**Abstract**

Recent advancements in high-resolution signal controller data logging and acquisition technologies have enabled development of fundamental performance measures that are effective at identifying split failures and rebalancing green times. However, from a system operator perspective it is important to scale these metrics system-wide for monitoring, triaging, and decision-making uses. This paper articulates the questions that concern a typical system operator, and the associated performance measures and tools that can be used to actively manage such systems macroscopically. To illustrate this methodology, the paper examines 70 signals across seven corridors over a six-month period. Approximately three billion high-resolution signal events including 217 million phase occurrences are analyzed, with 126 million of those phases occurring during the 0600–1800 time period. This paper proposes a scalable method to identify phase occurrences with insufficient green. Applying a previously developed split failure performance measure for this purpose, over 106,000 split failures (0.08% percent) of the phase occurrences are estimated to have failures for the time of day period. These are displayed using a graphical visualization we called the Purdue Split Failure Ticker (PSFT). Subsequent sections of the paper recommend Pareto ranking, drill-down analysis by movement and hour, and corridor movement split summaries to identify where to prioritize resources for signal re-timing activities and geometric improvements.

**Scaling Data – Reduction and Aggregation**

### Level 1 - Stateless Events

- **Output, Phase Events**
  - Signal Controller
  - Detectors

- **Level 2 - Intervals**
  - Phase and detector event pairs are combined into interval records, and non-essential records are removed to reduce the number of rows indexed.

- **Level 3 – 15-Minute Aggregates**
  - Once the intervals are produced, occupancy ratios and split failures can be aggregated into single 15-minute binned records for faster queries.

**What Constitutes a Split Failure?**

A split failure is when the duration of green for a movement at a signalized intersection is insufficient to service the amount of demand present. This study uses an occupancy-based metric that looks at the green interval and the beginning (first five seconds) of the red interval, i.e. if both are over 80% occupied.

- **Double-left turn queue**
  - Queue builds during first red interval.
  - Vehicles start to depart at the beginning of the green interval.
  - Vehicles finish departing during the yellow interval.
  - Vehicles left behind at start of red, RORS = 100%
Total Split Failures, January to June 2015
All days of the week, 24 hours per day

Time-of-Day Performance
All Systems, January to June 2015

Corridor Performance
Fridays, January to June 2015, 9AM to 4PM

System Summary
January to June 2015
Avg. split failures per intersection per hour

Movement Performance at US-31 Greenwood
Saturdays, January to June 2015, 11AM to 7PM

Monday to Friday, 6AM to 9AM
Monday to Friday, 9AM to 4PM
Monday to Friday, 4PM to 7PM

Most systems spiked during two snow events in February with the exception of US-31 Columbus (the southernmost system).

The first Friday of April broke seasonal trends as the NCAA Final Four tournament was in town.

The PM peak period generally saw the greatest number of split failures per hour, with significant increases after the beginning of April.

General trend from winter to summer is increasing split failures. Weekly trends show peaking characteristics for most Fridays, and Saturdays for some systems.

Memorial Day

Most split failures, with notable exceptions.

Friday are dominated by PM rush

Saturday trends toward mid-day, PM period

Saturdays, January to June 2015, 9AM to 4PM

Intersection Performance at US-31 Greenwood
Saturdays, January to June 2015

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Average Split Failures Per Hr.

System Summary
January to June 2015
Avg. split failures per intersection per hour

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Saturdays, January to June 2015, 11AM to 7PM

Corridor Performance
Fridays, January to June 2015, 9AM to 4PM

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