ARPA-E Workshop: Business Models in Transportation

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HERE, A division of Nokia

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Agenda

Business Model Framework
Application in Data & Technology
Business Model Shifts
Examples

Business Model Innovation Framework

Who do we serve?

- ✓ Target consumers
- ✓ Value chain locations
- ✓ Roles performed

How do we provide it?

- ✓ Channels
- ✓ Partnerships
- ✓ Supply chain configuration

What do we provide?

- ✓ Benefits/solutions
- ✓ Products & services

How do we differentiate & sustain?

- ✓ Brands
- ✓ Quality, consistency
- ✓ Core competency

How do we make money?

- ✓ Value levers
- ✓ Cost levers
- ✓ Pricing rationale

Who do we serve?
Guiding & Optimizing Transportation

Individual Mode Optimization, Mode Selection, Network Optimization

Driving	Transit	Pedestrian/Biking

Passenger

Freight/Truck

What are the biggest pain points?
What can we best address using our assets?

Navigate to destination considering
- time, distance, road characteristics (260+ attributes)
- real-time conditions (traffic flow, congestion, weather, incidents)
- energy/eco impact, safety (slope and curvature of roads)

What needs are addressed?
Mobility, Safety, and Eco Efficiency

Driver Information

Curve Speed Warning
Speed Limit Advisor
Driver Alerts

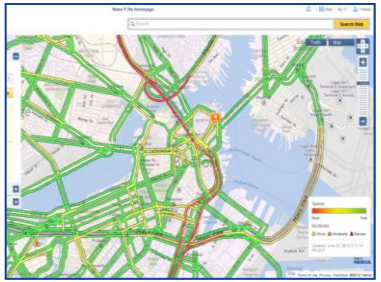
Active Safety

Adaptive Cruise Control
Adaptive Frontlights
Collision Avoidance
Lane Keeping

Powertrain Efficiency

Hybrid Powertrain Control
Transmission Control
Predictive Cruise Control

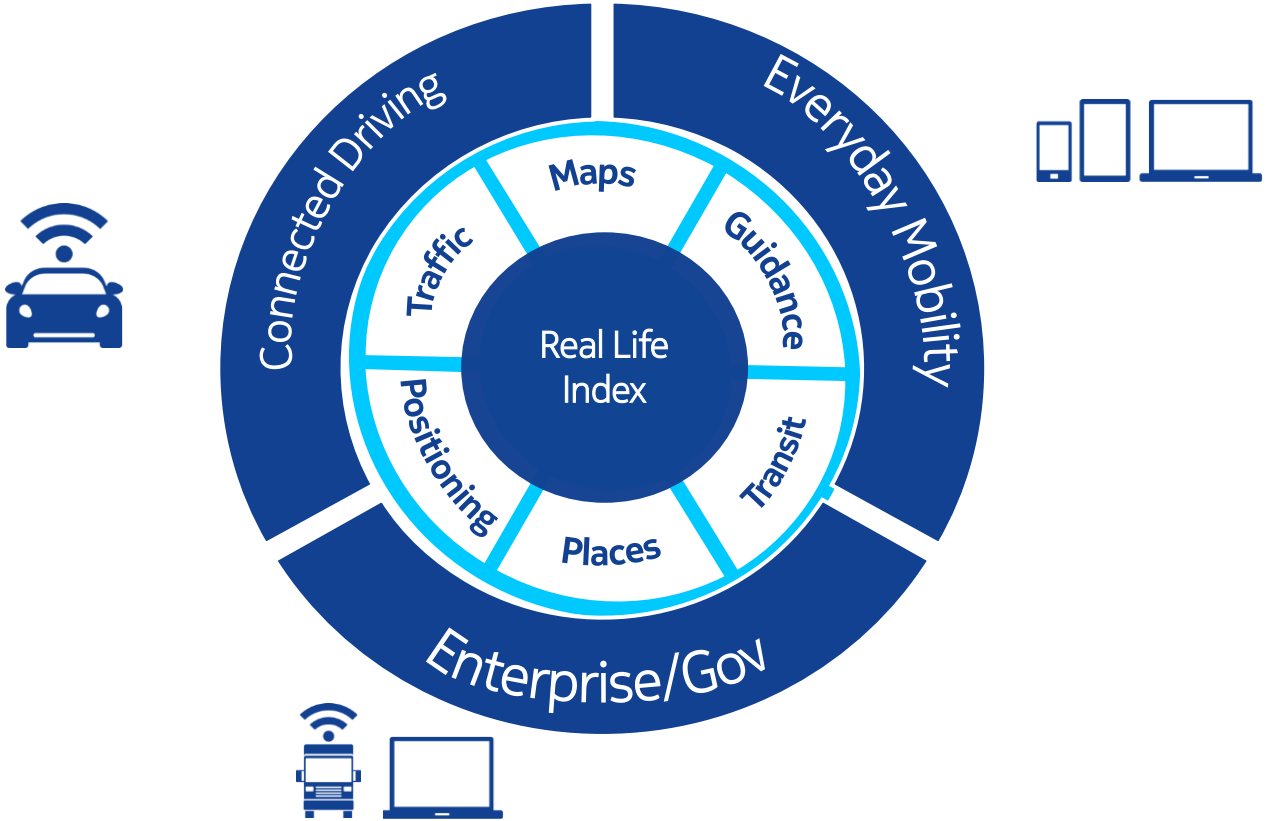
Traffic Management



Consumer Information
Operations
Planning
Performance Measurement

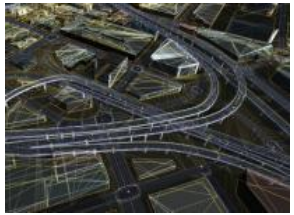
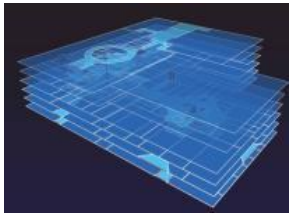
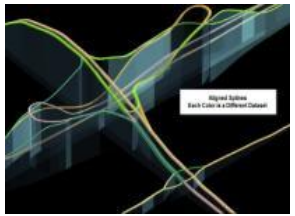
HERE Maps and Real-Time Data are combined in different ways to serve different needs

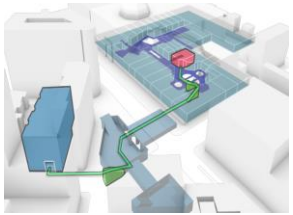
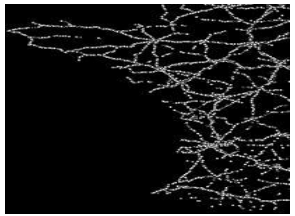
How do we provide?
Shifted to an index and platform centered view



What do we provide & where do we invest?
Investment in true-to-real-life index of the world




214
Countries mapped

27M
Changes per day

75,600
Buildings with indoor maps

96
Countries with voice-guidance

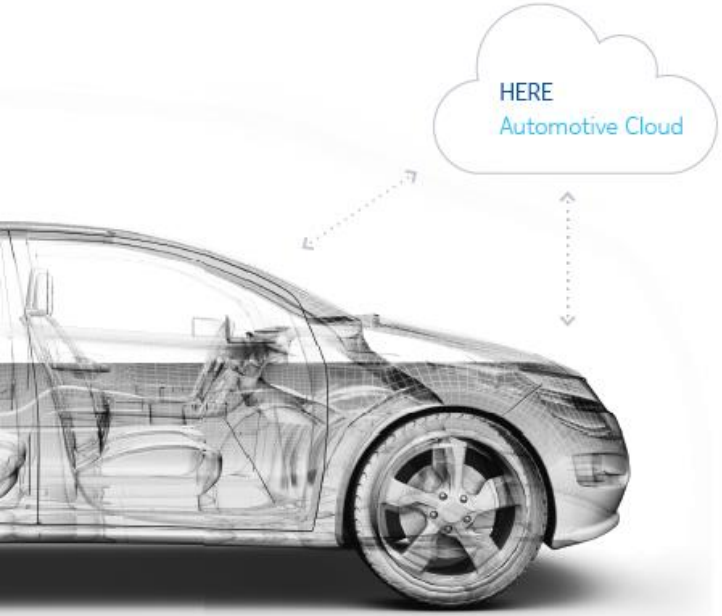
34
Countries with live traffic services

80,000
External sources help to create our maps

805
Cities with public transit

52
Languages

Partnerships/Value Chain:
Powering Automated Vehicle Technology



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

Joint development for next generation Electronic Horizon, Automated Driving and new Intelligent Transportation Systems based on high precision map technology

HERE's Ambition

Transforming the way the world moves

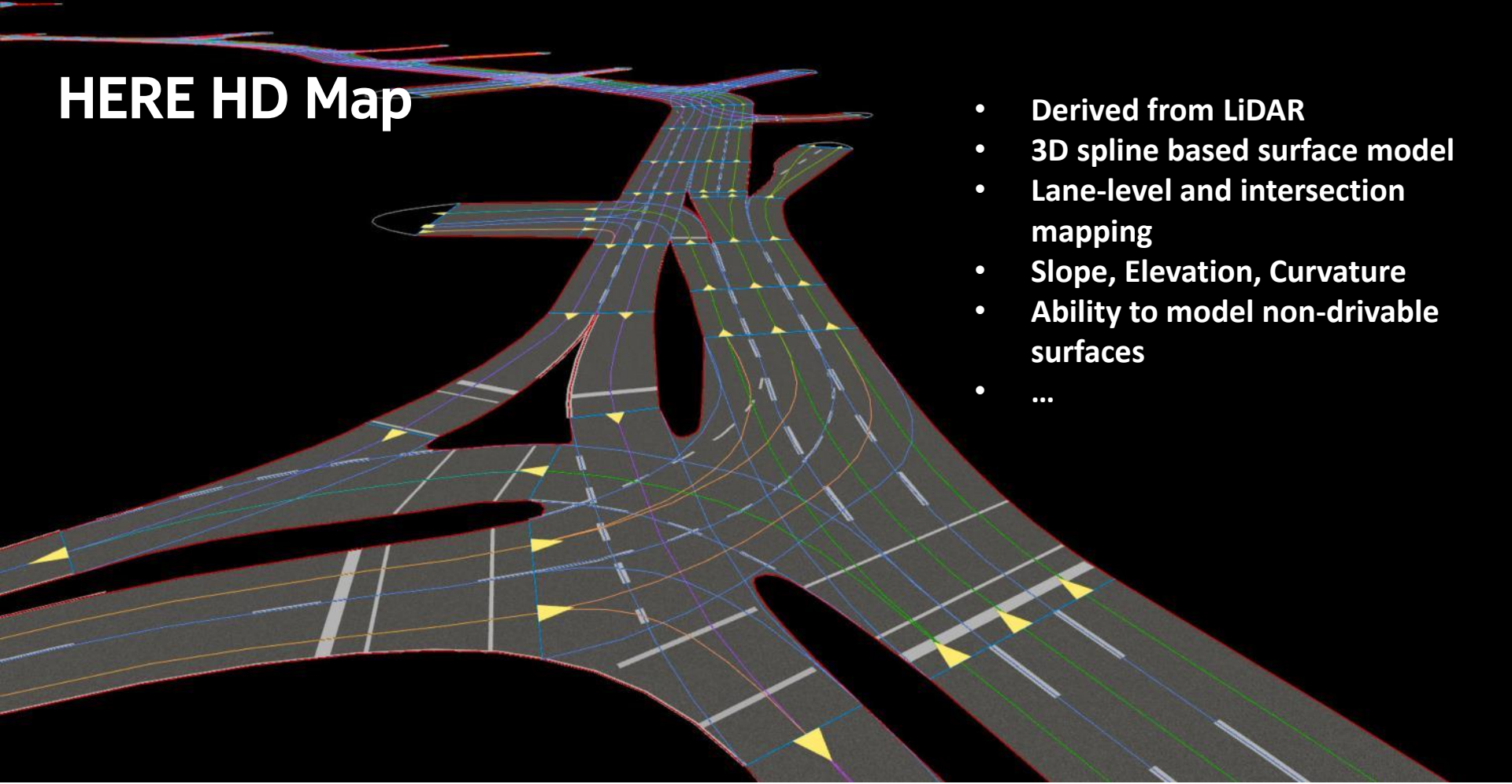
To produce state of the art computable index of the world around us

Computable Reality
Fully interconnected and attributed 3D models, combining aerial and street level technologies and real-time data

Computable Roads to Guide My Way
Precise road geometries with rich sets of attributes to make them computable

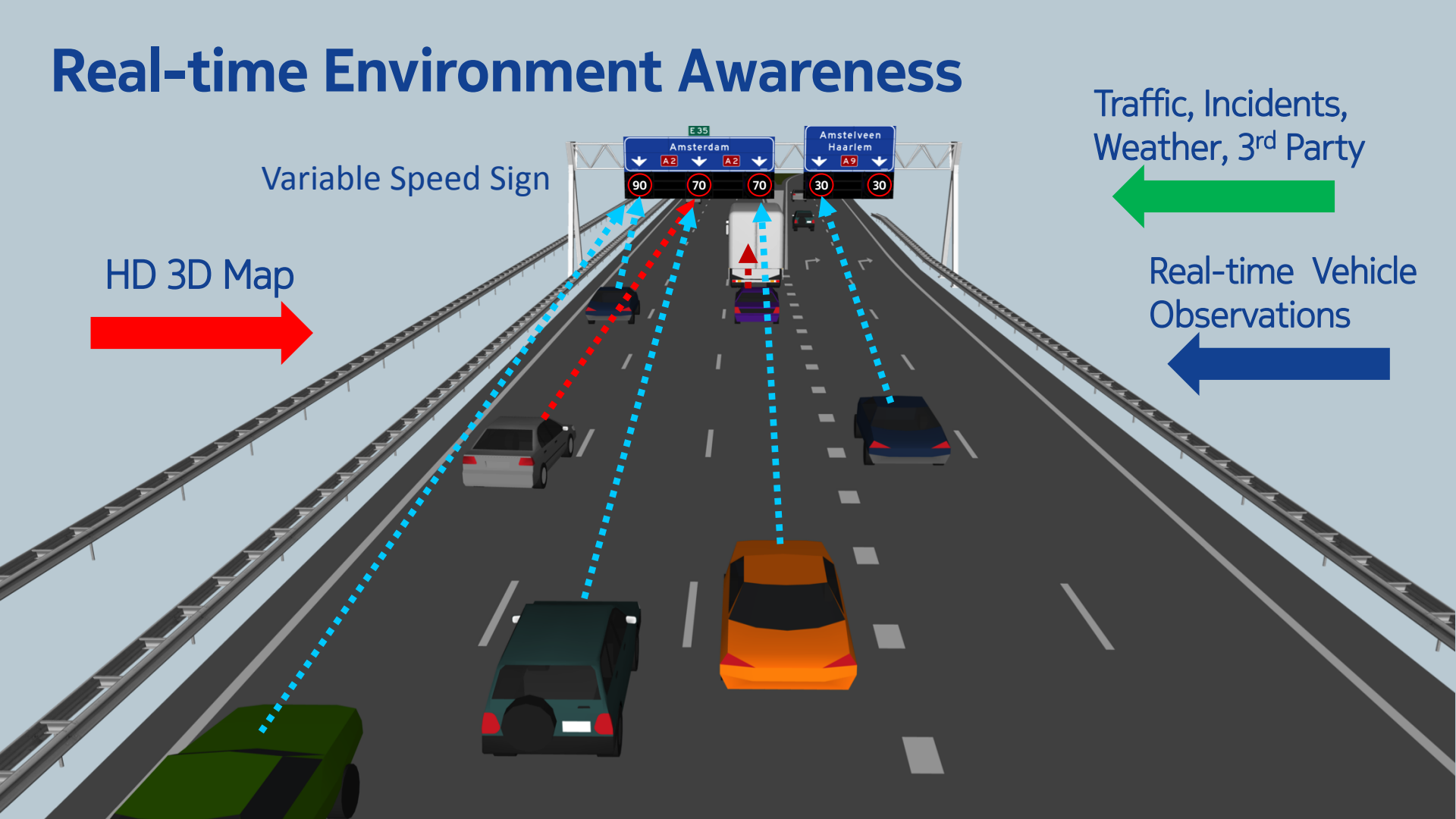
Digitized Maps to get from A to B
25 years ago map creation started out by digitizing physical map sources

HERE HD Map



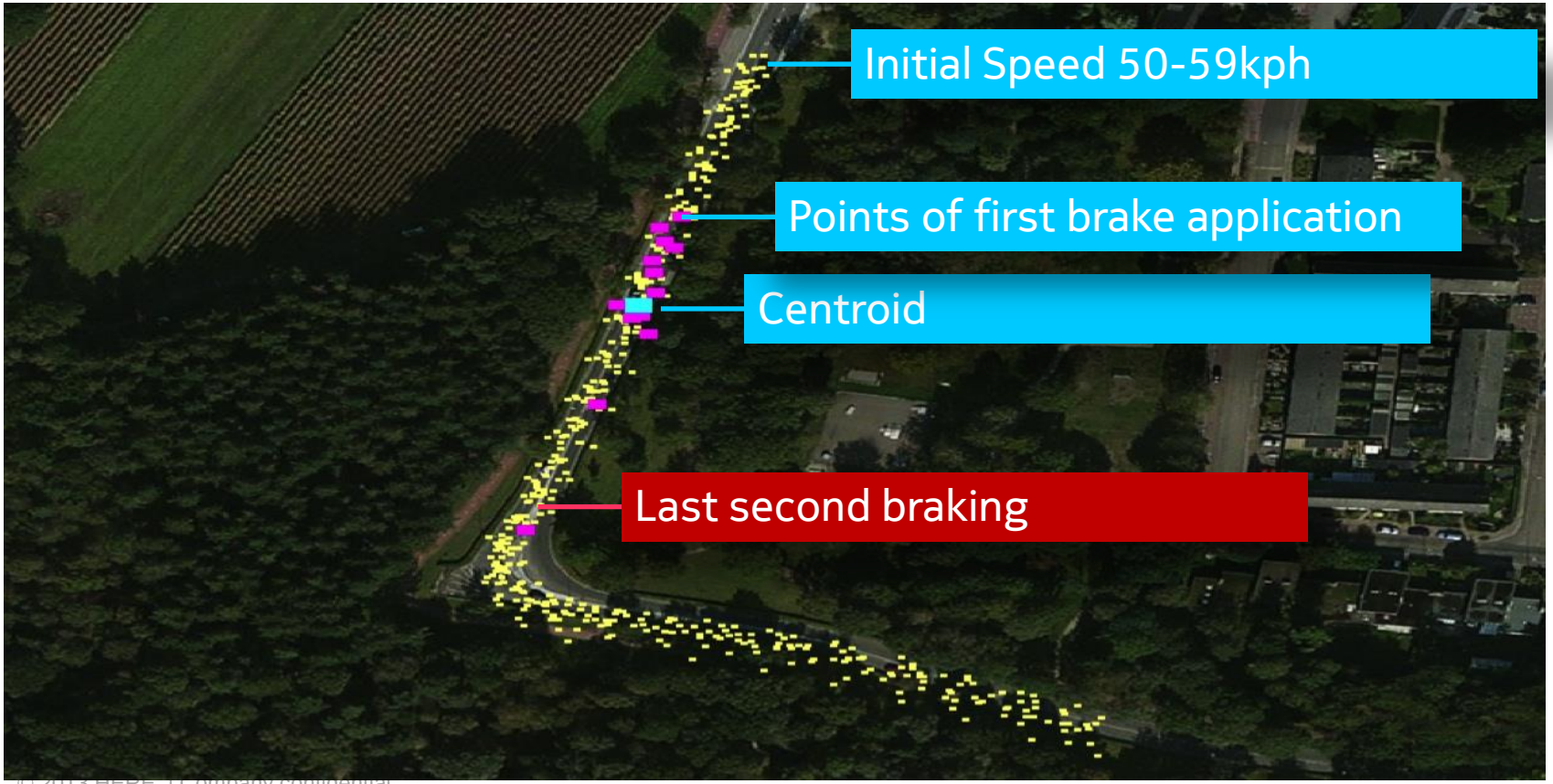
- Derived from LiDAR
- 3D spline based surface model
- Lane-level and intersection mapping
- Slope, Elevation, Curvature
- Ability to model non-drivable surfaces
- …

Real-time Environment Awareness

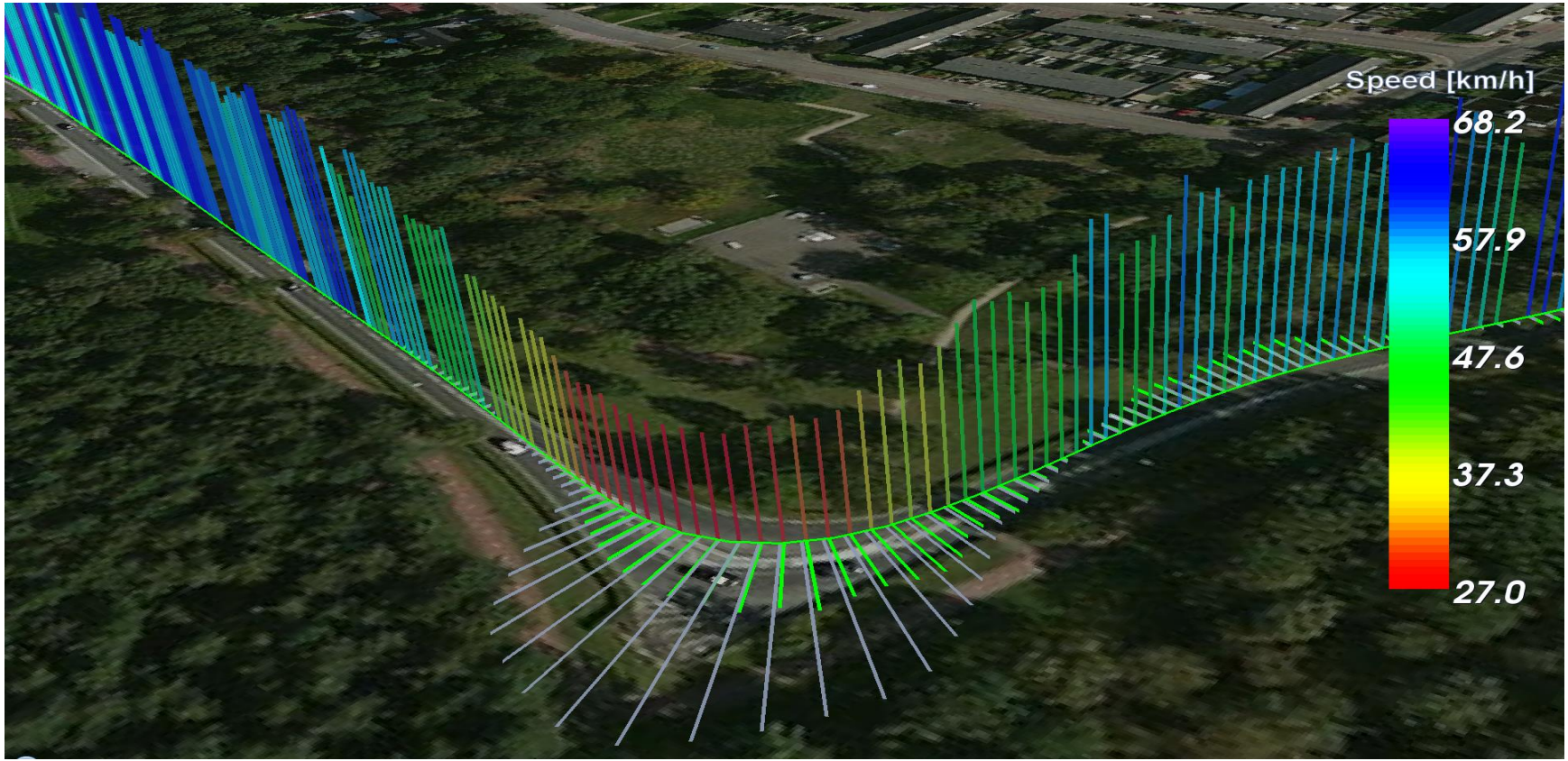


Driver Behavior

Behavior in sharp curve



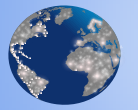
Southbound driving, rainstorm



Automotive Cloud

Leveraging vehicle sensors and location data to enable new solutions

High Definition Maps & Traffic



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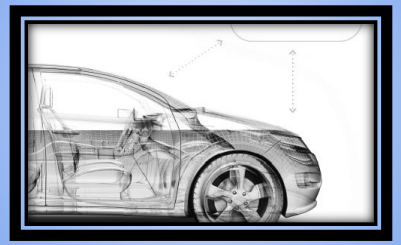
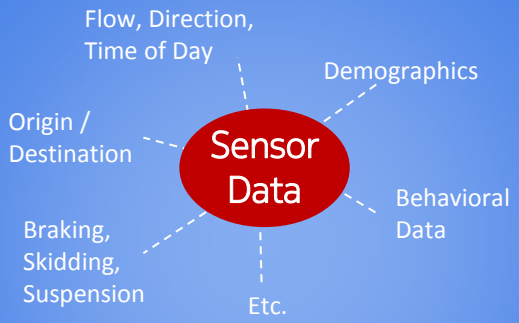
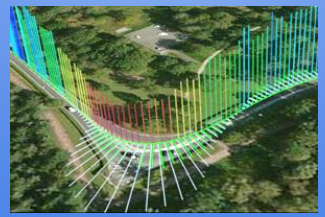
Vehicle Sensor Data



Cloud-Based Analytics Services





Enterprise

Fleet Management
& Optimization

Urban Planning

Traffic Management
Road Infrastructure Planning
Multi-modal

Auto Safety

Partially Automated Driving
Highly Automated Driving

Business Models

- Value chain specific (automotive, mobile, enterprise, government)
  - Players in the value chain
  - Sources of value
  - Roles are shifting in virtually every sector
- Shift from license and sell content to access platform and conduct transactions
- Build and sell applications
  - Free to consumer
  - Built into cost of device and/or automobile
  - Some location based advertising
- Public/Private Partnerships
- Create intelligence out of data assets and continue to fuel and improve the data and experience

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Eco-Routing Example

Hyundai Eco-Route using Geometry, Slope, Speed Limits

- Green routing feature will offer fuel-saving directions based on digital map and traffic data.
- Uses details such as hills, road geometry, and driving terrain, to calculate the path that will use the least fuel.
- Green route can save about 6 percent or more compared with traditional fastest and shortest route.

Source: C/NET

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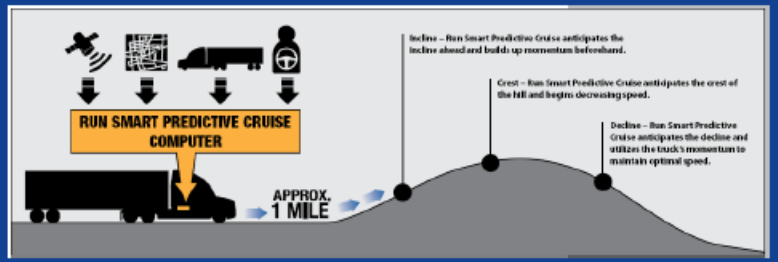
Optimizing Truck Routing & Efficiency

Predictive Cruise Control using HERE Slope Data

3% Fuel Savings with no travel time penalty

FREIGHTLINER

SCHNEIDER NATIONAL



GREEN BAY, Wis. – May 2, 2012 – Schneider National announced it will transform its fleet to reduce environmental impact. New trucks manufactured by **Freightliner** will include Predictive Cruise Control to save fuel and reduce CO2 emissions.

Source: Schneider National

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Safety & Efficiency Example

Real-World Commercial Launch – Audi A8, A6

Navigation system closely networked with assistance systems

Adaptive Cruise Control

Recognizes exiting car at ramp and avoids braking

Prevents acceleration on exit ramp

Predictive Frontlights

Activates highway lighting on entrance ramp

Activates cornering lamps at intersections

Dynamic Shift Program

8-Speed Automatic Transmission avoids unnecessary shifts on narrow curving roads

Source: Audi Media-Services

Multi-Modal Routing

Car, Public Transport and Pedestrian Routing

Public transport , pedestrian , and biking are becoming more central to the way people travel based on consumer choices, government initiatives, and urban growth.

Key HERE Functionality

- Automotive-grade global maps for effective car routing
- Extended navigation roads at key sites (malls, stadiums, etc.) to appropriate venue entrances
- Public transport (rail, bus, etc.) lines, stops and routes based on timetables (where available) or estimated routing
- Pedestrian routes including paths, connectors (stairs) and more
- Millions of POIs to route to

Benefits

- Addresses the transportation needs of all residents and visitors, thereby increasing the percentage of people that may access government services and facilities
- Increases use of public transport and walking: healthier people and healthier planet

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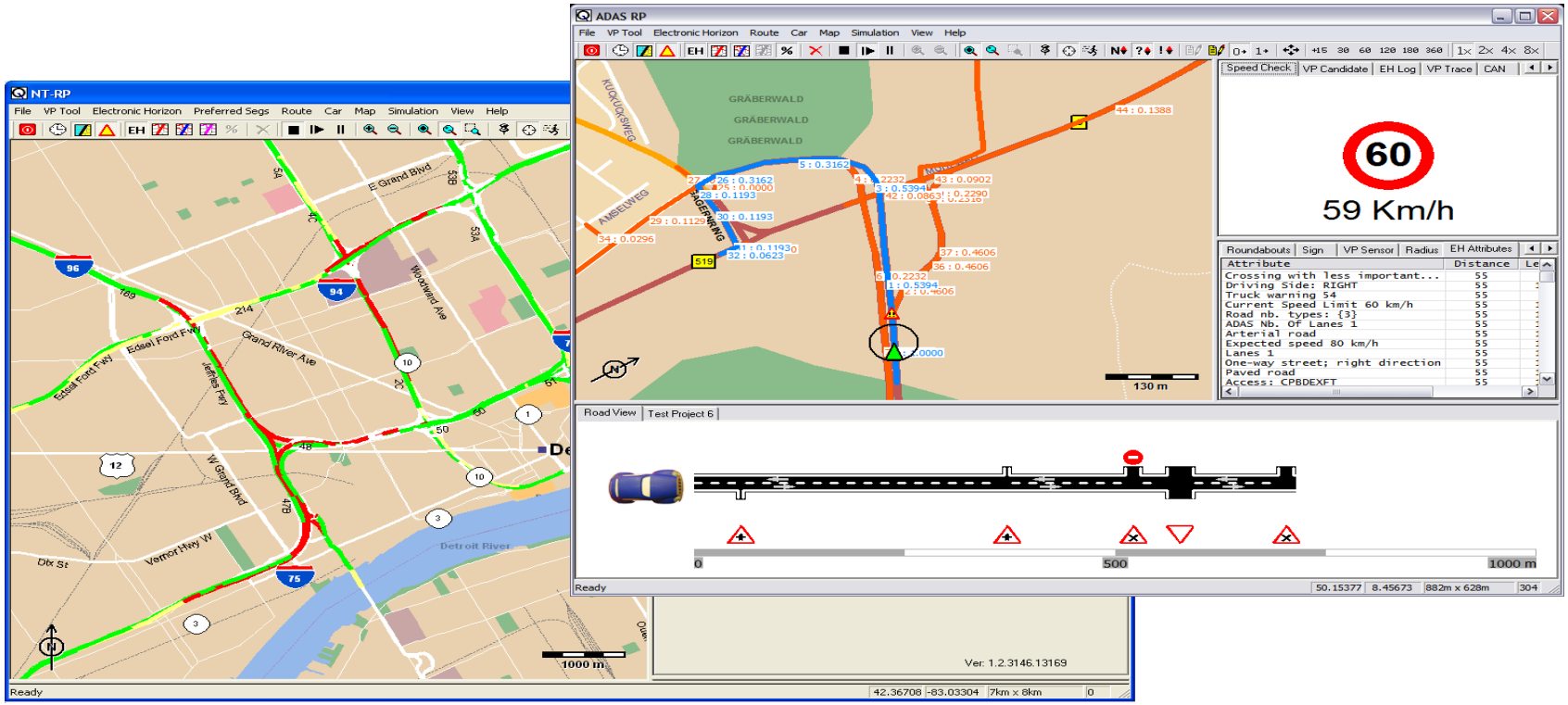
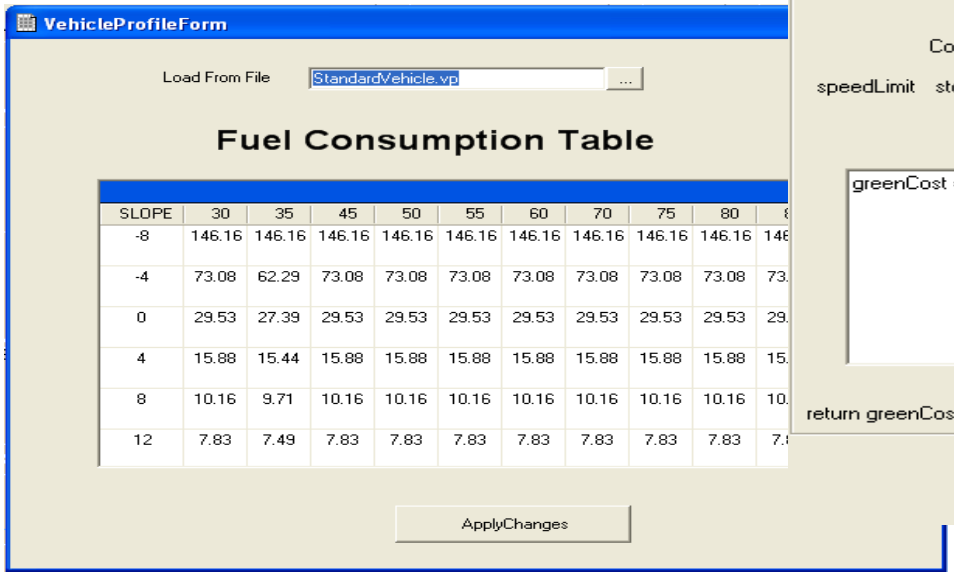
Transforming the way the world moves

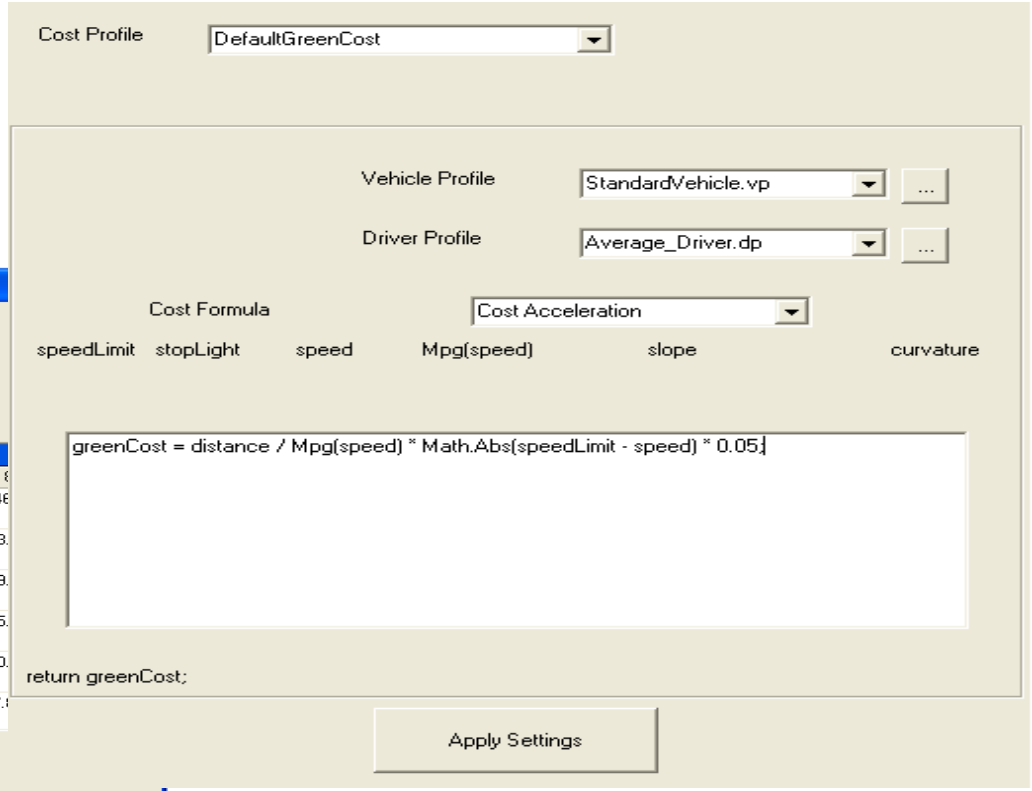
ADAS-RP (Research Platform)



Green Routing Plugins

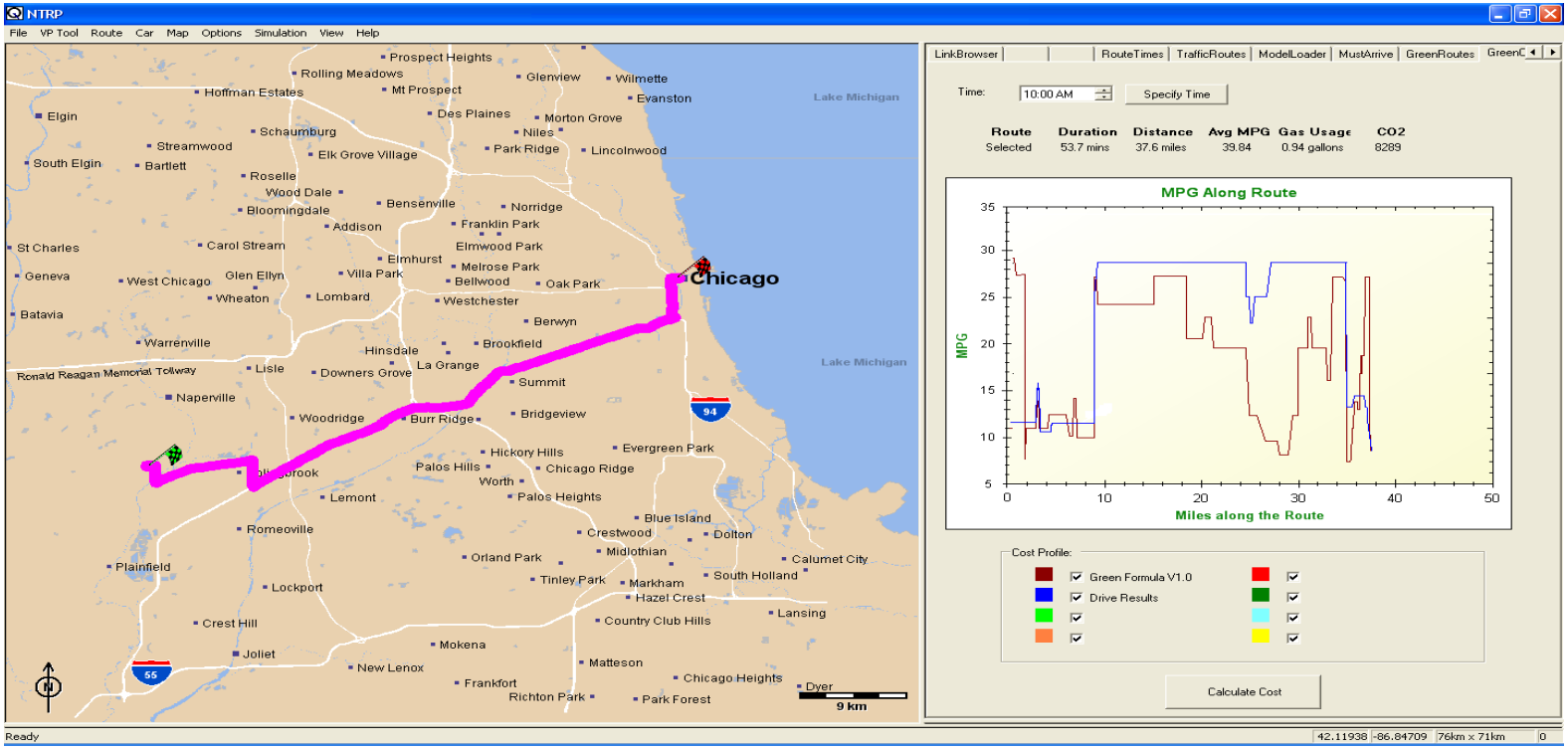
Allows one to customize the route cost calculations using the various NAVTEQ traffic and map attributes.





Compare Results with Predicted Values

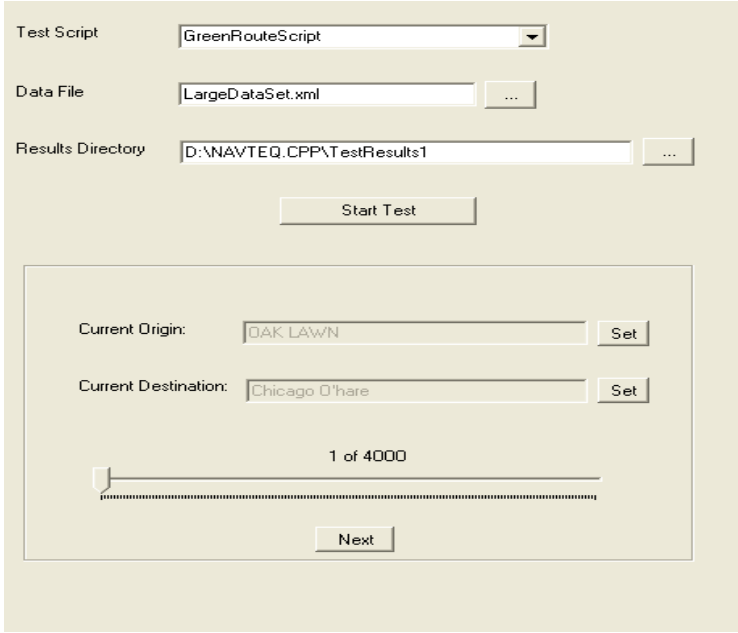
Compare Results with Predicted Values to Validate



Compare Results

Run through large number of routes with cost equations and analyze predicted results with ground truth realities.

	A	B	C	D	E	F	G	H	I	J
1	RouteNun	Time	HasDiffRo	OrigRoute	GreenRou	OrigFuelU	GreenFue	OrigRoute	GreenRouteDist	
2	1	4:15 PM	TRUE	107.3	179.69	0.63	0.28	65.22	144.31	
3	2	4:15 PM	TRUE	102.52	114.39	0.47	0.37	66.29	75.48	
4	3	4:15 PM	TRUE	169.99	226.65	1.25	0	111.41	175.93	
5	4	4:15 PM	FALSE	5.64	5.64	0	0	2.37	2.37	
6	5	4:15 PM	TRUE	109.13	181.54	0.63	0.28	65.98	145.07	
7	6	4:15 PM	TRUE	104.38	120.08	0.47	0.37	67.05	79.34	
8	7	4:15 PM	TRUE	171.5	195.39	1.25	0.55	112.17	145.68	
9	8	4:15 PM	FALSE	7.53	7.53	0.05	0.05	3.13	3.13	
10	9	4:30 PM	FALSE	43.52	56.23	0.15	0.12	29.55	38.48	
11	10	4:30 PM	FALSE	49.69	61.34	0.17	0.11	33.54	43.15	
12	11	4:30 PM	TRUE	119.41	116.85	0.74	0.29	82.48	92.98	
13	12	4:30 PM	FALSE	3.74	3.74	0.02	0.02	1.61	1.61	



Drive & Study Flow

Condition 1
Drive with Paper Directions

Condition 2
Drive using Standard GPS System

Condition 3
Drive using Natural Guidance

1. A pre-test survey was filled out to capture stated frustration responses of drivers, prior to the drive.
2. Drivers wore the unobtrusive biometric belt while driving in each of the conditions depicted on the left.
3. Each driver was instructed to drive from for approximately 30 minutes, with multiple destinations made in the city of Boston.
4. Following the driving experience, participants were asked to fill out a short post-test survey aimed at measuring cognitive load and self-reported driver experience.

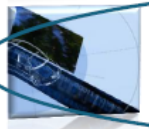
Eco Routing

Eco-Benefits of Map-Based Energy Efficiency

8-15% potential savings with **everyday navigation**
NAVTEQ Fuel Study 2009

5-10% potential savings with **eco-routing**
Magneti Marelli/NAVTEQ joint testing, 2008

5-15% potential savings with **green driving**
US Dept of Energy, 2009



2-5% potential savings with **predictive cruise control**
VA Tech NAVTEQ study, 2011

5-24% potential savings with **Hybrid Powertrain Control**
Ricardo Sentience Study 2009

NOKIA

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Fuel Efficiency Saves Money and Reduces CO2

Commercial Vehicle Savings Based on Fuel Economy Improvement

Annual Distance Driven (km)	Average Fuel C… (l…	Total Annual …	… Fuel (€)	Slope Fuel Economy Improvement	Annual Savings (€)	Annual CO2 Reduction (kg)
120,000			67,200	1.00%	€ 672	1297
120,000			67,200	3.00%	€ 2,016	3892
120,000			67,200	5.00%	€ 3,360	6487
160,000			89,600	1.00%	€ 896	1730
160,000			89,600	3.00%	€ 2,688	5190
160,000			89,600	5.00%	€ 4,480	8650
200,000			112,000	1.00%	€ 1,120	2162
200,000			112,000	3.00%	€ 3,360	6487
200,000			112,000	5.00%	€ 5,600	10812

Annual Savings
-€4,480
-8650 kg CO_2

Passenger … onomy Improvement

Annual Distance Driven (km)	Average Fuel C… (	Total Annual …	… l Fuel t (€)	Slope Fuel Economy Improvement	Annual Savings (€)	Annual CO2 Reduction (kg)
10,000			€ 1,260	1.00%	€ 13	24
10,000			€ 1,260	3.00%	€ 38	73
10,000			€ 1,260	5.00%	€ 63	122
20,000			€ 2,520	1.00%	€ 25	49
20,000			€ 2,520	3.00%	€ 76	146
20,000			€ 2,520	5.00%	€ 126	243
30,000			€ 3,780	1.00%	€ 38	73
30,000			€ 3,780	3.00%	€ 113	219
30,000			€ 3,780	5.00%	€ 189	365

Annual Savings
-€126
-243 kg CO_2

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Fuel Economy and Emissions

Some Numbers (2002 Base):

226 million	..... number of vehicles on the road in the U.S.
4.7 trillion	..... number of kilometers driven annually in the U.S.
637 billion	..... number of liters of petrol consumed annually in the U.S.
1.5 trillion	..... number of kilograms of CO_2 emitted annually by vehicles in the U.S.

Some Solutions (4% fuel savings with ADAS):

25 billion	..... number of liters of petrol saved annually - enough for 7.3 million cars!
58 billion	..... number of kilograms of CO_2 eliminated annually

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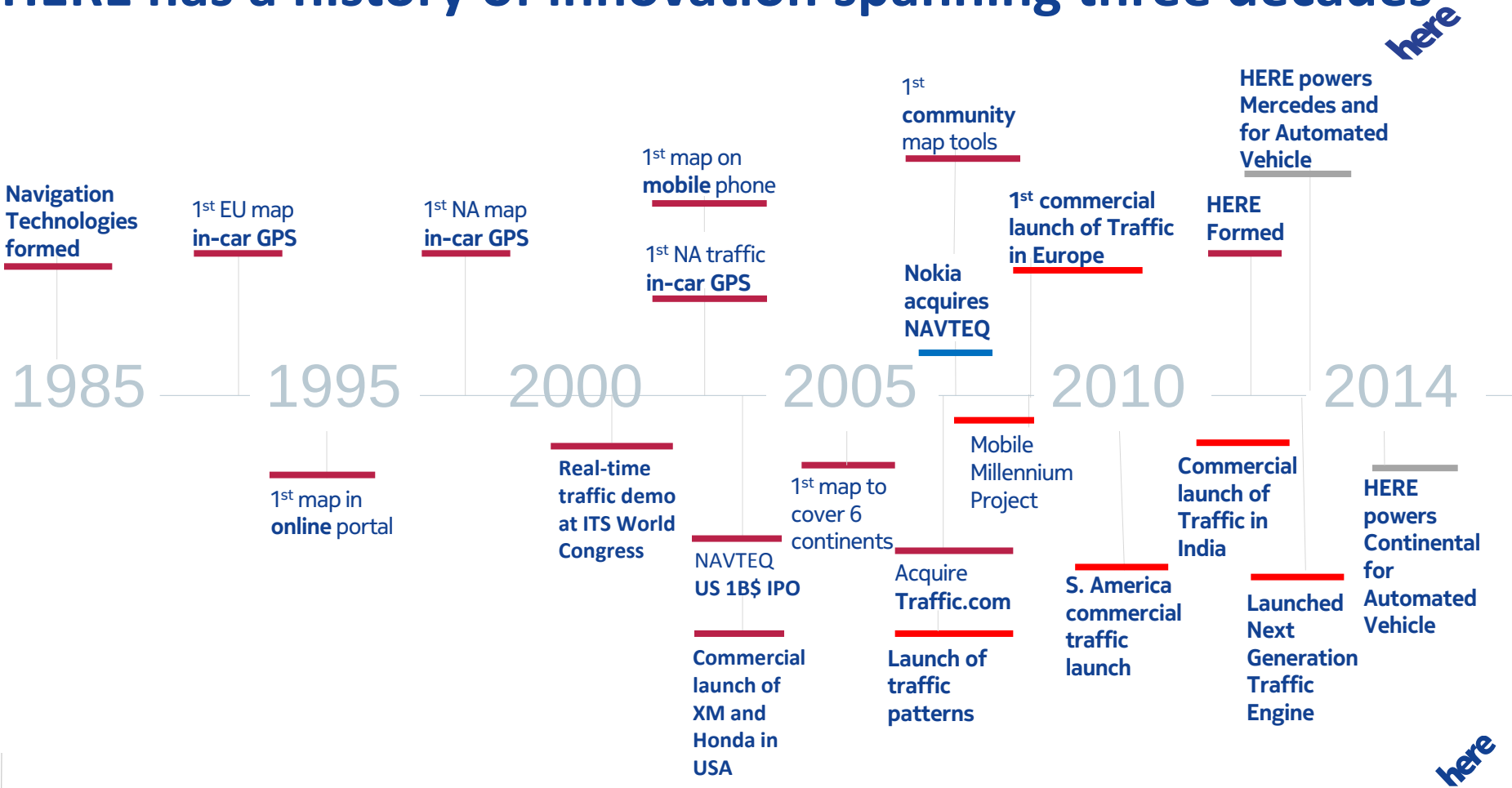
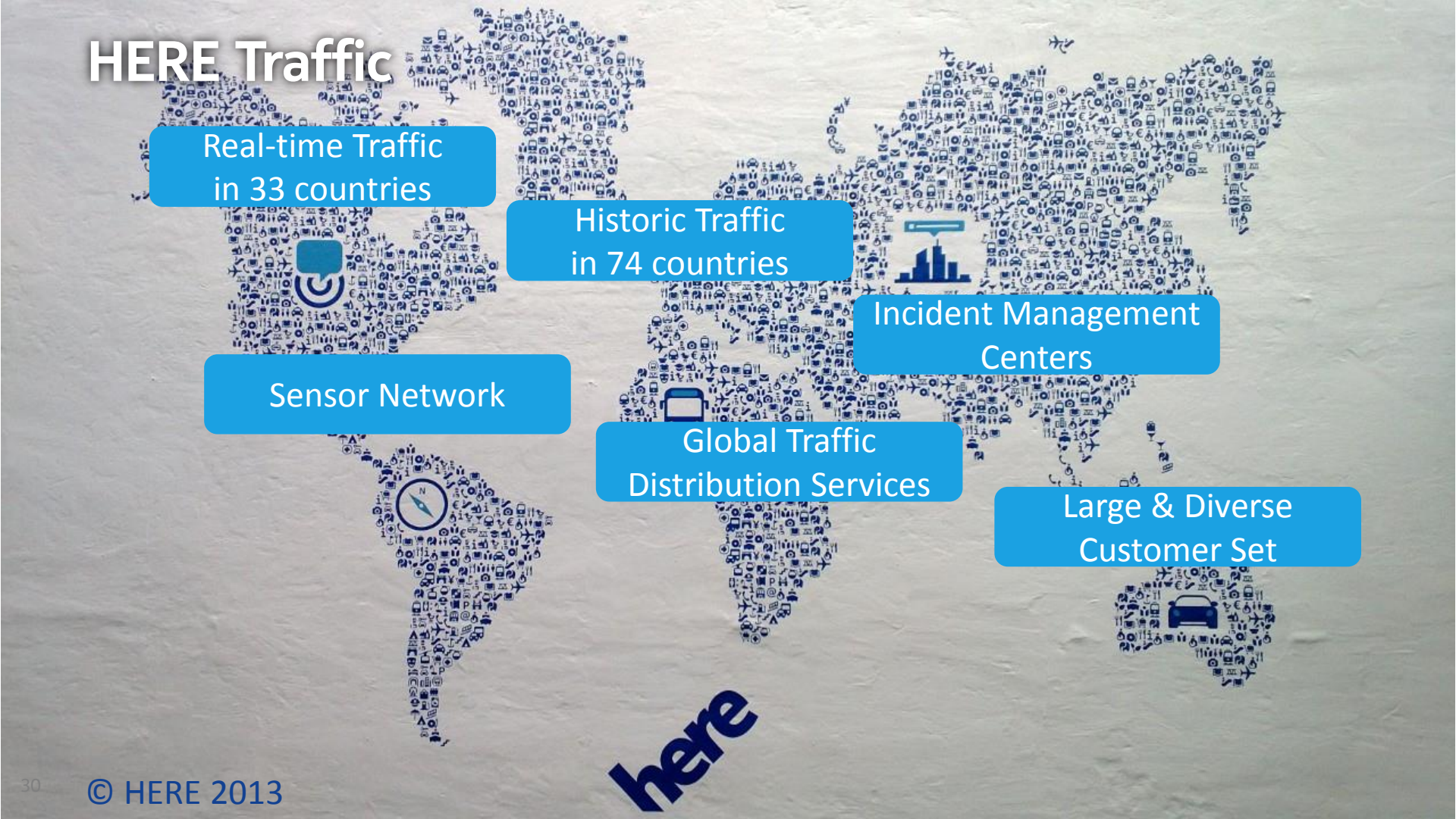
HERE has a history of innovation spanning three decades



HERE Traffic



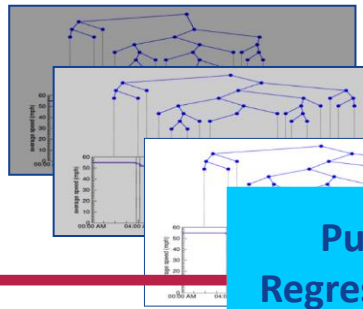
Learning Platform

Persistent Trends

- Regional Holidays
- Months
- Seasonality

Observed Historical Conditions

Filters, Clustering & Regression



Published Regression Trees

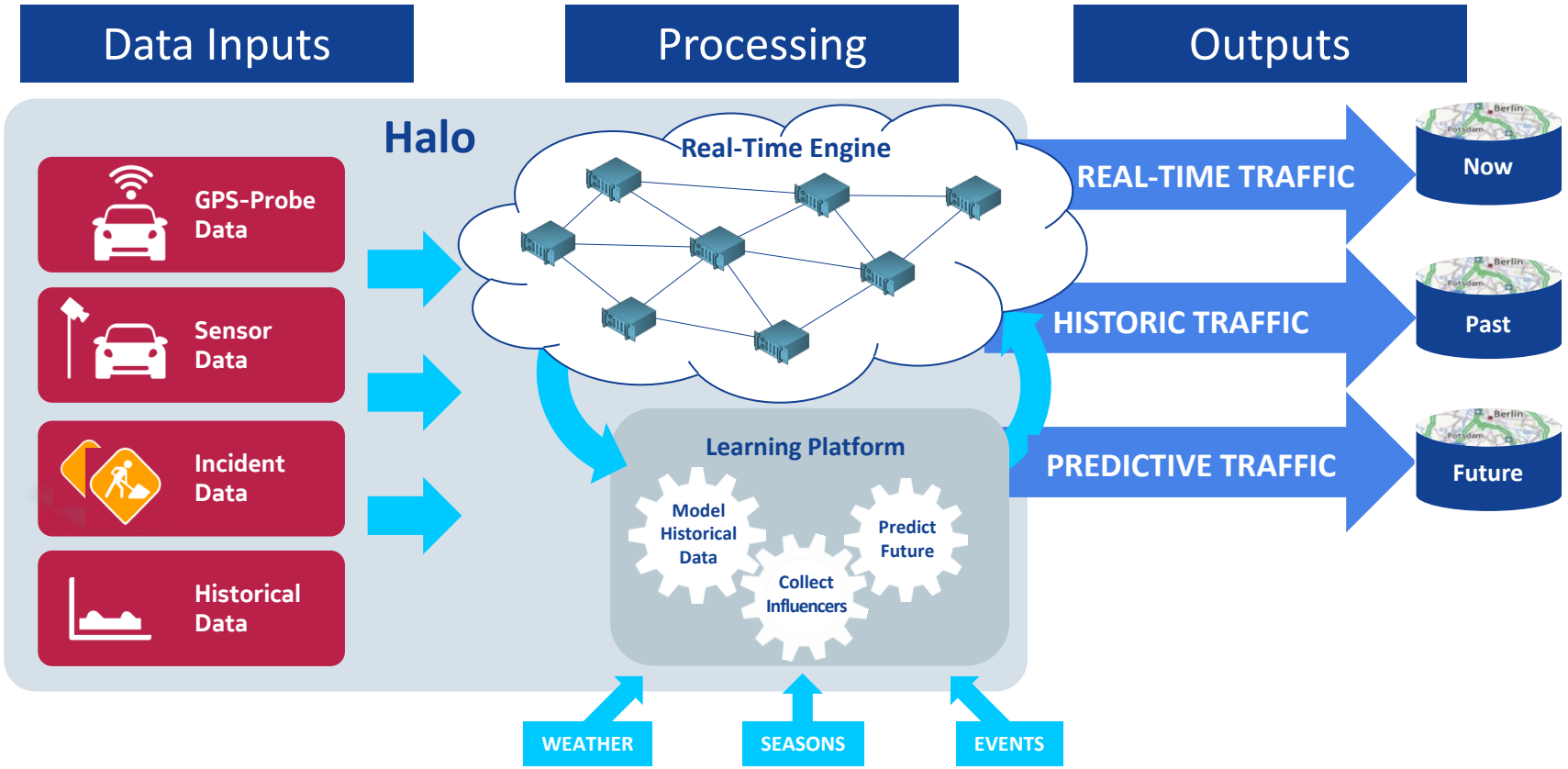
Champion Challenger Comparison

Construction & short term trends

Weather

Accidents & Events

Halo: Real-Time Data Processing Engine



Challenges of Highly Automated Driving

Localization	• Precise positioning for lateral and longitudinal control of vehicle on the road surface
Planning	• Accurate prediction of vehicle control maneuvers beyond sensor visibility

Mode Selection, Individual Mode Optimization, Network Optimization

- Mode – Driving, Transit, Pedestrian
- Driving – Eco, Safety, Mobility
  - Passenger
    - Eco routing
    - Real- time data
  - Trucks
    - Eco routing
    - Predictive cruise control
    - Real-time data