UNIVERSITY OF MARYLAND

National Transportation Center

PROCEEDINGS OF

1ST OUTSOURCED PROBE DATA SYMPOSIUM

JANUARY 15TH, 2015

COLLEGE PARK, MD

CATT Center For Advanced Transportation Technology

I-95 Corridor Coalition

here

INRIX

TomTom

SUMMARY:

The National Transportation Center at Maryland (NTC @ Maryland) and the Center for Advanced Transportation Technology (CATT) held a symposium on 1/15/2015 to discuss emerging probe data products and applications of private sector data in planning, operations, and performance management. The first objective was to provide a venue for industry to discuss currently available data products in the areas of speed, travel time, O-D, freight, emissions, and volume. The second objective was to have a forum of leading state executives and managers discussing the critical data needs in their organizations, so that industry can hear and respond. In addition to 43 live attendees, online participants joined the event via live webcast.

The symposium opened with reviewing I-95 Corridor Coalition Vehicle Probe Project. The I-95 Vehicle Probe Project is a groundbreaking initiative providing comprehensive and continuous travel time information on freeways and arterials using probe technology. Then representatives from leading probe data industry including HERE, INRIX and TomTom presented their current and existing data products. After a short break panel members discussed their current applications for the probe data and their expectations from the industry. Panel was consisted of a diverse group of experts from Federal Highway Administration, State DOT and MPOs and academia.

This proceedings includes summary of the panel talking points, list of attendees and a compilation of the presentation slides. Recording of the event webcast is available for viewing at the following link:

http://vid.umd.edu/detsmediasite/Play/1a6294d88a824163b84ecd82a1c408551d

Masoud Hamedi, PhD
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SUMMARY OF THE PANEL TALKING POINTS

Panel members:

- Nicole Katsikides, Freight Performance Program Manager, Federal Highway Administration
- Glenn McLaughlin, Deputy Director, CHART, Maryland State Highway Administration
- Wenjing Pu, Transportation Engineer, Metropolitan Washington Council of Governments
- Debbie Bowden, Motor Carrier & Logistics Policy Advisor, Maryland DOT
- Subrat Mahapatra, Transportation Manager, Maryland State Highway Administration
- Stanley Young, Center for Advanced Transportation Technology, University of Maryland

GLENN MCLAUGHLIN, DEPUTY DIRECTOR, CHART, MARYLAND STATE HIGHWAY ADMINISTRATION

Current MDSHA/CHART Operational Uses for VPP Data

- Travel Times on Dynamic Message Signs
- Travel Times on Maryland 511
- Subjective Assessment of Incident Related Queues
- Basic View of Congestion Patterns
- Some Basic Indication of Incidents
- Post-Event Review of Traffic Impacts

Potential Operations Uses for VPP Data

- Incident Detection
- Congestion/Bottleneck Detection
- Evaluate Effectiveness of Traveler Information Strategies (e.g. TT vs. Caution Messages on DMS)

- Monitoring Queue Lengths and Impacts on Secondary Roads
- Assess Queue Recovery Times
- Run Predictive Simulations to Analyze Potential Incident Impacts in Real Time
- Assess Safety Relationships between Traffic Congestion and Frequency/Types of Collisions
- Data to Plan the Optimal Distribution of ITS Resources (e.g. ATMS, Traveler Information, etc.)
- Determine Network Impacts of Closures (Adjoining Freeways and Arterials)
- Signal Operations Optimization

Data Characteristics which Could Support Potential Uses

- Sub-TMC Resolution (Queue Monitoring, Building Travel Time Routes, Safety Assessments)
- Arterial Data (Network Impacts, Signal Operations)
- Minimal Latency (Incident Detection, Congestion Detection, Queue Recovery Times)
- Estimated Vehicle Volumes in Real-Time (Network Impacts, Predictive Simulation, Signals)
- Origin-Destination Estimates (Network Impacts)
- Improved Penetration on Nights, Weekends and During Severe Weather (All)

Challenges/Observations for Moving Forward

- Develop Applications to Utilize VPP Data in the Context of Real-Time Operational Processes and Protocols (Particularly in Light of the New Sub-TMC Capabilities)
- Bridge the Gap between VPP Data, and Traditional Simulation Models (Needing Volume Data?)
- Keep Improving on the Confidence in Arterial Data
- Create a "Latency Model" that Captures/Characterizes the Components of Latency (e.g.):
    - Event Occurs
    - Observable Congestion Builds
    - VPP Data Changes
    - Data Analysis Reflects Impacts
    - Traffic Conditions Compiled in System
    - Condition Displayed on User Interfaces
- Also note, there can be two types of latency: real-time and archived. Archived latency consists of time that elapses while congestion builds, data changes, and analysis is completed and consequently the data is archived with latency relative to the "ground truth" conditions.

Wenjing Pu, Transportation Engineer, Metropolitan Washington Council of Governments

- **TMC availability and sub-TMC data**. We hope that the time lag between the opening of newly built highways or managed lanes and the availability of TMCs for those new highways/lanes could be shortened (the existing process takes about two years). All three vendors claimed that they offer sub-TMC level speed and travel time information to improve data granularity, but how or when we can access sub-TMC level data remains uncertain. The Vehicle Probe Project (VPP) Suite needs to be enhanced to handle such (bigger) data and additional funding is needed. Per the contracts between the Coalition and the vendors, vendors have to provide their own archive and made them accessible to users. We hope that such sub-TMC data can be accessed directly from vendors' own archives.

- **Volume**. We hope that real-time estimation of vehicle volume become available in the future. INRIX's existing method of integrating HPMS volume with speed could be used for historical annual average calculations, but may fall short for real-time operations, calculating seasonal variations or reliability measures.
- **Fuel use and emissions.** TomTom mentioned that they are testing the estimation of fuel use and emissions (including CO2, but not all of the criteria pollutants) based on probe speeds, classification of vehicles and other sources. This concept is particularly interesting for MPOs as it could provide another source for air quality information.
- **Managed lanes.** If new TMCs will be created for new managed lanes, we hope that the new TMC creation process could be shortened (as mentioned in 1.). For managed lanes without physical separation (i.e. no TMCs will be assigned to), we hope that future probe data could tell the difference between those managed lanes and general purpose lanes (such as conditions on I-66 and US-50 in the Washington region).

Debbie Bowden, Motor Carrier & Logistics Policy Advisor, Maryland DOT

Probe and other data needs related to multimodal freight policies and needs

- Highways
    - Truck parking – need to identify demand on shoulders and ramps
    - Oversize / overweight loads, both permitted and illegal – could allow for comprehensive coverage of weight limits across the entire network
    - Last mile truck movements and intermodal (truck to rail, truck to water) – provides a complete look at truck movements on the supply chain
    - Value of transport and value of lanes – relates to commodity flow per truck.

- Rail
    - Commodities movement, e.g. crude oil – we would like to know the type of items are moving along the shared-use rail corridors
    - Freight and passenger shared use on the corridors – need more data regarding operations and safety

Subrat Mahapatra, Transportation Manager, Maryland State Highway Administration

- Look for opportunities for volume based metrics
- Trip based congestion and reliability metrics (Origin to Destination) for people and goods
- Tour based information on people and goods travel
- Multi-modal and multi-resolution networks that can meet both performance management, travel modeling and analysis needs
- Insights on markets and trips (Internal, Thru' and with one trip end in study area)
- Expansion factors to develop population O/Ds from the sample O/Ds
- Lane based performance metrics (HOV lane or, ETL running next to a general travel lane)
- Lane based usage (disproportional use of some lanes over others) to understand operations better
- Interfacing of navigation networks with state LRS
- Fusing datasets with other data sources like land use, traffic counts, detectors etc.

LIST OF PARTICIPANTS

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CATT
CENTER FOR ADVANCED TRANSPORTATION TECHNOLOGY

UNIVERSITY OF MARYLAND
National Transportation Center

I-95 CORRIDOR COALITION

OUTSOURCED PROBE DATA SYMPOSIUM

15 January 2015
College Park, MD

here

INRIX

TOMTOM

AGENDA

08:45 AM – 09:30 AM	Registration & Breakfast
09:30 AM – 10:00 AM	Opening remarks and introduction to VPPII
10:00 AM – 11:30 AM	HERE, INRIX and TOMTOM presentations
11:30 AM – 11:45 AM	Break
11:45 AM – 12:45 PM	Data Forum
12:45 PM – 1:30 PM	Adjourn and lunch

CATT works

I-95 CORRIDOR COALITION

I-95 CORRIDOR COALITION

Alliance of many transportation agencies along the East Coast

Facilitates coordination, consensus, collaboration, and communication across state lines

Pulled resource together on research projects

States had issues with getting travel time data across states lines to support regional initiatives

VEHICLE PROBE PROJECT (VPP1)

RFP released in April 2007 for travel time and speeds that could be used for:

- Traveler information (511, websites, DMS)
- Incident Management
- Transportation operations and planning
- Calculating regional performance measures

A contract vehicle for state DOT to purchase coverage

Contract awarded to INRIX in December 2007

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VEHICLE PROBE PROJECT (VPP1)

FIRSTS

- First significant commercial deployment of probe data for public applications
- A specifications driven contract for travel time and speed
- On-going, transparent validation process to insure quality
- Introduction of 'Confidence Metric' for times when probe vehicle data not available
- Licensing allowed one purchase / all use
- Rapid adoption by states, first for operations, then followed by planning and performance measures

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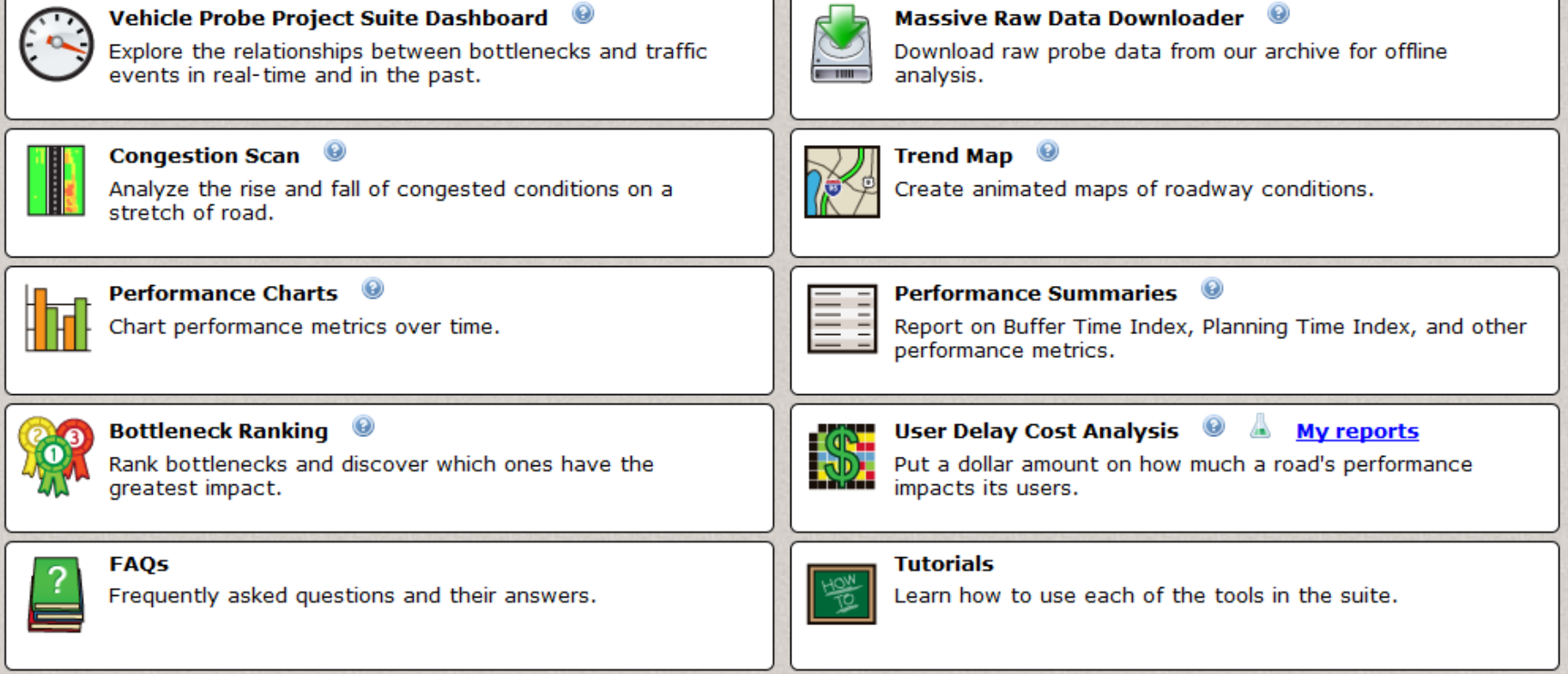
VPP SUITE/ RITIS



Sponsored by

VPP II HIGHLIGHTS

Nothing left behind from VPP I

Added

- Multi-vendor marketplace
- Added tools to work with data
- More emphasis on non-freeway roadways
- Alternate segmentation methods
- Specifications and validation of latency

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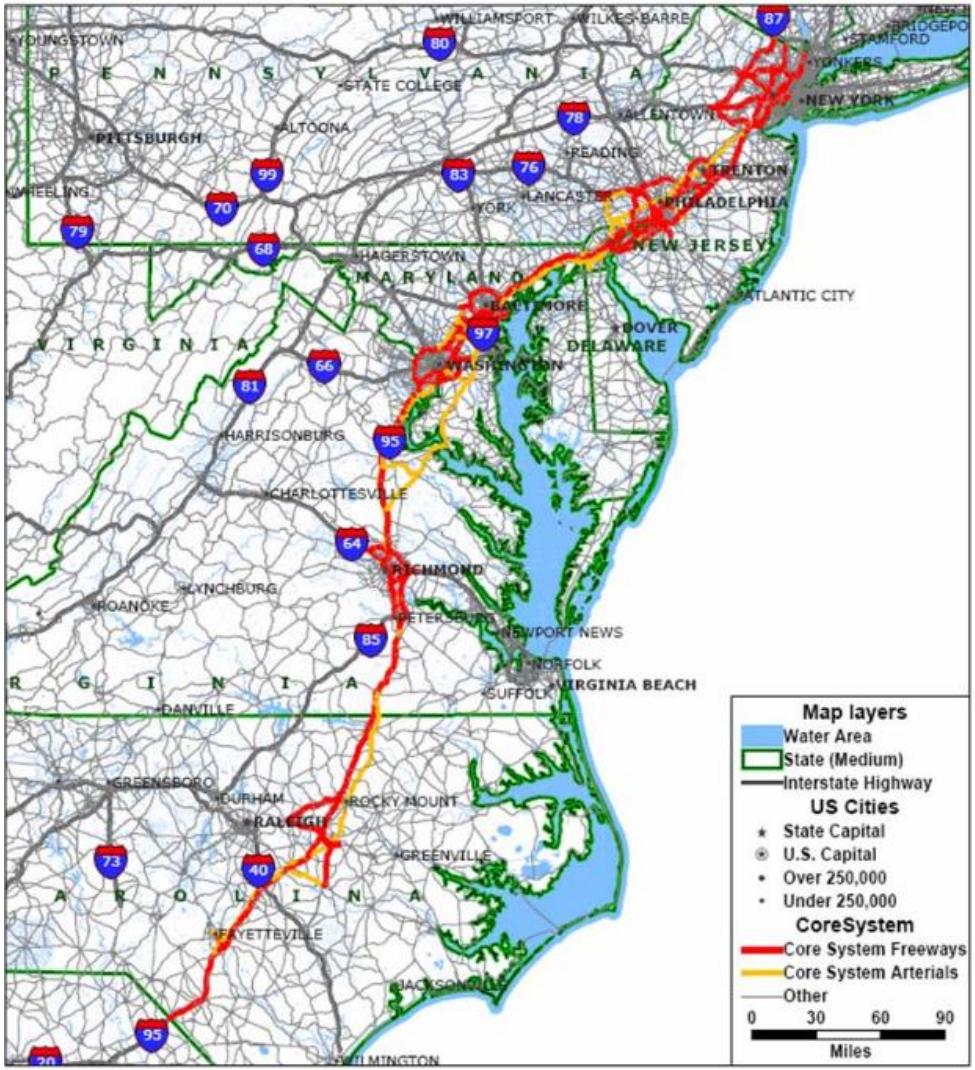
COVERAGE HAS GROWN

Initial Coverage (2008)



I-95 CORRIDOR COALITION

AND GROWN

September 2011

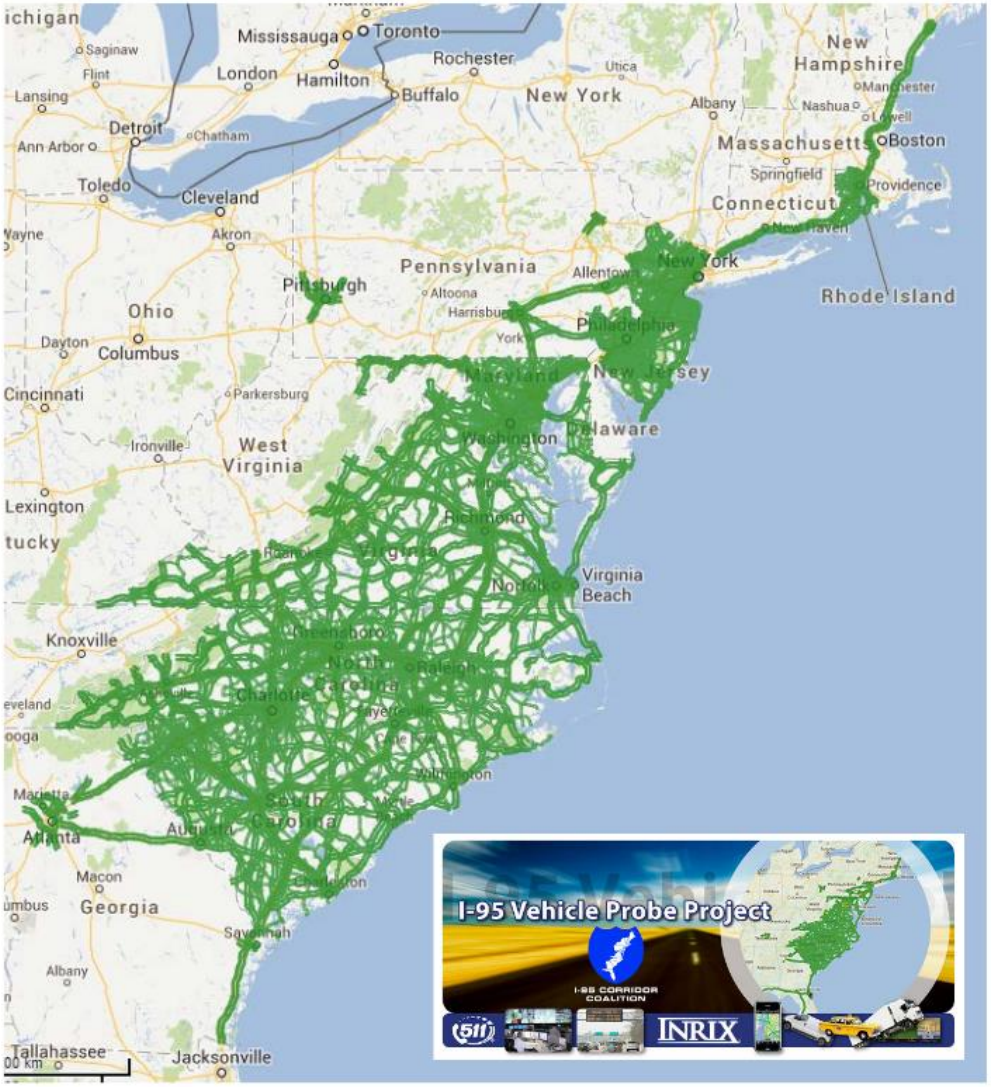
CATT Works

I-95 CORRIDOR COALITION

AND GROWN

December 2013

I-95 Vehicle Probe Project Coverage – December 2013



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UNEXPECTED CONSEQUENCES

Acceptance and dependency of out-sourced data to drive DOT processes

- Travel time on signs
- **Performance** measures
- Mobility reports
- Work zone assessment
- Anticipation for use on Non-Freeway facilities
- Questions and expectations of what other out-sourced data may be available for DOT's to leverage

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TODAYS TOPIC/S

Current and anticipated data products

- Presentations by HERE, INRIX, TomTom

User Data Needs

- Perspectives from Operations, Planning, Freight, MPO, Arterials

Open Discussion

- Can the two find middle ground

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THE VALIDATION CHALLENGE

Validate the accuracy of the freeway received data within the context of the data quality specifications

- This grew to arterials as well about 2010

Perform continuous validation that is representative of the entire corridor

- Continuous from 2008 till present

Provide ad-hoc and supplemental analysis as requested

Adjust contractor payments to reflect data quality

Manage expectations of multiple parties

Remains the largest, most comprehensive validation of any type of traffic data

- EXTENDED TO THREE VENDORS IN 2014

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TECHNICAL OVERVIEW

Frequency

- Initial validation July through October 2008
- Approximately monthly from 2009 till present (10 per year)
- All reports, data, and analysis open, available on website

Methodology

- Bluetooth Traffic Monitoring used as reference source
- Accommodates sophisticated filtering of outliers, and uncertainty in mean
- Segments selected based on propensity for congestion, picked in consultation with local jurisdiction

Metrics

- Average Absolute Speed Error (AASE) – measures deviation from reference source
- Speed Error Bias (SEB) – measures consistent high or low reading in data
- Analyzed in four speed bins, by segment, and overall

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VALIDATION EFFORT

Through December 2014

- 11states
- 49 evaluation reports
- 53 deployments, 829 days sensors on the road
- 1282 centerline mile (994 mile freeway, 288 mile arterial)
- 95,706 hour worth of ground truth data resulting from 11.7 million Bluetooth observations

State	Validation rounds
CT	1
DE	6
FL	1
GA	1
MD	8
NC	6
NJ	12
PA	8
RI	1
SC	1
VA	8

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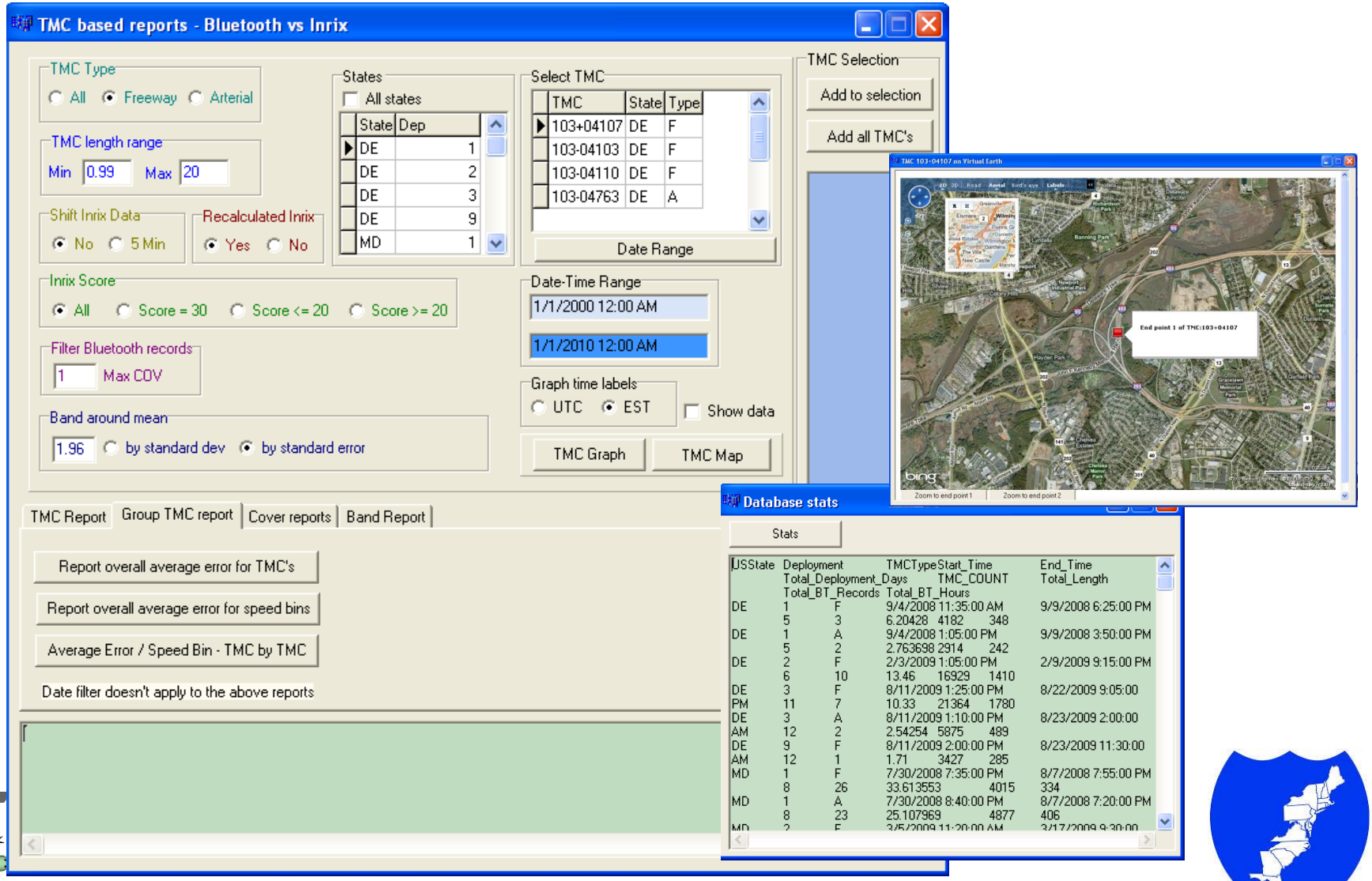
VALIDATION TOOL



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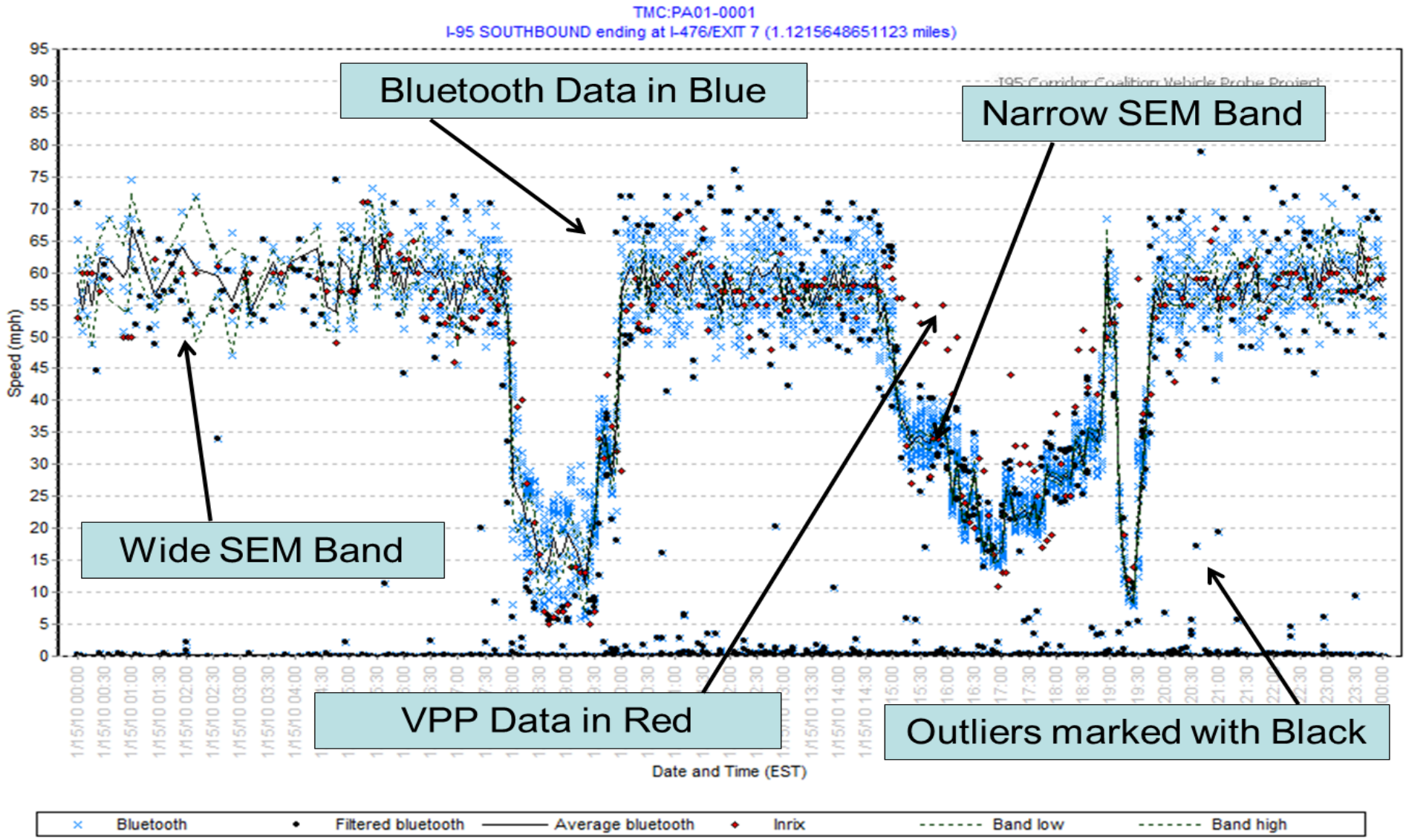
GRAPHICAL OUTPUT



FEATURES

Internet accessible

Outlier filtering

Path data analysis

Evaluation report generator

Graph generator

Data Import and export (XML, CSV)

Bluetooth penetration rate analysis

Bluetooth OD analysis and report

Statistics report

TMC mapping

Data mining

Programming language C++, Database Microsoft SQL Server

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Probe Data Symposium

University of Maryland
CATT Lab

Keith Hangland

January 15, 2015

Agenda

- Traditional Probe Data Products
- Newly Introduced Products
- Emerging Products

Flexible Options for End-to-End Deployment

Data

- Navigable maps
- Truck maps
- ADAS maps
- Real-time traffic
- Predictive traffic
- Historic traffic
- Dynamic content (fuel prices, parking, EV, etc)
- Visual content (landmarks, 3D models, junctions)

Platform APIs & SDKs

- Passenger Routing
- Traffic-enabled Routing
- Truck Routing
- Transit Routing
- Pedestrian Routing
- Matrix Routing
- Isoline Routing
- Geofencing
- Geocoding

Applications

- HERE Traffic Viewer
- HERE Automotive Nav
- HERE Mobile Apps (Maps, Drive, LiveSight)
- HERE Web Apps
- Partner Apps (In-vehicle nav, PND, web, mobile)

HERE Maps

214

Countries and territories mapped

2.7M

Changes per day

75,600

Buildings with indoor maps

96

Countries with voice-guidance

41

Countries with live traffic service

80,000

External sources help to create our maps

805

Cities with public transport

52

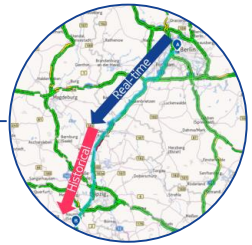
Languages

HERE Location Platform APIs

Multi-modal routing APIs and SDKs for routing and visualization

Truck Routing

Optimized routing based on the truck attributes data set



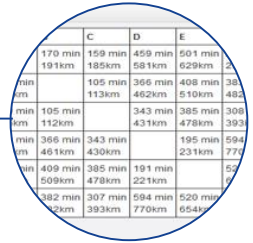
Traffic-enabled Routing

Optimized routing with real-time traffic data and/or

Historical traffic data

Isoline Routing

Route calculation based on areas of reach within a particular time or distance



Matrix Routing

Route calculation for multiple destinations

Pedestrian Routing

Optimized routing using pedestrian specific walk ways and virtual connections

Public Transit Routing

Estimated routing using frequency-based schedules

Timetable routing using dynamic up-to-date frequency-based schedules

HERE & Partner Applications & Devices

Smart Guidance

Multi-modal traveler applications for driving, public transit, pedestrian

HERE both creates applications and powers 3rd party applications for in-vehicle, PND, mobile devices and across operating platforms

HERE Maps | HERE Drive | HERE Transit

HERE TRAFFIC

Big Data turned into Useful Information: HERE Traffic

HERE Real Time Traffic

Continuous Dynamic Traffic Information, providing up to the minute data for 44 countries

- Real-time speeds and travel times
- Real-time incidents (accidents, construction)

HERE Advanced Analytics

Traffic Analytics

New

- A rich dataset of daily historical traffic speed and statistical information
- Sliced and diced on demand

NPMRDS

- Un-modeled research data set

Traffic Patterns

- Typical speeds & travel times by day/time based on historical data

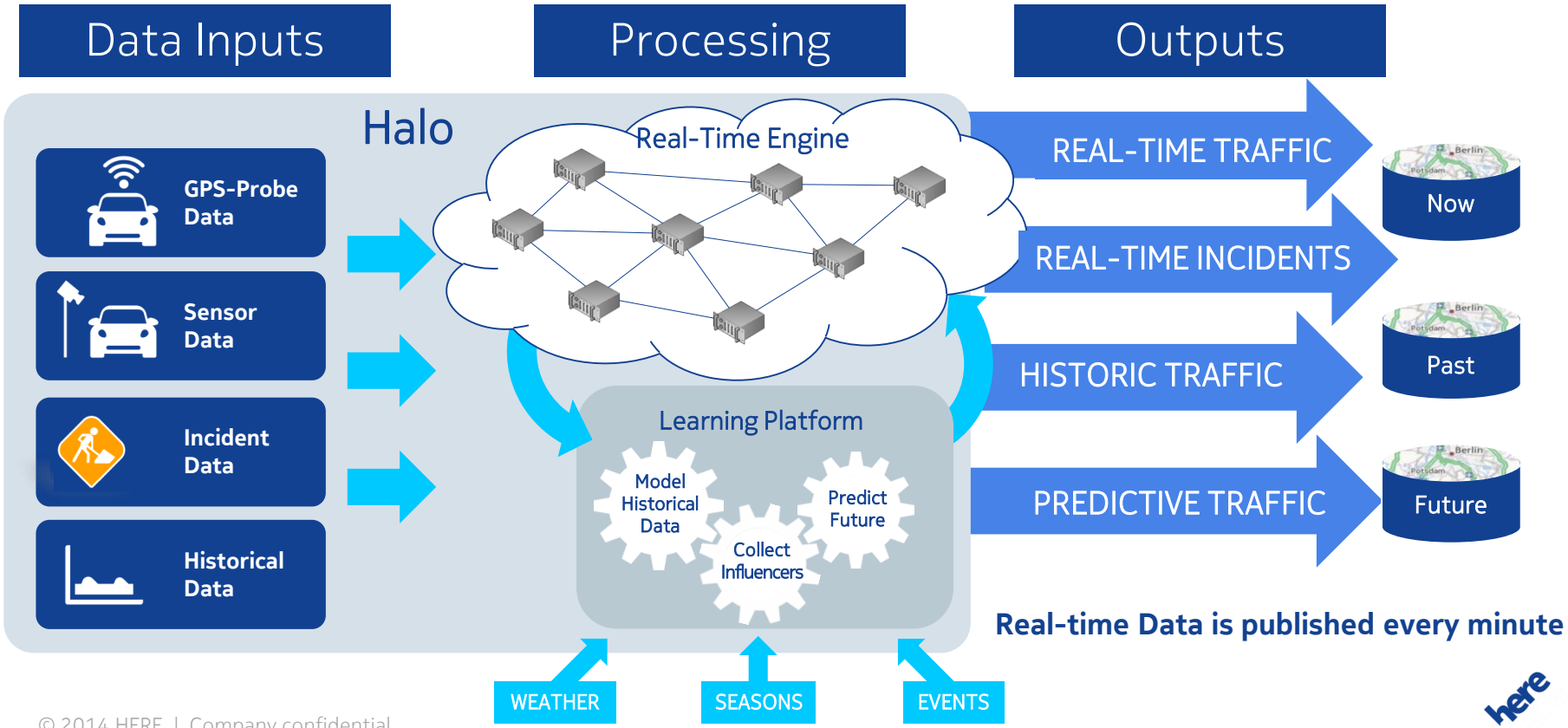
HERE Predictive Traffic

New

Modeled real-time traffic forecasts for future time slots to help drivers, fleets, and road network operators make better decisions.

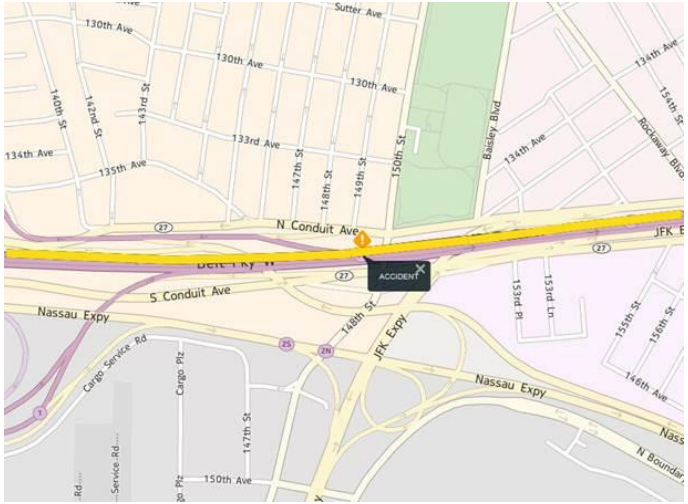
- Forecasted speeds and travel times
- 12 hours into the future

Halo: Real-Time Data Processing Engine



Granular Conditions

Micro-Traffic enables HERE Traffic to be reported at a sub-TMC level



Without HERE Micro-Traffic

With HERE Micro-Traffic

Captures the natural breaking of traffic speeds based upon real world conditions

Evolution of Archived Data Products

Traffic Patterns	Analytic Traffic Patterns	National Performance Dataset	Traffic Analytics
Suited for route planning, arrival time estimation	Suited for analysis of monthly and season trends	Unmolded raw speed data operations research and analysis	User defined, customizable data sets built on-the-fly

Traffic Analytics

New

- A rich dataset of daily historical traffic speed and statistical information
- Sliced and diced on demand

1. Tell your story using a data driven approach
2. Show and prioritize where investment is needed
3. Quantify and measure network performance

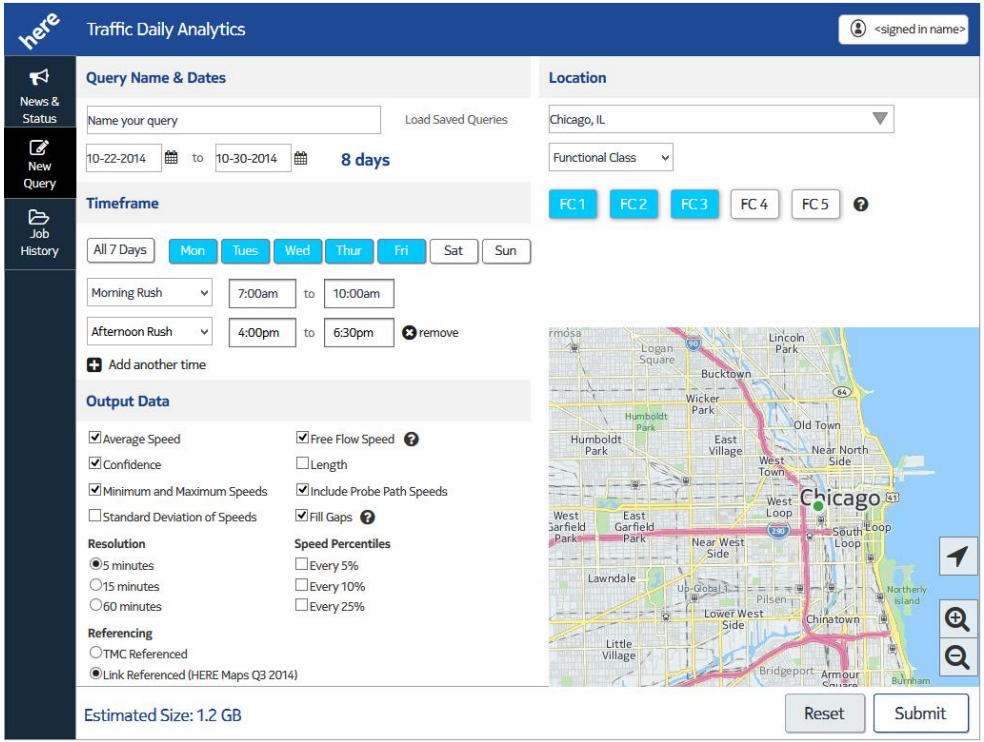
Traffic Analytics

User defined historical data sets for performance measurement

A rich dataset of daily historical traffic speed and statistical information

Slice and dice on demand by user preferences (date/time, location, resolution, modeling)

Includes analytical details



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Traffic Analytics: Benefits over existing options

- More Data: All Roads. More Probes.
- Consistency over Time
- Granularity: Smallest road segments.
- Flexibility: Data constructed by user preferences.
- Usability: Manageable and customizable data sets.

Real-Time Predictive Traffic

Modeled real-time traffic forecasts for future time slots

- Forecasted speeds and travel times
- 12 hours into the future

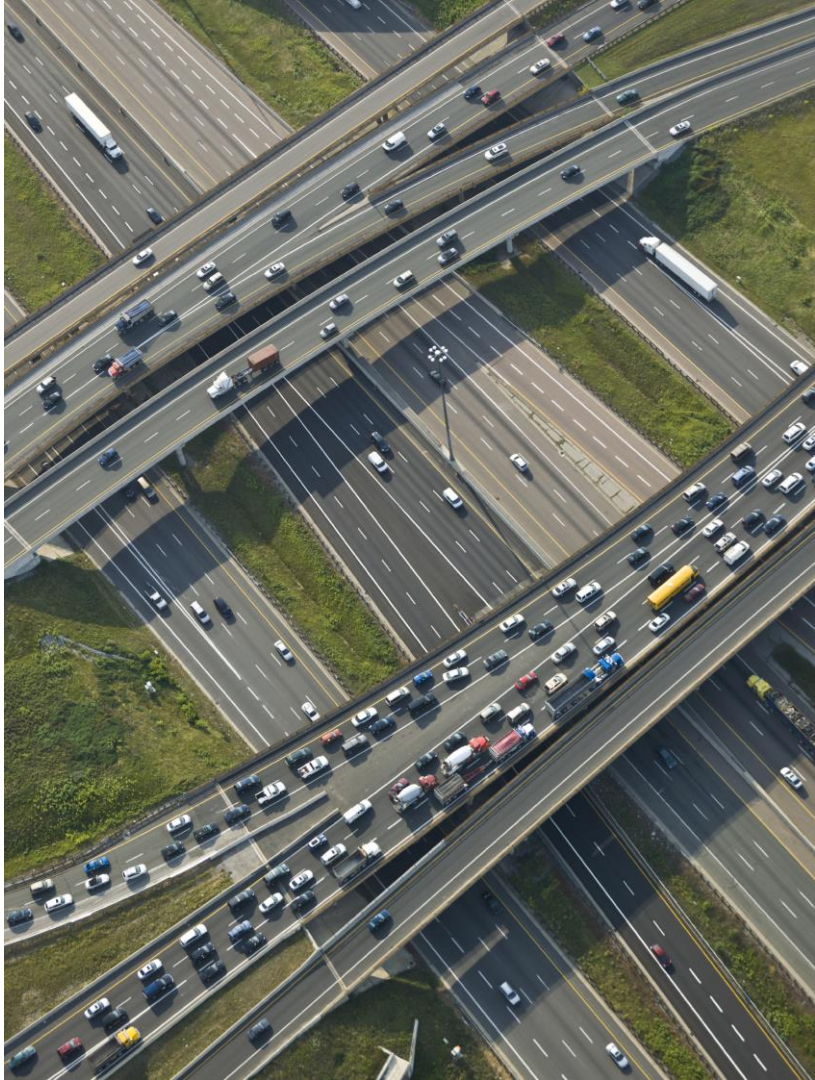
1. Improves planning and alerting capabilities
2. Anticipate the best routes and reduce the number of re-routes during a journey
3. Improves arrival time estimates for longer routes

Planning and Alerting
Manage expectations

Transportation Agency.
Alert travelers so they know what to expect and have alternate choices.

Planning and Alerting
Complex journeys

Fleet routing.
Optimize route planning and timing for multi-stop journeys.
Know when the truck will arrive.



More accurate arrival time estimates for long journeys

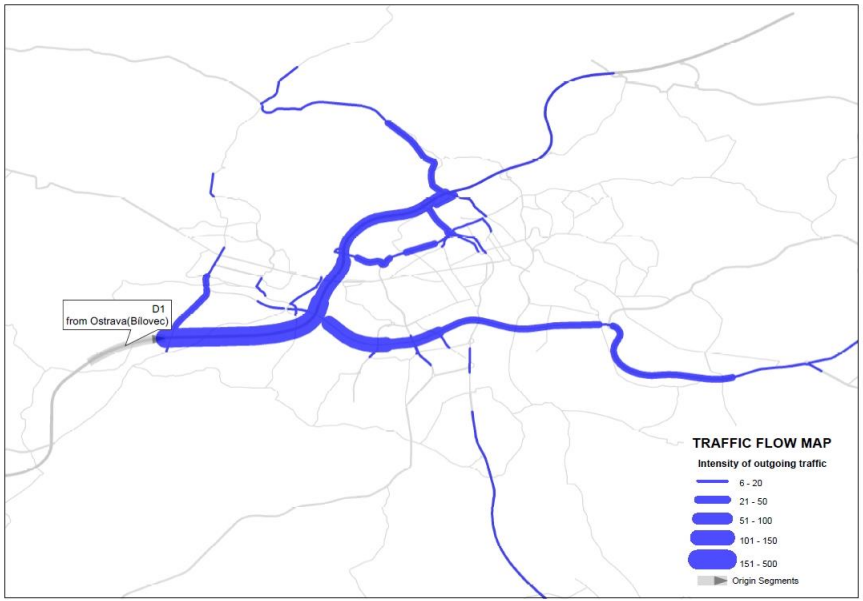
Routes more than 30 minutes

Friday drive to the beach

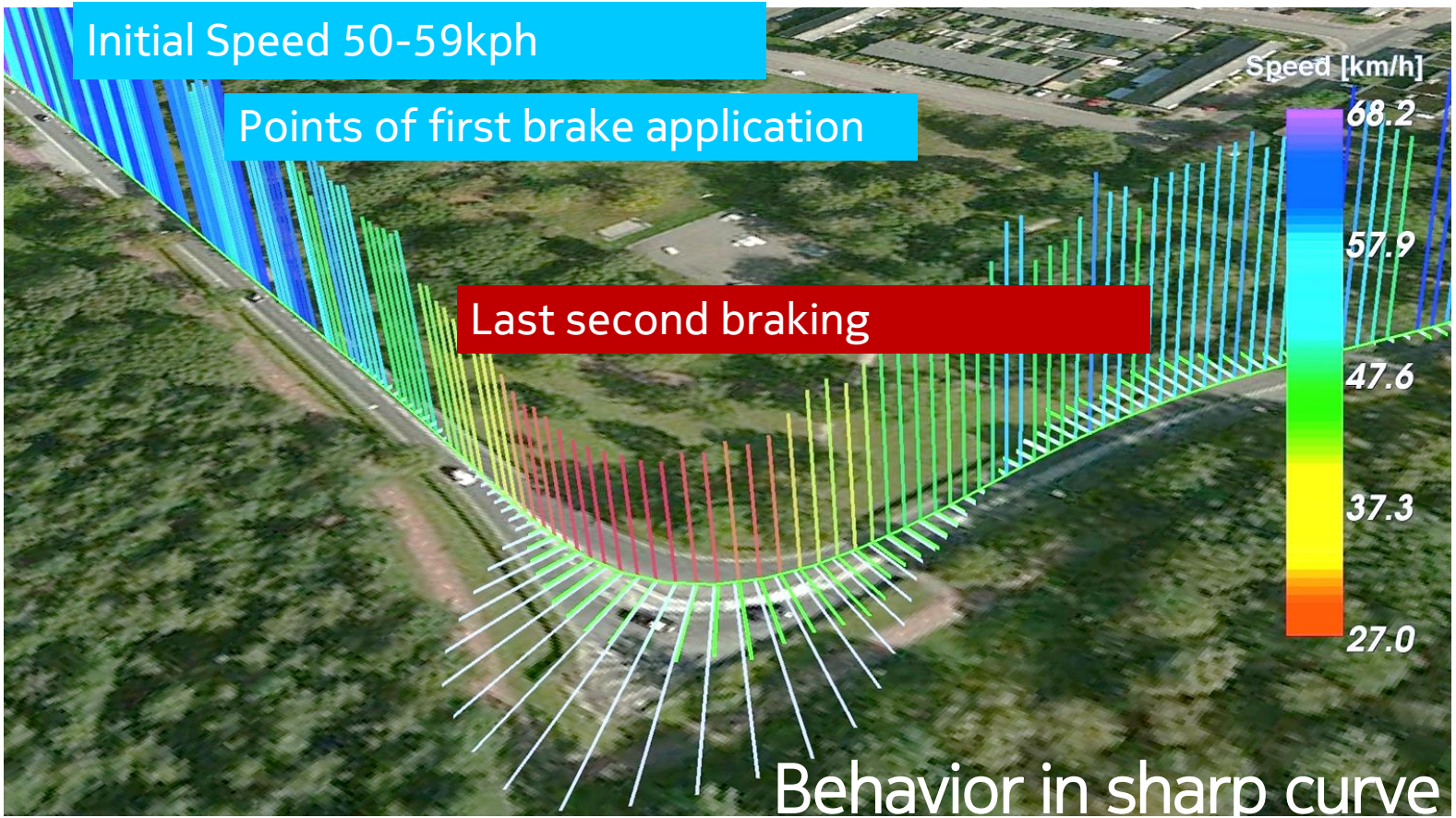
Hitting the slopes for the weekend

Emerging

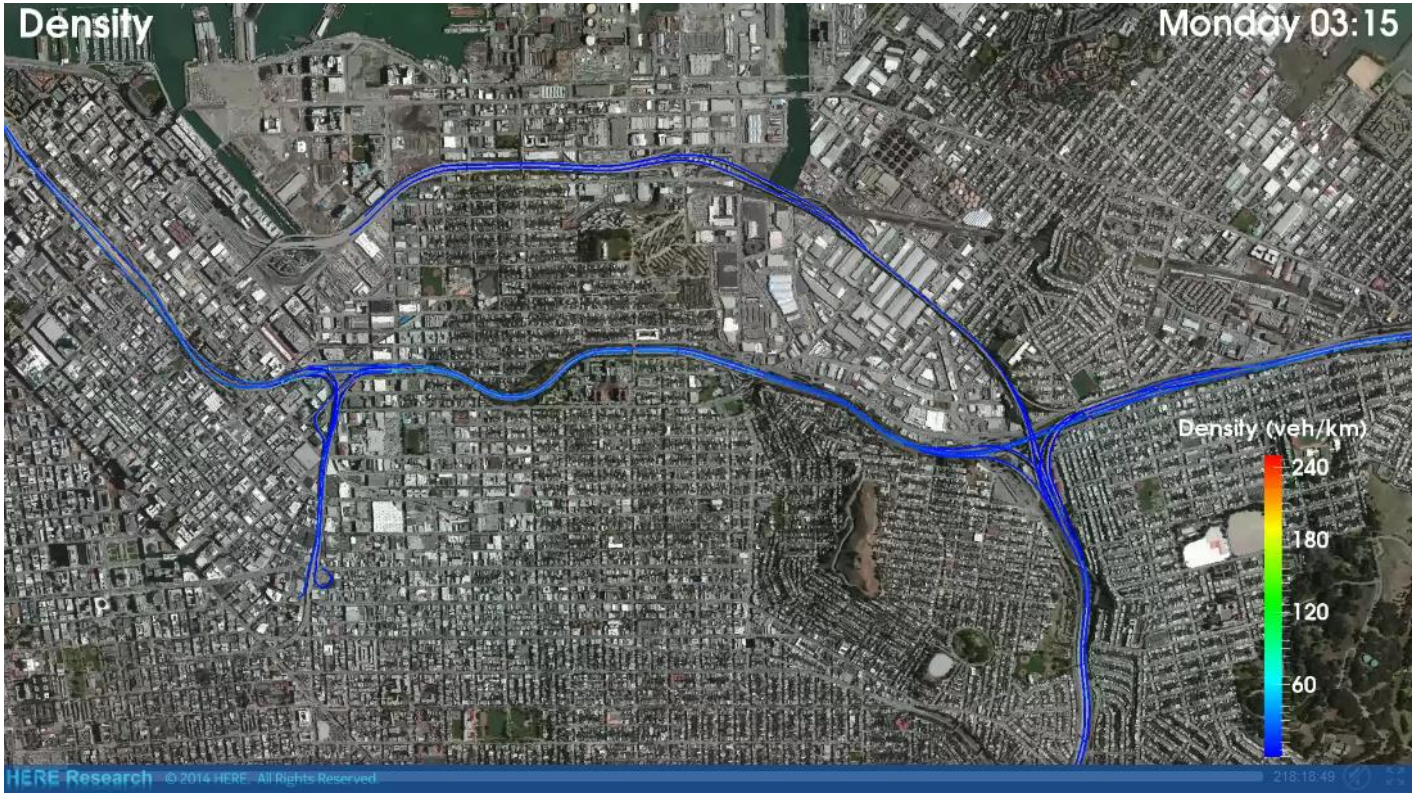
Origin Destination and Volume



Data Analytics: Aggregated Braking Patterns



Real-Time Traffic Volume Estimation



Connected Traffic Signals

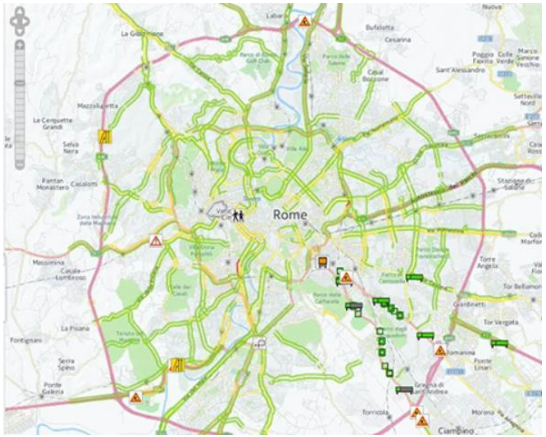
HERE Traffic Engine and SWARCO MISTIC Platform

- The use of Signal Phase and Timing (SPaT) data along with HERE to deliver enhanced traffic flow, prediction accuracy and real time mobility status

- For road authorities the combination can improve congestion management, vehicle efficiency and reduce carbon emissions.

- Demonstrated at ITS World Congress in Detroit

21ST WORLD CONGRESS DETROIT 2014 INTELLIGENT TRANSPORT SYSTEMS



Other Trends and Initiatives

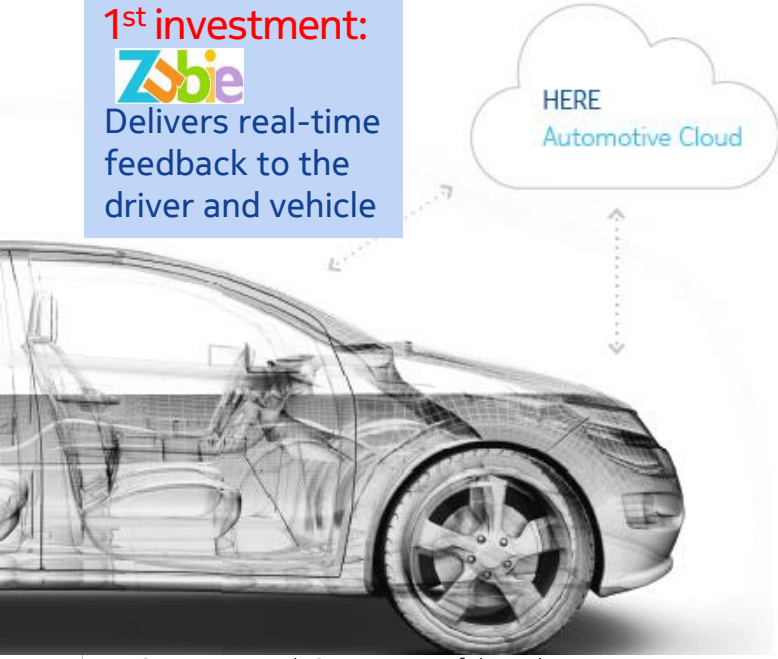
Nokia is investing and HERE is implementing connected and automated vehicle technology

Nokia announces $100M fund to accelerate connected car technology

1st investment:

Zubie

Delivers real-time feedback to the driver and vehicle



Nov 2013
HERE has teamed up with **Mercedes Benz** to jointly develop smart maps for connected cars and ultimately, self driving cars.

Jan 2014
North American Auto Show 2014: **Continental** and HERE team up to map out the future of vehicle connectivity using HERE maps and Electronic Horizon.

Oct 2014
HERE receives **BMW Supplier Innovation Award** in the area of Connected Driving.

HERE

SLASHGEAR REVIEWS COLUMNS FEATURES TEGRA

Nokia's HERE Maps arrive on Google Play, coming to iOS in early 2015

0

Dec 10, 2014

Tweet

here

Thank you!

CATT
CENTER FOR ADVANCED TRANSPORTATION TECHNOLOGY

I-95 CORRIDOR COALITION

1st Outsourced Probe Data Symposium

Rick Schuman, Ted Trepanier

January 15, 2015

INRIX

INRIX Overview

Leading Global Provider of Traffic Information, Analytics & Connected Car Services

- **World's largest driver network**
  - 175M real-time vehicles & devices; Hundreds of distinct data sources
- **Across 40 countries**
  - Covering 4M+ miles; Expanding across South America, the Middle East and Asia
- **Delivering breakthrough Connected Car services & transportation analytics**
  - Traffic, Fuel, Parking, EV, Multi-Modal; Transportation & Population Analytics
- **Serving 300+ B2B customers worldwide**

Automotive

Audi, Ford, BMW, Tesla, Porsche, Nissan, Toyota, Volkswagen, Jaguar, Land Rover, RACC, Denso, Clarion, Pioneer, Continental, Harman, JVC Kenwood, Bosch, Aston Martin, RAC, Fiat, Renault, Mercedes-Benz

Mobile/Internet

Deutsche Telekom, Samsung, TeleNav, Nuance, Orange, Intel, mapquest, Telmap, Garmin, Navigon, NDrive, fullpower, Optus, Mapbox, Oxygen 8 Group, TCS

Public Sector

Transport for London, Metropolitan Transportation Commission, Viasuisse, Cubic, transpogroup, Highways Agency, City of Calgary, Straßen.NRW, pennsylvania, mouchel, Transport for Greater Manchester, FDOT, OHIO DOT, vmz, MDOT, Jacobs

Enterprise

Berkshire Hathaway HomeServices, TAB, alk, Telogis, Atkins, SuperShuttle, cdcom, roadnet technologies, Windermere Real Estate, StreetLightData, Rand McNally, Purdue University, TELVENT, Better Homes and Gardens, RE/MAX, Universität der Bundeswehr München, MIT, Texas A&M Transportation Institute

Media

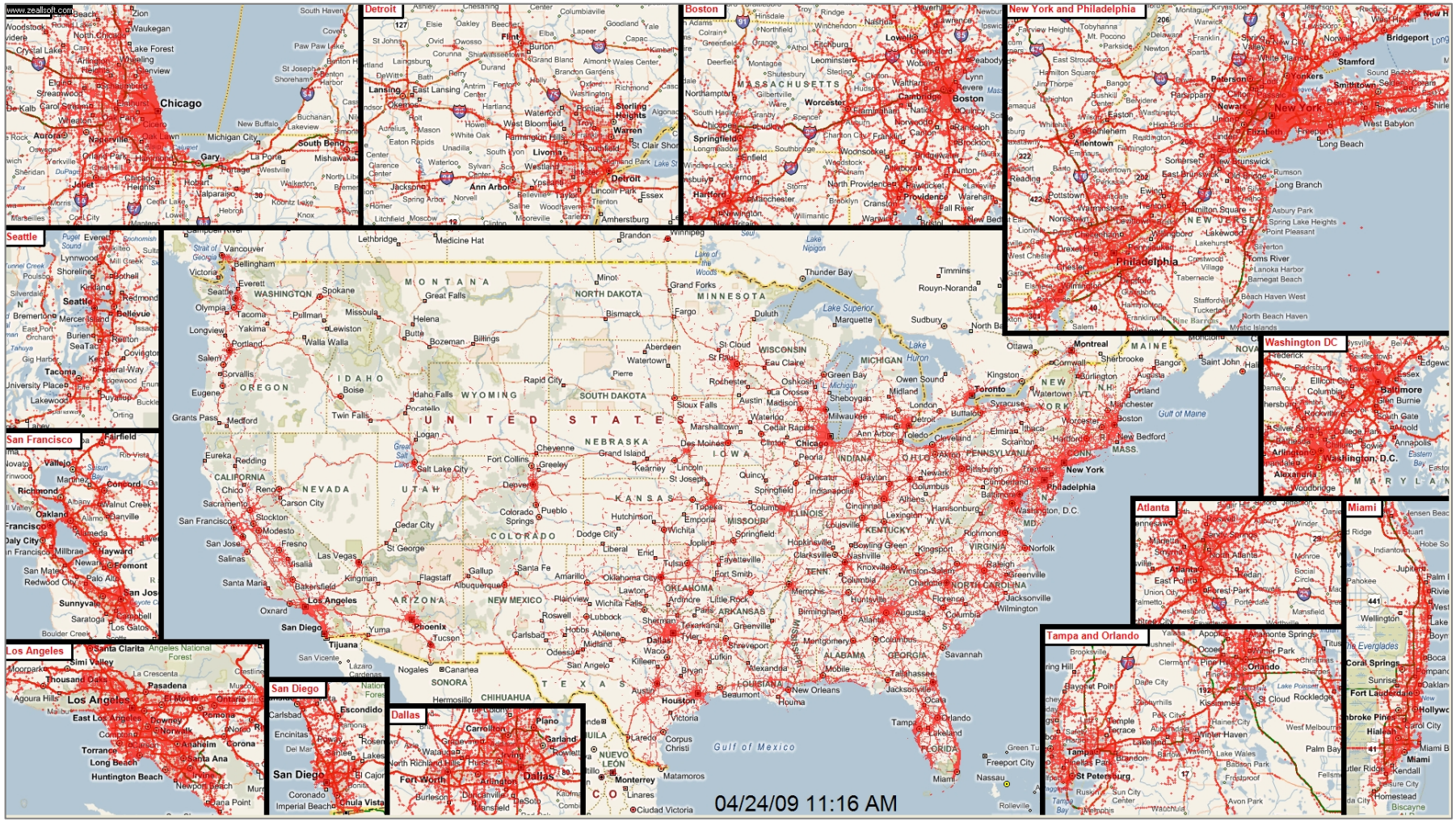
The Weather Channel, Comcast, BBC, WSI, AMSCREEN, Pelmorex Media Inc., Gannett, GTN Global, AccuWeather, NDT, aha

INRIX

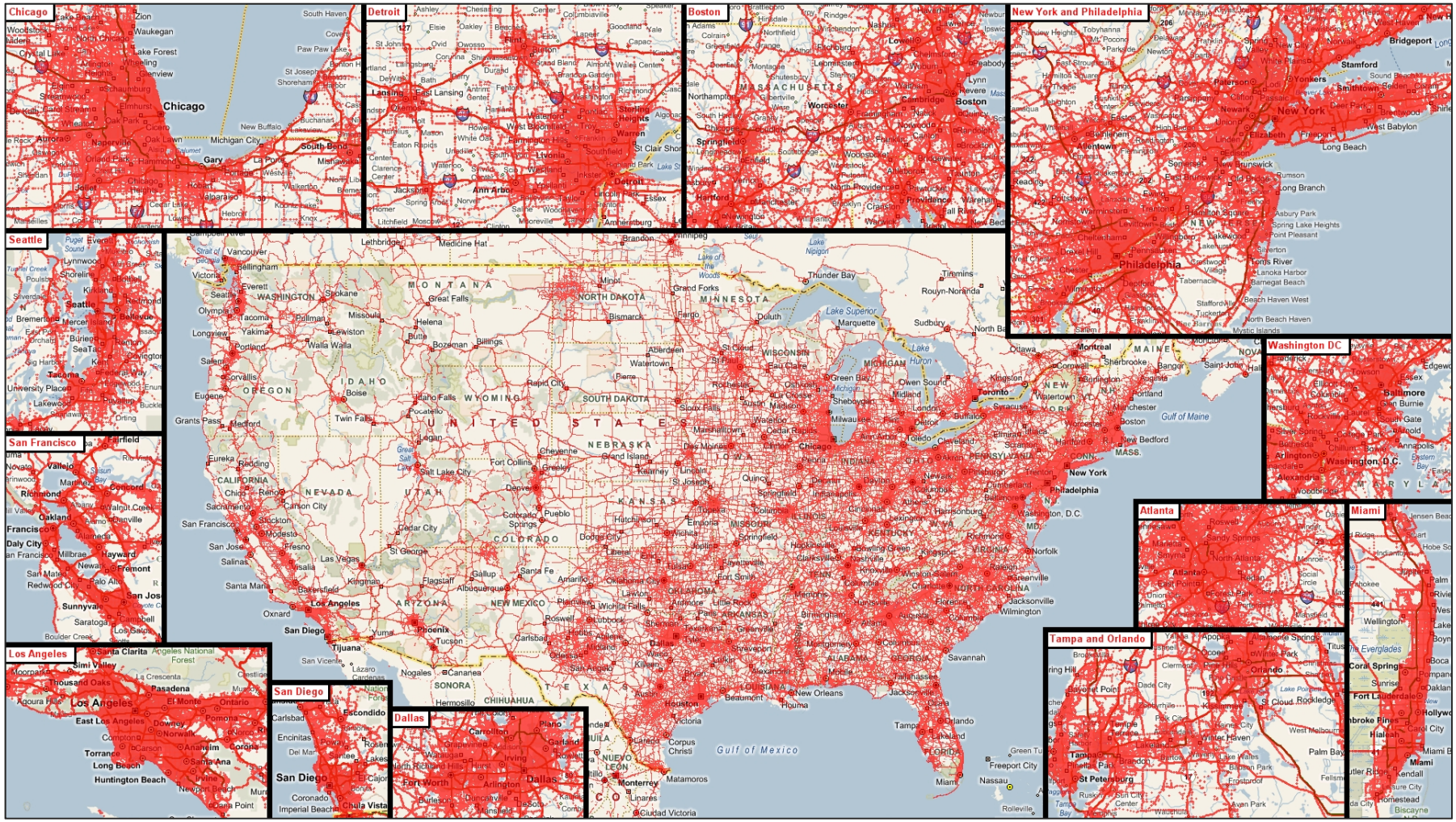
Keys to Useful Probe Data

- Sufficient Raw Source Data
- Fusion and Algorithms
- Reliability and Scalability
- Matching Products to Use Cases
- Ease of Use/Integration

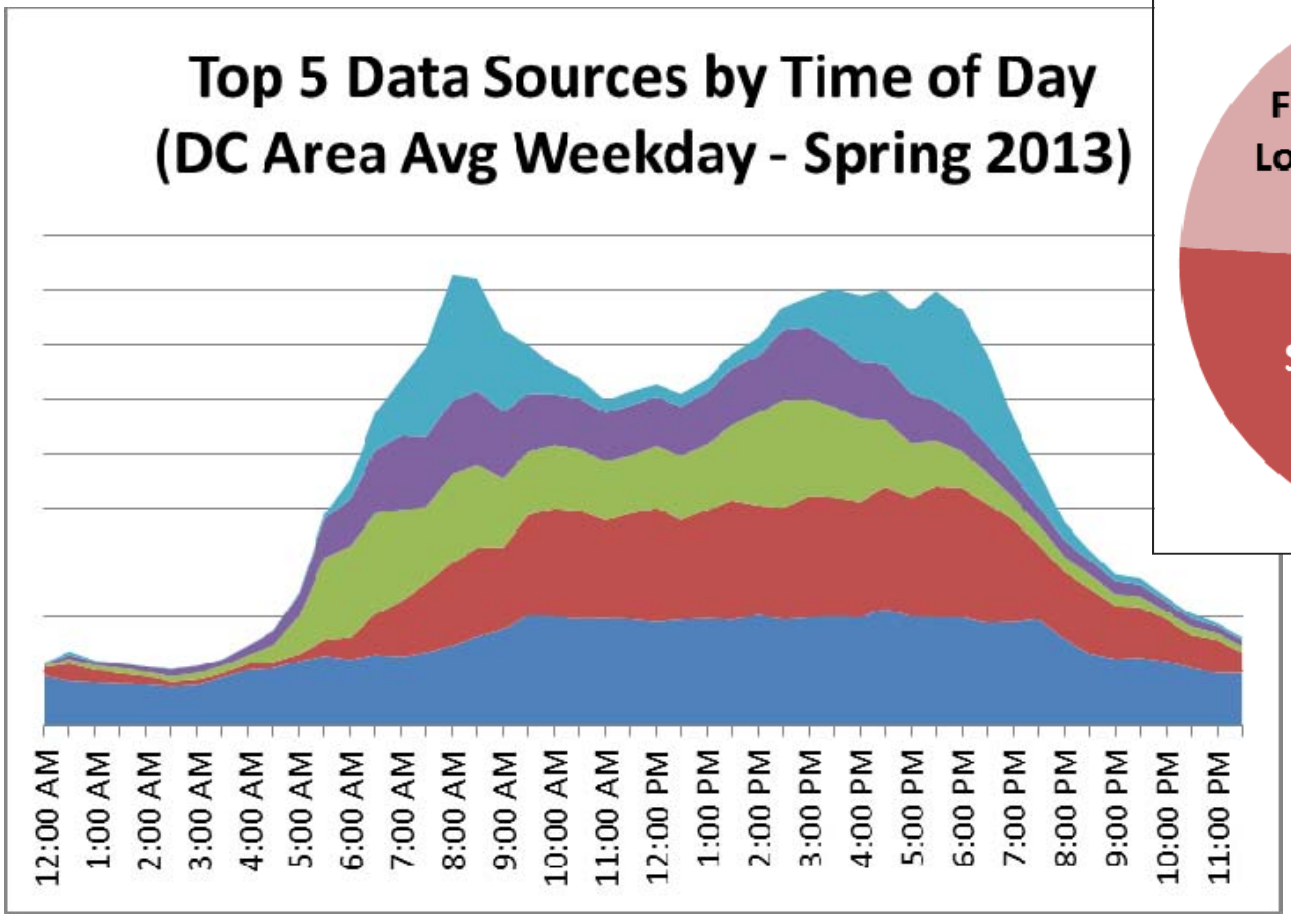
Incoming Data – April 2009

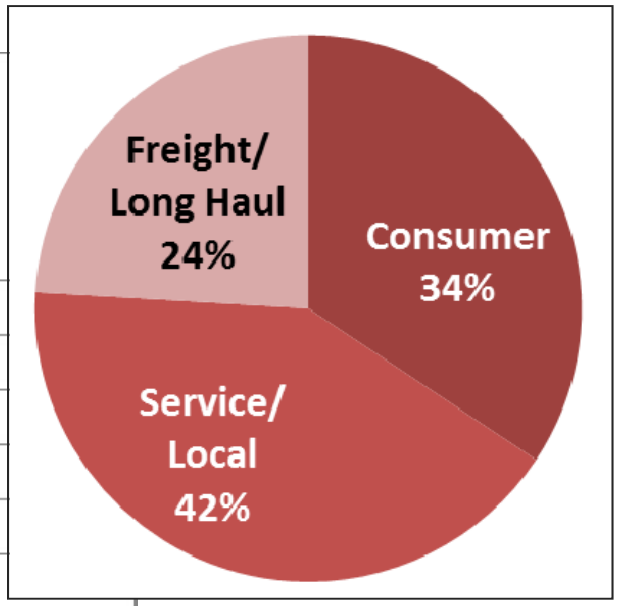


Incoming Data – April 2014



Robust Probe Data Managed as a Portfolio





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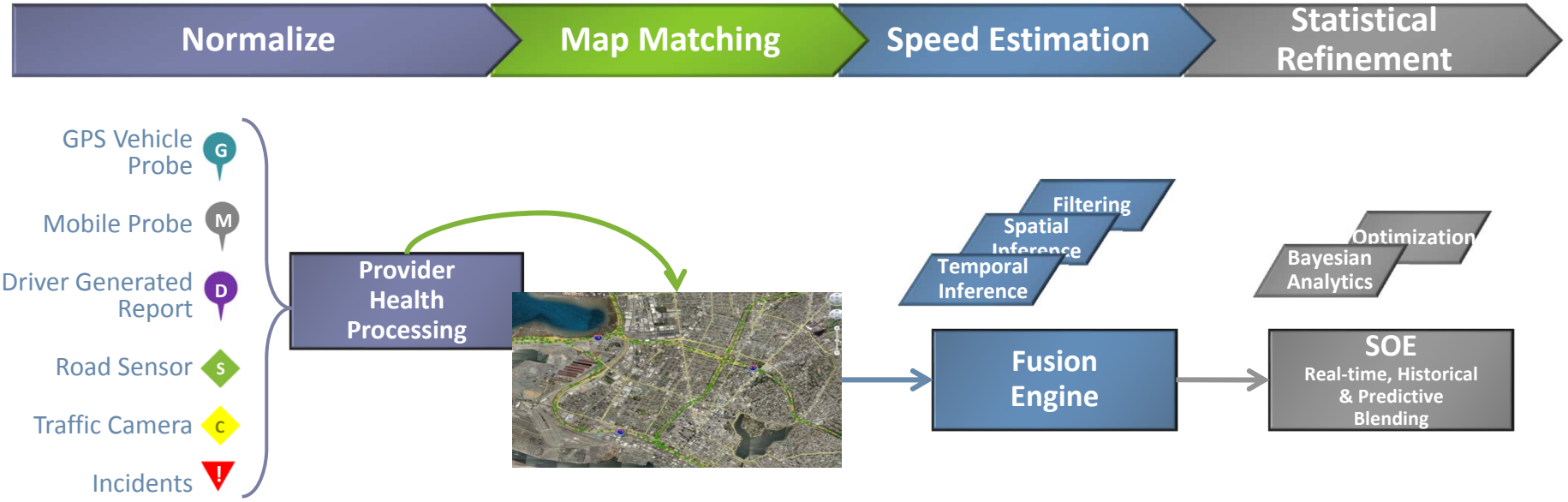
INRIX Processing Steps



Aggregate **speed data from probes and sensors**

- Collect data from over 400 sources
- Monitor to ensure proper data point – timely and valid
- Place valid data points on a specific road
- Sensor and Provider Health Processing

Snap **probe data to road network**

- Filter points based on location, heading, speed
- Locate points within a road segment

Compute **speed value based on data collected over 15 minutes**

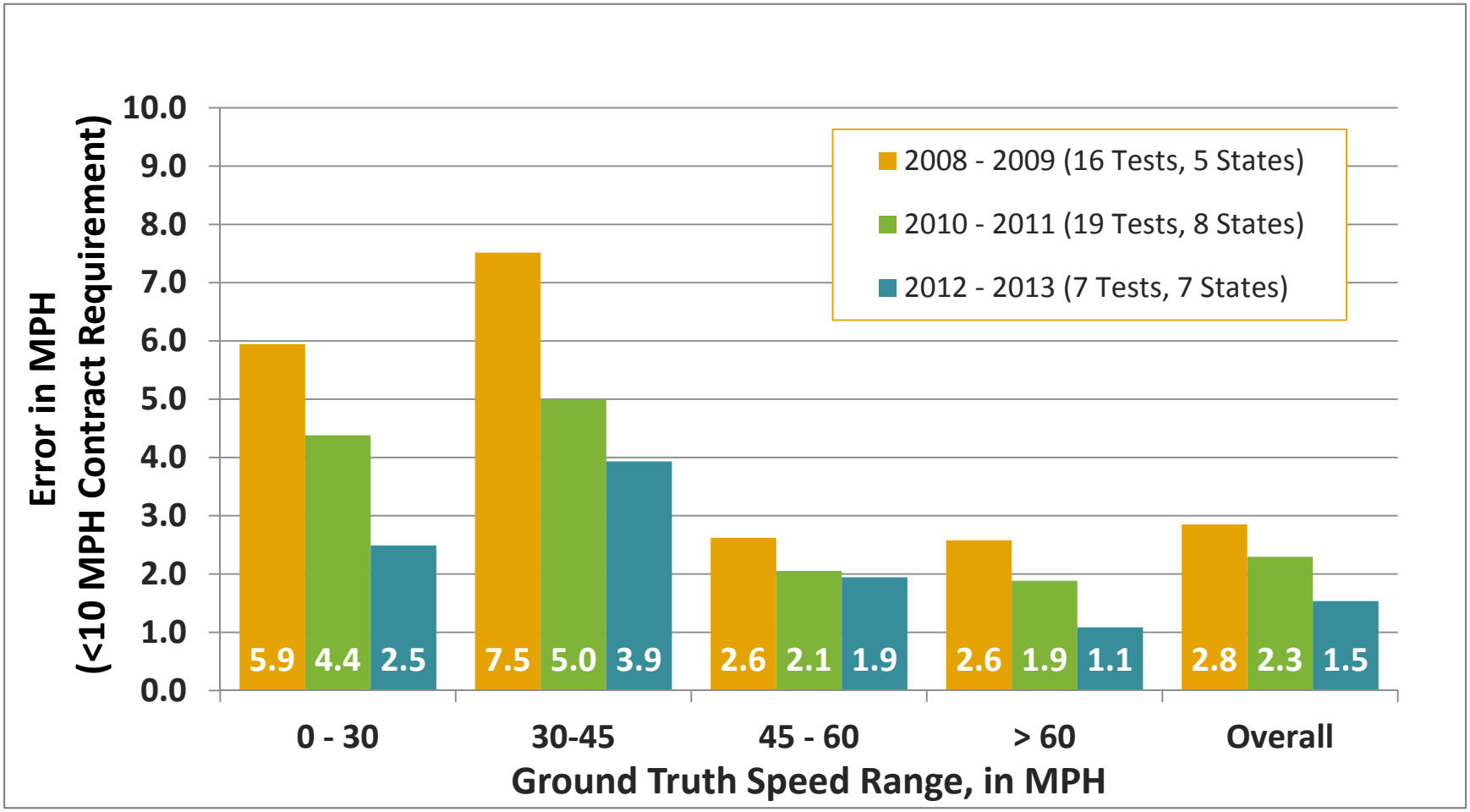
- Outlier detection to remove statistical anomalies
- Weight data based on source and latency
- Apply "Adaptive Spatial Resolution" to optimize accuracy and relevance

Enhance precision **of result and calculate confidence factor**

- Leverage real-time where possible
- Enhance data to leverage road closures
- Process less than ideal real-time estimates with typical and predictive forecasts

INRIX

VPP1 Freeway Validation Results



- Subject to world's most rigorous testing in VPP1 since 2008
- Agreed to Payment Penalty Formula in VPP1 – never penalized
- Significant accuracy during VPP1
- Agreed to 7MPH AASE rqmt in VPPII vs. 10 MPH in VPP1

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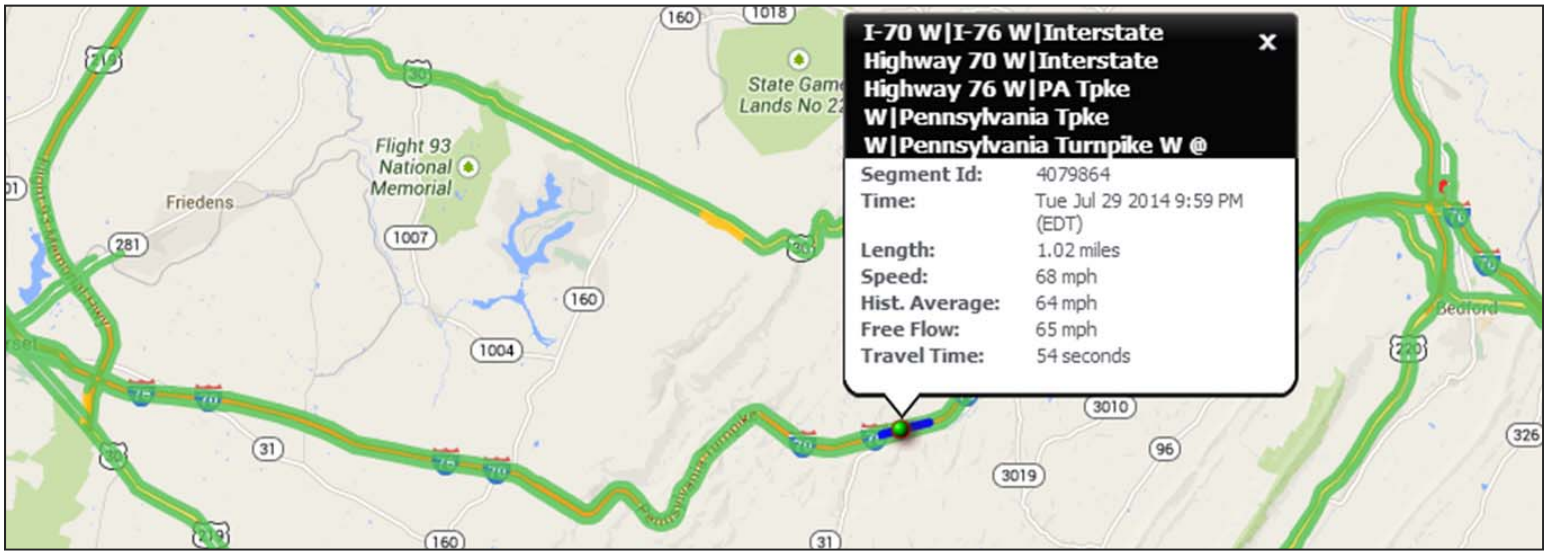
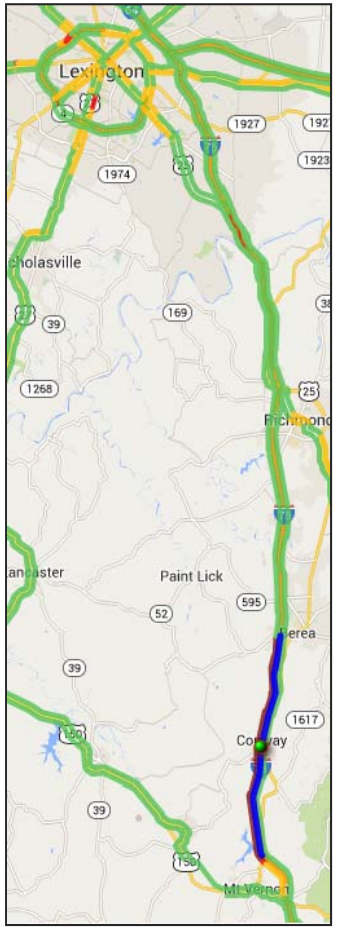
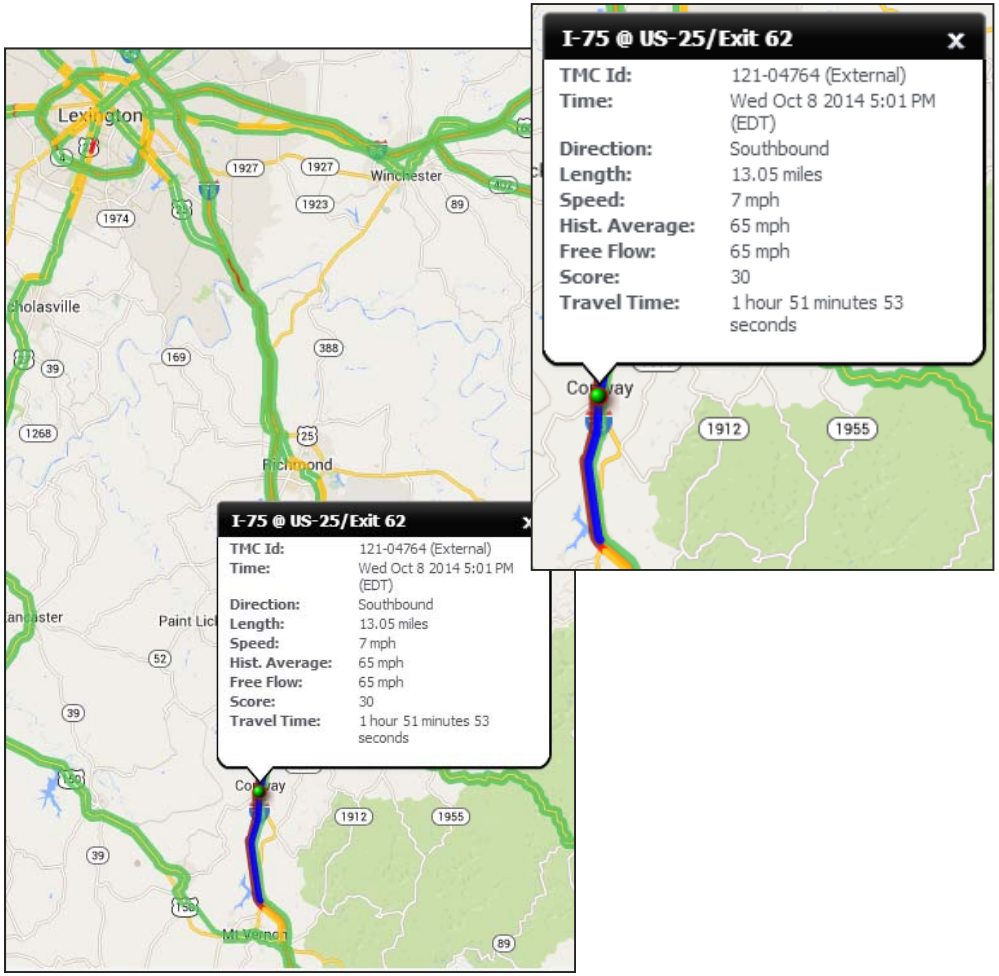
INRIX XD Segments (More Roads, Precision)

- Introduced late 2013 – Purpose built for dynamic traffic reporting
- Function precisely like TMC segments
  - Fixed segments, fully populated data, updated every minute
- Key Benefits of XD Segments
  - ~40% More Coverage nationally – large increases in ramps and arterials
  - Better segment granularity – typical segment length ~1 mile (1.7 mile max)
  - Eliminate gaps and overlaps endemic in TMC segments
  - Not dependent upon TMC Consortium for codes
  - Sub-segment granularity optional – data and tiles

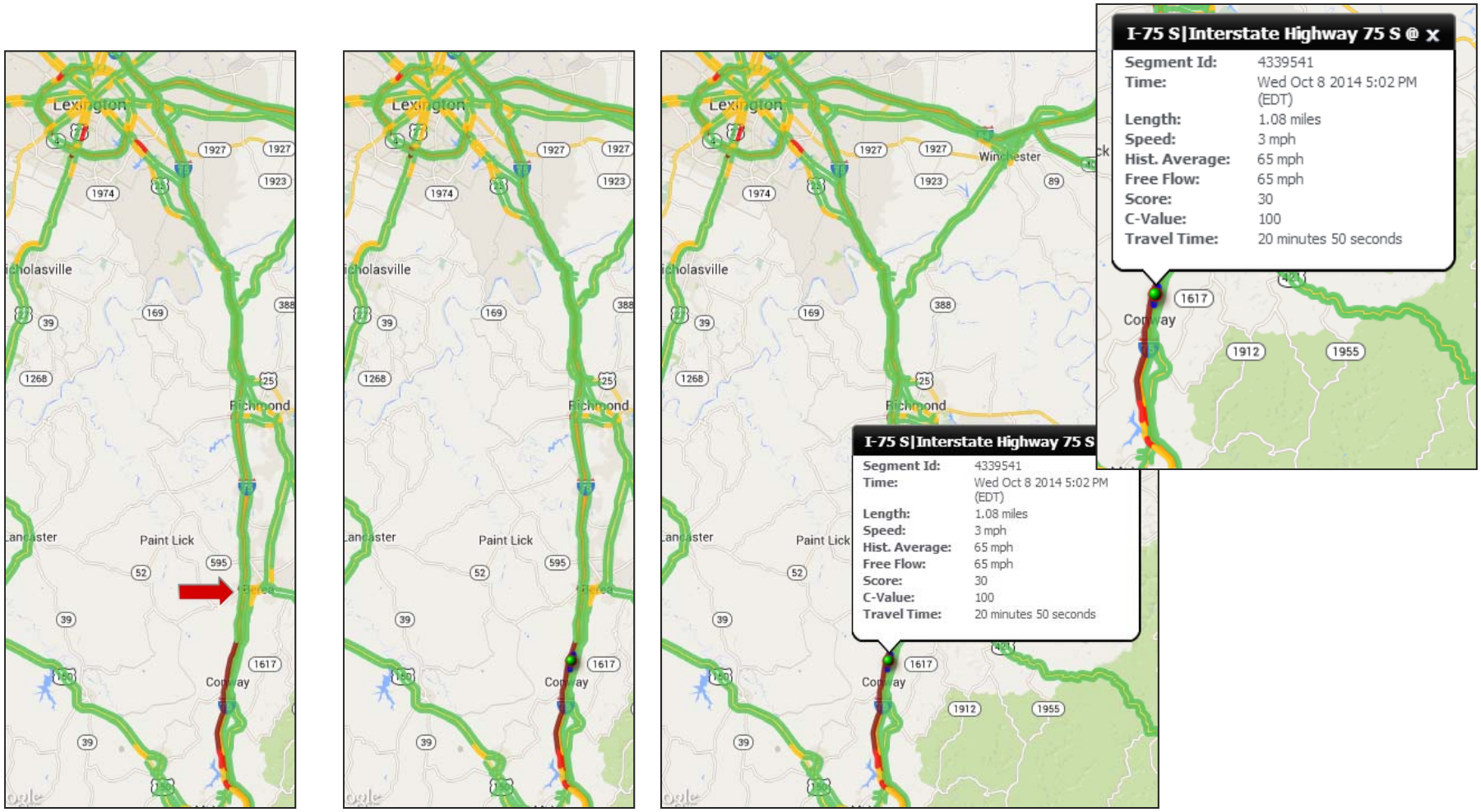


Queue Monitoring – TMC Segments



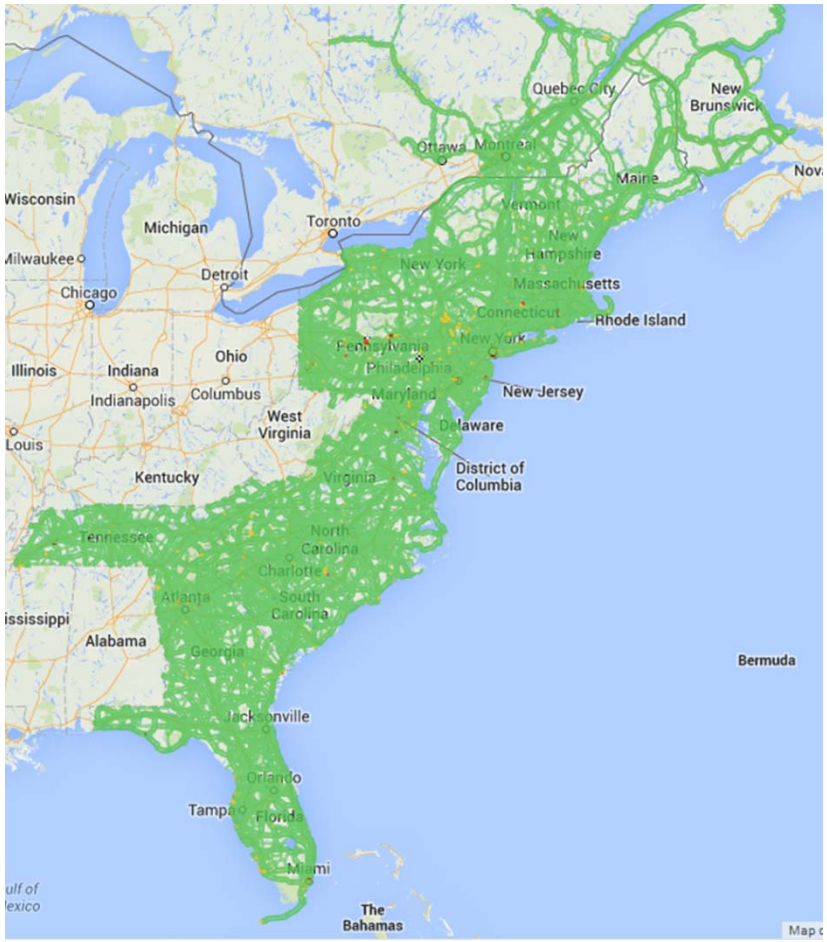


Queue Monitoring – XD Segments

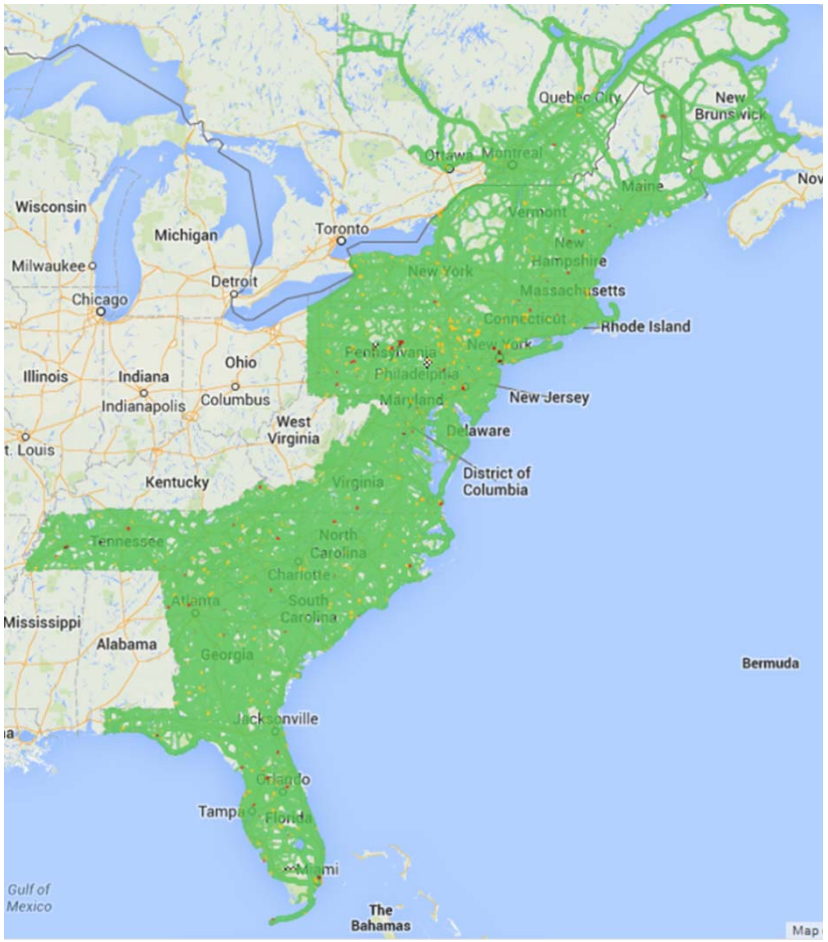


Available Road Coverage

TMC Segments – 133K miles



INRIX XD Segments – 187K miles



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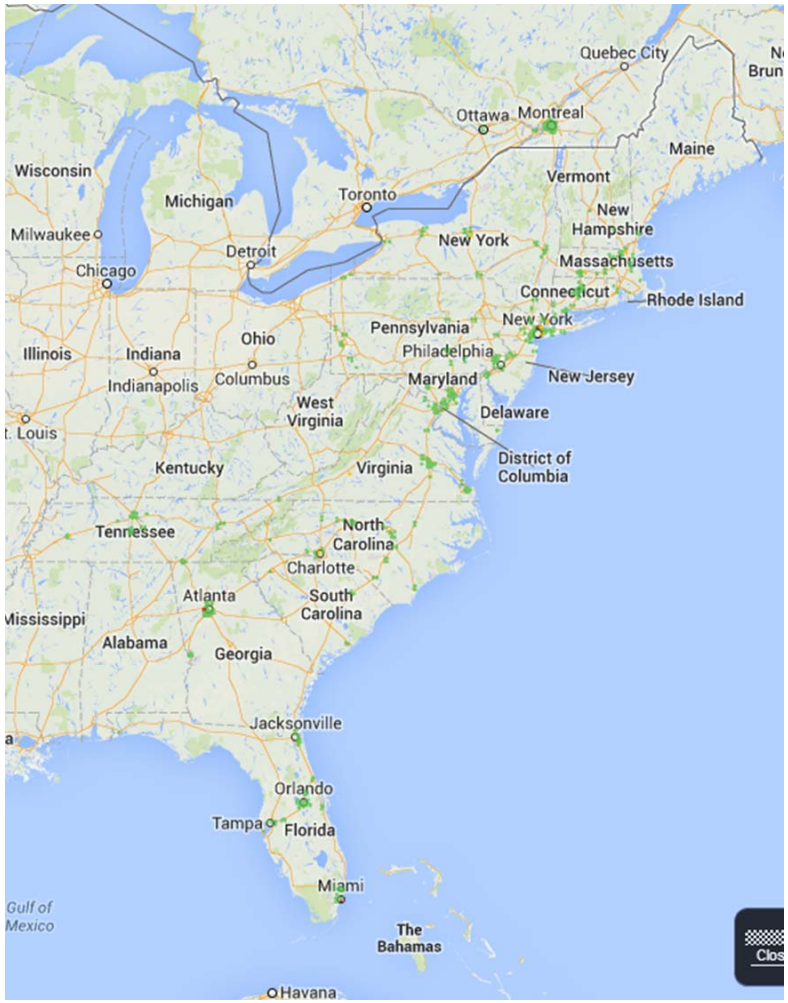
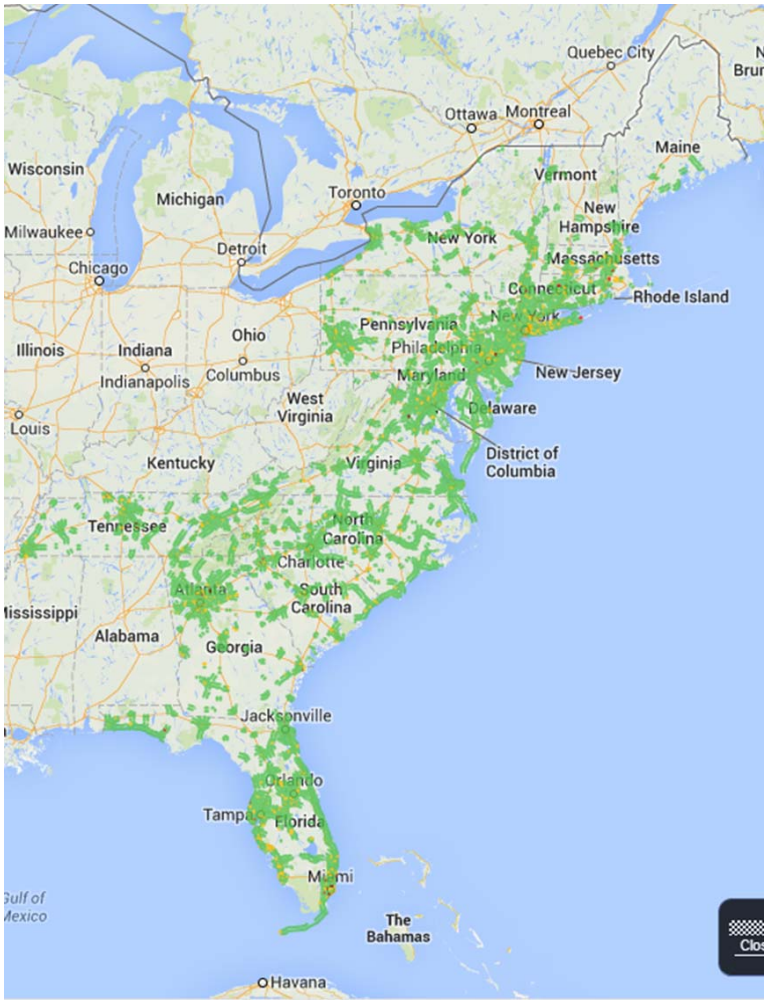
Available Interchange Coverage

TMC Segments

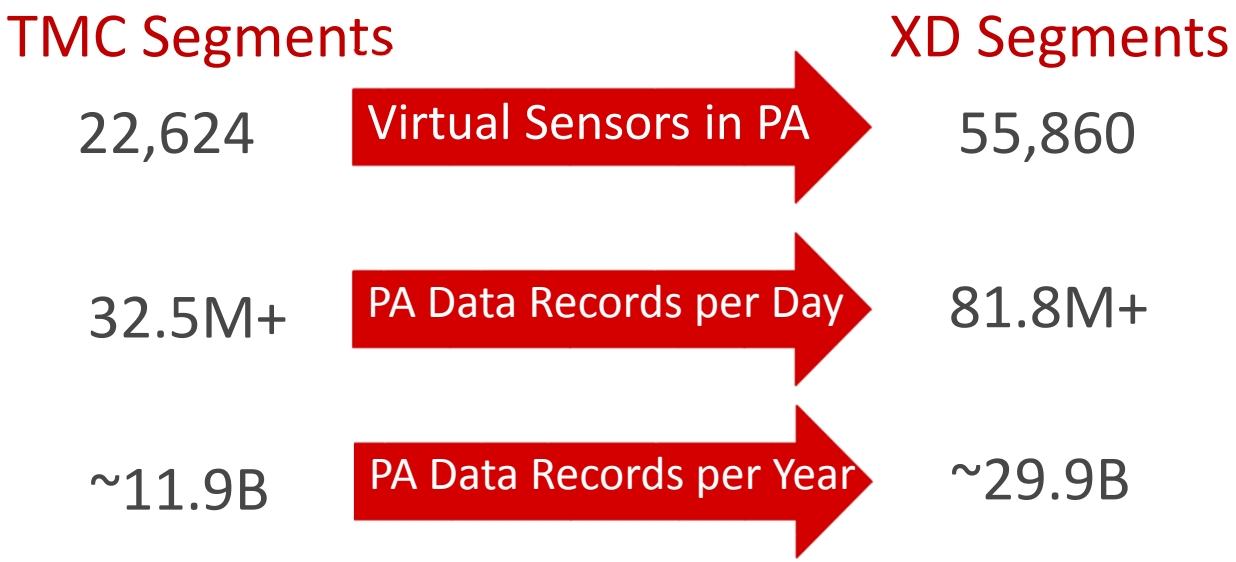


INRIX XD Segments



This is Big Data…

- INRIX Data Updates every minute…so…



- In other words, 30 BILLION of these each year…

tmc_code	measurement_tstamp	speed	average_speed	reference_speed	travel_time_minutes	confidence_score	cvalue
103N04275	12/11/2014 12:00	46	42	52	0.85	30	100

INRIX

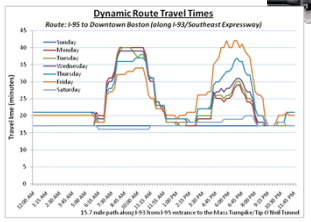
INRIX Public Sector Suite

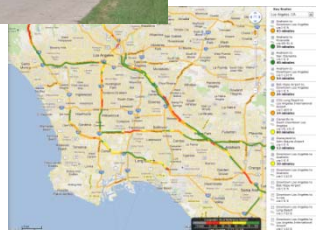
A traffic platform for planning, analysis and operations of road networks

Real Time Traffic

Effectively manage daily roadway traffic

- Traffic Speeds, Travel Times
- Traffic Tiles (Maps)
- Traffic Incidents
- Traffic Cameras
- Drive Time Polygons
- XD Monitoring

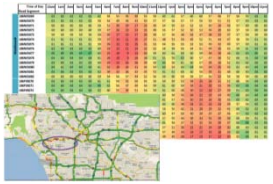


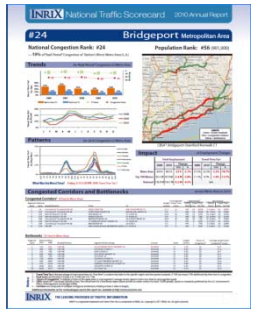


Historical Traffic

Determine how to best leverage infrastructure investments to optimize long term flow

- Traffic/Freight Profiles
- Traffic Data Archive
- OD: Trip Records, Matrices

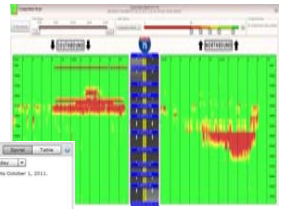


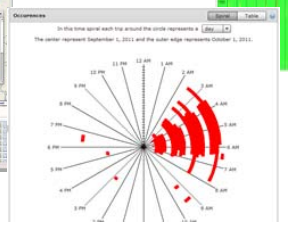


Analytics

Assessing performance of roadways and impact of investments in infrastructure

- Traffic Monitoring Dashboard
- Bottleneck & Congestion Analysis
- Historical Traffic Analysis





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Features Compared to Typical Applications

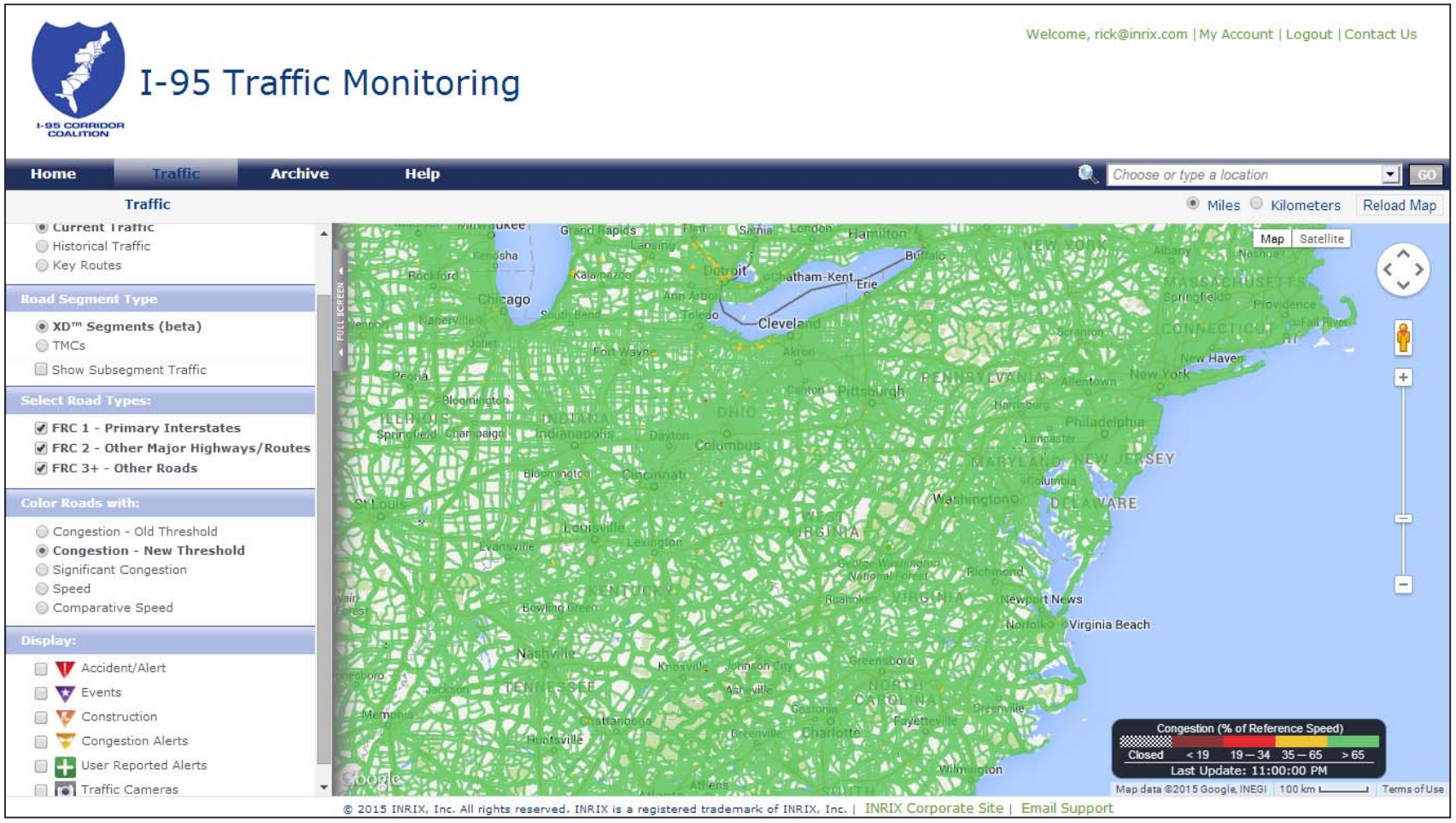
VPPII Services	Application: Travel Times on Message Signs	Application: Performance Measurement	Application: 511/Traveler Information	Application: Traffic/Incident Monitoring	Notes
Segment Speed/Travel Time Data API					
XD Segments					Best API in general - works for all use cases
XD Subsegments Option					Provides more detail than XD Segments, slightly harder to integrate
TMC Segments					Core API of Vehicle Probe Project 1
TMC Subsegments Option					Provides more detail than TMC Segments, slightly harder to integrate
Traffic Tile API					
XD Segments					Increased resolution over TMC, 40% more roads, 7x more interchanges
XD Subsegments Option					Optimal resolution option
TMC Segments					Core API of Vehicle Probe Project 1
TMC Subsegments Option					Improved resolution over TMC Segments
Other APIs					
RTSMIP Alert API					Translate slowdowns, accidents, work zones into formatted messages
Route Travel Time API					Designed to provide point-to-point travel times, made for DMS Use Case
Virtual Sensor ("Speed at a point") API					An option for ATMS software integration to mimic roadside detectors
i95.inrix.com Monitoring Site					
Site with TMC Segment Maps					Core Monitoring Site of Vehicle Probe Project 1
Site with TMC, XD and Sub-segment Maps					Enhanced coverage and precision; available for full coverage states only
UMD VPP Suite					
Full Statewide TMC Coverage					Purpose built for performance measurement, all contracted data included

Suitability: NA | Low | OK | Good | Ideal

All features available in base fee for contracted coverage

INRIX

Monitoring Sites – Multi-Dimensional, Easy Access Situational Awareness

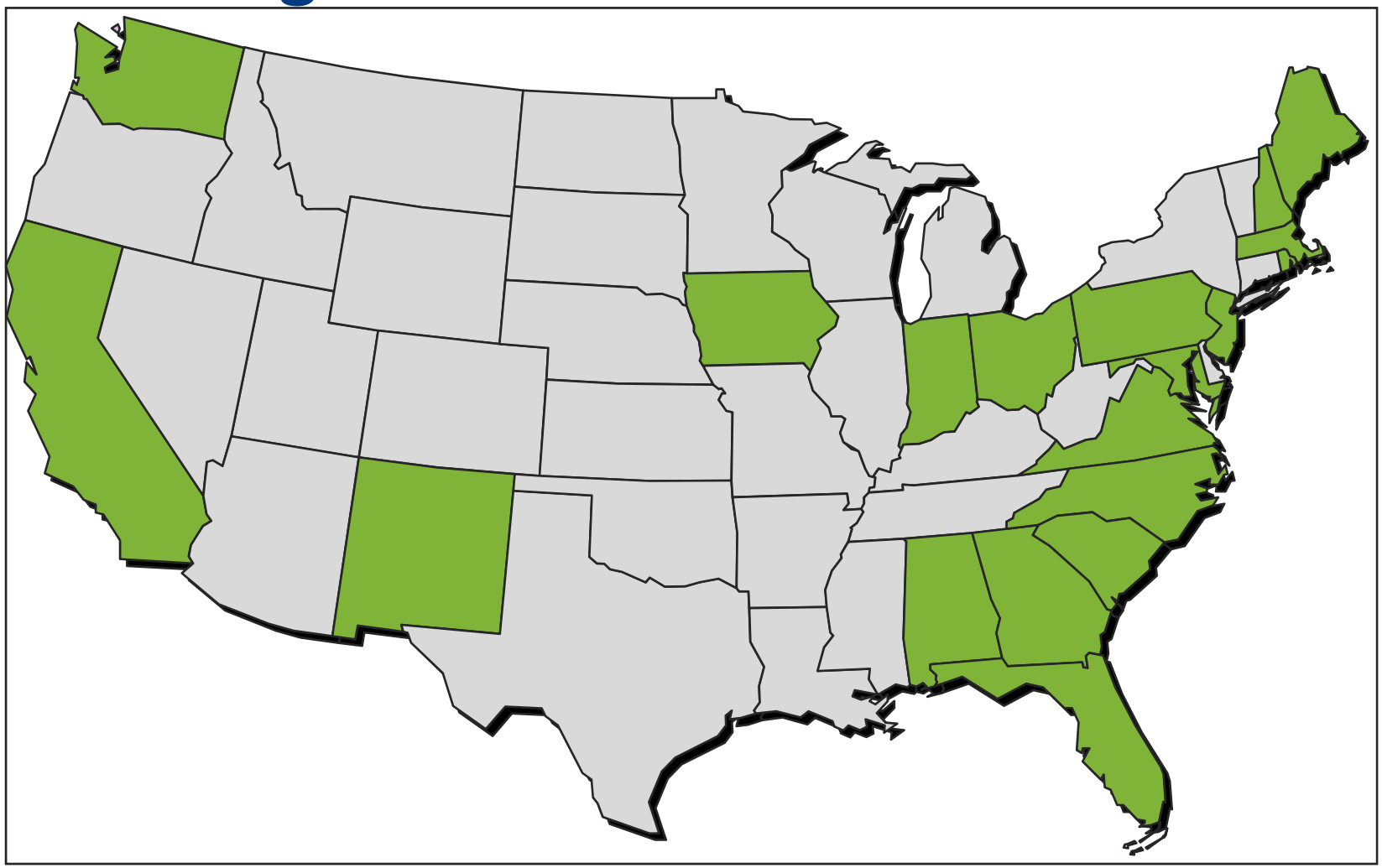


Interface Guide Simplifies Integration

TABLE OF CONTENTS

INRIX

19 States with Agencies/ Services Accessing INRIX APIs



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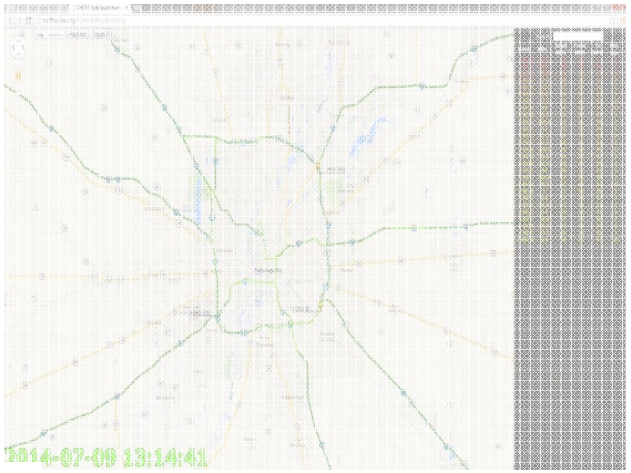
Incident Detection Application

Explanation



Delta Speed: Difference in speed from an initial segment to the adjacent segment downstream.

This is where we as an industry need to focus our attention. High speed to low speed indicates the back of a queue

Direction of Travel

Segment 2

Segment 3

XD Segments

Real Time Data
(every minute)

70 MPH

68 MPH

35 MPH

Delta Speed

-2 mph

-33 mph

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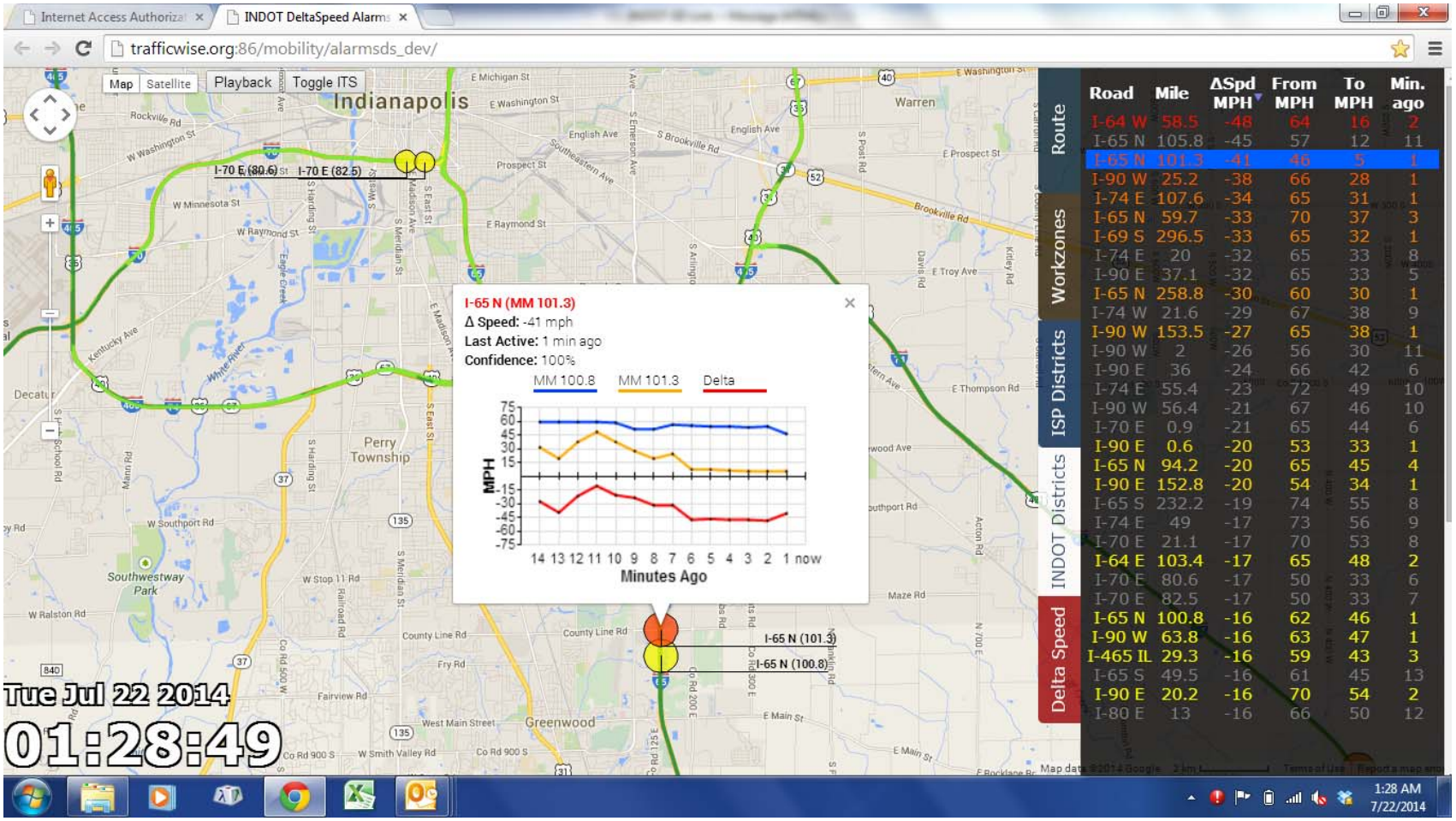
XD Segments Supporting Queue Detection
(Indiana DOT/Purdue) – "Game Changing Fidelity"



http://tinyurl.com/purdue-indot-queue-warning

http://youtu.be/5eFwSBGZkqI

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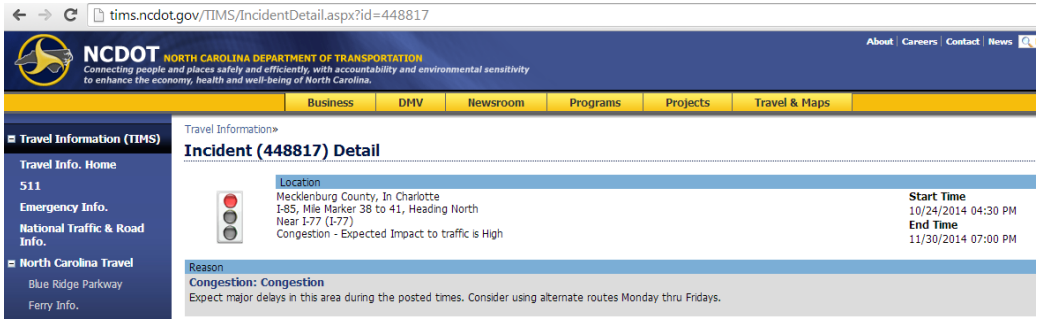
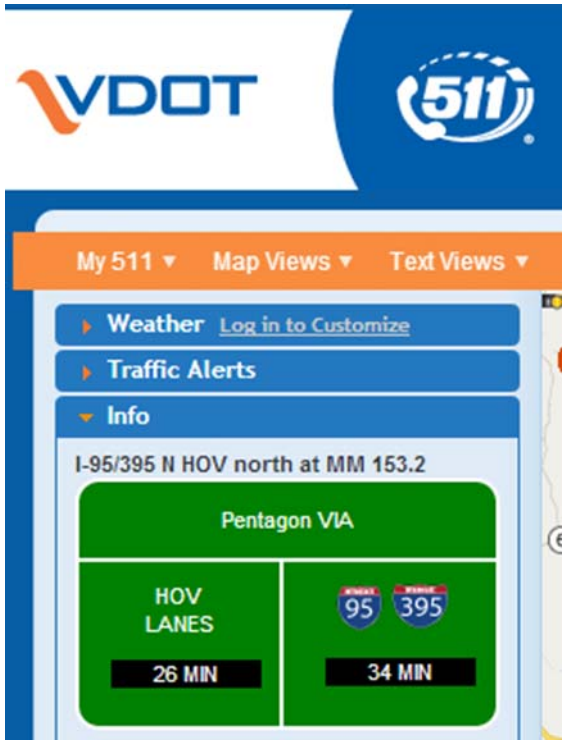
Types of 511 Services Supported

- Web Sites
  - Traffic Maps
  - Drive Times
  - Congestion Events
- Phone IVR
  - Congestion Events
  - Average Travel Times
- Mobile Apps
  - Congestion Ahead
- Text/Email Alerts





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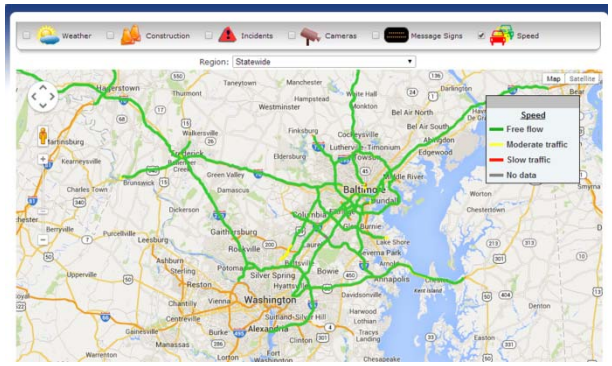
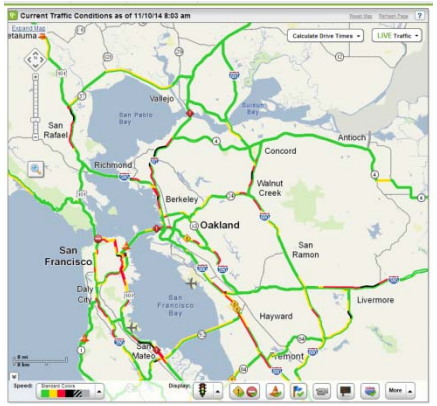
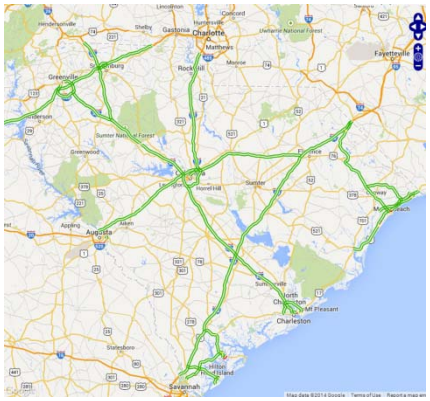
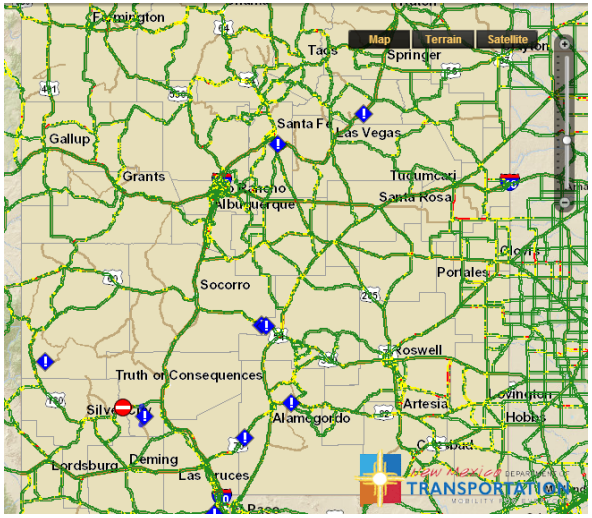
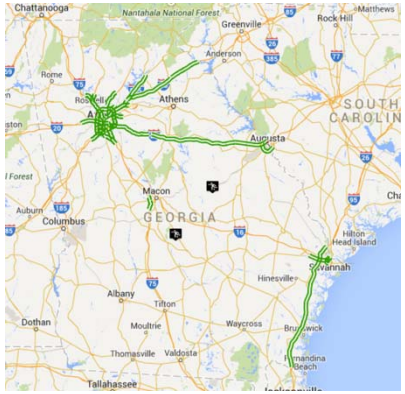
Examples: Maps











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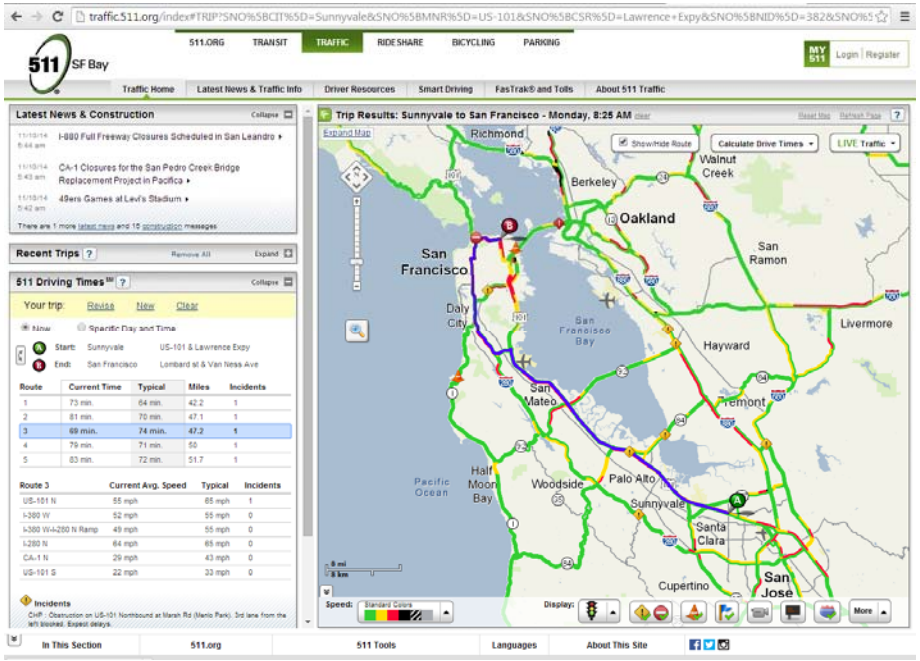
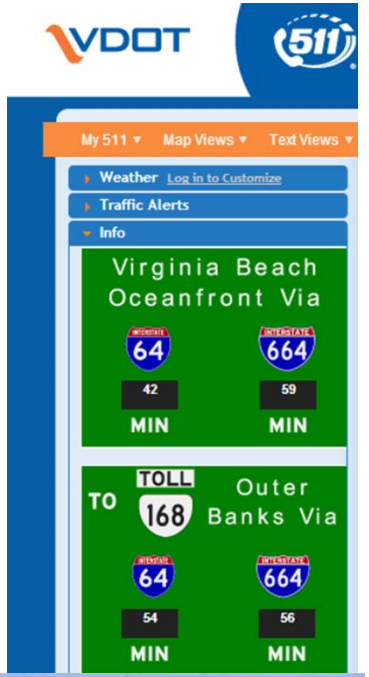
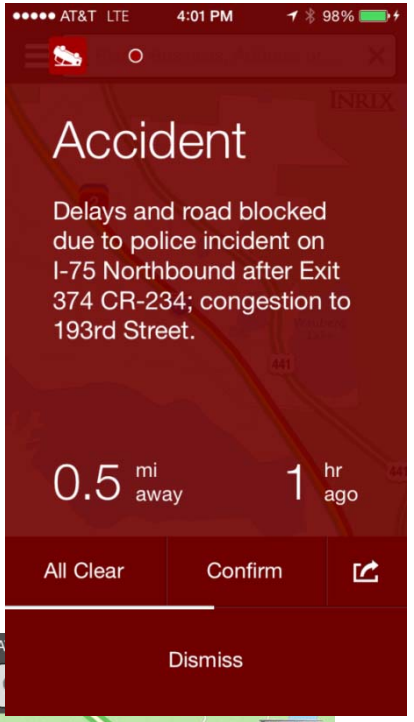
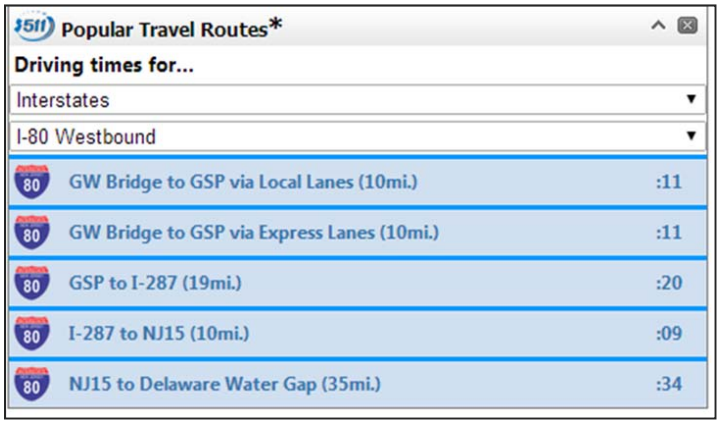
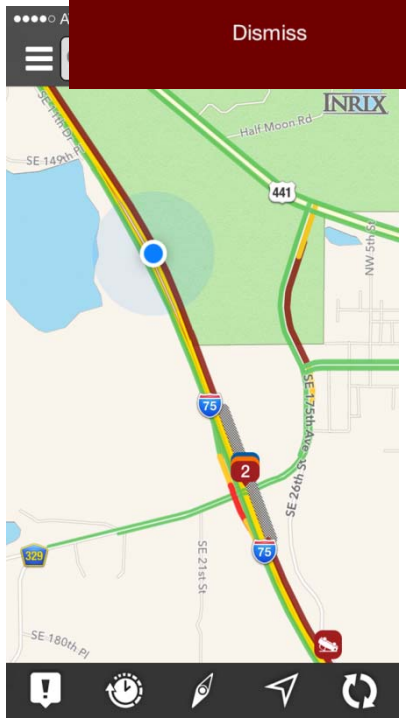
Examples: Drive Times/Congestion Events











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Examples of Analytics/Archived Data Uses

- Statewide Reports
  - "Texas 100 Most Congested Corridors" – TTI/TxDOT
    - http://www.txdot.gov/inside-txdot/projects/100-congested-roadways.html
  - Indiana Mobility Report – Purdue/INDOT
    - http://docs.lib.purdue.edu/imr/
  - Maryland Mobility Report – MDDOT/MDSHA/UMD
    - http://sha.maryland.gov/OPPEN/2013_Maryland__Mobility.pdf
  - Bottlenecks on the Florida SIS – FDOT/CDM Smith
    - http://www.dot.state.fl.us/planning/systems/programs/mspi/pdf/Executive%20Summary-letter%202-15-13.pdf
    - 2014 ITE Transportation Planning Council Best Project Award winner

- Metropolitan Area Reports
  - DC Congestion Management Process (MWCOG)
    - www.mwcog.org/cmp/
  - Baltimore Quarterly Congestion Analysis Report (BMC)
    - http://www.baltometro.org/downloadables/CMP/CMP_Congestion_2013Q3.pdf
  - Philadelphia Area "Using Operations Data for Planning in the Delaware Valley: First Steps" (DVRPC)
    - http://www.dvrpc.org/reports/11049.pdf

Arterial Retiming Cost – Benefit Analysis using Crowd Sourced Data

MARCH 2012

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Before Retiming

Week 13

APRIL 2012

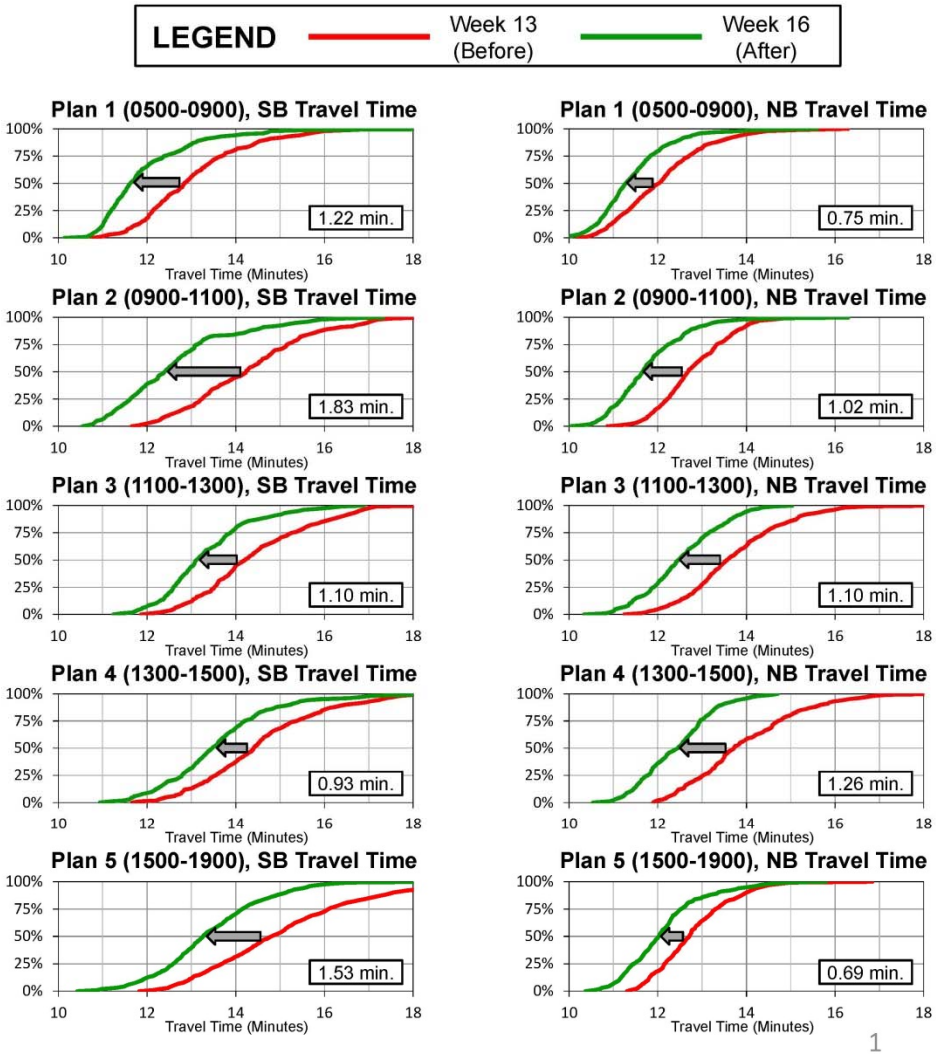
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Retiming

Week 15

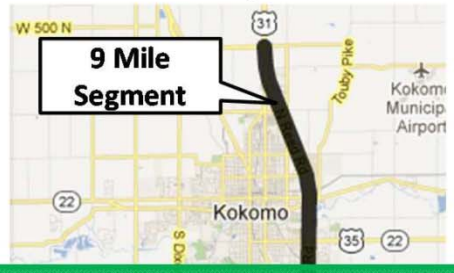
Week 16

After Retiming



Arterial Retiming Cost – Benefit Analysis using Crowd Sourced Data

PURDUE UNIVERSITY

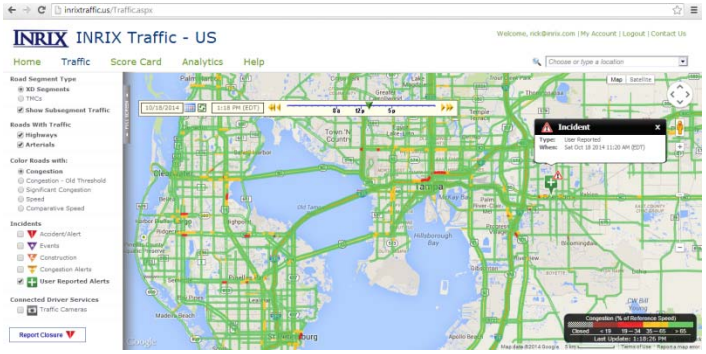


Using TTI Travel Time Savings Calculations: Expected Yearly Savings are $2.7 Million

	Plan	Median TT Savings (min)	% of Daily Traffic	TT Savings (h)	TTI Travel Time Savings ($)	CO2 Reduction (tons)	CO2 Emission Savings ($)
North bound US 31	Plan 0 (0000 – 0500)	0.79	2.2%	1987.34	$ 46,941.69	16.77	$ 368.96
	Plan 1 (0500 – 0900)	1.22	7.2%	9925.88	$ 234,453.24	83.76	$ 1,842.82
	Plan 2 (0900 – 1100)	1.83	5.3%	10877.93	$ 256,941.12	91.80	$ 2,019.58
	Plan 3 (1100 – 1[illegible]00)	1.1	6.7%	8246.25	$ 194,779.77	69.59	$ 1,530.98
	Plan 4 (1[illegible]00 – 1[illegible]00)	0.93	6.6%	6886.14	$ 162,653.47	58.11	$ 1,278.47
	Plan 5 (1[illegible]00 – 1[illegible]00)	1.53	13.5%	23311.22	$ 550,620.34	196.72	$ 4,327.91
	Plan 6 (1[illegible]00 – 2[illegible]00)	0.91	7.1%	7319.89	$ 172,898.62	61.77	$ 1,359.00
South bound US 31	Plan 0 (0000 – 0500)	0.58	2.2%	1462.30	$ 34,540.02	12.34	$ 271.49
	Plan 1 (0500 – 0900)	0.75	7.6%	6420.27	$ 151,649.25	54.18	$ 1,191.97
	Plan 2 (0900 – 1100)	1.02	5.5%	6316.57	$ 149,199.92	53.31	$ 1,172.72
	Plan 3 (1100 – 1[illegible]00)	1.[illegible]	7.0%	8627.08	$ 203,775.18	72.80	$ 1,601.69
	Plan 4 (1300 – 1500)	1.2[illegible]	[illegible]%	9881.93	$ 233,415.21	83.39	$ 1,834.66
	Plan 5 (1500 – 1900)	0.69	14.2[illegible]	[illegible]1040.76	$ 260,787.26	93.17	$ 2,049.81
	Plan 6 (1900 – 2400)	0.45	7.9%	401[illegible]	$ 94,906.91	33.91	$ 745.97
	Total		**100.0%**	**116321.6**	**$ 2,747,562**	**981.64**	**$ 21,596.03**

Free Tools and Trials

- Free tools
  - INRIXTraffic! Mobile App
  - INRIXTraffic.us Monitoring Site
    - For Transportation Agencies
  - I95.inrix.com Monitoring Site
    - For I-95 Corridor Coalition Members
- Trials
  - XD Monitoring
  - INRIX Analytics
  - Both trials available via INRIXTraffic.us



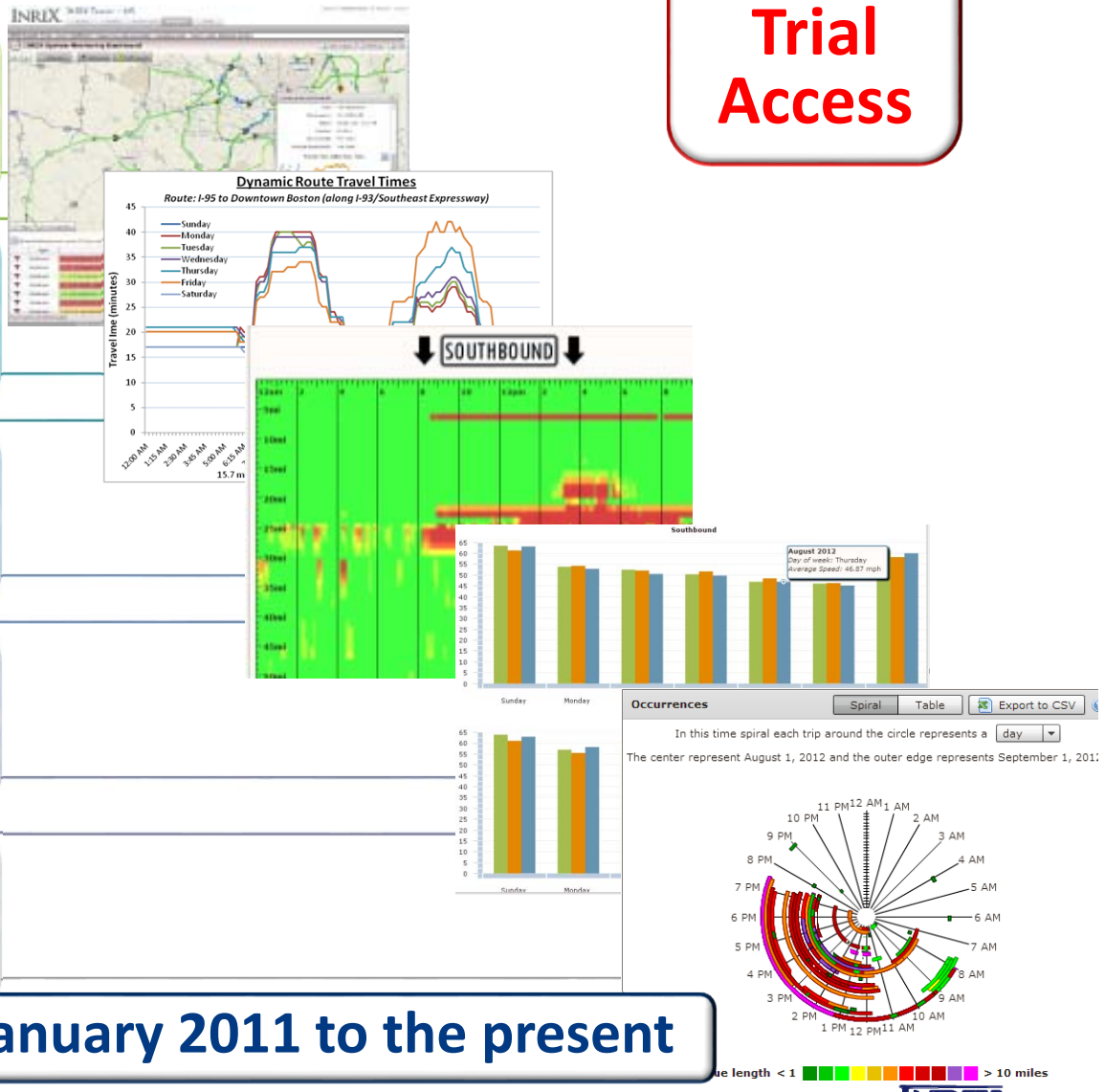

INRIX Analytics
Road Performance Analytics Overview
INRIX

Analytics for the Public Sector

Turning Data into Information

Free Trial Access

- Real-Time Bottlenecks Identification
- Historical Traffic Download for Custom Analysis
- Congestion Tracking Analysis
- Congestion Trends
- Bottleneck Ranking & Movement



Data from January 2011 to the present

INRIX VOLUMES

Updated nationwide volume data available

NATIONWIDE COVERAGE

National Highway System across all US States

Provides Volume estimates on roads where sensor infrastructure does not exist

TRUSTED PARTNERS

INRIX Volumes were developed in partnership with the Texas A&M Transportation Institute (TTI), the entity responsible for the Urban Mobility Report

INRIX is the leading provider of transportation intelligence and trusted by BMW, Audi, I-95 Corridor Coalition, RE/MAX, UK Highways Agency, and many others

INRIX VOLUMES

Dataset Details

Column Name	*Data Description*
TMC_Code	*TMC in 9 digit format. Delineates road segment specified in the TMC reference file attributes for each TMC Code.*
MarketID	*Unique identifier for the market in which the TMC code resides*
FRC	*Functional Road Class of the TMC segment*
CBSAName	*Core Based Statistical Area name where TMC Segment resides*
CSAName	*Combined Statistical Area name where the TMC Segment resides*
FHWA FRC	*FHWA designated Functional Classification System*
NumberofLanes	*Average number of lanes*
speed	*Average speed, in MPH, for the time of day and day of week*
TimeofDayBinID	*Time of day expressed as a number from 0 -95 with each number representing a 15 minute time bin, counted from midnight where 0=midnight, 95=11:45pm.*
DayofWeek	*Day of the week in 3 letter abbreviation. SUN=Sunday, MON=Monday, TUE=Tuesday, WED=Wednesday, THU=Thursday, FRI=Friday, SAT=Saturday*
AADTByDay	*Annual Average Daily Volume in number of cars per day*
VehicleVolume	*Average esimtated volume of vehicles for the specified day of week and 15 minute time bin*

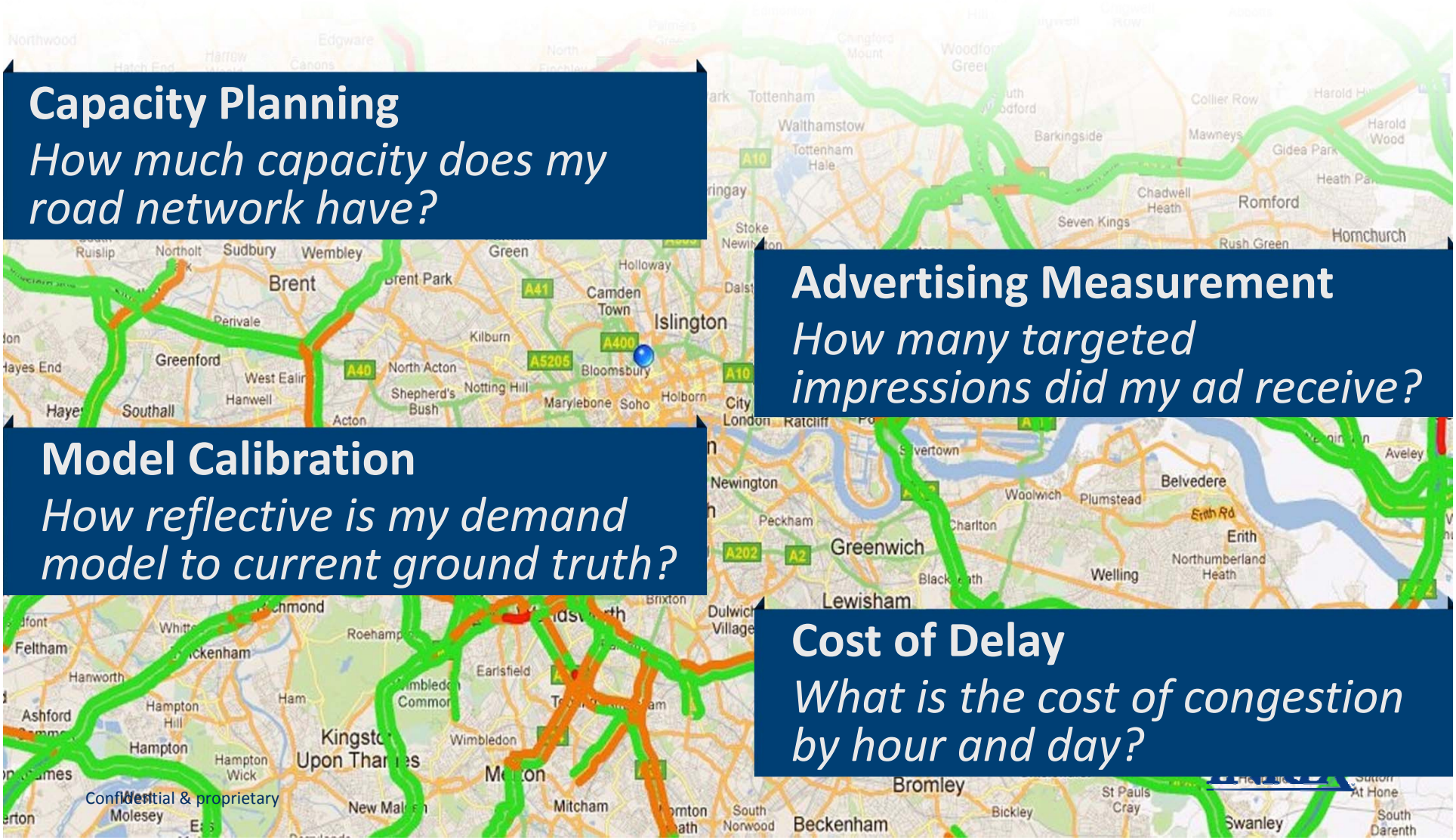
INRIX VOLUMES

Metrics Supported

Performance Measure	Definition
Volume	A measure of the number of vehicles which traversed a specified segment/route in a specified time.
Vehicle Miles Travelled (VMT)	The number of miles travelled by all vehicles over a specified segment/route in a specified time frame
% Arrival on Green (Arterial Signal Timing)	The percent of vehicles that arrive at a signal while the signal is green.
Turning Maneuver Percentile	The percent of traffic making each possible type of turning maneuver at a traffic control device
Emissions	Use of Volume, Congestion, and Travel Time to estimate pollution from vehicle emissions

INRIX VOLUMES

Use Cases Supported



Capacity Planning

How much capacity does my road network have?

Advertising Measurement

How many targeted impressions did my ad receive?

Model Calibration

How reflective is my demand model to current ground truth?

Cost of Delay

What is the cost of congestion by hour and day?


INRIX Analytics
Population Density Analytics Overview
INRIX

Insights Into the Movement of People

Population Analytics from INRIX is designed to answer the most pressing and valuable questions about how people move through our world

- ✓ How many people are here right now?
- ✓ What is the mix of vehicles which got them here?
- ✓ What is the relative density of people in this area?
- ✓ How many people saw my ad?
- ✓ Where did the people originate?

INRIX

INRIX Population Analytics

The Movement of People Regardless of Mode

Population Analytics from INRIX is designed to answer the most pressing and valuable questions about how we move through our world

Understand the Travel and Population Growth Patterns of Large Populations

- Volumes of anonymized data with sample sizes correlate statistically with real-world population volumes

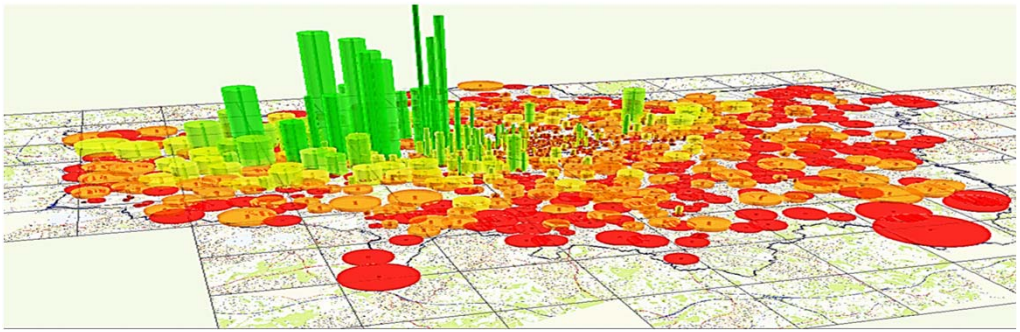
Accurate population movement analysis

provides valuable location insights

- Understand trip details, density, and routes to better model and plan for the future

Data + Analytics to Improve Your Planning and Prediction

- Make better investment decisions, choose the right retail site, model the smart city of the future



What is the relative density of people in this area?

How many people are here right now?

What is the mix of vehicles that got them here?

Where did the people originate?

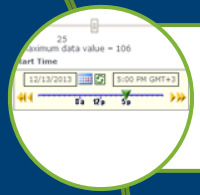
INRIX

Population Density

Summer 2014 Release Key Features

Population Heat Map

- View relative population density and movement in time and space

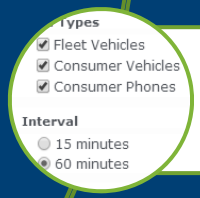


Historical Population Slider

- Compare population density intra-day and between days

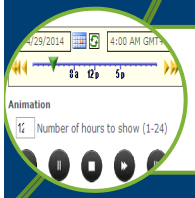
Population Detail View

- View detailed statistics of population types at a particular date, time, and space



Data Type Filter

- Customize the heat map to match your analytics needs by data type



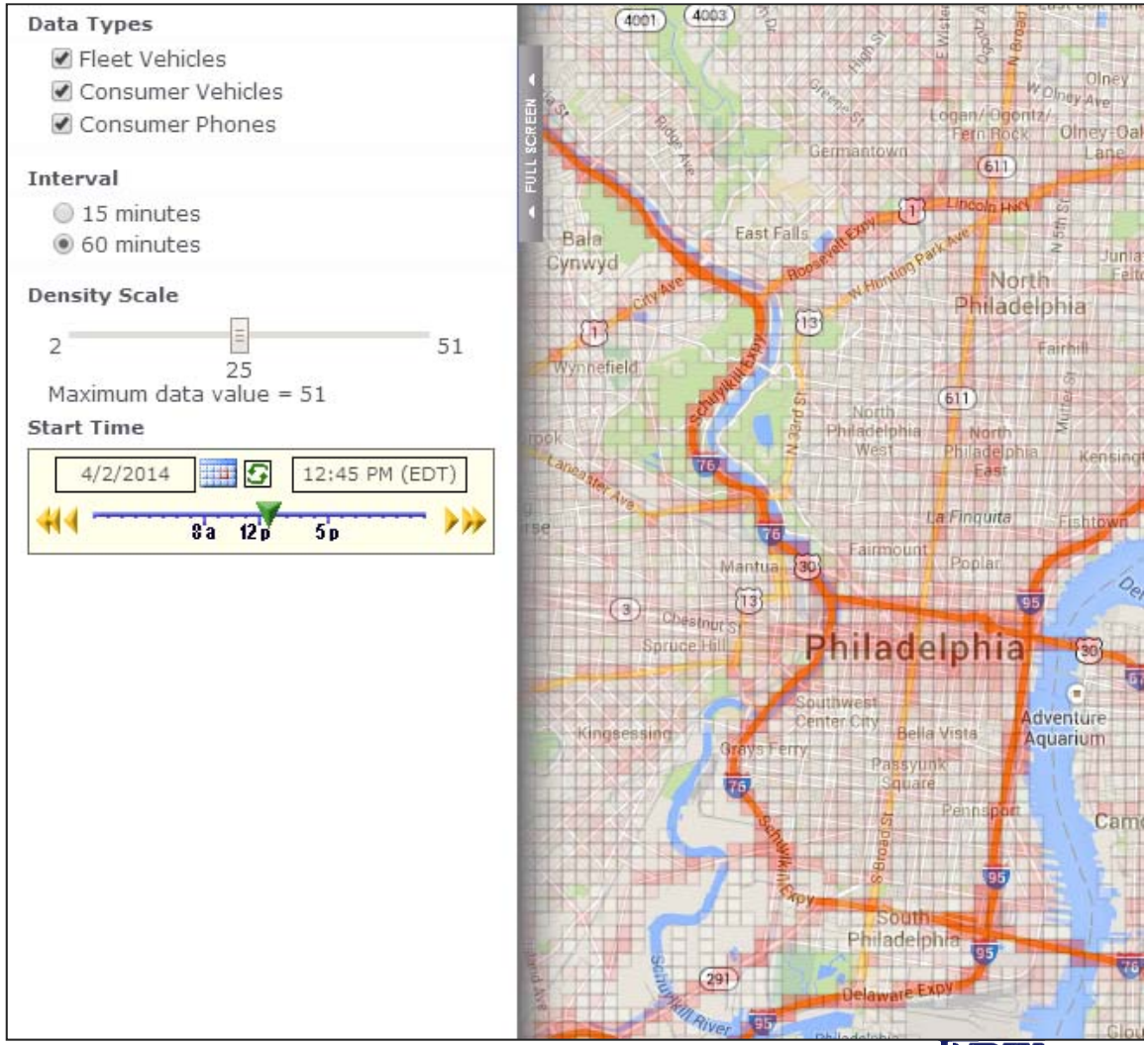
Auto Scroll

- View automated population density movement over a 24 hour period

INRIX

Population Heat Map

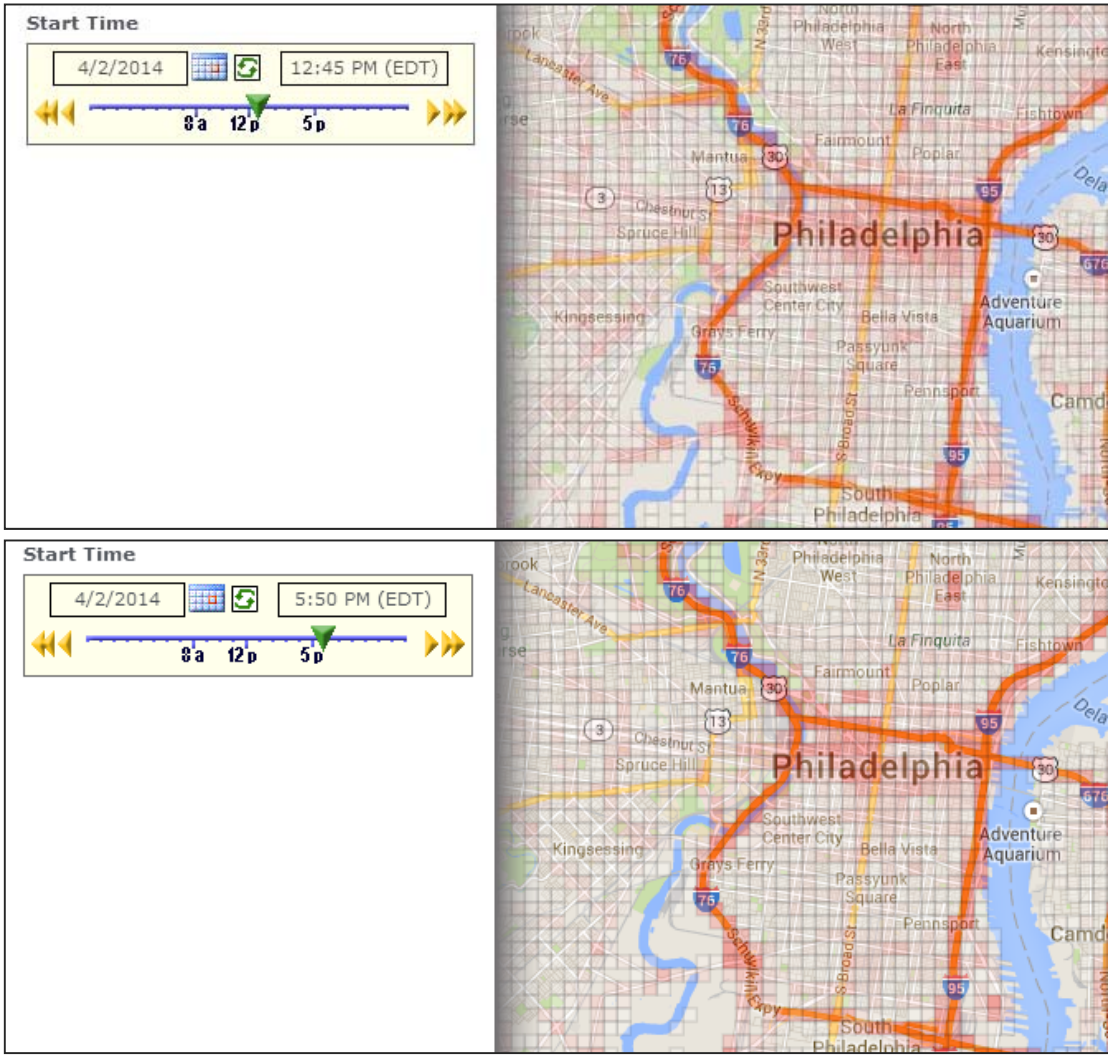
- ✓ View relative population density in time and space
- ✓ High granularity analysis with Interval Selection
- ✓ Customize heat map view with Density Scale



INRIX

Historical Population Slider

- ✓ View density for past days and times
- ✓ Quickly compare intra day trends such as morning and evening rush hour
- ✓ Compare a specific time of day between different days of week



INRIX

Population Detail View

- ✓ Quickly understand the mix of different device types to better target your analysis
- ✓ Data split by Freight (truck/taxi fleets), Consumer cars (eg BMW, Audi, Toyota), and Mobile Apps (eg INRIX, Mapquest)
- ✓ Use in combination with Historical Slider to compare across times and days

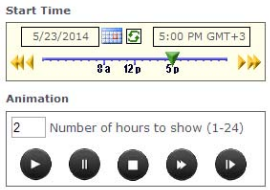
Data Type Filter

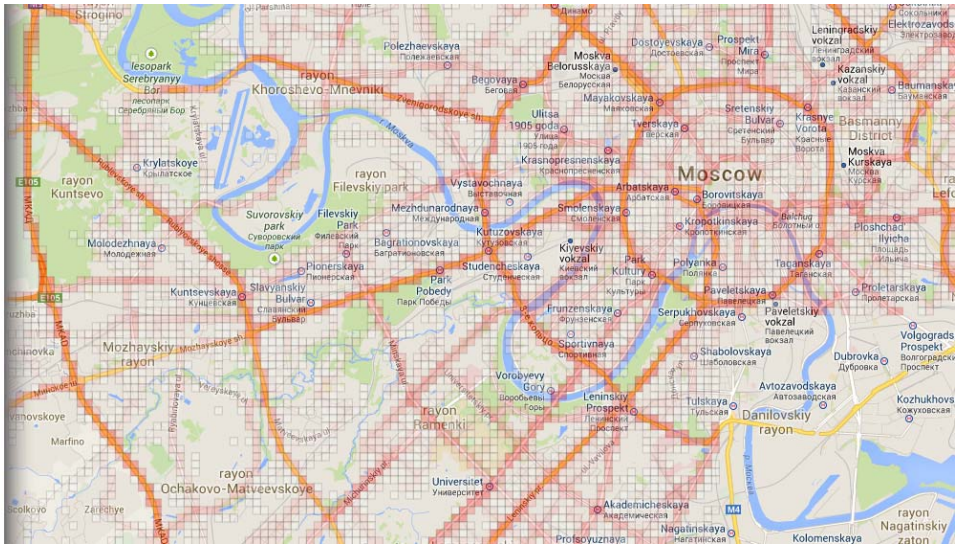
- ✓ Target your analysis by device type for faster insights
- ✓ Combine with Density Scale to understand where to focus
- ✓ Use together with Historical Slider to compare targeted density analysis between days or within a day

INRIX

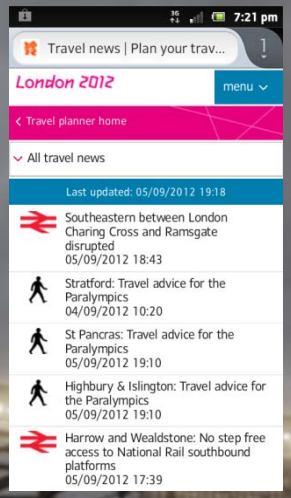
Auto Scroll

- ✓ Auto Play population density over time
- ✓ Play through up to 24 consecutive hours
- ✓ Pause, Rewind and skip forward density auto play





2012 Summer Games Traffic & Travel

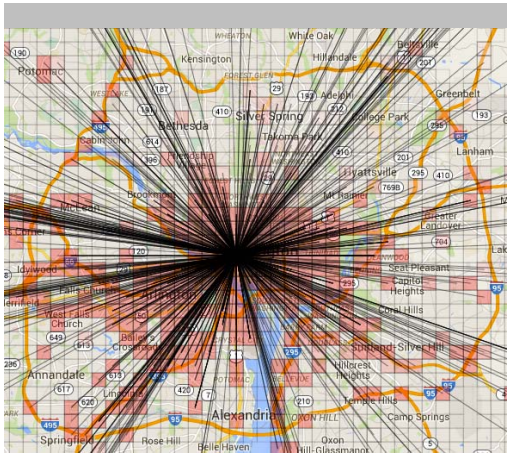


INRIX Selected by Olympic Development Authority

- Official Spectator Journey Planner website and mobile app powered by INRIX Traffic
- INRIX traffic analysts embedded in Games Travel Demand Management centre
- INRIX incident processing systems upgraded to support venue and spectator specific advice management INRIX disseminated traffic & travel data through INRIX media and online channels (40 million weekly consumer reach in UK) and through Spectator Journey Planner

INRIX Population Analytics

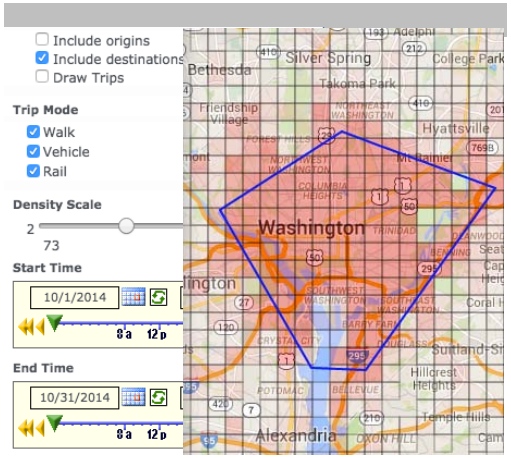
Origin/Destination and Trip Analysis



Visual Trip Exploration

Explore Trip data visually overlaid with a map

View trips in a heatmap or connecting lines overlay

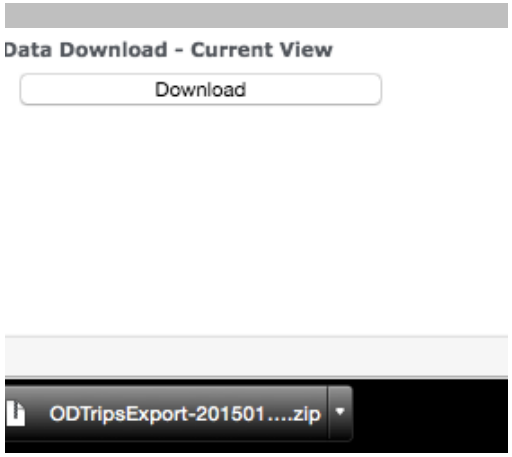


Customized Analysis

Define custom polygons to pinpoint spatial analysis

Filter trips on Mode (Walk, Vehicle, Rail)

Filter Analysis on origins, destinations, or start/end date/time



CSV Download

Download Trip Data in CSV format for offline analysis

Use Visual Trip Explorer to configure download

INRIX

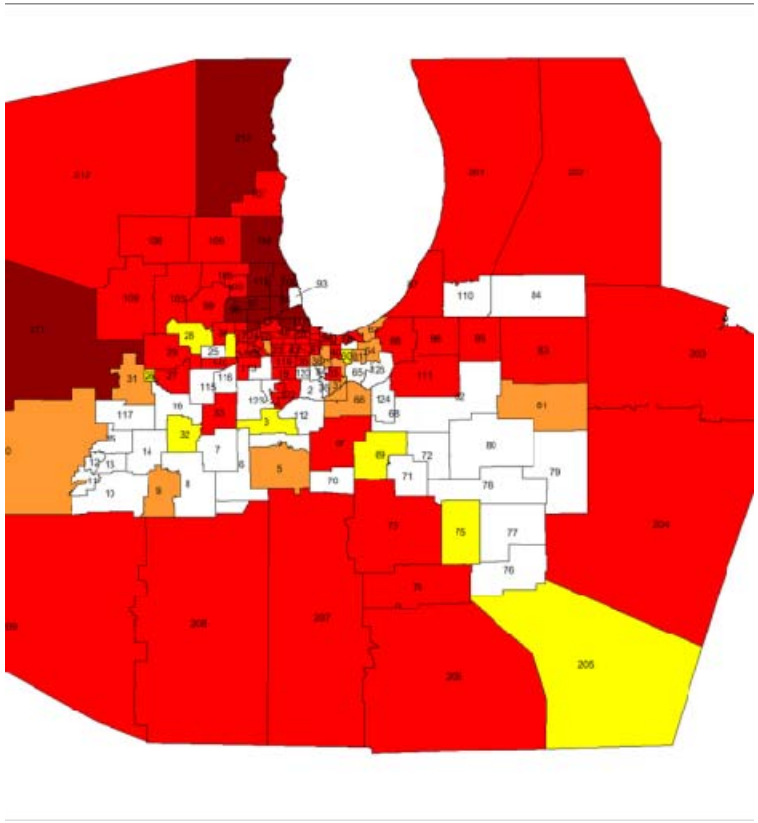
Types of Historical Freight Data

- Origin/Destination (OD)
  - Option 1: “Trip Record” – start and end location and time of trip
  - Option 2: “Trip Record + Waypoints” – adds waypoints to option 1
  - Option 3: OD Matrix (count and/or %) – based on customer zone definition

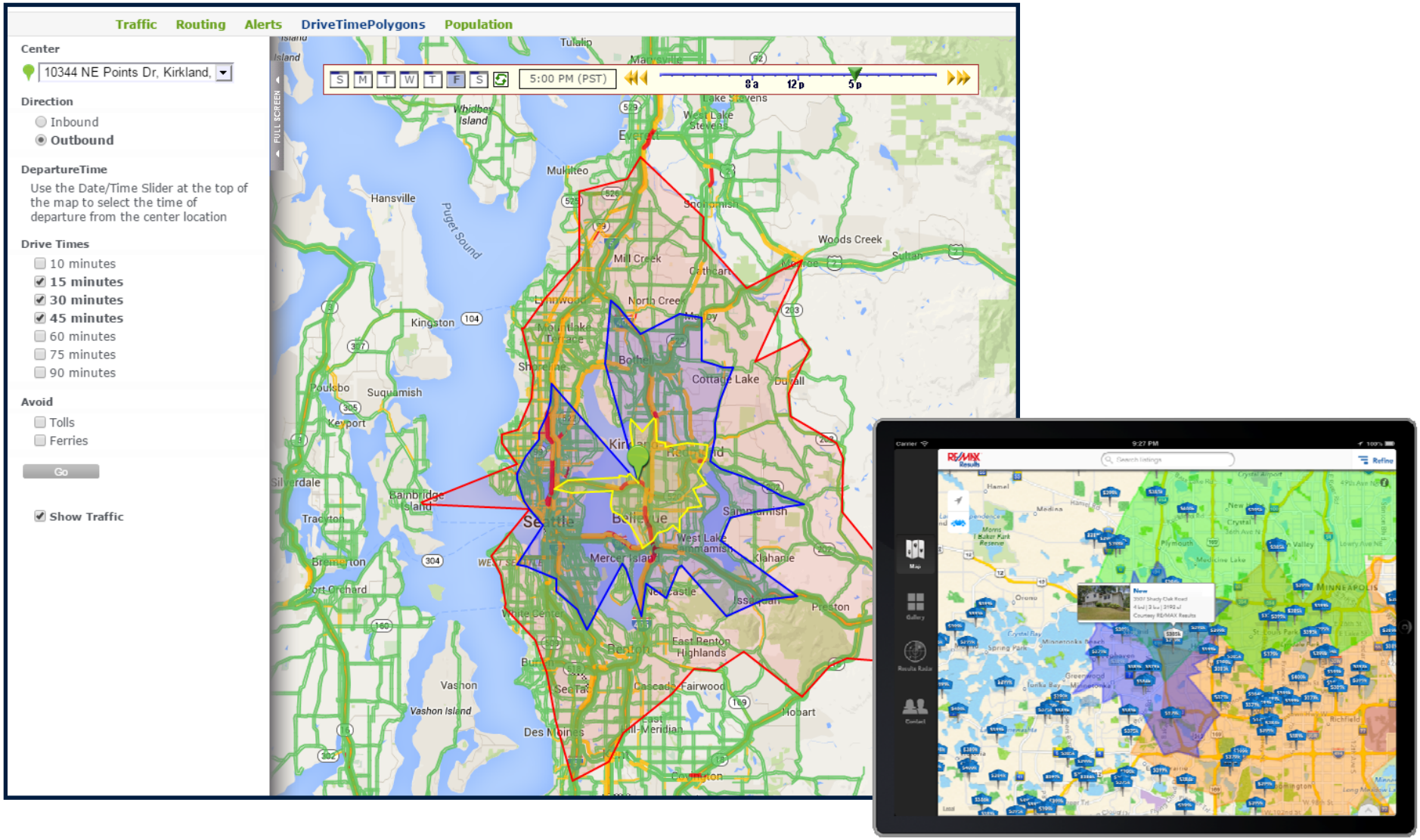
- Freight Profile
  - Calculated speeds and percentiles which represent historical profiles for a given location
  - Speed by day of week/time of day (15 minute bins)
  - Holidays reported as separate “day types”
  - In TMC Segment or XD segment formats

Chicago Freight Study

- Study Area:
  - Greater Chicagoland Area, and beyond
  - 154 zones
- Study Period:
  - July – Sept 2013 (3 months)
- Total Data Points Analyzed:
  - ~1.5 billion
- Freights Trips Identified:
  - 4.8 million
- Results provided as OD Matrix



INRIX Drive Time – Accessibility Metric



New Product – INRIX RoadWatch™

INRIX

Questions

rick@inrix.com

INRIX


41
Tamiami Trail
EXIT 3/4 MILE
Flagler St.
1/4 MILE
EXIT ONLY
Why we are all here
TOMTOM

I-95 CORRIDOR COALITION

Product:

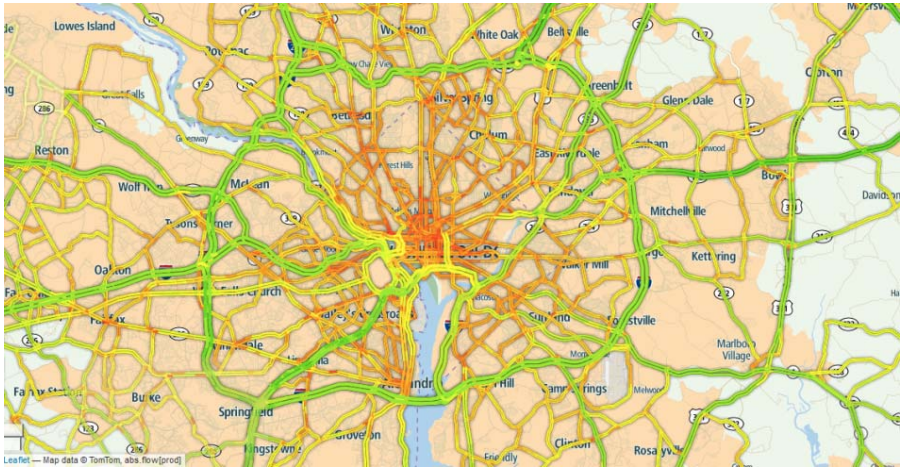
TomTom Traffic Flow Data

Requirements:

Provide accurate, real-time speed and travel time information to Coalition members.

Solution:

TomTom and the I-95 Corridor Coalition announced a partnership agreement to offer real-time traffic content to enhance transportation mobility, safety and efficiency.



TOMTOM

TomTom I-95 Team

Customer Facing

- Harriet Chen: Project Manager – Technical
- Mark Dykstra: Senior Account Manager – Programmatic
- Nick Cohn: Senior Advisor – Technical
- Ken Clay: Project Manager – Programmatic
- Bart DeWolf – Senior Solutions Architect, Customer Program Management

Back-end Support

- Stefan Lorkowski – Director Real-Time Traffic
- Peter Mieth – Director Historical Traffic
- Jeroen Brouwer – Product Manager + Traffic Stats Web Portal
- Mike Dannehy – Training & Support
- Barry Tremeer – Director, Product Management, Traffic & Travel Time Product Unit

WORLD LEADER
IN LOCATION AND NAVIGATION PRODUCTS AND SERVICES

4,000
EMPLOYEES WORLDWIDE

HEADQUARTERS:
AMSTERDAM
NORTH AMERICA:
LEBANON, NH

Business structure

B2C

B2B

Consumer

Drive - PND's
Sports – GPS Sports Watches

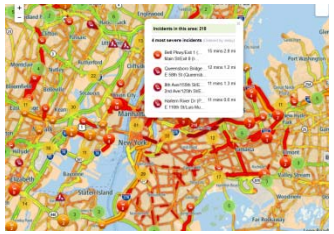
Connected Car

Car manufacturers and direct vendors
Connected services

Fleet

Fleet telematics and commercial fleet owners

Government



Tools for Traffic Management, Planning, Model Development, Policy Evaluation

Global Presence & Local Knowledge

Americas

- ✓ Burlington, MA
- ✓ Lebanon, NH
- ✓ Mexico City, Mexico
- ✓ San Jose, CA
- ✓ Sao Paulo, Brazil
- ✓ Southfield, MI

Europe

- Amsterdam
- Berlin
- Budapest
- Calne
- Copenhagen
- Edinburgh
- Eindhoven
- Ghent
- Harsum
- Helsinki
- Istanbul
- Leipzig
- Lisbon
- Lodz
- London
- Madrid
- Milan
- Moscow
- Munich
- Paris
- Prague
- Stockholm
- Warsaw
- Zurich

APAC

- Bangkok
- Irene
- Jakarta
- Kuala Lumpur
- Pune
- Seoul
- Shanghai
- Singapore
- Sydney
- Tokyo
- Taipei

TomTom Traffic

- Over 400 million connected GPS devices
- Thousands of journalists collecting incident data

Data from these sources is used to provide Real-Time traffic services in **46 countries**

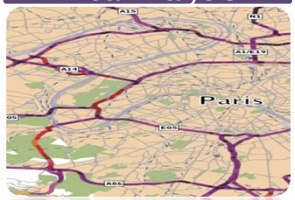
TomTom Traffic Portfolio

HISTORICAL TRAFFIC

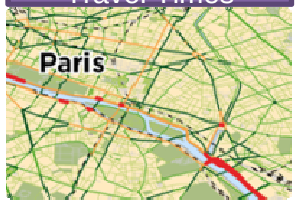
TRAFFIC STATS

Speed Profiles

Custom Area Analysis



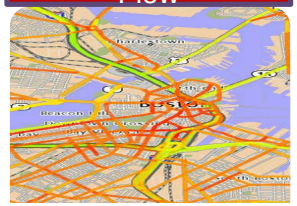
Custom Travel Times



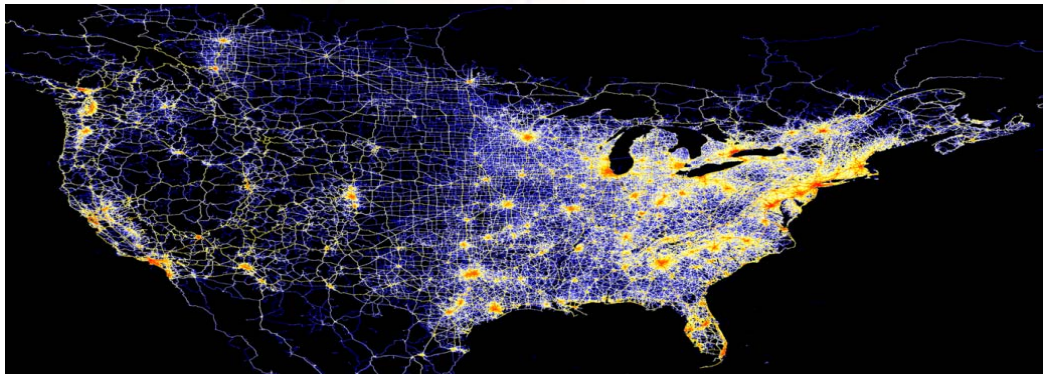
REAL TIME TRAFFIC

TomTom Traffic

TomTom Traffic Flow



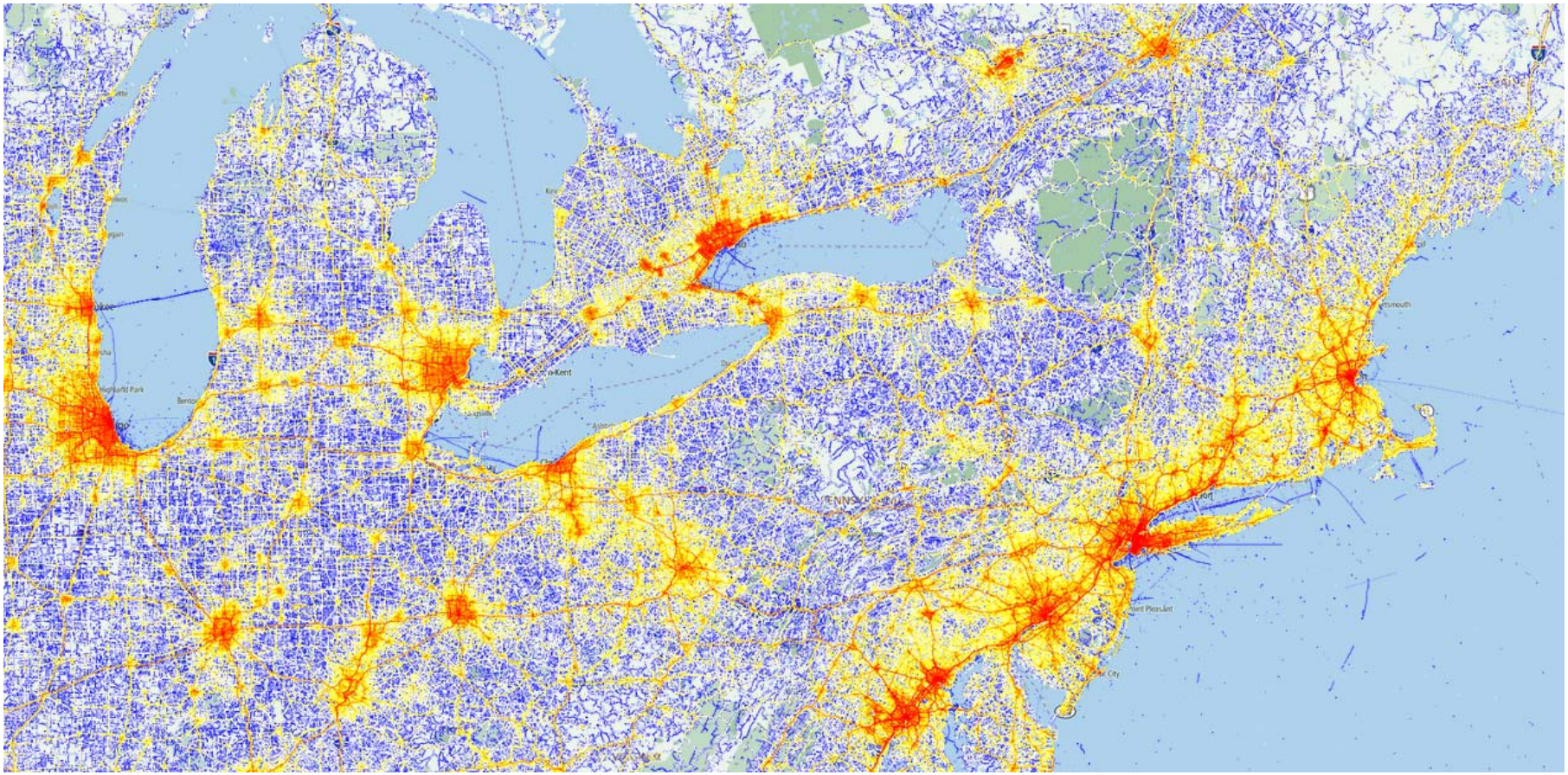
TomTom Route Times



- > 10 trillion anonymous GPS measurements since 2007
- > 7 billion new GPS measurements per day
- Many roads with >100,000 measurements
- > 175 billion miles driven
- > 700,000 years of actual driven GPS journey data

TOMTOM DATA IS EVERYWHERE

New Product Development



Selected New Products and R&D

Real-time services:

- Weather and its influence on Traffic
- Traffic Prediction
- Jam-ahead warnings
- Detection of Road Closures

Traffic Management Tools

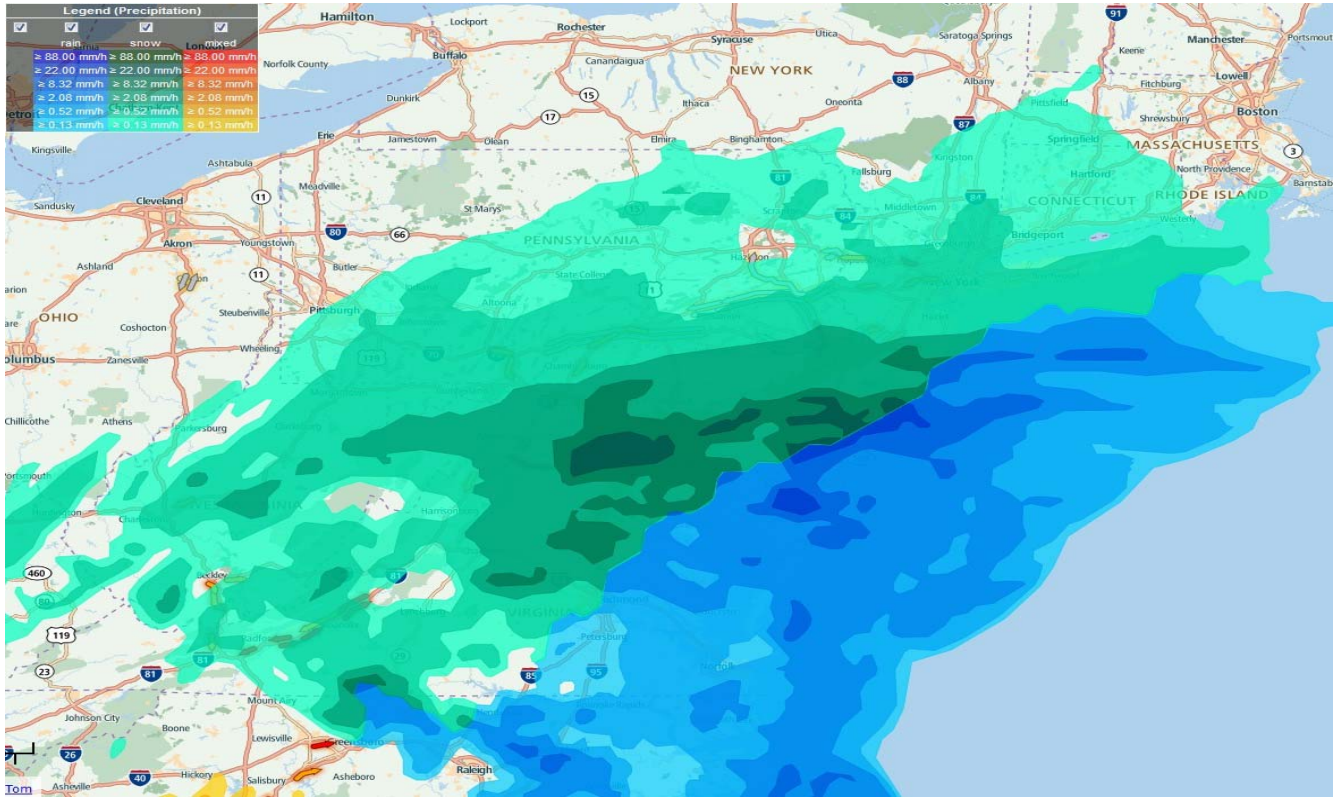
- Moderation

Analytical tools:

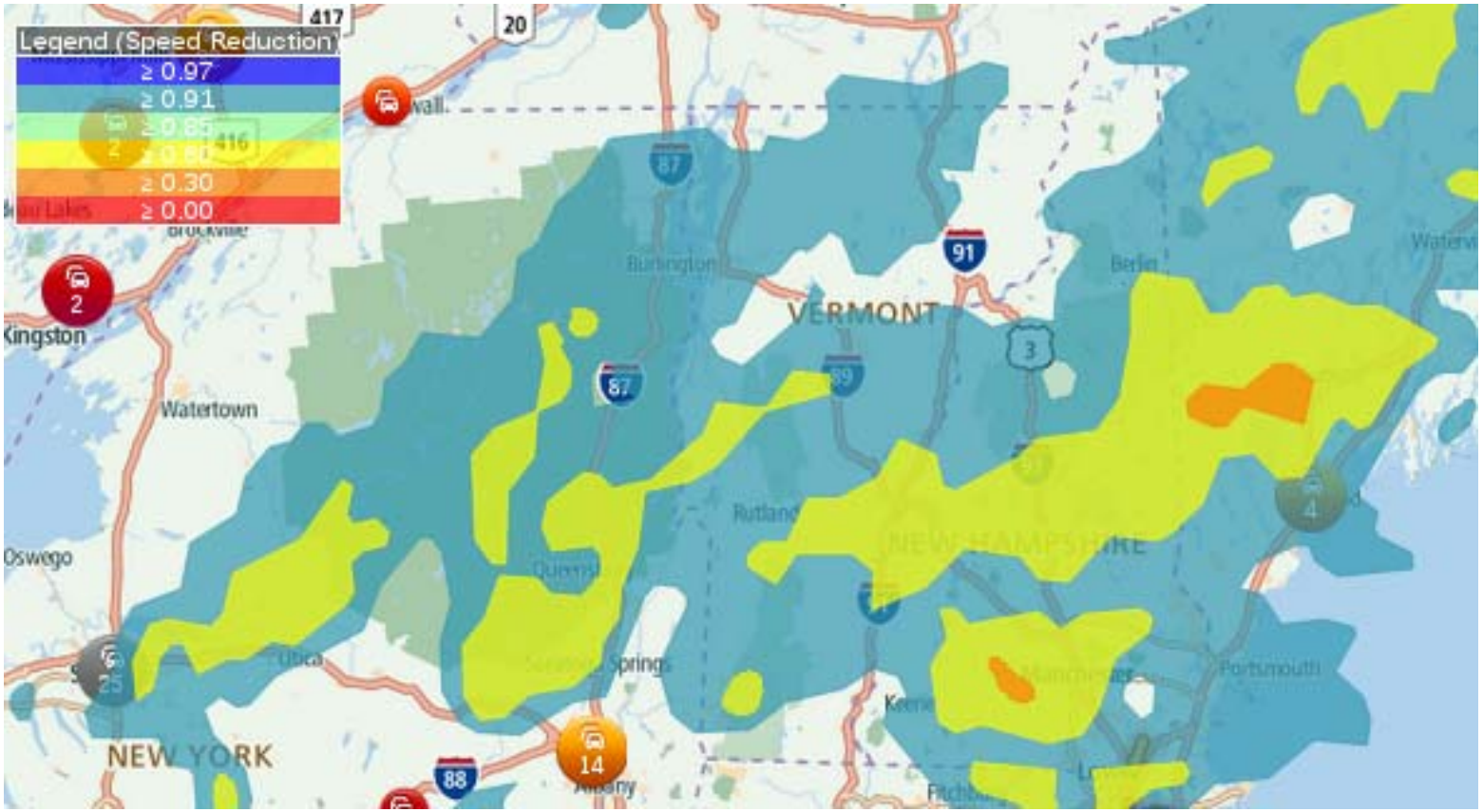
- Performance Reporting
- Origin-Destination

- Fuel Use and Emissions Prediction
- Content and Services for Highly Automated Driving

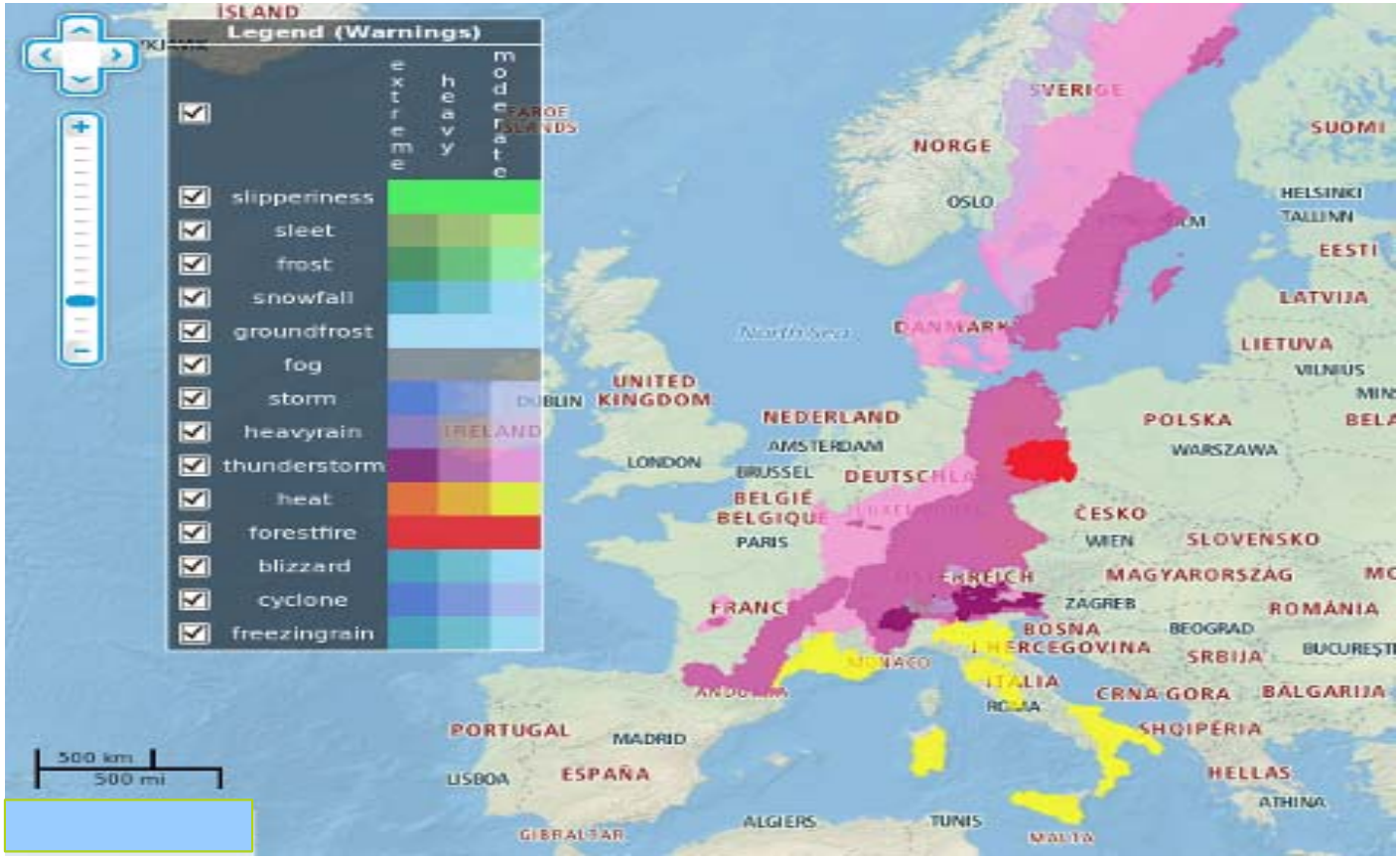
Advanced Weather Services



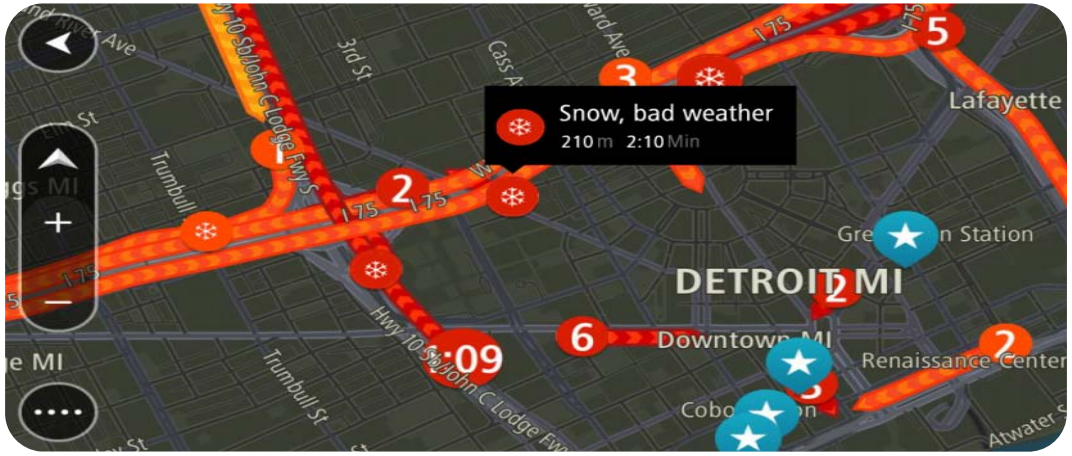
Advanced Weather Services

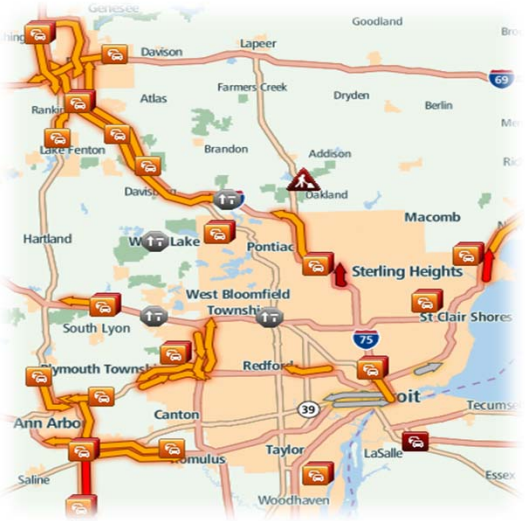


Advanced Weather Services



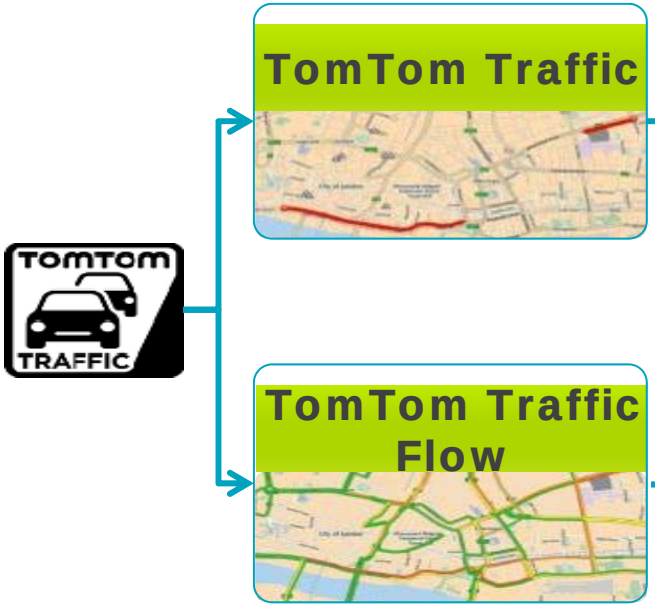
Advanced Weather Services





- Bad weather that impacts traffic such as *heavy rain, snow* or *hail* is displayed by using weather data in our fusion engine
- Weather information will be used for improving traffic prediction

Key Features & Options



Location Referencing	Optional Content Features
OpenLR: extended road network – average approx. 40% more messages - or - **TMC**: limited road network	**Jam Tendency** getting worse/better - and / or - **Jam Lifetime** minutes until freeflow - and / or - **Jam Ahead Warning** safety - significant speed difference ahead
	Predictive Flow 15/30/45 minutes ahead

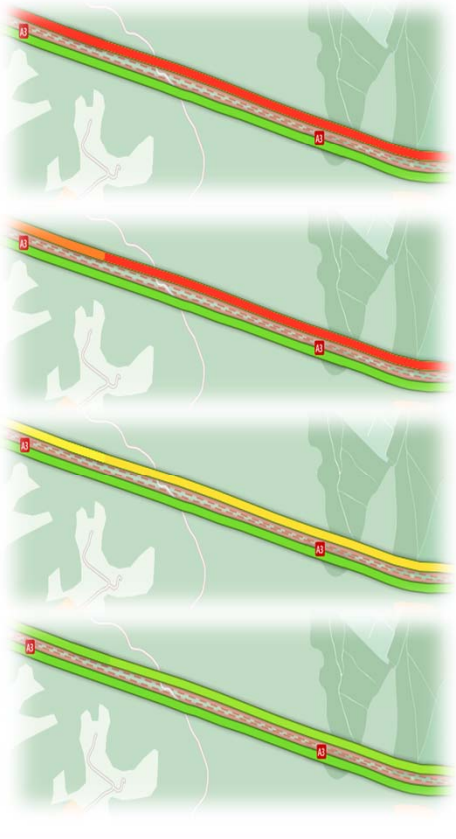
Flow Prediction, Jam Tendency and Jam Lifetime

NOW

+15 min.

+30 min.

+45 min.



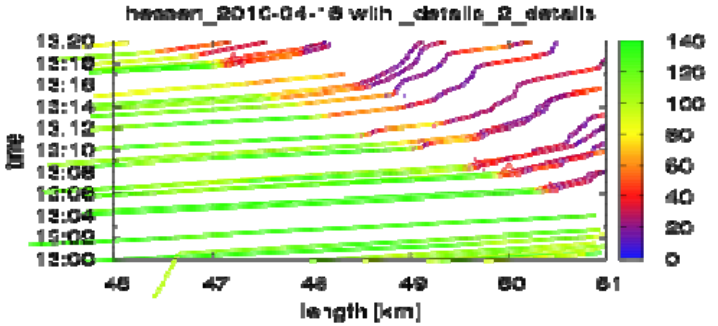
Tendency:

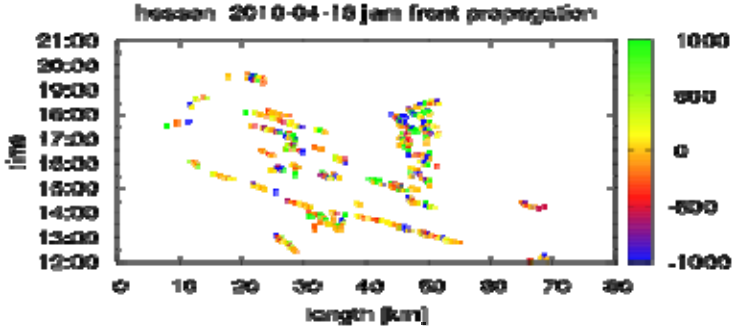
- Increasing
- Increasing Fast
- Decreasing
- Decreasing Fast
- Stable

Incidents

FLOW

Jam Ahead Warning Service



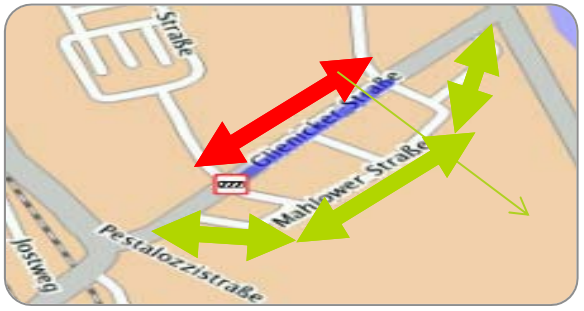


- Over 35% of drivers have admitted to experiencing an accident caused by sudden or unexpected traffic holdups
- Jam ahead warning messages in traffic output can be used to create these safety messages with great accuracy

Automatic detection of & correction of closures

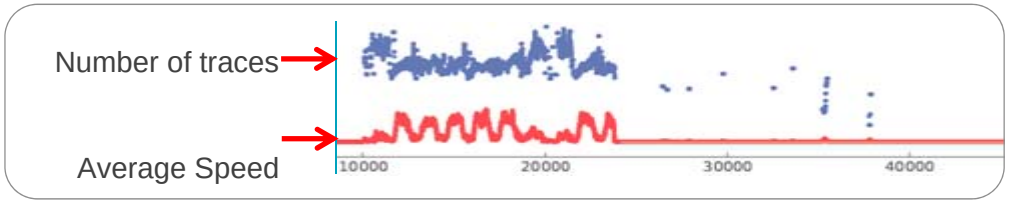
3rd party road closure report

Corrected by HD Traffic Fusion



Corrected by LIVE data input

Automatic detection of road and slip-roads (ramp) closures

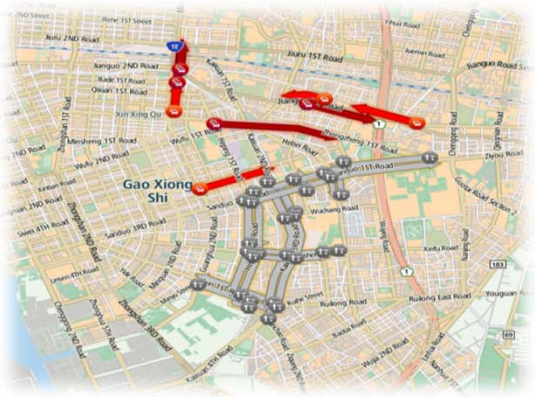


- Monitoring flow – roads with normally high volume of observations dropping to nothing

Traffic Incident Moderation

- Moderation tool by TomTom
- Available 24/7
- Access over a Traffic Moderation Tool to modify traffic incidents
- Access to Probe Data, Analyzing Tools and the Map Share Contributions

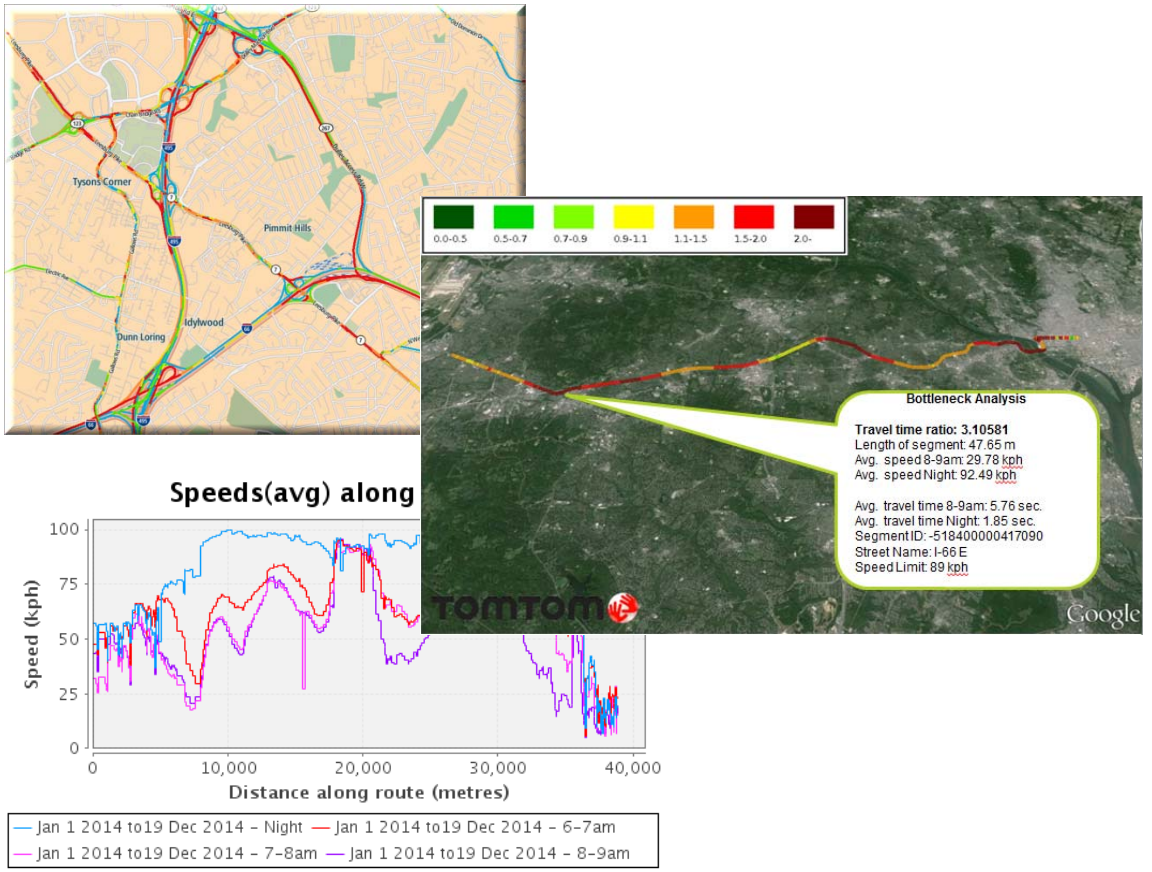
Example of the effort from the moderation team; closed all involved roads in Taiwan after the gas explosion



Performance Reporting

1. Travel Time Index
2. Traffic Jam Statistics
3. Traffic Index

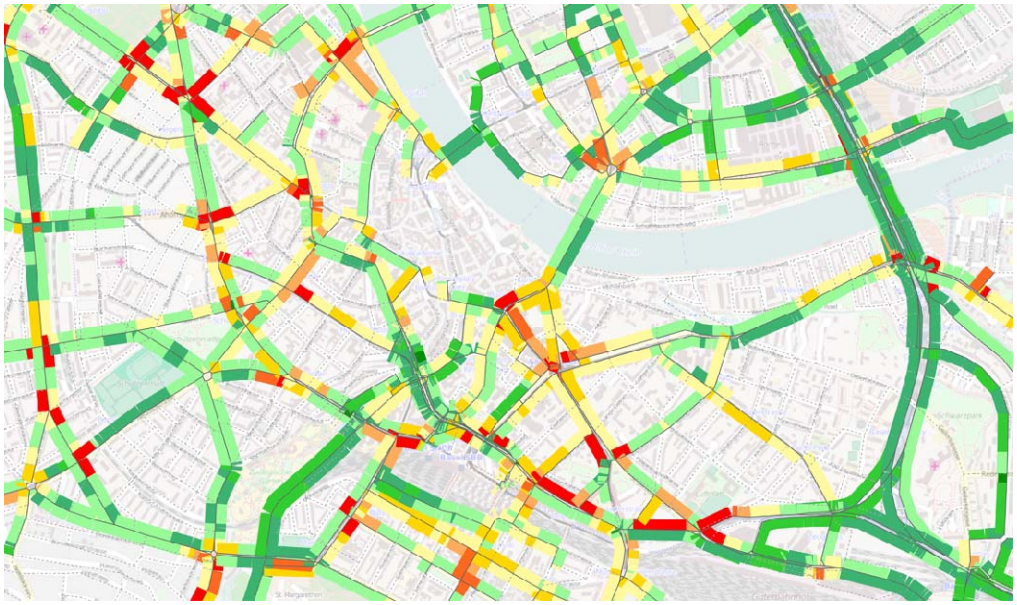
- ✓ By route
- ✓ By road segment
- ✓ By road class
- ✓ By road name
- ✓ By network
- ✓ By year, season, day
- ✓ By time

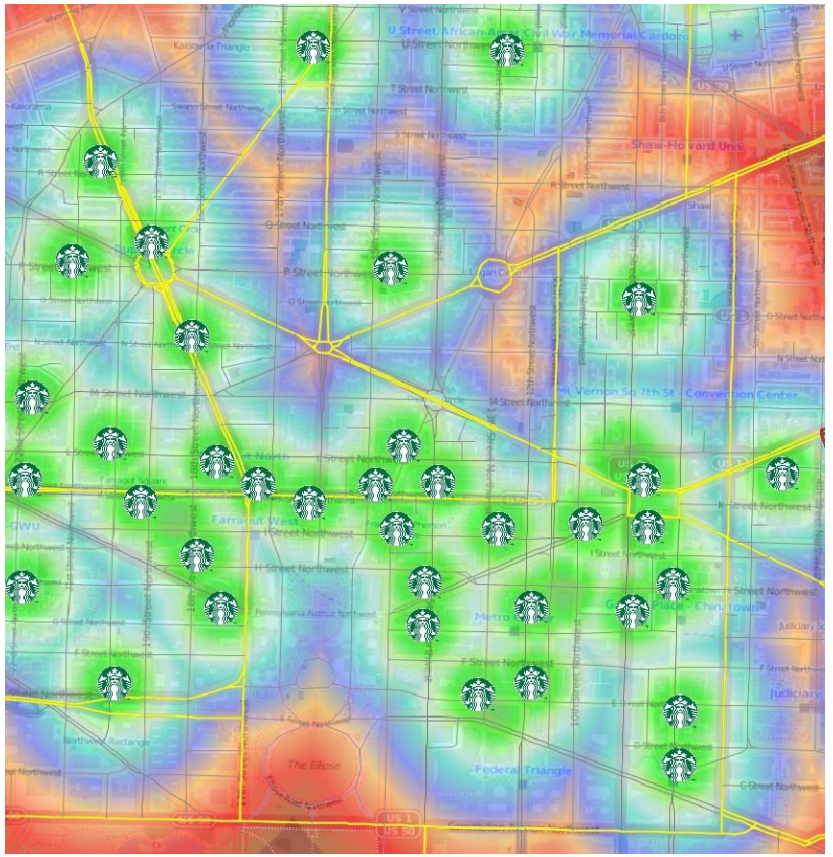


Analytical Tools

PTV GROUP

the mind of movement





TOMTOM

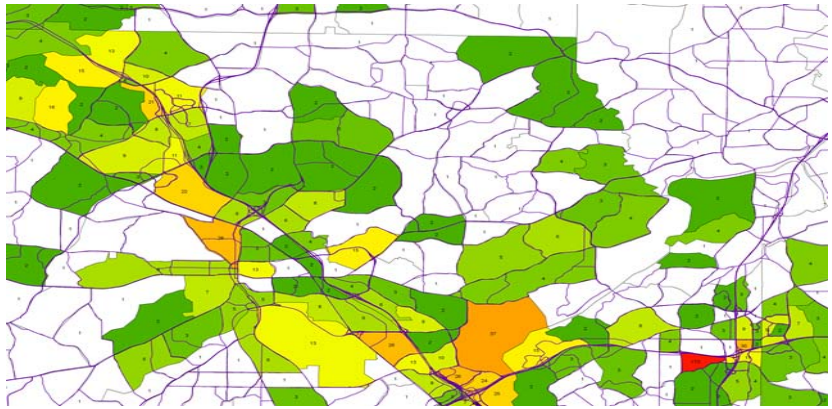
Origin Destination Applications in the field

Table 4: TomTom O-D Data – Morning Peak Period (6:00 AM to 9:00 AM)

Destinations	Origins							
	A	B	C	D	E	F	G	H
A – I-64 West of Staples Mills Interchange		9.72%	23.77%	21.48%	1.08%	16.48%	2.54%	15.98%
B – I-95 North of Bryan Park Interchange	12.63%		54.27%	7.59%	2.08%	39.35%	1.41%	17.58%
C – I-195 South of Bryan Park Interchange	15.48%	30.30%		5.41%	0.43%	2.03%	0.00%	0.80%
D – I-64 East of Shockoe Bottom Bridge	25.12%	7.01%	2.62%		65.18%	11.15%	12.39%	23.78%
E – I-195 West of I-95	0.44%	1.72%	0.14%	17.37%		6.88%	1.69%	0.30%
F – I-95 South of I-195 Interchange	10.38%	18.22%	0.75%	11.73%	12.85%		21.13%	4.70%
G – Belvidere Street North of I-95/I-64	0.26%	0.19%	0.14%	0.79%	0.57%	0.99%		19.68%
H – Belvidere Street South of I-95/I-64	3.41%	4.56%	0.25%	1.09%	0.07%	0.32%	49.01%	
Number of Measurements	5,020	5,762	4,426	5,320	1,393	5,875	355	1,001

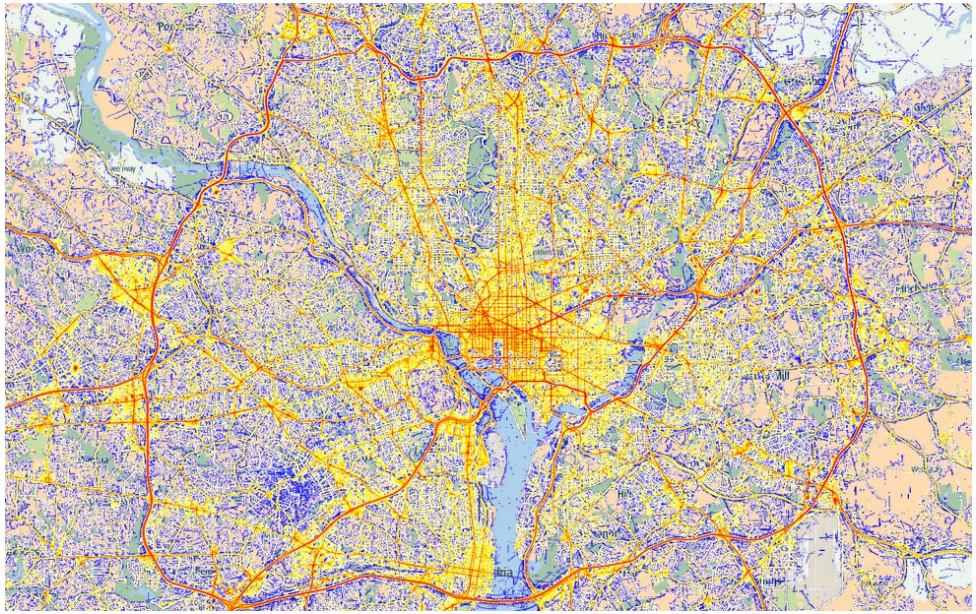
Table 5: TomTom O-D Data – Midday Peak Period (11:00 AM to 2:00 PM)

Destinations	Origins							
	A	B	C	D	E	F	G	H
A – I-64 West of Staples Mills Interchange		12.20%	25.52%	29.75%	2.78%	18.10%	3.19%	17.29%
B – I-95 North of Bryan Park Interchange	14.66%		52.59%	10.19%	3.57%	37.52%	3.09%	21.19%
C – I-195 South of Bryan Park Interchange	16.93%	29.76%		4.13%	0.56%	2.22%	0.43%	1.17%
D – I-64 East of Shockoe Bottom Bridge	28.32%	6.93%	3.54%		59.84%	14.51%	15.00%	25.59%
E – I-195 West of I-95	0.68%	0.98%	0.25%	13.62%		6.87%	2.34%	0.53%
F – I-95 South of I-195 Interchange	12.02%	22.83%	1.87%	12.06%	16.40%		13.40%	5.43%
G – Belvidere Street North of I-95/I-64	0.41%	0.28%	0.09%	1.70%	0.23%	1.52%		17.11%
H – Belvidere Street South of I-95/I-64	3.35%	4.80%	0.33%	0.33%	0.32%	0.67%	54.57%	
Number of Measurements	9,227	9,859	6,320	9,008	2,159	7,477	940	2,817

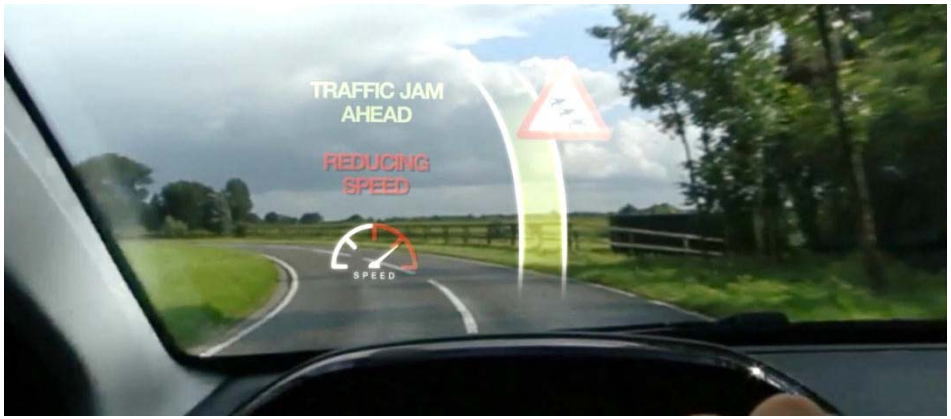


High-Precision Fuel Use & Emissions Prediction

- Creating ‘Fuel Use Profiles’
- Creating ‘Estimated Route Fuel Use’ taking real-time traffic situation into account
- Routing based on minimizing fuel use
- Identifying worst road segments for emissions
- Validated by vehicle type

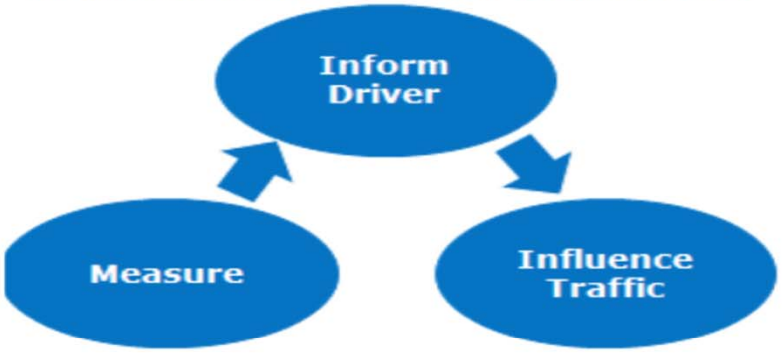


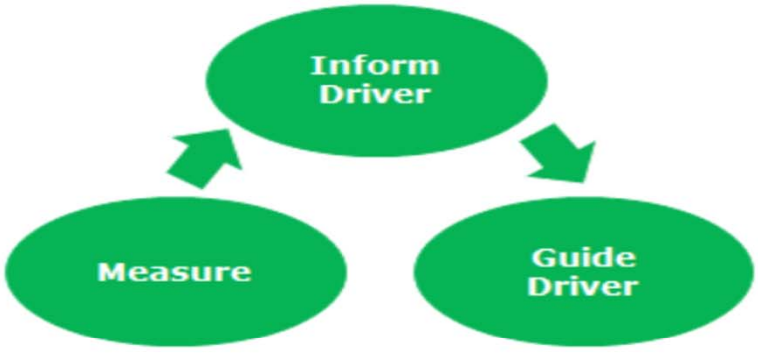
Highly Automated Driving: New Safety Services



Traffic Management: Traditional Situation

Road authorities **VS** service providers





Integrated Traffic Management

Road authorities & service providers