Analytics and Dashboards for Effective Roadside Sensor Network Management

Session: Rural Incident Management and Performance Data

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ite
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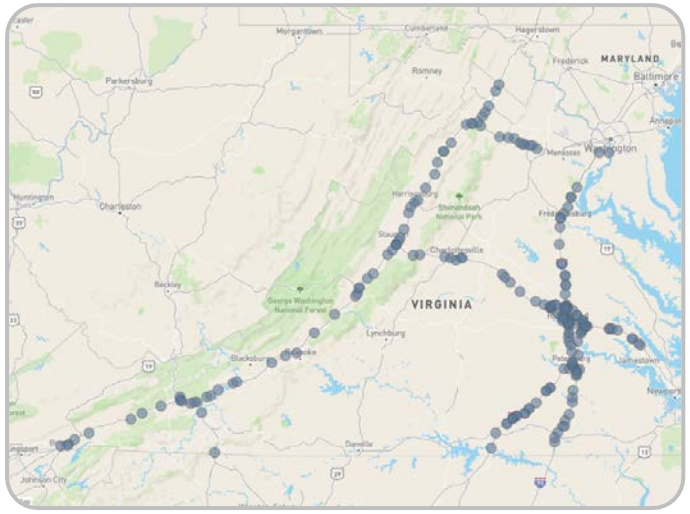
Topics

- Analytics and dashboards for traffic sensor network management in Virginia
- Proof-of-Concept application to support performance measure reporting for Traffic Incident Management

Traffic Data Collection Network in Virginia

- Digital Traffic Systems owns, operates and maintains a statewide radar sensor network to support transportation operations and data collection for VDOT
- 210 non-intrusive continuous count sites collect traffic volume and speed data



Cloud-Hosted Portal for Network Management

- We've developed a new approach for network management by creating a customized portal to enable access to all program data in one place

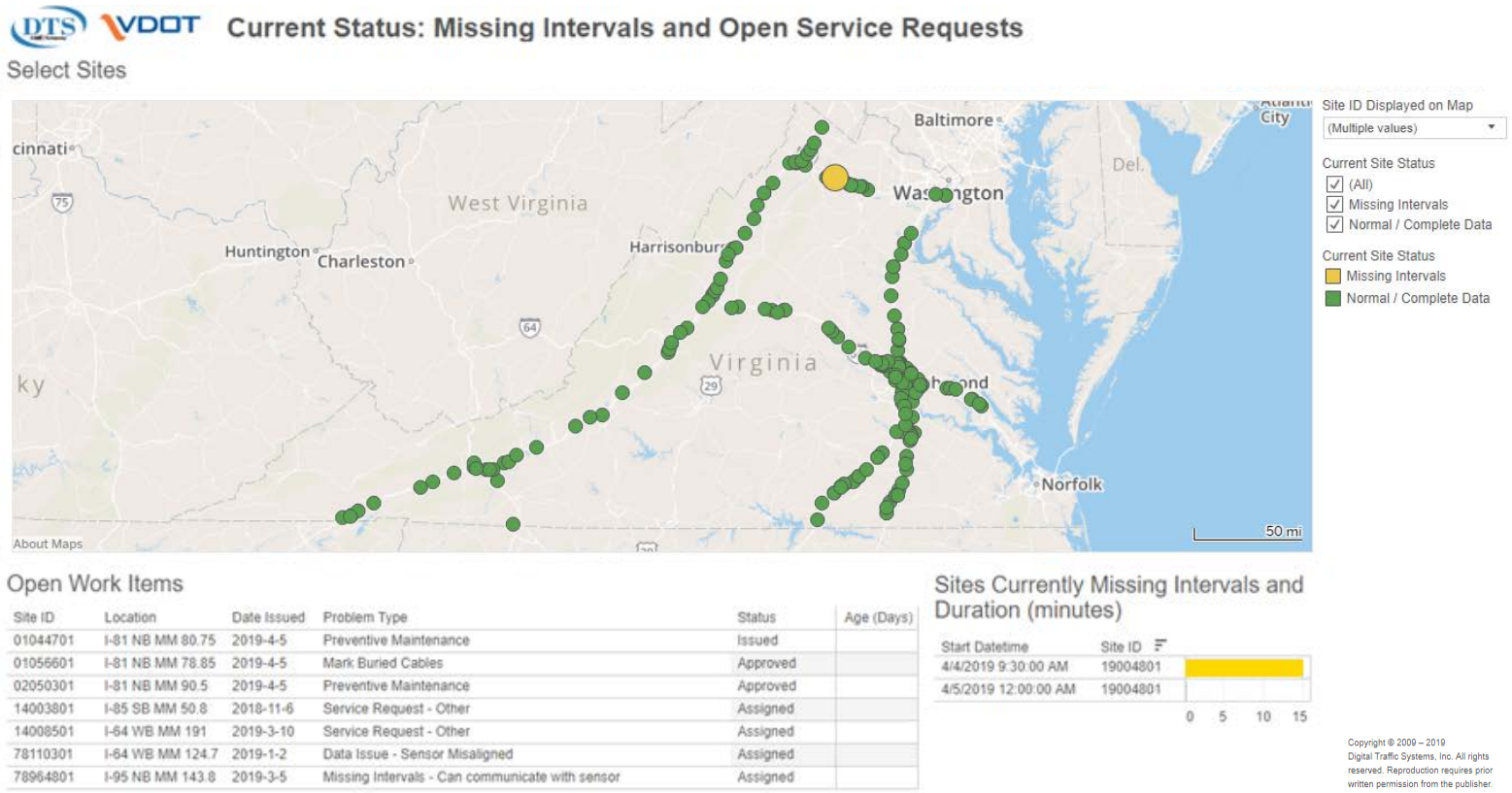
- Portal serves field technicians, operations engineers, analysts, office workers, and management
  - Operational status and automated notifications
  - Maintenance Management System – assets and work flow processes
  - Traffic data and quality checking
  - Performance measures and transparent reporting

- Dashboards make complex data easily accessible, and promote data-driven decision making and continuous improvement

Current Network Status

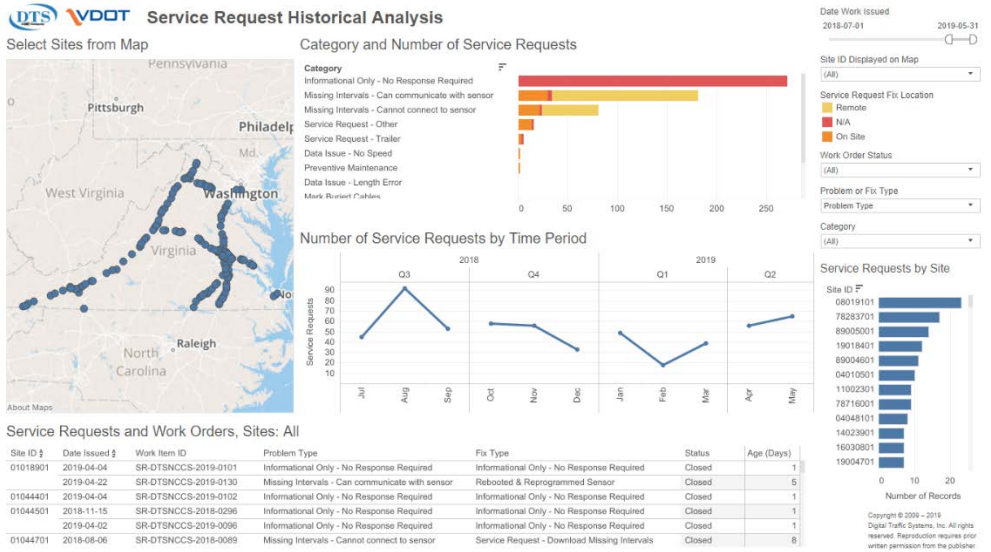
- Dashboard prominently displays potential data outages on a PC or mobile device, triggering a verification and diagnosis process
- Data transmissions are monitored throughout the day to rapidly detect “missing intervals” (5 minute bin data) and notify users

Users can check open service requests to determine if outage is due to scheduled maintenance work

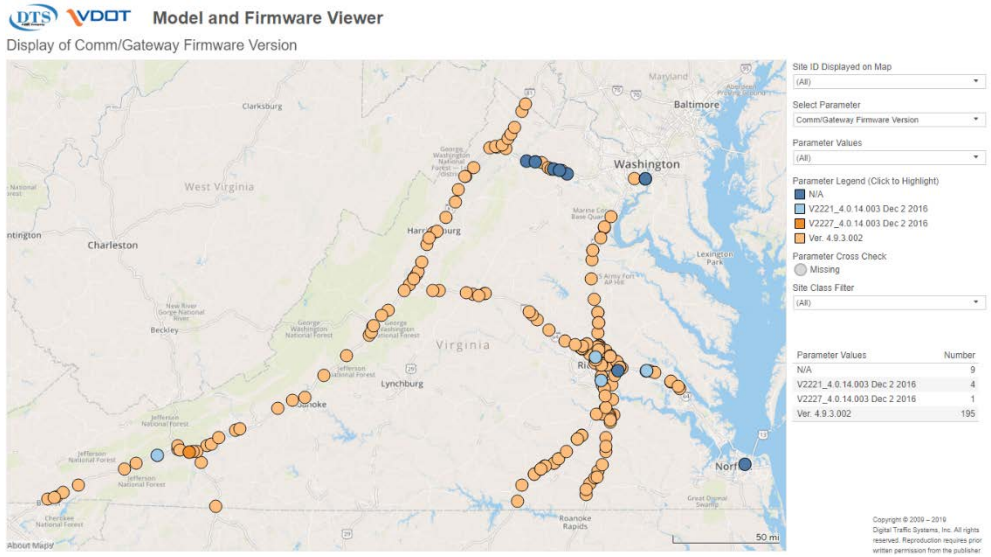


Process Control

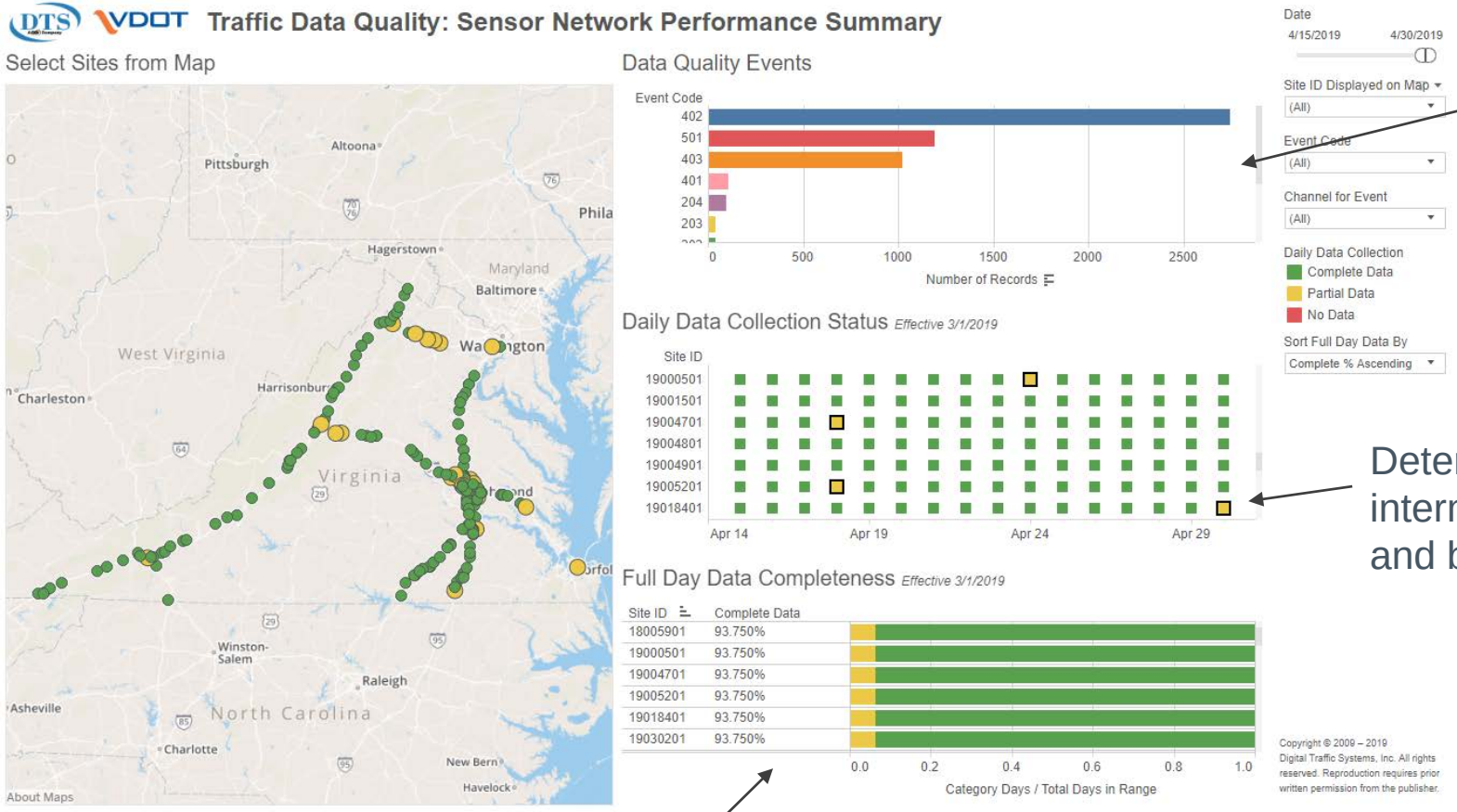
- Maintenance Management System
  - Assets and inventory
  - Network topology
  - Work flow
  - Classification of reported problems and fixes, and frequency of occurrence tracked for continuous improvement



- Make/Model and Firmware
  - Identify sites with outdated firmware
  - Track status of upgrade campaigns, such as sensor or battery replacement



High Availability Network Performance



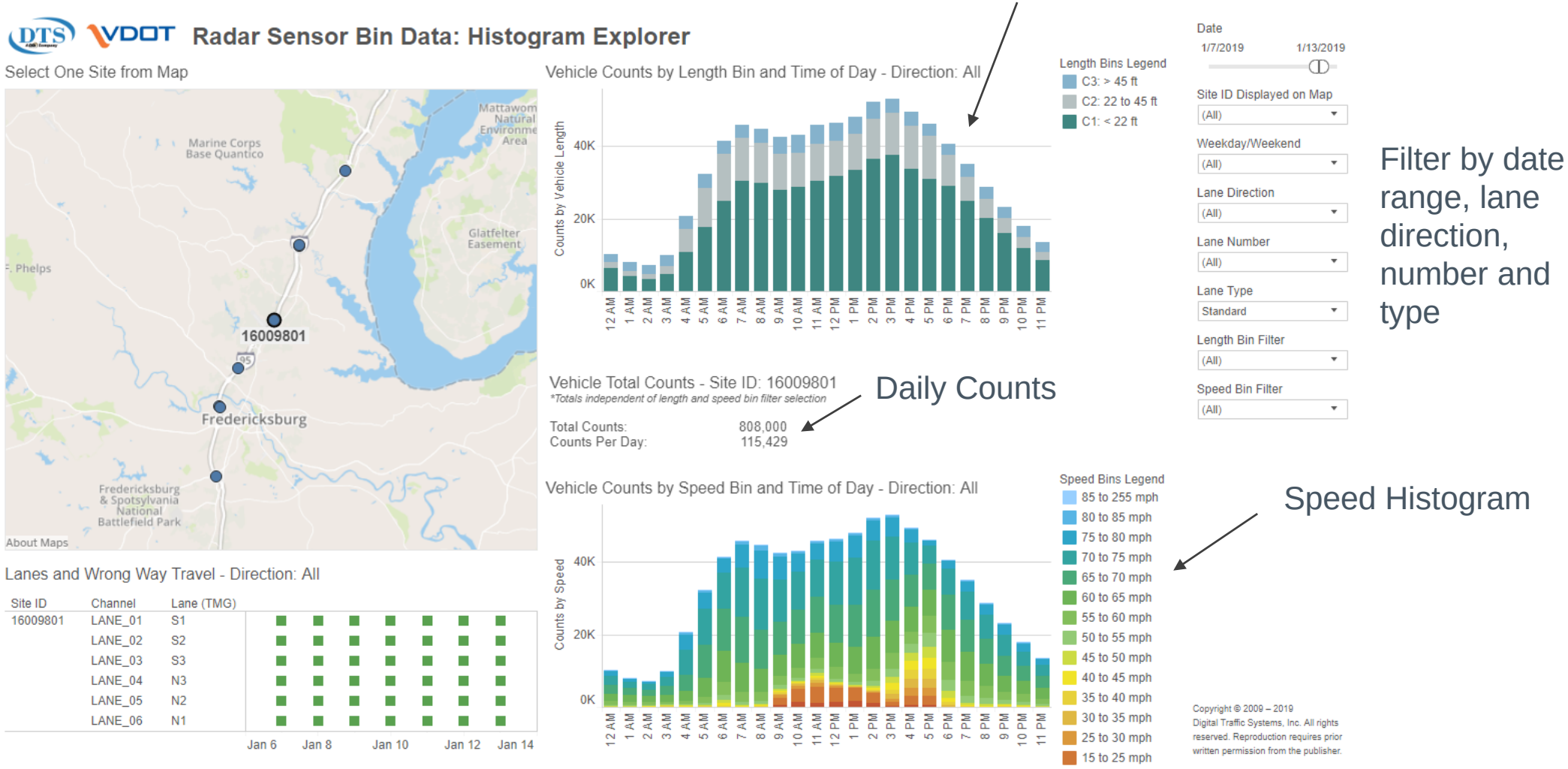
Summarize 20 types of quality checks for the collected data

Determine data loss patterns – intermittent, continuous, by site and by date

Performance measure is full day data completeness (100% of data) to support FHWA AADT reporting
Program typically achieves 99.0% full day data completeness, and 99.9% bin data completeness

On-Demand Visualization of Traffic Patterns

Suite of Dashboards Query Billions of Traffic Data Records



Filter by date range, lane direction, number and type

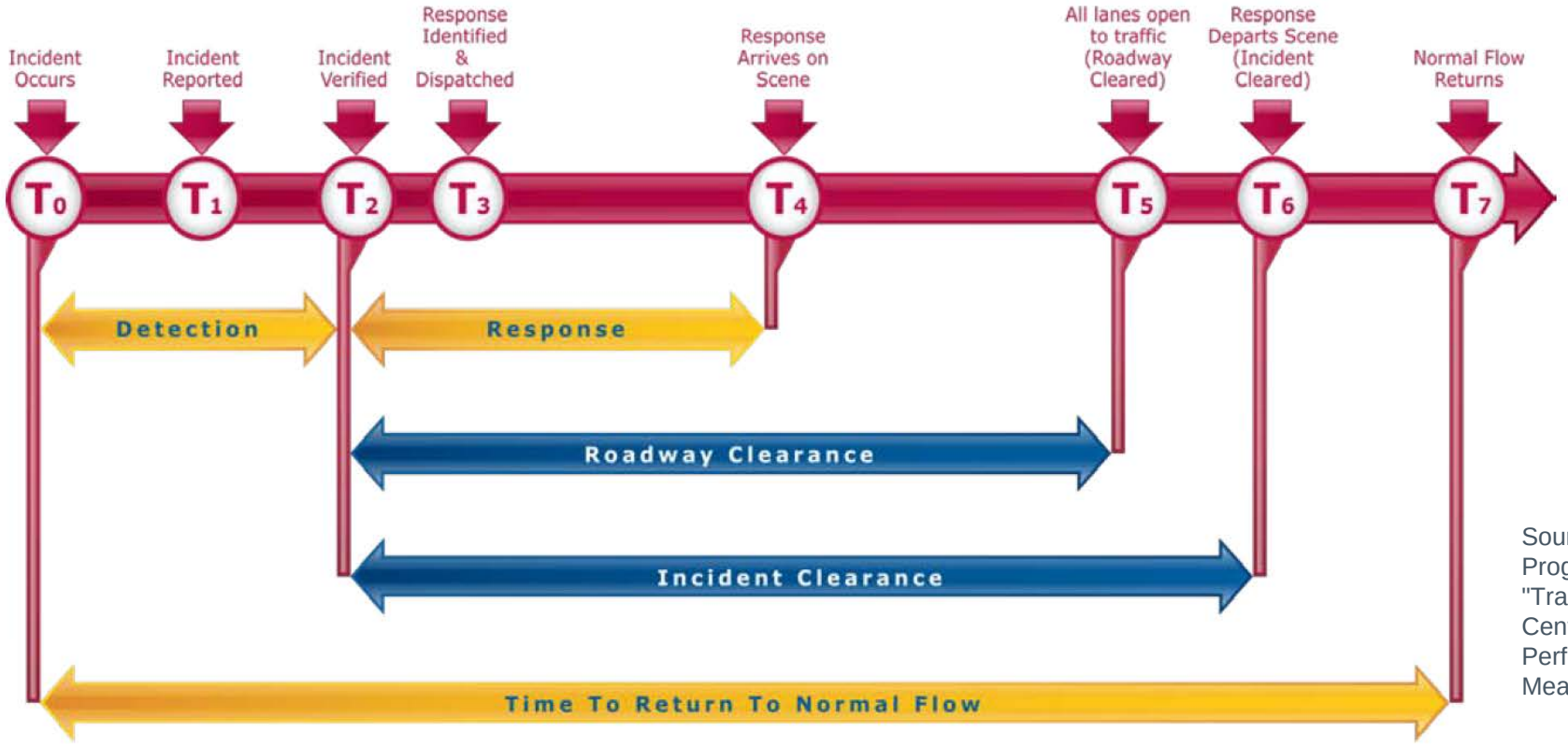
* VDOT currently doesn't use radar-based length classification due to its reduced accuracy compared to axle+weight classification

The traffic database contains high-quality data that are logged continuously…

Can we detect traffic incidents?

Traffic Incident Management Performance Measures

- The “timeline of events” for traffic incidents provides some commonly used performance measures
- Some events involve human data entry (police patrols, in blue) and are available in reported crash data, whereas other events are difficult to obtain
- Traffic data analytics can provide independent information to fill knowledge gaps and automate calculation of performance measures (notably, T0 and T7)



Source: USDOT ITS Joint Program Office (ITS JPO), "Transportation Management Center Data Capture for Performance and Mobility Measures Reference Manual”

Traffic Data and Crash Data Fusion

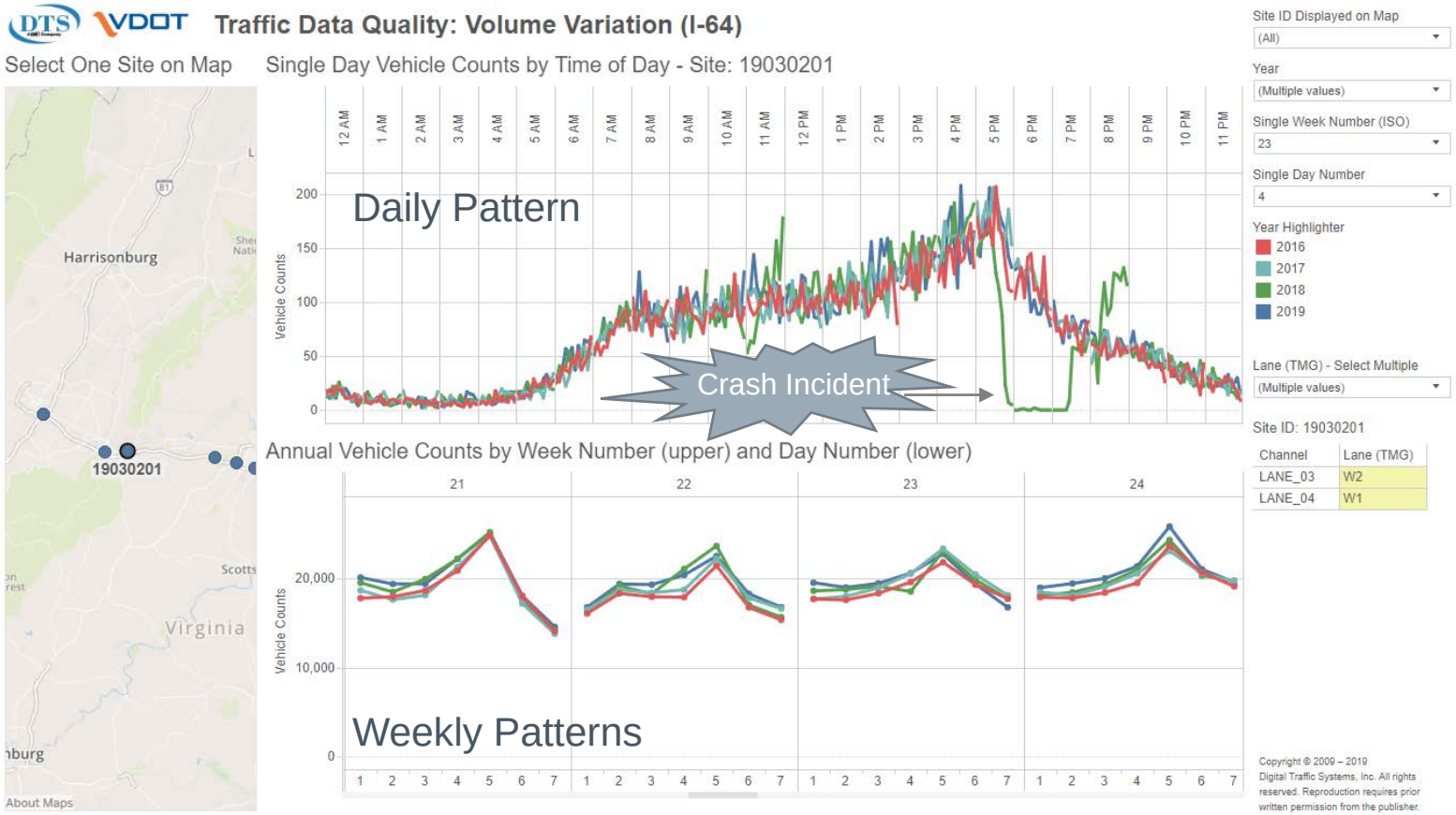
- Proof-of-Concept performed for a rural segment of I-64 from Richmond to Staunton, Virginia – Afton Mountain
- Traffic data from 13 radar sensor sites
- Crash data from VDOT Virginia Roads open data portal
- Analysis from Jan 2016 to Apr 2019
- Algorithm calculates incident statistics, by matching traffic data with crash data using the reported crash date and time

VIRGINIA ROADS

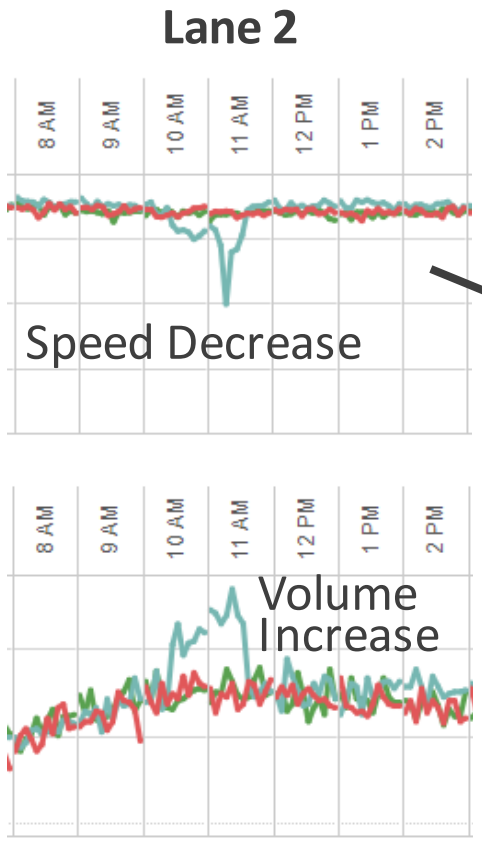
Historical Traffic Data

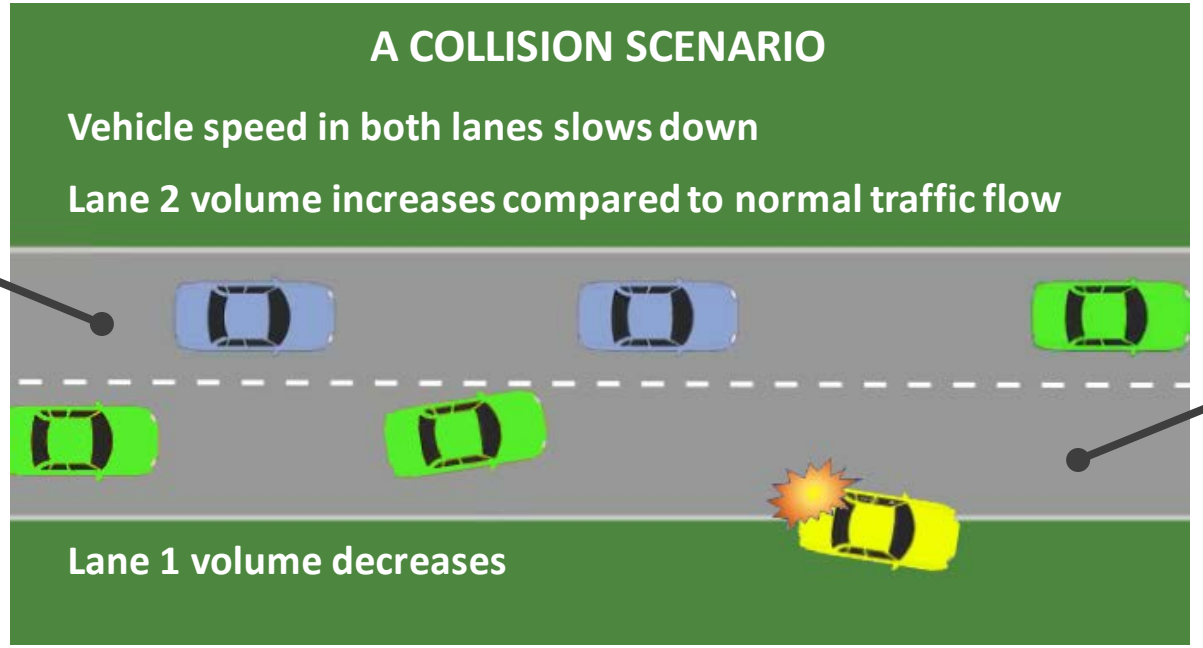
- Traffic volume and speed data can be very repeatable when aligned by week day and season
- DTS uses these patterns to check for radar sensor data quality problems
- Deviations to the daily traffic pattern may also reveal roadway incidents

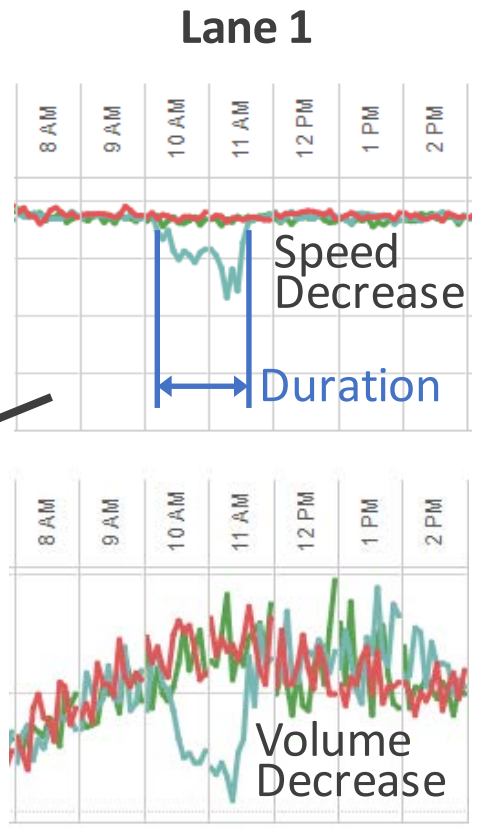
4-year traffic volume overlay for a rural interstate site



Crash Detection from Radar Sensor Data







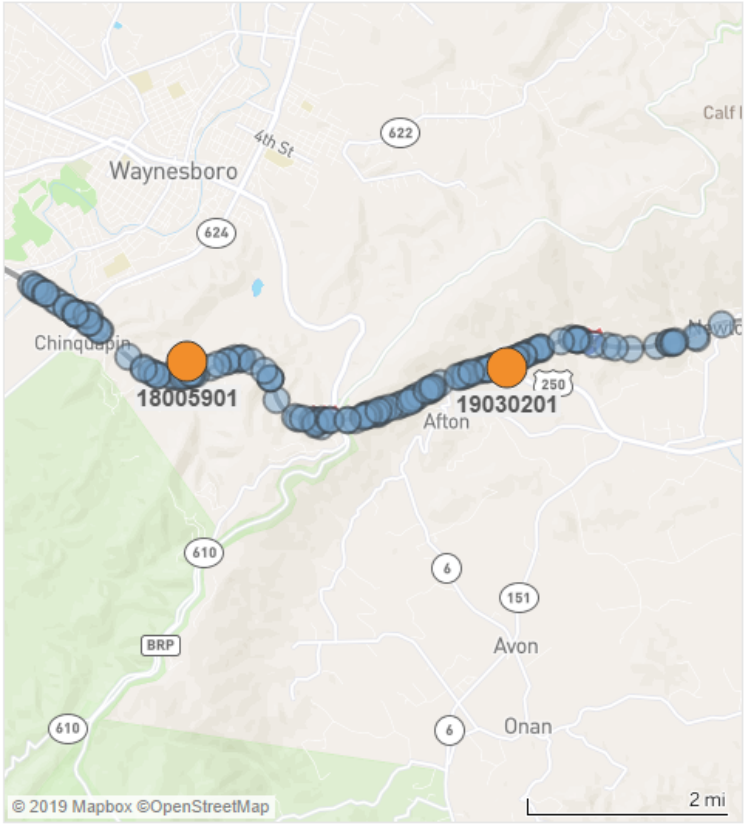
The algorithm uses both speed and volume measurements from each lane and compares to historical data to positively identify the crash event, and then calculates the incident duration and number of vehicles effected

Interactive Dashboard for Traffic Incident Analysis

All Weather

Traffic Incident Performance Measures

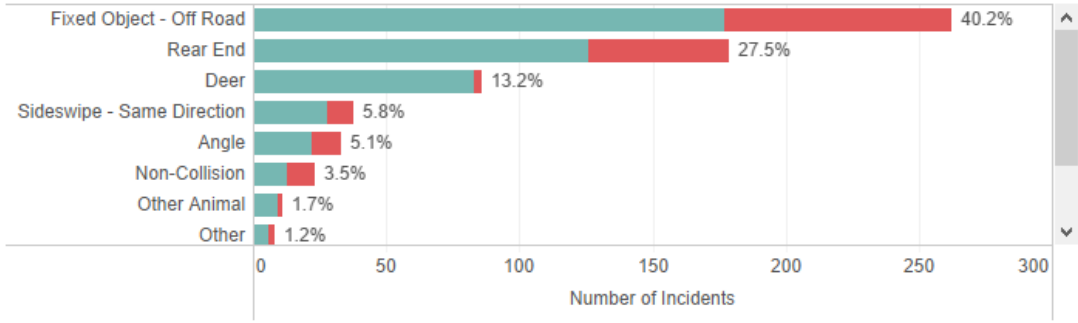
Incident Location and **Traffic Data Site**



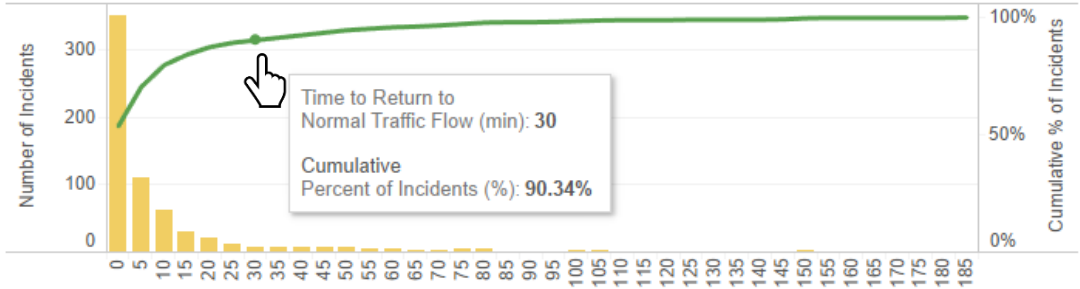
Number of Incidents	Incidents with Injuries or Fatalities
652	180

Number of Vehicles Delayed by Incidents	Average Time to Return to Normal Traffic Flow (minutes)
33,148	10.57

Frequency of Incidents by Report Type



Time to Return to Normal Traffic Flow (Minutes)



Incident Details and By-Lane Statistics

Start Date	Incident ID	Weather Condition	Lane	Vehicles Delayed	Vol Change (%)	Speed Change (%)
2018-12-14	544629	Mist	W2	367	-38	-90
			WR1	161	-78	-87
2018-12-13	60137	No Adverse Condition (Clear/Cloudy)	W1	52	-61	-18
			W2	170	198	-17
	640750	No Adverse Condition (Clear/Cloudy)	W1	70	-36	-65
			W2	64	-56	-89
			WR1	124	1	-29

Year of Incident: (All)

Weekday/Weekend: (All)

Weather Condition: (All)

Site ID: (All)

Incident Report Type: (All)

Injury/Fatality Incidents: (All)

Injury Status Legend
- Injury or Fatality
- Non Injury

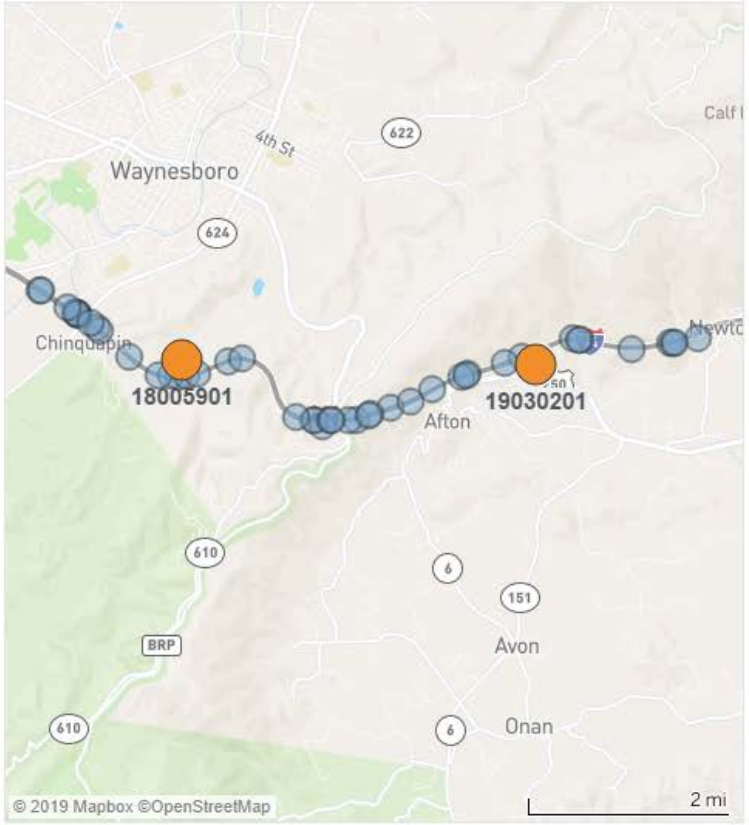
Incident Metrics Legend
- Cumulative %
- Number of Incidents

Traffic Incidents – Sensitivity to Weather

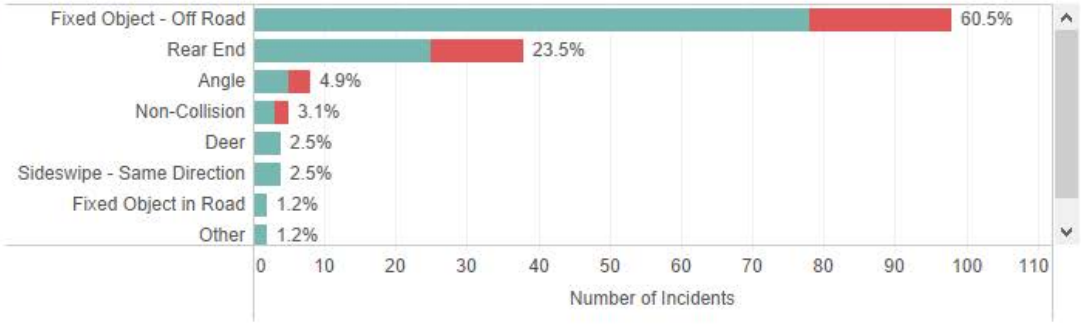
Adverse Weather (excludes clear and cloudy conditions

Traffic Incident Performance Measures

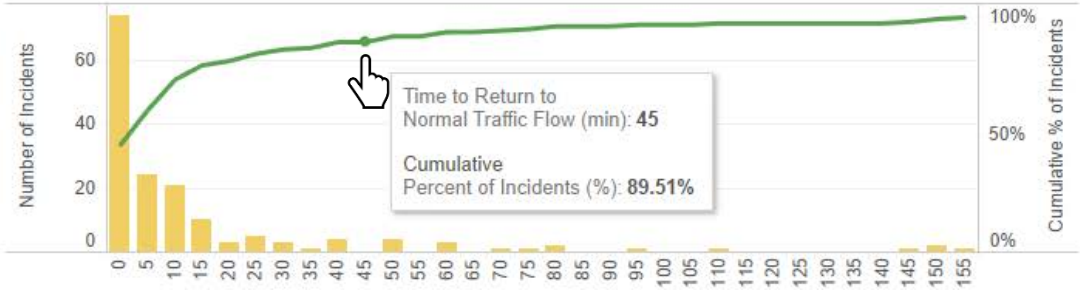
Incident Location and Traffic Data Site



Frequency of Incidents by Report Type



Time to Return to Normal Traffic Flow (Minutes)



Incident Details and By-Lane Statistics

Start Date	Incident ID	Weather Condition	Lane	Vehicles Delayed	Vol Change (%)	Speed Change (%)
2019-04-26	706968	Rain	E1	100	-24	-47
			E2	228	60	-60
2019-04-19	401608	Rain	W1	52	-9	-9
			W2	81	68	-13
			WR1	69	-1	-13
2019-04-14	262411	Rain	W1	0	-7	-3
			W2	0	-9	-3

Year of Incident: (All)

Weekday/Weekend: (All)

Weather Condition: (Multiple values)

Site ID: (All)

Incident Report Type: (All)

Injury/Fatality Incidents: (All)

Injury Status Legend
- Injury or Fatality
- Non Injury

Incident Metrics Legend
- Cumulative %
- Number of Incidents

Number of Incidents	Incidents with Injuries or Fatalities
162	39
Number of Vehicles Delayed by Incidents	**Average Time to Return to Normal Traffic Flow (minutes)**
9,980	15.06

Traffic Incidents – Sensitivity to Weekday/Weekend

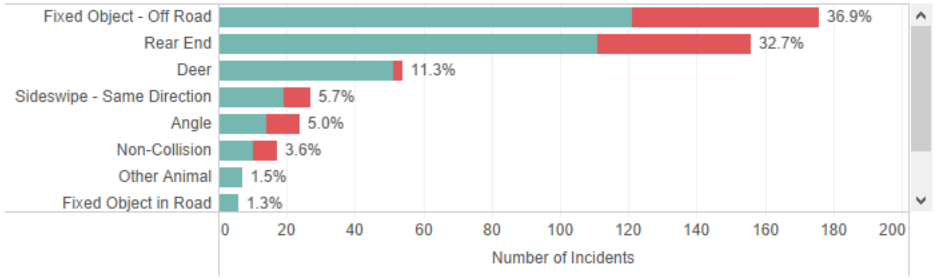
Weekdays

Number of Incidents	Incidents with Injuries or Fatalities
477	131
Number of Vehicles Delayed by Incidents	**Average Time to Return to Normal Traffic Flow (minutes)**
27,094	11.22

Weekends

Number of Incidents	Incidents with Injuries or Fatalities
175	49
Number of Vehicles Delayed by Incidents	**Average Time to Return to Normal Traffic Flow (minutes)**
6,054	8.800

Frequency of Incidents by Report Type



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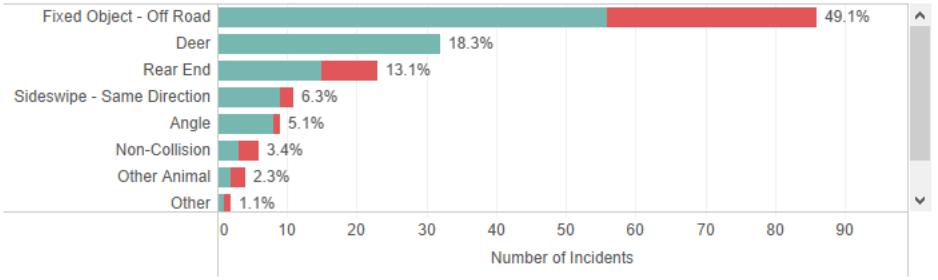
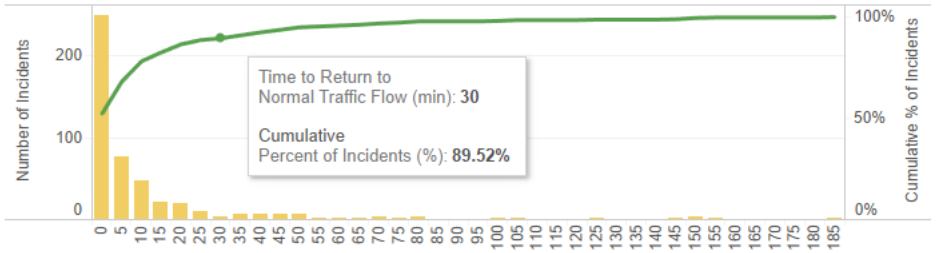
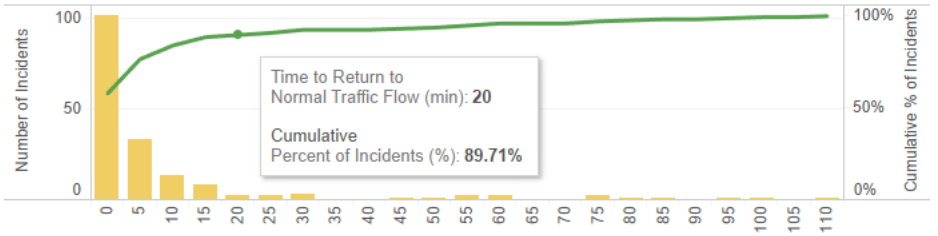


Time to Return to Normal Traffic Flow (Minutes)



Time to Return to Normal Traffic Flow (Minutes)



Data indicates:

- There are proportionally more rear end collisions on weekdays
- Time to return to normal traffic flow is faster on weekends

Summary

- Interactive dashboards are making complex data easily accessible by our data consumers, resulting in program efficiency, data quality and network availability gains
- Historical traffic data is a key enabler for more advanced analytics to track “real-world” performance measures
- Radar Sensor data combined with TIM analytics provide new and accurate performance measures not commonly obtainable
  - Detection of incident start time
  - Time to return to normal traffic flow
  - Number of vehicles affected by incident
  - Speed and volume impacts by lane, also useful as lane obstruction indicators