MONTANA
STATE UNIVERSITY

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

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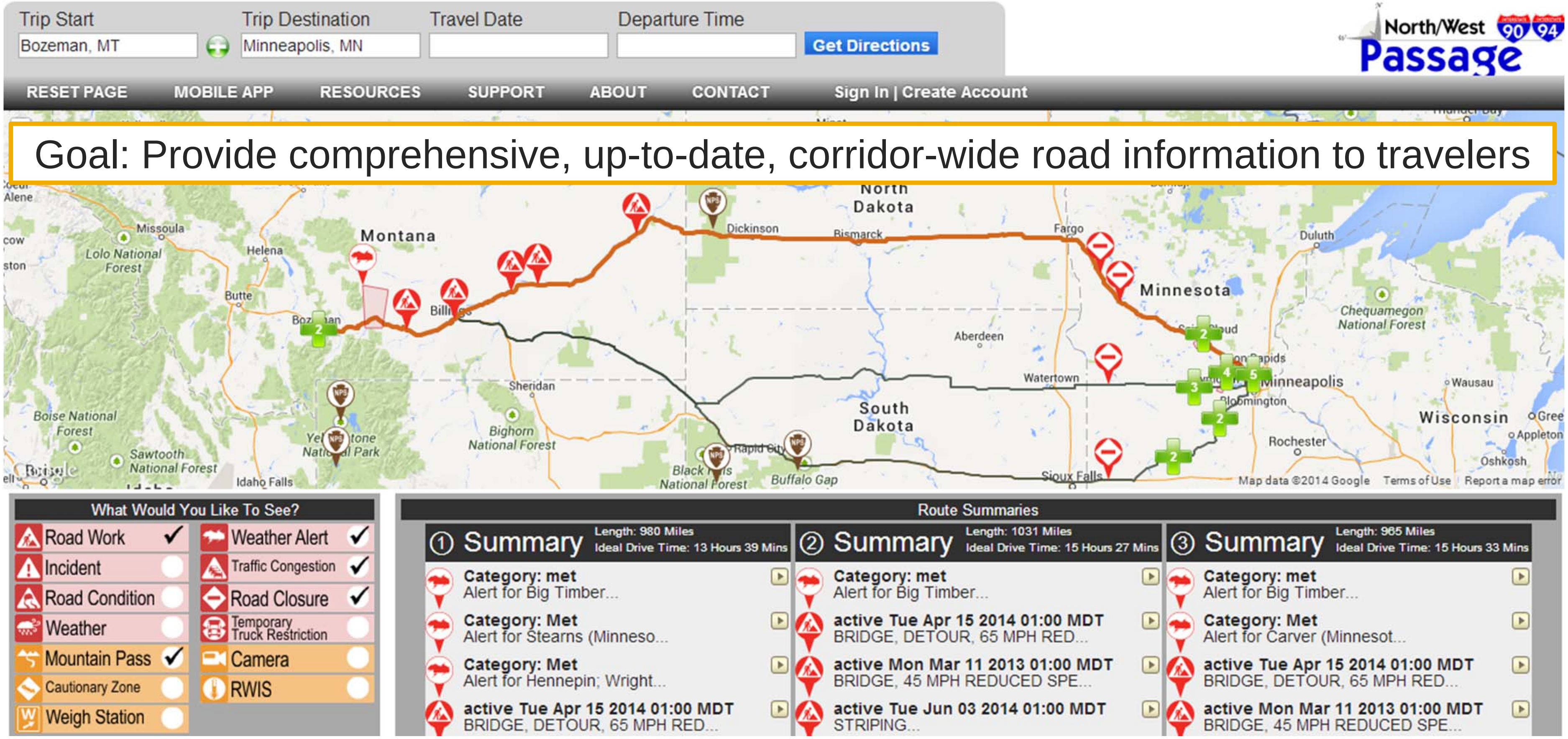
© AP

ROAD CLOSED
NO PARKING

YOU'LL NEVER GET TO WORK ON TIME HAHA!!

http://atom.smasher.org/construction/

NWP OTIIS


North/West Passage
90
94
Get Directions
RESET PAGE
MOBILE APP
RESOURCES
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ABOUT
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Sign In | Create Account
Montana
North Dakota
South Dakota
Minnesota
Wisconsin
Missoula
Helena
Butte
Bozeman
Billings
Dickinson
Bismarck
Fargo
Duluth
Aberdeen
Watertown
Sheridan
Rapid City
Sioux Falls
Minneapolis
Bloomington
Rochester
Wausau
Appleton
Oshkosh
Idaho Falls
Boise
Lolo National Forest
Boise National Forest
Sawtooth National Forest
Yellowstone National Park
Bighorn National Forest
Black Hills National Forest
Buffalo Gap
Chequamegon National Forest
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Trip Start: Bozeman, MT

Trip Destination: Minneapolis, MN

Travel Date:

Departure Time:

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 Length: 1031 Miles Ideal Drive Time: 15 Hours 27 Mins	③ Summary Length: 965 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...

NWP OTIIS – A partnership

MONTANA
STATE UNIVERSITY

U.S. Department of Transportation
Federal Highway Administration

North/West Passage
INTERSTATE 90
INTERSTATE 94

WTI
Western Transportation INSTITUTE

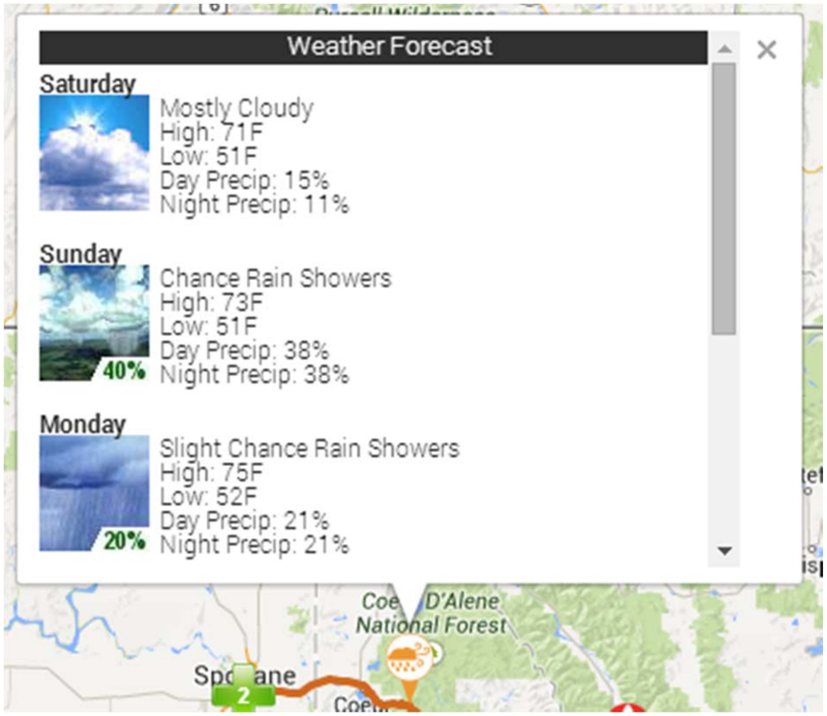
MONTANA
STATE UNIVERSITY
College of Engineering

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



Weather Forecast

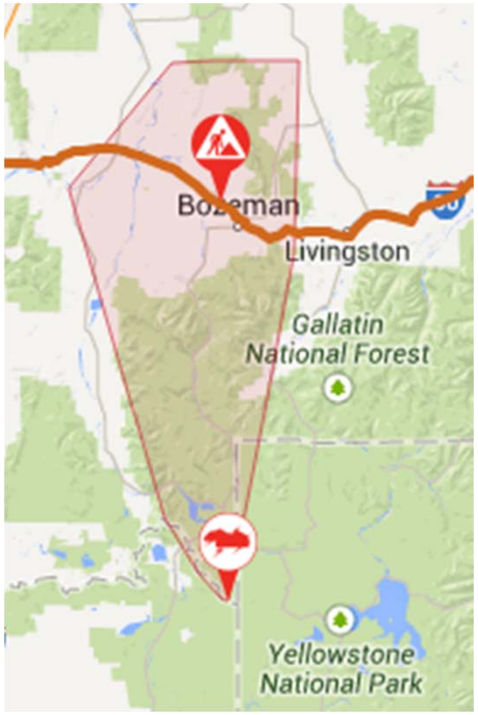
Saturday
Mostly Cloudy
High: 71F
Low: 51F
Day Precip: 15%
Night Precip: 11%

Sunday
Chance Rain Showers
High: 73F
Low: 51F
Day Precip: 38%
Night Precip: 38%

Monday
Slight Chance Rain Showers
High: 75F
Low: 52F
Day Precip: 21%
Night Precip: 21%

40%
20%
Coeur D'Alene National Forest
Spokane
2

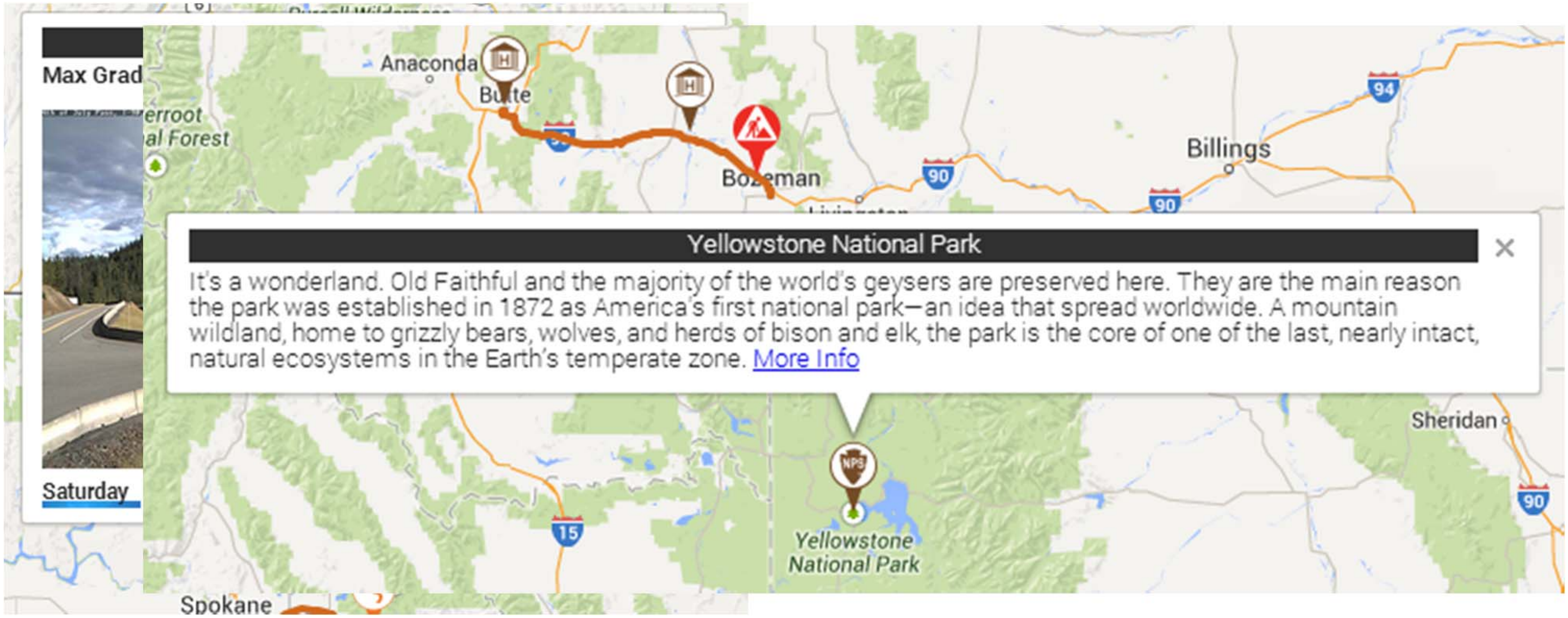
Alerts


Bozeman
Livingston
Gallatin National Forest
Yellowstone National Park

Other Information

Mountain Passes

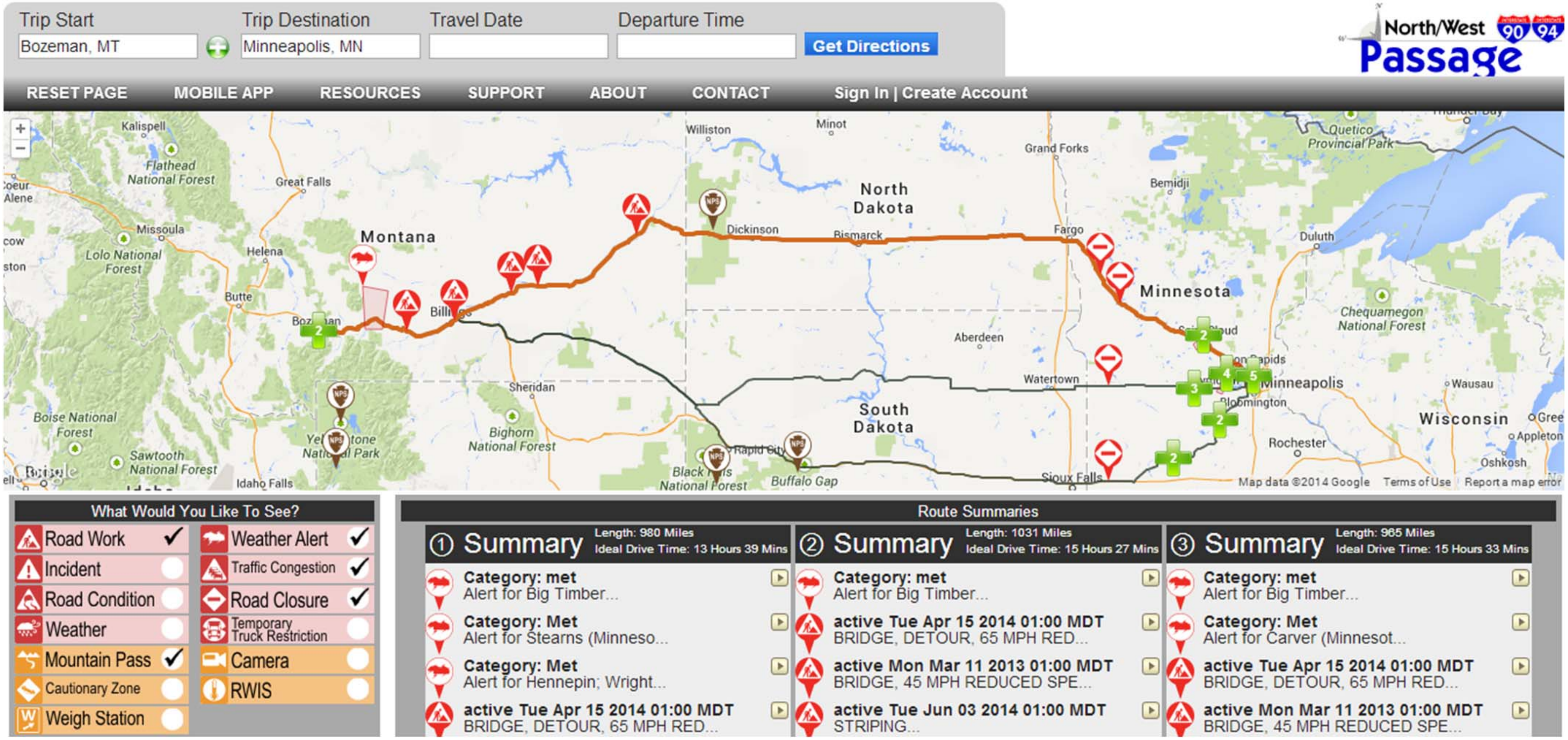
Attractions


Max Grad
Saturday
erroot
al Forest
Anaconda
Butte
Bozeman
Billings
Sheridan
Spokane
94
90
15
Yellowstone National Park

Yellowstone National Park

It's a wonderland. Old Faithful and the majority of the world's geysers are preserved here. They are the main reason the park was established in 1872 as America's first national park—an idea that spread worldwide. A mountain wildland, home to grizzly bears, wolves, and herds of bison and elk, the park is the core of one of the last, nearly intact, natural ecosystems in the Earth's temperate zone. More Info

NWP OTIIS Traveler View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Lolo National Forest
Helena
Butte
Bozeman
Billings
Sheridan
Bighorn National Forest
Yellowstone National Park
Boise National Forest
Sawtooth National Forest
Idaho Falls
Williston
Minot
Dickinson
Bismarck
Grand Forks
Fargo
Bemidji
Aberdeen
Watertown
Rapid City
Black Hills National Forest
Buffalo Gap
Sioux Falls
Minneapolis
Bloomington
Rochester
Duluth
Quetico Provincial Park
Chequamegon National Forest
Wausau
Appleton
Oshkosh
Map data ©2014 Google
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Report a map error

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What Would You Like To See?

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

Route Summaries

① Summary
Length: 980 Miles
Ideal Drive Time: 13 Hours 39 Mins

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  STRIPING...

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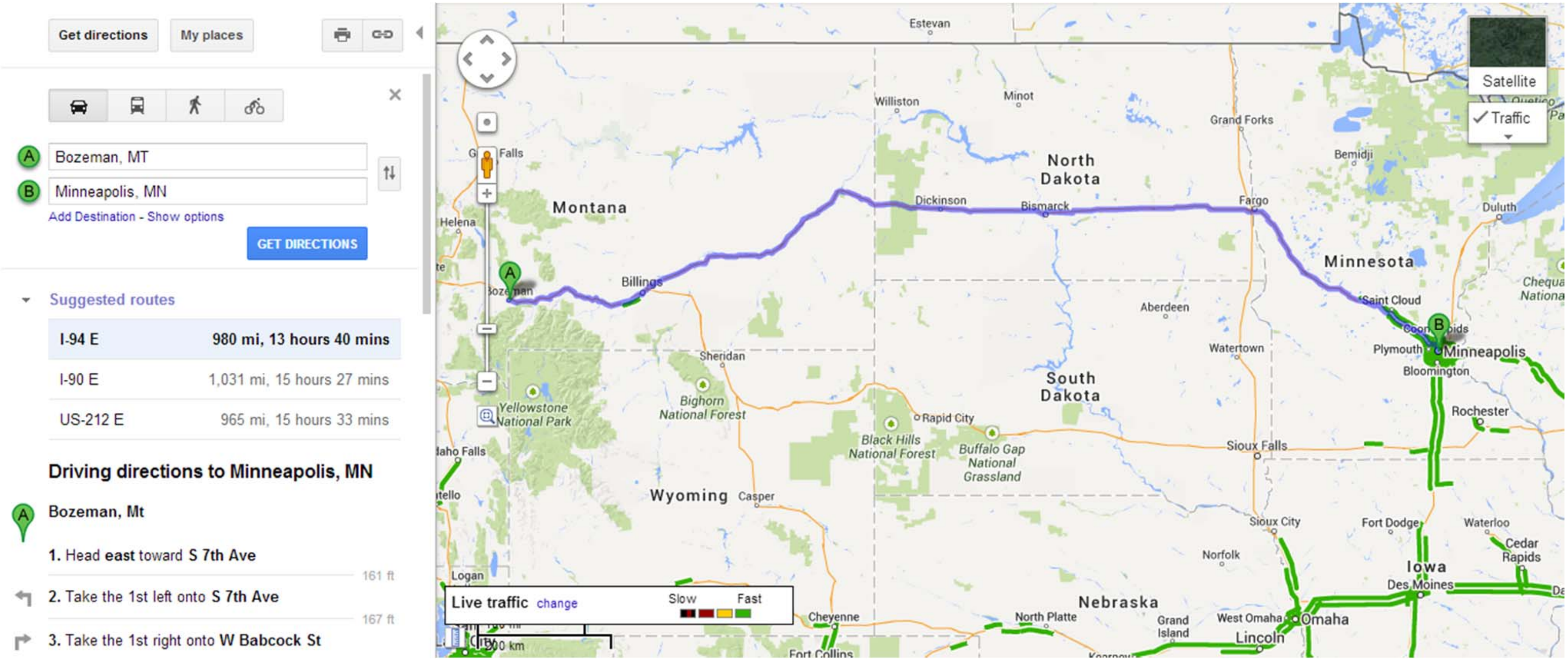
Google Maps Traveler View


Get directions
My places
GET DIRECTIONS
Add Destination - Show options
Live traffic change
Slow
Fast
Satellite
Traffic
Estevan
Williston
Minot
Grand Forks
Bemidji
North Dakota
Dickinson
Bismarck
Fargo
Duluth
Montana
Helena
Falls
Billings
Bozeman
Minnesota
Saint Cloud
Aberdeen
Watertown
Plymouth
Minneapolis
Bloomington
Sheridan
Bighorn National Forest
Yellowstone National Park
South Dakota
Rapid City
Black Hills National Forest
Buffalo Gap National Grassland
Sioux Falls
Rochester
Wyoming
Casper
Sioux City
Fort Dodge
Waterloo
Cedar Rapids
Iowa
Des Moines
Norfolk
Nebraska
North Platte
Grand Island
West Omaha
Omaha
Lincoln
Cheyenne
Fort Collins
Logan
Chequamegon National
300 km

A Bozeman, MT

B Minneapolis, MN

Suggested routes

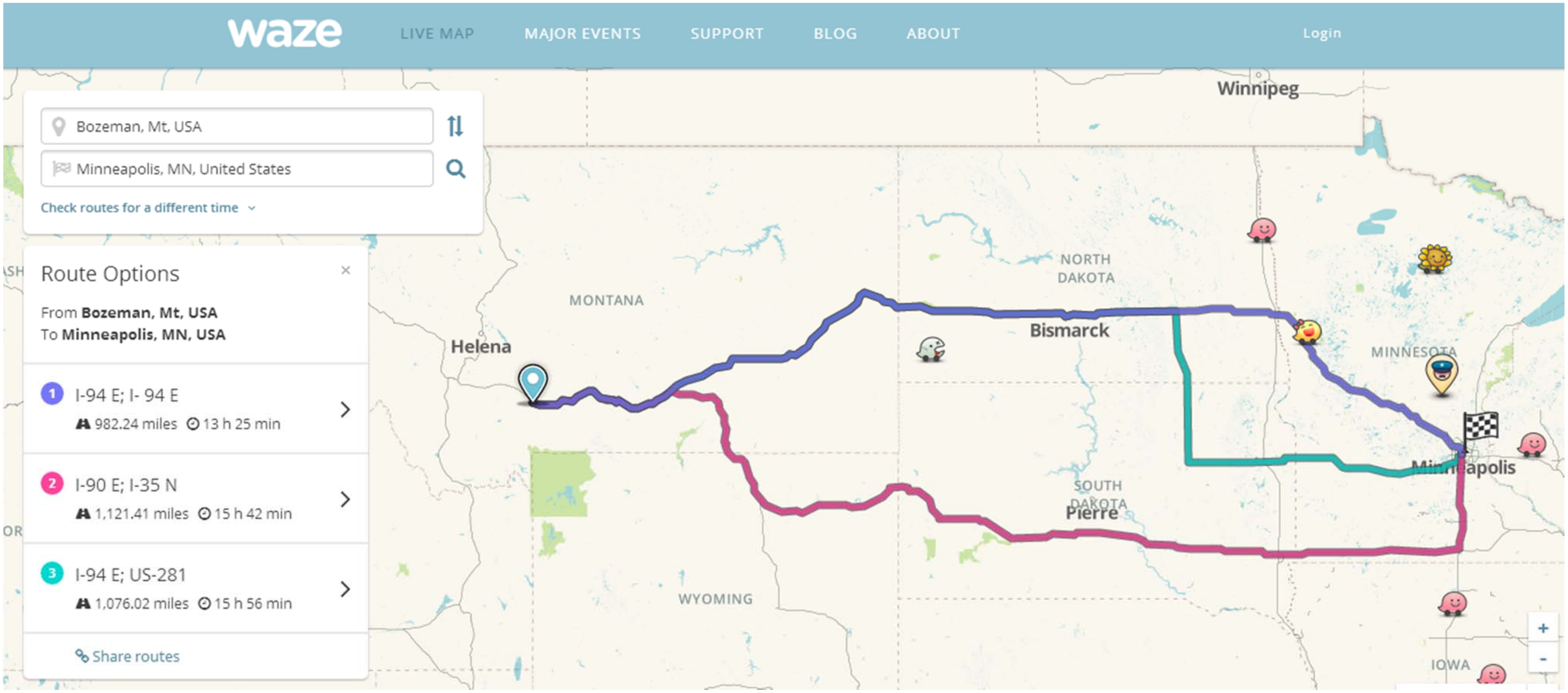
I-94 E	980 mi, 13 hours 40 mins
I-90 E	1,031 mi, 15 hours 27 mins
US-212 E	965 mi, 15 hours 33 mins

Driving directions to Minneapolis, MN

A **Bozeman, Mt**

1. Head east toward S 7th Ave
161 ft
2. Take the 1st left onto S 7th Ave
167 ft
3. Take the 1st right onto W Babcock St

Waze Traveler View


waze
LIVE MAP
MAJOR EVENTS
SUPPORT
BLOG
ABOUT
Login
Winnipeg
NORTH DAKOTA
MONTANA
Helena
Bismarck
MINNESOTA
Minneapolis
SOUTH DAKOTA
Pierre
WYOMING
IOWA
+
-

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

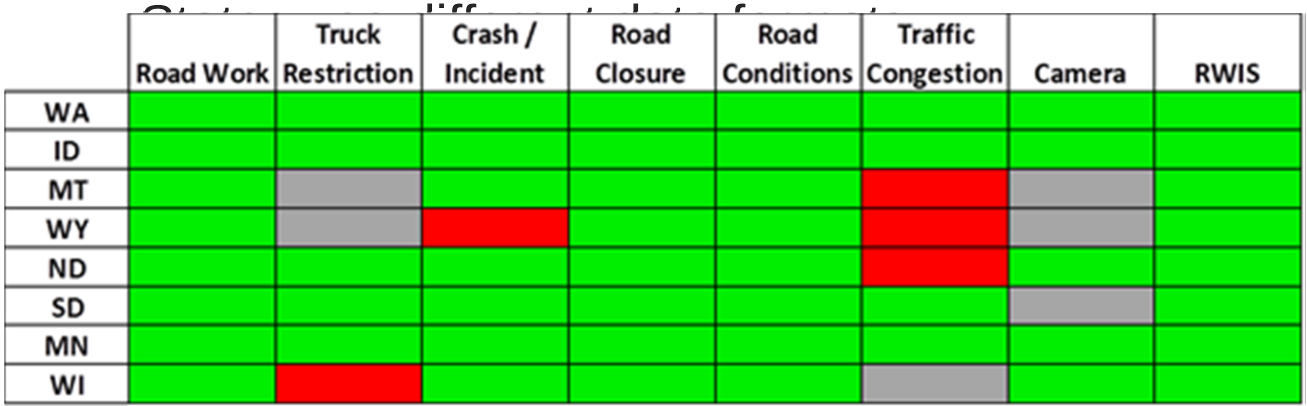
2 I-90 E; I-35 N
1,121.41 miles 15 h 42 min

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

Share routes

Challenges of data integration

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



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

- Heterogeneity of data
  - 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

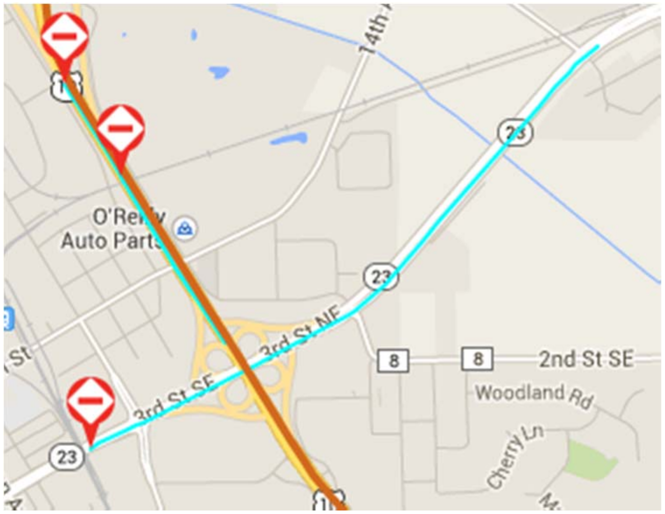
Aggregation icons

Keyword search

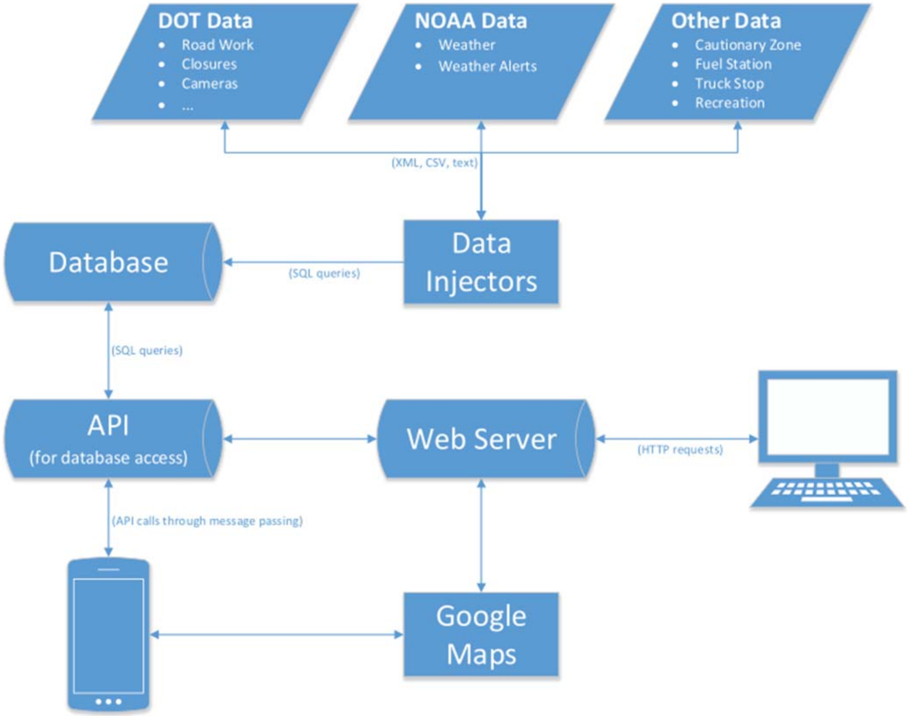
Unified ontology of road information

Functionality Enhancements

Two-point events


14th
23
O'Reilly Auto Parts
23
3rd St NE
8
8
2nd St SE
Woodland Rd
3rd St SE
23
Cherry Ln

Separation of data reporting, storage, and presentation



DOT Data
- Road Work
- Closures
- Cameras
- …

NOAA Data
- Weather
- Weather Alerts

Other Data
- Cautionary Zone
- Fuel Station
- Truck Stop
- Recreation

(XML, CSV, text)

Data Injectors

(SQL queries)

Database

(SQL queries)

API
(for database access)

Web Server

(HTTP requests)

(API calls through message passing)

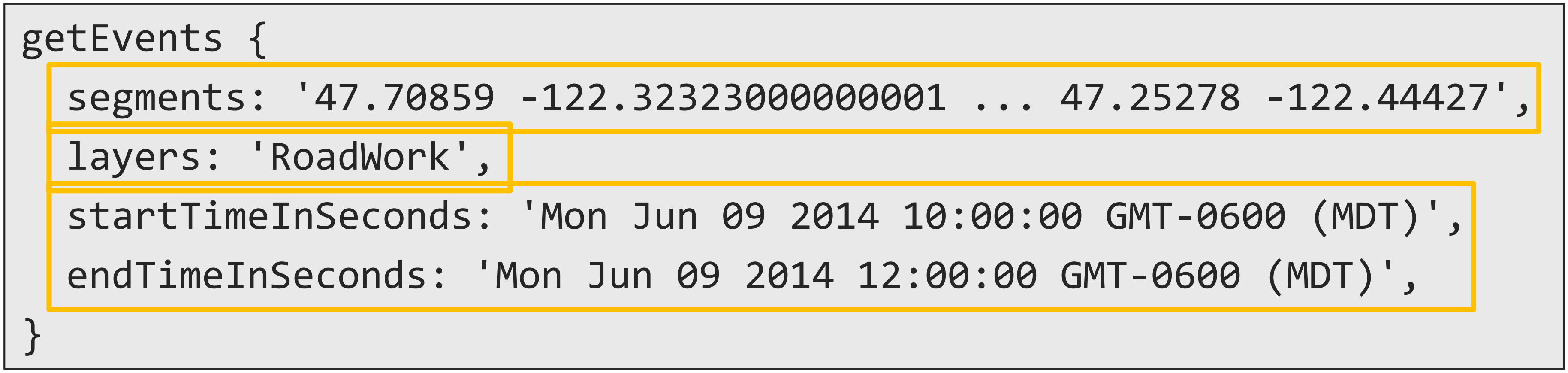
Google Maps

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

NWP OTIIS API

- 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

```xml
<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

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Thank You