



MONTANA
STATE UNIVERSITY



NWP OTIIS: Heterogeneous Data Integration for Operations and Travel Information Sharing

Mike P. Wittie

mwittie@cs.montana.edu





<http://atom-smasher.org/construction/>



Trip Start: Bozeman, MT Trip Destination: Minneapolis, MN Travel Date: Departure Time:

[RESET PAGE](#) [MOBILE APP](#) [RESOURCES](#) [SUPPORT](#) [ABOUT](#) [CONTACT](#) [Sign In | Create Account](#)



Goal: Provide comprehensive, up-to-date, corridor-wide road information to travelers



What Would You Like To See?

- Road Work Weather Alert
- Incident Traffic Congestion
- Road Condition Road Closure
- Weather Temporary Truck Restriction
- Mountain Pass Camera
- Cautionary Zone RWIS
- Weigh Station

Route Summaries		
① Summary	Length: 980 Miles Ideal Drive Time: 13 Hours 39 Mins	② Summary
<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Category: met Alert for Big Timber... <input checked="" type="checkbox"/> Category: Met Alert for Stearns (Minneso...) <input checked="" type="checkbox"/> Category: Met Alert for Hennepin; Wright... <input checked="" type="checkbox"/> active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED... 	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Category: met Alert for Big Timber... <input checked="" type="checkbox"/> active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED... <input checked="" type="checkbox"/> active Mon Mar 11 2013 01:00 MDT BRIDGE, 45 MPH REDUCED SPE... <input checked="" type="checkbox"/> active Tue Jun 03 2014 01:00 MDT STRIPING... 	③ Summary
		<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Category: met Alert for Big Timber... <input checked="" type="checkbox"/> Category: Met Alert for Carver (Minnesot...) <input checked="" type="checkbox"/> active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED... <input checked="" type="checkbox"/> active Mon Mar 11 2013 01:00 MDT BRIDGE, 45 MPH REDUCED SPE...

NWP OTIIS – A partnership



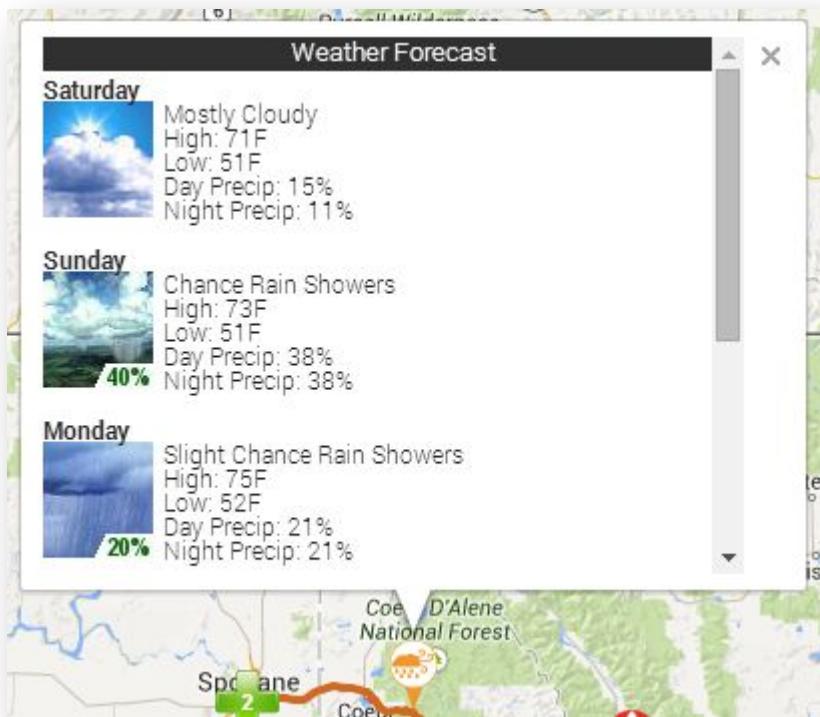
What makes NWP OTIIS unique



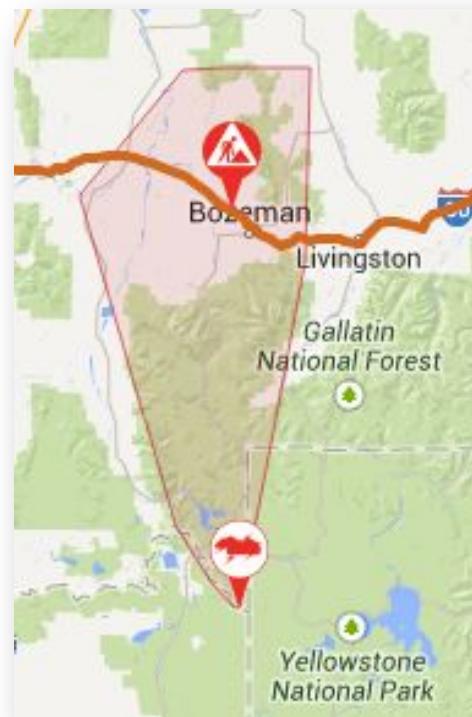
- Detailed and up-to-date road data
 - Richer and more accurate information than Google Maps and Waze
- Integration with weather and camera feeds
- Clear road data presentation
 - Categorization into user selectable layers
 - Clear route alternatives
 - Unified experience between website and mobile app
- Open access to data through Application Programming Interface (API)
 - Single corridor-wide data representation schema

Weather

Forecasts



Alerts



Other Information



Mountain Passes

Attractions



NWP OTIIS Traveler View



Trip Start: Bozeman, MT

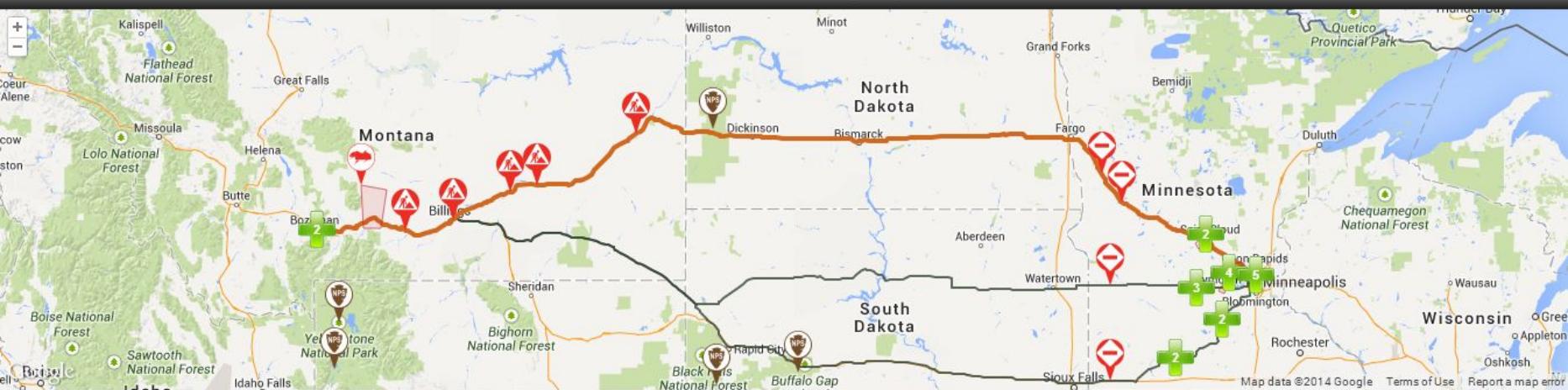
Trip Destination: Minneapolis, MN

Travel Date:

Departure Time:



[RESET PAGE](#) [MOBILE APP](#) [RESOURCES](#) [SUPPORT](#) [ABOUT](#) [CONTACT](#) [Sign In | Create Account](#)

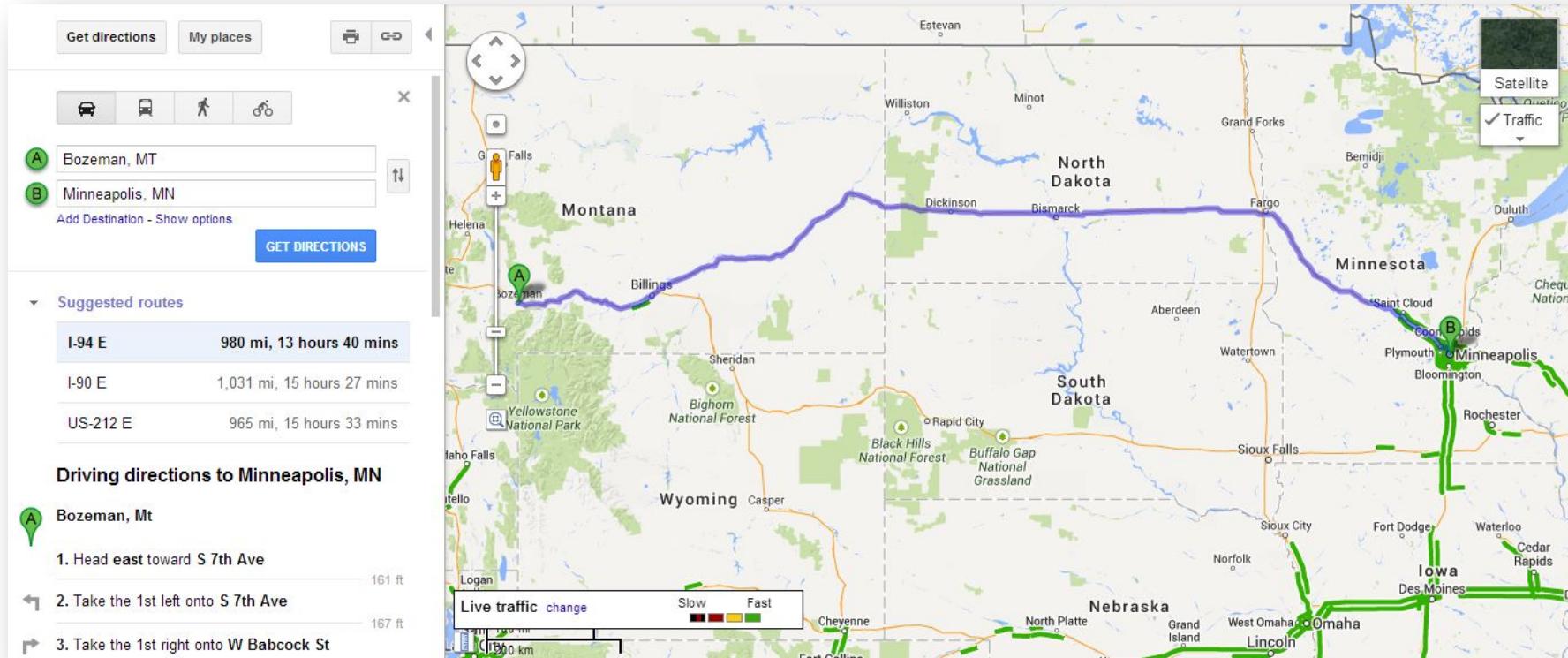


What Would You Like To See?

<input checked="" type="checkbox"/> Road Work	<input checked="" type="checkbox"/> Weather Alert
<input type="checkbox"/> Incident	<input checked="" type="checkbox"/> Traffic Congestion
<input type="checkbox"/> Road Condition	<input checked="" type="checkbox"/> Road Closure
<input type="checkbox"/> Weather	<input checked="" type="checkbox"/> Temporary Truck Restriction
<input checked="" type="checkbox"/> Mountain Pass	<input type="checkbox"/> Camera
<input type="checkbox"/> Cautionary Zone	<input type="checkbox"/> RWIS
<input type="checkbox"/> Weigh Station	<input type="checkbox"/>

Route Summaries		
① Summary Length: 980 Miles Ideal Drive Time: 13 Hours 39 Mins	② Summary Length: 1031 Miles Ideal Drive Time: 15 Hours 27 Mins	③ Summary Length: 985 Miles Ideal Drive Time: 15 Hours 33 Mins
Category: met Alert for Big Timber...	Category: met Alert for Big Timber...	Category: met Alert for Big Timber...
Category: Met Alert for Stearns (Minneso...)	active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED...	Category: Met Alert for Carver (Minnesot...
Category: Met Alert for Hennepin; Wright...	active Mon Mar 11 2013 01:00 MDT BRIDGE, 45 MPH REDUCED SPE...	active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED...
active Tue Apr 15 2014 01:00 MDT BRIDGE, DETOUR, 65 MPH RED...	active Tue Jun 03 2014 01:00 MDT STRIPING...	active Mon Mar 11 2013 01:00 MDT BRIDGE, 45 MPH REDUCED SPE...

Google Maps Traveler View



Waze Traveler View



Waze

LIVE MAP MAJOR EVENTS SUPPORT BLOG ABOUT Login

Bozeman, Mt, USA

Minneapolis, MN, United States

Check routes for a different time ▾

Route Options

From Bozeman, Mt, USA To Minneapolis, MN, USA

1 I-94 E; I-94 E
982.24 miles 13 h 25 min

2 I-90 E; I-35 N
1,121.41 miles 15 h 42 min

3 I-94 E; US-281
1,076.02 miles 15 h 56 min

Share routes

A screenshot of the Waze Traveler View interface. The map shows a route from Bozeman, MT to Minneapolis, MN. The route is highlighted in pink and blue. The map includes state borders for Montana, Wyoming, North Dakota, South Dakota, Minnesota, and Iowa. Major cities like Helena, Bismarck, Pierre, and Minneapolis are marked with location pins. Weather icons are scattered across the map, indicating current conditions. The Waze interface with route options and a live map header is visible.

Challenges of data integration

- Hard to get all needed data
 - States in different stages of digitizing their information

	Road Work	Truck Restriction	Crash / Incident	Road Closure	Road Conditions	Traffic Congestion	Camera	RWIS
WA								
ID								
MT								
WY								
ND								
SD								
MN								
WI								

Legend: Green = good data, Red = missing data, Gray = partially digitized

- Optional fields
- TMDD and custom formats
- Overlapping data
 - ex. truck restriction in accident feed

Solutions:

Good communication with DOT partners

Integrated with a separate milepost to lat/long database

Text pattern matching

Aggregation icons

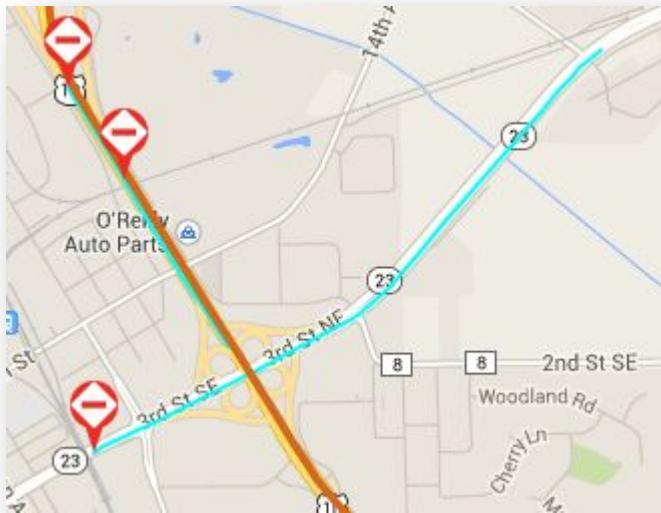
Keyword search

Unified ontology of road information

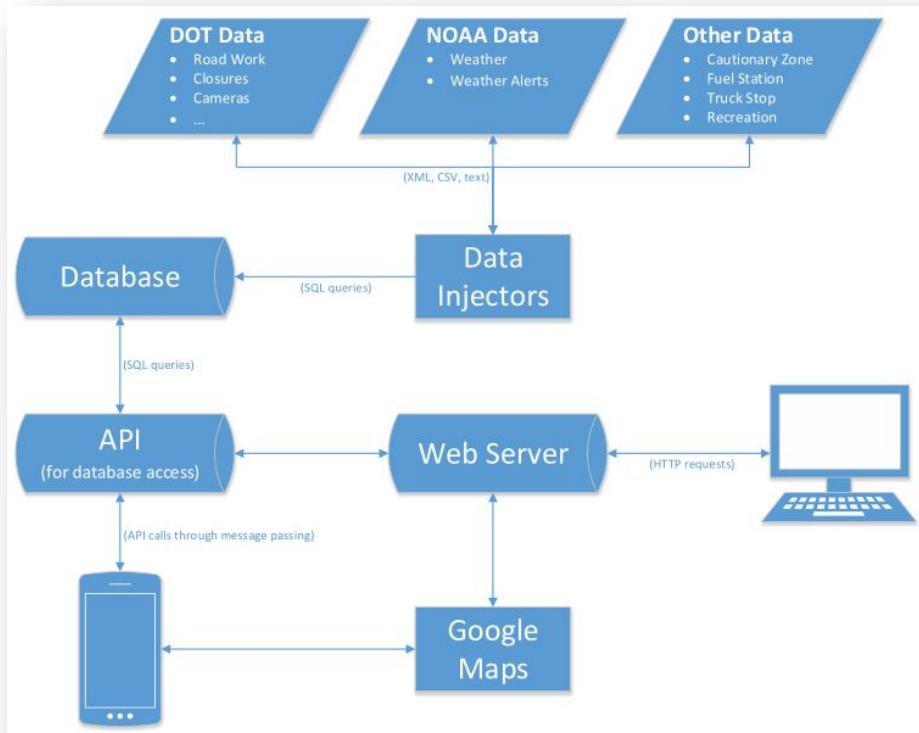
Functionality Enhancements



Two-point events



Separation of data reporting, storage, and presentation



Lessons Learned



- Separate data reporting, storage, and presentation
 - Ultimately will be able to support different users
- Consistent sentence construction aids semantic analysis
 - Ex. 'bridge construction' ☐ easy to interpret
 - Ex. 'bridge spanning the river is under construction' ☐ super hard!
 - Semantic analysis will always be hard as long as open text fields in data reporting
 - Consistent use of terms can produce both human and machine readable data
- Selective requests to DOTs
 - Standard data reporting formats, i.e. XML, CSV
 - No nested formats, ex. URL inside a description field

- Road information database accessible via Web requests

```
getEvents {  
  segments: '47.70859 -122.32323000000001 ... 47.25278 -122.44427',  
  layers: 'RoadWork',  
  startTimeInSeconds: 'Mon Jun 09 2014 10:00:00 GMT-0600 (MDT)',  
  endTimeInSeconds: 'Mon Jun 09 2014 12:00:00 GMT-0600 (MDT)',  
}
```

NWP OTIIS API Response



```
<eventListResponse>
  <roadWorkList>
    <roadWork>
      <eventID>WA_160533</eventID>
      <path>47.571880341, -122.319869995</path>
      <headline>Construction</headline>
      <headlineDescription>Ramp closures are scheduled.</headlineDescription>
      <impactEstimate>High</impactEstimate>
      <startTime>Fri Jun 06 2014 23:00:00 GMT-0600 (MDT)</startTime>
      <endTime>Tue Jun 15 2014 09:05:23 GMT-0600 (MDT)</endTime>
      <lastUpdated>Tue Jun 03 2014 12:05:23 GMT-0600 (MDT)</lastUpdated>
    </roadWork>
  </roadWorkList>
<eventListResponse>
```

Future work – Near term



- Enhance functionality of NWP OTIIS
- Mobile application
 - Mobile application version of the NWP OTIIS system
 - Route condition alerts pushed to users en route
 - Will collect and make available road congestion information
- Semantic analysis of data feed information
 - Allow more uniform presentation of data across all layers and states
- Order events in lists by travel distance along the route
 - Interleave driving directions with incidents

Future work – Long Term



- Major tasks that leverage NWP OTIIS data
- Accident prediction and integration with freight scheduling
 - Proposal under submission to the FHWA EAR program
 - Collaboration with JB Hunt and Watkins & Sheppard
 - MSU-lead team (CS and Civil Eng.) in collaboration with FSU
- Selective active traffic management
 - Suggest alternative routes in real-time through notifications
 - Balance traffic based on observed shifts
 - Keep trucks on highway, but route passenger traffic onto local roads
- Integration with connected vehicles, passenger and commercial

Thank
You