Real-Time Probe Data Dashboards for Interstate Performance Monitoring During Winter Weather and Incidents

Margaret McNamara[1], Howell Li[1], Stephen Remias[2], Deborah Horton[1], Edward Cox[3], Darcy M. Bullock[1]

1: Purdue University; 2: Wayne State University; 3: Indiana Department of Transportation

Paper No. 16-0622

PURDUE UNIVERSITY

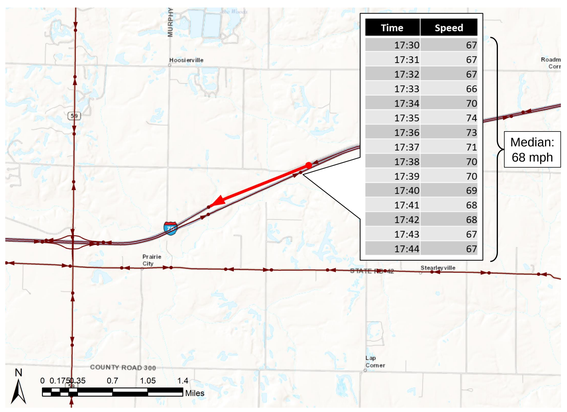
Follow us on Twitter @JTRP1937
or search #PurdueTLab

Abstract

The Indiana Department of Transportation (INDOT) manages over 1800 centerline miles of interstate that can be profoundly impacted by weather, crashes, and construction. Real-time performance measurement of interstate speeds is critical for successful traffic operations management. Agency managers and Traffic Management Center decision makers need situational awareness of the network and the ability to identify irregularities at a glance in order to manage resources and respond to media queries. One way to access this level of detail is crowdsourced probe vehicle data. Crowdsourced probe vehicle data can be obtained by collecting speed data from cell phones and GPS devices. In Indiana, approximately 2673 predefined interstate segments are used to generate over 3.8 million speed records per day. These data can be overwhelming without efficient procedures to reduce and aggregate both spatially and temporally. This work introduces a spatial and temporal aggregation model and an accompanying real-time dashboard to characterize the current and past congestion history of interstate roadways. The primary high level view of the aggregated data resembles a stock ticker and is called the "Traffic Ticker." The data archive allows for after-action review of major events such as ice storms, major crashes, and construction work zones.

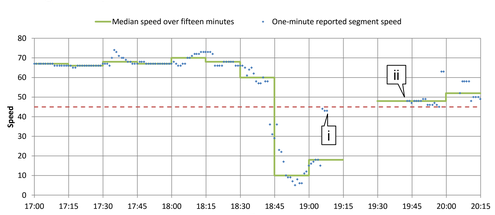
Crowdsourced Probe Vehicle Data

The crowdsourced probe vehicle data are obtained from a third-party vendor and are calculated from GPS locations and headings of cell phones and similar devices. Speeds are reported each minute for a segment. For analysis, the median of each fifteen-minute bin is used.



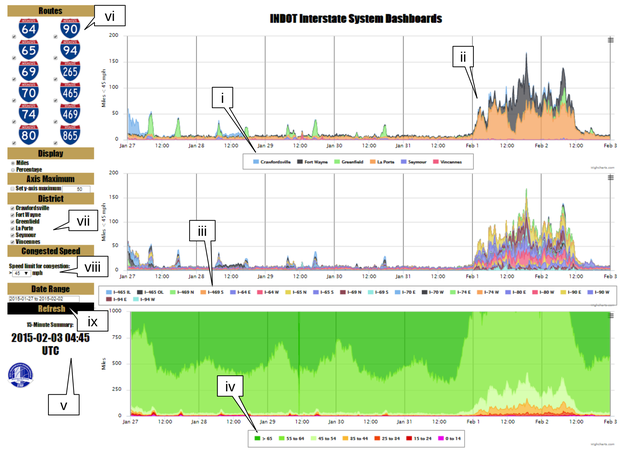
Time	Speed
17:30	67
17:31	67
17:32	67
17:33	66
17:34	70
17:35	74
17:36	73
17:37	71
17:38	70
17:39	70
17:40	69
17:41	68
17:42	68
17:43	67
17:44	67

As shown in the graph, using the median (green line) smooths out the minute-to-minute variation in the speeds and helps to account for missing data points.



Traffic Ticker

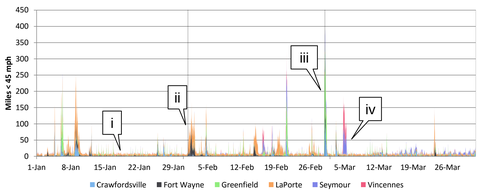
http://tinyurl.com/trafficticker

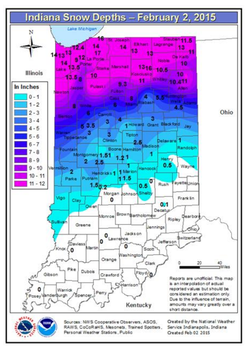


i. Miles of interstate operating below 45 mph, colored by district
ii. Abnormal congestion due to a winter storm (see below)
iii. Miles of interstate operating below 45 mph, colored by road
iv. Miles of interstate colored by speed bin - yellow for 35-45 mph, orange for 25-34 mph, red for 15-24 mph, and pink for 0-14 mph
v. Timestamp of last data
vi. Interstate selection
vii. District selection
viii. Congested speed threshold selection (defaults to 45 mph)
ix. Date range (defaults to past week)

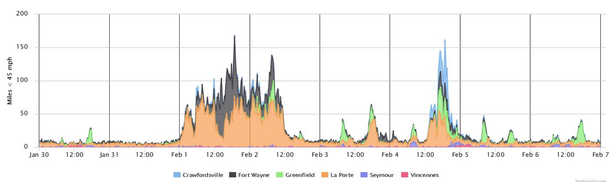
Winter Weather

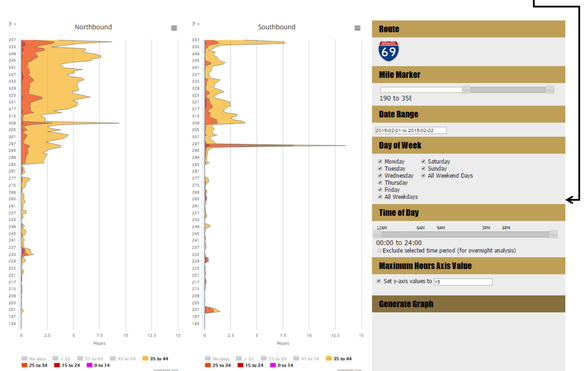
Winter storms disrupt travel due to low visibility and unsafe roads due to snow and ice. The graph at right shows Jan.-Mar. of 2015. Callout i shows normal congestion of around 20 miles, and callouts ii, iii, and iv show three large winter storms that all affected different parts of the state.





Over February 1 and 2, 2015, a winter storm swept across the upper half of the state, with snow depths as high as 17 inches in the northern two districts, Laporte and Fort Wayne, on the morning of the 2nd. Storm-related congestion had largely subsided by noon on Feb. 2nd.

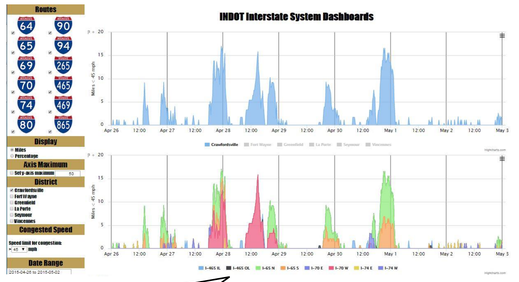




Traffic Ticker for Fort Wayne (shown in black) shows magnitude but not location of congestion. The dashboard at left provides drill-down capability from Traffic Ticker to show spatial distribution.

The longitudinal speed profile for a given road is accessed by clicking on the roadway graph in Traffic Ticker. Here, the congestion on I-69 in Fort Wayne during the two days of the snowstorm was primarily on Northbound from MM 285 to 257.

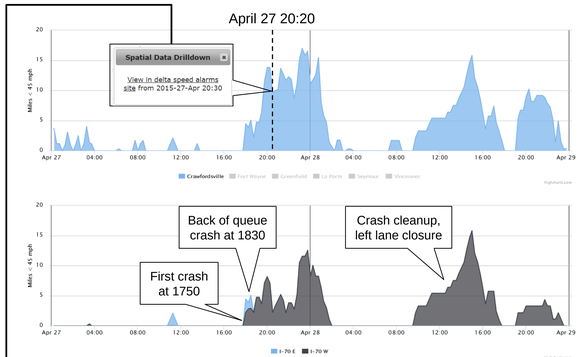
I-70 Crash

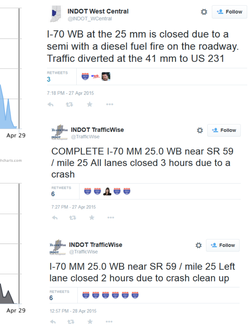


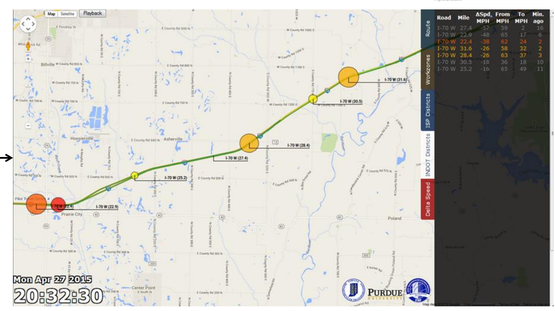
District ticker includes all roads. Graph below shows just I-70 for details

Photo credit WTHITV: http://wthitv.com/2015/04/27/second-i-70-crash-ends-with-semi-fire/

On April 27th at 1750, a crash on I-70 W in the Crawfordsville district caused a queue of two miles. At 1830, a secondary crash occurred at the back of the queue, causing a truck fire and closing the interstate.

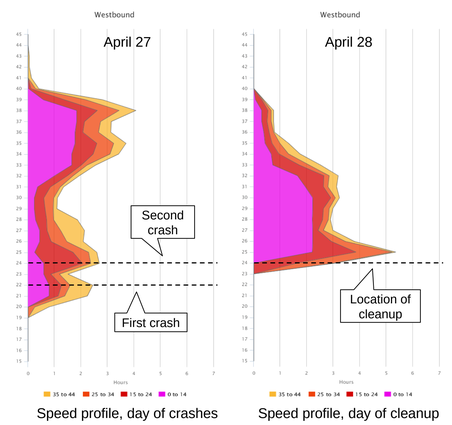






http://its.ecn.purdue.edu/mobility/deltaspeed/

The queuing shown in the delta speed alarms site above was a result of the second crash. The speed profiles to the right compare the day of the crash with the cleanup the following day. The crashes caused queueing for 20 miles and the cleanup effort for 16 miles for as long as 2 hours. The impact from both of these efforts on mobility can be seen in the data, and action can be taken to avoid dangerous back-of-queue situations in the future.

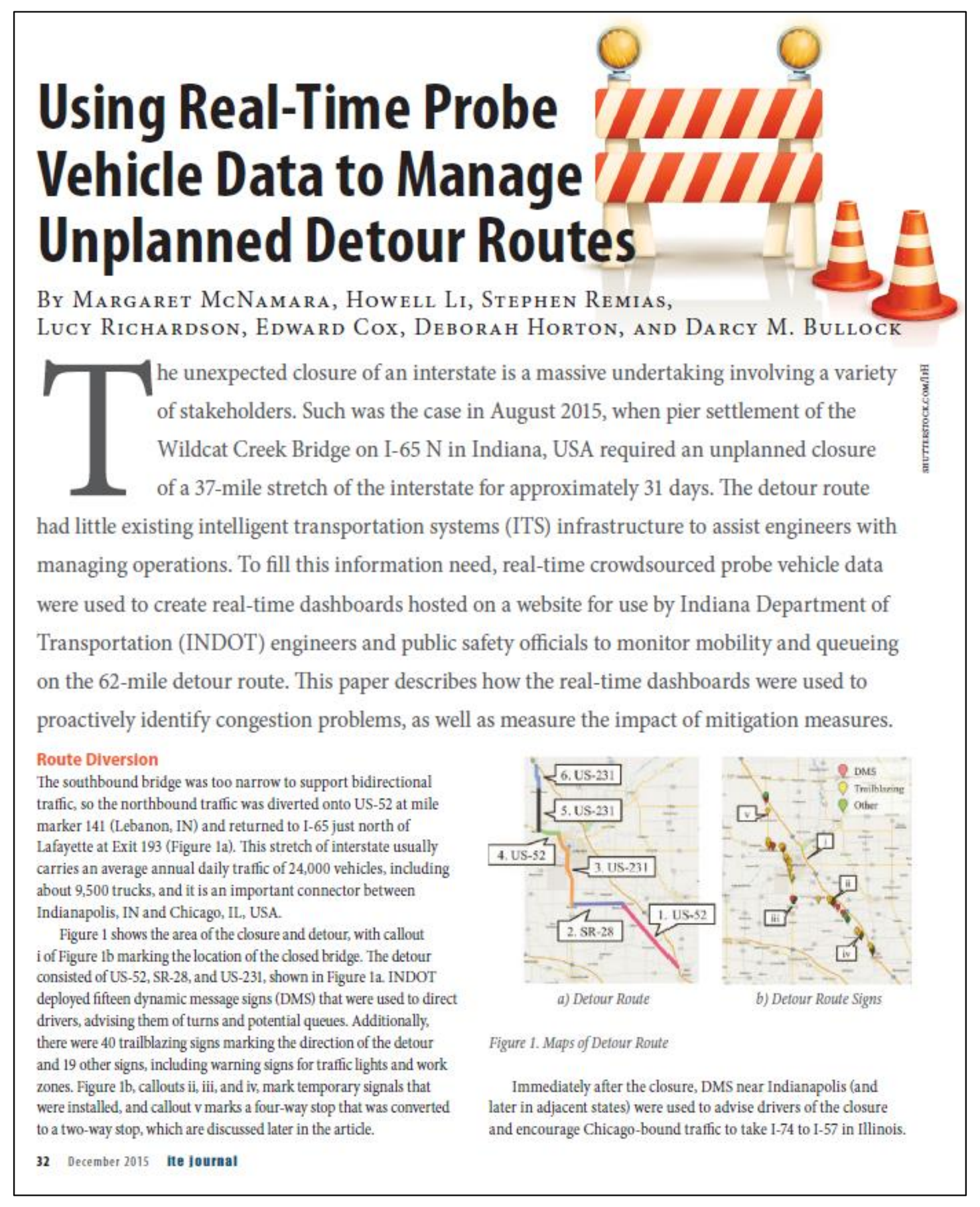


Speed profile, day of crashes

Speed profile, day of cleanup

Application of the Traffic Ticker: I-65 N Detour, Aug. 2015

On August 7, 2015 (seven days after TRB Paper #16-0622 was submitted), a 37 mile stretch of I-65 N from MM 141 to 178 was closed due to a structural settlement of a bridge. Traffic was detoured onto a series of rural 2- and 4-lane roads and a suburban arterial. The traffic ticker methodology described in this poster was implemented within 8 hours of the closure to provide state and local agencies with a real-time dashboard and prioritize traffic management activities. This poster documents the resulting impact of two temporary signals, retiming of the US-231 corridor, and conversion of US-231 and SR-18 to a two-way stop. Further details of this initiative are described in the December 2015 issue of ITE Journal


Using Real-Time Probe Vehicle Data to Manage Unplanned Detour Routes

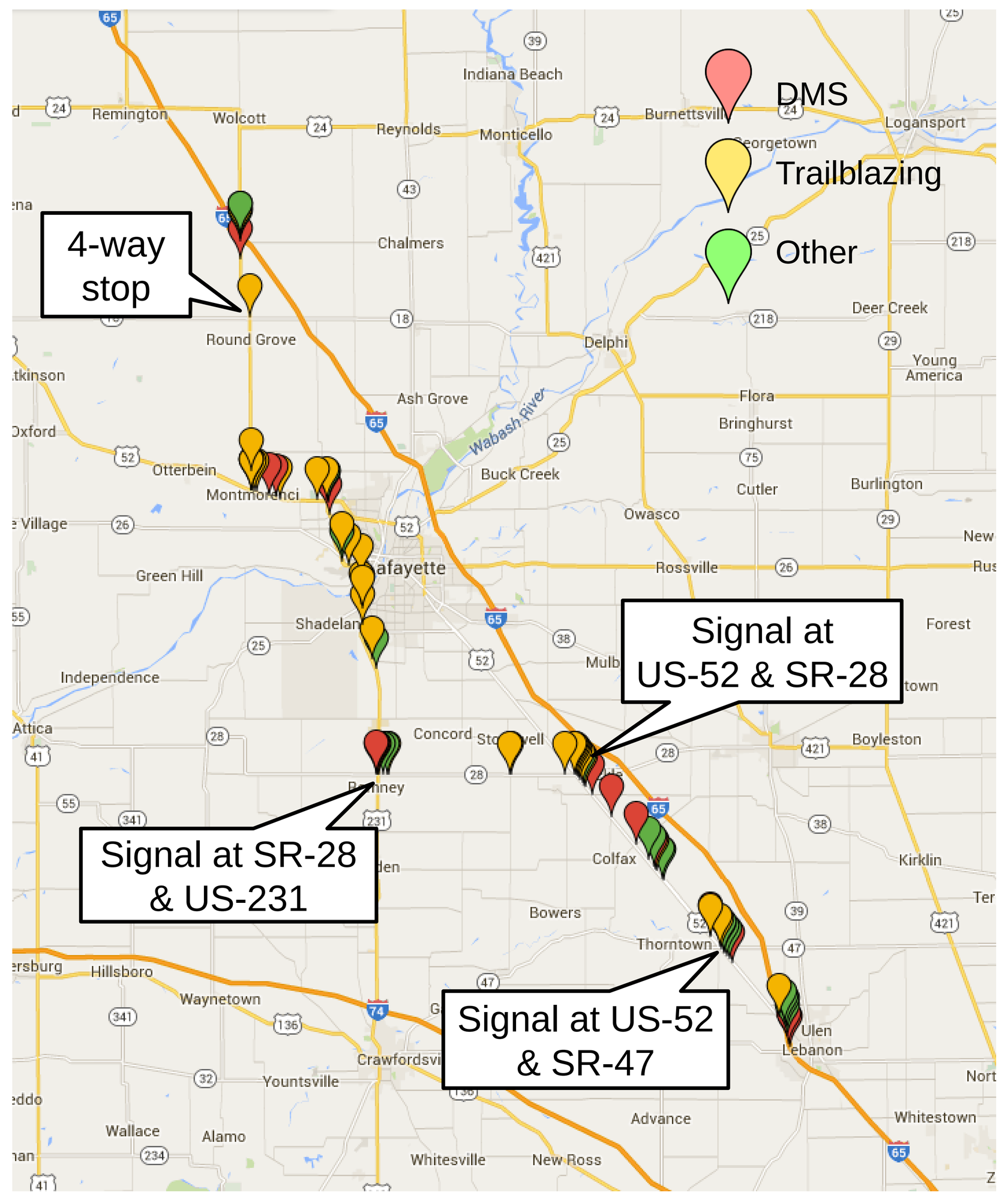
By Margaret McNamara, Howell Li, Stephen Remias, Lucy Richardson, Edward Cox, Deborah Horton, and Darcy M. Bullock

McNamara, Margaret*, H. Li, S. Remias, L. Richardson, E. Cox, D. Horton, and D.M. Bullock*, "Using Real-Time Probe Vehicle Data to Manage Unplanned Detour Routes," ITE Journal of Transportation, pp. 32-37, December 2015

Detour Route: Signs and Signals

The route of the detour is shown at right, with traffic diverting onto US-52 at Lebanon and following SR-28 to US-231 back to I-65 N.

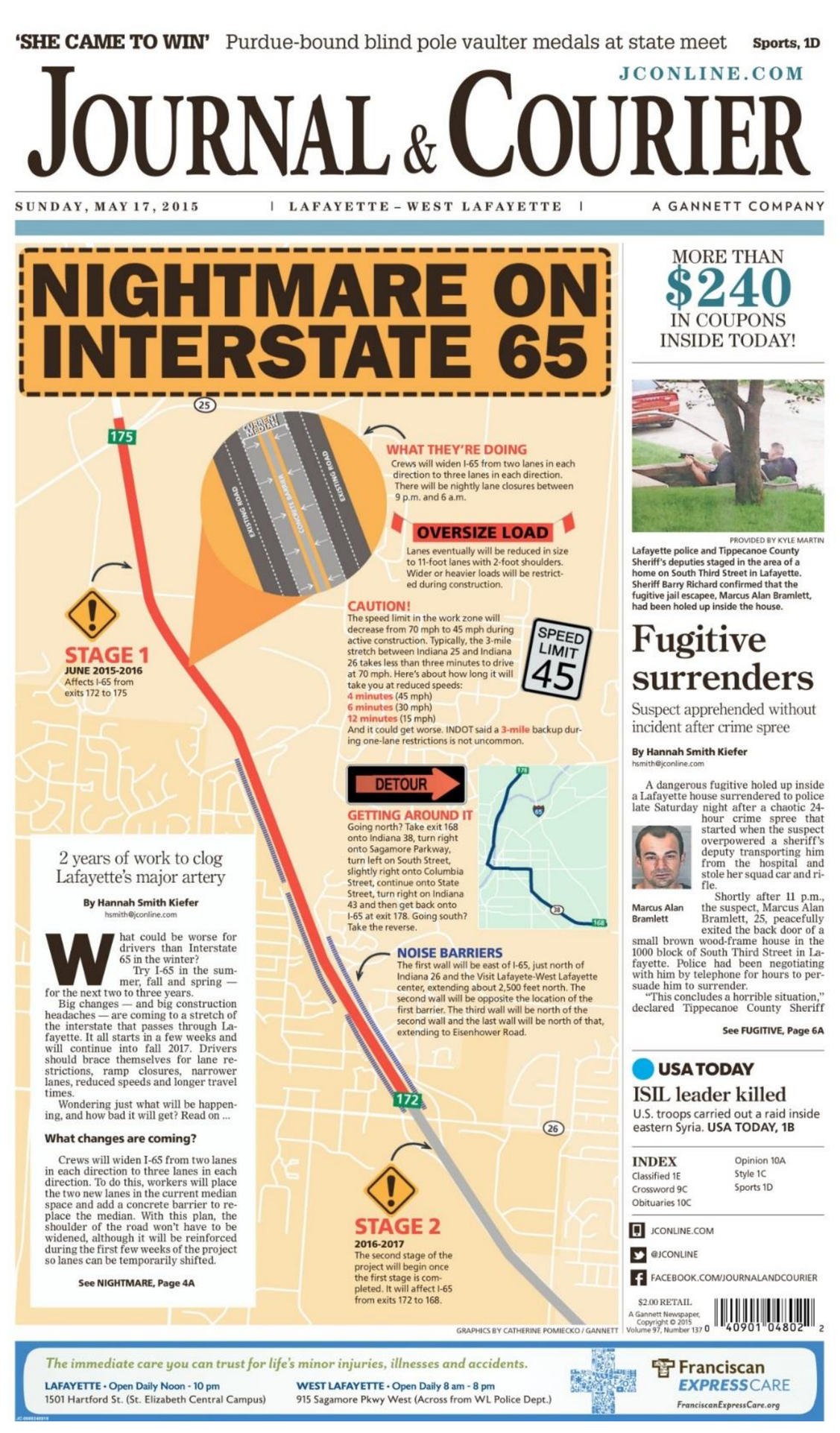
- Temporary signals were installed at
  - US-52 and SR-28
  - SR-28 and US-231.
  - US-52 & SR 47
- The four-way stop at US-231 and SR-18 was also converted to a two-way stop
- The balloons mark the location of
  - 15 dynamic message signs (DMS)
  - 40 trailblazing signs, and
  - 19 others (traffic light warning signs, work zone warnings, etc.).

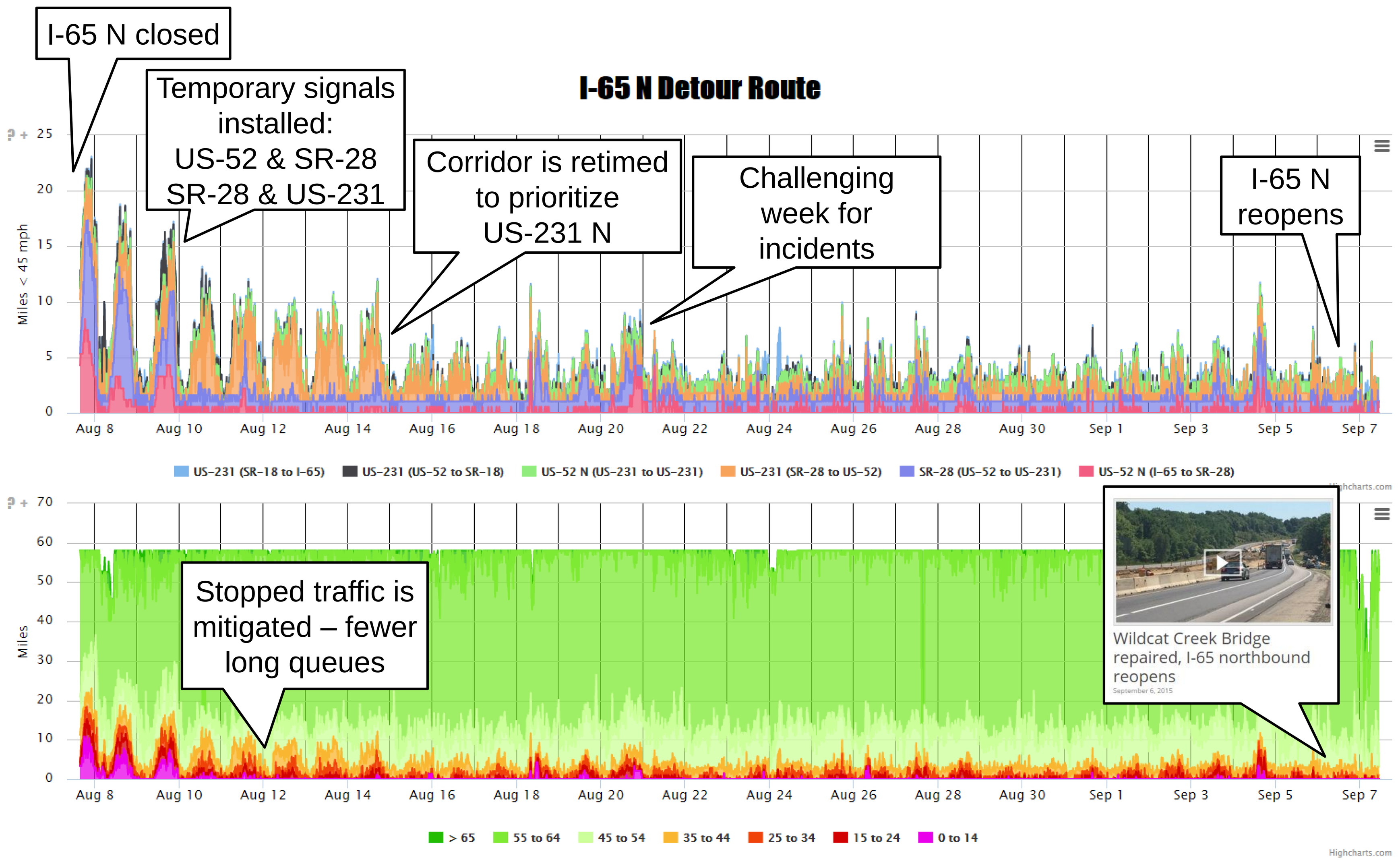


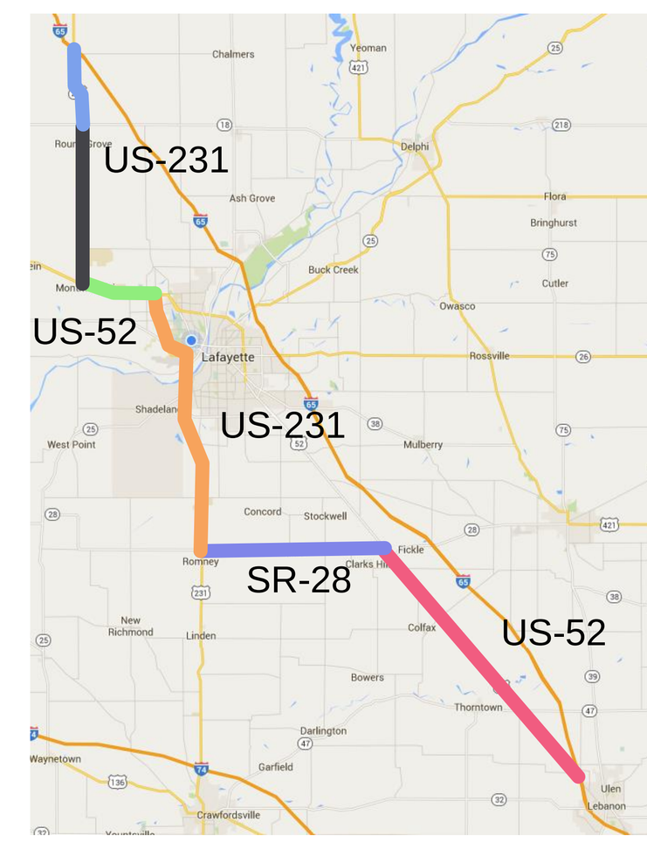
Dynamic Message Sign (DMS)	Trailblazing	Other
		

Congestion Profile on Detour Route from Aug. 7 to Sep. 7

Separating fact from fiction: Using data to tell the real story of the detour





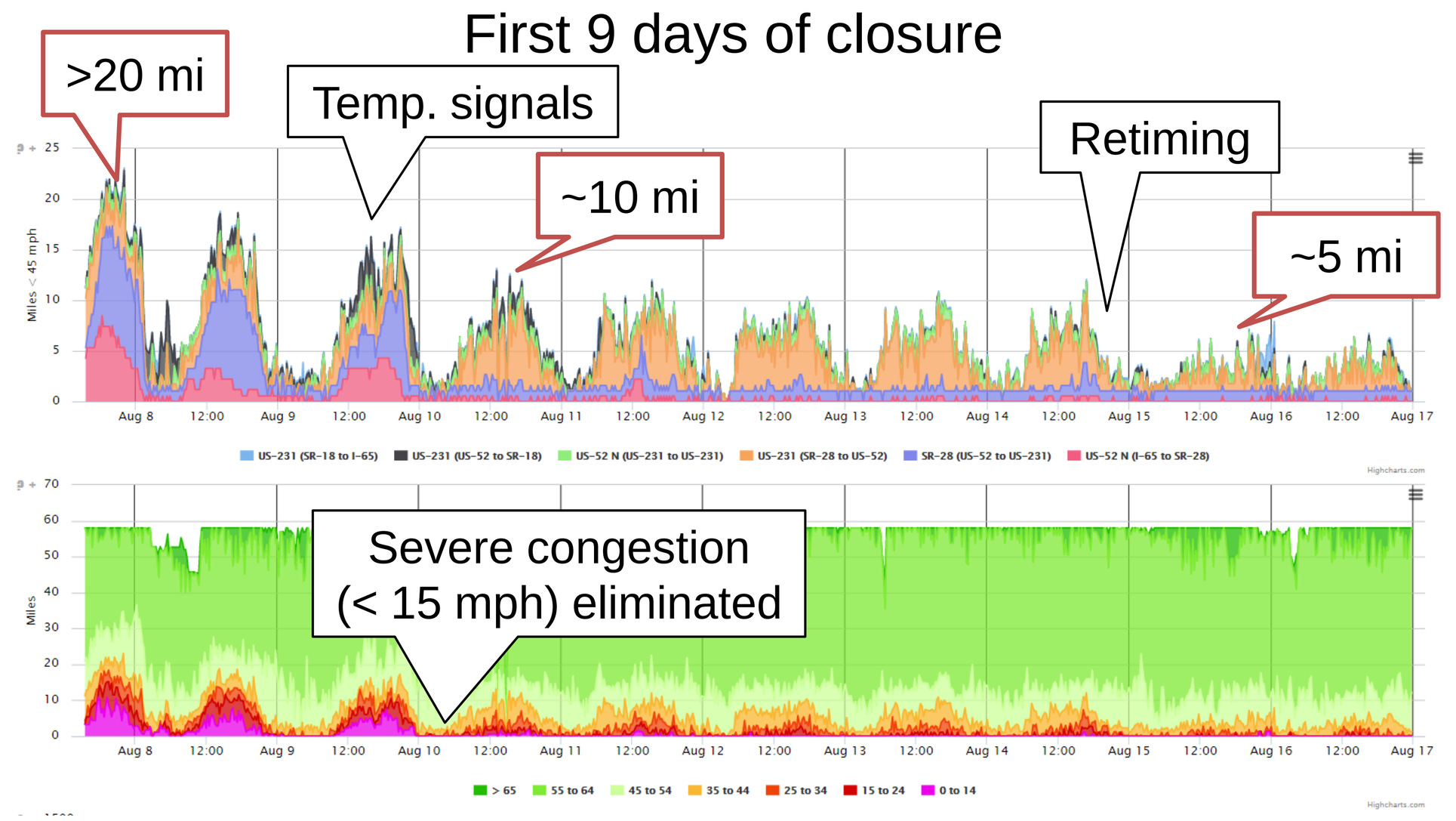


Detour route segments, colored to match graph

Five phases of Detour Route Management

1. Identification of Diversion Route
2. Trailblazing
3. Temporary Signals and Flasher changes
4. Optimization of Signal Timing
5. Incident Management

First 9 days of closure



Signs and Signals


Exit 141 from I-65 N


Temporary signal at US-52 and SR 28

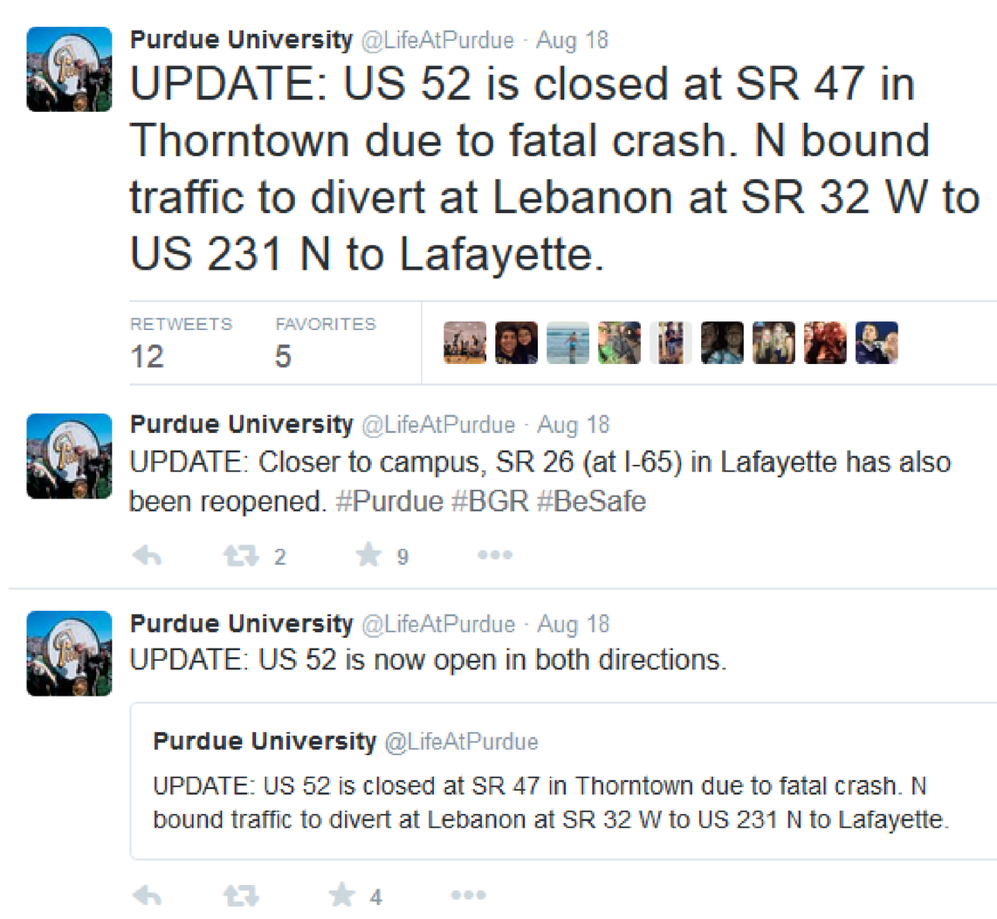
US-52, advance of at US-52 and SR 28

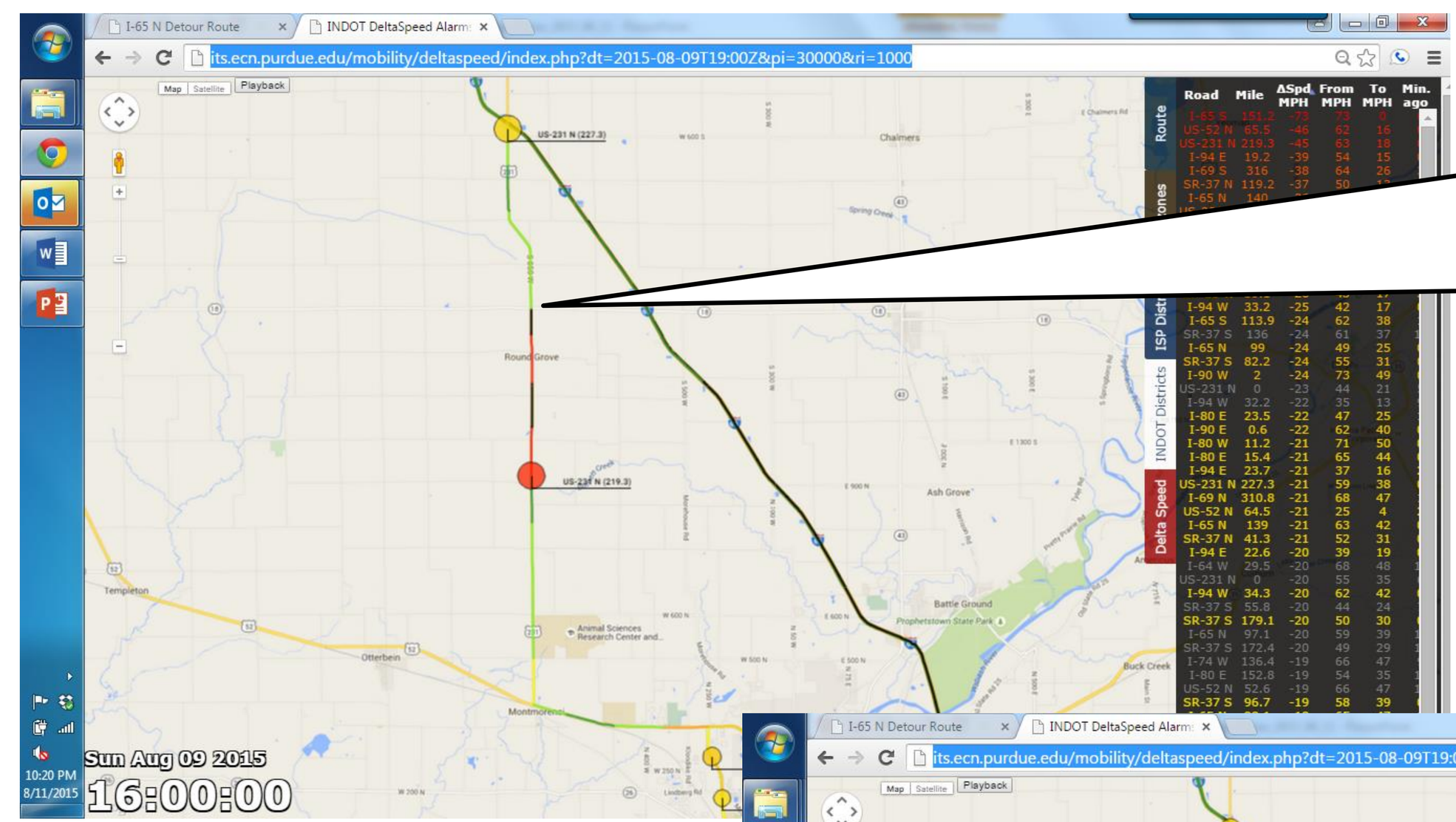

US-52, advance of US-52 & SR-47

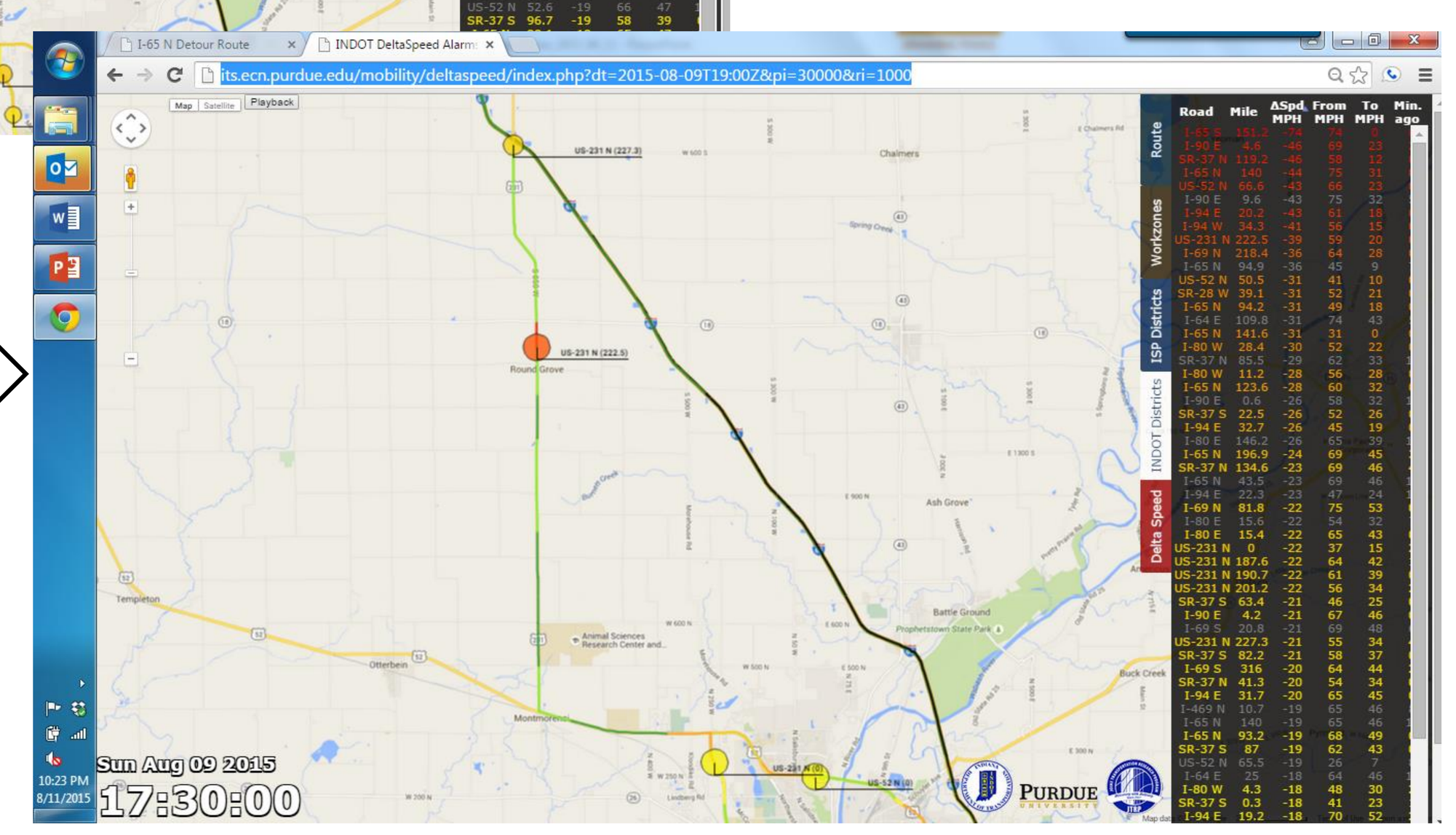

Temporary signal at US-52 and SR 28

US-231, advance of interchange with I-65

Coordination with Public Safety







ISP changes SR-18 from 4-way to 2-way stop and 90 minutes later, queue is cleared.