IBM Research Smarter Transportation Analytics

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INSTRUMENTED

We now have the ability to measure, sense and see the exact condition of practically everything.

INTERCONNECTED

People, systems and objects can communicate and interact with each

.

INTELLIGENT

We can respond to changes quickly and accurately, and get better results by predicting and optimizing for future events.

IBM Smarter Transportation Focus Areas

- Transportation Strategy and Planning
- Transportation Maturity Model
- Total Cost of Ownership Models
- Multi-Domain Impact Analysis

Transportation Advisory Services

- Integrated payment solutions for multiple transportation modes
- Shared Back office across multiple cities
- Cloud Infrastructure

Integrated Fare Management

IBM ITS Solutions

Innovative Transportation Pricing

- Single Highway/Bridge Tolling
- Network of Tolled Highway (incl. HOT networks)
- City Congestion Charging
- Usage Based Pricing/Taxation

Transportation Information Management

- Real Time Multimodal Traveler Information
- Performance Management and Reporting
- Traffic Prediction and Analytics
- Asset Management
- Decision Support Systems
- Multimodal Integration and Operations Optimization

Multimodal Transportation Maturity Model

Benchmarking

San Diego | London | Stockholm | Singapore | Seoul | Other

		Level 1 Silo	Level 2 Centralized	Level 3 Partially Integrated	Level 4 Multimodal Integrated	Level 5 Multimodal Optimized
strategic planning	Planning	Functional Area Planning (single mode)	Project-based Planning (single mode)	Integrated agency-wide planning (single mode)	Integrated corridor-based multimodal planning	Integrated regional multimodal planning
	Performance Measurement	Minimal	Defined metrics by mode	Limited integration across organizational silos	Shared multimodal system-wide metrics	Continuous system-wide performance measurement
	Customer Management	Minimal capability, no customer accounts	Customer accounts managed separately for each system/mode	Multi-channel account interaction per mode	Unified customer account tracks multiple modes	Integrated multimodal incentives to optimize multimodal use
real-time information creation capability	Data Collection	Limited or Manual Input	Near real-time for major routes/routes	Real-time for major routes using multiple modes	Real-time coverage for major corridors, all significant modes	System-wide real - time data collection across all modes
	Data Integration	Limited	Networked	Common user interface	2-way system integration	Extended integration
	Analytics	Ad-hoc analysis	Periodic, Systematic analysis	High-level analysis in near real-time	Detailed analysis in real-time	Multi-modal analysis in real-time
	Payment Methods	Manual Cash Collection	Automatic Cash Machines	Electronic Payments	Multimodal integrated fare card	Multimodal, multi-media (fare cards, cell phones, etc)
real-time intervention capability	Network Ops. Response	Ad-Hoc, Single Mode	Centralized, Single Mode	Automated, Single Mode	Automated, Multimodal	Multimodal Real-time Optimized
	Incident Management	Manual detection, response and recovery	Manual detection, coordinated response, manual recovery	Automated detection, coordinated response and recovery	Automated pre-planned multimodal recovery plans	Dynamic multimodal recovery plans based on real-time data
	Demand Management	Individual static measures	Individual measures with long term variability	Coordinated measures with short term variability	Dynamic pricing	Multimodal dynamic pricing
	Traveler Information	Static Information	Static trip planning, limited real-time	Multi-channel trip planning and account-based alert subscription	Location-based, on-journey multimodal information	Location-based, multimodal proactive re-routing

Multimodal Network Management Maturity Model version 1.1

Innovation Concepts – Transport Information Management

► *Issue:* strained infrastructure

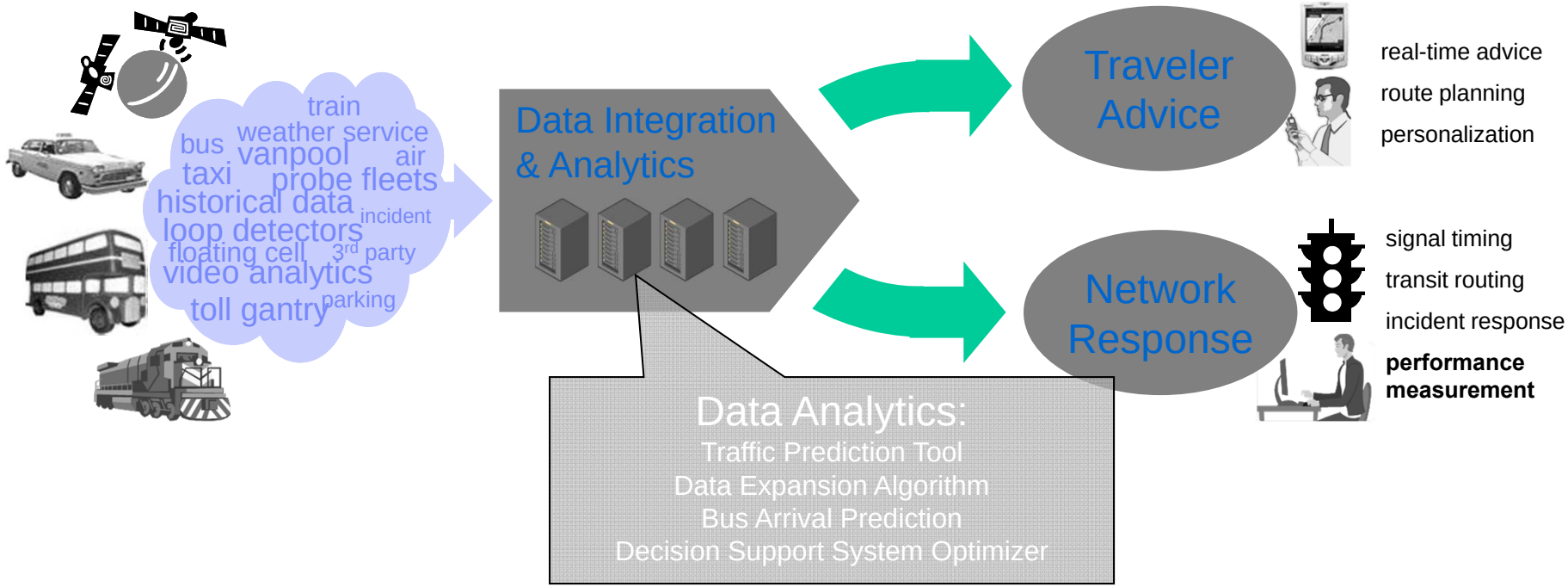
More transport capacity is needed, but construction of new physical infrastructure is **cost prohibitive**, if even possible

► *Issue:* navigating mass transit

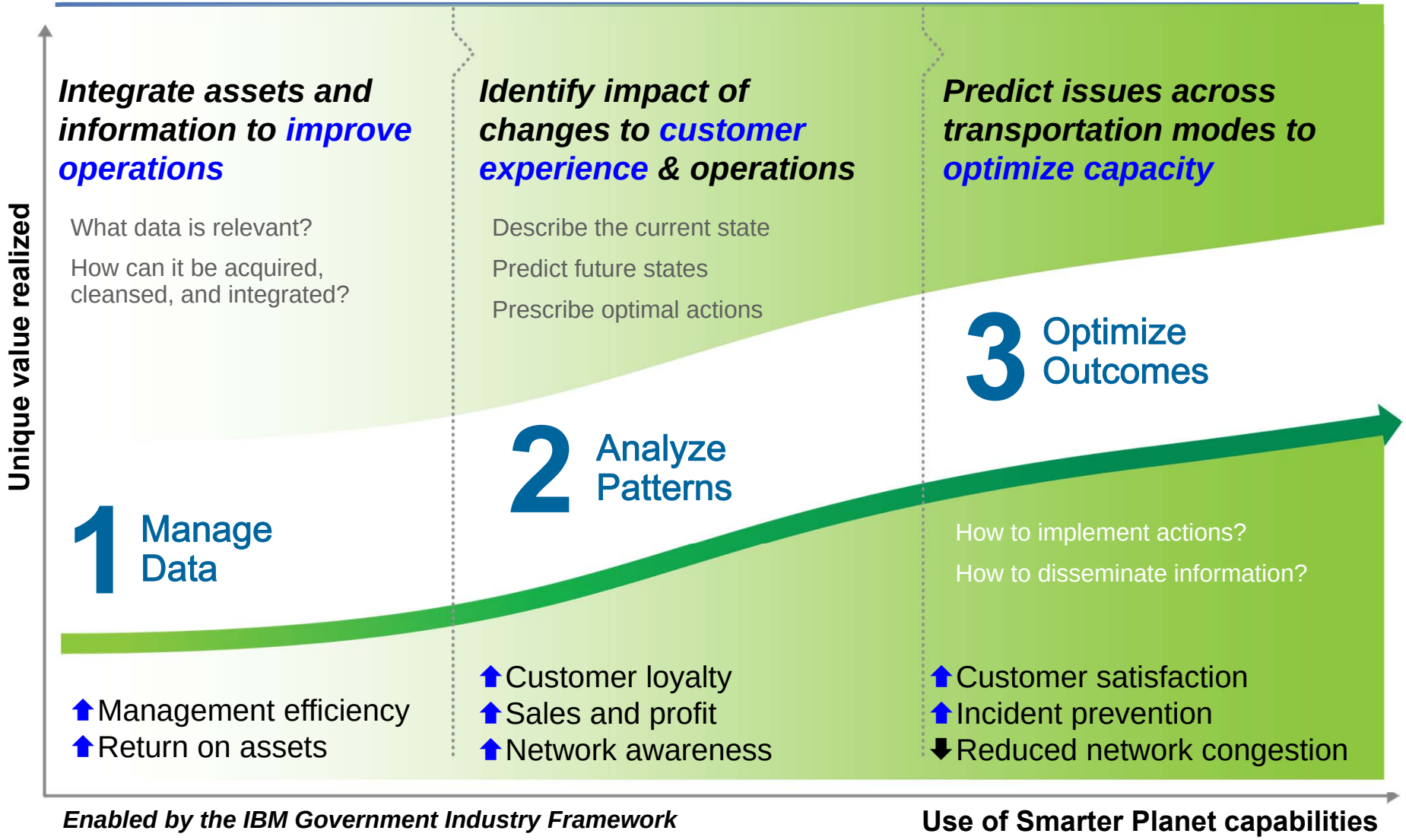
Transit is part of the solution, but it **must be easier** for travelers to find their way and weigh **options**

► *Required Innovation:* foundation of data integration & analytics

- Multiple data sources across transport modes
- Integrated to single **foundation of information**
- Leveraged for **multiple uses**
- Based on **open standards**
- Integrated **systems approach**, not point solutions



Building the Foundation for Smarter Transportation



Traffic Prediction Tool (TPT)

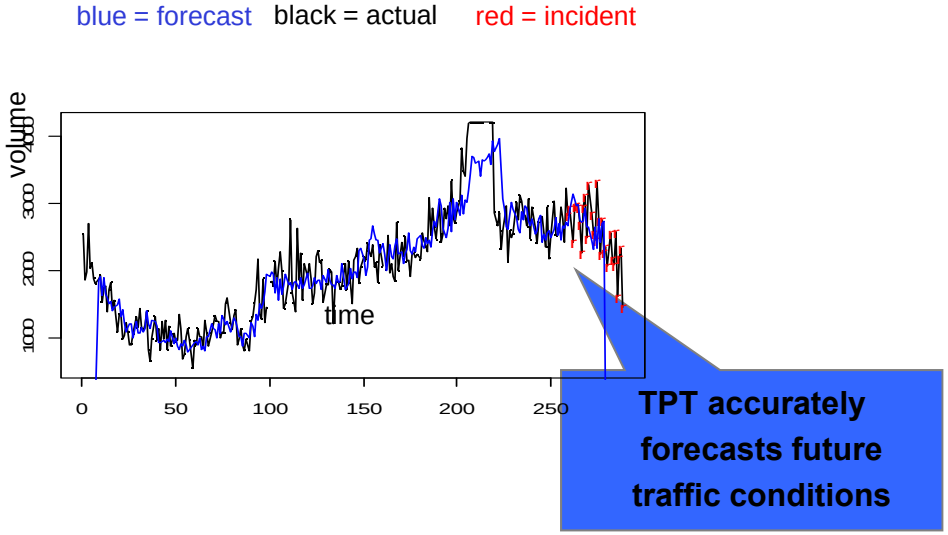
► *Issue:* "real-time" is too late

Little automated use is made of the **gigabytes of real-time traffic data** today; often, by the time it is received, it is **no longer representative** of the actual traffic

► *IBM Innovation:* forecast the future

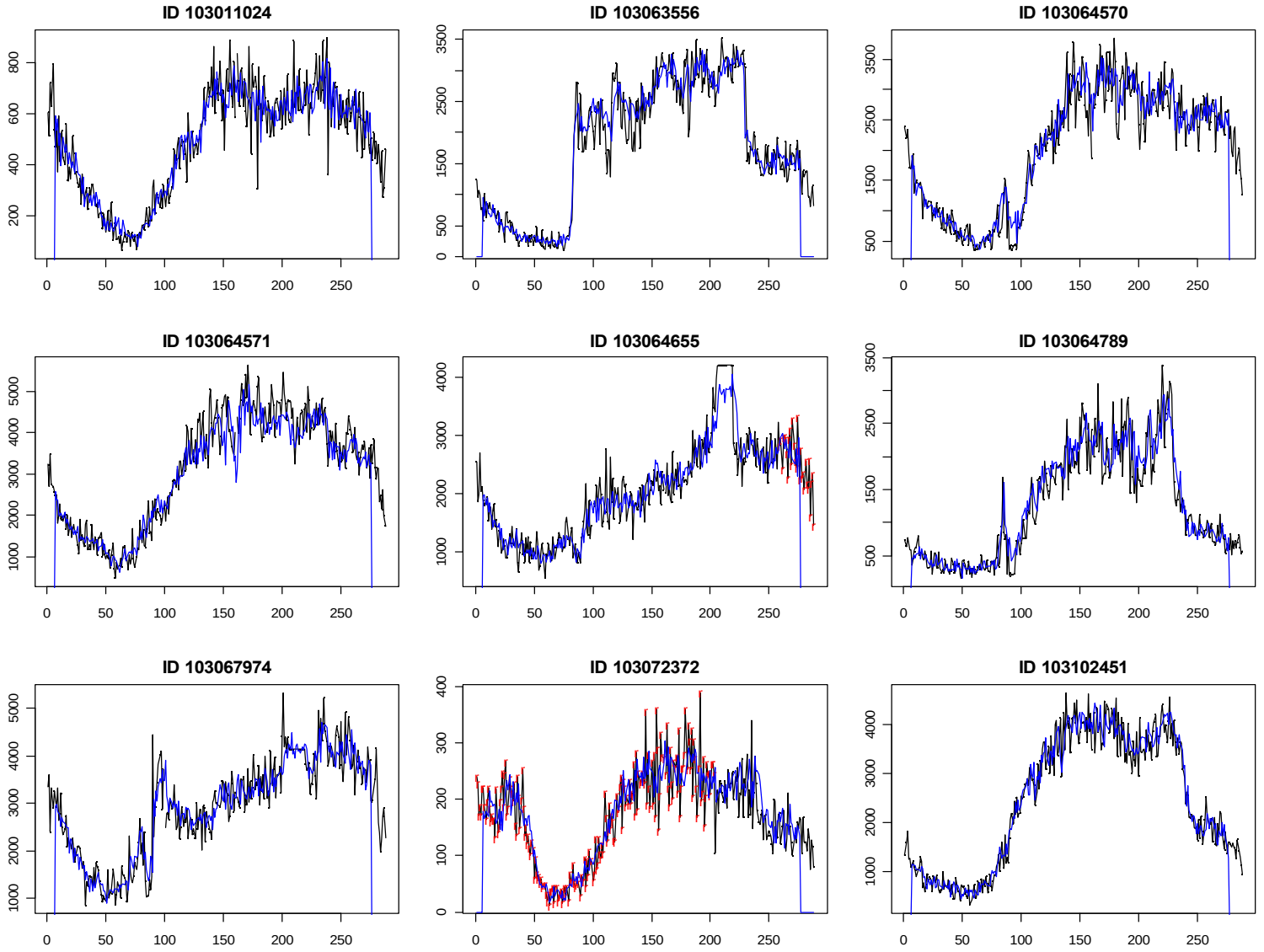
IBM's TPT provides a layer of **intelligence** by using sensor data in sophisticated algorithms that **create relevant insights** from the raw data

tool screenshot



Areas of Potential Use

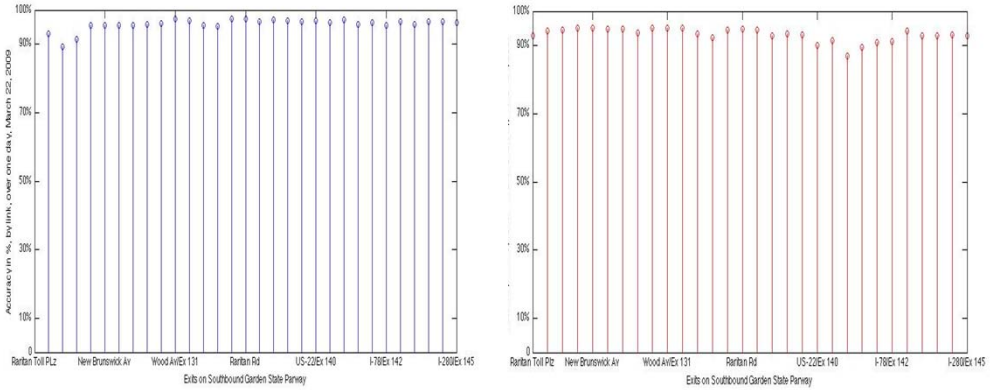
Traffic Operations: Advanced Traveler Information; traffic signal timing, ramp metering, route planning & advice, dynamic pricing



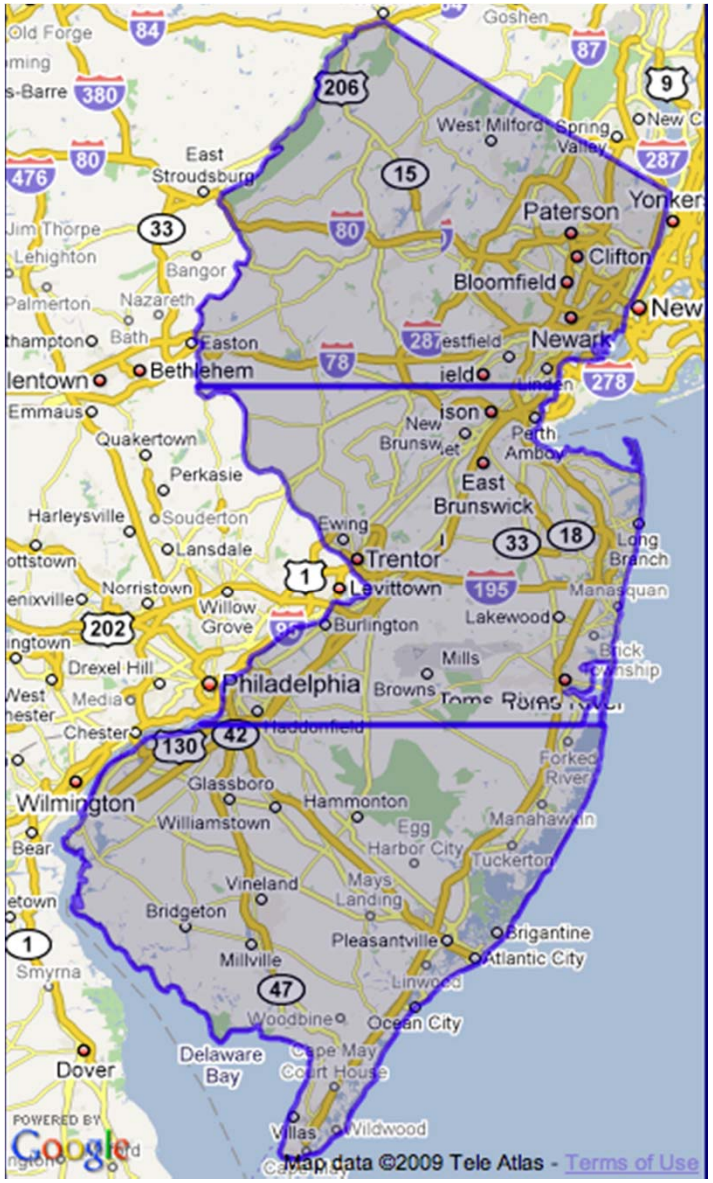
5 minute-ahead volume forecast (blue) vs. actual on Dec 10, 2006.
Roadworks were present on Link 103072372 and a vehicle breakdown on Link 103064655.

NJTA TPT Test
Section of Expressway Studied

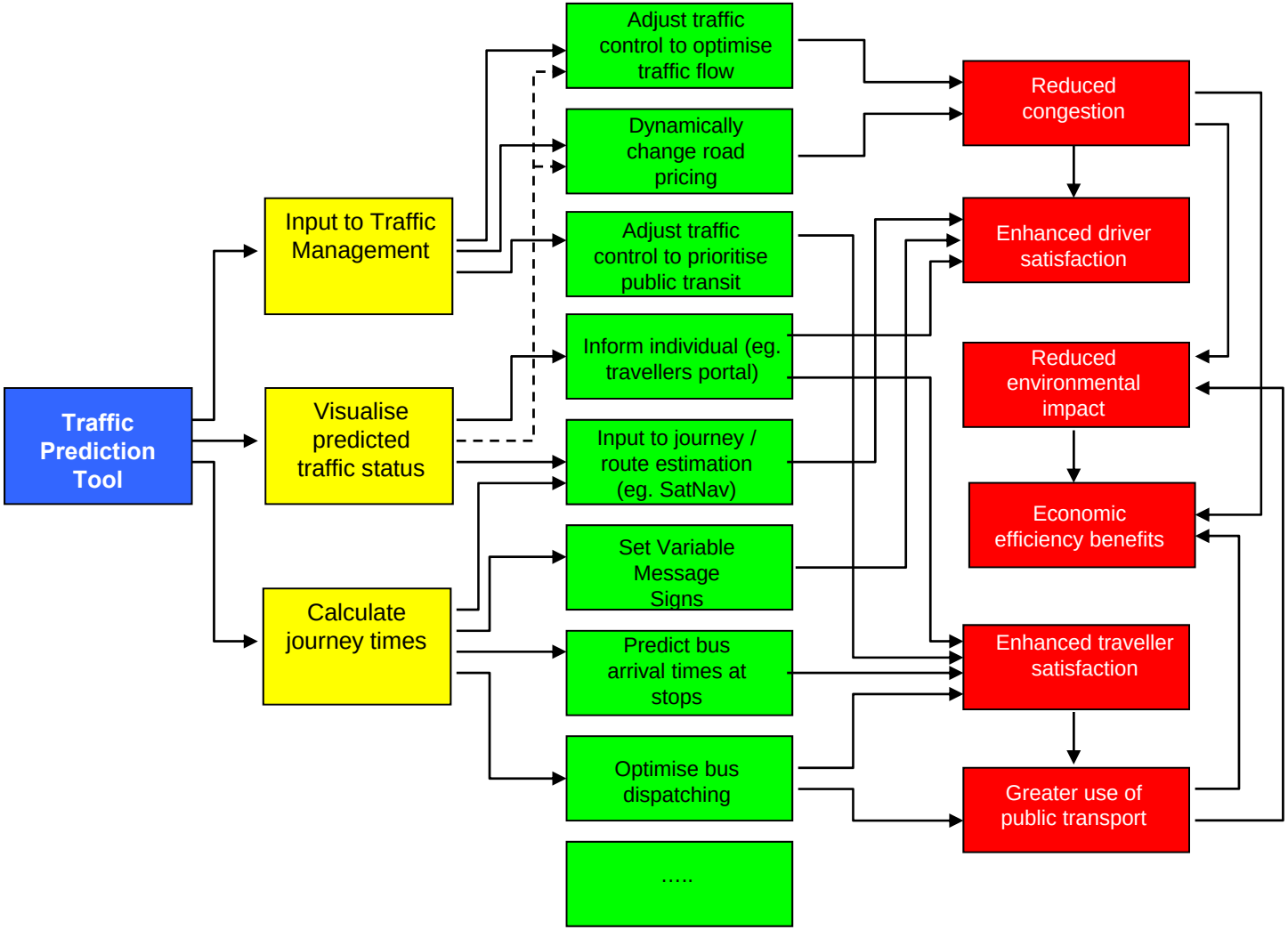
- Garden State Parkway
  - Raritan Toll Plaza to Exit 145/I-280
  - Southbound
  - Comprising 30 links on the Parkway
- New Jersey Turnpike - I-95
  - Northbound and Southbound
  - Comprising 65 links on the Turnpike
- Deployment underway following successful tests



Garden State Parkway, 10-mn predictions, daily average by road link
Overall average accuracy over two days analyzed is 95%

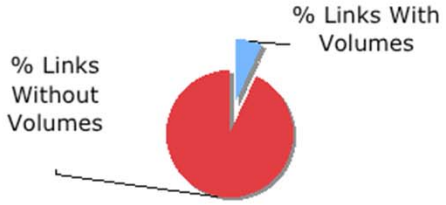


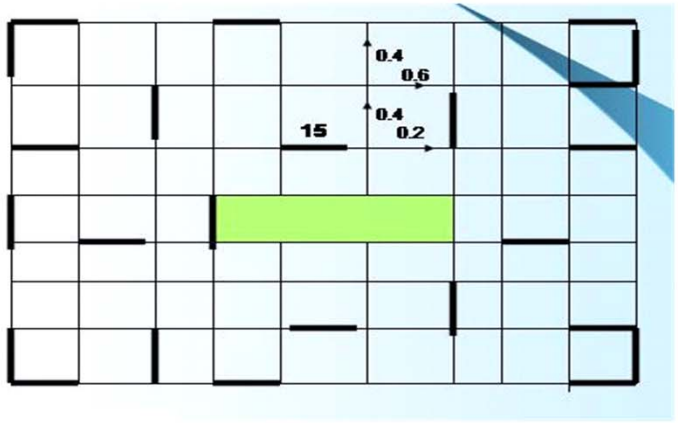
Traffic Prediction value proposition

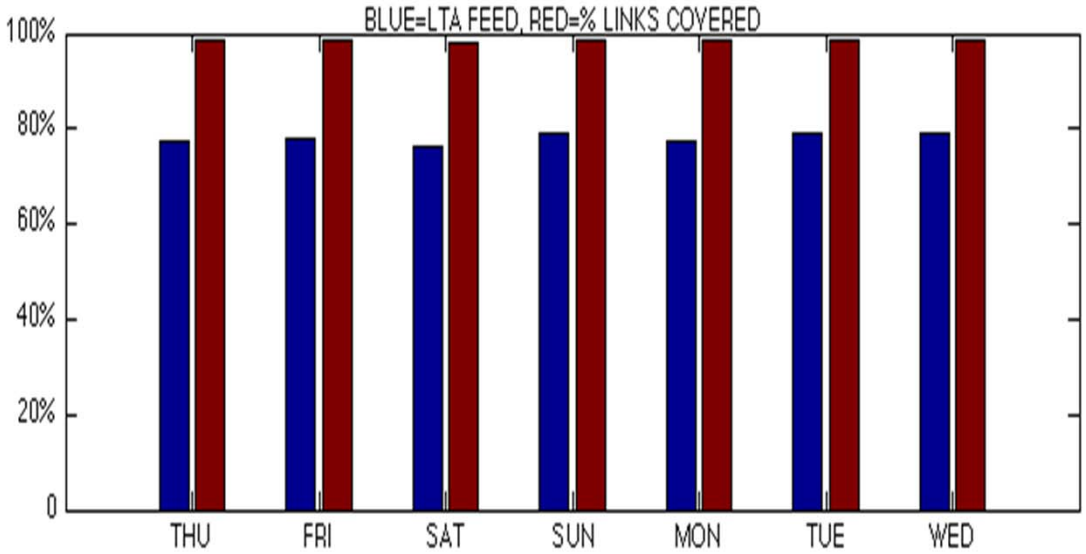


IBM DATA EXPANSION ALGORITHM (DEA)

Current state of LTA traffic volume data







- Problem description: Determine real-time traffic when sensor data is unavailable
- Solution: IBM's Data Expansion Algorithm (DEA)
- Outcome and Benefits: Expand real-time data to as close as possible to full network

BUS ARRIVAL PREDICTION (BAP)

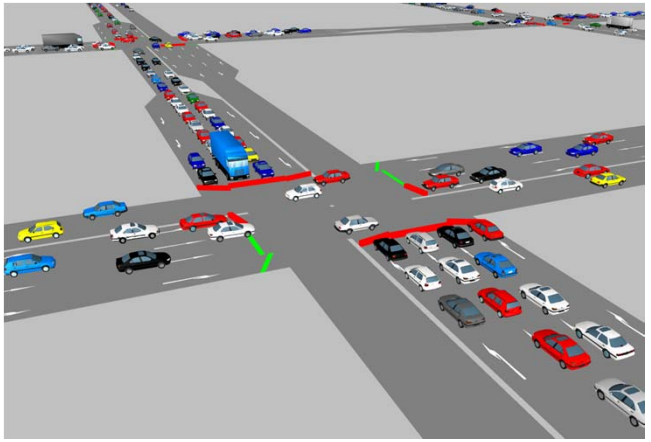
- Problem description:
  - Provide travellers with accurate and frequently updated future bus arrival time.
  - Existing similar systems' performance failed to match the sophistication level of data source.
  - Innovative approach is needed to fully unleash the useful information hidden in various data source in a more sophisticated manner, in order to bring the forecasting accuracy up to a level near plus/minus 1 minute with 90% confidence. (*Current service level is within +/- 3 min with 85% confidence)

- Solution:
  - IBM is currently collaborating with LTA, co-developing a new forecasting algorithm.
  - It is mining periodic trends and patterns of bus arrivals, using bus GPS data
  - as well as the TPT prediction of future traffic status on subsequent links along the bus routes.

- Outcome (*ongoing work, interim outcome*):
  - Selected bus service route 61 and 75, 8 bus stops each.

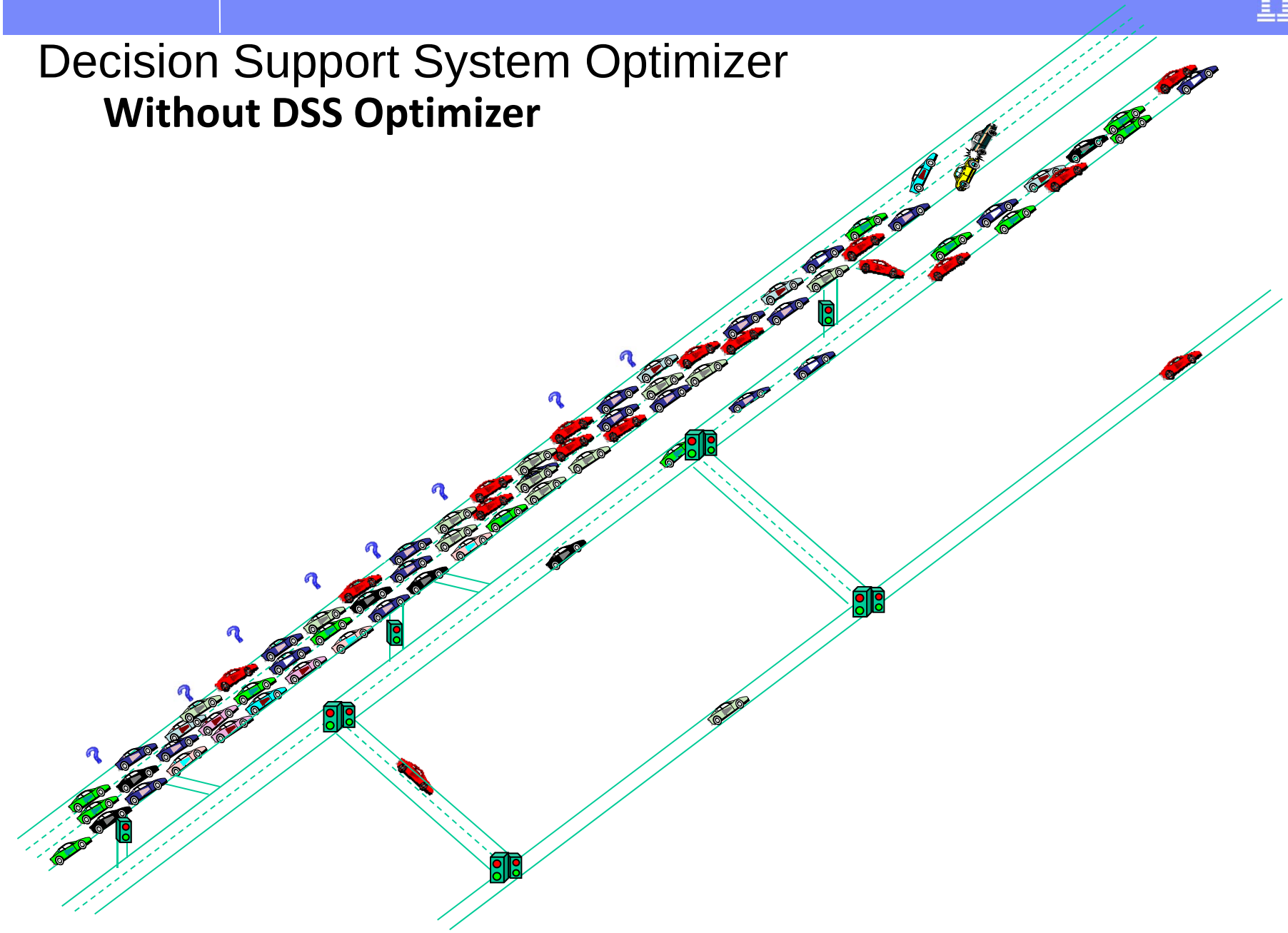
Decision Support System (DSS) Optimizer

- Transportation Command Centers today are largely not equipped to determine response plans based upon large volumes of data and analytic methods.
- Typically, today, some real-time data is visualized, but the expected outcomes of potential responses are generally not computed.
- It is widely accepted that the “Command Center of the Future” should leverage the massive amounts of transport data for more effective response plan generation.
- This is the motivation of the Decision Support System (DSS) Optimizer



Decision Support System Optimizer

Without DSS Optimizer



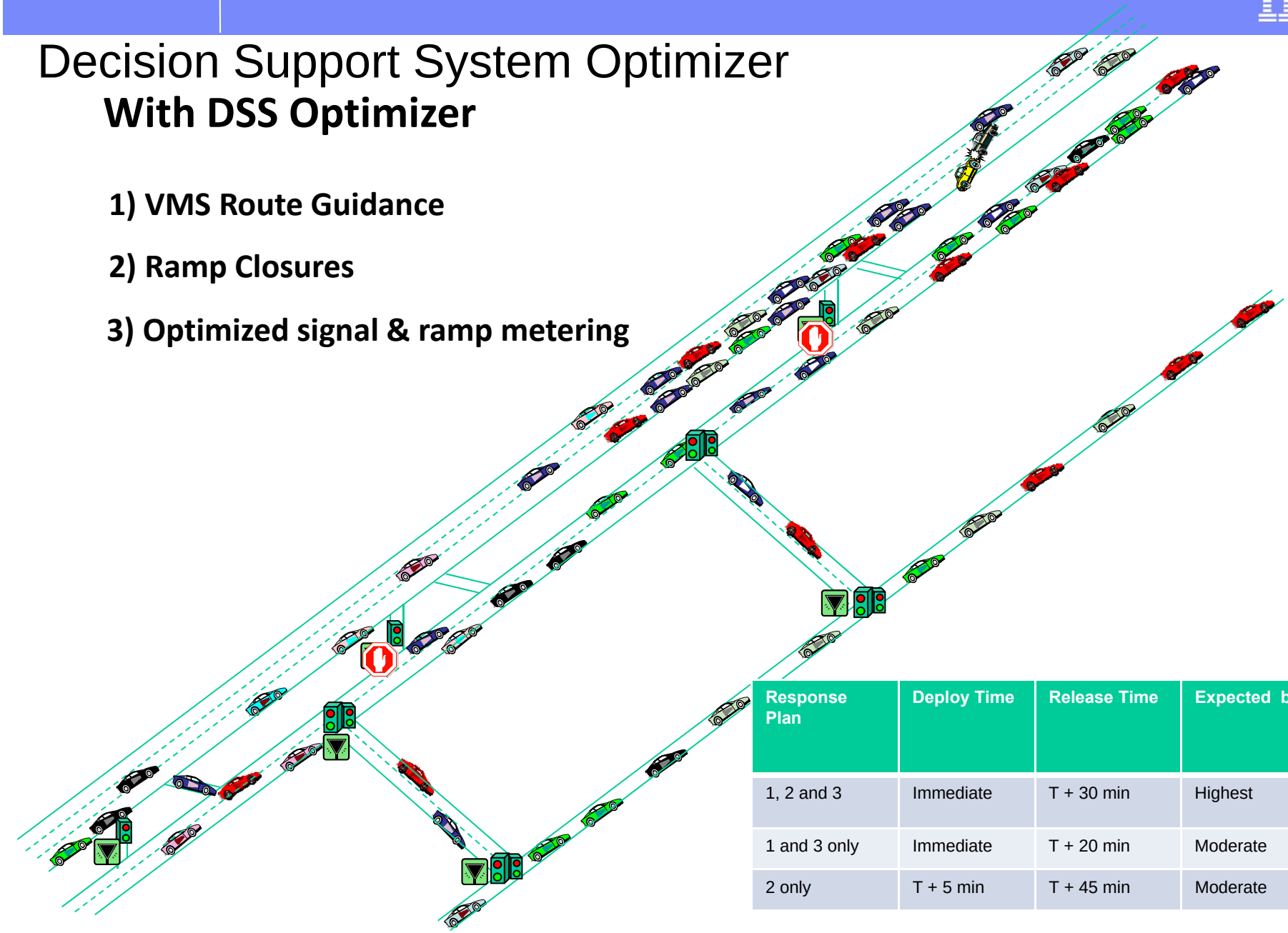
Decision Support System Optimizer

With DSS Optimizer

1) VMS Route Guidance

2) Ramp Closures

3) Optimized signal & ramp metering



Response Plan	Deploy Time	Release Time	Expected benefit
1, 2 and 3	Immediate	T + 30 min	Highest
1 and 3 only	Immediate	T + 20 min	Moderate
2 only	T + 5 min	T + 45 min	Moderate