

NORTH/WEST PASSAGE



August 2016

Operations and Travel Information Integration Sharing
(OTIIS) Website Structure and Ownership

Final Summary Report: Project 10.1



Table of Contents

1.0	INTRODUCTION	1
1.1	Purpose of the Document	1
1.2	Audience(s) for this Document	1
1.3	Supporting OTIIS Documentation	2
2.0	OVERALL OTIIS STRUCTURE	3
3.0	OTIIS WEB SITE HOSTING AND OPERATIONS	5
3.1	Hosting of the OTIIS Operational Website	5
3.2	Maintenance of the OTIIS Website	6
3.3	OTIIS Software Modifications, Enhancements, and Improvements	7
3.4	OTIIS Domain Name Registry	8
4.0	OTIIS SOFTWARE OWNERSHIP	9
5.0	OTIIS SOFTWARE SOURCE CODE AND DOCUMENTATION	10
6.0	CONCLUSIONS AND RECOMMENDATIONS	10

1.0 INTRODUCTION

In 2012, North/West Passage initiated the Operations and Travel Information Integration Sharing (OTIIS) project. Working in partnership with the Western Transportation Institute (WTI) at Montana State University (MSU), a proposal was submitted to FHWA and awarded federal funding through the Multimodal Corridor Operations and Management (MCOM) Program. The purpose of the MCOM program is to promote regional cooperation, planning, and shared project implementation for research programs and projects that improve multimodal transportation system management and operations. Research and development during the first phase of the OTIIS project was carried out by the Western Transportation Institute (WTI) and MSU Computer Science Department, and a final operational OTIIS website is now available at <http://www.roadstosafediscovery.com>.

The OTIIS website is not intended to replace individual state DOT traveler information websites, but rather to supplement existing sites with features not possible on state-centric sites. OTIIS offers users point to point route planning for routes that are either within one state or that span multiple states. Once a route is requested, the OTIIS system provides information on weather hazards, road work, crashes and incidents, as well as various tourist information. The OTIIS concept also includes a mobile application that would enable users to access information and view the most current information while en-route. The OTIIS mobile application is in the testing and initial use stage, and is not represented in diagrams or text descriptions below.

1.1 Purpose of the Document

A second phase of OTIIS has been funded to maintain operations and maintenance of the OTIIS website, as well as limited enhancements and feature modifications. North/West Passage members requested a summary of the structure and ownership of the OTIIS website to support future decisions about funding operations and maintenance. The primary intent of this document is to help answer the following questions asked by North/West Passage members such that they may make educated decisions about future hosting, operations, and maintenance activities of OTIIS:

- What components make up the OTIIS website and how is it structured?
- What is the ownership status of the OTIIS software components?
- What software languages, tools, and external processes are needed by OTIIS that may impact hosting and operations locations?
- What is the potential for OTIIS to be hosted and maintained by a member agency?

WTI provided input to this process and the results are documented in this deliverable to support ongoing discussions among members about the future of OTIIS.

1.2 Audience(s) for this Document

This document was written for two distinct audiences and uses:

- **Members of the North/West Passage Pooled Fund Steering Committee.** Members of the Steering Committee have expressed questions about whether OTIIS operations and support might be performed by one or more member agencies (hosted within the DOT), and if so whether cost savings would be recognized. Therefore, portions of this document are written to provide high

level summaries of the current costs of hosting and operations support to allow an informed discussion about whether this would be a cost savings.

- ***Information Technology (IT) staff members within North/West Passage member agencies.*** Member agencies have requested information about the structure and software needs of OTIIS to assist any member agency that may wish to explore whether OTIIS could be hosted within their agency. For example, if a Steering Committee member were to inquire within their agency about the potential to host OTIIS, the initial questions would include: What language is it written in? What database does it use? What skillsets are needed to support operations and maintenance? Therefore, there are details within this document that are directed more towards those member agencies that might decide to share this with IT staff, should they wish to investigate hosting OTIIS internally within their organization.

1.3 Supporting OTIIS Documentation

As required by the MCOM grant requirements, the OTIIS project followed a structured systems engineering process that resulted in a Concept of Operations document, and a Systems Requirement document, both of which fed into the design and development of the website. In addition, WTI created an OTIIS business model document and marketing/public education plan. These documents are available on the North/West Passage website at the following links:

- [Concept of Operations](#) (PDF, 2034K)
- [System Requirements](#) (PDF, 644K)
- [Business Model](#) (PDF, 1009K)
- [Marketing/Public Education Plan](#) (PDF, 662K)

2.0 OVERALL OTIIS STRUCTURE

The following illustration and related narrative identifies the primary components of OTIIS, and will be used multiple times within this document to highlight specific information.

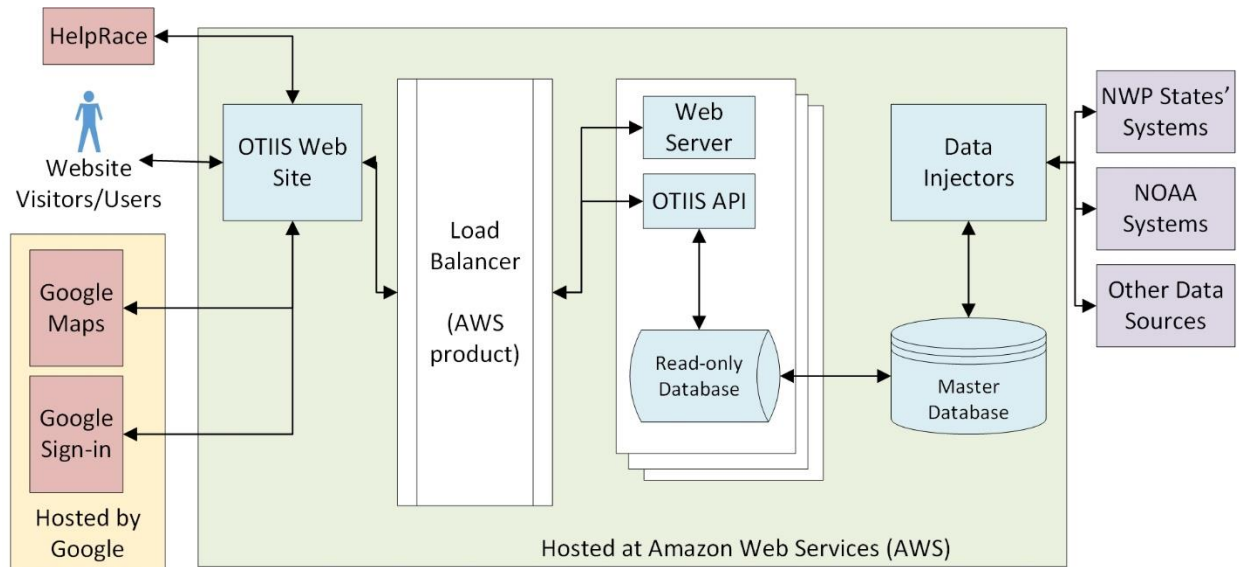


Figure 1: Overall OTIIS Structure

The OTIIS structure makes use of several resources, described as follows:

- **Existing web applications** available to standard browsers are used (illustrated in red above). These include Google Maps (providing full feature map navigation and supporting address specific navigation), Google sign-in (establishing credentials of users to maintain preferences and planned trips).
- Several **open source software components** are used in OTIIS. Open source software systems are available for use without any fees for royalties or use. Typically maintained by the open source community, open source software components tend to be kept current to state of the practice browsers and access equipment. Whenever possible, open source software presents a solid, reliable option that is typically less expensive than custom software. Open source components of OTIIS illustrated above include the [PostgreSQL](#) database, Javascript libraries, and road topology data available from [OpenStreetMap](#).
- The functionality of OTIIS required **custom software components** specific to OTIIS that were developed by the MSU Computer Science Department. These components (illustrated in blue above) include the following:
 - **OTIIS Web Page** – Including the user interface display and related functionality to support user requests and the display of information. The software languages used to develop the OTIIS Web page include:
 - HyperText Markup Language (HTML) – a standard markup language used to create web pages.

- Cascade Style Sheets (CSS) – a language that makes it possible to attach style attributes such as font size and color to structured documents (including HTML) and to separate the style from the content of the documents., and
- Javascript – a high level common programming language that (like HTML and CSS) is supported by all modern browsers without the need for plugins.
- **The Data Injectors** – that were written to interface with the NWP member agencies’ on-line data sources and other real-time data sources to acquire data and insert it into the appropriate database field. The Data Injectors are written in the software language Perl 5 – a recognized common gateway interface (CGI) programming language often used in applications where data is extracted and parsed from different sources. The Data Injectors include the following:
 - Member state XML feeds – Each state’s XML format is unique (with the exception of Idaho and Minnesota). Data is extracted from the XML feed every 5 minutes. Adding an additional feed of data (or modifying an existing state DOT injector requires programming effort to define the data parses.
 - Weather alerts – are acquired from NOAA’s public alerts XML feed every 15 minutes at the following site: <http://alerts.weather.gov/>
 - Weather forecasts - are acquired from NOAA’s public alerts XML feed every 15 minutes at the following site: <http://graphical.weather.gov/xml/>
 - Road Weather Information System (RWIS) data - are acquired from NOAA’s MADIS dataset XML feed every 30 minutes at the following site: <https://madis-data.ncep.noaa.gov/>.
- **The Application Programming Interface (API)** –The OTIIS API is written in JavaScript (Node.js) Node.js is an open source environment for developing server-side Web applicationsi
- The functionality of OTIIS also required **custom data sources** to populate portions of the databases. These include information about landmarks, tourist attractions, and parks. Typically created in Microsoft Excel by WTI, these are included in the database.

3.0 OTIIS WEB SITE HOSTING AND OPERATIONS

As a high level description, the OTIIS website hosting and operations can be described by four areas:

- **Hosting of the operational website** – including multiple load balanced servers, redundant power, and internet connectivity that is standard for operational websites.
- **Maintenance of the operational website** – including reacting to issues that temporary impact one or more components of the site.
- **Software modifications, enhancements, and improvements** – including the addition of new features, reacting to user feedback regarding preferences, and other modifications.
- **Domain name registry** – securing the name roadstosafediscovery.com.

The following subsections document the current approaches, together with alternatives and estimates of costs.

3.1 Hosting of the OTIIS Operational Website

During development and initial soft launch, the OTIIS web site was hosted at WTI/MSU facilities. The production OTIIS site was migrated to Amazon Web Services (AWS) cloud computing service, specifically at the Amazon data center in Oregon. The advantage of hosting OTIIS at a cloud computing service include the following:

- The software is load balanced across multiple servers to support peaks in usage;
- There is no need to purchase physical hardware or to maintain and replace physical hardware. If physical hardware were purchased for a non-cloud based hosting approach, it is likely that multiple servers would be required to accommodate unknown levels of peaks in usage as use increases.

Hosting services provided by AWS currently cost approximately \$205/month including monitoring tools. These costs are dependent upon actual usage and as requests per day increase this cost will increase moderately.

3.1.1 Alternate Options for Hosting the OTIIS Website

North/West Passage member states have inquired in the past about whether OTIIS could potentially be hosted at facilities operated by one of the member states. There is nothing in the OTIIS website that would prevent moving the software code to a different hosting solution, however a new provider would need to provide a load balancing service, or a load balancing service would need to be developed. WTI/MSU noted that OTIIS is currently running on the second lowest instance that AWS offers. Some specific descriptions of the individual components and requirements for the hosting environment are provided as follows:

- The OTIIS Data Injectors currently run on a single AWS instance. These require Perl 5 and standard Linux tools that include: cron, wget, and bash. The Data Injectors also require AWS Command Line Interface (CLI).
- The database requires version 9.3 or higher of PostgreSQL with PostGIS extension.

- The API and web server both operate on multiple load balanced AWS instances referred to as Front End Servers in the illustration above. The front end servers also contain local read-only copies of the databases.

3.1.2 Estimated Efforts to Migrate the OTIIS Website

In the event that the OTIIS website were to be migrated to a different hosting situation, the process to migrate the site is well understood as WTI/MSU migrated the site from their facility to AWS. Based upon the experiences of the initial migration, the following bullets summarize what is expected:

- Migration of the site to AWS was performed by a graduate student with no previous experience with AWS, but who was already familiar with the components of the OTIIS website. Approximately 160 hours were spent migrating the site to AWS.
- The prior experience was also a migration of OTIIS from a single server environment to the AWS environment that utilizes multiple servers for load balancing. The relational database server (RDS) used by AWS caused some difficulties because of limitations to root access to the hosting machine and not providing a true “super user” role. This is one example of the situations that present when migrating to a new environment.
- WTI/MSU estimates that migration to a new hosting provider would likely take 1-4 weeks, depending upon the individual’s familiarity with the hosting provider and with the OTIIS software.
- WTI/MSU have also noted that if the OTIIS website is likely to be ported multiple times, there are tools and modifications to the software that could be implemented to reduce the effort required to migrate to new locations.

3.2 Maintenance of the OTIIS Website

Any website being operated requires maintenance, regardless of whether new features or enhancements are being added. Some examples of the activities that would be performed and categorized as OTIIS website maintenance include:

- Failures that occur between components or with regards to access to the databases;
- Issues with the data injector, possibly related to changes in the data source; and
- Issues that result from common Internet browser upgrades that require modification to source code.

WTI/MSU estimates that without software improvements being performed, maintenance of the OTIIS website may require approximately 10 hours per month (estimated to be less than \$1,000 per month). However, it is also important to be respectful of the knowledge level that is required to perform maintenance of a software system like OTIIS. WTI/MSU are able to maintain the site with limited hours, because of the knowledge of how the software was created. The hours required by individuals not familiar with the software code would likely be increased.

3.2.1 Experience Required to Maintain the OTIIS Website

Individuals maintaining the OTIIS website would be required to have working knowledge of the following:

- **Knowledge of AWS (or an alternate hosting provider).** As long as OTIIS is hosted at AWS, any maintenance activities would require interaction with the AWS structure and therefore a working knowledge would be required by the individuals maintaining OTIIS.
- **Basic knowledge of relational databases and SQL.** At any time, the maintenance of OTIIS may require adjustments to the source code that directs the data inserts, data queries, data updates, and data deletes that are performed for the relational databases. As a minimum, individuals maintaining the OTIIS source code would need familiarity with SQL.
- **Knowledge of web software programming languages.** As noted earlier, the OTIIS webpage is written using HTML, CSS, and JavaScript. Troubleshooting or routine maintenance of the website portion of OTIIS would require working knowledge of all three of these languages. In order to edit or add additional Data Injectors, individuals would need a working knowledge of Perl 5 and Linux.
- **Knowledge of the process to create and edit Data Injectors.** As noted above, the data injectors are written in Perl 5. It is likely that the sources of OTIIS data (DOT hosted XML feeds or other NOAA sources) may be upgraded or modified at any time. As a result, to maintain current operations of OTIIS, it is likely the existing data injectors would need modifications. It is difficult to predict the frequency of this as it is dependent upon the changes made to external systems. However, should such a change occur, this would be a time critical maintenance feature needed to maintain functionality of the site.

It is also important to note that in situations where websites are simply maintained without any ongoing budget for improvements or enhancements, the sites become dated and eventually there is the risk that the number of human resources with familiarity with the software code will reduce. For these and other reasons, typical websites do not only budget for maintenance, but also for some degree of improvements and modifications, described in more detail in the next section.

3.3 OTIIS Software Modifications, Enhancements, and Improvements

The current funding for OTIIS maintenance and operations includes a set of hours each month for WTI/MSU to perform software improvements and to be responsive to requests. WTI/MSU maintains a list of modifications to be implemented for OTIIS, and dedicate the time allocated each month towards addressing as many of these features as possible.

An advantage to this approach is that staff members are working in the OTIIS code each month, maintaining familiarity with the code. This supports the maintenance of the software.

3.3.1 Experience Required to Perform Software Enhancements or Improvements to OTIIS

Individuals involved in adding features or functions to the OTIIS website would be required to have working knowledge of the same items required for maintenance of the site, but increased knowledge of the internal OTIIS logic and source code:

- **Basic knowledge of relational databases and SQL.** The addition of new features and functionalities would most likely involve modifications to the data inserts, data queries, data

updates, and data deletes that are performed for the relational databases. As a minimum, individuals modifying the OTIIS source code would need familiarity with SQL.

- **Knowledge of web software programming languages.** As noted earlier, the OTIIS webpage is written using HTML, CSS, and JavaScript. Individuals making edits to the website portion would require working knowledge of all three of these languages. In order to edit or add additional Data Injectors, individuals would need a working knowledge of Perl 5 and Linux.
- **Knowledge of the OTIIS source code.** The time required to add or modify functionalities of OTIIS will depend on each individual's working knowledge of the OTIIS source code.
- **Knowledge of the process to create and edit Data Injectors.** As noted above, the Data Injectors are written in Perl 5. In addition to the software language, any individuals modifying existing data injectors would need a working knowledge of this and relational databases, as well as an understanding of how to write software to parse data, and a familiarity with the data sources themselves. The data injectors acquire data from various sources, perform any normalization needed, and insert the data into the appropriate database fields. Therefore, this goes beyond software source coding to also require familiarity with the data sources. Data Injectors may need to be edited if the sources (DOT XML files, NOAA, other sources) change the format or add or subtract fields.

3.4 OTIIS Domain Name Registry

The OTIIS domain name is registered with namesilo.com. AWS Route 53 is being used for the DNS service. In addition to roadstosafediscovery.com, WTI/MSU also secured the .net and .org domains. Each domain name costs \$9/year, total cost is \$27/year.

4.0 OTIIS SOFTWARE OWNERSHIP

Developed as a public sponsored project, the OTIIS software developed through this project is considered to be owned by the project partners that contributed funding (including FHWA, the North/West Passage member states). All project partners have also discussed the benefits of, and are comfortable with WTI/MSU contracting with other agencies to expand OTIIS to additional states beyond the North/West Passage corridor. Potential benefits of this would be shared costs for enhancements and operations and maintenance.

As mentioned earlier, the OTIIS website was developed using a variety of external services, open source software, and custom software. The ownership of OTIIS software applies to the custom software developed for the project. Figure 2 below illustrates these portions using color coding.

Specific software called out by WTI as not custom software (and therefore not owned by the project partners) include:

- Google Maps and Google Sign-in as these are third party proprietary systems;
- A customer service tool called HelpRace is also being used for feedback and bug reporting.

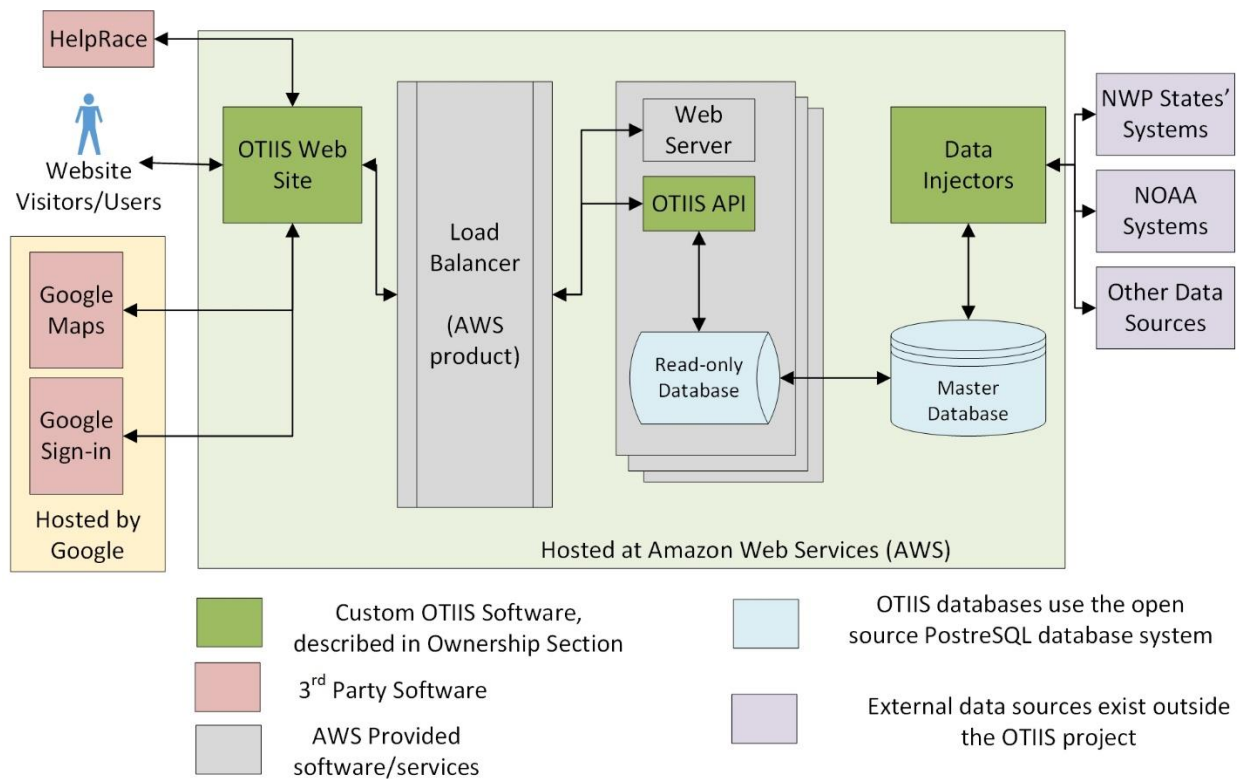


Figure 2: Illustration of OTIIS Ownership

5.0 OTIIS SOFTWARE SOURCE CODE AND DOCUMENTATION

The OTIIS software source code is maintained by WTI/MSU. The intent of this document was not to include the code, but the expectation is that the source code would be delivered by WTI before project completed.

6.0 CONCLUSIONS AND RECOMMENDATIONS

One of the primary intents of this document is to assist North/West Passage member states in assessing how best to proceed with operations of the OTIIS website. Member suggestions have included concepts for migrating OTIIS to one of the member states, where DOT staff could host and maintain the site.

Based on the data and information, the following is summarized:

1. The hosting costs are minimal considering the state of the art hosting features offered by AWS. Hosting costs with AWS would only increase as OTIIS reached a much higher level of system use.
2. The hosting approach of a third party provider such as AWS would support a scenario of additional states or corridors deploying OTIIS, allowing cost sharing to occur, which would be more difficult if OTIIS was hosted by one of the North/West Passage member states.
3. ***Because of Items 1 and 2, the recommendation is to not explore hosting OTIIS at one of the North/West Passage member state's facilities at this time.***
4. Maintenance of the OTIIS site is also not a large cost (estimated 10 hours per month for maintenance only).
5. Under a scenario of a North/West Passage member state taking over hosting the OTIIS website, it is likely that considerable time might be required to become familiar with the OTIIS system and during this "ramp-up" period, considerable more hours would be required beyond the 10 per month.
6. A risk to the maintenance of a website like OTIIS is that eventually (if there is not funding for continued improvements of the site) the individuals responsible for maintaining the site may leave current positions and it may become more difficult to accomplish maintenance for 10 hours per month. This risk is true regardless of who is maintaining the site.
7. ***Based on items 4-6, the recommendation is that North/West Passage members continue to plan on the costs for WTI/MSU to maintain the OTIIS website for as long a period as they consider it critical for operations.***
8. An ongoing commitment to website improvements, bug fixes, and expanded features represents the largest cost item. The current approach is to fund WTI/MSU at a fixed number of hours per month, and the requests for improvements and bug fixes are prioritized, and as many are accomplished as possible each month.
9. As items 1-7 have illustrated, simply maintaining OTIIS hosting and maintenance represents a relatively inexpensive option (roughly \$12,000/year). However, it is rare for a traveler information website to not be improved regularly, and North/West Passage members would need to determine if they are comfortable with the current version as the final version before committing only to hosting and maintenance. Also, the figure of \$12,000 should not be confused as a

minimum estimate for WTI/MSU to maintain operations annually. WTI/MSU would need to be involved in any discussions about minimum costs for them to maintain operations.

10. Based on items 8-9, the recommendation is for the North/West Passage member states to discuss and determine their overall plan for OTIIS in the coming years. The intent of the trial deployment period and extended operations period was to experience the software and assess the benefits to travelers. At this time, North/West Passage members should discuss and determine:
 - Has the operational period of OTIIS has been sufficient to understand the potential benefits of OTIIS operation or is an extended trial period is needed?
 - Are (based on the results to date) North/West Passage members (either collectively or individual states) committed to continuing to operate OTIIS and willing to invest annual resources to maintain hosting, operations, and continued website improvements, if so what annual funding level are members willing to commit to?
 - Is the potential impact of the mobile application understood or is additional assessment required?
11. Finally, the annual process of identifying WTI/MSU students and staff, and allocating time for a project team should be considered and included in the decision process and timing of decisions regarding future funding for operations and improvements.

¹ Wikipedia - <https://en.wikipedia.org/wiki/Node.js>