AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

ITS California
Technical Session 9 - Innovative Technology for Local Cities
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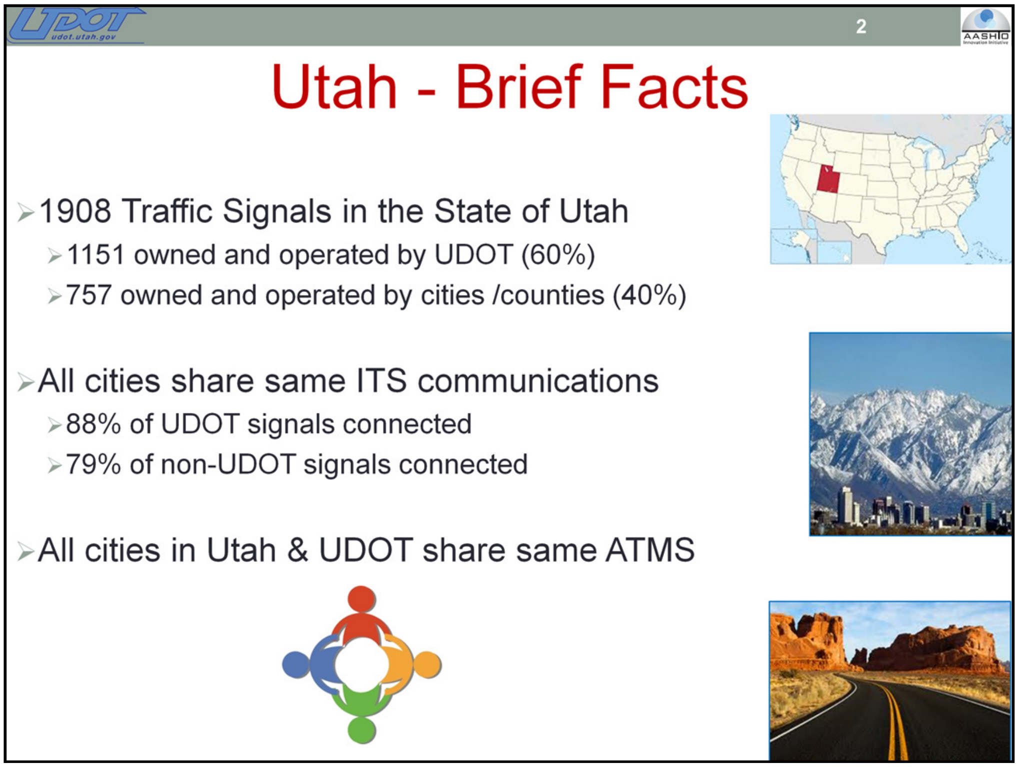
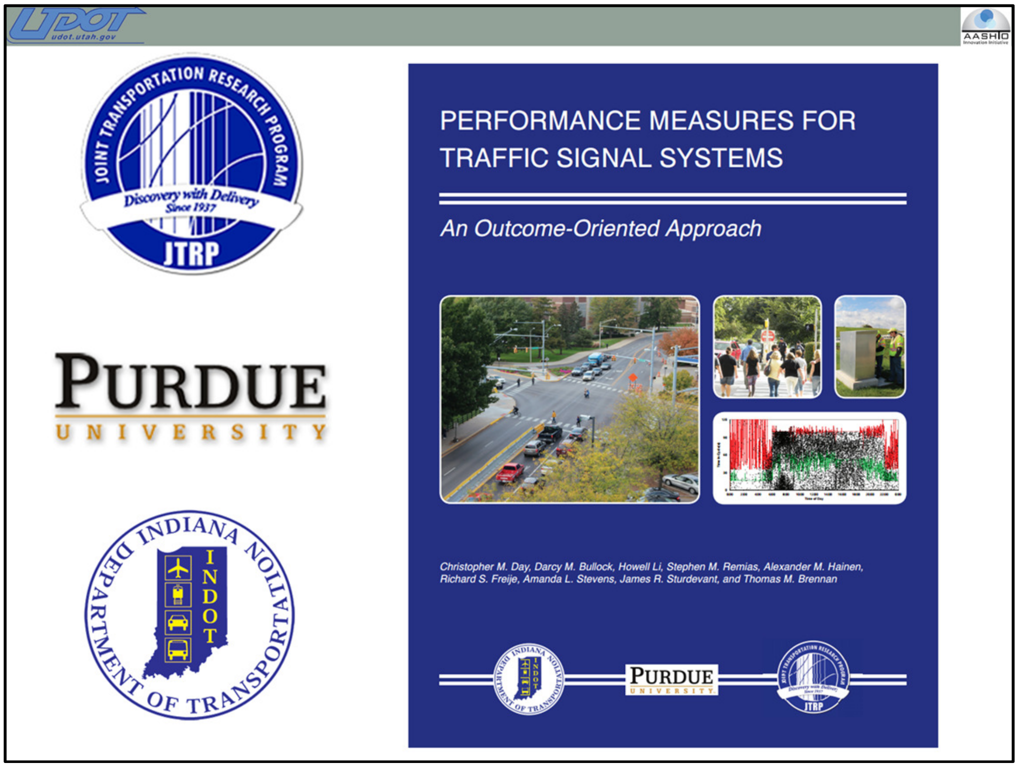
AASHTO Innovation Initiative

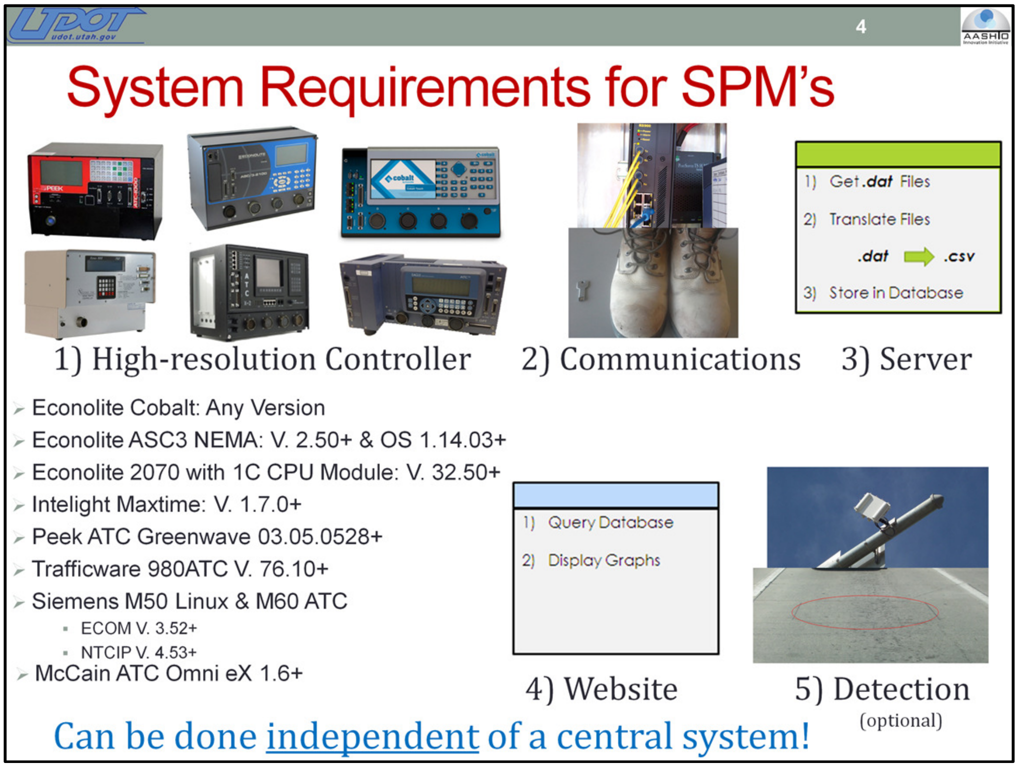
Good morning everyone. I'm glad to be back in the Bay Area, where I lived for 21 years.



We have approximately 1908 traffic signals in Utah, where most are owned and operated by UDOT. What makes us a bit unique is that all of the signals in Utah that are connected with communications share the same communications network. This approach has fostered a team-building environment with all jurisdictions in Utah, where we work very closely with each other and share the same ITS infrastructure, central signal system and signal performance measures.



The SPMs that Utah is using started with Darcy Bullock of Purdue University and Jim Sturdevant at Indiana DOT. They've been working on this concept for over 10 years. They have done some great work in pioneering this effort and working with equipment manufactures to get them to support the technology in their controllers. We were fortunate to run into them just as the technology was ready to take off.



The question is often asked, "How do SPM's work and what are the requirements?

1st, a signal controller is needed who's firmware includes a high resolution data logger. This data logger comes standard and is already available if you have one of these controllers. It is already installed and running, you just don't know it. This data logger records events every 1/10th of a second with a time-stamp, such as the begin of green, begin of yellow, detector on., etc. It buffers approximately 24 hours of data logs before it starts to override the data.

2nd, some sort of communications to the signal is needed, which can also include driving to the a signal to manually pull the data if no communications exists. External storage devices can be used to buffer weeks or months of data.

3rd, A large server is needed to store the data. Where communications exists, the server will FTP the signal about every 10 minutes to retrieve the data logs.

4th, The data logs are then interpreted and analyzed. The software was written in-house by UDOT and we are donating it for free to others. A website is used to easily visualize and use the data.

5th, Most but not all of the metrics need some type of detection to collect the information.

Please note that all of this is can be done independent of a Central System.

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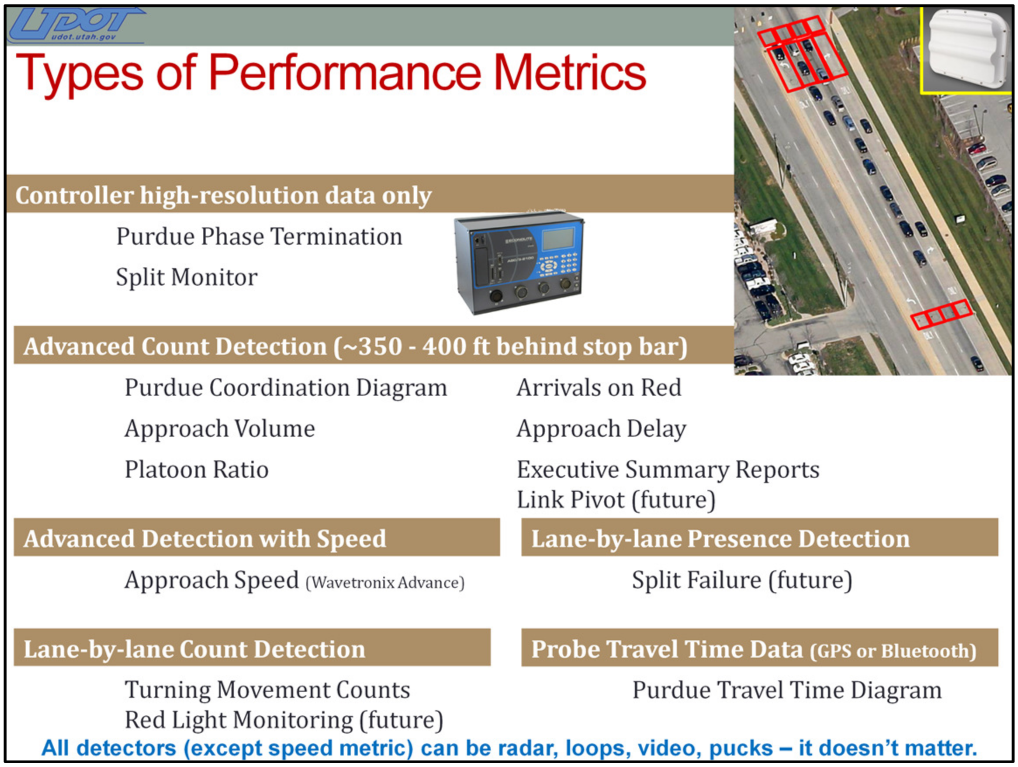
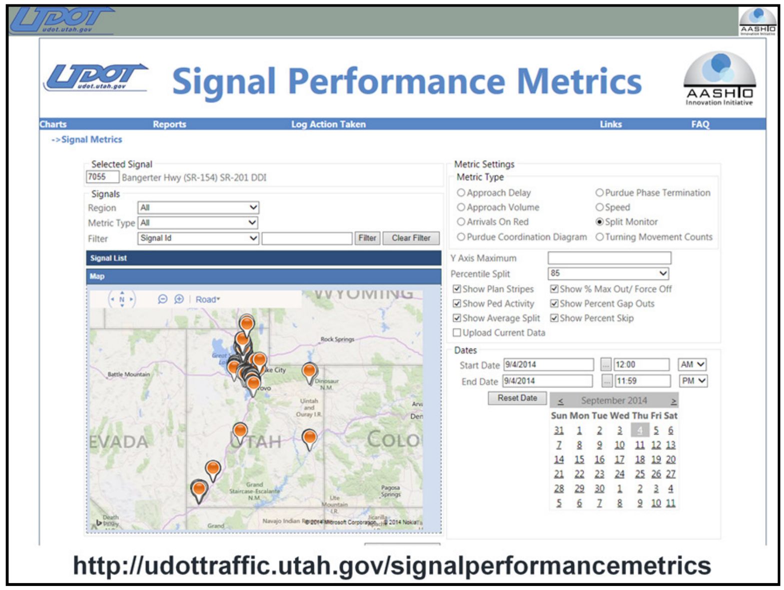
Controllers:

- Econolite Cobalt: Any Version
- Econolite ASC3 NEMA: V. 2.50+ & OS 1.14.03+
- Econolite 2070 with 1C CPU Module: V. 32.50+

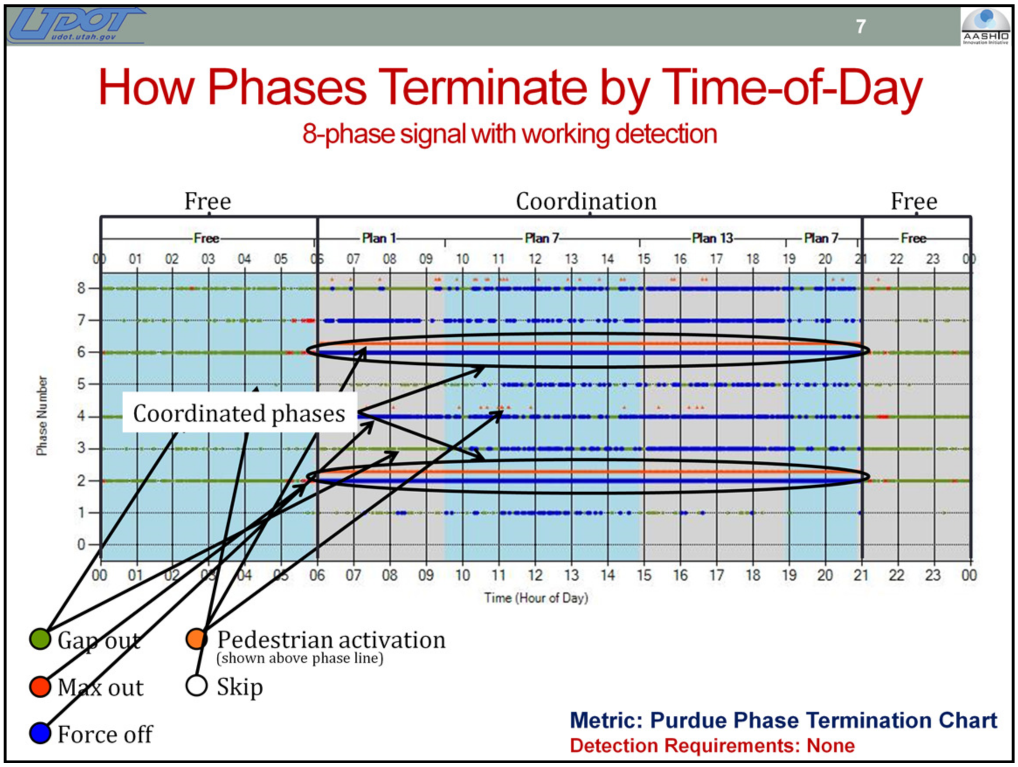
- Intelight Maxtime: V. 1.7.0+
- Peek ATC Greenwave 03.05.0528+
- Trafficware 980ATC V. 76.10+
- Siemens M50 Linux & M60 ATC
    - ECOM V. 3.52+ & NTCIP V. 4.53+



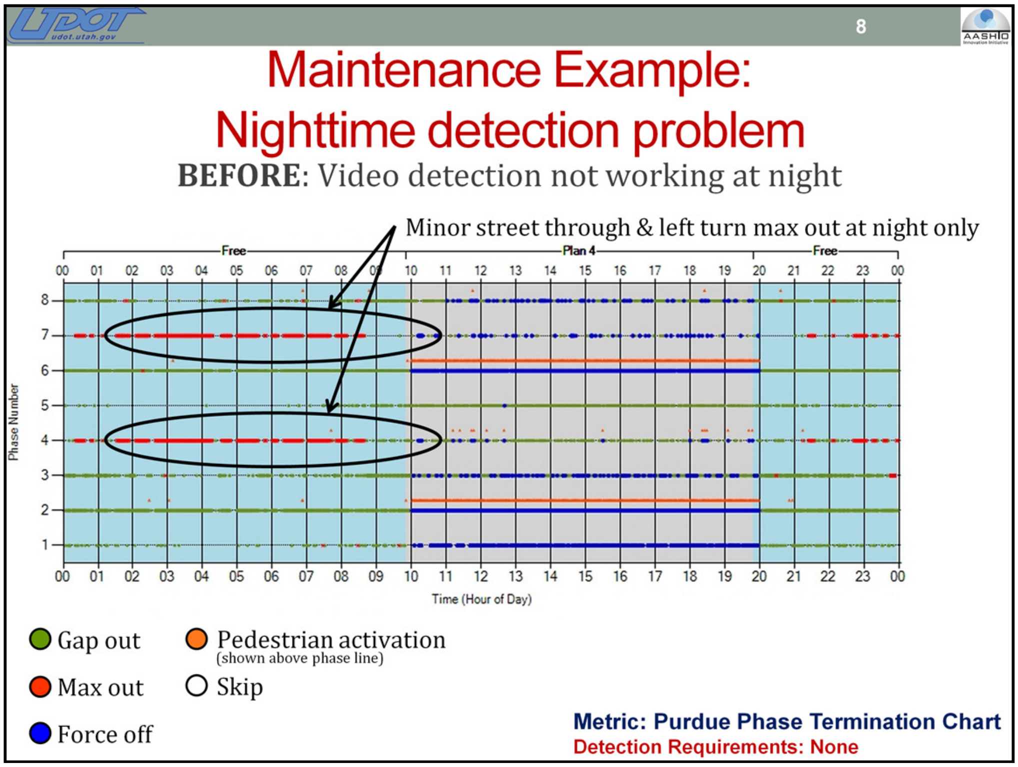
These are the metrics available on the UDOT website.
I would consider the Purdue Phase Termination and Split Monitor to be the most useful metrics for day-to-day operations. Neither of these have special detection requirements. The rest of the metrics require special detection, either setback or lane-by-lane at the stop bar. Some additional metrics are currently in development and will be available soon.



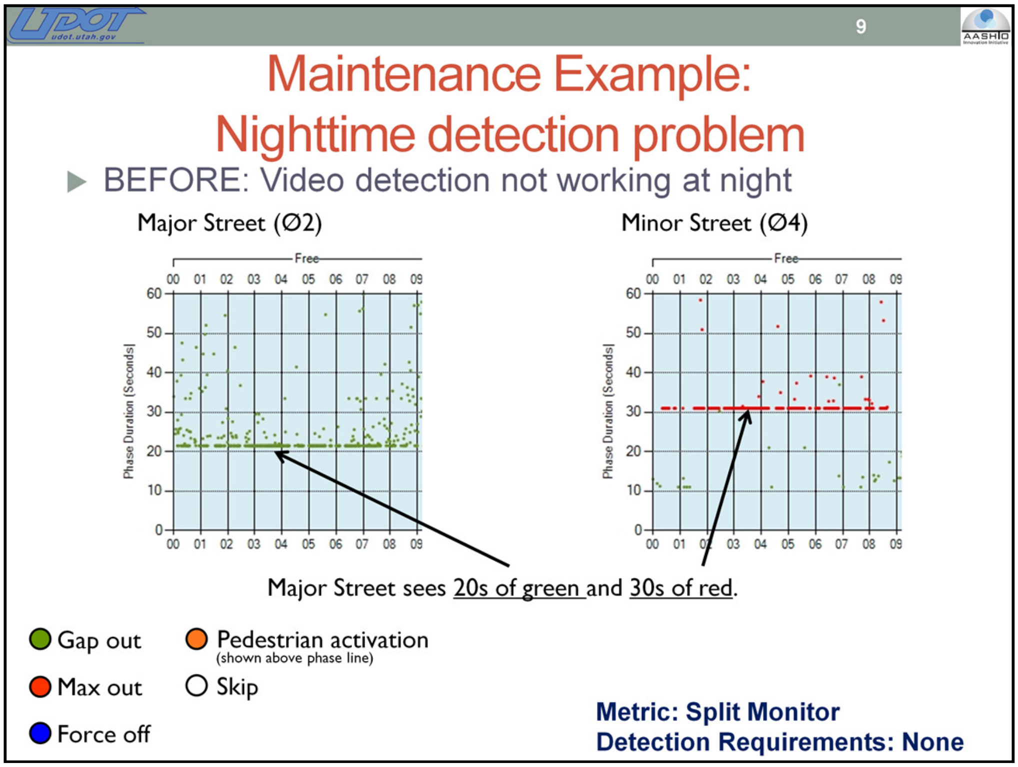
UDOT created a website without requiring any special software or passwords to access. In fact, you can pull this website up on your smartphone if desired. This helps us with our goal of transparency and allowing anyone who has a desire for the data to use it. The website is located at the URL shown on the bottom of the slide. In using the website, the top right corner under FAQ's will explain how to navigate and use the website. We have approximately 1250 intersections statewide in Utah bringing back near real-time SPM data.



- The first metric I have to show you is the Purdue Phase Termination Chart.
- The bottom axis shows the time of day. One day, midnight-to-midnight.
- The left axis show each phase at the signal.
- From the bars on the top, you can see that the signal runs fully actuated until 6 a.m., a few coordination plans run until 9 p.m., and then it runs fully actuated again.
- Each dot represents how the phase terminated in each cycle when it changes from green to yellow.
    - * The green dots indicate that the phase gapped out during that cycle.
    - * The red and blue dots show when the phase maxed out or forced off.
    - * An orange dot just above the phase line indicates that the pedestrian phase was active that cycle.
    - * A gap in the dots indicates that the phase was skipped. You can see that Phase 5 only came up once before 6 a.m.



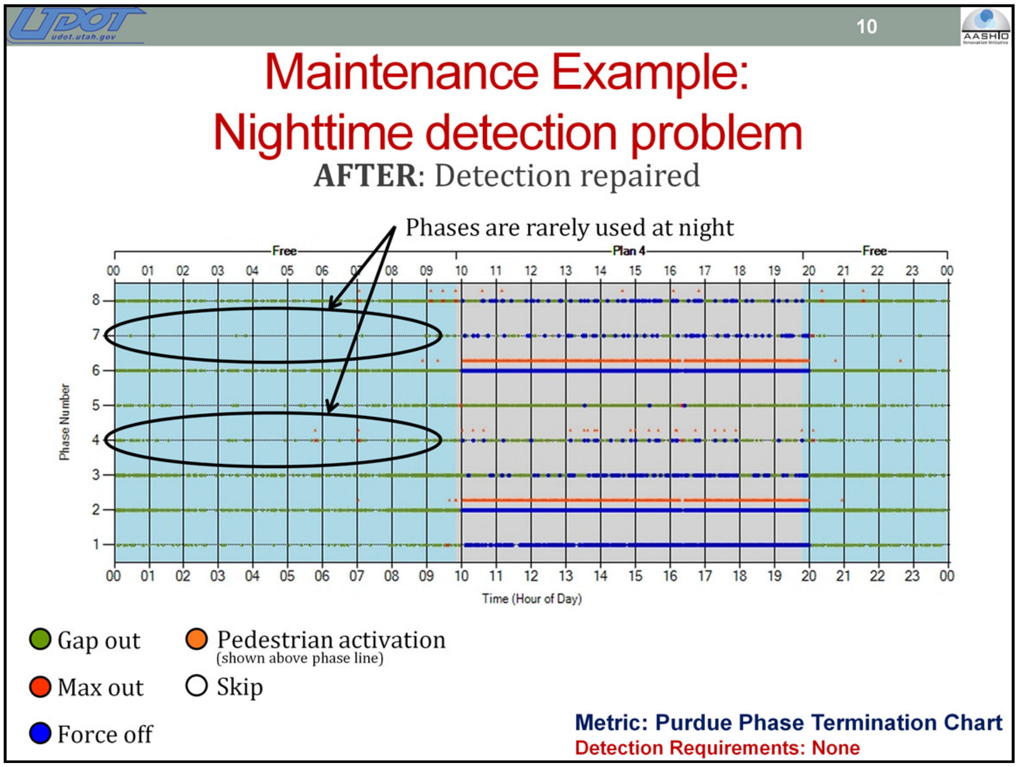
- This chart displays what used to be a very common complaint.
- It goes something like this: "I leave work at 2:00 a.m. every morning. And every day I drive down the road and I see the signal ahead turn green, but it turns red right before I get to it. Then I wait a minute for nobody. You guys are the worst! Please fix this stupid light."
- Previously, before Automated Signal Performance Measures, we would send a technician to check on the detection. He would get there around noon, not see any problem with the signal, leave without doing anything, and write me a nasty email about wasting his time.
*Now, he can look at this metric and see for himself that the issue only occurs at night and is likely video detection not working in the dark.
- Now they can attempt to fix the problem during the day, let it run overnight, and then check operation the next day. There is no need to come in at 4 in the morning.



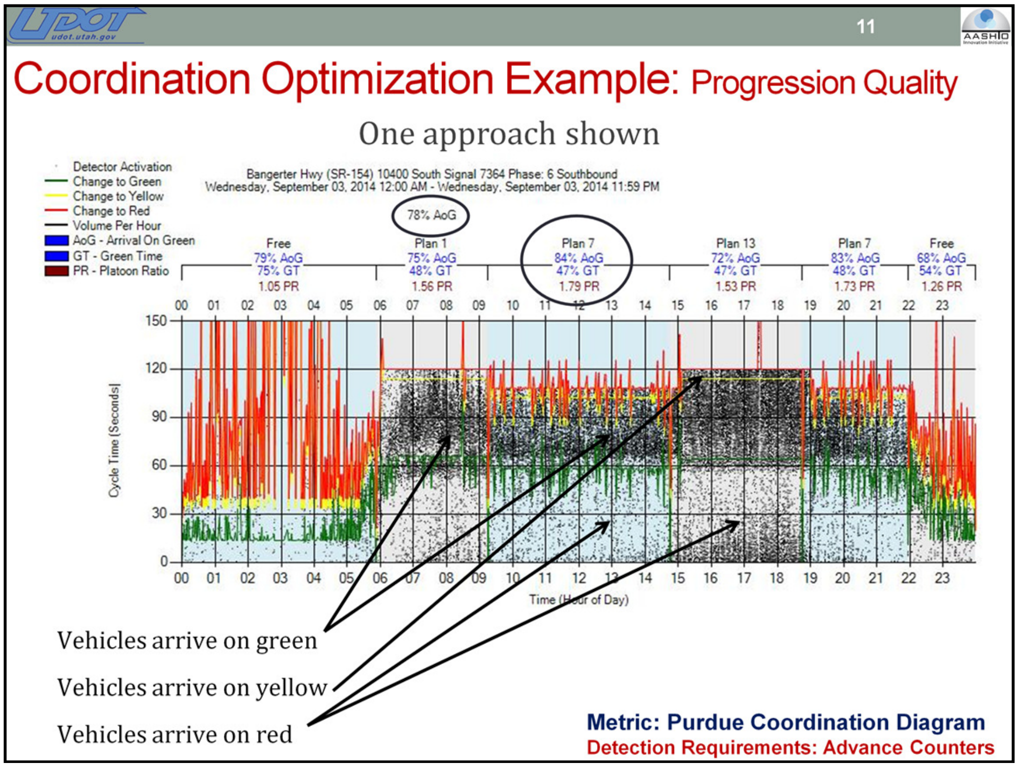
Notes updated 5/28/2014 – 20s

- This chart is the Split Monitor for the major street and the minor street at that same signal.
- The Split Monitor uses the same colors to indicate phase termination as the Phase Termination Chart. But with this metric, there is a separate chart for each phase and the left axis now represents the length of time the phase was active.

- The major street sees about 20 seconds of green followed by 30 seconds of red, likely for no vehicles.



Mention that we now have automated alert emails that look for this and let us know.

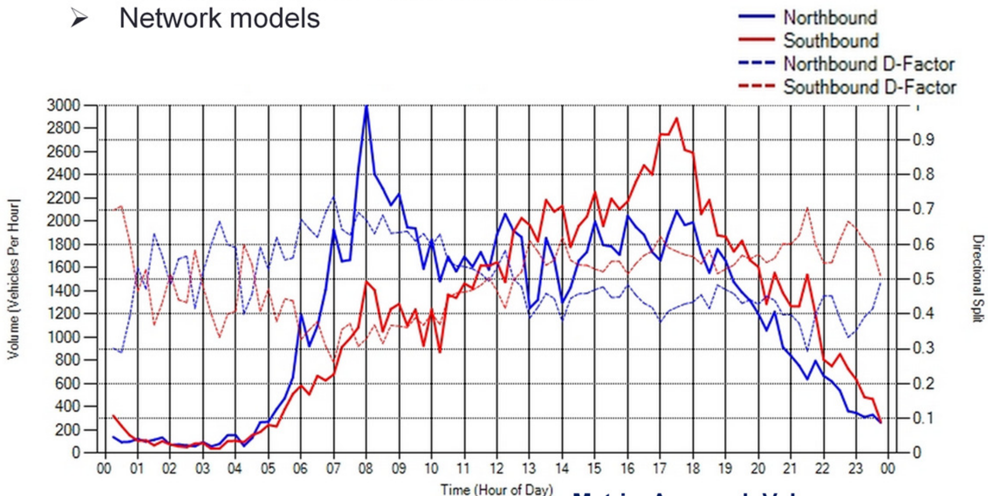


This metric is a Purdue Coordination Diagram. It shows the quality of progression for the SB direction at a CFI in Salt Lake City last yesterday, September 9th. The black dots are vehicles arriving at the intersection. Black dots above the green line are vehicles arriving during the green. Black dots above the yellow line are vehicles arriving during yellow. The black dots underneath the green line are vehicles arriving during red.

We also measure the percent of vehicles that arrive during green. From 9:00 AM to 3:00 PM yesterday, 84% arrive during green in the SB direction. Overall for the 24 hours of that day, 78% of vehicles arrived on green.

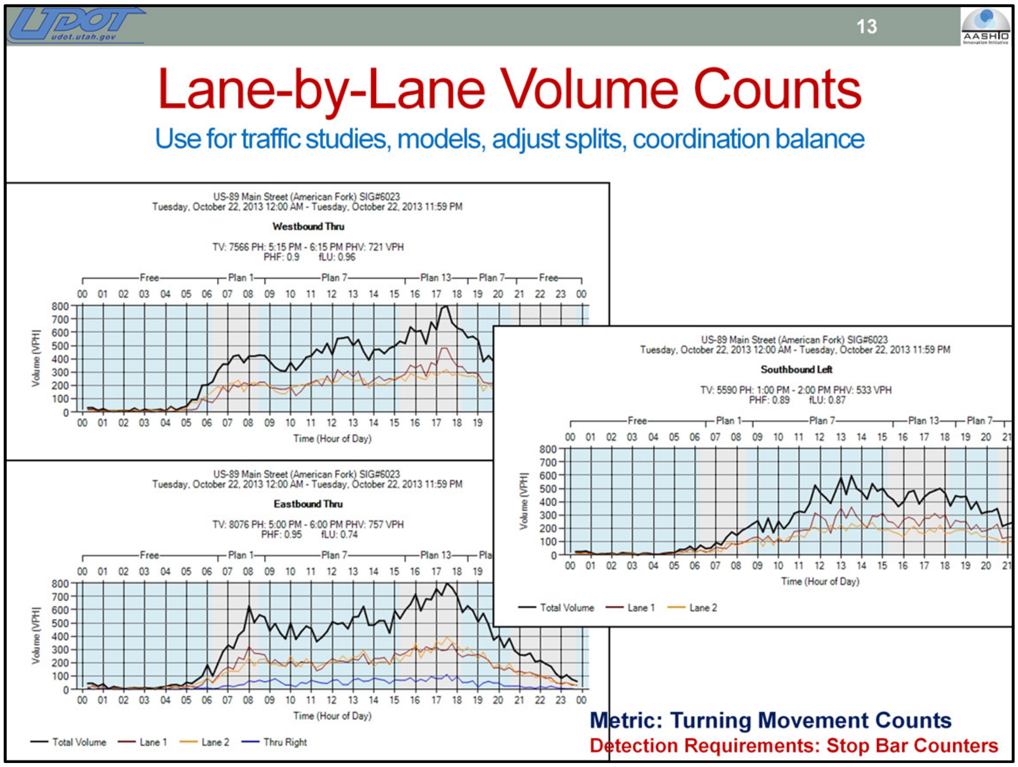
Approach Volumes

- When to take a lane for maintenance
- Directional splits for offset optimization
- Network models

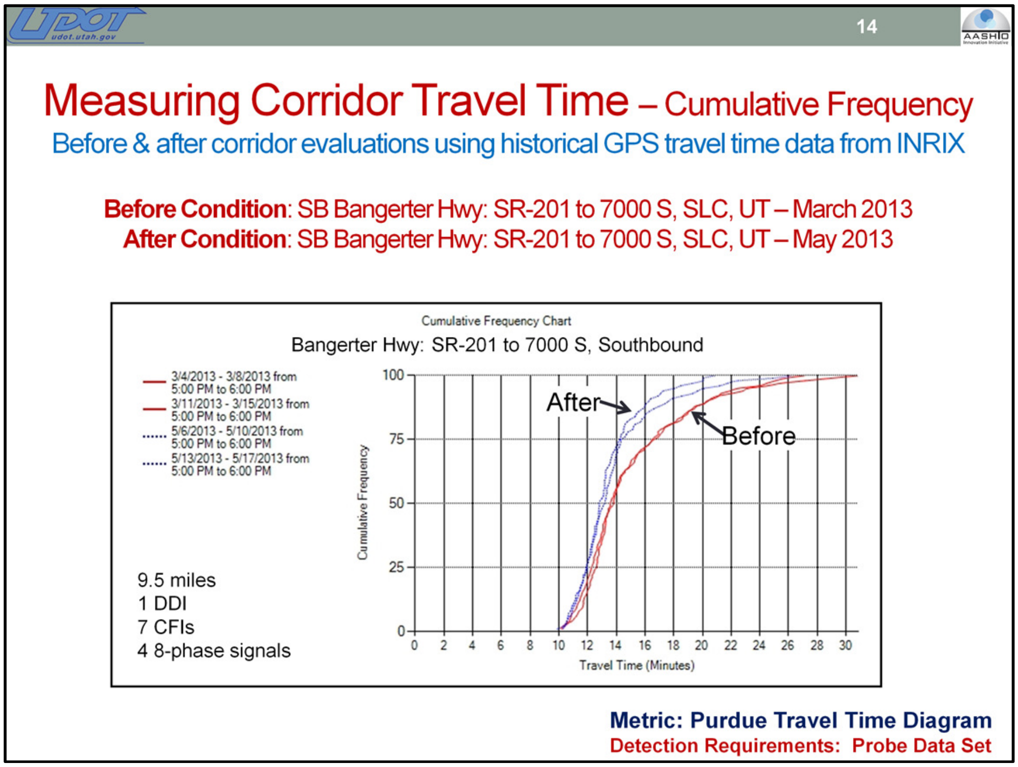


Metric: Approach Volumes

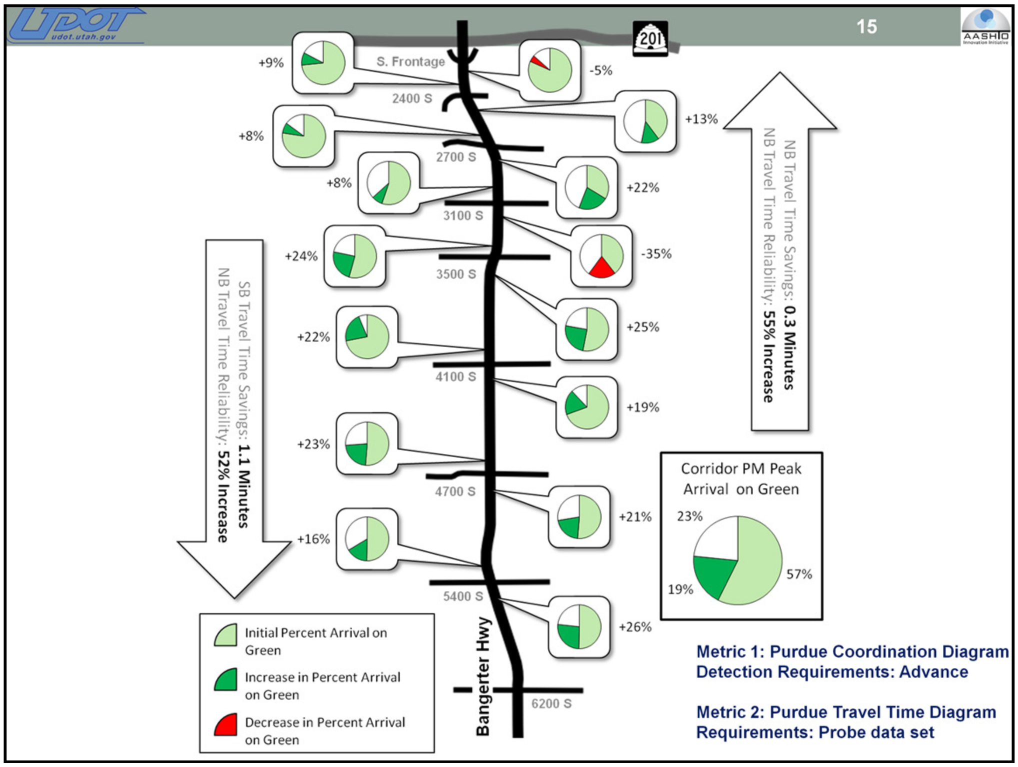
Detection Requirements: Advance Counters



[Slide 26]
This metric shows the lane-by-lane volume counts by using a detector located in each lane near the stop bar of the intersection. We have graphs for each turning movement. You can also see lane utilization issues, such as for the thru/right lane for the Eastbound direction.



This metric shows the Purdue Travel Time Diagram using INRIX 1-minute data. This information is also available on our website. The steeper the line and to the left is better. For example, you can see from this diagram that for the “before” condition in red, 25% of the travel time is 12 ½ minutes or less. 75% of the travel time is 17 minutes or less. For the “after” condition, 25% of the travel time is 12 minutes or less. 75% of the travel time is done in 14 minutes or less.



This chart shows a recent signal retiming study on a busy corridor in Utah using SPM's. You can see that overall the percent of vehicles arriving on green improved 19%. Using GPS probe data, the travel time savings in both directions improved , and travel time reliability improved over 50%.

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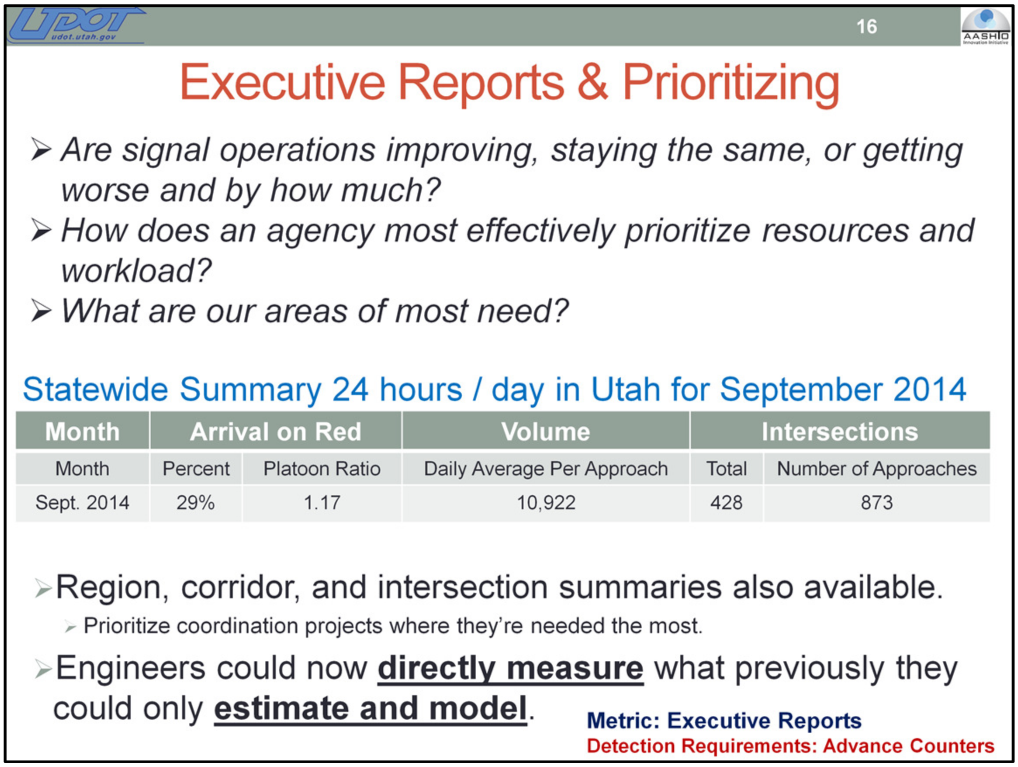
Travel time reliability: the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day.
Bangerter Hwy between SR-201 and 6200 S – PM peak changes to Arrival on Green before and after coordination in 3/2013

Note: the large NB decrease in Arrivals on Green at 3100 S is due to the poor spacing of this intersection. The previous timing plans provided for NB progress at the expense of SB progression. Actual data shows much heavier volumes for SB traffic. The new coordination plans provide great coordination for SB at the expense for NB traffic. It is not possible to provide good coordination for both directions due to the irregular spacing of this signal.

How to compute Reliability: Cumulative Frequency Chart: (Before – After) / Before: ((75th B – 25th B) – (75th A – 25th A)) / (75th B – 25th B)



Executive leaders and public officials are interested in program-wide signal performance and trends. They want to know if signal operations are improving, staying the same, or getting worse and by how much. They also want to know how an agency most effectively prioritizes resources and workload. We are now able to better respond to those questions.

You can see that overall, statewide in Utah during the month of August we had 30% of vehicles arriving on the red. This is measured data from approximately 400 intersections and 800 approaches and is averaged over the 24 hours of each day. We plan on enhancing our software so we can aggregate the executive reports by time-of-day as well. In addition, we are able to further drill down and access this same information for various areas, corridors and intersections statewide. This will help to prioritize our resources to focus signal timing improvements on the corridors of greatest need.

Engineers could now directly measure what previously they could only estimate and model.

SPM's have been selected as an AASHTO Innovation Initiative (formally TIG) focus technology. It's mission is to help others who are interested to implement this technology. So far to date, we have donated for free the software to the Minnesota DOT, Las Vegas, Overland Park Kansas and are currently working in assisting Georgia DOT and the City of Tucson. We have also donated the software to the private sector as well, including Olsson And Associates and Intelight. If you're interested in assistance with this technology, please let me or an Aii lead states committee member know.

Thank you so much for your time.