</tr>
<tr>
<td>c. Web-enabled non-interactive screen displays</td>
</tr>
<tr>
<td>d. Dynamic Message Signs (DMS)</td>
</tr>
</tbody>
</table>

c. **Description of the Current System.** The current (March, 2013) status of MORA ITS application areas recommended in the 2007 MORA ITS Technical Report is specified in Table 5 and depicted in Figure 3. In addition, Table 5 lists MORA ITS components that are planned, but not yet implemented. Further, devices and systems not mentioned in the 2007 MORA ITS Technical Report but important to support the purposes of the MORA ITS system are included in Figure 3. For example, the inductive loop counter at the Nisqually Entrance is depicted and provides a potential basis to calibrate the RTMS traffic counter data recorded at that location. Finally, Figure 4 depicts the regional ITS infrastructure that WSDOT manages and could be leveraged for MORA ITS applications.

<table>
<thead>
<tr>
<th>Table 5. Description of Current Deployment of MORA ITS Systems (March, 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2007 ITS component</strong></td>
</tr>
<tr>
<td>Real-Time Traffic Monitoring Systems (RTMS)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Table 5. Description of Current Deployment of MORA ITS Systems (March, 2013)

<table>
<thead>
<tr>
<th>2007 ITS component</th>
<th>Status of Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Cameras</td>
<td>Web Cams deployed (Imagery is not archived).</td>
</tr>
<tr>
<td></td>
<td>• Paradise Area</td>
</tr>
<tr>
<td></td>
<td>o View of the Mountain</td>
</tr>
<tr>
<td></td>
<td>o Looking east from the Jackson Visitor Center towards the Upper Parking Lot</td>
</tr>
<tr>
<td></td>
<td>o Looking west from the Jackson Visitor Center towards the Lower Parking Lot, with views of the road and sidewalk approaching the Jackson Visitor Center, but not of the Lower Parking Lot</td>
</tr>
<tr>
<td></td>
<td>o View of the Jackson Visitor Center</td>
</tr>
<tr>
<td></td>
<td>o Looking south towards the Tatoosh Range</td>
</tr>
<tr>
<td></td>
<td>• Longmire</td>
</tr>
<tr>
<td></td>
<td>o Looking southwest from the Longmire Administrative Building towards Nisqually Road in front of the National Park Inn</td>
</tr>
<tr>
<td></td>
<td>• Sunrise Area (Seasonal)</td>
</tr>
<tr>
<td></td>
<td>o View of the Mountain from the Visitor Center</td>
</tr>
<tr>
<td></td>
<td>o Looking east, towards the parking lot from the Visitor Center</td>
</tr>
<tr>
<td></td>
<td>Web Cams planned.</td>
</tr>
<tr>
<td></td>
<td>• Paradise Area</td>
</tr>
<tr>
<td></td>
<td>o With view of Lower Parking Lot</td>
</tr>
<tr>
<td></td>
<td>• Nisqually Entrance Station</td>
</tr>
<tr>
<td></td>
<td>• White River Entrance Station</td>
</tr>
<tr>
<td>Software for MORA ITS (Graphical User Interface or “GUI”)</td>
<td>MORA did attempt to have a GUI dashboard designed in 2008, but this effort was discontinued at the time due to security issues related to getting data and information from MORA internal servers through the NPS firewall to external public devices.</td>
</tr>
<tr>
<td>Highway Advisory Radio systems (HAR)</td>
<td>HAR systems deployed</td>
</tr>
<tr>
<td></td>
<td>• State Highway 706 near Tahoma Woods, on approach to the Nisqually Entrance to MORA.</td>
</tr>
<tr>
<td></td>
<td>• State Highway 706 at the Nisqually Entrance to MORA.</td>
</tr>
<tr>
<td></td>
<td>• Paradise Road, on approach to Paradise.</td>
</tr>
<tr>
<td></td>
<td>HAR systems/activities planned</td>
</tr>
<tr>
<td></td>
<td>• Upgrade to new HAR system at the Nisqually Entrance to MORA.</td>
</tr>
<tr>
<td></td>
<td>• Purchase and install HAR at the Ohanapecosh sewage treatment area, with sufficient range to reach the Stevens Canyon Entrance to MORA.</td>
</tr>
<tr>
<td></td>
<td>• Fix connectivity issue problem with the Paradise HAR by converting the existing poor quality phone line to an Ethernet connection.</td>
</tr>
<tr>
<td></td>
<td>• Install 50’ antenna at Tahoma Woods HAR to increase broadcast range.</td>
</tr>
<tr>
<td></td>
<td>• Connect all HAR systems to internet for remote operations and maintenance.</td>
</tr>
<tr>
<td></td>
<td>• Purchase portable/trailer mounted Dynamic Message Sign (DMS) with integrated HAR and use on approach to White River Entrance to MORA (tentative).</td>
</tr>
</tbody>
</table>
### Table 5. Description of Current Deployment of MORA ITS Systems (March, 2013)

<table>
<thead>
<tr>
<th>2007 ITS component</th>
<th>Status of Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration with WSDOT 511 System</td>
<td>Integration not designed, tested, or deployed. Opportunities for integration with WSDOT 511 and website were discussed at the October, 2012 stakeholder workshop (see Appendix A for workshop meeting notes).</td>
</tr>
<tr>
<td>Web-enabled Non-Interactive Screen Displays (refers to screen displays at regional visitor centers with MORA information feeds via internet)</td>
<td>No activity.</td>
</tr>
<tr>
<td>Local Area Network (LAN)</td>
<td>Nisqually Entrance</td>
</tr>
<tr>
<td></td>
<td>• Ethernet LAN ITS connectivity for RTMS – deployed.</td>
</tr>
<tr>
<td></td>
<td>• Ethernet LAN ITS connectivity for Web Cam – deployed.</td>
</tr>
<tr>
<td></td>
<td>Longmire Area</td>
</tr>
<tr>
<td></td>
<td>• Ethernet LAN ITS connectivity for Web Cam – deployed.</td>
</tr>
<tr>
<td></td>
<td>Paradise Area</td>
</tr>
<tr>
<td></td>
<td>• Ethernet LAN ITS connectivity for Web Cam of view of the Mountain.</td>
</tr>
<tr>
<td></td>
<td>• Ethernet LAN ITS connectivity for Web Cam of view of the Upper Parking Lot - planned.</td>
</tr>
<tr>
<td></td>
<td>• WiFi connectivity for RTMS on Paradise Valley – planned.</td>
</tr>
<tr>
<td></td>
<td>Carbon River</td>
</tr>
<tr>
<td></td>
<td>• No LAN ITS connectivity deployed or planned.</td>
</tr>
<tr>
<td></td>
<td>Sunrise Area</td>
</tr>
<tr>
<td></td>
<td>• No LAN ITS connectivity deployed or planned (Note: Web Cam imagery and RTMS counter planned to use 128 kbps satellite uplink).</td>
</tr>
<tr>
<td></td>
<td>White River Entrance</td>
</tr>
<tr>
<td></td>
<td>• LAN ITS connectivity via existing T-1 line – planned.</td>
</tr>
<tr>
<td></td>
<td>White River Campground</td>
</tr>
<tr>
<td></td>
<td>• No LAN ITS connectivity deployed or planned.</td>
</tr>
<tr>
<td></td>
<td>Stevens Canyon Entrance:</td>
</tr>
<tr>
<td></td>
<td>• No LAN ITS connectivity deployed or planned.</td>
</tr>
</tbody>
</table>
Figure 3. Existing ITS, Mount Rainier National Park.
Figure 4. Existing regional ITS infrastructure managed by WSDOT.
In summary, very few of the recommendations from the 2007 MORA ITS Technical Report have been deployed, as of March, 2013. The most used of the MORA ITS components that have been deployed to date are the web cameras, based on information from park staff that the web cameras are the second most visited webpage on the MORA website, after the homepage. Secondly, the HAR systems that have been deployed provide useful information for visitors on approach to MORA, although the effectiveness of the existing HAR systems is limited, to some extent, by the limited broadcast range of the systems and corresponding challenge to provide a sufficiently informative message within the time provided by the broadcast range. The RTMS at the Nisqually Entrance to MORA has been operating for approximately one year. However, recent analysis of the traffic count data from the RTMS suggest there are measurement errors associated with the installation location of the RTMS. Thus, it will be necessary to re-configure the RTMS operating parameters to record traffic count data accurately. If re-configuration of the RTMS operating parameters is not successful, it will be necessary to relocate the RTMS, preferably to a location proximate to the inductive loop counters just east of the Nisqually Entrance Station. Moreover, the utility of the RTMS traffic count data are limited in their application, until the RTMS systems planned for installation on Paradise Road and Paradise Valley Road are deployed. In particular, without the RTMS systems installed at the two Paradise locations, it is not possible to monitor and communicate to visitors in real-time parking availability at Paradise, nor is it possible to estimate parking and traffic conditions at Paradise based on inbound traffic counts at the Nisqually Entrance. Primary constraints to MORA ITS deployment to date include limited infrastructure and operational resources available to MORA, and are not attributable to a lack of validity of the recommendations in the 2007 MORA ITS Technical Report. These circumstances frame the subsequent sections of the 2013 MORA ConOps.
4. **Justification for and Nature of Changes.** As noted, the 2013 MORA ConOps updates the 2007 MORA ITS Technical Report. According to the IEEE standard, this section includes justification for changes, description of desired changes, priorities among changes, changes considered but not included, and constraints and assumptions.

a. **Justification for Changes.** As noted, very few of the recommendations from the 2007 MORA ITS Technical Report have been deployed, as of March, 2013. Furthermore, since the 2007 MORA ITS Technical Report was completed, the communications infrastructure of the nation has been rapidly changing and the manner in which travelers access information and make travel decisions has changed significantly, based on the dynamics of the consumer electronics market. The 2013 MORA ConOps is designed to help advance MORA ITS by scaling the recommendations from the 2007 MORA ITS Technical Report into a more narrowly focused approach for planning, deployment, operations, and management of MORA ITS over the next five year period. Moreover, the 2013 MORA ConOps provides an opportunity to update the 2007 MORA ITS Technical Report with knowledge of technological advances over the past five years.

b. **Description of Desired Changes.**

i. Based on input from MORA ITS stakeholders during the October, 2012 stakeholder workshop, add an item emphasizing public and employee safety to the high priority park needs and operational policies on which MORA ITS recommendations are based (Table 6).

<table>
<thead>
<tr>
<th>Table 6. 2012 High Priority Park Needs/Operational Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Ensure public and employee safety using MORA roadways [NEW]</td>
</tr>
<tr>
<td><strong>2.</strong> Get visitors to (voluntarily) visit popular places during less congested times (peak hour, day, weekend, and season).</td>
</tr>
<tr>
<td><strong>3.</strong> Inform visitors of options and conditions “before they decide” -- to modify behavior patterns and moderate expectations.</td>
</tr>
<tr>
<td><strong>4.</strong> Coordinate delivery of en-route driver information with timely suggestions for alternative activities (and increased information content about those activities) based on drivers’ geographic location.</td>
</tr>
<tr>
<td><strong>5.</strong> Provide real-time information regarding weather, road conditions, parking availability, and the availability of services in the Park.</td>
</tr>
<tr>
<td><strong>6.</strong> Provide timely and accurate information dissemination to support improved internal Park communications and operations.</td>
</tr>
<tr>
<td><strong>7.</strong> Support alternative transportation strategies that mitigate limited vehicle access issues at popular locations (e.g. shuttles).</td>
</tr>
<tr>
<td><strong>8.</strong> Provide reliable data to measure and determine congestion “threshold/standards” and to assist in the development of transportation system operations requirements.</td>
</tr>
<tr>
<td><strong>9.</strong> Provide current information to welcome centers in gateway corridors.</td>
</tr>
</tbody>
</table>

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13 “Table 1. Key Needs Identified by Park Staff for ITS”, Ibid. p 2 with addition of safety.
Concept of Operations for MORA ITS

ii. Concentrate efforts to record and disseminate real-time information and likely near-term future (e.g., 2 hours later than current time) conditions regarding traffic and parking initially on just the Nisqually Corridor, generally, and Paradise in particular. In doing so, demonstrate the feasibility and utility of recording, processing, and disseminating real-time information and likely near-term future conditions regarding traffic and parking in the Nisqually Corridor before proceeding with ITS deployments in other areas of the park.

iii. Establish a “virtual” MORA Transportation Management Center (TMC) on the park’s intranet with software applications capable of responding to the high priority park needs and operational policies identified in 2007 MORA ITS Technical Report and affirmed during the October, 2012 MORA ITS stakeholder workshop. Software application areas of focus for the TMC include:
   1. Traffic, parking, and visitor use monitoring applications
   2. Data processing applications
   3. Information dissemination applications
   [NOTE: Appendix B provides detailed documentation of software options and recommendations for MORA TMC applications]

iv. Pursue Cloud-based, inter-governmental traveler information innovations with little or no capital or operational costs.
   1. Establish links to WS DOT 5-1-1 and other Regional Transportation Management Centers and Tourist Centers.
   2. Encourage development of smart phone apps by providing free real-time data feeds and archives for developers, pending appropriate NPS approval and according to federal government procurement requirements.

v. Leverage public and private modernization of communication infrastructure as much as possible for MORA ITS.
   1. Explore partnerships with cellular carriers for coverage in high use areas (e.g., Paradise, Longmire, Sunrise).
   2. Explore possibilities for shared use and development of the WSDOT/DOC 700 MHz and 800 MHz radio frequencies for data and voice service within the MORA region.
   3. Be alert for U.S. Department of Commerce (USDOC) follow-on broadband infrastructure economic stimulus activities that would support MORA and gateway communities.

c. Priorities among Changes.
   i. The changes listed above are in order of priority.

d. Changes Considered but not Included.
   i. The development of automatic vehicle location systems (AVL) and web-mapping applications for the MORA shuttle bus system and/or inter-city bus services directly from the center of nearby metropolitan areas to MORA venues was considered. It was dropped because of the uncertainty in funding for shuttle bus services and inadequate communications technology in the near-term.
ii. The development of “last-mile” fiber optic broadband connection to MORA was considered as a part of the 2013 MORA ConOps to provide out-door WiFi and/or enhanced cellular connectivity to provide fast Ethernet for ITS devices. It was dropped from consideration in the near-term because of the long distances from MORA access roads to the current ARRA broadband network and the high cost for providing that connectivity to MORA.

iii. Civilian applications of unmanned aerial vehicles (UAVs) as real-time remote sensing platforms for TDM and law enforcement applications has been well developed by federal transportation research and demonstration programs. However, until the Federal Aviation Administration de-regulates civilian UAVs for public agencies (in 2014), there is little opportunity for MORA and other NPS units to apply UAV technology outside of law enforcement activities.

e. Constraints and Assumptions.

i. Technology products such as smart phones, tablets, wireless routers, and other hardware for cellular communications and Outdoor WiFi will continue to provide more capabilities at lower cost in response to global demand.

ii. Rural broadband opportunities will increase as a national policy of capital infrastructure investment moves from education and health care to economic development, including tourism.

iii. The public will increasingly demand/expect communications connectivity in public transportation and at recreation/tourism destinations.

iv. Public expectations for the federal government to “do more with less” will continue to increase, requiring capital investments that ultimately lower the cost of operations by automating processes and services.

v. Public–Private partnerships in developing communication infrastructure for out-door WiFi and small cell multi-carrier cellular networks will emerge in rural areas nationally, but not in an area as isolated and mountainous as MORA.

vi. There are greater limits to technology applications for MORA ITS than in “conventional” settings due to potential impacts of technology on MORA’s historical, cultural, natural, and/or Wilderness resources.

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14 See the private non-profit Broadband provider’s web site at [http://www.noanet.net/](http://www.noanet.net/)
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5. **Concepts for Proposed System.** Based on the summary of recommendations from the 2007 MORA ITS Technical Report, current MORA ITS system, and above justification for changes, this section describes the MORA ITS system proposed in this document. This includes information about the system not only at a conceptual level, but also in terms of specific operational procedures, staff roles, system users, and partners that constitute the support environment for MORA ITS.

a. **Background, Objectives and Scope.**
   
   i. Retain original high priority park needs and operational policies as developed in the 2007 MORA ITS Technical Report, with the addition of public and employee safety needs and recognition that this is the top priority.
   
   ii. Implement ITS system recommendations in the 2007 MORA ITS Technical Report, within available and/or acquired resources. Specifically, initial focus is on deploying the RTMS and HAR units on approach to and in the Nisqually Corridor and at Paradise, and on the acquisition and operation of the software system required for TMC applications (referred to in the 2007 MORA ITS Technical Report as the software for the MORA ITS GUI).
   
   iii. Establish a “virtual” MORA TMC on the park’s intranet with software applications to process, archive, analyze, and disseminate real-time and historical ITS data flows from MORA-owned and operated data collection devices (i.e., RTMS units and web cameras, initially; Figure 5).
Figure 5. Data Flows for MORA ITS.
b. **Operational Policies and Constraints.**
   
i. Mount Rainier National Park should focus on low-cost, real-time information collection on traffic and parking status within the Nisqually Corridor, with focus on Paradise. In addition, focus should be on using traffic and parking data from RTMS systems at the Nisqually Entrance, Paradise Road, and Paradise Valley Road to develop statistical relationships to estimate parking, traffic, and visitor use conditions at Paradise, based on traffic count data at the Nisqually Entrance, weather conditions, and seasonal factors. Further, focus should be on disseminating real-time information and forecasted conditions to home computers, smart phones and tablets, HAR’s, and DMS’s. The importance of this would be particularly pronounced if NPS adopted a policy to prohibit overflow parking on Paradise Valley Road.
   
ii. Mount Rainier National Park should focus on completing deployment of RTMS systems at the Nisqually Entrance, Paradise Road, and Paradise Valley Road first, and network, communications, and software capabilities to collect and disseminate real-time information and likely near-term future conditions regarding traffic, parking, and visitor use in the Nisqually Corridor and at Paradise. The information should be broadcast to a range of outlets, to provide information to potential visitors as early in their trip planning process as possible. For example, internet outlets should be used to disseminate information to the public before they depart for MORA, and regional information centers/tourist businesses should serve as outlets for visitors en route to MORA who might choose an alternate destination based on real-time parking and traffic information. This should be completed before deploying RTMS systems elsewhere in the park.
   
iii. MORA should promote a diverse community of internal (MORA staff) users of the MORA RTMS data and TMC software for applications in visitor information, transportation planning and management, visitor use management and resource protection, public and employee safety, and law enforcement. In addition, real-time information and estimated traffic and parking conditions should be disseminated to “external users” (e.g., WSDOT, US Forest Service, etc.) as a part of statewide ITS systems deployment and for application at Regional Traveler Management Centers.

c. **Description of the Proposed System.**
   
i. The Operational Environment. The operational environment for ITS deployment in MORA is very challenging. The park is centered on an active volcano, in a remote and isolated part of the state of Washington. There have been no substantive increases in NPS financial and/or human resources available for ITS deployment at MORA since the 2007 MORA ITS Technical Report, and consequently no notable opportunities for expanding the approach outlined in 2007. Moreover, financial resources are expected to be constrained in out-years. Safety and security incidents in MORA resulting in loss of life in 2012 reinforced the need to re-address communication difficulties inherent in mountainous areas that are subject to historic and wilderness restrictions on types of development. On a positive note, national policies to address the digital divide in communications infrastructure between rural and urban regions were addressed in
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Washington State and across the nation with the 2009 American Recovery and Reinvestment Act through the construction of fiber optic broadband network. In addition, since the 2007 MORA ITS Technical Report was completed, computer network hardware and software have increased data transmission speeds for data and video at little or no increase in cost.

ii. Sub-Systems

1. Physical Facilities. As noted, as part of the MORA ITS planning effort in 2007, NPS assessed existing infrastructure and the feasibility of upgrading or installing new infrastructure required to support MORA ITS systems (Table 3). The park’s ITS-related infrastructure has not substantially changed since the 2007, with one notable exception. Road construction is scheduled for the Nisqually Road between the Nisqually Entrance Station and Longmire during 2014 and 2015, and from Longmire to Paradise during 2016 and 2017. As part of the project, conduits and vaults will be installed within the Nisqually Entrance to Paradise Road corridor which will provide the pathway for future upgrades to fiber-optics in this area of the park. Future ITS communications require high-speed Internet that is 10 times faster than is currently available in common 2 megabit per second (mps) with latency of 1 second or less. The fiber optic cable deployed at MORA can accommodate 1 gigabit per second with a latency of a millisecond or less and support the future ITS hardwired needs and wireless capabilities of dedicated short range communication (DSRC) for ITS infrastructure.

2. Hardware and Software

   a. Computer hardware and software have significantly improved since the development of the 2007 MORA ITS Technical Report. Advances in hardware and software will improve the NPS’ capacity for ITS applications in MORA, where the communications infrastructure exists to support their use. Similarly, computers have considerably more processing power, and storage media have become much less expensive when compared to 2007 costs and performance capabilities. Computer operating systems have improved in reliability and performance (e.g., MS Windows 7 corrected many of the problems of MS Vista). Microsoft’s applications suite (MS Office 2010) contains major user improvements and upgrades Web-based applications that make much more achievable the software development task for what was referred to in the 2007 MORA ITS Technical Report as the MORA ITS GUI. On the consumer-side, there have been substantial advances since 2007 in the use of relatively inexpensive smart phones and tablets for travel planning and en-route trip planning with real-time data.

   b. Standards for outdoor WiFi networks are evolving to orders of magnitude increases in capacity for transmitting data and video for real-time trip planning. When the 2007 MORA ITS Technical Report was completed, the WiFi standards were IEEE 802.11 a, b, and g (Table 7). These standards had serious speed and geographic limitations for wireless communication of web
camera images and other real-time data. Pending approval, IEEE 802.11 ac and ad standards will be available on the market (Table 7). These new WiFi networks and associated broadband communication improvements will provide extraordinary capacity for communicating real-time traveler information from MORA’s web cameras and RTMS systems, within the constraints of MORA’s geography, and National Historic Landmark District and Wilderness management policies.

### Table 7. WiFi/WiGig Technology Comparisons

<table>
<thead>
<tr>
<th></th>
<th>802.11a</th>
<th>802.11b</th>
<th>802.11g</th>
<th>802.11n</th>
<th>802.11ac</th>
<th>802.11ad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year Adopted</strong></td>
<td>1999</td>
<td>1999</td>
<td>2003</td>
<td>2009</td>
<td>Pending</td>
<td>Pending</td>
</tr>
<tr>
<td><strong>Radio Frequency</strong></td>
<td>5GHz</td>
<td>2.4GHz</td>
<td>2.4GHz</td>
<td>2.4 or 2.5GHz</td>
<td>5GHz</td>
<td>60Hz</td>
</tr>
<tr>
<td><strong>Band</strong></td>
<td>20MHz</td>
<td>20MHz</td>
<td>20MHz</td>
<td>20 or 40MHz</td>
<td>80 or 160MHz</td>
<td>7GHz</td>
</tr>
<tr>
<td><strong>MIMO Streams</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Up to 4 Streams</td>
<td>Up to 8 streams</td>
<td>&gt;10</td>
</tr>
<tr>
<td><strong>Maximum Data Rate</strong></td>
<td>54Mbps</td>
<td>11Mbps</td>
<td>54Mbps</td>
<td>600mbs</td>
<td>1Gbps</td>
<td>7Gbps</td>
</tr>
<tr>
<td><strong>Approximate Indoor/Outdoor Range</strong></td>
<td>115/390 feet</td>
<td>125/460 feet</td>
<td>125/460 feet</td>
<td>230/820 feet</td>
<td>90 feet/NA</td>
<td>&lt;15 feet/NA</td>
</tr>
</tbody>
</table>

3. **Staffing.** MORA was established in 1899, and correspondingly has a very mature organizational structure with the staff development capabilities necessary to meet the challenges of managing a ‘crown jewel’ unit of the National Park System. However, transportation planning and operational needs transcend all divisions, and this creates the need for a ‘Transportation Planner/Manager’ position to oversee and coordinate the deployment and management of a comprehensive transportation system across divisions with existing staff. This position would have comprehensive responsibility for the entire transportation program at MORA that would include ITS as one component of the overall program. This position could probably be a 10-month subject-to-furlough position and could be funded via a transportation fee increase to the park entrance fee. In addition, an initial organizing framework was implicitly introduced as part of the process of planning the MORA ITS stakeholder workshop that was conducted in October, 2012, and included the following groupings of stakeholders (Note: the below list is incomplete, in that it does not specify the MORA Management Team, and may also exclude other key stakeholders who were not able to attend the October, 2012 stakeholder workshop).

a. **MORA Compliance – Internal Stakeholders**
   i. Barbara Samora, Biologist
   ii. Sueann Brown, Historical Architect
   iii. Greg Burtchard, Archaeologist
iv. Karen Thompson, Environmental Protection Specialist

b. MORA IT/Telecommunications/GIS – Internal Stakeholders
   i. Darrin Swinney, IT/Telecom/GIS Program Manager
   ii. Casey Hicks, Radio Shop Manager

c. MORA Operations (Visitor Information) – Internal Stakeholders
   i. Patti Wold, Interpretive Media Specialist
   ii. Kristyn Loving, Web and News Media Manager
   iii. Curt Jacquot, Interpreter – HAR Recordings Manager
   iv. Patty Klump, Human Resources Officer (NOTE: Patty Klump is included as an internal stakeholder because she supervises the front desk staff at Tahoma Woods who answer the public-listed phone number for MORA)
   v. Lee Snook, Acting Chief of Interpretation

d. MORA Operations (Maintenance) – Internal Stakeholders
   iii. Eric Walkinshaw, Civil Engineer/Project Manager
   iv. Aaron Bougie, Electrician

e. MORA Operations (Visitor Protection) – Internal Stakeholders
   i. Chuck Young, Chief Ranger
   ii. Debbie Hannevig, Fee Operations Manager
   iii. Kraig Snure, Wilderness District Ranger
   iv. Jordan Mammel, Park Ranger

Table 8 provides an update to the staffing assignments specified in the 2007 MORA ITS Technical Report for deployment, operations, and maintenance of ITS in MORA. It is important to note the substitution of the concept of a “virtual” MORA TMC in the 2013 MORA ConOps for the ITS GUI recommended in the 2007 MORA ITS Technical Report. Moreover, it is important to emphasize the importance of seeking partnership support from FHWA, WSDOT, and other key partners, as noted in a subsequent sub-section.
## Concept of Operations for MORA ITS

### Table 8. 2007 Staff Roles and Responsibilities for MORA ITS Deployment, Operation, and Maintenance

<table>
<thead>
<tr>
<th>Phase</th>
<th>ITS Component</th>
<th>Lead and Supporting Responsibility</th>
</tr>
</thead>
</table>
| **Purchase and Deployment** | **HAR – Permanent Sites**                           | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Electrical Shop and Compliance                                                       |
| **Purchase and Deployment** | **Real-time Traffic Counters and Web Cameras**      | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Electrical Shop and Compliance                                                       |
| **Purchase and Deployment** | **Local Area Networks**                             | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Electrical Shop and Compliance                                                       |
| **Purchase and Deployment** | **Software Applications for MORA TMC**             | Lead: MORA IT/Telecommunications/GIS Program  
Support: Consultant/Contractor, MORA Visitor Protection and Interpretation Divisions, WSDOT ITS Division, FHWA |
| **Purchase and Deployment** | **Mobile HAR/DMS Units**                            | Lead: MORA Visitor Protection Division  
Support: MORA IT/Telecommunications/GIS Program and Electrical Shop                                  |
| **Operation**          | **HAR – Permanent Sites**                           | Lead: MORA Interpretation Division  
Support: MORA Visitor Protection and Resource Management Divisions, and MORA IT/Telecommunications/GIS Program |
| **Operation**          | **Mobile HAR/DMS Units**                            | Lead: MORA Visitor Protection (placement)  
and Interpretation (messaging) Divisions  
Support: MORA IT/Telecommunications/GIS Program and Resources Management Division                    |
| **Operation**          | **Software Applications for MORA TMC**             | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Visitor Protection, Interpretation, and Resource Management Divisions, WSDOT ITS Division, Inter-agency Information Center Staff, Consultant/Contractor |
| **Maintenance**        | **HAR – Permanent Sites, Mobile HAR/DMS Units**    | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Electrical Shop                                                                       |
| **Maintenance**        | **Real-time Traffic Counters, Web Cameras, and Local Area Networks** | Lead: MORA IT/Telecommunications/GIS Program  
Support: MORA Electrical Shop and Radio Shop                                                          |
| **Maintenance**        | **Software applications for MORA TMC**             | Lead: MORA IT/Telecommunications/GIS Program  
Support: Consultant/Contractor                                                                        |
4. Operational Procedures
   a. As noted in the Forward to the 2013 MORA ConOps, the scale of the ITS Systems Engineering process at MORA should be commensurate with the scope of the ITS projects NPS chooses to pursue (see the Systems Engineering “V” Diagram in Figure 1 of the Forward to the 2013 MORA ConOps). For example, the scale of the ITS Systems Engineering process would necessarily be more substantial if NPS chooses to pursue major interagency infrastructure capital improvements as a significant service-wide initiative, such as extending the U.S. Department of Commerce’s Rural Broadband Initiative to MORA, than if NPS focuses on “local, stand-alone” projects only.

5. Other Support Necessary to Operate MORA ITS
   a. Management Team – To sanction and create a high priority for deployment, operations, and maintenance of ITS recommendations in the 2007 MORA ITS Technical Report and 2013 MORA ConOps. Specific actions to support this include assigning ITS-related staff roles and responsibilities, establishing a “virtual” MORA TMC, and using MORA ITS information, products, and services in daily management decision support.
   b. Human Resources – To assist with staff issues relating to deployment, operations, and maintenance of ITS components specified in the 2007 MORA ITS Technical Report and re-emphasized in the 2013 MORA ConOps, and to the extent necessary, development of subsequent ITS Systems Engineering steps.
   c. Finance – To assist with budgeting resources for completing deployment, in a phased fashion, of ITS components recommended in the 2007 MORA ITS Technical Report and re-emphasized in the 2013 MORA ConOps; and, to assist with budgeting resources for ongoing operations and maintenance of ITS components, once deployed.
   d. Maintenance – To assist management and staff in providing reliable, real-time automatic data collection on highway and parking facilities, and the design and operation of dissemination capabilities (e.g. hardened and mobile HAR/DMS in extreme environmental conditions).
   e. Consultants – To facilitate subsequent steps of the ITS Systems Engineering process, as needed; and to create, test, and deploy the software for processing, archiving, analyzing, and disseminating real-time and historical RTMS and web camera data.

   d. **Modes of Operation**. Modes of operation are specified in Table 9, by MORA ITS application area.
Concept of Operations for MORA ITS

### Table 9. Modes of Operation for Proposed MORA ITS System.

<table>
<thead>
<tr>
<th>System Component</th>
<th>Modes of Operation</th>
</tr>
</thead>
</table>
| i. RTMS for Real-time Information and Likely Near-Term Future Traffic and Parking Conditions | 1. Cordon off the Paradise area with RTMS units installed on Paradise Road and Paradise Valley Road for real-time accounting of all inbound and outbound vehicle traffic at Paradise. Relocate the RTMS unit at the Nisqually Entrance Station, proximate to the inductive loop counters just east of the Nisqually Entrance Station for real-time accounting of inbound and outbound vehicle traffic at the Nisqually Entrance and correlation to Paradise vehicle counts.  
  2. Develop or apply algorithms within the TMC software to compare real-time vehicle traffic accumulation at Paradise (based on inbound and outbound traffic counts recorded by RTMS units on Paradise Road and Paradise Valley Road) to Paradise parking capacity.  
  3. Develop or apply algorithms within the TMC software to create a predictive model of parking availability at Paradise, based on correlations among vehicle accumulation at Paradise, inbound vehicle traffic counts from the RTMS unit at the Nisqually Entrance to MORA, time of day, day of week/holidays, and weather (local and/or Seattle/Tacoma area weather).  
  4. Disseminate real-time information about parking availability at Paradise and likely near-term future parking conditions (e.g., likely parking conditions at 10 AM, 12 PM, 2 PM, 5 PM of the current day) using Internet with links to a broad range of information outlets, including:  
    a. Multi-agency visitor centers  
    b. Local, regional and state tourist information web-sites  
    c. Local and regional hotels and restaurants  
    d. WSDOT 511 and website  
    e. Municipal 3-1-1 (if available)  
    f. Smart phone/tablet applications  
    g. Social media (e.g. Facebook and Twitter). |
| ii. Network Web Cameras for Real-time Information and Likely Near-Term Future Traffic and Parking Conditions | 1. Install web-cameras at unobtrusive locations that cover a representative majority of parking spaces at major venues (e.g., near the Jackson Visitor Center at Paradise).  
  2. Publish web camera images in near real-time (e.g., 60 second intervals for “up to the minute” parking information) using Internet with links to information outlets noted.  
  3. Use archived imagery to create time-lapse videos that depict parking conditions under various scenarios, for example, including: 1) peak visitation parking conditions visitors could expect to experience on a sunny summer weekend day; 2) off-peak visitation parking conditions visitors could expect to see during early morning hours or late afternoon/evening hours on a “typical” mid-week day; and 3) special circumstances, such as a sunny winter day with snow plowing operations clearing the Paradise parking lots and featuring/emphasizing road closings and safety considerations.  
  4. Publish the time-lapse videos of parking scenarios on YouTube™ and/or the park’s website as a TDM strategy to help shape visitors’ expectations and influence their pre-trip planning decisions. As an integral part of this TDM strategy, the time-lapse videos should be accompanied with information from NPS about alternatives to visiting Paradise and other popular park destinations during peak hours of peak days; some examples include: 1) providing a scenic auto touring guide to encourage some visitors to drive through the park without stopping at the most popular park destinations, but instead stopping at lesser used scenic overlooks [Inspiration Point, for example]; 2) informing visitors of less popular but rewarding destinations at MORA; 3) encouraging trips to other regional destinations, such as the Chinook Scenic Byway and Crystal Mountain in the Mt. Baker-Snoqualmie National Forest; and 4) linking to alternative activities in the MORA region via a 5-1-1 or 3-1-1 type web site/phone system with state and local partners. |

Concepts for Proposed System 29
Table 9. Modes of Operation for Proposed MORA ITS System.

<table>
<thead>
<tr>
<th>System Component</th>
<th>Modes of Operation</th>
</tr>
</thead>
</table>
| iii. Permanent HAR and Mobile HAR/DMS Units | 1. Locate permanent HAR sites to provide timely visitor information that is geographically relevant to the transmission site and can be transmitted within the range of the transmitter. If aesthetic, historical, cultural, and/or Wilderness resource considerations preclude the use of adequate transmission power or antenna configuration for a given HAR unit, it is recommended that the unit be installed outside of the park’s boundaries where aesthetic, historical, and/or Wilderness constraints may be mitigated.  
2. Use combination HAR/DMS mobile units (on trailers with self-contained power capabilities) to assist with managing traffic, parking, and visitor use during peak congestion periods and emergency situations. Because the units are not permanently installed, mobile HAR/DMS units have the advantage of not having long-term aesthetic, historical, cultural, and/or Wilderness resource impacts. As with the permanent HAR sites, the messages conveyed via mobile HAR/DMS units have to be carefully crafted to conform to the advantages and limitations of the medium (relatively short audio for the HAR and short LED messages for the DMS) and the geographic relevance of the message. Mobile HAR/DMS units do not, and should not, be deployed for long periods in the same location; rather, they should be deployed for predictable peak visitation periods and emergency management situations and the multi-media messages should be crafted according to the particular situation. Candidate locations for use of HAR/DMS mobile units include on approach to Ashford, WA and/or the Nisqually Entrance, and on approach to the White River Entrance; however, the units should be deployed according to emergent needs.  
3. Using the TMC software system, real-time RTMS and web camera data should be used to “trigger” near real-time changes to the messages conveyed via permanent HAR units and mobile HAR/DMS units as part of the system of information outlets used to inform visitors of parking conditions in the park (at Paradise, specifically, in the first phase of MORA ITS deployment). |
| iv. Software Applications for MORA TMC | 1. Establish a “virtual” MORA TMC on the park’s intranet with software applications to process, archive, analyze, and disseminate real-time and historical ITS data flows from MORA-owned and operated data collection devices (i.e., RTMS units and web cameras) to support the flow of data as depicted in Figure 5.  
2. In addition, establish the TMC to develop and apply software applications to leverage MORA ITS to support all MORA management and operational functions. For example, develop algorithms to correlate real-time and/or historical traffic count data from RTMS units with visitor use densities, crowding, and crowding-related capacities on the Paradise Meadow trails and other visitor destinations. Software applications for the MORA TMC should be maintained by the MORA IT Division, but accessible to all MORA functional units.  
3. Encourage development of smart phone apps by providing to developers free real-time data feeds and archives via TMC data archives and software applications. |

e. User Types and Other Involved Personnel.  
i. User types for MORA ITS applications specified in the 2013 MORA ConOps have been identified through the development of the 2007 MORA ITS Technical Report and during planning for the October, 2012 MORA ITS stakeholder workshop.  
ii. The user types for the MORA ITS applications specified in the 2013 MORA ConOps are organized into the following functional areas:  
1. MORA Office of the Superintendent (including Information Technology, Community Planning, Environmental Compliance, and Concessions Management)  
2. MORA Visitor Protection Division (including Emergency Management)  
3. MORA Interpretation Division  
4. MORA Information Technology Division
5. MORA Maintenance Division
6. MORA Resources Management Division
7. MORA – Environmental Compliance

iii. The user types included

1. Internal MORA users
   a. MORA Superintendent, Deputy Superintendent, IT/Telecon Staff, Community Planner, Environmental Protection Specialist, and Concessions Manager
   b. MORA Chief Ranger, District Rangers, Law Enforcement and Wilderness Management staff
   c. MORA Facilities Management staff
   d. MORA Natural, Cultural, and Historical Resource Management staff
   e. MORA Interpretive Rangers and Visitor Use Assistants

2. External MORA users
   a. Intergovernmental partners
      i. Federal
         1. NPS, Pacific West Region
         2. NPS, Denver Service Center
         3. US Forest Service
         4. FHWA, Western Federal Lands Highway Division (WFLHD)
         5. FHWA, Washington Division, ITS
         6. Multi-agency visitor centers
      ii. State
         1. WSDOT, ITS Division
         2. WSDOT, Olympic Region
         3. WA State Travel and Tourism Offices
         4. University of Washington, Intelligent Transportation Systems Research Center
      iii. Local
         1. County Governments in MORA region
            a. Pierce County Highway, Transit, and Planning Divisions
            b. Yakima County Highway, Transit, and Planning Divisions
            c. Lewis County Highway, Transit, and Planning Divisions
         2. Washington municipalities in MORA region
            a. Local Municipality Highway and Planning Divisions
            b. Local Municipality Tourism Offices
   b. Private Partners
      i. Major private outdoor recreation and tourist destinations (e.g., Crystal Mountain Ski Resort and White Pass Ski Resort)
      ii. Visit Rainier
      iii. Mount Rainier Visitors Association
      iv. Destination Packwood
      v. Tacoma Convention and Visitors Bureau
vi. MORA gateway community Chambers of Commerce
vii. Northwest Open Access Network (NoaNet) providing “middle mile” fiber optic cable broadband in Pierce, Yakima and Lewis Counties
viii. Microsoft Corporation
   1. Microsoft Research
   2. Bing Maps and Bing Search
c. MORA visitors, including potential visitors considering a trip to the park, and actual visitors en route to, arriving at, and in the park.

f. **Support Environment.**
   i. State – It is recommended that state-level support and coordination for MORA ITS be sought by MORA from the following:
      1. WSDOT: To share technical capacity and capabilities for statewide communication, operations, and maintenance of historical highways. To link with the WSDOT 511 system and website as an outlet for traffic, parking, visitor use, and weather conditions in MORA.
      2. Washington State Department of Commerce (WSDOC): To coordinate MORA ITS efforts with state-level initiatives for developing the outdoor recreation and tourism-related economy. In addition, WSDOC is the state agency responsible for “last mile” application of the $80 million dollar rural broadband infrastructure economic stimulus project.
      3. University of Washington’s Intelligent Transportation System Research Center: To focus faculty and student research projects on MORA as a potential “study site” for studies to develop TDM technologies and applications.
   ii. Local – It is recommended that NPS seek support from and coordination with local universities and colleges, local regional school districts, and regional healthcare facilities that are current beneficiaries of the rural broadband investments. In addition, it is recommended that NPS seek support from and coordination with local and regional chambers of commerce and other industries that represent the outdoor recreation and tourism-related economy.
   iii. National and Regional (Interstate) – It is recommended that NPS seek support from and coordination with national and regional interagency organizations (e.g. USDOC, Broadband Technology Opportunities Program) to pursue “last mile” fiber optic broadband for outdoor recreation and tourism destinations as part of an international tourist economy similar to the successful model linking health care and educational institutions with “middle mile” fiber optic broadband.
6. Operational Scenarios Related to High Priority Park Needs/Operational Policies. The following operational scenarios are designed to illustrate the ways in which the proposed MORA ITS system can help MORA achieve its management objectives, with specific focus on congestion management, visitor use management, public safety, and operations and maintenance.


i. Scenario 1. Larry is a graduate engineering student from Boston who has just arrived in Seattle and is settling in for the fall semester at the University of Washington (UW). An early riser, Larry is up on Labor Day at dawn watching a spectacular sunrise from his dormitory window. Larry’s dorm room has a spectacular view of Mount Rainier, and with the mountain in full view, Larry decides he has to go there today. Larry checks his smart phone application on traveling to outdoor recreation destinations in the Pacific Northwest and finds a WSDOT/NPS application that encourages you to “Know Before You Go” and has a page specifically about trip-planning for visits to MORA, including real-time information and expected traffic, parking, and visitor use conditions at popular destinations in the park. On the MORA website are a series of videos that show the parking lot at the Paradise Visitor Center during peak visitation on a sunny summer weekend day or holiday, and during off-peak periods that generally occur on weekdays, and particularly during early morning and late afternoon/evening hours. Each video is a compilation of individual web camera images, each with a date and time stamp. From the video of a sunny summer weekend day or holiday, Larry realizes that the parking lots at Paradise are likely to be full by as early as 9:00 AM or 10:00 AM and will not start to empty out until about 4:00 PM, or later. Larry figures he can grab his camera and hiking gear, have breakfast, and get to MORA by about 8:30 AM, if he gets going now. This will set him up to find a place to park at Paradise, get a hike in on the trails in Paradise Meadow, and be back to campus by late afternoon to prepare for classes tomorrow.

ii. Scenario 2. Sunhay, a UW undergraduate art student from Vermont is sleeping in the same dorm a few floors below Larry this Labor Day morning. When she gets up it is about 10:00 AM. Friends told Sunhay that MORA has a great website, with incredible real-time web camera images of various locations in the park. Remembering this, Sunhay has a look at the MORA website and quickly realizes from the real-time parking information and web camera images for Paradise that she won’t find a place to park there, and would be better off making another plan. Sunhay knows that it will be a spectacular sunset that evening with the mountain turning pink with the setting sun when viewed from the west – a perfect project for her photograph class. Looking at the MORA website, she finds information from the NPS about other outdoor recreation areas in the MORA region, including a park in Eatonville, WA where she can get some great shots of the mountain. Sunhay has a leisurely lunch at the dorm with friends, after which she organizes her cameras and tripods, and heads for Eatonville.

b. Visitor Use Management Scenarios.

i. Scenario 3. A software system has been selected, purchased, and deployed for the MORA TMC. Alex, an analyst within MORA’s IT Division, has configured the software
to receive data feeds from the RTMS units at the Nisqually Entrance, and on Paradise Road and Paradise Valley Road, and process them through algorithms that compute vehicle accumulation and corresponding parking availability at Paradise, in real-time. Alex has further configured the software to relay data about real-time parking conditions to “trigger” changes in the messages conveyed on the permanent HAR’s at Tahoma Woods and the Nisqually Entrance, the park’s website, and the “Know Before You Go” smart phone app to inform visitors at various stages of their trip-planning and travel to MORA of the parking conditions they can expect, if they choose to visit Paradise. In conjunction with the “rollout” of Alex’s applications of the TMC software for real-time traffic dissemination, a NPS contractor has designed and is administering an evaluation study to assess the effects of the real-time traffic and parking information on traffic, parking, and visitor use conditions at Paradise and other areas in the Nisqually Corridor. Moreover, a visitor survey is administered in conjunction with the launching of the TMC software application to assess the extent to which visitors know of, use, and adjust their plans based on the real-time traffic information provided via the various information outlets. The results of the evaluation suggest the system is effective in reaching visitors and helping to inform their trip planning decisions, and there is a corresponding decrease in the number of visitors who have difficulty finding a place to park at Paradise and who choose to travel to Paradise during the busiest hours of the day.

ii. Scenario 4. Millie, a visitor use management and resource protection specialist in MORA’s Resources Management Division, has been tasked with assessing the effectiveness of TDM measures to address parking congestion and visitor crowding in MORA. The MORA TMC serves as, among other things, a source for real-time and archived vehicle traffic count data recorded by the RTMS units installed at the Nisqually Entrance, and on Paradise Road and Paradise Valley Road. Millie is able to access the TMC data via the web-based, intranet user interface, and begins to browse the data files for what she needs. Millie finds within the TMC data archives a three year history of time-stamped vehicle traffic count data and corresponding hourly weather data. Using these data, and statistical models developed by a NPS contractor that correlates traffic counts to visitor use densities on trails in Paradise Meadow, Millie is able to estimate crowding-related capacities for Paradise Meadow trails that specify the maximum number of vehicles per day that can enter the park at the Nisqually Entrance without causing levels of crowding that exceed the park’s standards. Millie prepares a briefing document for the MORA Management Team, and a decision is made about the park’s capacity to accommodate visitation at Paradise, beyond which TDM measures, and potentially other more restrictive measures would be implemented to maintain NPS management objectives.

   i. Scenario 5. In this scenario, the western slope of Mount Rainier has received two feet of snow overnight and the MORA snow plows are preparing to clear the road from Longmire to Paradise. Jim, the Law Enforcement Ranger on duty, knows the gate on
the Nisqually Road at Longmire is locked to prevent cars from coming driving up the mountain and interfering with the snow removal operations. However, a local Boy Scout troop that finished working on their winter camping merit badge overnight has returned to their parked van at Paradise and has no idea that there are snow plows about to begin clearing the road. Fortunately, Jim has temporarily positioned a mobile HAR/DMS unit at Paradise, in anticipation of the weather event and subsequent snow plowing. Now that the weather has arrived and the snow plows are preparing to clear the roads, Jim starts the mobile HAR/DMS remotely and runs the radio spot and LED message that lets the Boy Scout troop know the road is closed until snow plowing operations are complete. When dispatch informs Jim that the road is plowed, he changes the messages on the mobile HAR/DMS unit remotely and the scouts know they are good to go.
7. **Summary of Impacts**

a. **Operational Impacts.**
   
   i. Deployment of the recommendations in the 2007 MORA ITS Technical Report and the 2013 MORA ConOps will help MORA shift from reactive management of traffic and parking congestion to proactive strategies to influence visitors’ trip planning and corresponding conditions in the park. It is expected that the MORA ITS will better position MORA to manage congestion, protect park resources, and promote high quality visitor experiences.

   ii. Deployment of the recommendations in the 2007 MORA ITS Technical Report and the 2013 MORA ConOps support indicator-based adaptive management to achieve NPS management objectives for NPS, as stated in the MORA GMP.

b. **Organizational Impacts.**

   i. Deployment of the recommendations in the 2007 MORA ITS Technical Report and the 2013 MORA ConOps will ultimately support and improve all management and operational functions of NPS staff at MORA.

c. **Impacts during Development.**

   i. By definition, MORA is home to a diverse array of cultural, historical, and natural resources. Furthermore, one of the primary reasons visitors come to MORA is to enjoy the park’s scenic views while driving on park roads. Consequently, development of any nature, including deployment of the recommendations in the 2007 MORA ITS Technical Report and the 2013 MORA ConOps, can have substantive impacts to park resources and the quality of visitors’ experiences in MORA. Moreover, the park roads themselves are integral to the historical fabric of the park’s National Historic Landmark District (NHLD), and the park’s designated Wilderness boundaries extend within close proximity of the road corridors. The presence of modern, permanent human-made structures directly conflicts with the historical and Wilderness character NPS is mandated to preserve in the park’s NHLD and designated Wilderness, respectively. Therefore, deployment of the proposed MORA ITS system must be conducted in a context-sensitive manner, and must first be approved through environmental compliance processes. For example, installation of a RTMS unit on Paradise Valley Road, which is the park’s oldest and most historic road, would require a detailed compliance process. If installation of the RTMS unit on Paradise Valley Road is permitted, the unit must be installed in an inconspicuous place and camouflaged. Other devices included in the proposed MORA ITS system, such as the RTMS traffic counter at the Nisqually Entrance, require trench digging for power and connectivity, and this too requires compliance. Similarly, antennae used to broadcast HAR signals must be installed with minimal or no intrusion on the scenic landscape, particularly for the HAR units installed in the park. While the potential for impacts during development of the proposed MORA ITS system to park resources and visitors’ experiences is real, it is anticipated the proposed projects can be implemented in a manner that minimizes these impacts to an acceptable degree. To do this, it will be necessary to complete environmental compliance for these projects, and work in
collaboration with park staff who are responsible for reviewing and approving compliance requests.

d. **Measuring the Impacts** (i.e., Validation Plan) – It is recommended that MORA develop and implement a system to evaluate the effectiveness of the ITS applications deployed. At a minimum this system should include:

i. Analysis of RTMS traffic count data and corresponding Paradise parking demand before and after implementation of real-time traffic and parking information services for visitors.

ii. A visitor survey administered in conjunction with the initial operation of the ITS components to assess the extent to which visitors know of, use, and adjust their plans based on the real-time traffic information provided via the various information outlets. A draft visitor survey designed as a potential MORA ITS evaluation tool is included in Appendix C. The draft survey instrument in Appendix C is the result of a preliminary effort to adapt ITS evaluation survey instruments administered at other national parks to evaluate MORA ITS. It is anticipated that the survey instrument will require additional refinements to meet MORA’s specific circumstances and needs. Moreover, the survey instrument must be reviewed and approved by the Office of Management and Budget (OMB) before it can be administered.

iii. Long-term monitoring of traffic, parking, and visitor use conditions at Paradise and other key destinations, via RTMS counter data and periodic visitor counts and surveys. In addition, periodic parking counts should be conducted in parallel with vehicle traffic data collection via RTMS to verify and validate the correlations estimated with MORA TMC software applications between RTMS traffic counts and parking demand at Paradise.

iv. Monitoring and analysis of ITS-related webpages on the MORA website.
8. **Analysis of the Proposed System.** The 2013 MORA ConOps provides an update to the concepts and recommendations presented in the 2007 MORA ITS Technical Report. As part of this, the 2013 MORA ConOps has “downgraded” the scope of ITS deployment in MORA in the near term, to emphasize the importance of focusing on successful deployment, operations, and maintenance of a “stand-alone” system of RTMS, HAR, TMC software applications, and information outlets related to traffic, parking, and visitor use conditions in the Nisqually Corridor, with particular focus on Paradise. In the long term, the 2013 MORA ConOps provides initial direction and position for NPS to pursue major improvements service-wide in the global ITS deployment of connected vehicle technology and rural wireless broadband communications infrastructure.

a. **Summary of Improvements.**
   i. With the benefit of mass market economics, the hardware and software of wireless communications have dramatically reduced the cost of ITS applications recommended in the 2007 MORA ITS Technical Report and the 2013 MORA ConOps. Real-time traffic and web camera data can now be generated, processed, archived, and retrieved using relatively low-cost information technology.
   
   ii. Automated information dissemination through the Web to multiple outlets including RSS feeds on established traveler information portals, Facebook®, Twitter®, and emerging social networks substantially enhance the potential to inform and influence MORA visitors’ trip-planning and travel behavior.
   
   iii. The 2013 MORA ConOps envisions increased inter-governmental and inter-agency cooperation and coordination to share assets and capabilities, particularly for longer-term initiatives to develop wireless communication facilities in and outside MORA’s boundaries.
   
   iv. Public-private partnerships, particularly with Microsoft Research, private for-profit, and private non-profit wireless broadband utilities (e.g., NoaNet) and the state of Washington’s University System can greatly increase the efficiency and effectiveness of ITS traveler information systems at MORA.

b. **Disadvantages and Limitations.**
   i. During peak periods, MORA experiences intensive levels of visitor use and parking demand that substantially exceeds parking capacities. Thus, the systems needed to disseminate information to visitors about traffic and parking issues must necessarily be developed, tested and deployed in real-time and under challenging conditions.
   
   ii. The initial focus of the proposed MORA ITS system is on managing traffic, parking, and crowding impacts of intensive visitation during peak periods. Consequently, less emphasis is placed in the description of the proposed MORA ITS system on applications to facilitate winter operations (e.g., snow removal, road closures, etc.). However, the technologies included in the proposed MORA ITS system would be readily adaptable to applications that support and facilitate winter operations and other park operations during non-peak periods.
   
   iii. Some of the potentially most effective ITS-related technology (e.g., fiber optic and wireless broadband) may be out of reach for portions of the approach routes to...
MORA, due to the park’s remote location and terrain. It is recommended that NPS adopt a service-wide policy to work aggressively with FHWA to advocate for NPS units to be “next in line” (after schools and hospitals) for connection to the NoaNet rural communications network as an economic stimulus initiative.

iv. The budgetary, organizational, and other constraints that have prevented much progress on deployment of recommendations in the 2007 MORA ITS Technical Report might persist and may, in fact, get worse with the constrained Federal fiscal environment, which is expected to persist in out-years.

c. Alternatives and Trade-offs Considered. In this section, three alternatives for the deployment, operations, and maintenance of MORA ITS are considered and the proposed system is re-iterated to provide a recommendation regarding the alternatives.

i. Alternative 1 - No Action: In this alternative, MORA ITS would be managed in its current state, as outlined in Section 3.C Description of the Current System. There would be one RTMS unit at the Nisqually Entrance, which would provide real-time and archived information about vehicle traffic entering and exiting the park at the Nisqually Entrance Station. However, RTMS units would not be installed on Paradise Road or Paradise Valley Road, and consequently, could not be used to provide visitors and potential visitors with real-time information about parking conditions at Paradise. The HAR units at Tahoma Woods, the Nisqually Entrance, and Paradise would be maintained, though no new HAR systems would be installed or purchased for other park locations.

Pre-trip planning information about parking and traffic conditions in MORA would be limited to real-time video feeds on the park’s website from web cameras at Paradise and Longmire. Information broadcast via the park’s existing HAR units could not be adapted based on real-time traffic data feeds from RTMS units in the park.

It is expected that in this alternative MORA’s ability to use ITS strategies to help manage parking and traffic congestion would be substantially limited, and these issues would be more likely to persist without the benefit of travel demand strategies that rely on providing pre-trip, en route, and in park traveler information to potential and actual park visitors.

ii. Alternative 2 - Targeted Implementation in the Nisqually Corridor of MORA: In this alternative, MORA would focus on low-cost, real-time information collection on traffic and parking status within the Nisqually Corridor, with focus on Paradise. In addition, focus would be on using traffic and parking data from RTMS systems at the Nisqually Entrance, Paradise Road, and Paradise Valley Road to develop statistical relationships to estimate parking, traffic, and visitor use conditions at Paradise, based on traffic count data at the Nisqually Entrance, weather conditions, and seasonal factors.

Network, communications, and Travel Management Center (TMC) software capabilities would be developed to collect and disseminate real-time information and
likely near-term future conditions regarding traffic, parking, and visitor use in the Nisqually Corridor and at Paradise. The information would be broadcast to a range of outlets, included home computers, smart phones and tablets, HAR’s, and DMS’s to provide information to potential visitors as early in their trip planning process as possible. For example, internet outlets would be used to disseminate information to the public before they depart for MORA, and smart phone apps, DMS, HAR, and regional information centers/tourist businesses would serve as outlets for visitors en route to MORA.

MORA would promote a diverse community of internal (MORA staff) users of the MORA RTMS data and TMC software for applications in visitor information, transportation planning and management, visitor use management and resource protection, public and employee safety, and law enforcement. In addition, real-time information and estimated traffic and parking conditions would be disseminated to “external users” (e.g., WSDOT, US Forest Service, etc.) as a part of statewide ITS systems deployment and for application at Regional Traveler Management Centers.

It is expected that in this alternative MORA ITS would substantively improve the park’s capabilities, with respect to managing parking and traffic congestion, public and employee safety, and visitor use in the Nisqually Corridor. However, other areas of MORA (e.g., Sunrise/White River, Carbon River, Ohanapecosh) would not benefit directly from the actions in this alternative. In fact, it is possible that a long-term consequence of limiting MORA ITS deployment to the Nisqually Corridor is that this strategy might simply shift congestion and related issues from the Nisqually Corridor to other areas of the park.

iii. Alternative 3 – Park-wide Implementation: In this alternative, MORA ITS would be deployed park-wide, rather than just in the Nisqually Corridor, and would have a focus on real-time information collection on traffic and parking status at key locations throughout all of the park. In addition, focus would be on using traffic and parking data from RTMS systems throughout the park to develop statistical relationships to estimate parking, traffic, and visitor use conditions at key visitor destinations (e.g., Paradise, Sunrise, White River, Carbon River) based on traffic count data at the Nisqually, Stevens Canyon, White River, and/or Carbon River Entrance Stations, weather conditions, and seasonal factors.

Network, communications, and Travel Management Center (TMC) software capabilities would be developed to collect and disseminate real-time information and likely near-term future conditions regarding traffic, parking, and visitor use in locations throughout the park. The information would be broadcast to a range of outlets, included home computers, smart phones and tablets, HAR’s, and DMS’s to provide information to potential visitors as early in their trip planning process as possible. For example, internet outlets would be used to disseminate information to
the public before they depart for MORA, and smart phone apps, DMS, HAR, and regional information centers/tourist businesses would serve as outlets for visitors en route to MORA.

MORA would promote a diverse community of internal (MORA staff) users of the MORA RTMS data and TMC software for applications in visitor information, transportation planning and management, visitor use management and resource protection, public and employee safety, and law enforcement. In addition, real-time information and estimated traffic and parking conditions would be disseminated to “external users” (e.g., WSDOT, US Forest Service, etc.) as a part of statewide ITS systems deployment and for application at Regional Traveler Management Centers.

It is expected that MORA ITS in this alternative would do the most to improve the park’s capabilities to manage parking and traffic congestion, public and employee safety, and visitor use throughout all of the park. Moreover, a park-wide approach to MORA ITS would help reduce the unintended consequences of focusing ITS deployment and corresponding travel demand management strategies on just one corridor of the park (i.e., shifting congestion and related issues from one area of the park to another). However, this alternative would require the greatest financial resources and time to implement.

iv. *Recommendation:* As implied by the proposed system in this document, it is recommended that MORA adopt a phased approach to implement *Alternative 3 – Park-wide Implementation.* In particular, it is recommended that the first phase of MORA ITS deployment should focus on implementing *Alternative 2 - Targeted Implementation in the Nisqually Corridor of MORA,* and subsequent phases should focus on extending ITS deployment to other areas of the park, including Sunrise/White River, Carbon River, Mowich Lake, and Ohanapecosh.
Appendix A. Workshop Meeting Notes

Mt. Rainier Intelligent Transportation Systems (ITS) Planning and Implementation: Summary of Workshop Notes

Wednesday October 10th and Thursday October 11th, 2012

Mt. Rainier National Park, Washington State

Summary of Opening Sessions

October 10, 2012: 8:30am-10:30am

Attendees: Bryan Bowden (MORA); Roger Andrascik (MORA); Lee Snook (MORA); Kraig Snure (MORA); Chuck Young (MORA); Lorant Veress (MORA); Sueann Brown (MORA); Randy King (MORA); Karen Thompson (MORA); Greg Burtchard (MORA); Darin Swinney (MORA); Debbie Hannevig (MORA); Curt Jacquot (MORA); Tracy Swartout (MORA); Patti Wold (MORA); Kristyn Loving (MORA); Bill Legg (WSDOT-HQ); Steve Kim (WSDOT-WA Div.); Nathaniel Price (FHWA-RC); James Coylar (FHWA-WA Div.); Laurie Miskimins (FHWC-CFLHD); Susan Law (FHWA-WFLHD); Steve Lawson (RSG); Brett Kiser (RSG); Larry Harman (Harman Consulting)

Confirmed SAIC High Priority Needs from 2007:

- Disperse use to off-peak times and locations
- Provide trip planning information to visitors
- Support shuttle service use and operations
- Support park communications and operations
- Help determine visitor capacity and congestion thresholds

Suggested ‘need’ additions included:

- Ensuring public and employee safety;
  - ITS can and is being effective in letting people know of road closures; work crews on road; chain requirements and chain-up areas; accidents or “bear jams”
  - Winter operations – could know how many visitors by road segment/zone

Suggestions for parameters/sideboards to how this whole process is done:

- Be mindful of financial constraints; approach in phases, bundles
  - Shuttle in particular
- Be clear on who will do what
- Take advantage, maximize approaches with tools already in place
- Incorporate businesses and tourism into our approaches more
- Identify most valuable investments;
What messages do they need before they get to the Park and what is still valuable or informative once they are here?

Do a great-job with the ‘before they leave their driveway’ information; that is the best opportunity to shift time of day and destination

Real-time information can be valuable and still provided as they approach the front door, but they are already here, so they are coming in, our strategies and messaging near the Park must account for that

- E.g., shuttle use; congested park destinations

Approach must be comprehensive; deal with all types, including those that will choose to ignore all the advice we give them; don’t forget the multi-day visitors

Need to consider the wide range of “audiences,” and how they receive information (e.g., social media, smart phones, “old school”)

- Absent an established cap/Park policy you can still try and persuade people to go elsewhere. Things can be done, messages communicated beyond just saying ‘it is closed’
- Need to have roles and responsibilities clearly defined; management team needs to adopt it and be invested/committed to getting those roles filled; direction and support to come from them
- The more that can be automated, the easier it will be to maintain

### Summary of Small Group Discussions

**Mid-Morning October 10th-Mid-day October 11 Small Group Discussions**

**Attendees:**

**Attended All Sessions:** Bryan Bowden (MORA); Susan Law (FHWA-WFLHD); Laurie Miskimins (FHWA-CFLHD); Steve Lawson (RSG); Brett Kiser (RSG); Larry Harman (Harman Consulting)

**Small Group #1 – WSDOT/FHWA:** Bill Legg (WSDOT-HQ); Steve Kim (WSDOT-Olympic); Nathaniel Price (FHWA-RC); James Coylar (FHWA-WA Div.)

**Small Group #2 – Compliance:** Barbara Samora (MORA); Sueann Brown (MORA); Karen Thompson (MORA); Greg Burtchard (MORA)

**Small Group #3 – Operations:** Curt Jacquot (MORA); Kristyn Loving (MORA); Lee Snook (MORA); Patti Wold (MORA)

**Small Group #4 – IT/Power/Communications:** Darin Swinney (MORA)

**Small Group #5 – Operations:** Daniel Camiccia (MORA); Debbie Hannevig (MORA); Chuck Young (MORA); Kraig Snure (MORA); Geoff Walker (MORA)
What is working? What is not? What is missing? What are the gaps? What are the needs?

The notes from these sessions are summarized into the broader topic areas that arose from the discussions.

HAR/TIS
- Currently done by dial-up phone; working to fix that; will be hooked up to computer, and use recorded sound wave.

- Tahoma Woods has limited coverage; would like the signal to get all the way to Elbe; working on higher antenna to help fix this

- Opportunity for WSDOT HAR (to be installed in Elbe for flooding messages) to broadcast other messages when flooding is not an issue; on a different frequency than T-Woods HAR, so not an issue of conflicting use of frequency

- In Winter, Paradise HAR unit only reset option is quite the endeavor (drive up, ski down, dig through snow):
  - If they don’t reset it, cannot record or send out a message
  - Power fluctuations, not hanging up properly when record a message, can create a need to go and reset it

- HAR used very little for real-time; Can it be used for this?

- Need more ways/methods to notify people to tune-in (earlier)

- Need to consider length of message; uncertain

- Need more standardization and protocols for messaging substance

- Observations on current messages:
  - T-Woods HAR: A good length relative to actual signal coverage on one HAR
  - Nisqually Entrance HAR: messages too long to be heard

- Questions about effectiveness of HAR; may be outdated, unless we can get it broadcast on mobile phones, etc...
  - Who is listening and who isn’t?

- First time visitors probably utilize and get more value from HAR than repeat visitors

- Message sets are recorded in checklist (Curt controls some, dispatch the other)
- HAR should concentrate on short-term immediate messages that could be effective. They have already made the decision to come, they are at the front door; what messages are most effective at that point?

- As part of the evaluation the effectiveness of the HAR needs to be assessed

- Potentially promote the scenic driving experience for visitors (market the NHLD) as an alternative to driving to and parking at Paradise.

### Traffic Counters

- Nisqually counter needs to be verified and calibrated; being collected in 15 minute intervals on the intranet

- Need to identify who needs to get counter information and who/how data is disseminated

- Could be very powerful for capacity and visitor management in the Park
  - Tool to optimize decisions or reasons to implement management techniques (including TDM strategies)
  - Trigger points, identify real-time information; and what will we do when we do reach a given trigger point or capacity?

- Need to install the 2nd RTMS counter (sewer plant on Paradise Road)

- Severe limitations to monitoring the back door (Valley Road and Steven’s Pass); and lacking the infrastructure to do it; power, communication etc...

<table>
<thead>
<tr>
<th>Location</th>
<th>PUSO</th>
<th>FOTSC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nisqually</td>
<td>X (daily/monthly counts)</td>
<td>X (very reliable data)</td>
<td></td>
</tr>
<tr>
<td>Stevens Canyon</td>
<td>N/A</td>
<td>X (although not working)</td>
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<tr>
<td>Ohanapecoh</td>
<td>X (daily/monthly)</td>
<td>N/A</td>
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<tr>
<td>Mather Wye</td>
<td>X (weekly)</td>
<td>X (although not working)</td>
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<tr>
<td>Carbon River</td>
<td>X (was daily, missing or not working)</td>
<td></td>
<td>Using estimates</td>
</tr>
<tr>
<td>Mowich</td>
<td>X (was daily, missing or not working)</td>
<td></td>
<td>Using estimates</td>
</tr>
<tr>
<td>Tipsoo Lake</td>
<td></td>
<td></td>
<td>Counter targeted for here, although not installed yet</td>
</tr>
</tbody>
</table>
- While multiple counters at some locations are valuable for validating data, need to also consider who manages them, who uses it and how

Cameras
- Park Cameras do not have web archive, cannot go back and look after the fact
- Cameras were not purposed for traffic or incident management in the beginning; the purpose and use of them has grown after installation
- Need better resolution on all cameras; plans are in place to do this at Nisqually entrance
- MORA Webcam page gets second most hits after home page (~1 million/ a month or year?)
- Look at opportunities to get webcams up/out/displayed in other venues (WSDOT, Visitor Centers downstream)

Power and connectivity
- Cell phone towers in the Park:
  - A report came out after Margaret Anderson was murdered; towers were mentioned as a priority for public safety
  - On top of existing structures would be most ideal
  - IT staff says there is some likelihood of localized cell phone towers at Paradise in next 3 years; subject to overcoming compliance issues MORA is engaging in conversation with Verizon on this subject and Verizon is very interested in providing cell phone coverage at Paradise.
  - Small cell opportunity? Would serve more than one provider. Larry’s lab has been working on it.
- Nisqually Corridor:
  - Fiber conduit to be installed in Nisqually corridor roadway sometime between 2014 and 2015
  - Need right fiber breakouts in the FLH project to make it most useful to Park (talk to Eric Walkinshaw about where design is at for these); these locations have already been identified, according to Randy King, so it is too late to identify new locations for fiber breakouts other than those already included in the plans for the roadway project
  - Nisqually RTMS counter; IT sent us the data to validate against PUSO and FOTSC.
- Paradise:
  - Living on 1T1 at Longmire and Paradise; suffer bandwidth shortages in peak season
  - Installing Park wide Wi-Fi this summer; most major buildings have it; not open to the general public
Concept of Operations for MORA ITS

- Cameras at Paradise only approved (compliance only done) for installation in the interior of buildings, not on their exteriors, and this is also preferred from a Maintenance perspective.

- LAN up at Paradise

- Current connectivity at Paradise is not strong enough for more than internal Park use; they would need a much larger tower/equipment to get a strong enough signal to provide connectivity to a larger population. Large amounts of visual equipment will not be easy to install from a compliance standpoint.

- Sunrise

  - Summer 2013 to improve connectivity to Sunrise; will try point to point from Crystal Mountain (Darrin Swinney noted in his review comments for the 2013 MORA ConOps that these efforts are no longer feasible in the specified timeframe due to funding and technical challenges)

  - Currently Sunrise on slow satellite; Carbon River is also black hole (Darrin Swinney noted in his review comments for the 2013 MORA ConOps that Carbon River does have satellite network similar to Sunrise)

- Steven’s Canyon:

  - Steven’s Canyon entrance; limited existing power supply to support any ITS technology, satellite not really possible; solar only;

  - There is phone line, but poor connection. Currently Park, IT gets the phone line working. Fee is responsible for reading and reporting count data; important from a PUSO perspective; however Fee register data still important from a perspective to identify non-rec versus rec entries.

- Point to Point up to Camp Muir; but need staff present to manage

- Plans to support Camp Schurman

- LAN for public not planned. There has been talk through concession contract to provide it. Currently in theory they could open up current networks to public, BUT really could not support public traffic on the existing network.

Road/Public Safety: Winter Operations

- Numerous ways they manage snow and roads here that differ from the rest of what the public experiences out there; the more they can remind the public about this, the better

- There may be opportunity to integrate road condition information into Google and notify people, on their way to MORA, via the web of hazards; road conditions
- Radio communications about road conditions go to dispatch and down to fee station
  
  o This information is also relayed to the chain control/chain-up areas outside of the Park, who can then notify visitors

- Safety on the road between Longmire and Paradise is huge concern; overnight visitors coming down road in morning while plow going up = safety issue
  
  o At least a flashing light up top to say ‘when flashing don’t go down the road;’

- Avalanche dangers are another safety issue they need to be able to warn the public about; there are specific avalanche danger locations

White River Entrance/Sunrise Operations

- Electronic/flashing VMS that park recently bought could be used over there; currently not working
  
  o If possible, adding a HAR to this unit and using it to inform visitors when there will be a wait at the WR entrance might be ideal

- Need to get a better understanding of what goes on (traffic wise) when they hold cars at the entrance station when parking is full at Sunrise. Data on these events (record dates and times already) exist, but not understanding of percentage/number of turnarounds, or a lot known about wait times for visitors. Estimate the closure is about 2-3 hours; maybe 10% turn around, although most stay with ranger explanation. Some visitors wait up to 1 + hours before they are allowed to enter and drive to Sunrise.

- White River closure regular enough to warrant getting that info out early enough. The VMS with HAR added might be a good way to do this. Would be good to do it even before enter the park, too, when people still have the option to go to Crystal Mtn or other destinations instead

- Crystal Mountain would be an excellent alternative to promote when road to Sunrise closes

- When road access to Sunrise is metered, it is the rate of flow allowed in that changes; not a one car out one car in. Generally allow 10-20 cars every 10-20 minutes. This figure is based on ranger observations.

Compliance; Operating with NHLD

- 30 foot corridor on both sides of road centerline are NHLD; beyond this is all wilderness; MORA General Management Plan, page 167 confirms the 30 foot corridor measurement.

- Does not prohibit doing projects or adding infrastructure; but projects must be compatible and camouflaging can be an important part of this
- Detailed traffic data will be very useful for future projects, funding requests, and compliance work

- There is more use for trail data but good traffic data could be utilized to derive trail usage

- Wilderness Plan does describe actions (when X we will do X), but currently not being implemented

- Dynamic/flashing signs inside the Park would be extremely difficult to implement; not a great fit inside this Park; outside the Park they are a great idea

- Cumulative effects are the bigger issue when we talk about implementing ITS elements. Should consider if an EA for everything might be more efficient, versus one element at a time

- Pilots, testing can be done under Categorical Exclusion or Research Permit; low hanging fruit (installation of traffic counters don’t need to wait for EA)

**Visitors: Where and how to intercept them; what to tell them, where to send them?**

- “Know Before You Go” system, like WSDOT program for holiday weekend traffic

- High percentage of repeat/local visitors

- Remember non-English speaking visitors; numbers were not known at time of discussion, but believed to be relatively high
  
  o Need better understanding of how non-English speaking populations are getting their information and if we have ability to work with or influence the information that goes out there.

- Consider incentives by age, group type, local vs. out of State
  
  o Incentives and pictures: show them what it will be like, assure them they will get a special experience and less crowding (ideas include: interp talks, incentives, coupons); if they come at another (off-peak) time

- Market other parts of the Park? Should this be part of the messaging?
  
  o Ex: promoting scenic drive, rather than driving to Paradise and parking? Feeling was the Park Should be open to it. This Park was built as a driving experience. It is a NHLD. That is a story that should be promoted and told.
  
  o BUT might just be trading parking issues for roadway congestion issues

- Repeat visitors; more opportunity to train them to seek info ahead of time; distribute to other places (either inside or outside of Park) and different times
Concept of Operations for MORA ITS

- Some staff expressed perception that flashing signs are seen by more visitors
- Currently they get more visitor emails than calls. Park replies usually encouraging people to go to the website
- Have about 3000 Twitter subscribers now
- One stop ideas, where visitors can get road, weather, activity information; anything that can do that will work best (GUI interface)
- Currently when visitors call the Park phone information line they have an option they can choose to get ‘Road’ information

Day to Day Operations

- Dispatch:
  o Usually has the most up-to-date information about road conditions or traffic incidents in the Park; time for this information to be disseminated varies depending on the situation. Often if you are not right by your radio you may not hear about a road closure or Park incident for a long time.
  o Currently they in conjunction with Curt can switch certain elements of the HAR message
  o They do Twitter updates about the road opening in the Winter until Interpretation Staff come in for the day
  o Dispatch is NPS employees ~7am-7pm everyday; contracted out to Enumclaw after hours
  o Likely to go to more centralized dispatch for Washington Parks in the future

- When thinking about roles and responsibilities: IT would probably play a significant role behind the scenes, but many elements will still require a ranger on the ground; such as to verify traffic conditions, or control traffic

- Season to accomplish work on the ground is extremely short

- Short manpower; capabilities to add duties and maintain very limited

- Better integration of work across divisions is needed (ex: many projects need maintenance, IT, and LE or Interp to complete)

Opportunities with Partners: State, Other

WSDOT Discussion:

- Connecting the Park to WSDOT 511 could happen, but details need to be worked out
  o Immediately they are open to connecting the Park via a link on the website and maybe a line transfer from 511 to a Park information line. Park staff later noted it might be best if the link went directly to the Park’s Roads page.
Concept of Operations for MORA ITS

- Long-term: How would real-time HAR, phone, or web messages about the Park be updated in WSDOT 511 system? WSDOT would want them to be as accurate and recent as possible.
- WSDOT 511 driven by application that puts updates on the webpage, but not to Twitter. Twitter is not automatically updated with this info, not used as a data feeder. WSDOT has someone interpret the data and put out a Twitter message. This person also responds to all Twitter posts.
- Planned WSDOT HAR in Elbe will be for flooding, but they are open to running another message when floods are not happening

- WSDOT visitor information use stats, by media type (all stats need to be verified):
  - Website gets 1-2 million hits a month
  - Twitter has 15-20,000 followers; not automatically updated
  - Use of 511 system is leveling off
  - Mobile application has quarter million downloads; about 5-20% using the application (estimated); on a huge upward trend
  - Travel alerts go out to subscribers; and they can tailor alerts to what the audience wants (ex: subscriber can ask for alerts on I-5 only)
  - HAR, according to WSDOT less than 5% are using it. First time visitors/people going through an area (e.g., national park visitor) is probably higher

- WSDOT uses companies to collect and manage real-time and historical travel time and speed data; to measure traffic congestion/flow; Ex companies they use or might use: BlueTOAD, Inrex

- No parking management systems managed by WSDOT. But worked with Sea Tac, and Seattle Center on a couple of their systems
  - Key with parking data: needs to be calibrated every night; never zeros out. Seattle Center has a report documenting reset method.
  - Noted that a truck parking facility at weigh station in Oklahoma or Kansas used video system to relay info to truckers about parking availability and where to park. WSDOT unsure how well it works. But software exists that can count and calibrate for you. If you really want to count with video, you sacrifice other things. Weather significantly effects video detection’s ability to work. Can only be used for certain locations.

- Pavement pucks (for calculating number of parked cars) work in snow

- Mentioned the CDOT mobile application; incentivize when people go through the I-70 pass, get a coupon for a Big-Mac if you go outside of peak time.

- WSDOT ‘Know Before You Go’ Campaign
  - WSDOT on three-day weekends, publishes graphs of historic traffic flows (for that weekend) on major corridors and ferries.
- Safety info: travel time and speed info is good to communicate in bad weather conditions.
  - LED flashing lights work well to notify people of safety issues ahead, or maybe rumble strips. Compatibility with Park; what would be allowed in historic roads. Ask cultural.

- Broadband:
  - Can be installed on State Routes, through a utility permit. How will it be paid for? Under the Federal ARRA Broadband Technology Opportunity Program (BTOP) $288 million has been awarded to grantees in Washington State. $138 million has been awarded to NoaNet in Tacoma for rural broadband infrastructure grants throughout Washington. NoaNet has installed broadband fiber cable on the state highways bordering the park under a permit from WS DOT. The focus of the BTOP broadband has been to connect local schools and colleges and health care facilities with fast internet fiber optic cable service. Connecting major attractions for the State of Washington tourist economy with fiber optic cable could be the next infrastructure investment to tap into the initial BTOP capital infrastructure. In Washington State, as well as 100 other BTOP projects, these additions to the BTOP fiber optic network can be a partnership of Federal and state government and private non-profit and private for profit partners.
  - WSDOT currently uses 700 MHz radio systems for mobile data, info for fleet management, (know when plowing, laying salt, etc...) and 800 MHz radio systems for voice communications. In urban areas they use fiber optics. WSDOT, is getting everything they need (in terms of data communications from their fleet and facilities operations) to meet their needs without fiber optic broadband.
  - WSDOT is not interfacing with ARRA Broadband work because they don’t need anything else to provide data they need to operate their fleet and facilities. Many rural areas are using the US Department of Commerce’s “Broadband USA” BTOP initiative to support public and private investment in tourist economies by leveraging the BTOP infrastructure grants with additional capital infrastructure grants from transportation and economic development programs. As a minimum, WS DOT can provide the right-of-way for fiber optic cable to connect the National Park and National Forest venues with the statewide broadband network. In addition, WS DOT can act as a convener for Federal, State and local agencies supporting intelligent transportation systems and the tourist industries relating to national historic and recreational sites.

- Buses and Van Pools:
  - Shuttle and inter-city bus service very active across country. Other areas, give people the bus in return for certain level of service. Is WSDOT interested? Bill Legg says process exists to do this. He can get us in touch with right person.
  - WSDOT administers the Federal rural public transportation capital and operating assistance program. As such, it could encourage local public or private non-profit agencies and private for profit entities to submit proposals that provide alternative transportation to MORAs using U.S. DOT subsidies (S. 5311 of Chapter 49 U.S.C). For
example, WS DOT could provide capital assistance for inter-city buses providing direct service from Tacoma and/or Seattle to MORA using S. 5311 capital resources.
  o WSDOT buys a lot of vans for van pools.

- Advice from WSDOT: Park needs to decide needs and prioritize:
  o What do they want to work on or pursue first/most?

Other Potential Partners or External Connections

- ‘Visit Rainier’ website. Great partner to help get information out
- Hotels, motels, and local lodging – get information out to visitors that may have limited connectivity, yet at MORAs’s doorstep
- Crystal Mountain wants more visitors; may be opportunities to promote visitors going over there; For example: When road to Sunrise closes and cars are backed up waiting to get up there
- Visitor Centers outside of Park, on way to Mt. Rainier. What opportunity is there to put real-time or video shots of the Park in these places?
- WASO is still developing a Public Lands Traveler Application; need update on where that is at and what information it will include.

Summary of Closing Session
October 11, 2012: 2:00pm-4:00pm
Attendees: Bryan Bowden (MORA); Debbie Hannevig (MORA); Curt Jacquot (MORA); Patti Wold (MORA); Kristyn Loving (MORA); Rangy King (MORA); Darin Swinney (MORA); Chuck Young (MORA); Roger Andrascik (MORA); Geoff Walker (MORA); Kraig Snure (MORA); Patti Sacks (DSC, on the phone); Laurie Miskimins (FHWC-CFLHD); Susan Law (FHWA-WFLHD); Steve Lawson (RSG); Brett Kiser (RSG); Larry Harman (Harman Consulting)

Immediate/Next Year Discussion:
The closeout discussion with the bigger group involved confirming some next steps for FY13:

- Move forward with new HAR’s at Nisqually Entrance and Ohanapecosh; get computer messaging up and running for the HARs
- Connect Tahoma Woods HAR to the internet and install 50’ utility pole to add antenna height.
- Move Paradise HAR to sewer treatment plant (reset button inside)
Concept of Operations for MORA ITS

- White River HAR should be considered in the Con/Ops; perhaps a portable/trailer mounted unit that could be added to the DMS sign

- More immediately other, simple solutions may be needed for White River area

- White River and Nisqually would be simultaneous priorities absent funding constraints; with constraints concentrate on Nisqually, consider mobile HAR for the DMS at White River, and look into opportunities to promote Crystal Mountain

- Begin exploring immediate opportunities with WSDOT in consultation with the Park (specifically 511 coordination)

- Get the other RTMS in place and validate all three (Nisqually Entrance, Paradise Road, and Valley Road); need these counters to understand parking at Paradise; get them in place by 2013; downloadable;

Potential Action Items

Entity listed in (parentheses) for those items with an identified lead.

- Immediately: ‘Action Plan Memo for FY13;’ to cover the actions the Park is going to keep moving forward on immediately (Bryan)

For the Concept of Operations Plan:

- Discuss with Management Team how we roll out this Con/Ops with MORA; going back to the comments that this needs to come out with Management support and direction (RSGNPS/Bryan, and FLH)

- Recommendations regarding length and components/elements to include in HAR message sets. May need current message list from Curt Jacquot. He mentioned a checklist of message components he is currently using. (RSG to include recommendations in ConOps; NPS/Bryan to get current message list from Curt Jacquot to provide to RSG)

- Sunrise Data on closures should be obtained from Chuck. Needed to inform best tools to use on that corridor

- Talk with Tim McDowell at WSDOT about what they are doing with Broadband and what opportunities may exist there.

- May need to discuss further whether implementation of ITS elements becomes part of a comprehensive EA or still approach element by element (NPS/Bryan)
- Need to talk with Amy Pederson, National Fee Program; Get an update on where the Fee Program is going in terms of entrance tools, how it will work. Hand-held card readers are most likely a part of it we need to know where it is going (NPS)

- Follow-up conversations with Eric Walkinshaw, members of the Maintenance Staff, Road Crew, and maybe Dispatch? (NPS/Bryan)
  
  o For Eric: Ask about status of 16 junction box locations in upcoming road project

- Should we consider looking more closely at the Commercial Tour Data and permits and/or getting more information on the regular recreation groups that come to the Park? There could be multiple partnering opportunities. (Core group to discuss?) Thinking along the lines of information distribution and also marketing/incentive opportunities. (NPS)

- What is the status or future of the FOTSC counters coming back online permanently (FLH)

**Evaluation Methodology and Instrument(s):**

- Future/pilot Evaluation needs to identify percentage of visitors tuning into HAR? And what messages are most effective. In the meantime, for the Con/Ops use best available information to decide future use and placement of HAR. (RSG)

**Partnering Opportunities**

- What opportunities are there with the Public Lands Traveler Application (WASO project) being developed? Need update on where that stands, where it is going and what it can do. (FLH/Laurie)

- Follow up with WSDOT to get official statistics on use of their various visitor information Medias. With so many repeat and local visitors to MORA, this data could inform where the Park puts its energy with ITS tools. (FLH/Laurie)

- Initiate discussions between Park and WSDOT to get a link added to the WSDOT website. First follow up with Chuck and see if Park staff is willing to handle this, then go back to WSDOT (FLH/Laurie and Susan)
Appendix B. MORA ITS Software Options and Recommendations

B.1 Introduction

The proposed ITS system in the 2013 MORA ConOps includes establishing a “virtual” MORA Transportation Management Center (TMC) on the park’s intranet or in the Cloud with software applications to process, archive, analyze, and disseminate real-time and historical ITS data flows from MORA-owned and operated data collection devices (i.e., RTMS units and web cameras, initially; Figure 6)\(^\text{15}\). In particular, software capabilities would be developed to collect and disseminate real-time information and to forecast likely near-term future conditions regarding traffic, parking, and visitor use in the Nisqually Corridor and at Paradise, and ultimately throughout the park. The information would be broadcast to a range of outlets, including home computers, smart phones and tablets, highway advisory radio units (HAR units), dynamic message signs (DMS units), WSDOT traveler information systems (e.g., WSDOT 511), and regional tourist information centers to provide real-time information to potential visitors as early in their trip planning process as possible, whether they are at home, in route to the park, or in the park traveling towards specific park destinations.

\(^{15}\) Ultimately, MORA may wish to pull data from Washington State Department of Transportation (WSDOT) devices as well. If so, MORA will need to use either publicly available WSDOT data or obtain permission from WSDOT to pull data directly from WSDOT devices.
Figure 6. Data Flows for MORA ITS.
This Appendix to the 2013 MORA ConOps reports the results of research to investigate known software requirements and options for the MORA TMC included as part of the proposed ITS system in the 2013 MORA ConOps. The Appendix documents the high level MORA TMC software requirements known at this time and presents advantages and disadvantages of commercial and custom software options to address these requirements. Details about specific commercial software packages that can meet some or all of the known MORA ITS requirements are reported, and the preliminary specifications and estimated cost of a fully custom software solution are presented.

B.2 Software Requirements

In order to recommend a software approach for the MORA TMC, system and software requirements must be defined. Requirements are a means to evaluate commercial software that might be appropriate to this effort, and to estimate an order-of-magnitude cost to construct a fully custom solution. Software and system requirements will be developed as part of the systems engineering process MORA is following for ITS planning and deployment in the park (Figure 7).

Figure 7. Systems Engineering “V” Diagram.

While detailed system and software requirements are yet to be specified in the MORA ITS systems engineering process, enough is known at this time to consider high-level system requirements documented in the 2013 MORA ConOps and this Appendix to do a first-order analysis of software options. In particular, the proposed ITS system in the 2013 MORA ConOps will need to include the following:

1. Input and sensing devices;
2. Output or information reporting devices, including 3rd party web applications;
3. A central database repository;
4. Operational interface software that manages input and output devices, implements processes and procedures based on analysis of the data, and provides a system administration and management dashboard (Figure 6).

Thus, MORA TMC software requirements considered in this analysis are organized into several functional categories, as follows:

- Software operating environment
- Central database
- Input device interfaces
- Output device interfaces
- Operational interface requirements

B.2.1 Software Operating Environment

A variety of software operating environments would satisfy known requirements for the MORA TMC, thus, the optimal choice will result from a cost/benefit analysis; this Appendix identifies key factors to consider in the cost/benefit analysis of options for software operating environment. One choice is to host the MORA TMC software within MORA’s intranet. An alternative hosting strategy is a software-as-a-service (SaaS) solution, in which the MORA TMC software is hosted by a third party cloud service provider such as Amazon Web Services, Rackspace, or Microsoft Azure. One advantage of cloud hosting is that it guarantees adequate client/server bandwidth as MORA’s and the public’s use of MORA TMC data increases. Cloud services ensure bandwidth through auto-scaling – monitoring server performance and automatically replicating application and database servers as required to maintain consistent performance under varying load. That being said, MORA staff noted that cloud service could present bandwidth issues, in the short-term, because the park’s network is already congested. However, park staff noted bandwidth is likely to be an issue for any option, in the short-term.

Another advantage of cloud hosting is that it frees MORA’s Information Technology (IT) Division from having to maintain the web and database server for the MORA TMC, which at a minimum would involve periodic operating system and application upgrades. A third advantage of cloud hosting is that it opens the door to sharing the web services software between National Park Service (NPS) units because the software functionality is wholly available via the internet, instead of residing behind MORA’s firewall. However, MORA would have to assess whether a cloud based system conforms with federal government security requirements for cloud computing. At a minimum, a proposal would have to be submitted by MORA to the US Department of Interior (DOI) to request a firewall exception. However, if the MORA ITS is not on the DOI network, it may not be necessary for MORA to request a firewall exception from DOI. Further research on DOI’s firewall policies and requirements is warranted, if MORA decides to further explore a cloud hosting solution. Finally, cloud hosting has the advantage of redundant servers for reliable system backup and recovery. While a cloud-hosted solution would come with monthly hosting and maintenance charges, cloud computing economics are deliberately positioned such that cloud service hosting is less expensive than self-hosted hardware and IT costs over the long term due to economies of scale realized by cloud providers.

Based on conversations with MORA IT Division staff, if a solution is to be hosted within MORA’s intranet, a Windows-based solution is preferred because MORA’s IT infrastructure is Windows-based. Although MORA’s IT Division staff indicated that they can support a non-Windows solution, such a solution would require additional expense to maintain beyond the other MORA systems – for example, ongoing operating system upgrades and expertise in multiple operating systems. Thus, a solution built with Windows-based technology (e.g., C#/.NET, SQL Server) would be the most cost effective intranet solution for maintenance by MORA’s IT Division.
A hybrid intranet/cloud option is to house the bulk of the MORA TMC software within MORA’s intranet, but to store collected and archived data in the cloud. In addition, data dissemination software to publish the data to third party clients such as external web sites and mobile apps could be stored in the cloud, rather than within MORA’s intranet. This hybrid approach has the bandwidth advantages of a cloud-hosted solution, while also minimizing the cloud hosting fees. However, the total IT maintenance cost of a hybrid solution, which includes MORA’s intranet, plus the cloud hosting fees, is likely to be more expensive than either single hosting option.

B.2.2 Central Database

A relational database would be required for the MORA TMC to store a variety of collected and archived time-series data for analysis and display through the software operational interface and for dissemination to other 3rd party software. Historical parking volumes and traffic counts are two examples of data that would be archived in the relational database. In addition, the database would store pre-recorded text messages for display on Dynamic Message Signs (DMS) units and audio messages for broadcast via Highway Advisory Radio (HAR) units and WSDOT 511. Further, the relational database would store all of the operational and configuration parameters of the MORA TMC software system. Any database technology that supports standard SQL queries would be sufficient for the MORA TMC system; for Windows 7, this would be a SQL Server database, and for Linux this would be either a MySQL or postGREs database (it should be noted, MORA IT staff are not able to support Linux-based systems, therefore, Linux-based systems are viable options only in the case of a cloud-based or other hosted system).

For efficient system performance, it may be desirable to store some business logic within the MORA TMC relational database itself, in the form of stored procedures. In particular, statistical model- or algorithm-driven responses to input data can be viewed as the custom business logic of the MORA TMC software. Simple examples include the automatic dispatch of emergency vehicles when traffic incidents are detected or the automated closure of facilities under adverse weather conditions. A more complex example might be a set of parking and traffic forecasting models, which utilize stored historical data to estimate current and future parking and traffic conditions at selected park locations (e.g., Paradise, Sunrise, White River Entrance Station, etc.), and trigger messages with specific wording for specific conditions that are pushed out via software to information sources such as DMS, HAR, MORA’s public website, and the WSDOT 511 system.

B.2.3 Device Interfaces

MORA has already purchased or is planning to purchase a variety of input and output devices that constitute the core components of the ITS system proposed in the 2013 MORA ConOps, including:

- Traffic Monitoring Devices
  - Real-time traffic counters (RTMS) – X3/K3 (EIS Traffic)
  - Real-time network Web cameras – Axis M1114
- Information Distribution Devices
  - HAR units – Alert AM NX8R (Information Station Specialists)

These devices must be considered in the context of the software requirements for the MORA TMC. However, supporting these specific devices may not be the most cost effective option, depending on the detailed system and software requirements that MORA specifies in a subsequent phase of the systems engineering process. Existing commercial packages support specific hardware device types,
manufacturers, and models which may be different than the hardware MORA has purchased to date. Thus, commercial software options may need to be customized to support MORA’s existing ITS hardware, and consequently, other device types might meet system and software requirements at a lower long-term cost. If building a custom software solution, certain devices may be easier to develop support for than others. Thus, it is strongly recommended that MORA discontinue purchasing any additional devices until completion of the next phase of the systems engineering process (i.e., development of detailed system and software requirements) and decisions have been made about specific devices to deploy at MORA.

Ultimately, MORA faces at least three choices, with respect to TMC software solutions for device interfaces:

1. Use the commercial software provided with each of the above devices MORA owns, including customizing the software as needed
2. Purchase new devices and use the software provided with the new devices, including customizing the software as needed
3. Create entirely new, customized software for the existing devices or for newly purchased devices

Regardless of whether a commercial or custom software approach is chosen, the most cost effective input and output devices will conform to the National Transportation Communications for ITS Protocol (NTCIP) standard. The NTCIP standard defines both the format and content of messages sent between devices (e.g., RTMS units and ITS software). Interested readers can find additional information about the NTCIP standard at http://www.ntcip.org/library/documents/pdf/9001v0406r.pdf.

Conformance to the NTCIP protocol does not guarantee that devices from different manufacturers are compatible without software variation. However, NTCIP-compliant devices and software would lower the cost of custom software development in the event of adding new devices or manufacturers. In particular, if all MORA ITS devices are NTCIP-compliant, the TMC software can be implemented with a single communication protocol for all devices. In contrast, without NTCIP-compliant devices, each device might have a unique communication protocol, and the TMC software would have to be customized for each unique communication protocol.

Another benefit of having all MORA ITS devices be NTCIP-compliant is that it allows MORA flexibility in both initial and replacement choices, without risking expense software customizations. Moreover, NTCIP-compliant devices are more likely to be interchangeable across manufacturers due to their common communication protocols. In summary, developing a system with NTCIP-compliant devices is efficient both for initial software implementation, as well as for software upgrades and maintenance. Unfortunately, none of the devices that MORA has purchased or plans to purchase are reported in their respective user manuals to be NTCIP-compliant.

Section 3 of this Appendix provides detailed information about commercial and custom software options that will help MORA weigh the relative advantages and disadvantages of supporting the devices that MORA has already purchased or plans to purchase versus purchasing new devices, and of using commercial versus custom software solutions for the MORA TMC.

The following subsections provide additional detail about input and output device interface considerations for the MORA TMC software.
B.2.3.1 Input Source Interfaces

All input devices for MORA ITS must have some hardware and driver software that allows them to communicate with a network-connected server. As the device and location warrant, the communication protocol may be RS232, Ethernet, Bluetooth, WiFi, or equivalent. For devices without built-in network connectivity, intermediate computers and software may be needed to receive a local stream of data from a device and relay it to a central server. On the receiving end, a network-connected central server is needed to receive the real-time data feeds, parse and process them as necessary, and store the results in a central database. The operational interface software (described in more detail in Section B.2.4) acts on the received data in real-time and on the stored data for operational procedures, analysis, reporting, and dissemination. For example, the TMC software might use real-time traffic data feeds, coupled with statistical models and algorithms stored in the central database to trigger messages (also stored in the central database) to be pushed out via software to information sources such as DMS, HAR, MORA’s public website, and the WSDOT 511 system.

Other input sources, for example regional weather conditions, might come from outside MORA. In this case, the communication protocol may be RSS, HTTP, or other. The data feed would be received by a central server via the internet, and parsed, processed, stored, and acted upon.

Finally, the MORA TMC software system must accommodate manual input of data that is not sensed by devices. Examples include attraction opening/closing hours and incident-based road closures.

The following paragraphs provide additional information about specific types of input devices included as key components of the proposed ITS system in the 2013 MORA ConOps, or that could be incorporated into the MORA ITS system in the future (i.e., ITS technology for shuttle service management).

RTMS

MORA’s RTMS devices (from EIS Traffic) sense vehicles crossing a microwave field and communicate traffic count data via radio modem to an IP network. The RTMS devices sense both volume and speed of traffic, and so are suitable for traffic monitoring at MORA’s entrance stations and other key park locations (e.g., access roads to popular park destinations, such as Paradise Road). In addition, the proposed ITS system in the 2013 MORA ConOps includes use of the RTMS traffic count data to estimate parking conditions in real-time. Using single types of devices for multiple purposes (such as RTMS devices for both parking and traffic monitoring) provides a cost advantage over single-purpose devices for each function because the same device communication and control software can be used for multiple functions. However, if the cost of integrating these devices into the MORA TMC software is prohibitive (e.g., requires substantial software customization), other device types and corresponding software solutions should be considered. As noted, the relative advantages and disadvantages of developing software solutions for the existing RTMS units versus purchasing new units are considered in Section 3 of the Appendix.

Web Cameras

MORA currently owns Axis web cameras that are used to monitor parking, traffic, and weather conditions at Paradise and Longmire. MORA’s web cameras communicate over an IP network and compress the real-time video stream to avoid overuse of bandwidth, but do not internally reduce the data further to time-lapse videos. MORA’s web cameras, or similar CCTV cameras, webcams, or equivalent could also be used to detect traffic incidents and record license plate numbers for a variety of applications (e.g., at park entrance stations to measure visitor trip patterns). If additional cameras are purchased, it is preferable to have a single type/model of camera, if possible, to minimize cost and
complexity of integrating with the MORA TMC software. Choosing a camera that compresses output and automatically produces time-lapse videos in real-time would reduce the cost of constructing custom software for that functionality, as well as the database storage needed for raw video. As with the RTMS devices MORA already owns, the software cost of developing support for MORA’s existing web cameras must be weighed against the cost of purchasing new hardware with accompanying software that meets MORA’s requirements without customization.

Weather

Real-time weather reports are available from the National Weather Service and others via RSS feeds or HTTP protocol. For the MORA TMC, a central server would receive the data feed via the internet and parse, process, and store it. For weather forecasting, the most cost-effective approach is to select a data supplier for weather that includes forecasts. However, software can be written to predict future weather based on the stored weather history, if necessary.

Automatic Vehicle Location (AVL) for Shuttle Service Management

If shuttle service operates in MORA in the long-term, an automatic vehicle location (AVL) system is recommended to track the location of shuttle buses and display real-time shuttle locations and next arriving bus times at shuttle stops and other key locations. Typically, AVL systems feature Global Positioning System (GPS) units combined with wireless radios to transmit GPS information about shuttle bus locations over WiFi to a receiving computer.

Manual Input

The MORA TMC system must be capable of handling manually entered data, either as an override to sensed data, or as supplemental information. For example, a manual override might be used to reserve parking spaces in a parking lot for service vehicles, or to re-route traffic away from the site of a traffic incident. Other manually entered data might include changes to staff schedules that impact facility capacities or report of an unusual event or incident (e.g., traffic accident). A full specification of the types of manual input required for the MORA TMC should be developed as part of the MORA ITS systems engineering process to develop detailed system requirements (Figure 7). Typically, this is done through detailed enumeration of the users of the system, and for each user, the specific ways in which they will use the system.

B.2.3.2 Output Source Interfaces

Similar to input devices, MORA ITS output devices will either have built-in wired or wireless network connectivity, or will require external interface computers and software to provide a path for data streams between the MORA TMC software and the output devices.

Some output sources are simply streams of data to be sent over a network, such as historical and real-time traffic data that 3rd party websites might choose to display, or time-lapse videos of parking conditions at Paradise to be uploaded to YouTube. Depending on the output source, the network communications protocol may be an RSS feed, an HTTP protocol, a REST interface, or another protocol providing equivalent functionality.

The following paragraphs provide additional information about specific types of output devices included as key components of the proposed ITS system in the 2013 MORA ConOps.

DMS Units

The 2013 MORA ConOps proposes the use of portable DMS units to display static and real-time informational messages to visitors about traffic, parking, weather, and/or other conditions in the park.
Using remote-controlled DMS hardware, standard operating messages could be pre-formed, stored in the central database, and triggered automatically by the MORA TMC software (based on real-time data from input devices and algorithms in the MORA TMC software) or triggered manually by an operator in response to readings from input devices. Currently, MORA owns one AMSIG DMS unit, which, according to the user manual, must be programmed manually through an attached terminal, and therefore cannot be programmed automatically via MORA TMC software. This suggests MORA would have to purchase different DMS units to have a system that would allow DMS messages to be formed and sent directly from the MORA TMC software, however, MORA should verify this with their AMSIG DMS vendor. In either case, the AMSIG DMS hardware does allow multiple messages to be stored and time-triggered, though this is substantially less control than would be achieved by hardware that can communicate with the MORA TMC software directly.

HAR Units

Mount Rainier National Park owns and operates HAR units (Alert AM NX8R Digital Message Player units) with low-frequency AM radio broadcasts that provide park visitors with information on approach to and within the park. Currently, MORA’s HAR units broadcast pre-recorded voice messages, however, the 2013 MORA ConOps proposes using standard, pre-recorded messages that are stored in the MORA TMC central database, and selected either automatically or manually through the MORA TMC software. In special cases (e.g., traffic incident or other special event), messages would be recorded “on-the-fly” and manually selected for broadcast.

The user manual for the HAR units MORA owns indicate that they are programmed by telephone, either local to the unit or remotely, and programmed messages are triggered either locally on the device or by a remote device (e.g., by the MORA TMC software). Therefore, the information in the user manual for the HAR units owned by MORA suggest they would be suitable for automated selection of pre-recorded messages based on commands from the MORA TMC, assuming MORA purchases commercial or custom software with this capability. To record messages, the client computer accessing the MORA TMC software would need a microphone or other audio input. Alternatively, HAR messages may be specified and stored as text, if the MORA TMC software contains text-to-speech functionality.

WSDOT 511

Traveler information 511 systems receive data from traffic management centers over the internet in a standard text format developed by the American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers (ITE) Committee. If the MORA ITS system is to interface with WSDOT 511, as proposed in the 2013 MORA ConOps, the MORA TMC software will need to send this data stream as well as adhere to the WSDOT 511 reporting requirements for timeliness and content. As with the other output devices discussed, standard reports can be pre-recorded, stored in the MORA TMC central database, and selected automatically by the MORA TMC software or manually by an operator. Ad hoc reports can be typed by an operator as text and converted “on-the-fly” to the transmission format by the MORA TMC software. To conform to WSDOT 511 timeliness requirements, reports from real-time devices such as MORA’s RTMS units might need to be automated, because the time delay for operator intervention may be prohibitive. If such is the case, the MORA TMC software must be able to receive real-time sensing data, and generate and send the WSDOT 511 transmission protocol without operator intervention.

Municipal 311

Municipal 311 systems are local in scope, with calls either handled by human operators or by Interactive Voice Recognition (IVR) systems. The data feed to Municipal 311 systems is ad hoc, as there is no standard for data transmission as there is with 511 systems. If there are local 311 administrators in the...
vicinity of MORA, park staff should separately negotiate a data transfer mechanism with the local 311 administrator(s), and then design a corresponding means to implement this protocol within the MORA TMC software. Options for data transfer to Municipal 311 systems include an RSS feed, email, or fax, though any electronic protocol that is supported on both the sending and receiving end is acceptable.

**Websites and Mobile Applications (Apps)**

An application programming interface (API) to the central database, accessible over the internet, is needed for MORA to develop content for its public website based on MORA ITS input device data streams, data stored in the central database, and business logic built into the MORA TMC software. The API would also be needed if MORA wants to make any of the MORA TMC data available for 3rd party developers to build their own web sites and mobile apps. A REST or HTTP interface are the typical ways to publish such an interface today. The federal government has established API security procedures and processes that MORA should follow when planning and implementing an API for MORA ITS.

**National Park Service Vehicles**

National Park Service vehicles need to be capable of receiving detected incident locations and other service-related information via radio dispatch. It is assumed that this functionality will not be integrated and automated within the MORA TMC software. Rather, communication with NPS vehicles is expected to be done by radio manually by an operator in response to indicators observed on the MORA TMC dashboard and other sources of information (e.g., telephone calls reporting incidents, etc.). However, it is possible that in the future MORA would adopt a computer aided dispatch (CAD) system, in which case, it would be necessary to work with MORA’s selected software vendor to customize a solution to integrate the CAD system within the TMC.

**Social Media**

Currently, MORA is using several social media outlets to provide information to the public. For example, MORA has a Facebook site, Twitter feed, and Flickr group. By implementing a general API as specified above, MORA will be able to use other social media outlets that emerge in the rapidly evolving social media environment.

**YouTube**

Mount Rainier National Park’s website has a link to a YouTube video gallery designed to provide the public with a variety of information about the park. Time-lapse videos, taken from CCTV cameras, webcams, or equivalent, could be published as YouTube videos to inform visitors of potential parking and traffic conditions on “typical” summer weekends versus “off-peak times”. A straightforward technique to accomplish this would be to record and store video in real-time, then post-process the real-time footage to create and compress time-lapse videos. However, some cameras can produce compressed time-lapse videos internally, saving data bandwidth, storage costs, and additional processing steps. If MORA’s Axis web cameras are used for this purpose, then the MORA TMC software must create the compressed, time-lapse videos, because the Axis web cameras do not do so themselves. An alternative is to use a camera such as the Epic HD1080P, which does internally produce time-lapse videos.

**B.2.4 Operational Interface Requirements**

The operational interface software would be a component of the overall MORA TMC software system. The operational interface software would provide all of the controls and indicators to MORA TMC system operators, and would internally do required forecasting and estimation of conditions. The operational interface software would also provide the drivers for all input and output devices and
channels, store data in the MORA TMC central database, and disseminate stored data to 3rd parties. The operational interface software could possibly be packaged as a single monolithic application, or may in fact be a collection of programs from the same or even different manufacturers. The following subsections (Sections B.2.4.1 through B.2.4.6) provide additional detail about operation interface requirements for the MORA TMC software.

B.2.4.1 Input and Output Device Control

The operational interface software would be the means of MORA ITS input and output device control. In general, the operational interface software should be able to turn input and output devices on and off, reset them, and configure them. Specific sources will then have their own requirements; for example, DMS units must be able to be written to, either through automated messaging, or via manual override. The operational interface software should be capable of supporting the specific controls needed for each input and output source noted.

B.2.4.2 Maintaining Historical Data

The 2013 MORA ConOps proposes that real-time parking and traffic data would be stored so that there is a history that can be used for estimation of future conditions and other analyses to support park management. It is not clear at this time exactly how detailed the stored data would need to be (e.g., timestamp counts, hourly bins, daily bins, etc.), however, it will be necessary to balance the precision of the data with the cost of storage when the detailed system requirements are specified in a subsequent phase of the systems engineering process (Figure 7). In addition, storage of web camera image files and/or time-lapse video may be needed, if MORA wishes to maintain these data for review following incidents or for other purposes. At least temporary storage of real-time video for compression within the MORA TMC software may be necessary, if time-lapse videos are to be used as part of the MORA ITS system, as proposed in the 2013 MORA ConOps.

B.2.4.3 Business Logic for Estimation of Parking, Traffic, and Other Conditions

The 2013 MORA ConOps proposes that the MORA TMC software system would contain the statistical models and algorithms (i.e., MORA ITS business logic) used to estimate parking and traffic conditions from historical data stored in the central database. As described in the 2013 MORA ConOps, model estimation output would be used by output devices such as DMS and HAR, 3rd party web sites, mobile apps, and MORA’s website to provide visitors with trip planning information. The business logic for estimating park conditions would be executed in the operational interface software.

B.2.4.4 Map-based Interface

A map-based user interface is recommended for the operational interface software. Maps and mapping software, which should be free from royalties, could display icons at locations of input and output devices. Clicking on an icon of an input or output device would bring up a dashboard appropriate for the device, including device controls and indicators. The map could also be used to display locations of shuttle buses if shuttle service is operated in the park with AVL technology; show indicators for traffic speed, congestion, and parking lot status; and depict the location of construction or incidents. Populating and updating the indicators on the map would happen automatically, in response to real-time information changes, and therefore, device management would have to be automated within the operational interface software, rather than being conducted manually.

The underlying base map for the MORA TMC dashboard interface might contain aerial photography, but should also contain a digital roads and structures overlay, because tree cover may prevent observation of key ground features (e.g., parking lots) in aerial photographs. Choices of license-free maps and rendering suppliers include Google, Bing, and OpenMap. However, MORA also has an ESRI software
license, so that ArcGIS Server, or an equivalent is also a viable option. Thus, a cost effective solution from a licensing perspective would be to use the same ESRI-licensed mapping software within the MORA TMC software that is used for the park’s website and other MORA applications. That being said, MORA IT staff will have to confirm whether or not the park’s ESRI license supports online public map publishing. If additional ESRI licensing is required and cost-prohibitive, MORA should consider license-free map sources, as noted (i.e., Google, Bing, OpenMap).

B.2.4.5 Static Data
The operational interface software would need to be configured with a large range of operational parameters to support implementation of the proposed ITS system in the 2013 MORA ConOps. Examples include pre-recorded audio for HAR units to describe specific conditions, content for DMS messages, open/close times for park destinations or facilities, and “trigger thresholds” for various conditions (e.g., parking or traffic) beyond which messages are broadcast/displayed and/or actions are taken. Trigger thresholds must be specified based on science and management judgment, and are likely to require experimentation, monitoring, and adaptation over time.

B.2.4.6 Manual Operation vs. Custom Process Automation
The MORA TMC software system is intended to include what is needed to gather and disseminate all required data for deployment of the proposed ITS system described in the 2013 MORA ConOps. However, the MORA TMC software system as described in this Appendix thus far does not connect the inputs and outputs to the modeling and estimation algorithms. Without this, an operator is needed to analyze data and control the input and output devices.

As noted, automation of responses to input data via statistical models and algorithms can be viewed as the custom business logic of the MORA TMC software. Simple examples include the automatic dispatch of emergency vehicles when traffic incidents are detected, or the automated closure of facilities under adverse weather conditions, or the specific wording to send to a DMS message sign under specific traffic conditions. Automation can be simple or intricate. As an intricate example, a decision about which alternative venues to suggest when an attraction is overcrowded may be based on a combination of time of day, season, weather forecast, traffic, and parking.

Whether commercial or custom software is used for the MORA TMC, process automation software must be custom-developed in order to be optimized for MORA’s particular operational procedures and system requirements. Rather than trying to anticipate and fully specify this automation in advance, it is recommended that automation be evolved over time through an incremental process of observation and adaptation once system and software requirements are fully specified in the MORA ITS systems engineering process (Figure 7), and a base system is functional.

B.3 Single-source, Multiple-source, or Custom Software
Several transportation software companies produce software that partially meets the high-level system requirements documented in the 2013 MORA ConOps and this Appendix, such that it is probable that a complete solution could combine software from multiple manufacturers (called multi-sourcing). However this is the least desirable solution for several reasons. One of the reasons is that operational interface software is needed to present an integrated view of the MORA TMC system. Single-sourced software would include the needed operational interface software to integrate the MORA TMC system. In contrast, if the software is multi-sourced, then the operational interface software needs to provide the integration across manufacturers, and this is likely to require custom software development that once written, also needs to be maintained as the underlying multiple sources evolve and change. The cost of multiple commercial packages, plus custom software to provide the integration across packages
will be higher than any other solution under consideration. Another reason to avoid a multi-vendor solution is support. With a multi-vendor arrangement, it is often difficult to get any single vendor to take ownership of a problem that cannot be clearly attributed.

A purely custom software solution is likely to be more expensive than all but a multi-vendor solution, both to construct and to maintain, but has the advantage of being tailored to MORA’s particular requirements. One reason that the initial expense is higher with custom software than commercial software is that the entire development cost is borne by one user (i.e., MORA), rather than being amortized over multiple installations. Maintenance can also be more expensive with custom software because there is no leverage from features built for other customers that may be used in the future by MORA. Perhaps the most limiting factor with construction of custom software is the time required to design and build it, which could significantly delay comprehensive ITS deployment in MORA.

The most cost effective solution for MORA ITS in terms of both time to deploy and cost will likely be to source commercial-off-the-shelf (COTS) software from a single vendor, utilizing the input and output devices which that software already supports, or having the software vendor customize the software for use with the devices MORA has purchased or plans to purchase. Purchasing and deploying such systems is typically accomplished in a few months. Since there is no COTS software that exactly matches MORA ITS needs, some additional customization of commercial software would be needed. The cost and time involved to customize existing software is likely to be significantly less than building a completely custom software system because it is likely that far less software would need to be written.

The following subsections review in more detail commercial and custom software options, relative to the high-level system requirements documented in the 2013 MORA ConOps and this Appendix.

B.3.1 Commercial Software

Approximately 20 commercial software products were investigated for suitability for MORA ITS, including software in use for similar efforts at Yosemite National Park and the Chincoteague National Wildlife Refuge. No products were found that fully meet the high-level system requirements documented in the 2013 MORA ConOps and this Appendix, but four commercial products cover these requirements substantially and could be further customized for MORA’s use. Customization of course comes at a price – first of all, development of additional software. Just as important from a cost perspective, customization is software written and maintained for only one customer, and this negates the advantages of economies of scale of having multiple customers use the same software. Therefore, if commercial software is chosen as the basis for MORA ITS, it would be most cost effective to use the software as-is as much as possible, rather than having the product highly customized. A second cost that comes with a commercial product of this scale is software maintenance, typically 10% of the initial purchase price annually. Maintenance includes technology upgrades, bug fixes, support for new devices, and new software features.

Based on a preliminary assessment of each of the initial commercial products investigated and vendor responsiveness, four companies/products were examined in greater detail, as follows:

- Transdyn Dynac
- McCain Products
- Earthcam
- Kimley-Horn KITS

A fifth solution, produced by Siemens Mobility, should also merit consideration. However Siemens stood out as the lone vendor that did not respond to inquiries for this investigation. As any solution will
Concept of Operations for MORA ITS

need good vendor support for customization and maintenance, lack of vendor responsiveness should be considered a serious negative for any proposed solution. Finally, information about the software system supplied with MORA’s RTMS units is provided in this section.

It was not possible to get vendor pricing for any commercial product based on the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. Rather, vendors require fully specified system and software requirements that MORA will develop in a subsequent phase of the MORA ITS systems engineering process (Figure 7). Thus, the comparison of commercial software options in this Appendix primarily focuses on features and capabilities.

B.3.1.1 Transdyn Dynac

Transdyn, Inc. makes an ITS-related software system called Dynac. Dynac is built on the open-source Red Hat linux platform and is written in Java. It uses Apache Tomcat or equivalent for a web server and can work with a variety of RDBMS, including Microsoft SQL Server and postGRE’s. Transdyn delivers Dynac as a software package for installation on clients’ computers, or as a server pre-packaged with hardware. Dynac is installed within the user’s intranet, rather than being delivered as a cloud-based software service. A typical Dynac installation uses three servers; one for the database and two for the Dynac application (one as a redundant backup). Thus, the Dynac system has a greater degree of redundancy than the other intranet-based commercial software options considered in this analysis, but less than the one cloud-based option considered (i.e., Earthcam).

Dynac is a closed system, meaning that 3rd party developers cannot customize the product themselves. Instead, Transdyn has a software team dedicated to Dynac who customize and extend the product to meet customer requirements on either a time and materials or fixed cost basis. As shown in the comparison matrices below, TransDyn is one of the commercial software packages that already includes interface capabilities for MORA’s existing input and output devices.

B.3.1.2 McCain Products

McCain offers an ITS-related software solution based on a Windows platform and designed to be hosted within clients’ intranets. Similar to Transdyn, the McCain solution meets most of the high-level system requirements documented in the 2013 MORA ConOps and this Appendix, and can be further customized by McCain engineers for requirements that are not met by their existing product. The McCain product contains additional roadway management features not needed by MORA ITS, such as traffic light and intersection management and freeway ramp metering. According to McCain, its software cannot be customized for compatibility with MORA’s existing hardware devices. Therefore, McCain software can only be considered if MORA intends to replace the existing hardware with devices already supported by the McCain software.

B.3.1.3 Earthcam

Of all vendors investigated, Earthcam stands out for their proactive responsiveness and stated flexibility in customizing solutions for specific situations. Unlike the other products discussed so far, Earthcam delivers its software as a service in the cloud. Thus, there are is no MORA TMC software installation on MORA’s intranet, and no maintenance required by MORA IT for the software infrastructure (operating system patches, software upgrades, etc.); instead, there is a monthly cost to operate the software. Mount Rainier National Park’s input and output devices would communicate with the Earthcam software via the internet, but the Earthcam software would require customization to interface with the devices MORA currently owns. Like the other products discussed so far, Earthcam has dedicated software engineers to customize the product for specific installations to meet requirements not covered by their standard product.
The cloud-based delivery style has several unique characteristics. For example, ongoing IT maintenance costs are borne by the cloud service provider rather than MORA, and installing software upgrades does not require MORA IT Division staff time. If this or another cloud-based option is selected, it will be important that the contract for the software service include a maintenance clause with specific information about which entity is responsible for system maintenance, and within what timeframe. As noted, arguably the biggest advantage of a cloud-based solution is that bandwidth scales automatically with use. If use of the MORA TMC system by MORA staff and the public grows over time, a cloud-based solution automatically adds bandwidth to maintain consistent performance. In contrast, installing MORA TMC software on MORA’s intranet means that bandwidth is limited to what is available for MORA TMC applications on the intranet, and increased use by MORA and the public could impact other MORA software applications that rely on the intranet.

B.3.1.4 Kimley-Horn KITS

Kimley-Horn’s KITS software is a Windows-based client/server package that would be installed within MORA’s intranet. Like Dynac, the Kimley-Horn KITS software already includes support for the input and output device hardware that MORA ITS currently owns. However, like the other commercial packages considered for this effort, KITS meets some, but not all, of the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. Kimley-Horn uses their own software engineers to customize their software for each installation as necessary. One unique feature of the KITS software compared to other packages is that it already includes an API that supports mobile and 3rd party applications, while the other solutions considered in this analysis do not.

B.3.1.5 MORA’s RTMS Software

As noted, MORA has currently deployed Image Sensing Systems X3/K3 RTMS units which measure distance to objects using microwaves. Software supplied with MORA’s RTMS units allows the devices to count vehicles and determine individual vehicle speed and to report this information to a connected computer via a serial or Ethernet port. The Ethernet port can be configured to send data to a specific web address using a TCP/IP protocol; MORA has configured a Web server to read and report RTMS data on the park’s Intranet. The Image Sensing Systems software reports data using a compact byte-encoded data format.

While the software supplied with MORA’s RTMS units is capable of serving traffic, parking, and incident monitoring functions within the MORA ITS system, higher level software functions required by MORA ITS are not supported by the software. In other words, the software is simply a driver for the RTMS devices; moreover, the software is not NTCIP-compliant. Consequently, customizing MORA’s RTMS software to support other MORA ITS system functions may not be possible, and would certainly not be cost effective. That being said, two of the software packages considered in this effort can support MORA’s RTMS units “out of the box”, and the other two can be customized to support the devices, as detailed in the feature matrices included in the next section.

B.3.2 Comparison of Commercial Software Capabilities

The following feature matrices provide additional detail to compare the four commercial software packages described above, with respect to key software system attributes (e.g., operating environment, database type, host location, etc.), device interface capabilities, and operational interface capabilities. Based on conversations with each of the four vendors included in the matrices, features not currently supported by these packages but potentially relevant to MORA ITS applications can be implemented through customization by the vendor. Green text is used in the matrices to note relative advantages, with respect to corresponding features, and red text is used to note relative disadvantages. Black text is used to report information which is descriptive, rather than evaluative.
### Table 10. Software Operating Environment and Central Database Features:

<table>
<thead>
<tr>
<th></th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Linux</td>
<td>Windows</td>
<td>Linux</td>
<td>Windows</td>
</tr>
<tr>
<td>Customizable</td>
<td>By manufacturer</td>
<td>By manufacturer</td>
<td>By manufacturer</td>
<td>By manufacturer</td>
</tr>
<tr>
<td>Host Location</td>
<td>MORA intranet</td>
<td>MORA intranet</td>
<td>Cloud</td>
<td>MORA intranet</td>
</tr>
<tr>
<td>Database Type</td>
<td>MySQL, postGREs</td>
<td>SQL Server</td>
<td>MySQL, postGREs</td>
<td>SQL Server</td>
</tr>
<tr>
<td>Single Failure Point</td>
<td>Redundant webserver, but not database</td>
<td>Single</td>
<td>Fully redundant</td>
<td>Single</td>
</tr>
<tr>
<td>or Redundant Servers?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 11. Input Source Interface Capabilities:

<table>
<thead>
<tr>
<th></th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports NTCIP-</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>compliant devices</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supports MORA</td>
<td>Base package</td>
<td>Requires</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>webcams (Axis M1114)</td>
<td></td>
<td>Customization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supports MORA RTMS</td>
<td>Base package</td>
<td>Requires</td>
<td>Requires</td>
<td>Base package</td>
</tr>
<tr>
<td>(EIS Traffic X3/K3)</td>
<td></td>
<td>Customization</td>
<td>customization</td>
<td></td>
</tr>
<tr>
<td>Supports other traffic monitoring devices</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>Supports other parking lot monitoring devices</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>Supports incident detection</td>
<td>Base package</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
<td>Base package</td>
</tr>
<tr>
<td>Supports license plate recording</td>
<td>Base package</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
</tr>
<tr>
<td>Provides remote camera control</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>Supports weather station units</td>
<td>Base package</td>
<td>Requires Customization</td>
<td>Base package</td>
<td>Requires Customization</td>
</tr>
</tbody>
</table>
Table 12. Output Source Interface Capabilities:

<table>
<thead>
<tr>
<th>Supports MORA DMS (T-331/332/333 &amp; GP-232/432/465)</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base package</td>
<td>Requires Customization</td>
<td>Requires customization</td>
<td>Base package</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supports MORA HAR (Alert AM NX8R)</th>
<th>Base package</th>
<th>Requires Customization</th>
<th>Requires customization</th>
<th>Base package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base package</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supports LCD interface</th>
<th>Base package</th>
<th>Base package</th>
<th>Base package</th>
<th>Base package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports WSDOT 511 interface</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
<td>Base package</td>
<td>Base package</td>
</tr>
<tr>
<td>Supports Municipal 311 interface</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
<td>Requires Customization</td>
</tr>
<tr>
<td>Supports API (web/app interface)</td>
<td>Requires customization</td>
<td>Requires customization</td>
<td>Requires customization</td>
<td>Base package</td>
</tr>
</tbody>
</table>

Table 13. Operational Interface Capabilities:

<table>
<thead>
<tr>
<th>Stores historical data (e.g., traffic, parking data)</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base package</td>
<td></td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supports business logic for parking and traffic estimation</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires customization</td>
<td></td>
<td>Requires customization</td>
<td>Requires customization</td>
<td>Requires customization</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supports other business logic(^{16})</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires customization</td>
<td></td>
<td>Requires customization</td>
<td>Requires customization</td>
<td>Requires customization</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process automation</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires customization</td>
<td></td>
<td>Requires customization</td>
<td>Requires customization</td>
<td>Requires customization</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Map-based interface</th>
<th>Transdyn Dynac</th>
<th>McCain Products</th>
<th>Earthcam</th>
<th>KITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires Customization</td>
<td></td>
<td>Base package</td>
<td>Base package</td>
<td>Base package</td>
</tr>
</tbody>
</table>

\(^{16}\) Other business logic includes all other prediction and estimation, including weather forecasts, as well as decision making and actions based on system data, for example, how full a parking lot needs to be before the system updates DMS signs to re-route traffic.
### B.3.3 Custom Software

As discussed previously, any COTS software would need to be extended and customized to fully meet the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. The commercial systems investigated are proprietary and closed so that customizations are performed by the vendors themselves. An alternative approach is to create an entirely custom software solution for the MORA TMC software.

Comparing the cost of COTS vs. custom software for MORA ITS is difficult. First, as noted, COTS suppliers were unable to quote even a ballpark estimate for their software and customization with just the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. Each vendor that was contacted has offered to develop a cost estimate, once the MORA ITS system and software requirements are specified in detail as part of a subsequent phase of MORA’s systems engineering process (Figure 7). Similarly, bottom-up pricing for a custom solution is difficult, based on just the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. However, a top-down cost and effort analysis for a custom software solution for the MORA TMC was developed for this analysis, as described below.

It is estimated that an initial release of MORA TMC software could be constructed by a team of three experienced software developers in nine months (i.e., 27 developer-months), assuming the system requirements have already been fully specified and designed, and are not substantively different in concept from the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. The major components of the system and the estimated effort to construct them are:

- Input device interfaces: 3 months
- Output device interfaces: 3 months
- Database implementation: 1 month
- Historical data: 1 month
- Time-lapse data: 1 month
- Prediction and estimation: 3 months
- Map-based interface: 2 months
- Automated responses: 2 months
- Manual controls: 2 months
- Operator dashboard: 2 months
- System configuration/params: 2 months
- 3rd-party API: 2 months
- Testing/bug fixes/acceptance: 1 month
- Installation and training: 2 months

Total: 27 developer-months = 9 months @ 3 developers

Depending on the rates of the firm chosen to construct the software, an order-of-magnitude estimate of the cost for the initial construction would be approximately $500,000.

Following initial construction, it is expected that a custom MORA TMC software solution would require continual software maintenance in the form of bug fixes, increased automation, technology upgrades, and other process fine-tuning. As is typical for such systems, on the order of 10% of the initial purchase price should be budgeted for maintenance annually, in this case, on the order of $50,000 per year. It should be expected that annual maintenance will continue as long as the MORA TMC software is in use.
B.4 Recommendation

Based on the analysis of software options reported in this Appendix, it is recommended that the most cost effective option for MORA TMC software would be to select from a commercial software option that most closely matches MORA ITS system requirements and that either already supports, or can be easily customized to support the device hardware MORA owns today. Then, through a combination of having the vendor extend the software, and by selectively relaxing MORA ITS requirements, the system can be fine-tuned to meet MORA ITS needs.

The feature matrices in Section 3.2 of this Appendix provide an initial basis for choosing among commercial software options. However, as noted, the comparison of alternatives in this analysis is based on the high-level system requirements documented in the 2013 MORA ConOps and this Appendix. Detailed system and software requirements must be specified and documented in a subsequent phase of the MORA ITS systems engineering process (Figure 7), before it is possible to estimate costs of commercial and custom software options, and ultimately, to select a preferred software solution.

Thus, the following next steps for selecting a MORA TMC software system are recommended:

1. Using the high-level system requirements documented in the 2013 MORA ConOps and this Appendix as a foundation, specify and document detailed MORA TMC system and software requirements.
2. Solicit bids from software manufacturers to meet the specified requirements.
3. Select the software manufacturer that provides best value to meet requirements, including required customizations.
Appendix C. MORA ITS Evaluation Survey Instrument

C.1 Introduction

As the 2013 MORA ConOps is implemented, it is recommended that MORA evaluate the effectiveness of the ITS deployments at achieving the high priority needs and operational policies identified as goals for the MORA ITS system (Table 14). Evaluation of MORA’s ITS system should include measures to assess potential crowding- and congestion-related improvements (e.g., traffic volumes, parking accumulation, visitor use densities), as well as measures of visitors’ use of MORA ITS applications, modifications to visitors’ behavior due to the influence of MORA ITS applications, and visitors’ evaluation of the information provided by the MORA ITS system.

<table>
<thead>
<tr>
<th>Table 14. 2012 High Priority Park Needs/Operational Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ensure public and employee safety using MORA roadways.</td>
</tr>
<tr>
<td>2. Get visitors to (voluntarily) visit popular places during less congested times (peak hour, day, weekend, and season).</td>
</tr>
<tr>
<td>3. Inform visitors of options and conditions “before they decide” -- to modify behavior patterns and moderate expectations.</td>
</tr>
<tr>
<td>4. Coordinate delivery of en-route driver information with timely suggestions for alternative activities (and increased information content about those activities) based on drivers’ geographic location.</td>
</tr>
<tr>
<td>5. Provide real-time information regarding weather, road conditions, parking availability, and the availability of services in the Park.</td>
</tr>
<tr>
<td>6. Provide timely and accurate information dissemination to support improved internal Park communications and operations.</td>
</tr>
<tr>
<td>7. Support alternative transportation strategies that mitigate limited vehicle access issues at popular locations (e.g. shuttles).</td>
</tr>
<tr>
<td>8. Provide reliable data to measure and determine congestion “threshold/standards” and to assist in the development of transportation system operations requirements.</td>
</tr>
<tr>
<td>9. Provide current information to welcome centers in gateway corridors.</td>
</tr>
</tbody>
</table>

The 2013 MORA ConOps specifically recommends that MORA administer a visitor survey in conjunction with the initial and ongoing deployment and operation of ITS applications in the park. The purpose of the MORA ITS evaluation survey would be to assess the extent to which visitors know of, use, and adjust their plans based on the real-time traffic and other information provided via the various information outlets proposed in the 2013 MORA ConOps.

This Appendix includes a draft MORA ITS evaluation survey instrument, which was developed based on a preliminary effort to adapt ITS evaluation survey instruments administered at other national parks to evaluate MORA ITS. The Appendix also includes options and recommendations regarding methods to administer the MORA ITS evaluation survey instrument. Finally, the Appendix includes some information about potential measures to assess the effects of the MORA ITS system on crowding and congestion. Additional work is needed to fully develop and specify crowding- and congestion-related measurement instruments and methods with which to evaluate the efficacy of MORA’s ITS system.

The remainder of this Appendix is organized as follows: Section 2 includes the draft MORA ITS evaluation survey instrument, including a description of how the survey instrument is structured; and Section 3 includes recommendations regarding the administration of the MORA ITS evaluation survey instrument.

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17 2013 MORA ConOps.
C.2 MORA ITS Evaluation Survey Instrument

As noted, the 2013 MORA ConOps recommends that MORA administer a visitor survey in conjunction with the initial and ongoing deployment and operation of ITS applications in the park. The purpose of the MORA ITS evaluation survey would be to assess the extent to which visitors know of, use, and adjust their plans based on the real-time traffic and other information provided via the various information outlets proposed in the 2013 MORA ConOps.

This section presents a draft MORA ITS evaluation survey instrument, which is the result of a preliminary effort to adapt ITS evaluation survey instruments administered at other national parks to evaluate MORA ITS. It is anticipated that the survey instrument will require additional refinements to meet MORA’s specific circumstances and needs that emerge as MORA proceeds with ITS deployments in the park. For example, the survey instrument may need to be shortened to minimize respondent burden and focus on the most salient information needs at the time the survey is administered. In addition, questions may need to be edited or added to the survey instrument to evaluate specific ITS applications implemented in the future. Moreover, the final version(s) of the MORA ITS evaluation survey instrument should take into account questions and question wording used in previous visitor surveys administered at MORA (e.g., 2011 Visitor Services Project Survey) Finally, the MORA ITS evaluation survey instrument must be reviewed and approved by the Office of Management and Budget (OMB) before it can be administered to park visitors and/or other members of the public.

The draft evaluation survey instrument includes a front cover and three primary sections. The front cover includes places for the survey administrator to record the date and time, location, weather conditions, and occurrence of special events when the survey was administered. The first section, entitled “Trip Description,” includes questions concerning respondents’ group sizes, the presence or absence of children under the age of 16 in respondents’ groups, the time respondents entered the park, respondents’ routes of travel to the park, , the number of days respondents were visiting the park, the locations where respondents stayed overnight in the park or surrounding area (if they were visiting for more than one day), the locations in the park respondents visited, and the activities in which respondents had participated in the park.

The second section of the draft MORA ITS evaluation survey instrument, entitled “Planning Your Trip to Mount Rainier National Park”, includes questions about when respondents decided to visit the park, what MORA ITS applications and other information sources respondents used to get information about traffic, parking, and crowding conditions in the park, whether respondents obtained information about traffic, parking, and crowding in the park that influenced their plans for visiting the park, and how traffic, parking, and crowding conditions in the park compared to what respondents had expected. This section also includes questions designed to assess whether respondents looked for and were able to find other types of trip planning information (e.g., road closures, park operating hours, etc.), and assess respondents’ perceptions of the quality of the trip planning information they obtained.

The final section of the draft MORA ITS evaluation survey instrument, entitled “Background Information,” includes questions concerning respondents’ ownership of smartphone devices, gender, age, state or country of residence, level of formal education, ethnicity, and race.

It should be noted, the draft MORA ITS evaluation survey instrument uses question wording that assumes the survey would be administered as a mail-back survey. The next section of this Appendix describes the relative advantages and disadvantages of administering the MORA ITS evaluation survey instrument as a mail-back survey or an onsite intercept survey. If a decision is made to administer the MORA ITS evaluation survey as an onsite intercept survey, it will be necessary to make minor edits to the question wording.
C.2.1 Draft ITS Evaluation Survey Instrument
Mount Rainier National Park
Intelligent Transportation Systems
Evaluation Survey
20XX

ID: ________     Date: ______________
Time:___________AM/PM    Binder # ____________
Location:__________________________________________________

Weather: Sunny / Partly / Overcast / Raining
Special Event: No/Yes_________________________________________
A. Trip Description

The following questions ask about your visit to Mount Rainier National Park (MORA) on the day you were contacted for this survey.

1. Including yourself, how many people were in your personal group in MORA on the day you were contacted for this survey? (Enter number of people.)
   
   ____________ Number of people

2. Were there any children under the age of 16 in your group in MORA on the day you were contacted for this survey? (Check one box.)

   □ Yes: ____________ Number of children
   □ No

3. Approximately what time did you enter MORA on the day you were contacted for this survey? (Enter time or check the box.)

   Approximate time: ____________AM/PM (CIRCLE ONE)

   OR

   □ I stayed overnight in the park the night before I was contacted for the survey.

   OR

   □ Don’t know/Not sure

4. In how many vehicles did you and your personal group travel to MORA the day you were contacted for this survey? (Enter number of vehicles.)

   Number of vehicles: ____________

   OR

   □ My group and I traveled to MORA by bicycle

   OR

   □ My group and I traveled to MORA by other means (please specify): __________________________
5. Which route did you use to travel to MORA on this trip? (Refer to the route map and check one box.)

☐ (#1 on route map)
☐ (#2 on route map)
☐ (#3 on route map)
☐ (#4 on route map)
☐ Other (Please specify): ________________________________

6. For how many days did you visit MORA and the surrounding area on the trip when you were contacted for this survey? (Check one box.)

☐ Just 1 day (SKIP TO QUESTION 8)
☐ More than 1 day

7. If you visited MORA and the surrounding area for more than one day during the trip when you were contacted for this survey, where did you stay? (Check all that apply and enter number of nights.)

<table>
<thead>
<tr>
<th>Did Not Stay Here</th>
<th>Stayed here</th>
<th>Number of nights stayed here</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradise Inn</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>National Park Inn (Longmire)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cougar Rock Campground</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Ohanapecosh Campground</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>White River Campground</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Mowich Lake Campground</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Hotel/motel outside of MORA (Please specify):</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Campground outside of MORA (Please specify):</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Other (Please specify):</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
8. Which of the following locations did you visit in MORA on the day you were contacted for this survey? (Check one box for each location.)

<table>
<thead>
<tr>
<th>Location</th>
<th>Visited</th>
<th>Did Not Visit</th>
<th>Don’t Know/Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradise</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Longmire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sunrise</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>White River</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Ohanapecosh</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Carbon River area</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Mowich Lake area</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Other (Please specify):</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

9. What was your primary destination in MORA on the day you were contacted for this survey? (Enter name of primary destination or check the box.)

Primary destination in MORA: ________________________________

OR

☐ I did not have a primary destination in MORA.
10. Which of the following activities did you do in MORA on the day you were contacted for this survey? (Check one box for each line.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Did Activity</th>
<th>Did Not Do Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Attend ranger-led talks/programs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Bicycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Climb to the summit of Mount Rainier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Creative arts (photography/drawing/painting/writing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Day hike</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Drive to view scenery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G Enjoy solitude/quiet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Have a picnic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J Camp in developed campground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K View wildflowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L View wildlife</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M Wilderness/backcountry camping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N Ride the park’s shuttle bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O Other (Please specify):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. Which of the activities listed in Question 10 would you consider to have been your primary activity in MORA on the day you were contacted for this survey? (Enter letter of primary activity or check the box.)

Letter of primary activity in MORA: ______

OR

☐ I do not have a primary activity today.
The next set of questions asks about planning you may have done to prepare for the trip you took to Mount Rainier National Park when you were contacted for this survey.

12. **How long before the day you were contacted in MORA for this survey did you decide to take this trip to the park? (Check one box.)**

- [ ] The day I was contacted in MORA for the survey
- [ ] The day before I was contacted in MORA for the survey
- [ ] The week before I was contacted in MORA for the survey
- [ ] More than a week, but less than a month before I was contacted in MORA for the survey
- [ ] A month or more before I was contacted in MORA for the survey

13. **Did you use any of the following to look for information about traffic, parking, or crowding conditions in MORA when you were planning or during your trip to the park? (Check one box for each item.)**

<table>
<thead>
<tr>
<th>Information Source</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>MORA website (<a href="http://www.nps.gov/mora">www.nps.gov/mora</a>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other website (please specify): _________________________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live web cameras on MORA website</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speak to a MORA employee on the phone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smartphone app with information about MORA (please specify app): ______________________________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSDOT 511 traveler information telephone line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSDOT traveler information website (<a href="http://www.wsdot.com/traffic/">http://www.wsdot.com/traffic/</a>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORA Facebook page</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORA Twitter feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORA YouTube videos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORA Flickr group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORA highway advisory radio station (1610 AM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic highway message sign with information about MORA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel/Motel/Campground staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel guide/Tour book</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify): _________________________________</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14. Did you find any information about traffic, parking, or crowding conditions in the park that affected your plans for visiting MORA during the trip when you were contacted for this survey? (Check all that apply.)

Yes, information about traffic, parking, or crowding caused me to…

- Visit places in the park I thought would be less crowded
- Visit the park on a day I thought would be less crowded
- Visit the park at a time of day I thought would be less crowded
- Use the park shuttle bus, rather than try to park at our destination in the park

OR

- No, I did not find information about traffic, parking, or crowding that affected our plans for visiting MORA

15. Please indicate how your experience of each of the following items during your visit to MORA on the day you were contacted for this survey compared with your expectations. (Check one box for each line.)

<table>
<thead>
<tr>
<th>How did it compare to your expectations?</th>
<th>More than expected</th>
<th>About as expected</th>
<th>Less than expected</th>
<th>I had no expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The amount of time you had to wait in line to enter the park.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>The amount of traffic you saw on park roads.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Difficulty you had finding parking spaces at your destination(s) in the park.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>The number of people you saw in the park.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
16. What other types of information did you look for and find while you were planning or during your trip to MORA? (Check one box for each item.)

<table>
<thead>
<tr>
<th>Found Information</th>
<th>Could Not Find Information</th>
<th>Did Not Look For Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park hours and entrance fees</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Activities available at park</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Trail and/or road conditions</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Information on road closures</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Information on road work/construction/closures</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Availability of parking</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Transit/shuttle information</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Road accidents</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Weather conditions</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Directions to park attractions</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Interpretive information</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Trail/attraction crowding conditions</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Roadway/parking congestion</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Campground/lodging availability</td>
<td>❏</td>
<td>❏</td>
</tr>
<tr>
<td>Other (Please specify):</td>
<td>❏</td>
<td>❏</td>
</tr>
</tbody>
</table>
17. Do you agree or disagree with each of the following statements about the information you used to plan or obtained during your trip to MORA? (Check one box for each item.)

<table>
<thead>
<tr>
<th>The information was…</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to understand and read</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timely for making decisions about my/our trip.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to find.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistent with what I experienced in the park.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete/comprehensive.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Background Information

18. Were you and/or anybody else in your group traveling with a smartphone, tablet, or other device that connects remotely to the internet on your trip to MORA when you were contacted for this survey? (Check one box.)

- Yes: _________ Number of smartphones/tablets/other internet devices
- No

19. What is your gender? (Check one box.)

- Male
- Female

20. In what year were you born?

Year born: __________

21. Do you live in the United States? (Check one box.)

- Yes (What is your zip code? __________)
- No (What country do you live in? ______________________________)

22. What is the highest level of formal education you have completed? (Check one box.)

- Some high school
- High school graduate or GED
- Some college, business or trade school
- College, business or trade school graduate
- Some graduate school
- Master’s, doctoral or professional degree

23. Are you Hispanic or Latino? (Check one box.)

- Yes
- No
24. **What is your race?** (Check all that apply.)

- [ ] American Indian or Alaska Native
- [ ] Asian
- [ ] Black or African American
- [ ] Native Hawaiian
- [ ] Pacific Islander other than Native Hawaiian
- [ ] White

Thank you for your help with this survey! Please return it to the surveyor.
PRIVACY ACT and PAPERWORK REDUCTION ACT statement:
16 U.S.C. 1a-7 authorizes collection of this information. This information will be used by park managers to better serve the public. Response to this request is voluntary. No action may be taken against you for refusing to supply the information requested. Your name is requested for follow-up mailing purposes only. When analysis of the questionnaire is completed, all name and address files will be destroyed. Thus the permanent data will be anonymous. Data collected through visitor surveys may be disclosed to the Department of Justice when relevant to litigation or anticipated litigation, or to appropriate Federal, State, local or foreign agencies responsible for investigating or prosecuting a violation of law. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

BURDEN ESTIMATE STATEMENT: Public reporting burden for this form is estimated to average 10 minutes per response. Direct comments regarding the burden estimate or any other aspect of this form to Information Collection Clearance Officer, WASO Administration Program Center, National Park Service, 1849 C Street, N.W., Washington, D.C. 20240.
C.3 Methods

This section includes recommendations regarding methods to administer the MORA ITS evaluation survey instrument. The methods described in this section assume that when the survey is administered, MORA will have fully adopted and implemented the ITS system proposed in the 2013 MORA ConOps 2013. It is reasonable to expect that the 2013 MORA ConOps may be implemented in phases, and therefore the evaluation methods (and survey instrument itself) may need to be adapted according to phases of MORA ITS deployment.

C.3.1 Survey Administration

It is recommended that the MORA ITS evaluation survey instrument be administered as either an onsite intercept survey or as a mail-back survey; both options have advantages and disadvantages which are described below. Whether the survey is administered as an onsite intercept or a mail-back survey, it is recommended that the survey be administered to visitors after they have visited the park. In this way, the survey would be administered to visitors after they have had a chance to use (or not use) any or all of the components of MORA’s ITS system and have experienced the park.

The exact locations and logistics of survey sampling cannot be fully specified at this time, as they will be dictated, to a large extent, by the objectives of the evaluation at the time(s) the survey is administered. Moreover, the survey administration locations and procedures should be reviewed in the field and approved by park staff before the survey is administered. More generally, regardless of whether an onsite intercept or mail-back survey administration method is selected, it is recommended that the survey be administered to exiting visitors at all of the primary areas of the park, including:

- Nisqually Corridor
- Stevens Canyon Corridor
- Sunrise/White River
- Carbon River
- Mowich Lake
- Ohanapecosh
- Tipsoo Lake

The purpose of administering the survey at all of the above park locations is to assess the extent to which visitors’ park destinations were influenced, to any extent, by information they received via MORA’s ITS system. If surveys are administered only in the Nisqually Corridor, for example, it won’t be possible to assess whether some visitors chose to visit other areas of the park (e.g., Carbon River or Mowich Lake) based on information about traffic, parking, or crowding at sites within the Nisqually Corridor. Similarly, if shuttle service is operating from park-and-ride locations outside of the park to MORA when the MORA ITS evaluation survey is administered, the survey should also be administered to visitors who use these park-and-ride locations for shuttle service to the park.

Ideally, the MORA ITS evaluation survey would also be administered to visitors at other regional outdoor recreation areas and facilities (e.g., US Forest Service units) to assess whether information from MORA’s ITS system altered these respondents travel plans away from MORA to these other locations. However, it may not be possible to administer surveys at non-park locations, due to budget and staff constraints. In addition, it may be difficult to acquire a sufficient size sample of respondents at any one particular regional outdoor recreation area whose travel plans were altered by information from MORAs’ ITS system (i.e., who chose to visit alternate outdoor recreation areas to avoid crowding or congestion at MORA).
Finally, the MORA ITS evaluation survey instrument should, ideally, be administered in MORA during peak and non-peak periods of the day, days of the week, and months of the year to assess whether information from MORA’s ITS system persuades some people to visit MORA during non-peak periods to avoid crowding and congestion at MORA during peak periods. However, if a choice must be made, due to financial and/or administrative constraints, about when to administer the survey, the priority should be to administer surveys during peak periods to maximize survey sampling efficiency and cost effectiveness. That being said, if surveys are not administered during non-peak periods, it will be difficult to assess the extent to which and what components of MORA ITS persuade people to visit MORA during non-peak periods.

Onsite Intercept Exit Survey

Administering the MORA ITS evaluation survey as an onsite intercept exit survey has the advantage that visitors are intercepted and complete the questionnaire immediately after experiencing the park. Their experiences in the park are fresh on their mind and visitors are less likely to experience recall bias (record inaccurate responses on the questionnaire due to faulty memory of events and experiences). A disadvantage to an onsite exit survey is visitors would be contacted at the end of their park visit, as they are heading home or to another destination, and consequently may be unwilling to participate in the survey or might complete the questionnaire in a rushed manner.

If MORA chooses to administer the MORA ITS evaluation survey instrument as an onsite intercept exit survey, a minimum of two survey administrators are needed at each location where the survey is administered. In locations where it is necessary to intercept exiting visitors traveling on park roads (e.g., outbound travel lanes at park entrance stations), one survey administrator would be stationed on the shoulder of the road near the exit point, to intercept visitors while they are exiting the park. The survey administrator at this location should wear a traffic safety vest and use a hand-held stop sign to stop selected cars and direct them into a safe stopping area, off road, that may be designated with traffic cones. At the start of each sampling day, the survey administrator would intercept the first automobile approaching the intercept location and direct them into the parking area. Once the automobile is safely off the road and located in the designated area, the survey administrator would return to the road shoulder and intercept the next automobile to approach the intercept location. This procedure would continue until a maximum of two visitor vehicles are in the pull-off area (if space is limited in the pull-off area, it may not be possible to pull over more than one car at a time).

A second survey administrator would be stationed in the designated area for survey administration. This second survey administrator would conduct survey participant screening and recruiting, once visitor groups’ automobiles are safely off the road and positioned in the designated area (Figure 8). The survey administrator would approach each automobile that has pulled over in the designated survey location and request their participation in the survey. A randomly selected adult member (18 years of age or older) of each visitor group who agrees to participate in the survey would be given a copy of the survey instrument and asked to complete it onsite. Alternatively,
the survey instrument could be administered to the person identified as the group’s trip planner. In the former case, the survey results are generalizable to visitor groups, and in the latter case, survey results are generalizable to the visitor groups’ trip leaders. The respondent selection method should be made based on MORA’s objectives for the evaluation (e.g., to understand how visitor groups, generally, or trip planners, specifically, use and respond to MORA ITS). Visitor groups who were unwilling or unable to participate in the survey would be thanked for their consideration. After each visitor group completes the survey instrument or declines to participate, the survey administrator would direct them safely back onto the road.

In some locations it would be possible to intercept respondents as they are exiting the park, but before they enter their vehicles (e.g., Mowich Lake, Carbon River). In these cases, the intercept procedures would be similar to those described above for roadside intercepts (which would be required for visitors exiting the Nisqually Corridor, for example), with the exception that visitors would be intercepted at trailheads or parking lots, rather than on the roadway.

Mail-Back Survey

Administering the MORA ITS evaluation survey as a mail-back survey has the advantage that visitors would not complete the entire questionnaire onsite, but instead would be administered a survey instrument to fill out at home and mail back to the survey administrator at a later time. This approach would require less time from visitors onsite, as they are exiting the park, and would allow them to complete the questionnaire on their own time. In addition, visitors may have fewer distractions to contend with than if they were asked to complete the survey instrument onsite. However, in the case of a mail-back survey, visitors’ responses to survey questions are more likely to be subject to recall bias than in the case of answering questions at the time of their visit in an onsite intercept exit survey. In addition, in the case of a mail-back survey, visitors would not complete the questionnaire in the presence of a survey administrator and consequently could not ask questions of the administrator, if needed. Finally, mail-back surveys tend to have lower response rates than onsite intercept surveys. However, mail-back survey response rates can be optimized by following the Tailored Design Method (Dillman, 2000)\(^\text{18}\), which provides best practices for mail surveys. The Tailored Design Method includes the following general steps for administration of a mail-back survey:

1. Intercept visitors onsite as they are exiting the park, using procedures described above.
2. Hand out survey instruments (with postage-paid return envelopes) to respondents at the onsite intercept location.
3. Collect respondents’ names, mailing addresses, and other descriptive information at the onsite intercept location.
4. Mail a follow-up reminder/thank you postcard to each study participant approximately four days after they were contacted at the onsite intercept location.
5. Mail a follow-up letter and replacement questionnaire to those study participants who have not completed and returned the survey instrument within four weeks of when they were contacted at the onsite intercept location.

While the Tailored Design Method is likely to result in higher response rates than a mail-back survey administered onsite with no follow-up mailings, it raises the cost of survey administration. Despite the additional cost, it is recommended that if the MORA ITS evaluation survey is administered as a mail-back survey, the administration procedures follow the Tailored Design Method.

C.3.2 Crowding and Congestion-Related Measures of MORA ITS Efficacy

As noted, the MORA ITS evaluation survey instrument is designed to assess visitors’ use and evaluation of MORA’s ITS system. A comprehensive evaluation of MORA’s ITS system should also include congestion- and crowding-related measurement instruments and methods. While it is beyond the scope of this Appendix to fully specify crowding- and congestion-related measures and methods with which to evaluate MORA’s ITS system, it is recommended that the MORA ITS evaluation include measures of real-time roadway traffic volumes, parking accumulation, and visitor use. The crowding- and congestion-related measures should be recorded each year preceding, during, and following implementation of the 2013 MORA ConOps to establish baseline conditions and assess the potential effects of MORA ITS on traffic, parking, and visitor use conditions over time.