

**NEBRASKA 2018**

# Leveraging Technology for Snow/Ice Treatment at KYTC

Kevin Martin, PE

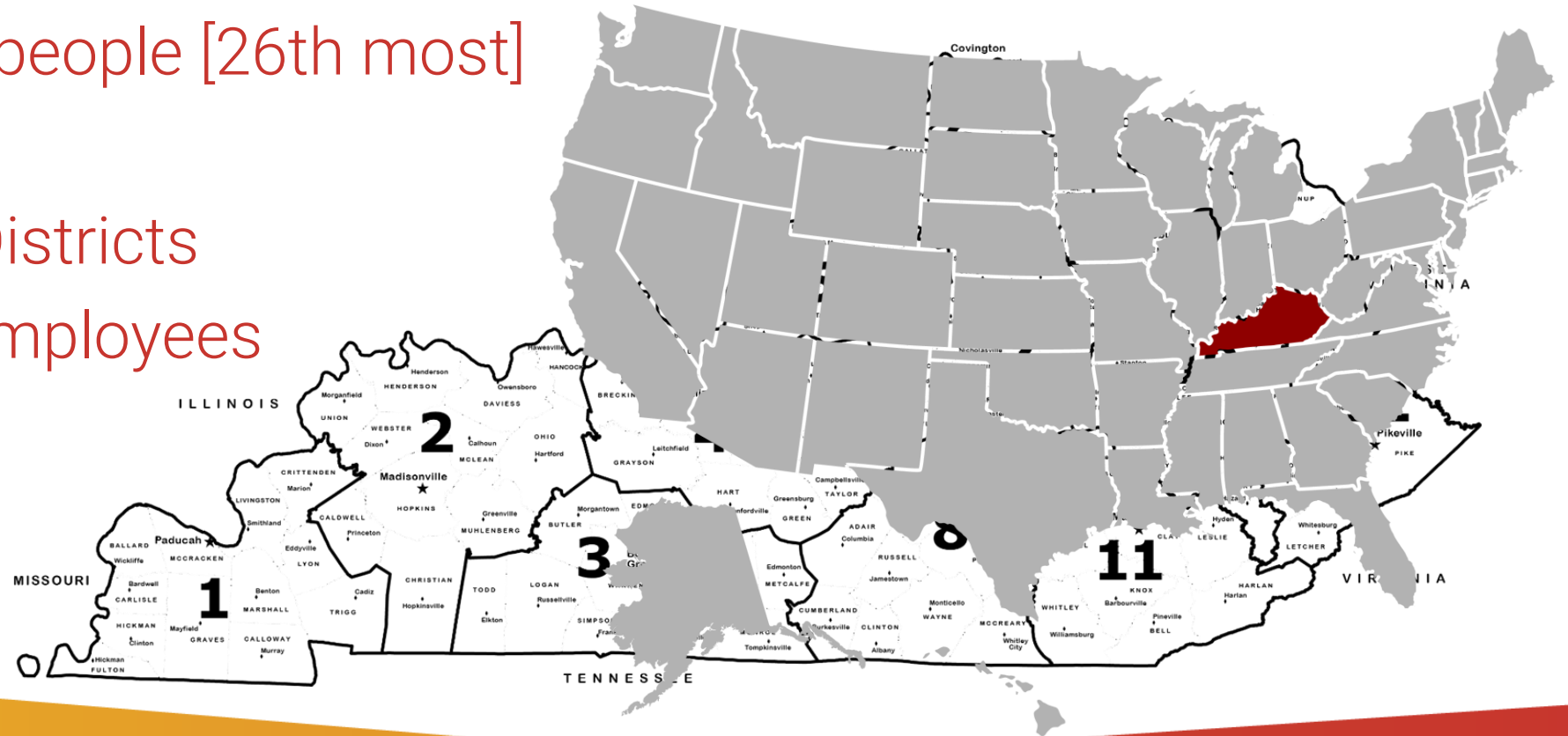
KY Transportation Cabinet

# Subject Matter Experts

- Mike Williams, Snow & Ice Program Coordinator  
Division of Maintenance – [Michael.Williams@ky.gov](mailto:Michael.Williams@ky.gov)
- Chris Lambert, ITS  
Division of Maintenance – [Chris.Lambert@ky.gov](mailto:Chris.Lambert@ky.gov)
- Jeremy Gould, Spatial, Education and Quality Services Branch  
Office of Information Technology – [Jeremy.Gould@ky.gov](mailto:Jeremy.Gould@ky.gov)

# Kentucky Geographics/Demographics

- 104,695 km<sup>2</sup> (40,400 mi<sup>2</sup>) in area [37th largest]
- 4.395 million people [26th most]
- 120 Counties
- 12 Highway Districts
- Appx. 2000 Employees



# Roadway Network


- Interstates (A+) 1,287 km
- Parkways (A) 998 km
- State Primary (A) 6,228 km
- State Secondary (B) 12,553 km
- Rural Secondary (C) 20,519 km
- Supplemental 2,815 km

Total = 44,400 km (96,560 lane km)

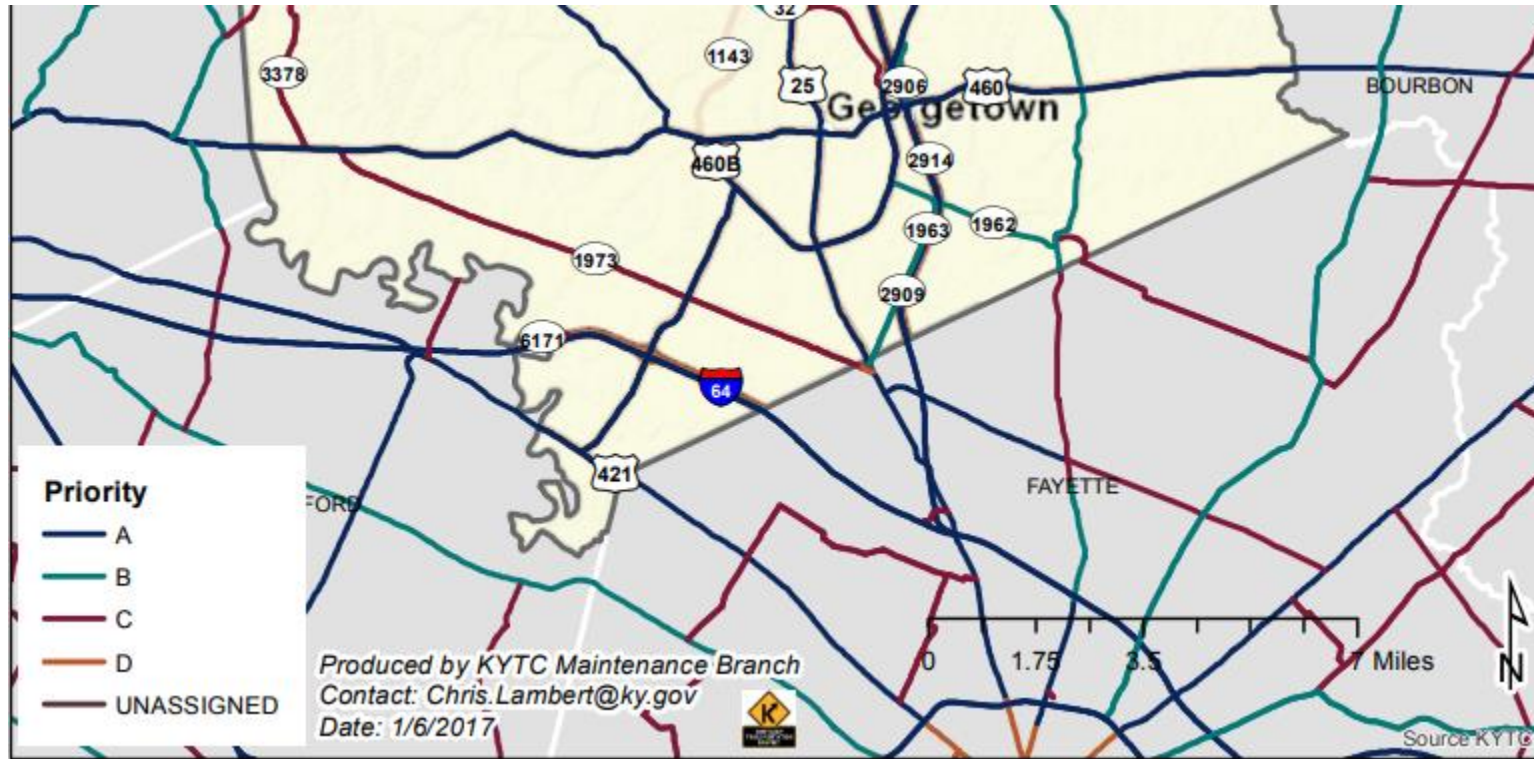
- **Priority A**—The routes designated for this category consist of all interstates, parkways, federal-aid primary routes, and any other route
- **Priority B**—The routes designated for this category consist of all federal-aid secondary routes that are not designated as Priority A routes and those routes having an ADT greater than 500. The lowest ADT on the route should be used for this determination. The total Priority B mileage within a county should not be less than 20% or more than 50% of the two-lane road mileage within that county.

<https://transportation.ky.gov/Organizational-Resources/Policy%20Manuals%20Library/Maintenance.pdf>

# Maintenance Funding

- Combination of State and Federal Funds (80% Federal Reimbursement)
  - Sources: Gas Tax, Bonds, Oversize and Freight Transport, misc. Federal Grants
  - FEMA (emergency use)
- 

# Levels of Service



# Levels of Service

Route Designation	Level of Service (LOS)
Interstates	1 hour response time
Priority A	2 hour turn around time
Priority B	4 hour turn around time
Priority C	8 hour turn around time after A's and B's Clear

# Annual Materials/Cost





# Snow and Ice Goals

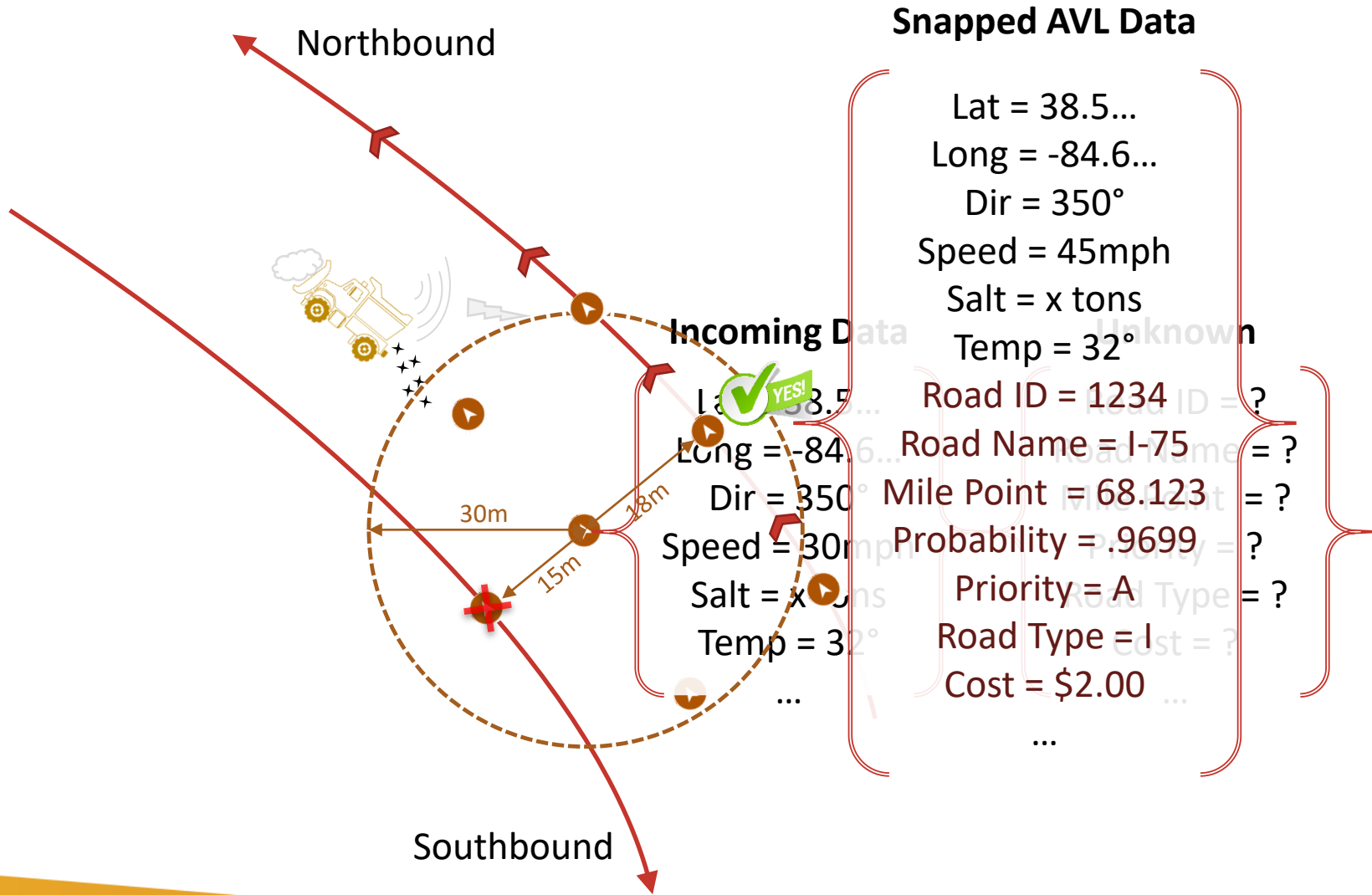
- Reduce Waste
  - Increase Level of Service
  - Provide Accurate Record Keeping
  - Perform Detailed Historic Analytics
  - Create Predictive Models
  - Move Towards Dynamic Routing
- 

# Data Sources

- HERE Traffic Speeds
- Google/Waze
  - Incidents
  - Traffic Jams
  - Traffic Viewer
  - Trip
- iCones Traffic Speeds
- Digital Short Range Communications
- CoCoRahs
- Doppler Radar & Weather Services (KY Mesonet)
- KYTC Snow Plows
- KYTC County Activities
- KYTC ITS
- KYTC Twitter

# AVL Equipment

- 300 Trucks Currently Equipped
  - 980 State owned/operated trucks
  - 430 Contractor trucks
- Full implementation by 2018 Season
- \$750 - \$4,000



# AVL Processing



84,000 AVL records

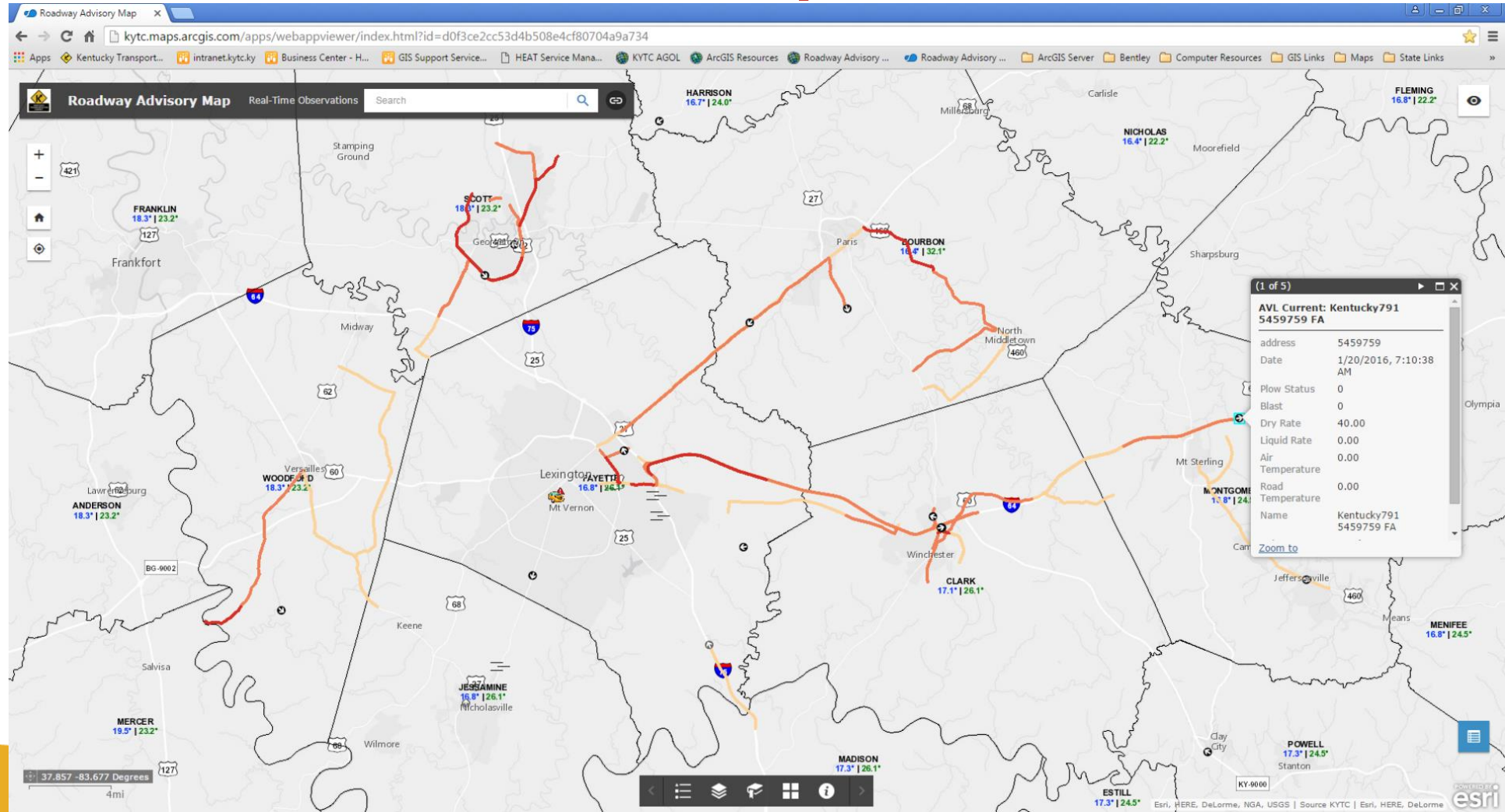
1400 trucks every 10 seconds  
over 10 minutes time period



70,000+ road segments

28,000 Miles State Maintained Roads  
divided into ½ mile segments or less

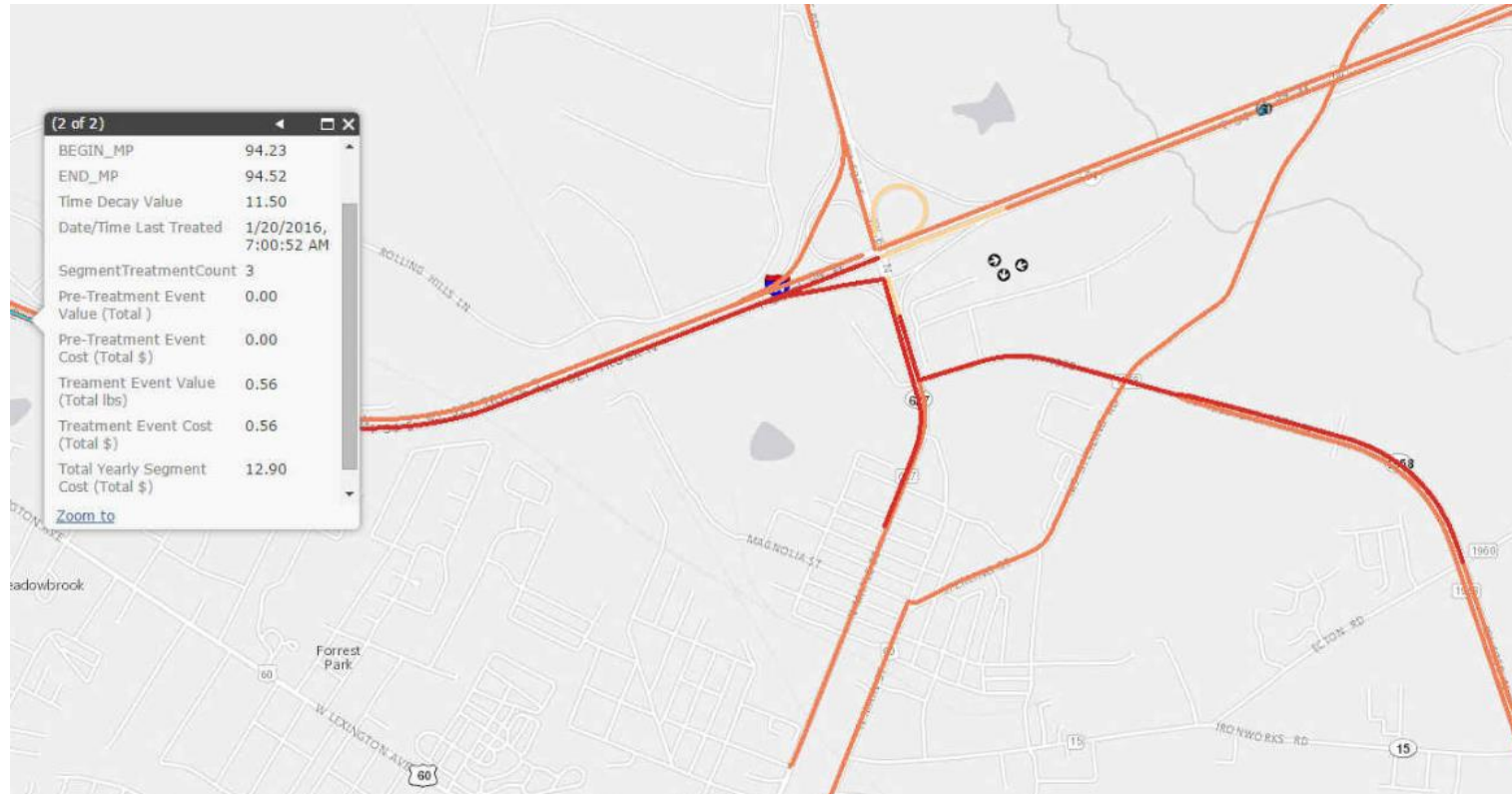
# Snow/Ice Roadway Advisory Map



# Treatment

## Treatment Decay Time Decay Value

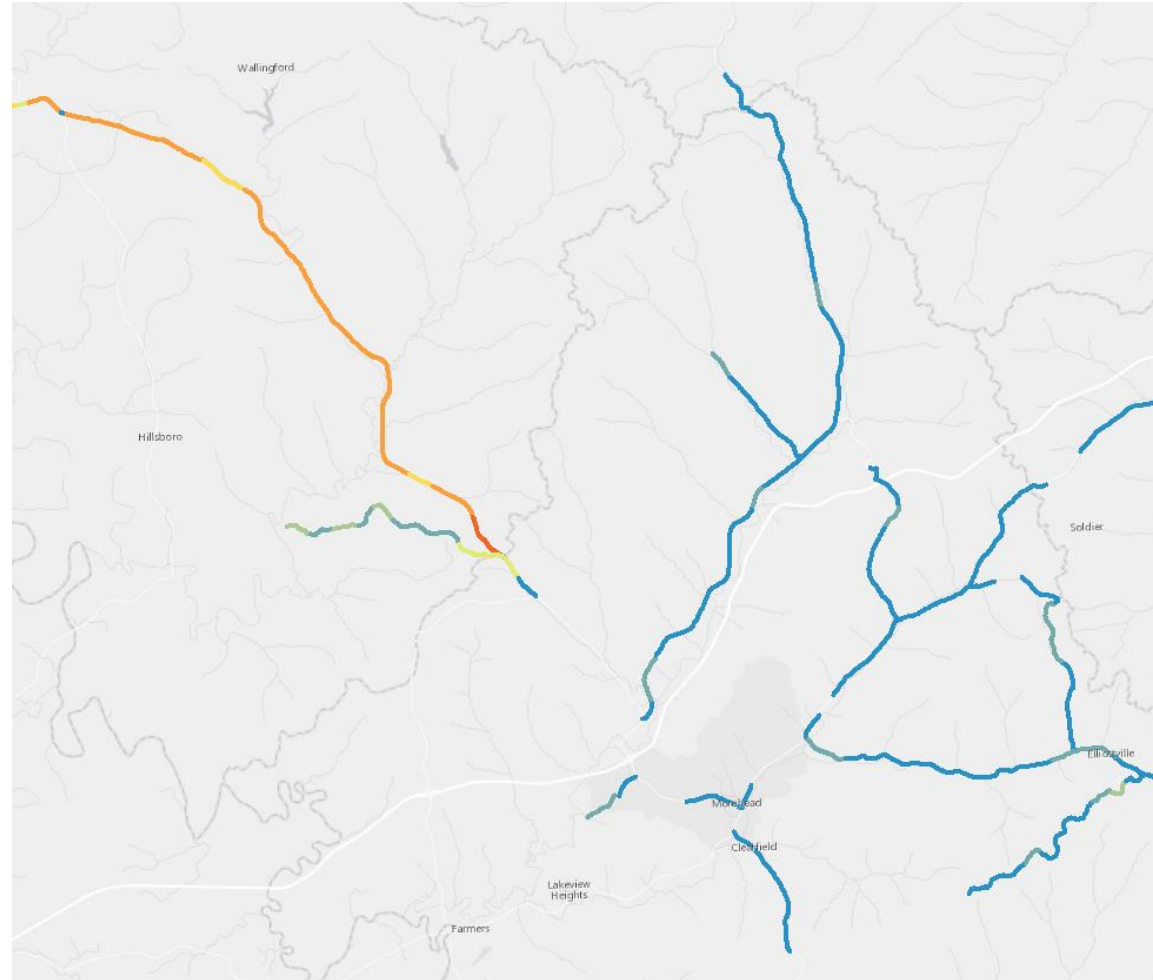
- Last Hour
- 1-2 Hours ago
- 3-4 Hours ago
- 4-6 Hours ago
- 6-12 Hours ago



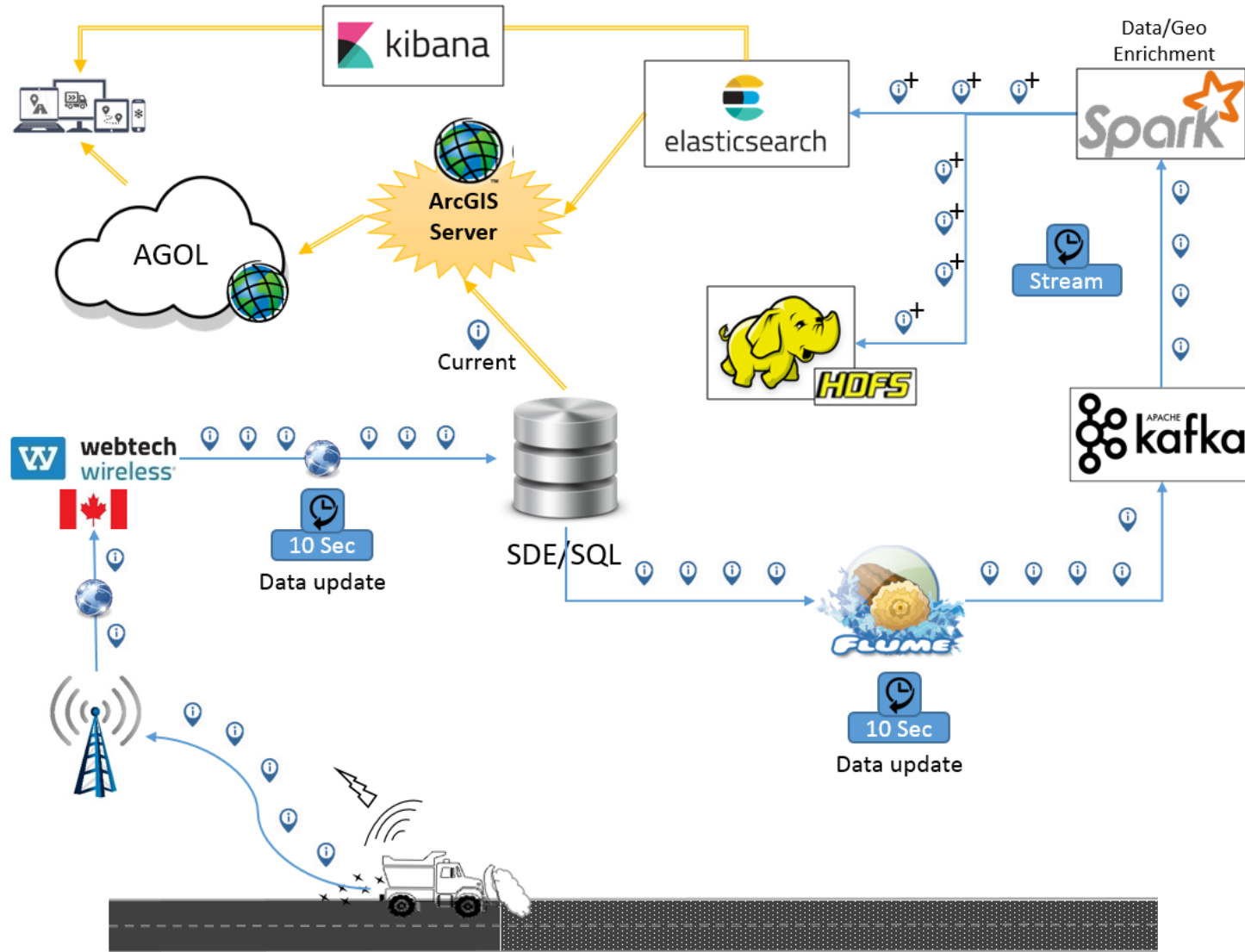
# Treatment Count

## Treatment Count Segment Treatment Count

- 1 Pass
- 2 Passes
- 3 Passes
- 4 Passes
- 5 Passes
- 6-10 Passes
- 11-20 Passes
- 21-100 Passes









- Hadoop (Processing and Storage of BIG DATA)
  - An open source, Java-based programming framework that supports the processing and storage of extremely large data sets in a distributed computing environment. It is part of the Apache project sponsored by the Apache Software Foundation
- It address's the 3 V's of data
  - Volume
  - Velocity
  - Variety
- It is an ecosystem of projects/products

# Who uses Hadoop?





## • Elastic Stack



### • Elasticsearch (Indexing)

- A distributed, open source search and analytics engine, designed for horizontal scalability, reliability, and easy management.
- Works with Points, Lines and Polygons
- Aggregation Techniques



### • Kibana (Dashboarding)

- A open source data visualization platform that allows you to interact with your data through stunning, powerful graphics.



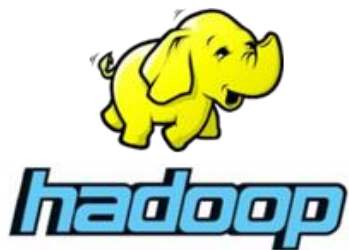
### • Logstash (Data Ingestion)

- An open source, server-side data processing pipeline that ingests data from a multitude of sources simultaneously, transforms it, and then sends it to your favorite “stash.”

# Who uses Elastic Stack?



# Kentucky Big Data Hardware Environment



- Hadoop
  - Nodes (10 Linux boxes):
    - Name Node:2 (“Managers”)
    - Data Nodes: 5 (“Processors”)
    - Kafka: 3 (“Message Queing”)
    - Storage: 60TB usable (180TB RAW)
      - Data replicated 3x as failover/backup.
    - Hadoop Cloudera Distribution

- Nodes: (3 Linux boxes)
  - Storage: 3TB usable (12TB Raw)

~\$250,000 Investment  
\$160K hardware  
\$90K software licensing  
(\$50k Hadoop, \$35k Elastic)

# Various Data Sources for Snow & Ice Maintenance

# Kentucky Mesonet



- Data Source: Western Kentucky University
- Data Format: XML (RSS feed)
- Approximate # Records: ≈63
- Update Frequency: 15 minutes (5 min during storm)
- Data Availability: Free

**KYMesonet Stations: Campbell County - HHTS Observation**

Title	Campbell County - HHTS Observation
Link	<a href="#">More info</a>
county	Campbell
Observation_date	10/13/2016, 11:00 AM
AirTemperature	54.30
Precipitation	0.10
geo_lat	39.02
geo_long	-84.47
elevation	838 ft.

[Zoom to](#) [Get Directions](#)

**County Temperatures/Status: Campbell**

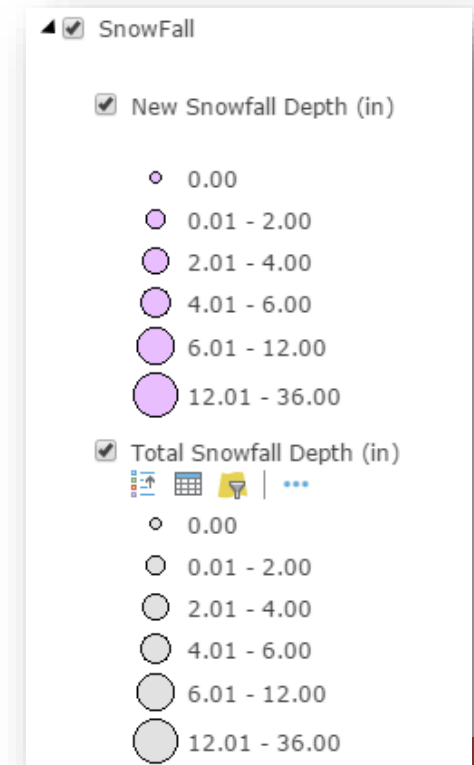
County	Campbell
District	6
Air Temp (Deg F)	54.30
Pavement Temp (Deg F)	61.48
County Status	
County Status Link	
County Status Date	
SM Comments	
Status Comments	
County	
County Status	
Status Comments	
Date	

[Zoom to](#)



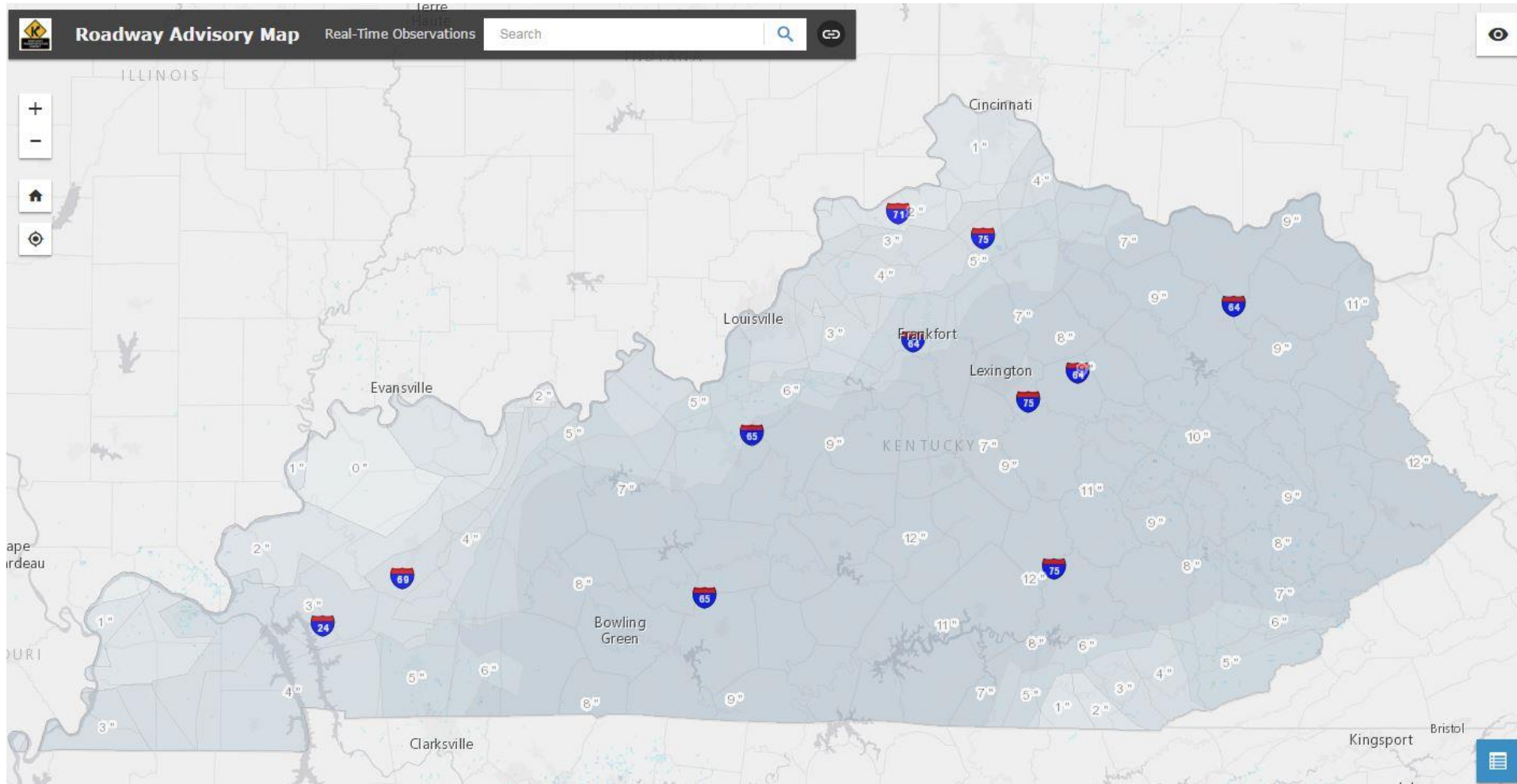
# CoCoRaHS

- Data Source: CoCoRaHS
- Data Format: JSON
- Approximate # Records: 1000-3000 (KY and surrounding states)
- Update Frequency: 1 hour
- Data Availability: Free





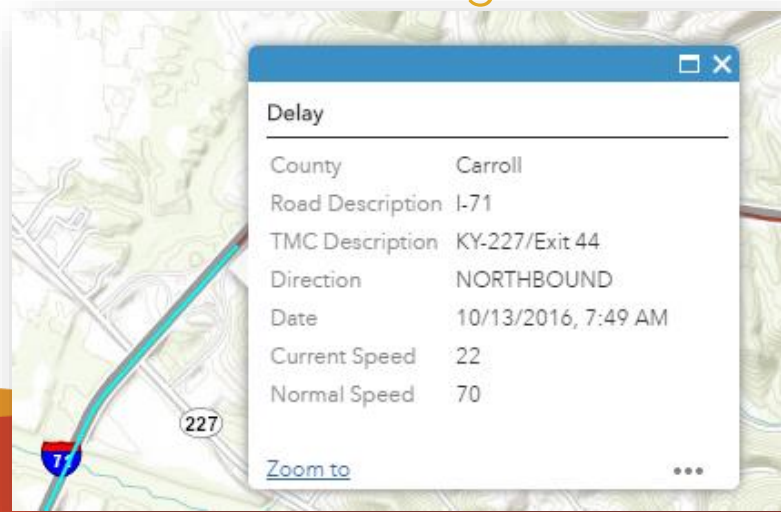
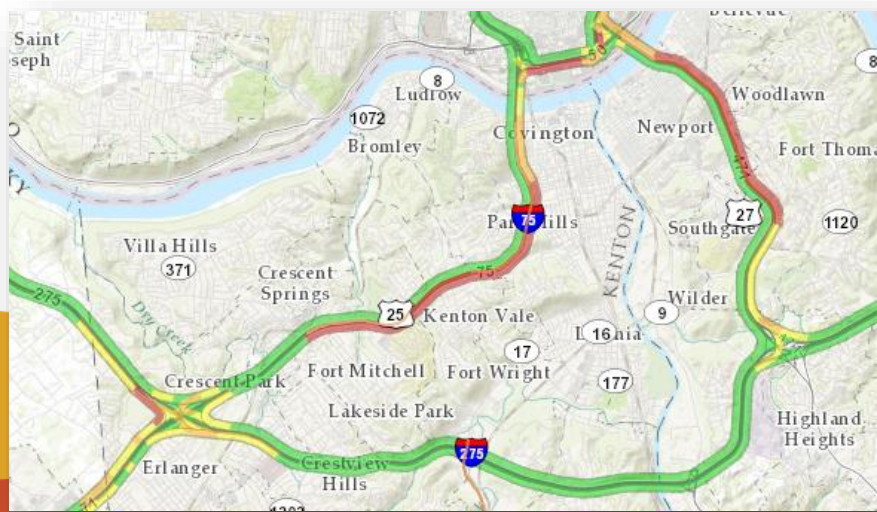
# Snowfall Interpolation



# HERE (Traffic Flow)



- Data Source: HERE
- Data Format: XML (licensed)  
AGOL Service (free w/ AGOL)
- Approximate # Records: 7000
- Update Frequency: 2 minutes
- Data Availability: Licensee (for XML data)  
Free to display with AGOL Org. Acct



# Waze Jams



- Data Source:
- Data Format:
- Approximate # Records:
- Update Frequency:
- Data Availability:

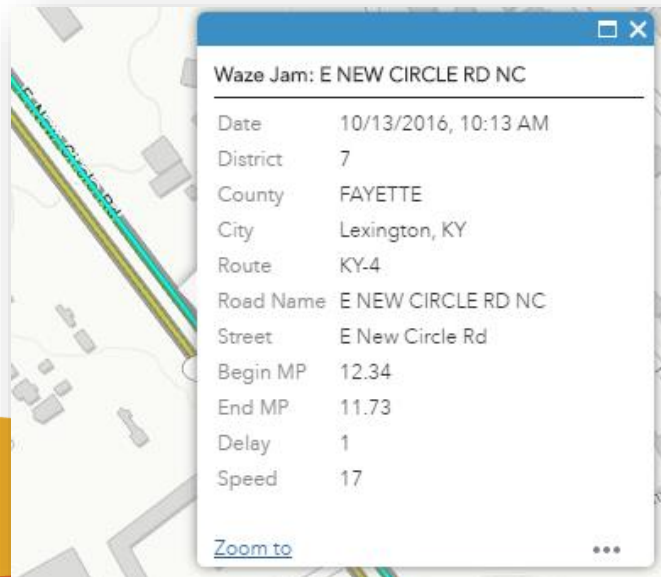
WAZE

XML or JSON

100-1000

2 minutes

Free partnership with  
data sharing agreement



# Waze Alerts



- Data Source:
- Data Format:
- Approximate # Records:
- Update Frequency:
- Data Availability:

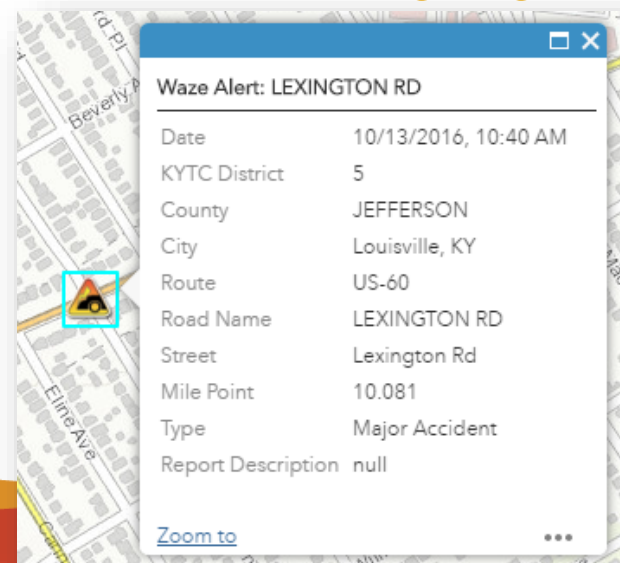
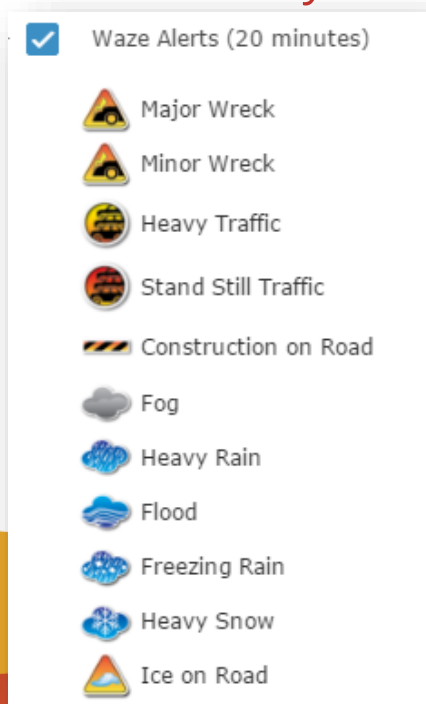
WAZE

XML or JSON

100-1000

2 minutes

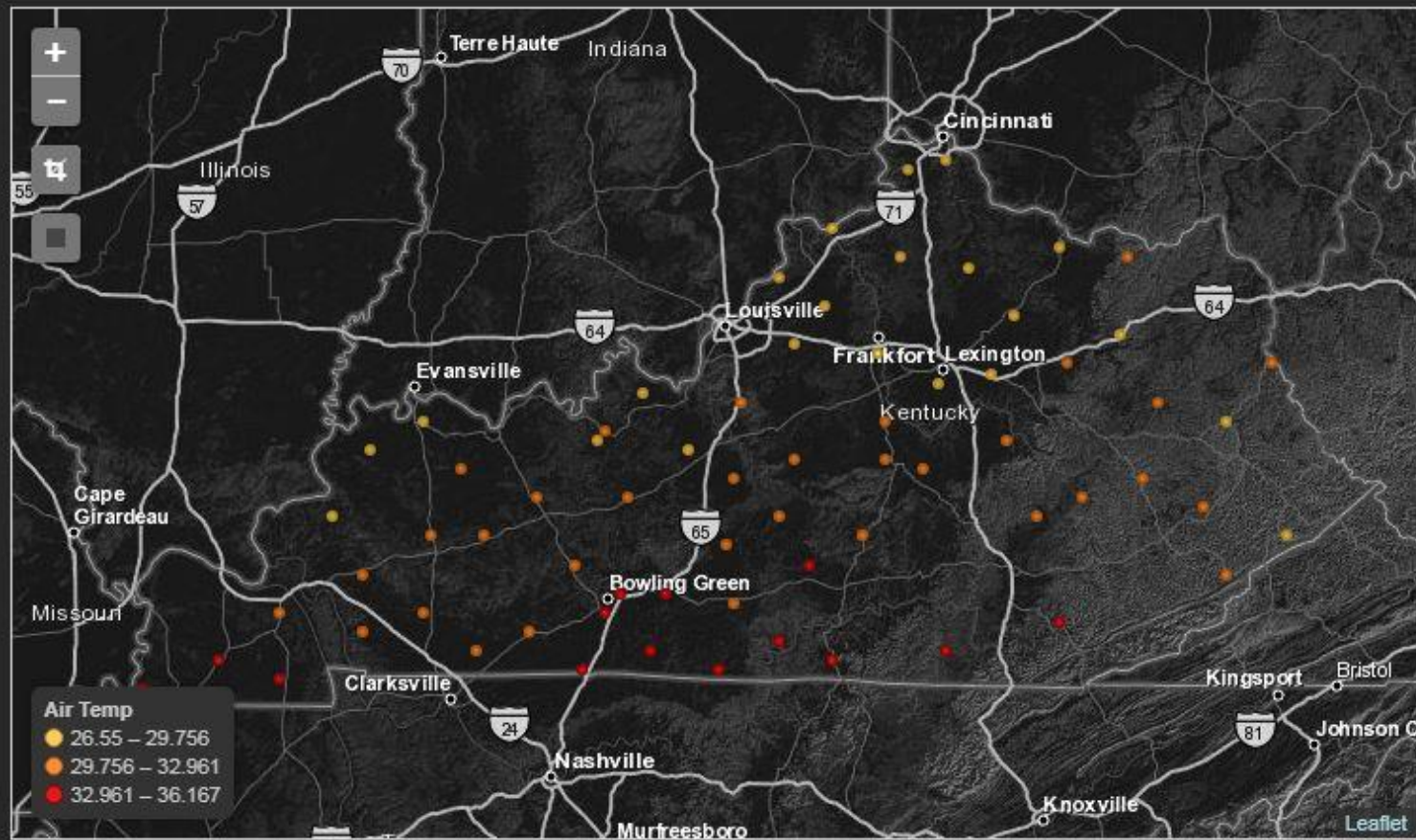
Free partnership with  
data sharing agreement



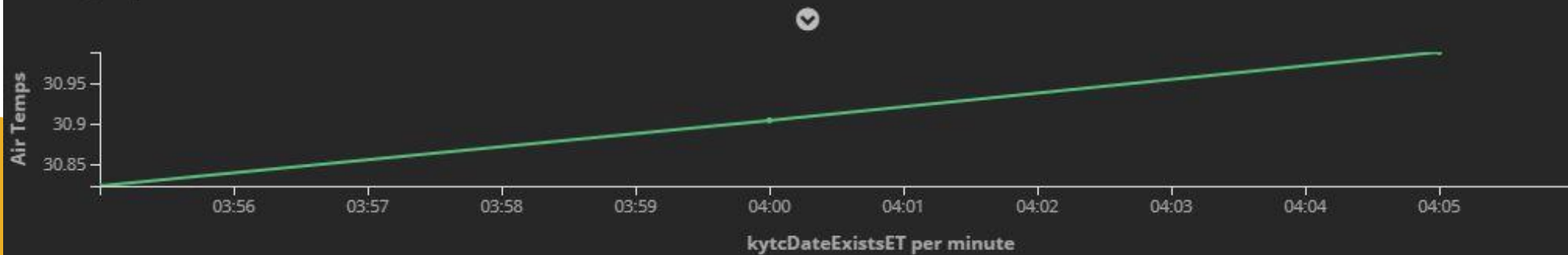
Dashboards using  ibana

District ^	Air Temp ⇅
1	32.255
2	30.452
3	33.021
4	30.754
5	29
6	27.87
7	30.113
8	33.55
9	29.296
10	30.139
11	32.442
12	30.137

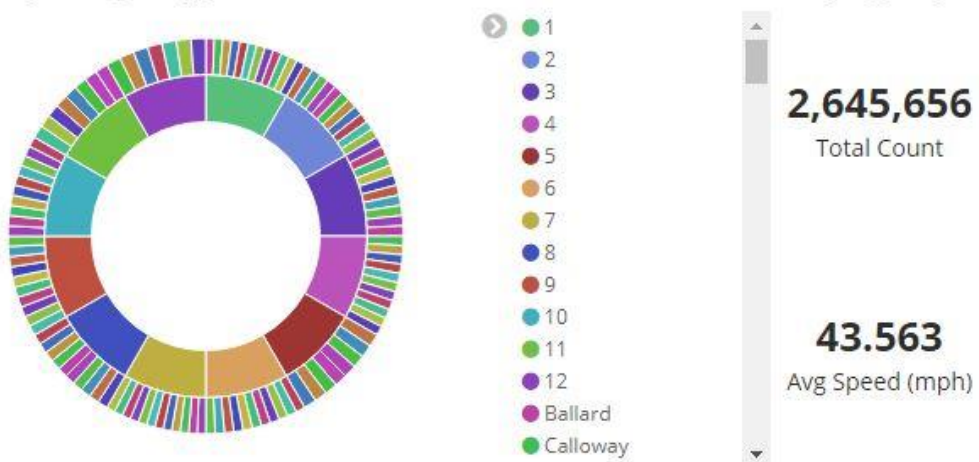
Export: [Raw](#) [Formatted](#)



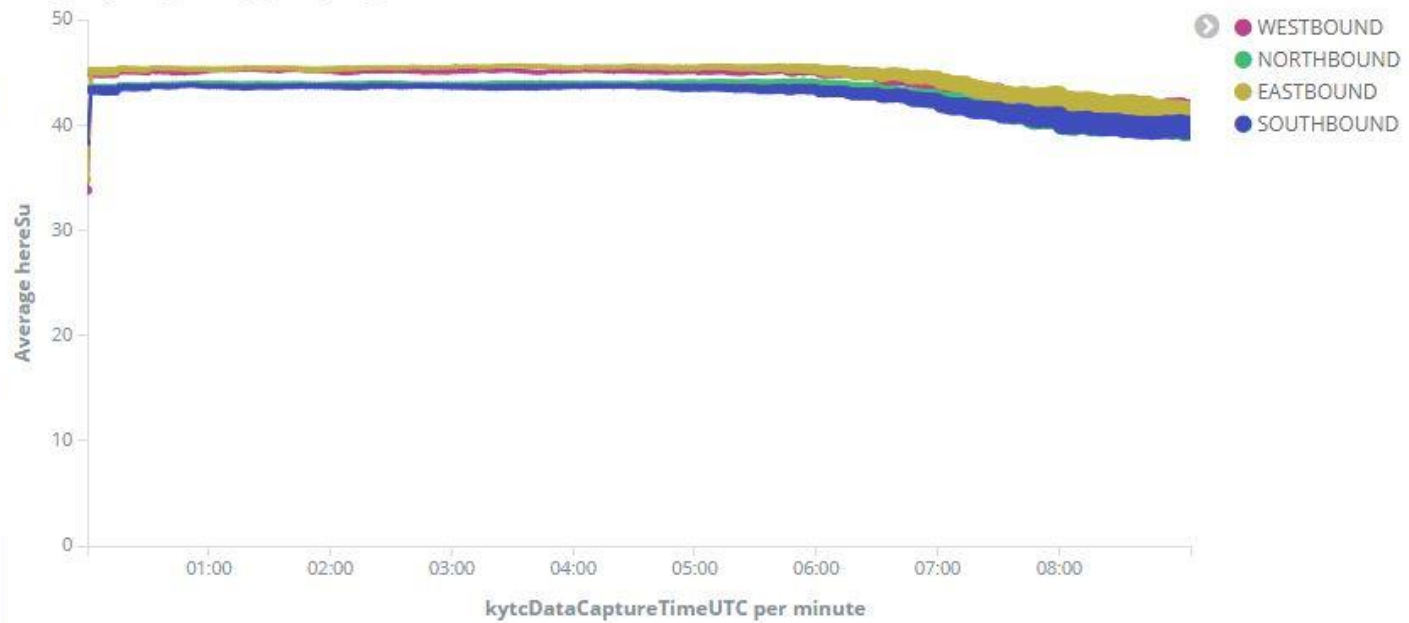
ITS-Air\_Temps



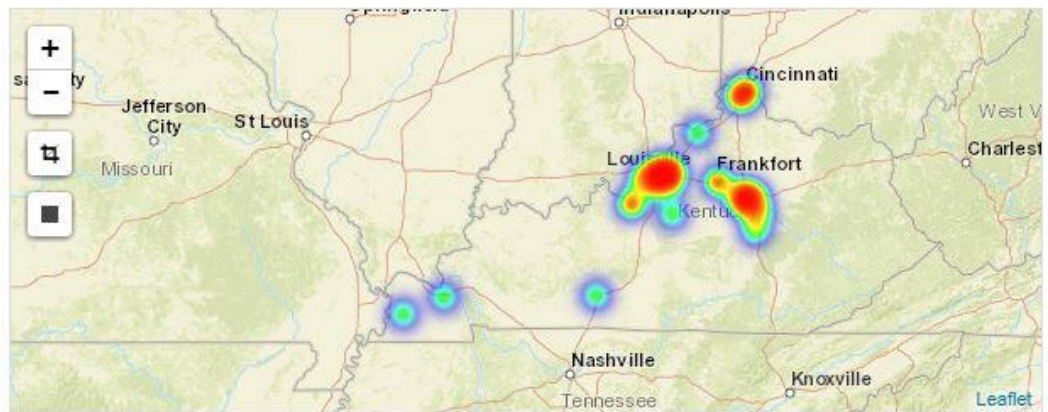
OIT\_GIS\_district\_county\_pieChart



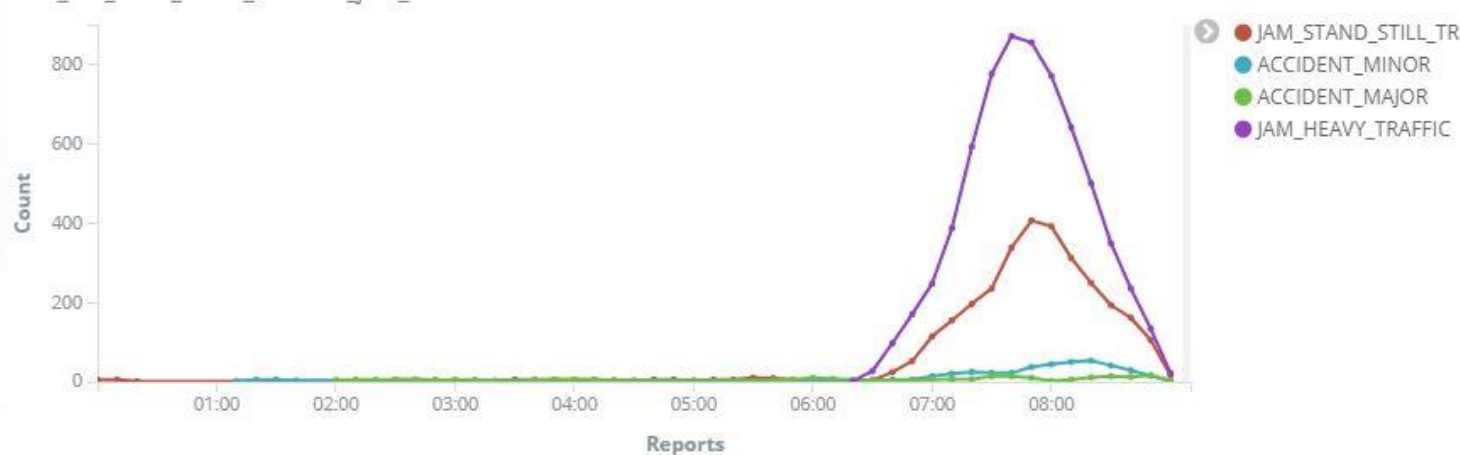
OIT\_GIS\_here\_tr... OIT\_GIS\_here\_traffic\_speed\_line\_chart



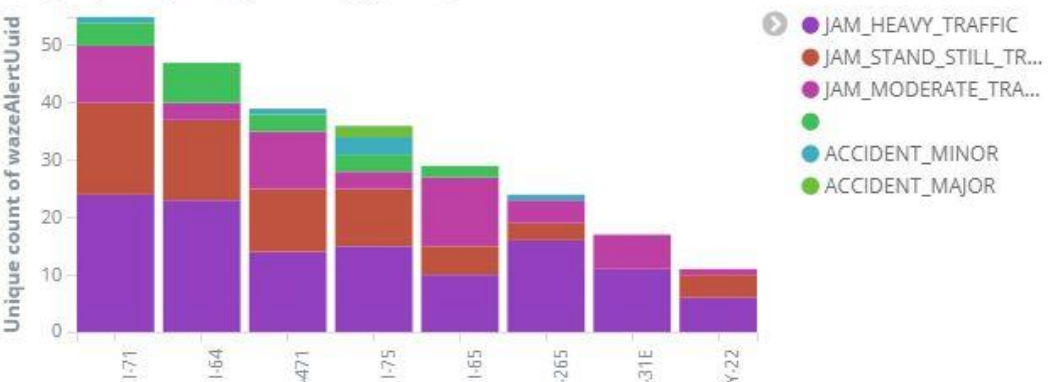
OIT\_GIS\_waze\_alerts\_accidents\_tilemap



OIT\_GIS\_waze\_alerts\_accident\_jam\_linechart



OIT\_GIS\_waze\_alerts\_accidents\_byroute\_barchart





ITS-District4Counties



- Breckinridge
- Grayson
- Green
- Hardin
- Hart
- Larue
- Marion
- Meade
- Nelson
- Taylor
- Washington

ITS-Trucks

9

Active Trucks

ITS-Salt\_Rate

443.884

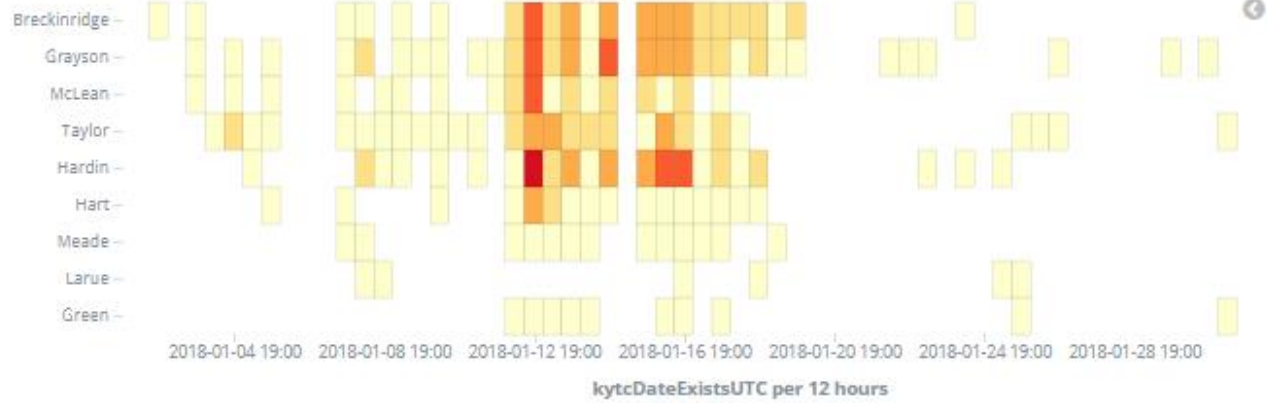
Avg Distribution Rate

ITS-Salt\_Cost

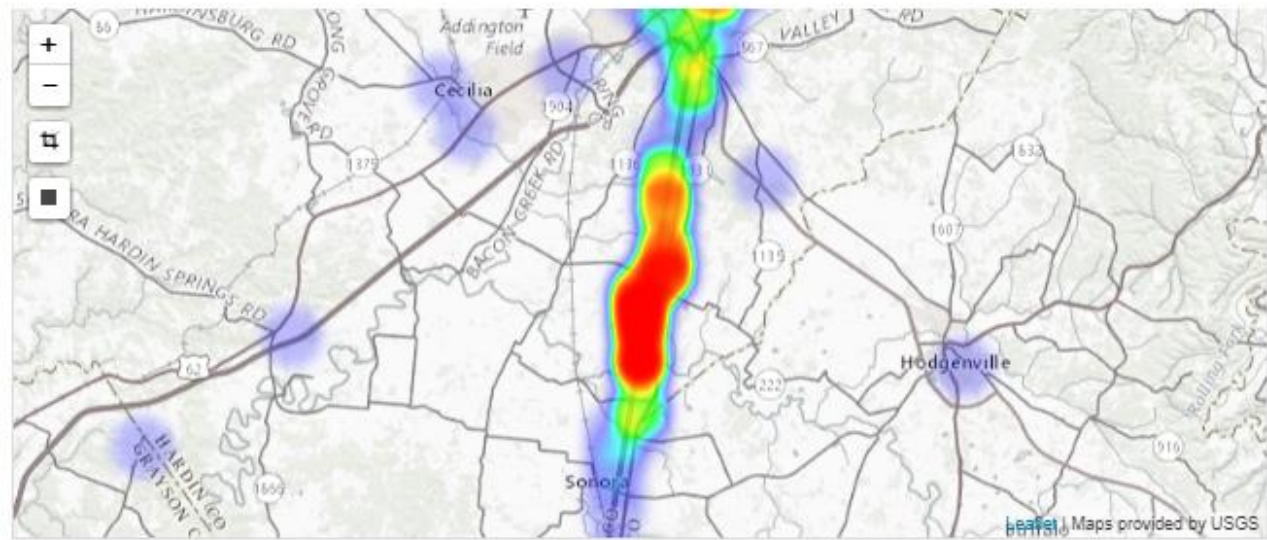
6,949.885

Total Salt Cost

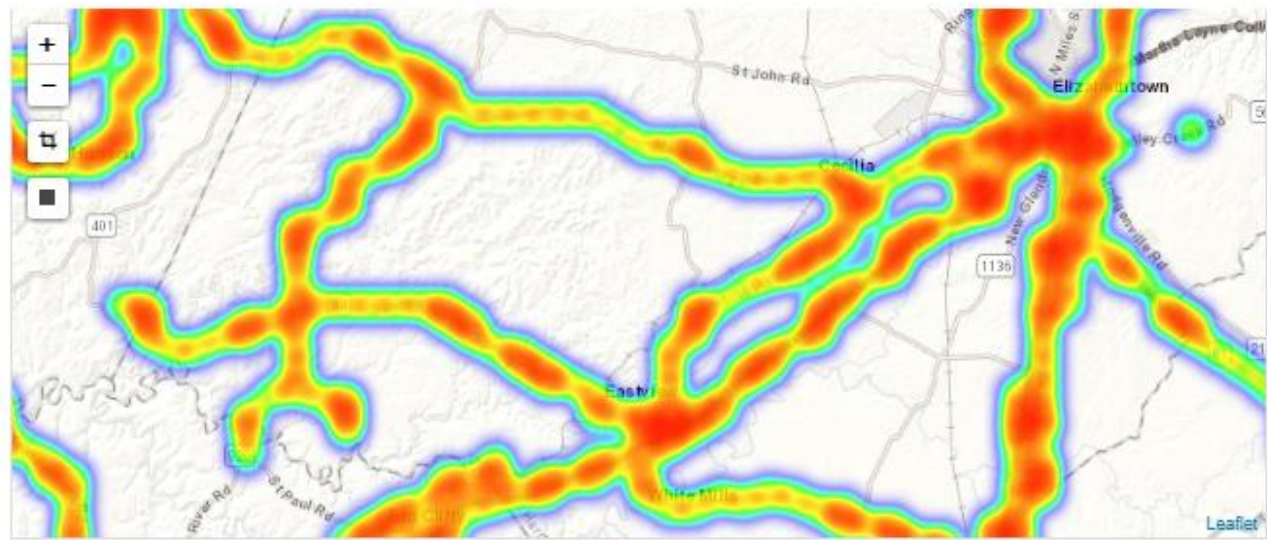
ITS-D4\_AVL\_Activity



ITS-Waze-TrafficDelays



ITS-Salt\_Use



ITS-Trucks

8

Active Trucks

ITS-Salt\_Rate

464.184

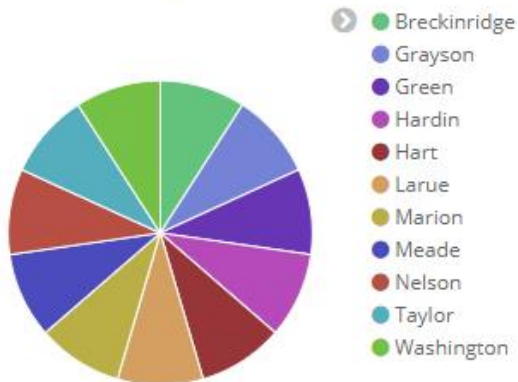
Avg Distribution Rate

ITS-Salt\_Cost

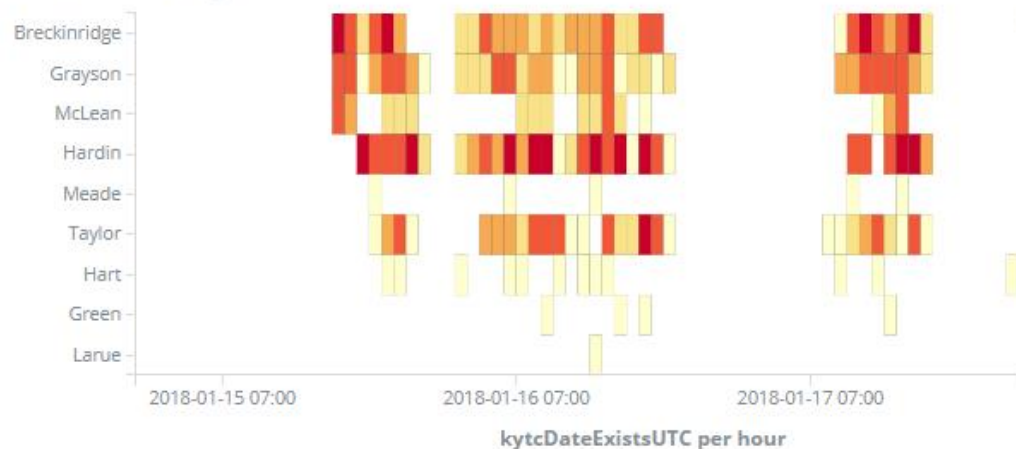
2,787.072

Total Salt Cost

ITS-District4Counties



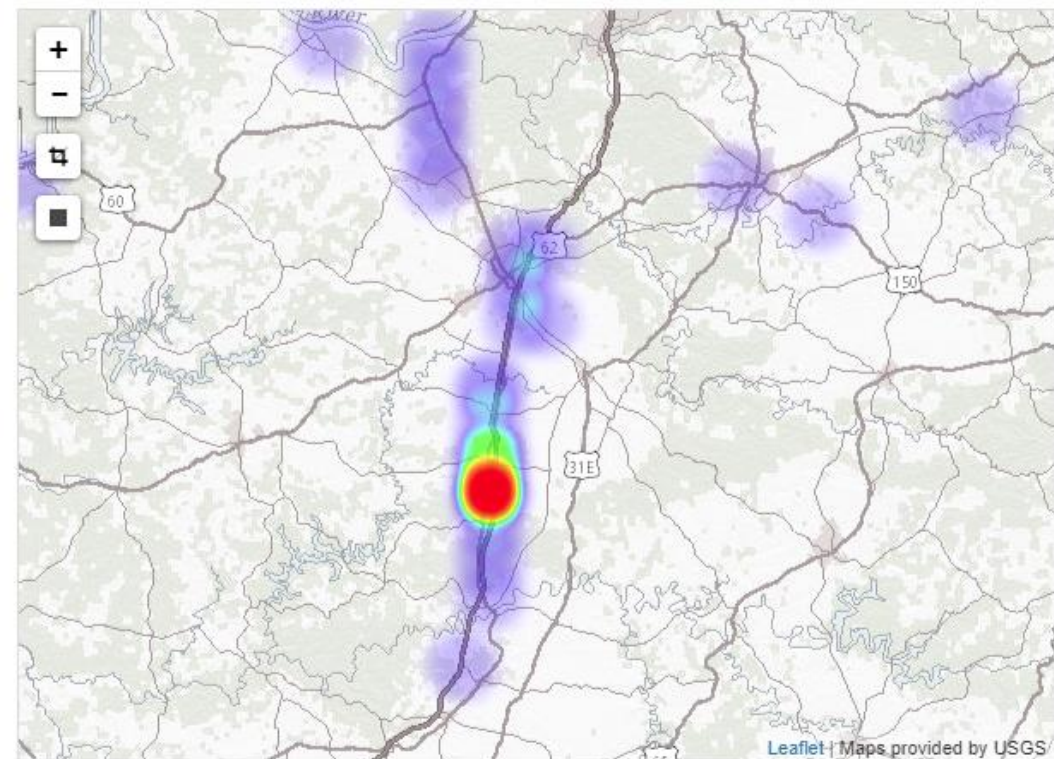
ITS-D4\_AVL\_Activity



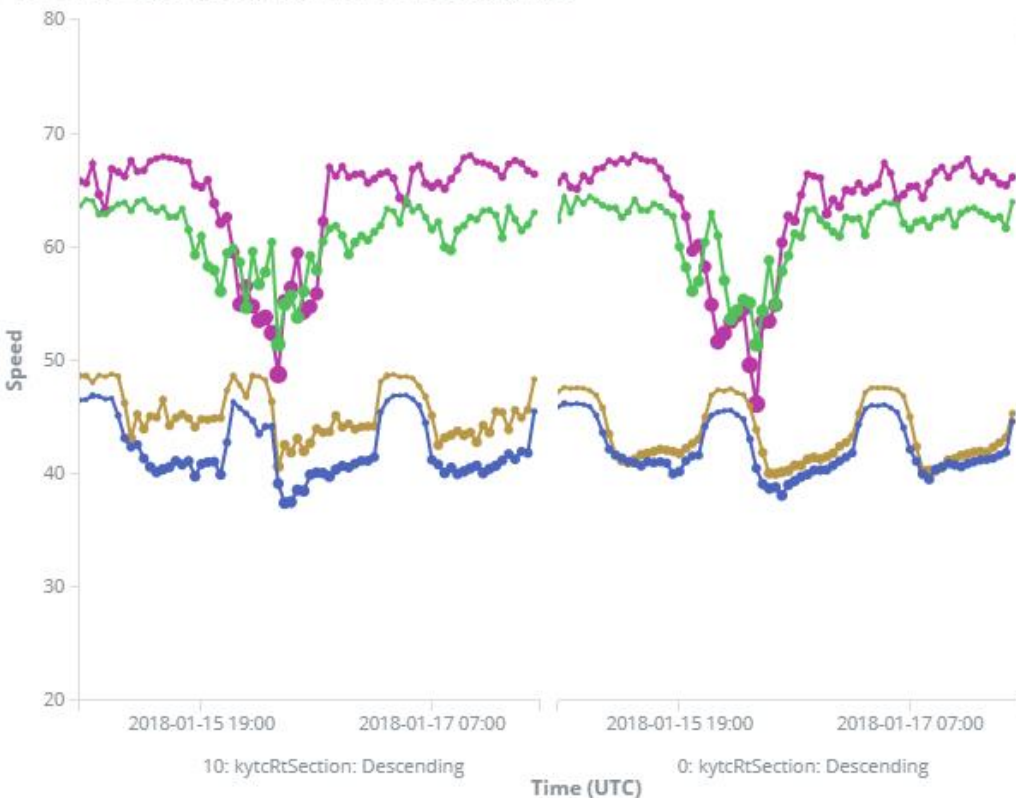
ITS-Major\_Delays

kytcRdName.kw:	Min Speed
I-65 NC	-1
I-65 RAMP from WENDELL H FORD WESTERN KENTUCKY PKWY	8.11
I-65	8.43
I-65 RAMP to WENDELL H FORD WESTERN KENTUCKY PKWY	13.05
I-65 RAMP to MARTHA LAYNE COLLINS BLUEGRASS PKWY	17.76
INTERSTATE 65 RAMP	23.27
I-65 RAMP to KY 313	27.02
I-65 RAMP from MARTHA LAYNE COLLINS BLUEGRASS PKWY	31.72
I-65 RAMP from MARTHA LAYNE COLLINS BLUEGRASS PKWY	32.34
I-65 RAMP from KY 313	32.71
INTERSTATE 65 RAMP from WENDELL H FORD- WESTERN KY PKWY	36.7

ITS-Waze-TrafficDelays



ITS-HERE-MajorRoutePerformanceGroupedByType



# Snow and Ice Goals

- Reduce Waste
  - Increase Level of Service
  - Provide Accurate Record Keeping
  - Perform Detailed Historic Analytics
  - Create Predictive Models
  - Move Towards Dynamic Routing
- 