PTV GROUP
the mind of movement

PTV OPTIMA
the mind of movement

SMART TRAFFIC MANAGEMENT WITH PTV OPTIMA

CAN THE ROADS BE 1 STEP AHEAD?

Prabhu TD – Transport Planner

Sonal Ahuja – Regional Director

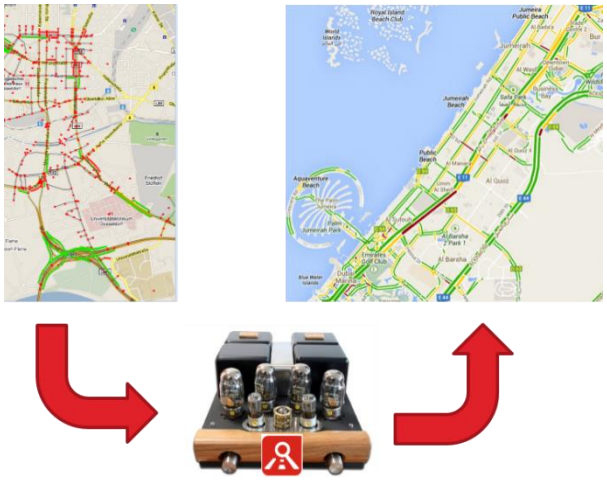
Florian Weichenmeier – Realtime Traffic Software

OUR SOLUTION IS A DYNAMIC TRAFFIC CONTROL TOOL FOR REAL-TIME DATA FUSION AND TRAFFIC PREDICTION

Provides:

- Complete overview of your roads and PT
- Speed and flow and KPI evaluation everywhere
- Predict future effects for the next few Hours or Days
- Evaluate response strategies within the next 5-120 minutes”
- Calibration in real-time - KPIs continuously collected
- “From a reactive to a proactive approach to traffic management and info-mobility”
- “Provide reliable, on-time, useful traveller information”
- Emergency/ Disaster Plan Mitigation

DATA FUSION AND AMLIFIER



INFORMATION SOURCES AND CONTROL DEVICES

Civil Defence/
Emergency Vehicles

In Car Navigation System/Taxi/Bus GPS (FCD)
Metro/LRT and PT Data/ Journey planner

Bluetooth Data
(FCD)

Emergency Response Centre/ 999 Control Room/
Radio Broadcasts/ Disaster/Event Response

The Transport Model
Traffic Counts

Salik/ CCTV/ ANPR/Loop Detector Data

Mobile Apps
(FCD)

Traffic Signals and
Detectors

VMS Signs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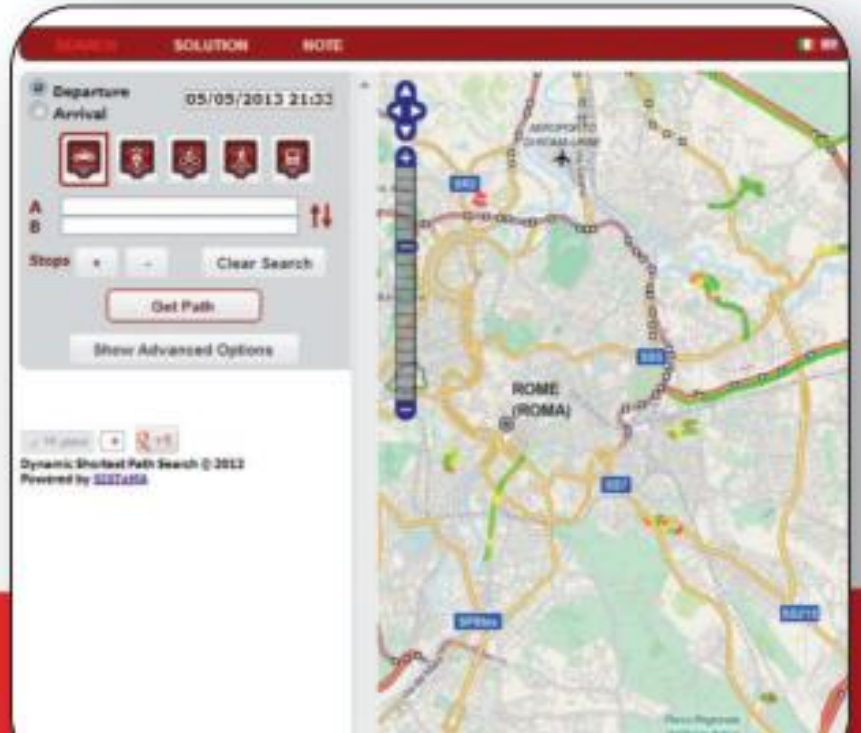
big
data
vision-traffic.ptvgroup.com

hyperpath

a new way to find your way

The first journey planner for intermodal dynamic routing taking into account real-time conditions of road networks and transit



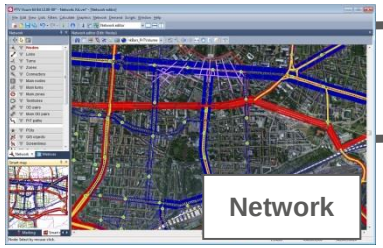
Agile

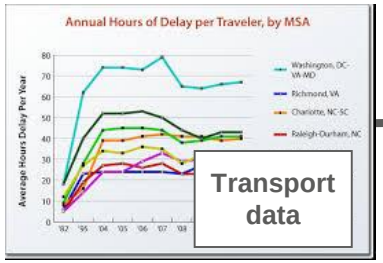
Travel on a **multi-modal** transport network by car, bus, subway, bicycle, coach, train, taxi and on foot.

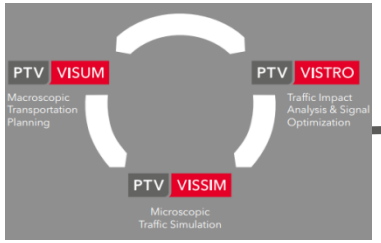
Hop on and off exploiting any feasible interchange, including private-public trips like **park and ride**.

Consider **time dependencies** such as schedule coincidences, service frequencies and limited access zones.

OPTIMA Logical Model







ON LINE

Data Fusion

PTV OPTIMA:
- Real time TI
- Instant propagation
- instant ST forecasts
- Event impacts

Output convertors

Result Dissemination and Decision Support by XML, GPRS, RDS, VMS, etc

Events from Operator GUI and other systems

Dynamic Model

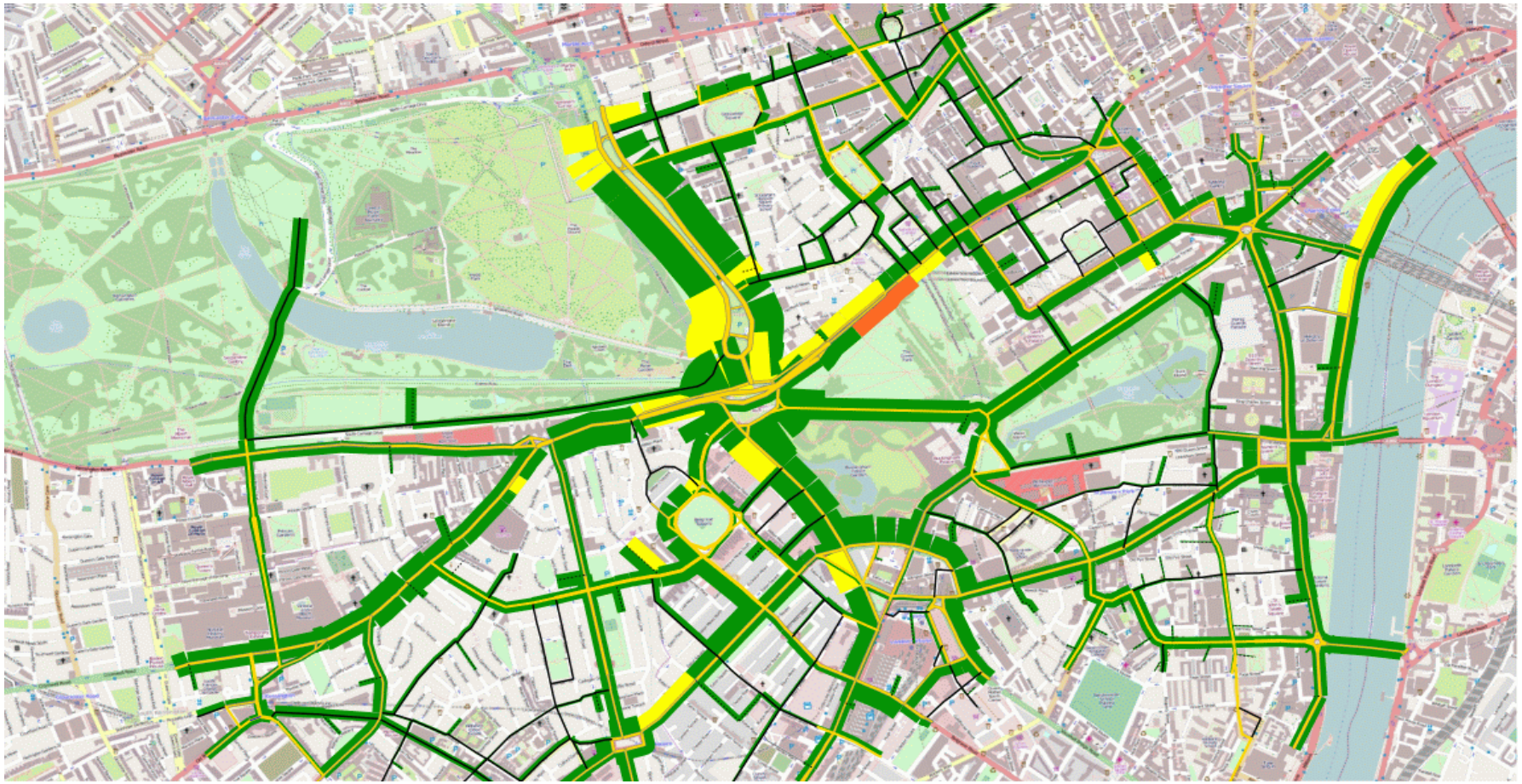
Full coverage in space

Full coverage in time

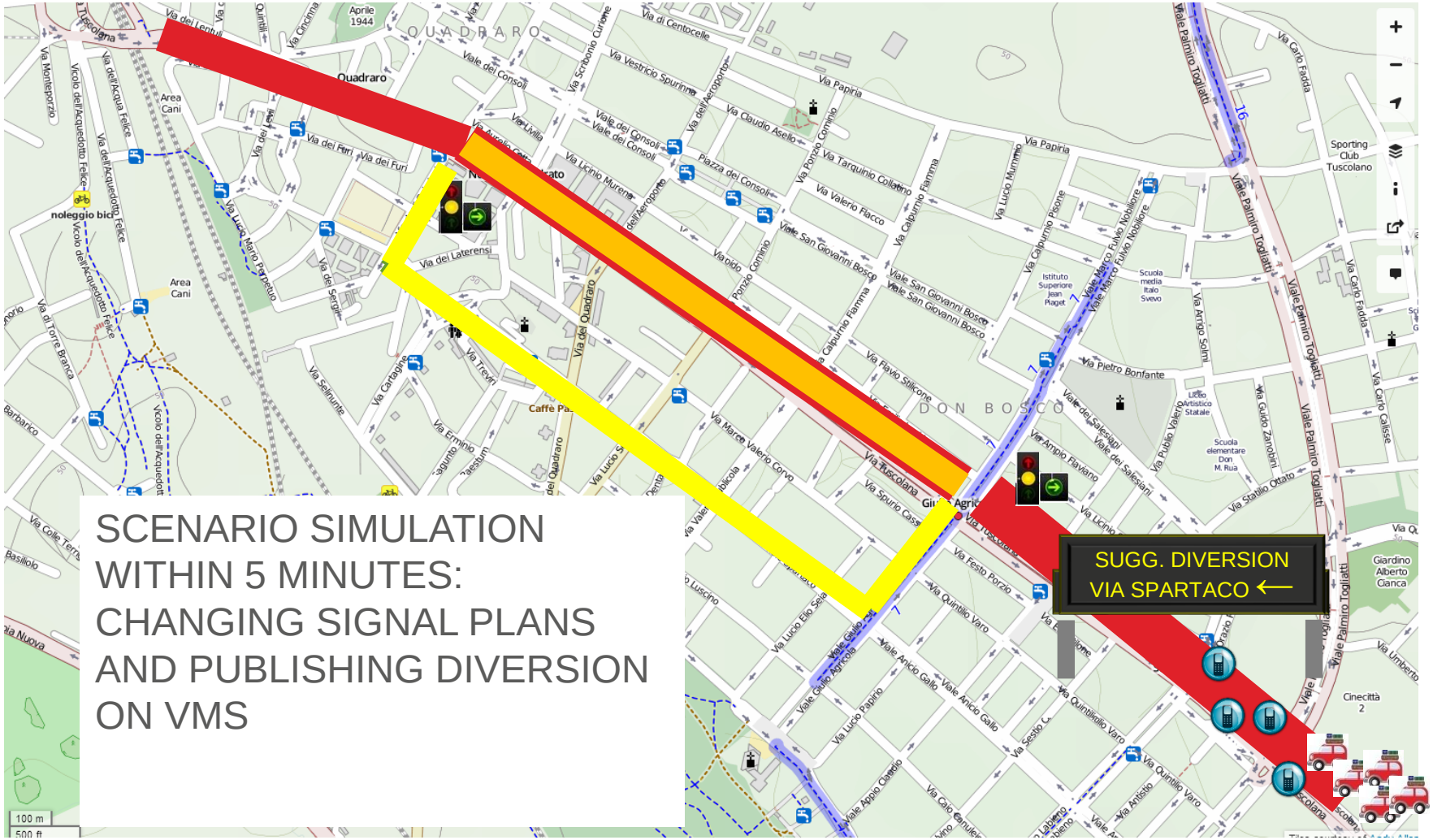
Pro-active decisions

<<AUGMENTED>> INFOMOBILITY

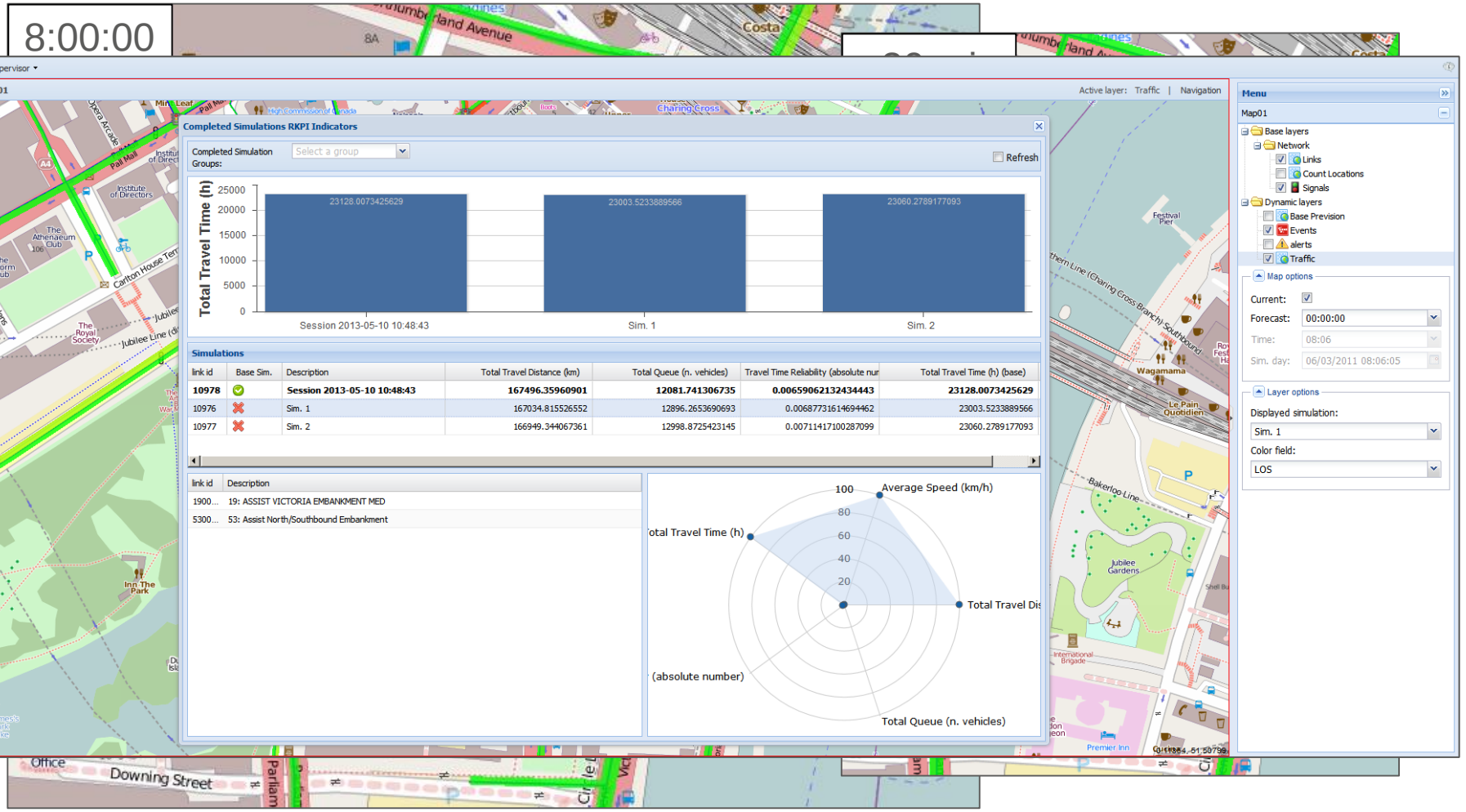
… FORECAST FOR 7:30 AM … SPACE AND TIME EXPANSION



DECISION SUPPORT



PTV OPTIMA - KEY FUNCTIONS
DECISION SUPPORT SYSTEM - COMPARISON OF RESULTS



Background image from OpenStreepMap

REAL-TIME

Upgradability from PTV Visum to PTV Optima
Revolutionary real-time traffic management

COMPARING APPROACHES FOR TRAFFIC FORECAST

Objective → / Method ↓	**Traffic Estimation** *"What is going on?"*	**Traffic Forecast** *"What is going to happen?"*	**Scenario Evaluation & Decision Support** *"What would happen if?" "What should we do?"*
Observed data EASY	Maybe with extensive measures	No	No
Statistical approach ROBUST	YES	"usual" conditions only	No
Simulation Approach EFFECTIVE	YES	YES	YES

OPTIMA REFERENCES

- Paris: 2016
- Dubai: 2017
- London: 2016
- Munich: 2015
- Turino (ITALY) : 2014
- ERFURT (GERMANY) : 2014
- VIENNA (AUSTRIA) : 2015
- CATANIA (ITALY) : 2015
- RUSSIAN HIGHWAYS : 2015
- MOSCOW (RUSSIA) : 2014 - 2015
- SACHSEN ANHALT REGION (GERMANY) : 2015 - 2016
- ABU DHABI (UAE): 2016

➡ REAL INSTALLATIONS and not PILOT or small areas

REAL-TIME DISASTER MANAGEMENT CENTER

Smart Traffic Solutions for Smart Cities – PTV Group

Project EC^3 - Dubai

WHY IMPLEMENT THE SYSTEM

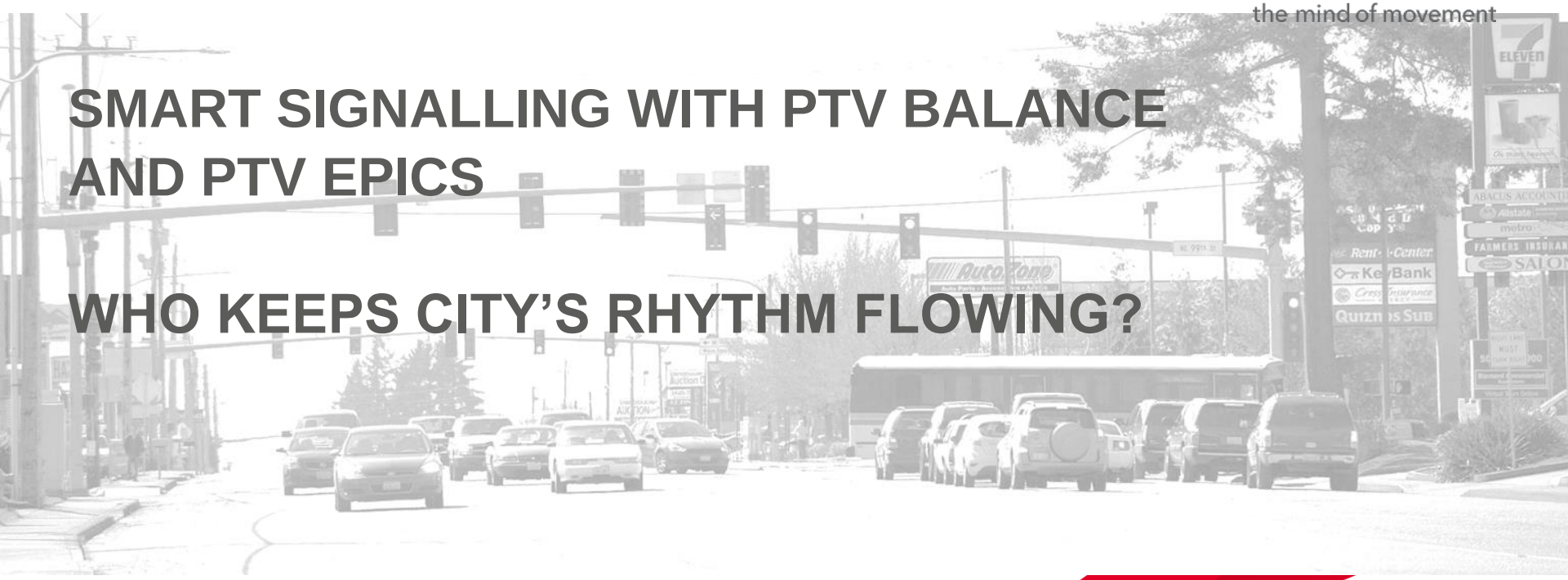
- PREDICT AND PREVENT ROAD DISASTERS
- CREATE POSTIVE AND GOOD GOVERNANCE IMAGE
- IMPROVE QUALITY OF LIFE
- PROVIDE BACKBONE FOR POLICY FRAMEWORK
- HELP DEVELOP WORLD CLASS INFRASTRUCTURE
- SMART TRAFFIC MANAGEMENT FOR SMART CITIES

SAVE PRECIOUS LIVES

PTV GROUP
the mind of movement

PTV BALANCE
the mind of movement

PTV EPICS
the mind of movement

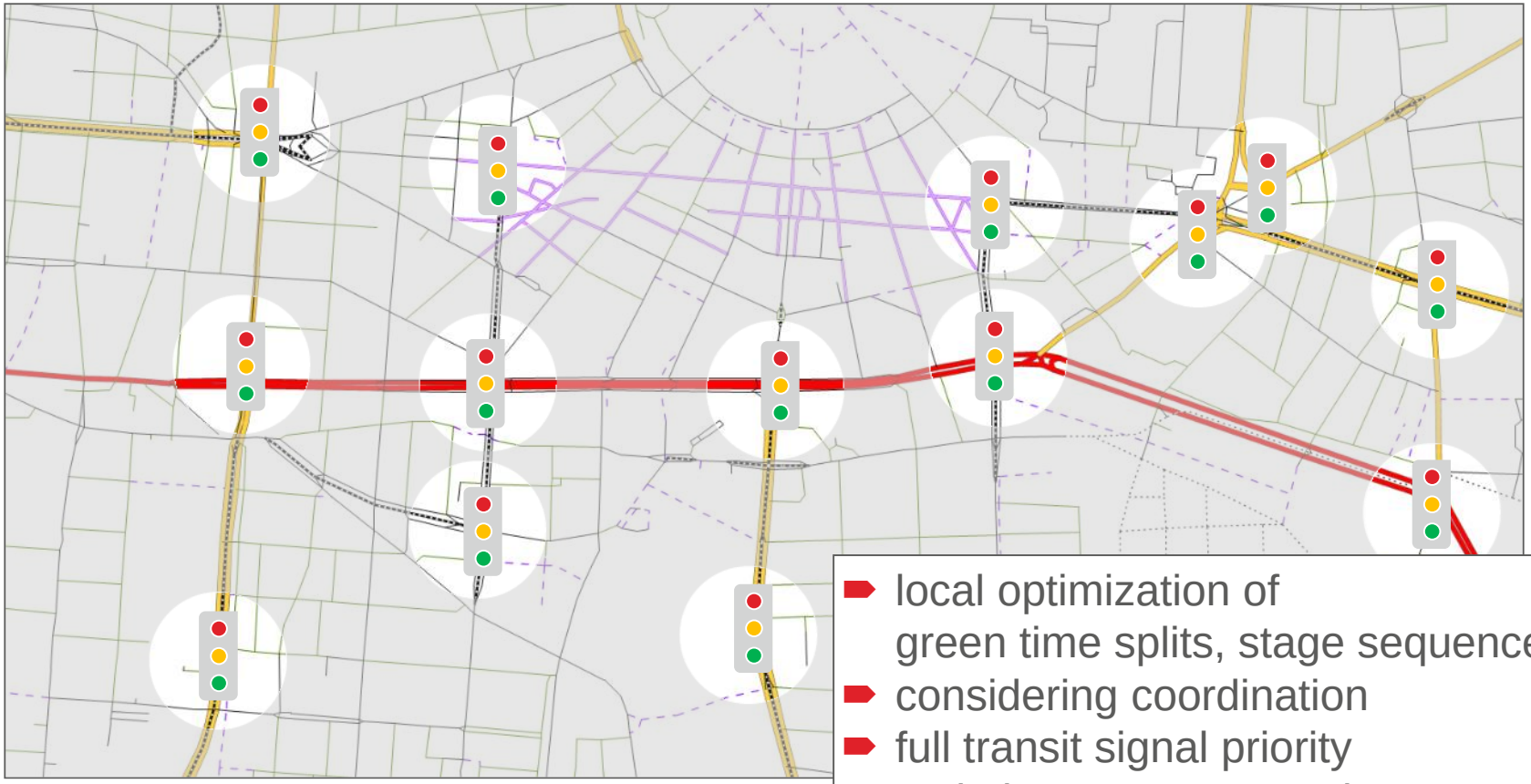


SMART SIGNALLING WITH PTV BALANCE AND PTV EPICS

WHO KEEPS CITY'S RHYTHM FLOWING?

VEHICLE ACTUATED SIGNAL CONTROL
INTRODUCING PTV BALANCE AND PTV EPICS

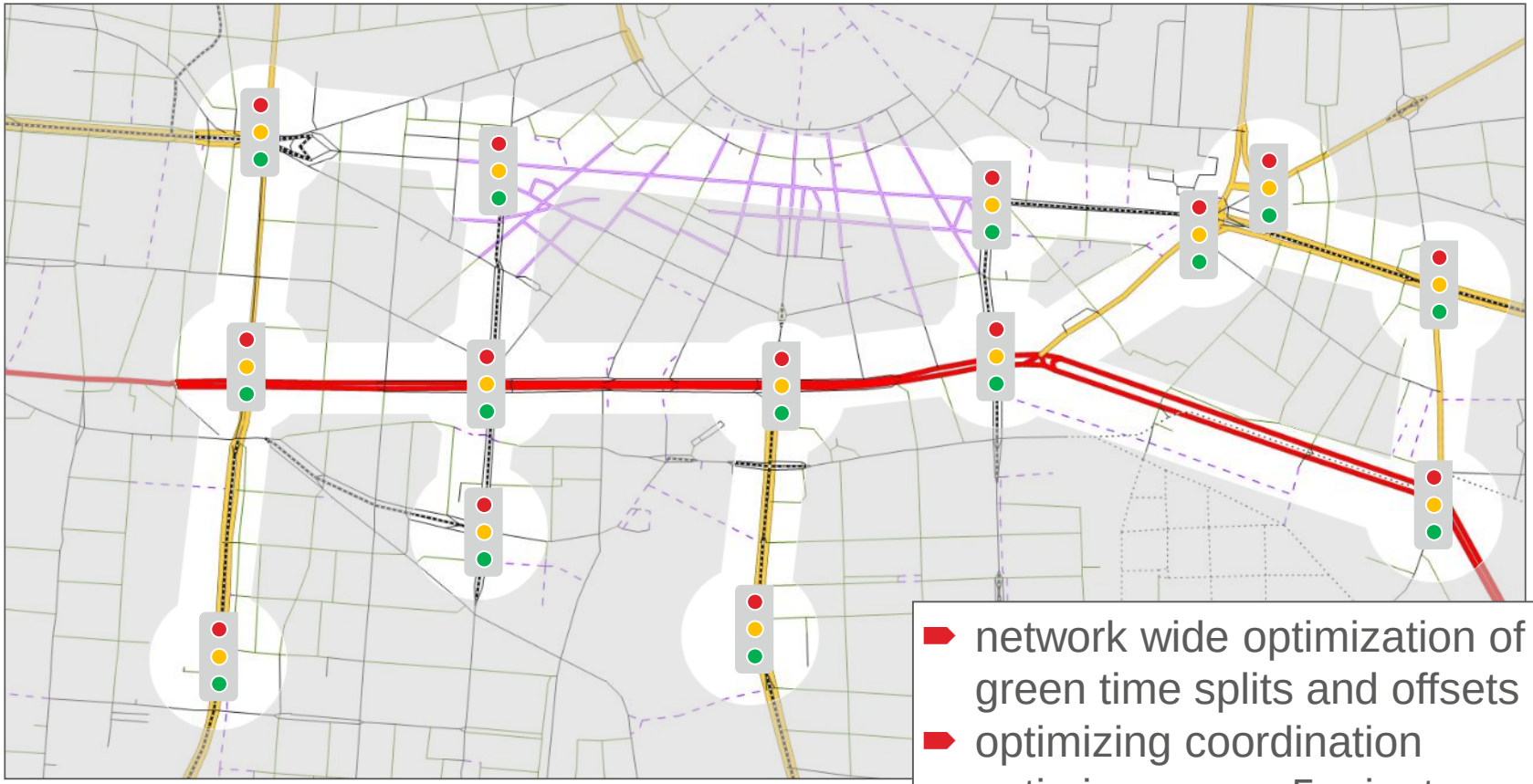
Entire **P**riority **I**ntersection **C**ontrol **S**ystem - PTV **Epics**



- local optimization of green time splits, stage sequence
- considering coordination
- full transit signal priority
- optimizes every second

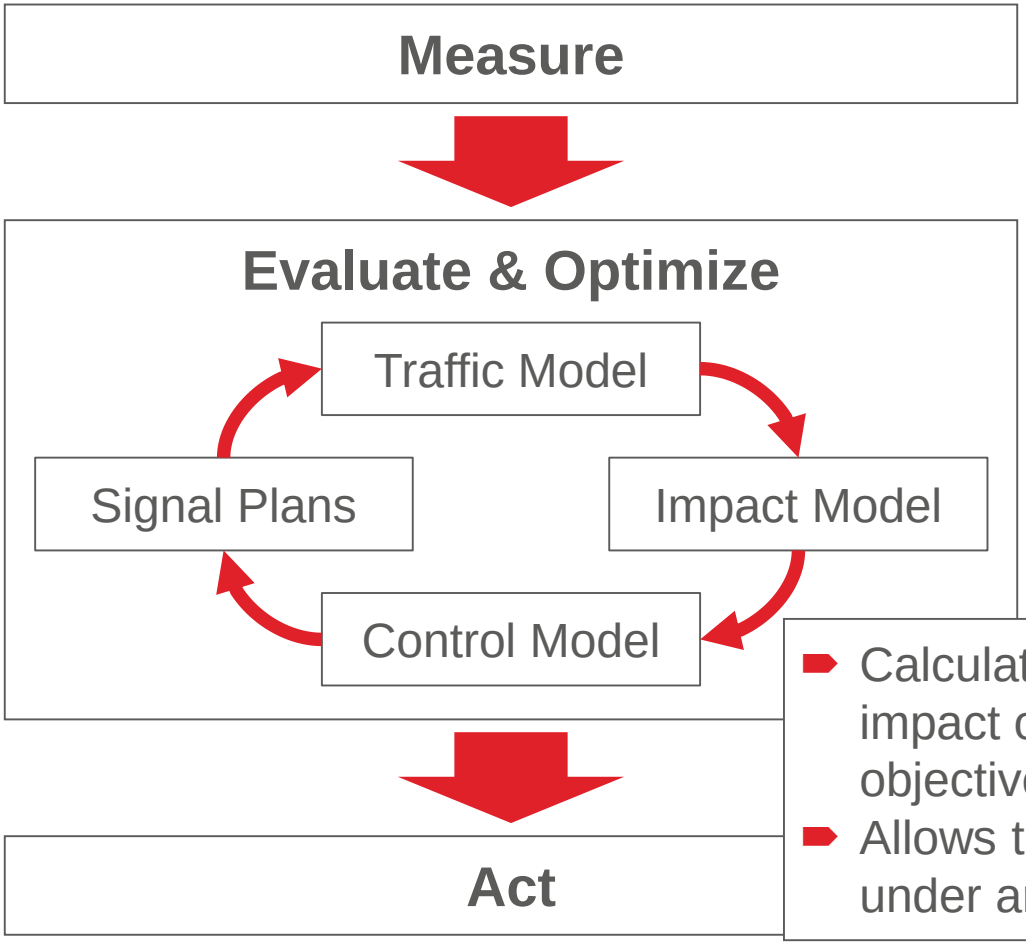
VEHICLE ACTUATED SIGNAL CONTROL
INTRODUCING PTV BALANCE AND PTV EPICS

Balancing **A**daptive **N**etwork **C**ontrol M**e**thod - PTV **Balance**



- network wide optimization of green time splits and offsets
- optimizing coordination
- optimizes every 5 minutes

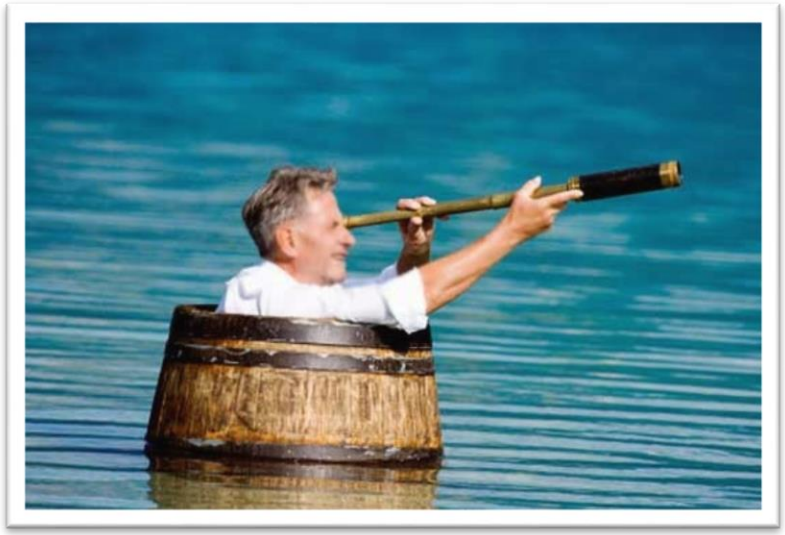
VEHICLE ACTUATED SIGNAL CONTROL
ADAPTIVE (MODEL-BASED) CONTROL



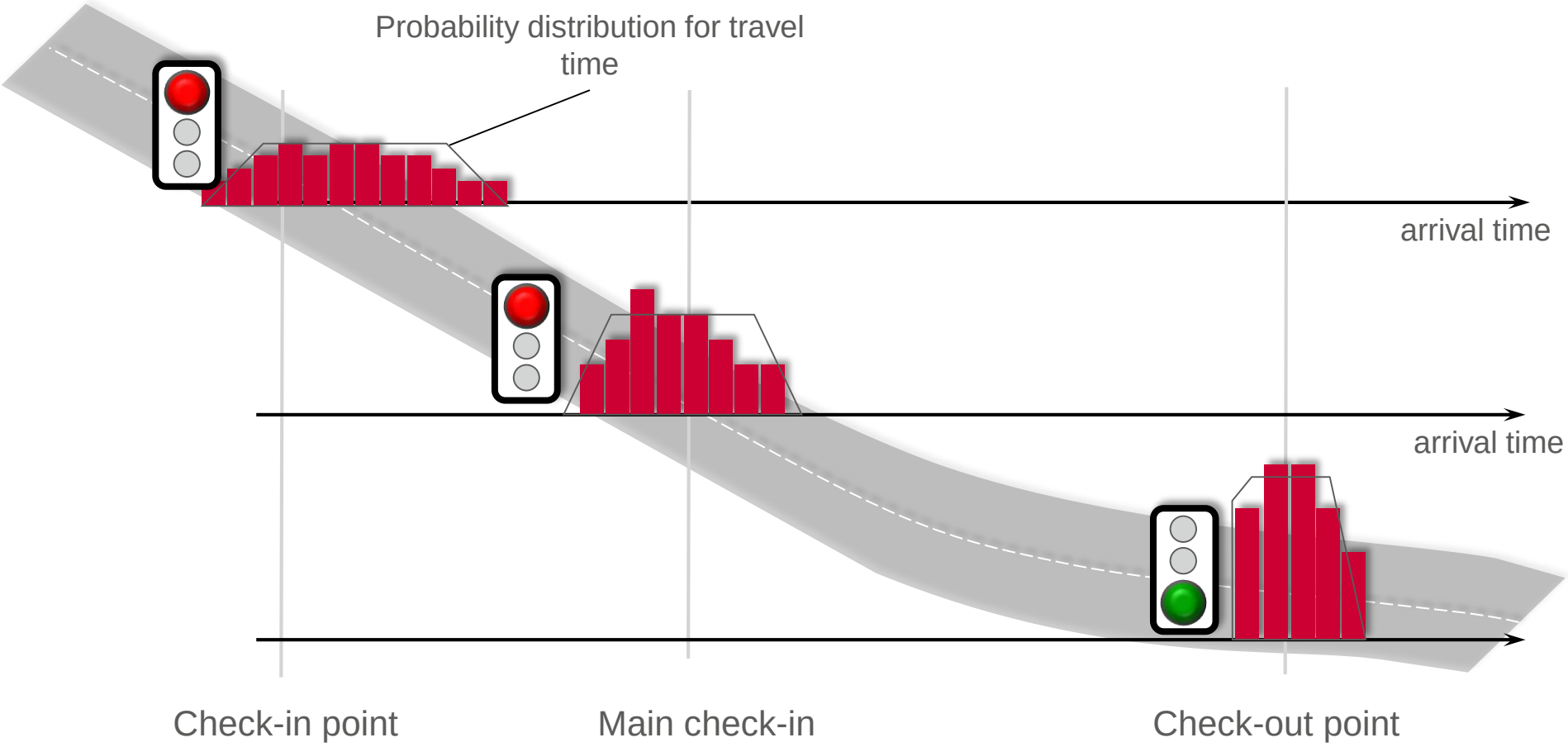
- Calculates and evaluates impact of control on objective
- Allows true optimization under arbitrary conditions

PTV EPICS - TRAFFIC MODEL
LOOKING INTO THE FUTURE

- Epics prognoses the traffic for the next 100 seconds, based on:
  - Current detector demand (one detector per lane 1-100m before the stop line)
  - Current queue lengths (dedicated queue estimator)
  - Cyclic flow profiles
  - Public transport information
  - Pedestrian push buttons



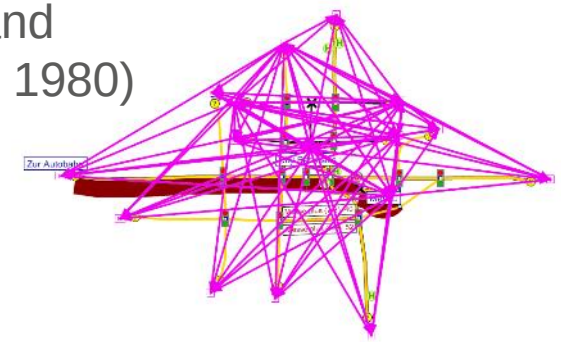
PTV EPICS - TRAFFIC MODEL FOR PUBLIC TRANSPORT



PTV BALANCE - TRAFFIC MODEL

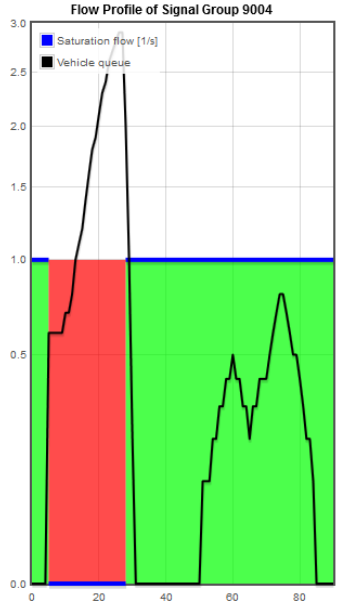
Origin-Destination-Estimation

- Adaptation of existing OD-Matrix to current traffic demand
- By maximization of entropy (van Zuylen and Willumsen 1980)
- According to current detector data



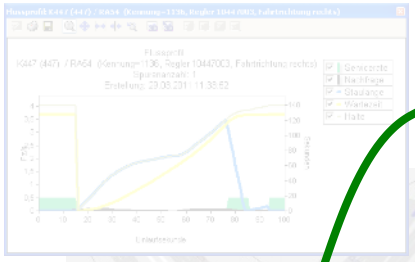
Traffic Flow Model

- Second-by-second approach
- Deterministic flow profiles according to OD-routes
- Stochastic influence via model by
  Kimber and Hollis



PTV BALANCE - IMPACT MODEL

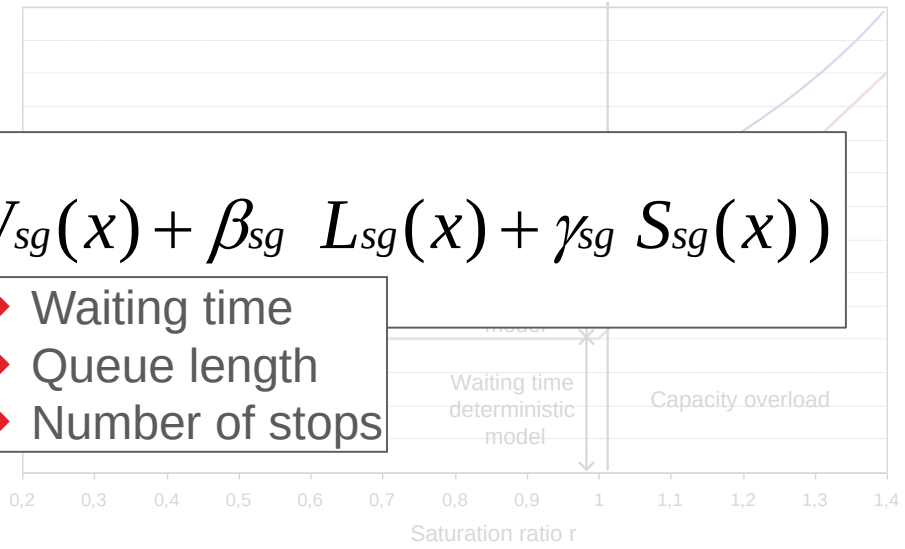
Based on the traffic flow model...



To be minimized by control model

$$PI(x) = \sum_{sg \in Sg} \left(a_{sg} W_{sg}(x) + \beta_{sg} L_{sg}(x) + \gamma_{sg} S_{sg}(x) \right)$$

- Waiting time
- Queue length
- Number of stops



PTV BALANCE - CONTROL MODEL METHODOLOGY

Network Wide Optimization of “Green Waves” Based on Genetic Algorithms (GA)

- Mimicking the evolutionary process of nature
- Heuristic optimization with a wide number of applications
- “Smart” Trial and Error

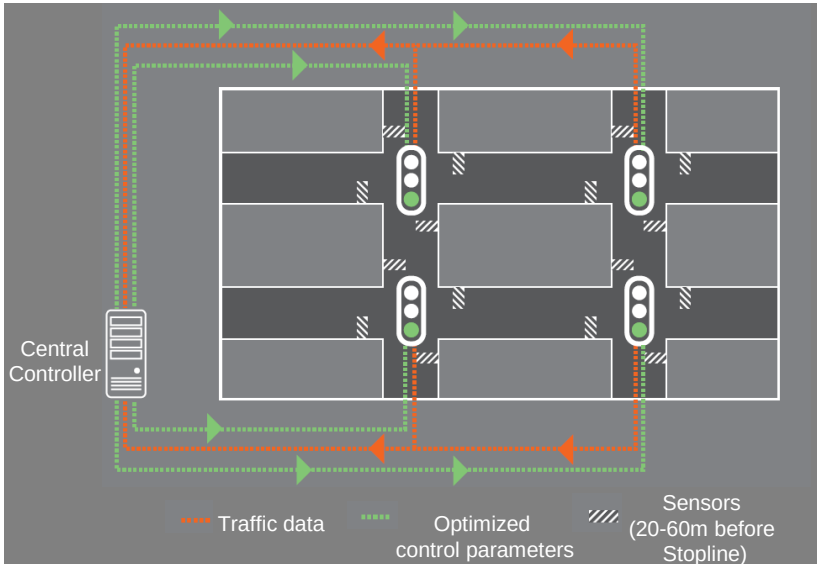
Advantages

- Fast search in big solution spaces
- Simultaneous optimization of all parameters
- Risk of „local optimum" reduced

PTV BALANCE - CONTROL MODEL CAPABILITIES

- Mathematically established - genetic algorithms
- Simultaneous optimization of split und offset
- Optimization of cycle time through choice of signal plan
- Network wide assessment of traffic impact
- New frame signal plan every 5 minutes

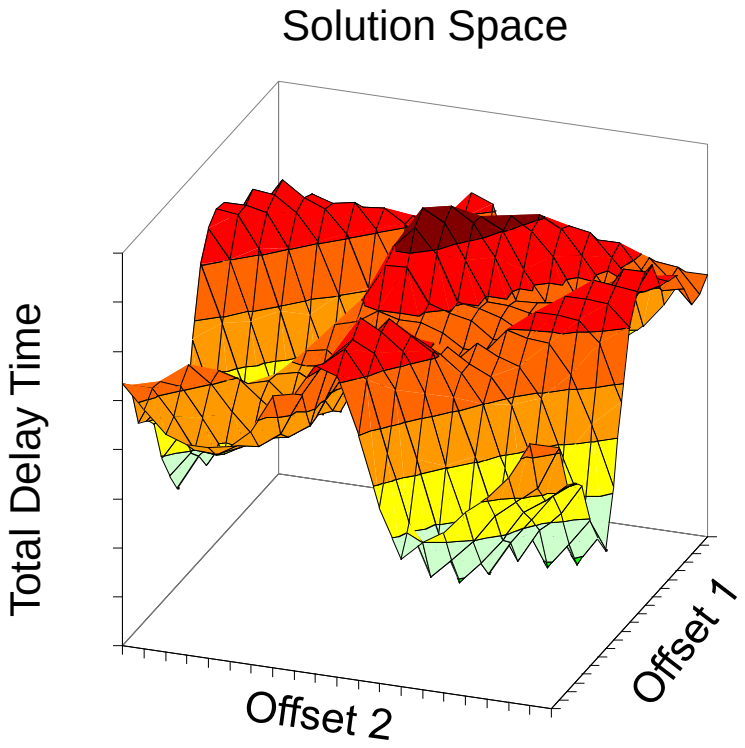
- Local adaptation by PTV Epics



PTV BALANCE - CONTROL MODEL USING A GENETIC ALGORITHM

Network Wide Optimization of “Green Waves”

- Very complex
- Not solvable analytically
- Not solvable using “brute force”

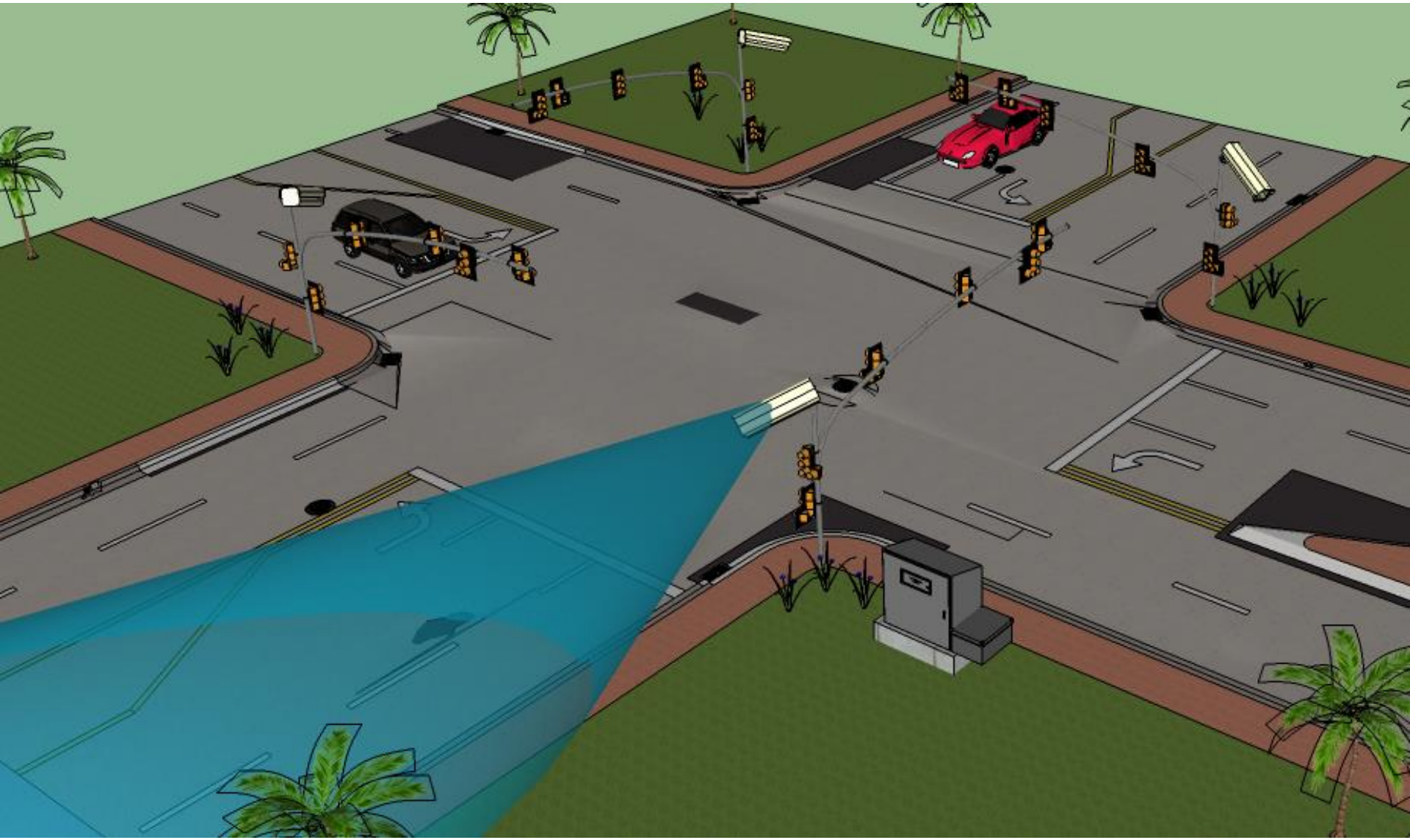


WHY ARE WE BETTER?

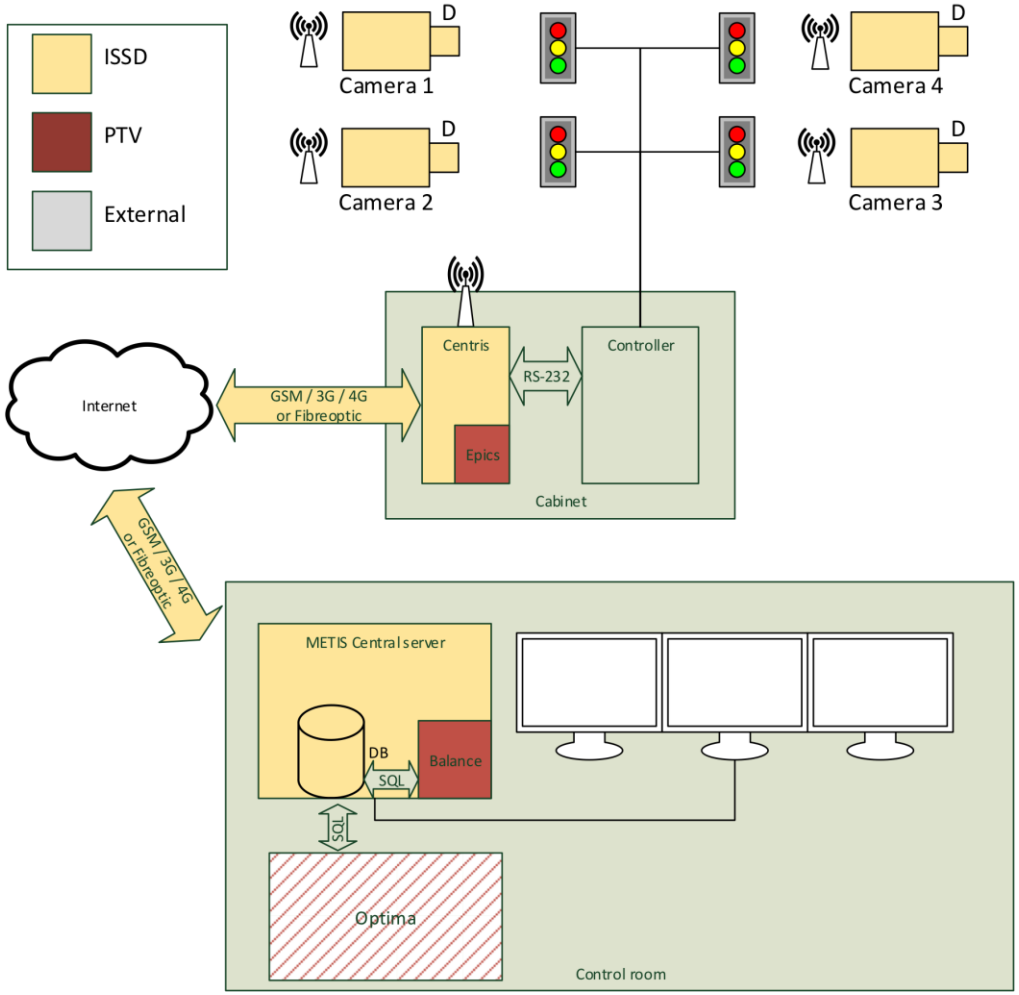
In a nutshell

- Actuated and Predictive Control
- OD Matrix and Travel Time Estimation using BT/ GPS/ RFID data/ Wifi
- Emissions Optimisation
- Multiple Users Multiple Objectives
- Any Detection system
- Non lane based traffic
- Slow moving vehicles
- Non Deterministic equations
- Evolutionary algorithms larger search space
- Local Adaptation
- Latest Traffic Optimisation
- Safety Solutions Integrated
- Not exclusive to signal manufacturer
- Low cost!!! Higher Benefit
- We are the LOCAL!

PROPOSED INFRASTRUCTURE LAYOUT WITH ISSD



PROPOSED SYSTEM ARCHITECTURE

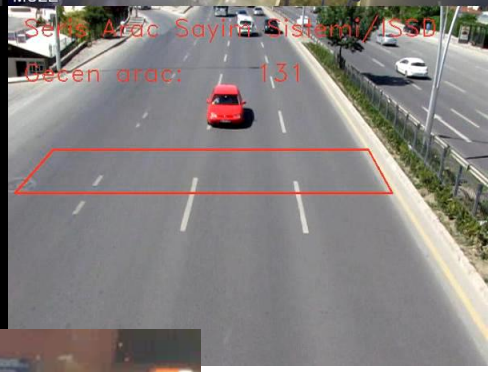


CAMERA AND VEHICLE COUNTING UNIT


Seris Arac Sayim Sistemi/ISSD
Gecen arac: 120


13-11-2013 16:45:55
MUZE


Seris Arac Sayim Sistemi/ISSD
Gecen arac: 110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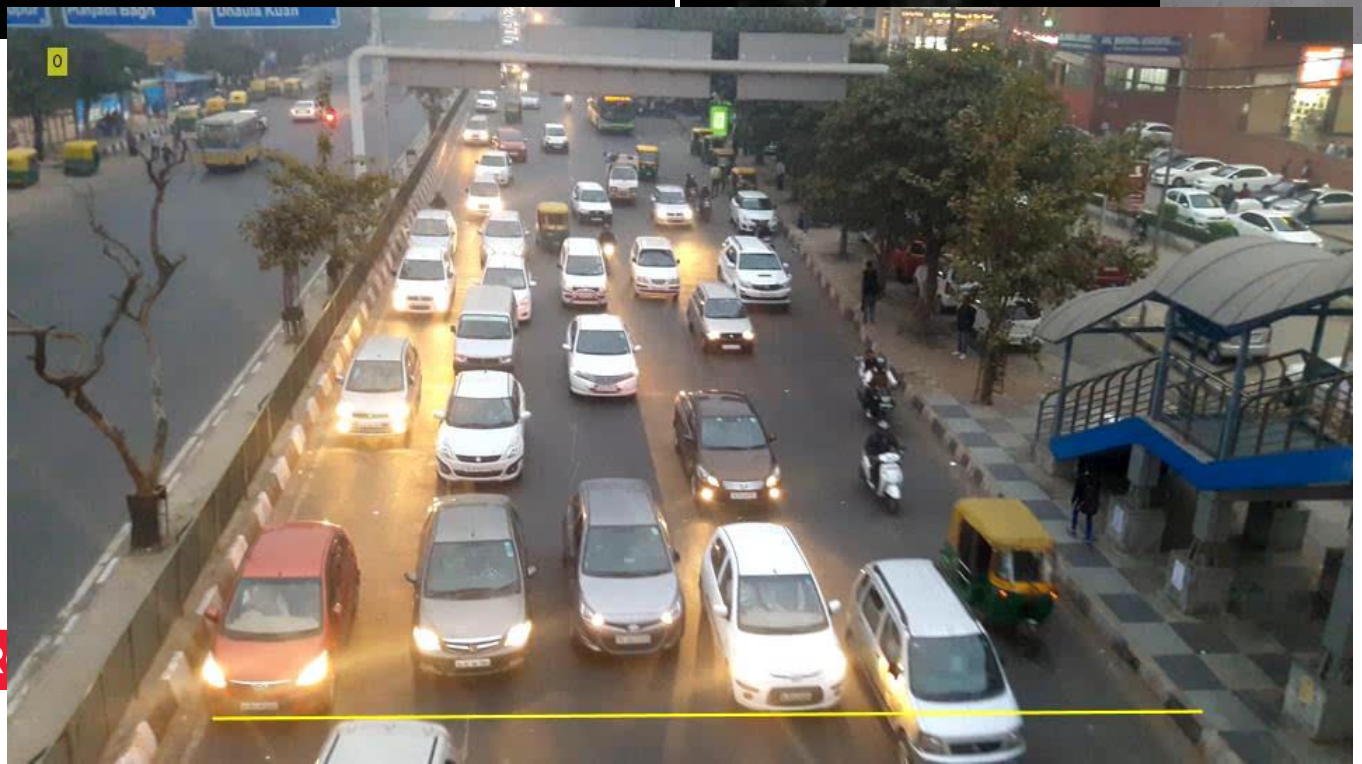
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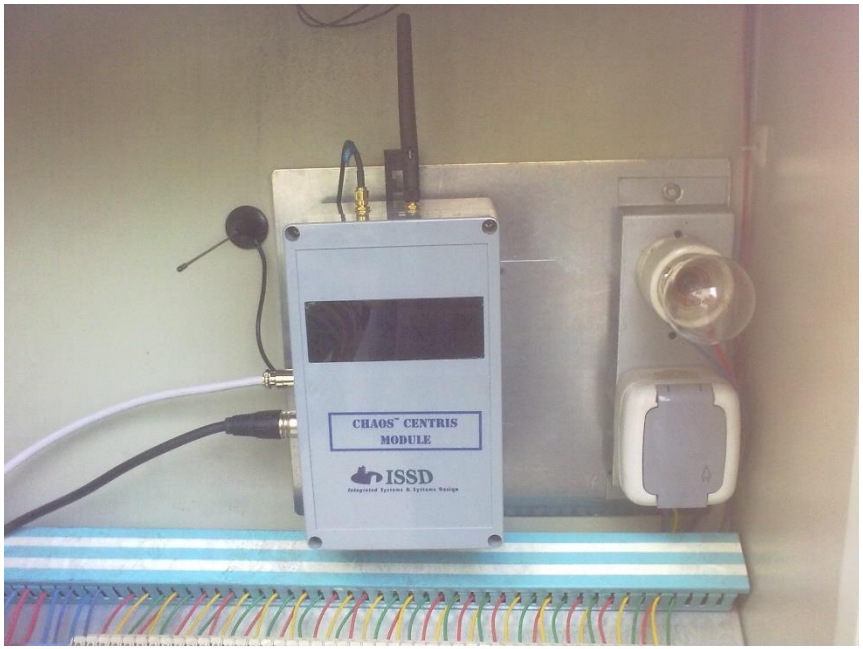
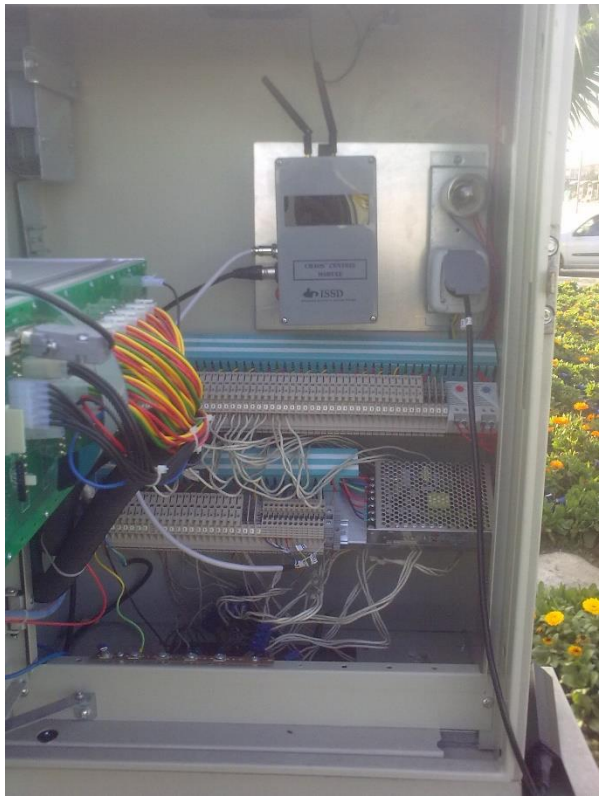
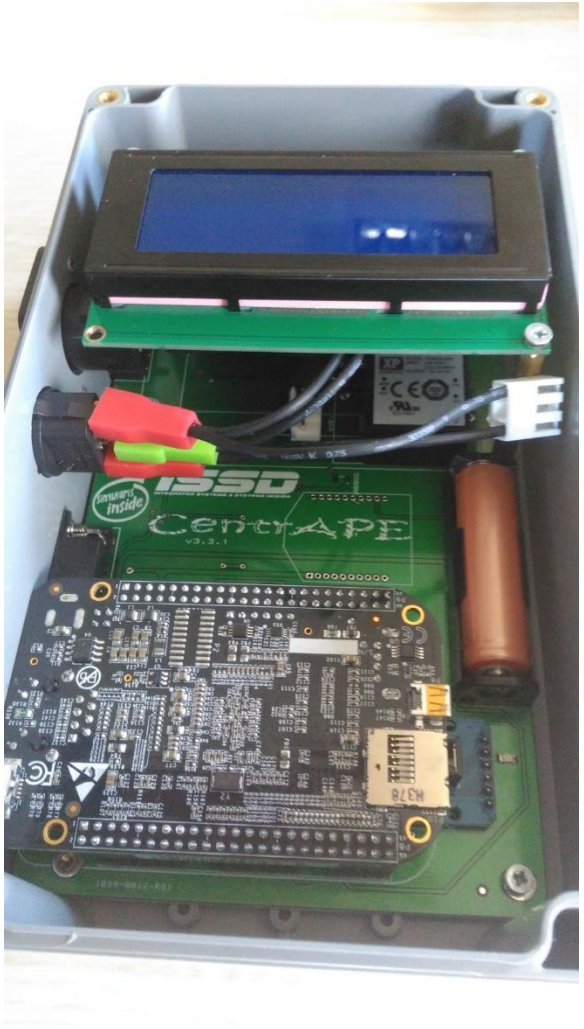
INTEGRATED CITRIS EPICS UNIT WITH BLUE TOOTH DETECTION UNIT WITH SIEMENS MAESTRO CONTROLLERS



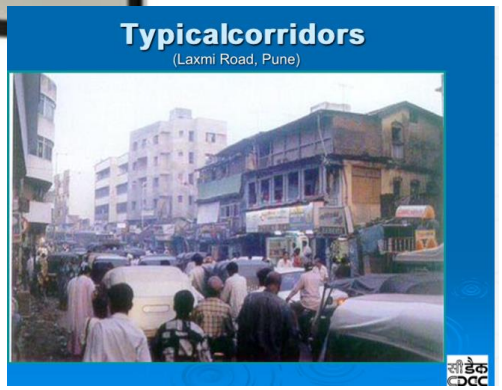


EXISTING CENTRIS UNIT WITH BT UNIT

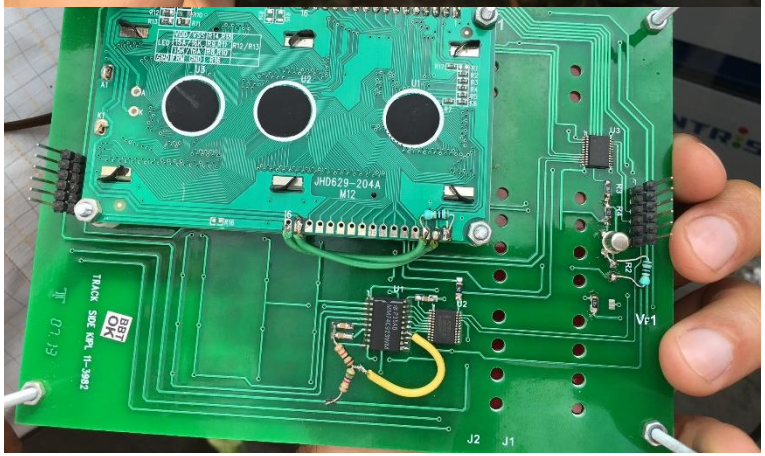


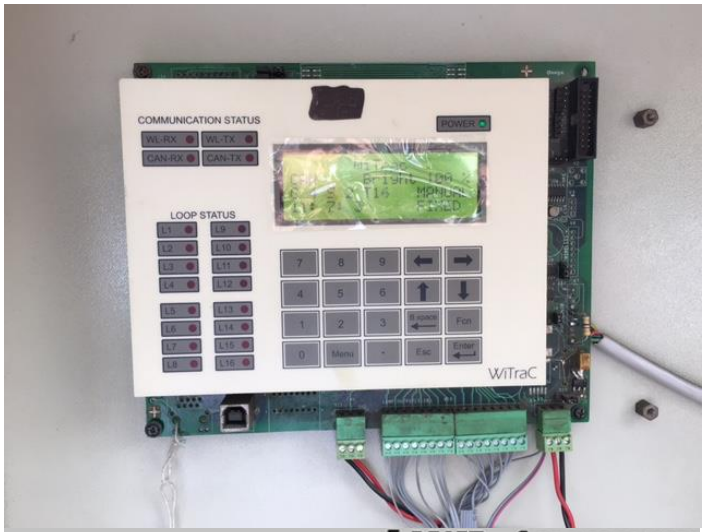
EXISTING JUNCTION CONTROLLER IN INDIA

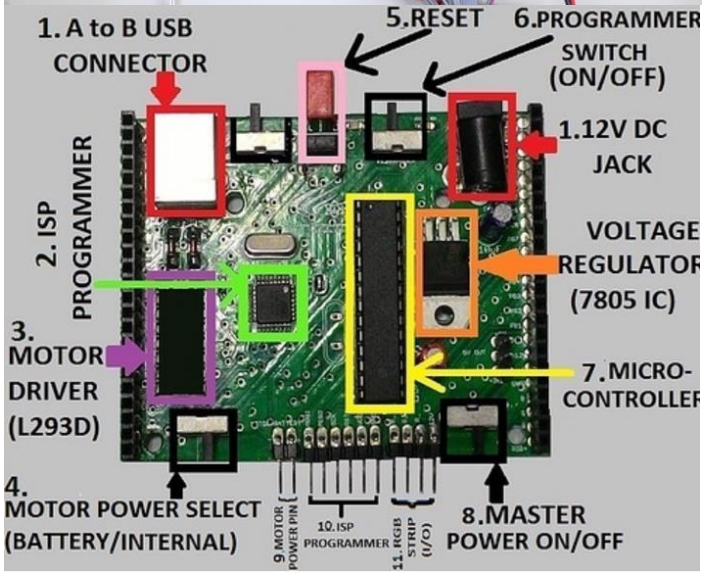
2 MAIN DEVELOPERS : CDAC (GOVT), CMS
4 MAIN SUPPLIERS: ONRYX (CDAC), KELTRON (CDAC), DIMTS (CDAC) AND CMS



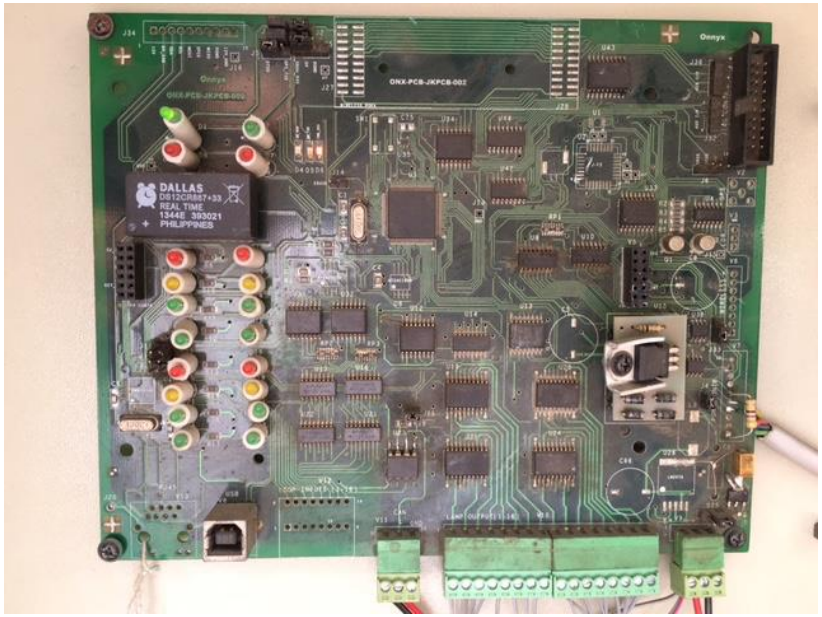
EXISTING JUNCTION CONTROLLER IN INDIA
CDAC CONTROLLER

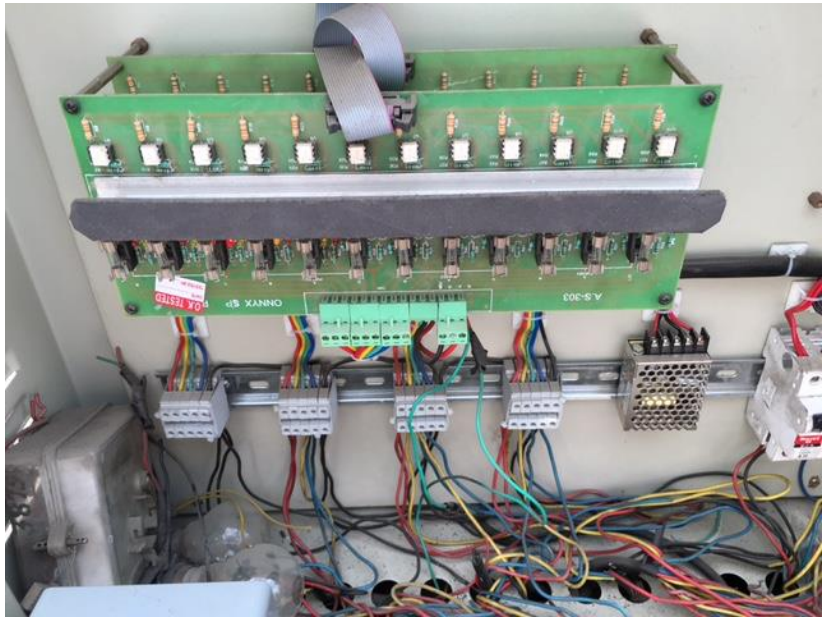




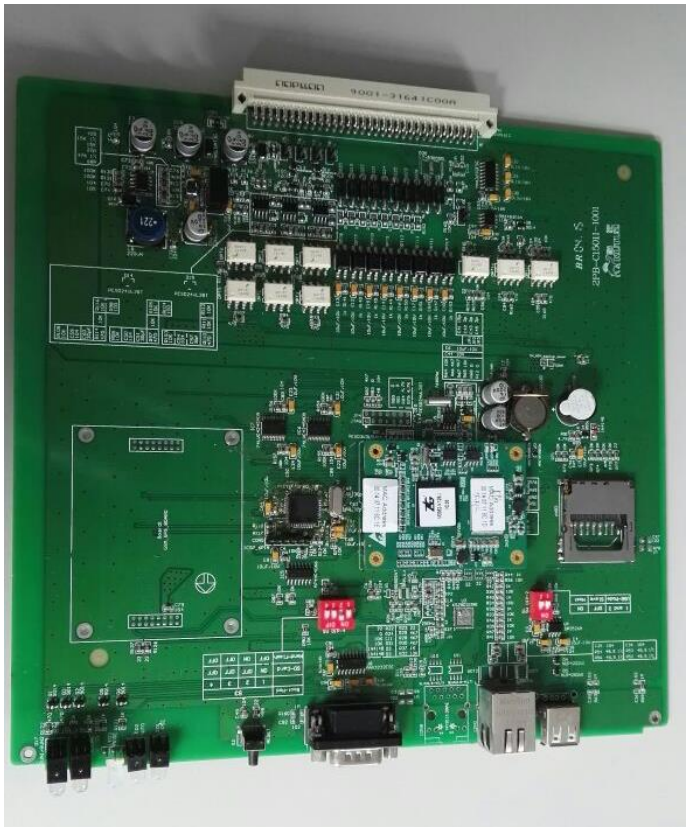


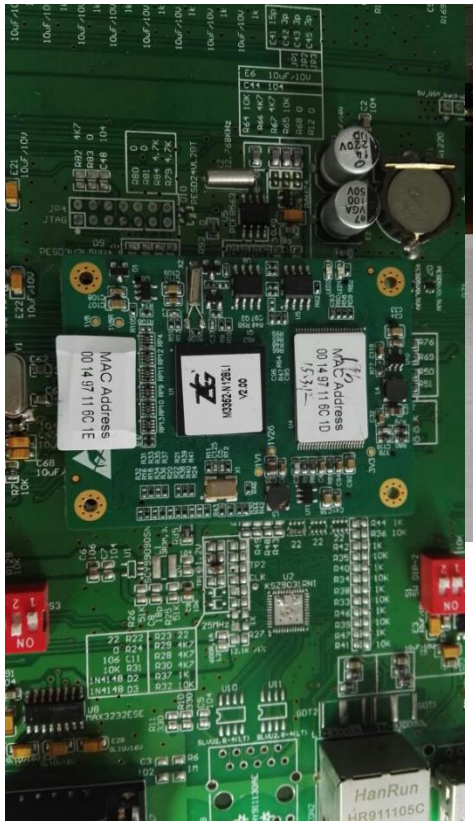
EXISTING JUNCTION CONTROLLER IN INDIA
CDAC CONTROLLER





SIGNAL CONTROLLER IF REQUIRED



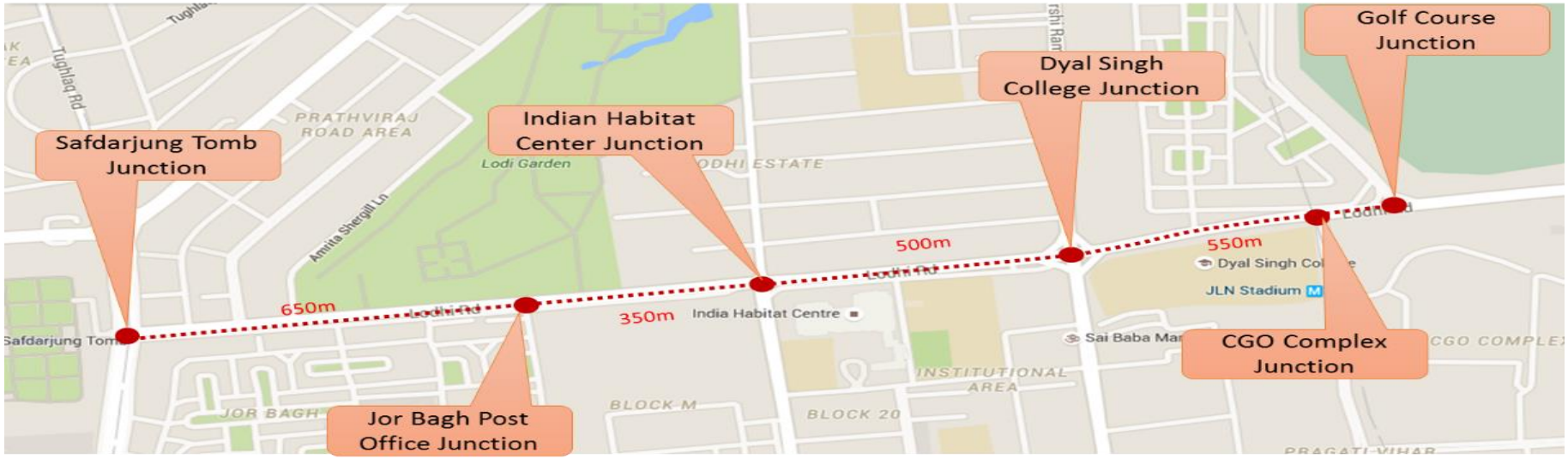


EXISTING JUNCTION CONTROLLERS UAE SIEMENS ST800

MID-LOW COST TRAFFIC CONTROL CENTER

DEMO STUDY SECTION

- LODHI ROAD which falls under Zonal D has been selected for a Demo study on Adaptive Traffic Signal Control.
- It is one of the major arterial road in Delhi with 45m ROW.
- A stretch of 2.5 km covering 6 signalized intersection is selected.
- The predominant land use along the corridor is residential and Institutional.



DEMO STUDY SECTION

DATA COLLECTION

- The primary traffic survey have been conducted for 16 hour time frame.
  - Turning Movement Count
  - Travel Time
  - Speed and Delay
  - Signal Timing (Morning, Afternoon and Evening peak and Non-peak)
- Sample Videos at Every intersection for Driving Behaviour Parameter.

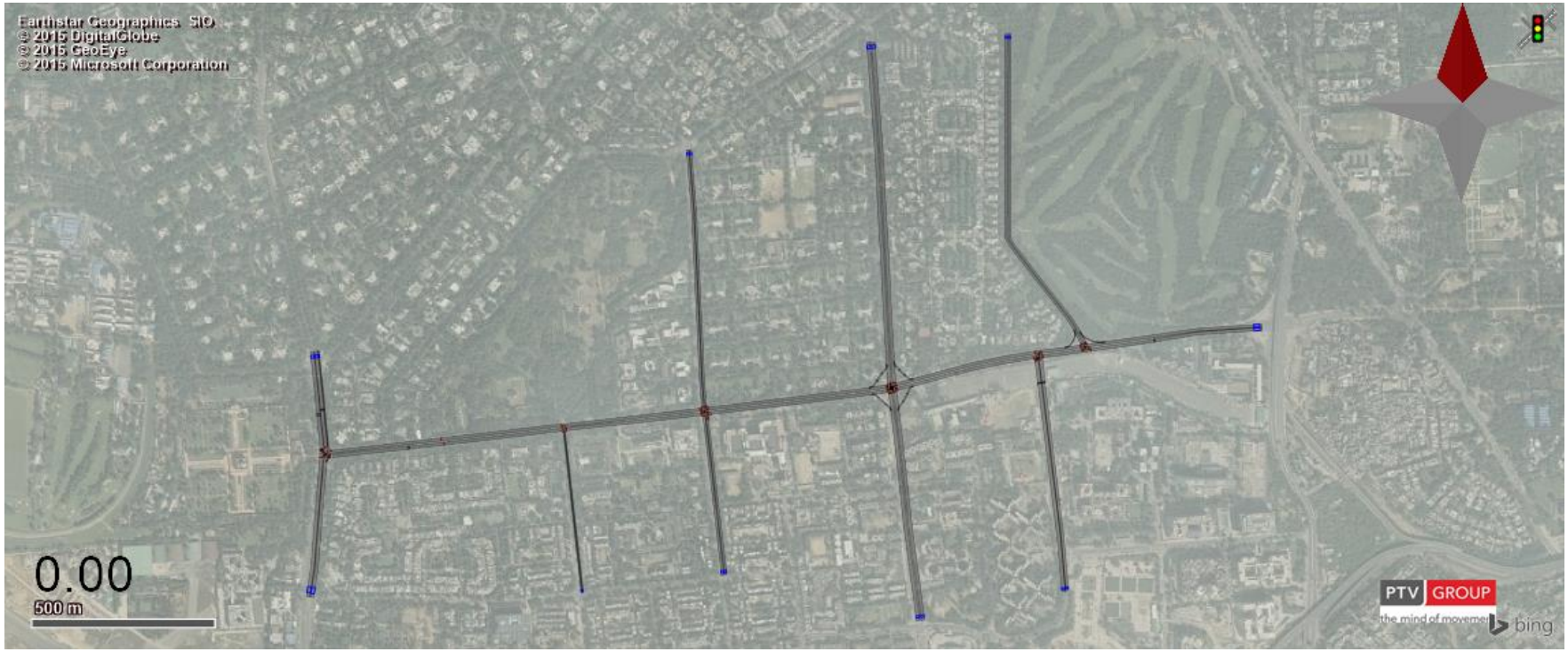
DATA COLLECTION – JUNCTION LEVEL SUMMARY - DELHI

- Safdarjung Tomb Junction holds maximum traffic with 96,227 Vehicles during 16 hours.
- The maximum peak hour share of 9.4% was observed at Safdarjung Tomb Junction.

Junction Name	Total Junction Volume	Peak Hour Junction Volume	Peak Hour Share
Safdarjung Tomb	96,227	9056	9.4%
Indian Habitat Centre	78,287	6906	8.8%
Dayal Singh College	76,343	6417	8.4%
CGO Complex	70,165	5826	8.3%
Golf Course	62,440	5495	8.8%

BASE MODEL - DELHI

- Model was coded between 1715-1830 with 15 minutes buffer time and results are extracted from 1730 to 1830 and it was validated with observed data.



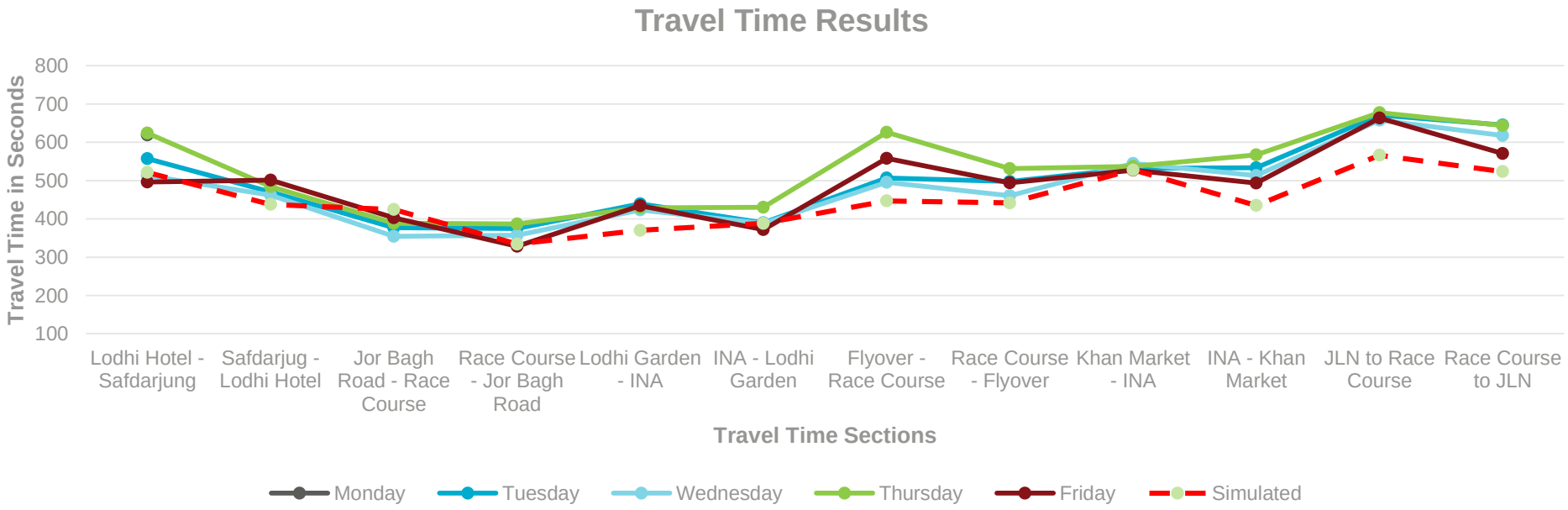
BASE MODEL- VALIDATION (TRAFFIC VOLUME) - DELHI

- The data are extracted every 15 minutes (900 seconds) from the simulated model and it is observed that 95.8% of the flow was under <5 GEH value.

GEH Value	Percentage
< 5	95.83%
> 5 to < 10	4.17%
> 10	0%

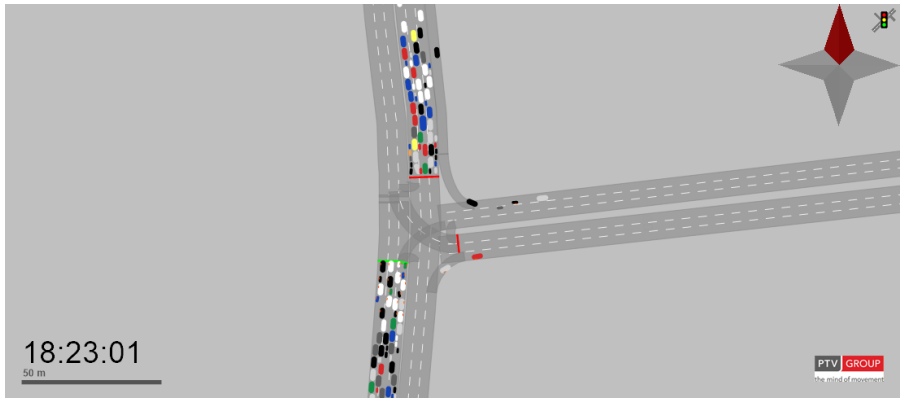
BASE MODEL- TRAVEL TIME-DELHI

- 12 routes with section wise travel time are observe and compared with the simulated model.
- It is observed that more than 75% of the travel time data are under 15% difference in travel time.

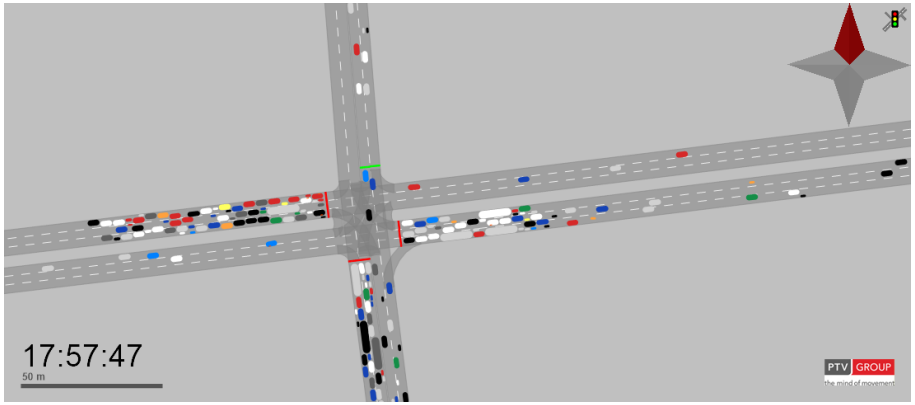


BASE MODEL- SNAPSHOTS-DELHI

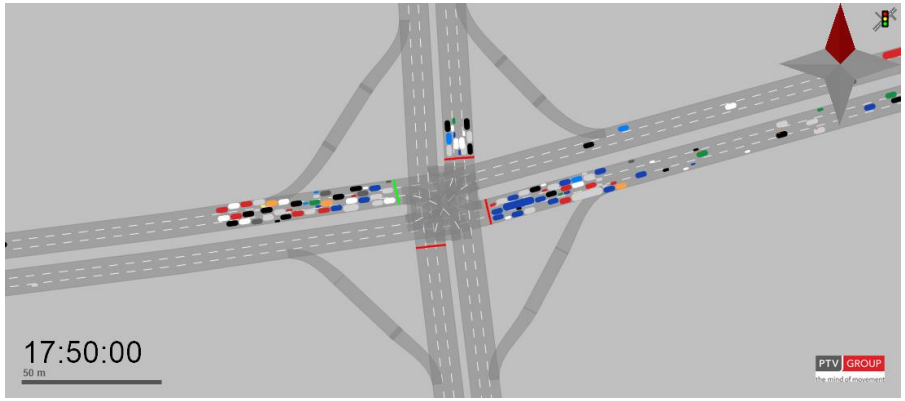
Safdarjung Tomb Junction



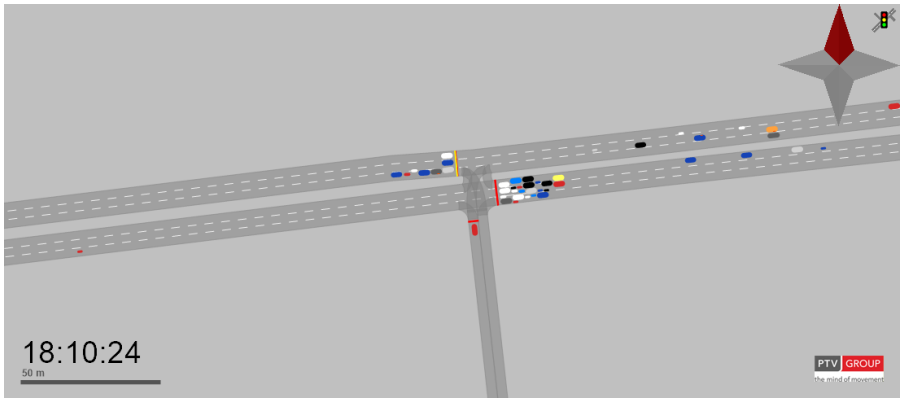
Indian Habitat Centre Junction



Dayal Singh College



CGO-Complex



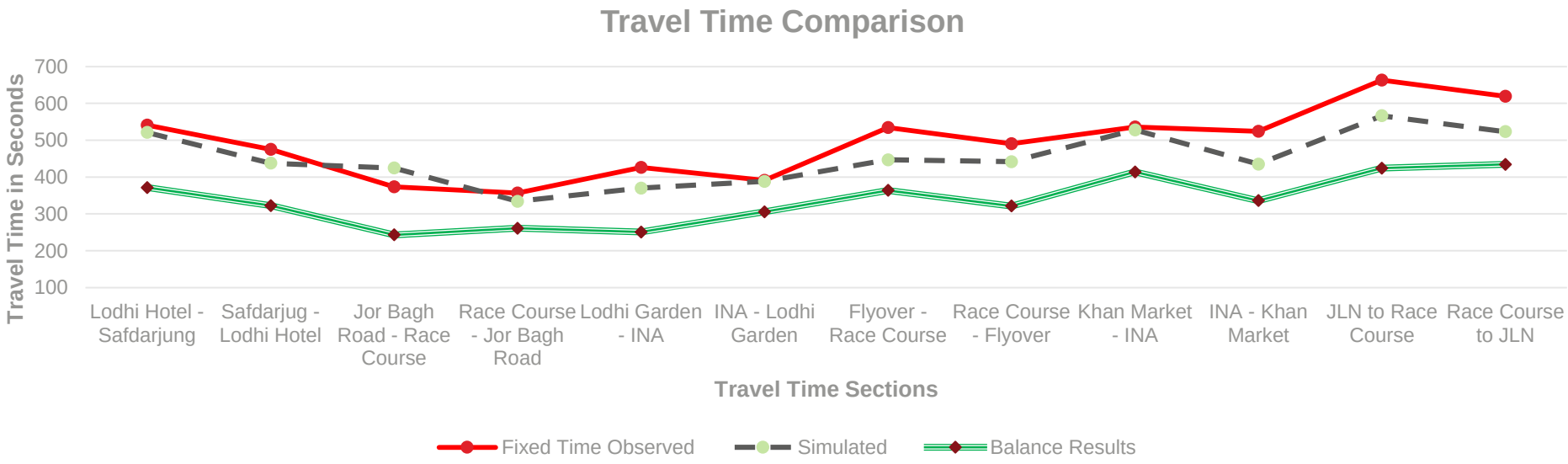
RESULT COMPARISON – FIXED TIME (BASE MODEL) VS BALANCE / EPICS - DELHI

- The traffic congestion is reduced compared to Fixed Time Controller.
- Travel Time, Queue Length, Delay are reduced by around 25-45%.

Parameters	Changes
Travel Time (Seconds)	▼ 26%
Queue Length (Meters)	▼ 37%
Journey Delay (Seconds)	▼ 45%
Network Speed (Kmph)	▲ 27%
Network Delay (Seconds)	▼ 30%

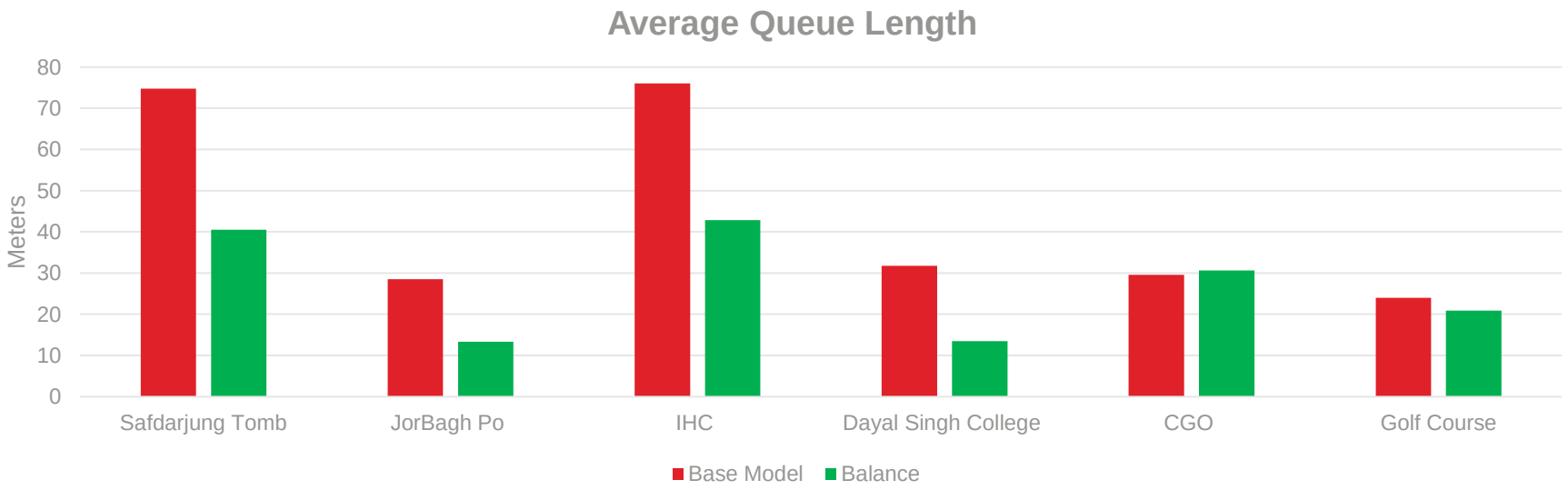
RESULT COMPARISON – TRAVEL TIME-DELHI

- Travel Time from all the observed journey routes are decreased by 26% compared to Fixed Time Controller.



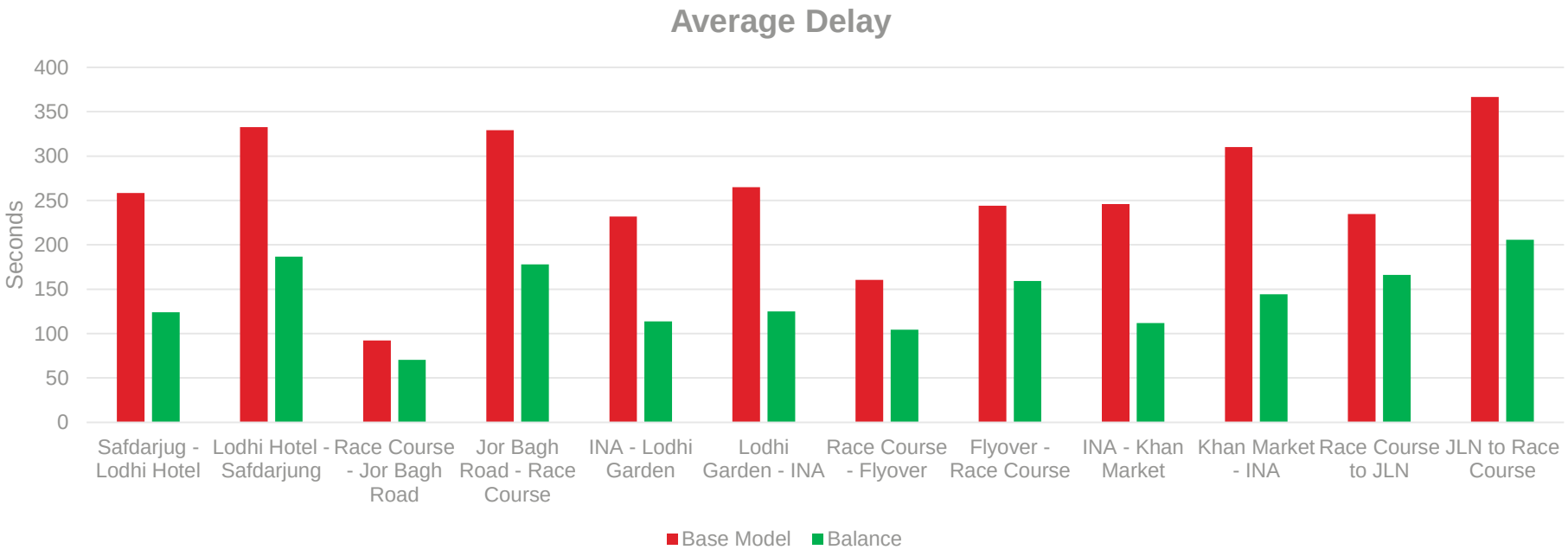
RESULT COMPARISON – AVERAGE QUEUE LENGTH-DELHI

- An average queue length is decreased by 37% compared to base model.
- At JorBagh Post Office, IHC Junction, Dayal Singh College junction queue lenght is reduced by 50%.



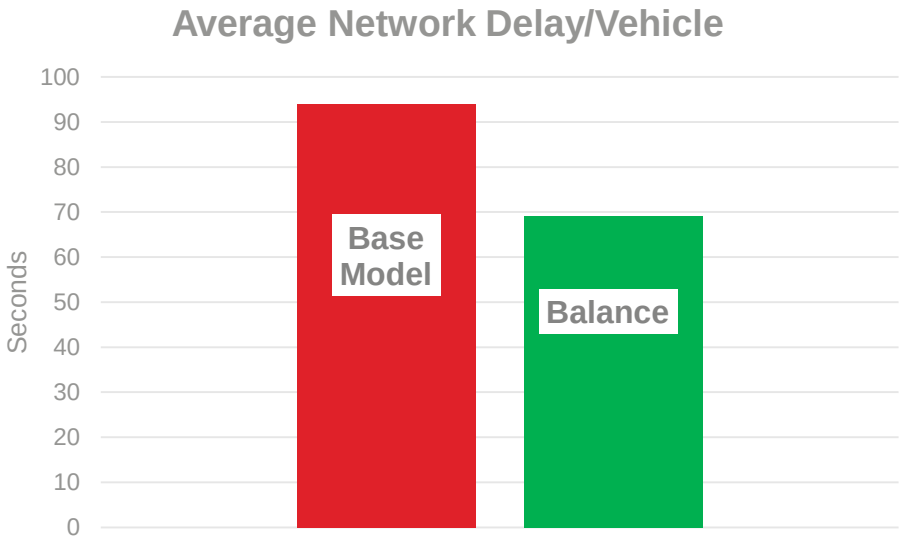
RESULT COMPARISON – AVERAGE DELAY-DELHI

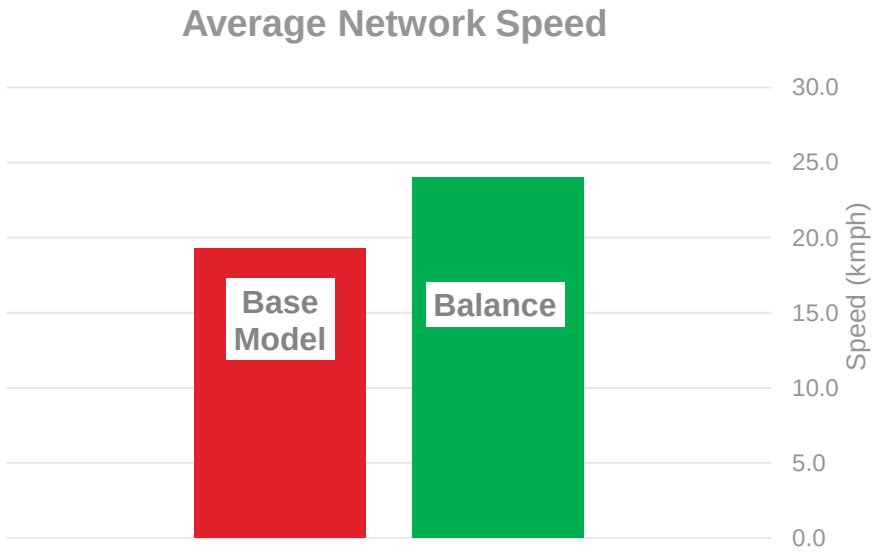
- The average journey delay from the Balance model is 45% decrease from the base model.



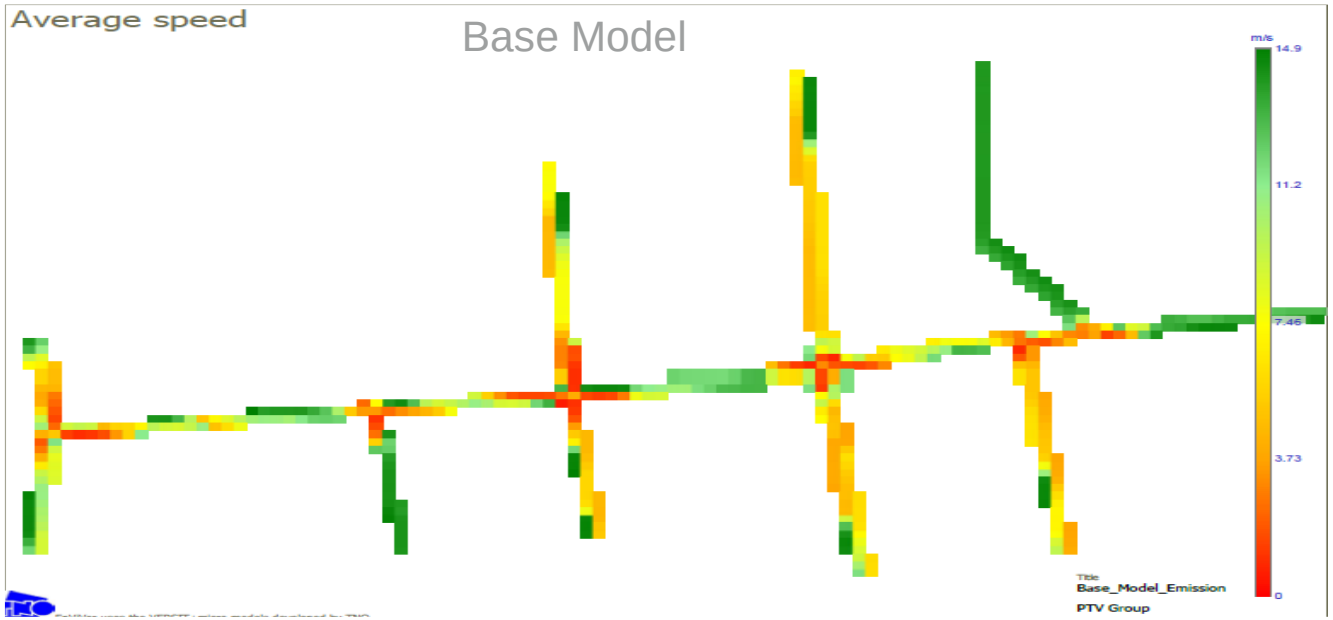
RESULT COMPARISON – NETWORK PERFORMANCE-DELHI

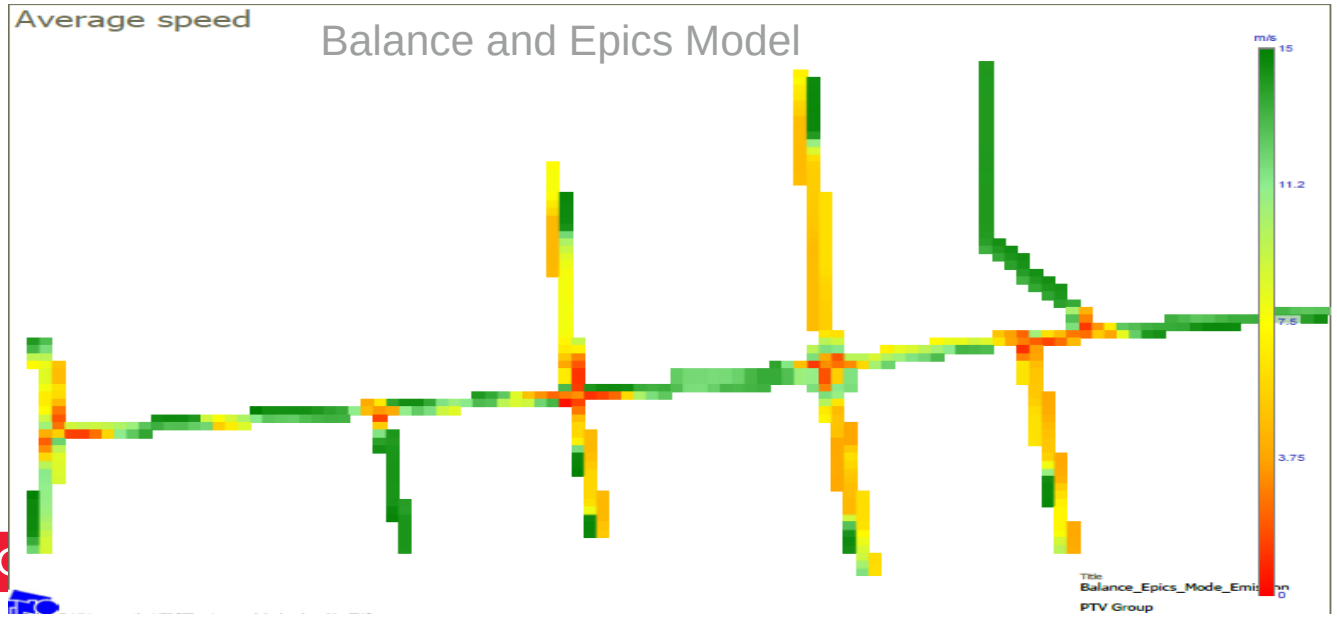
- From 99 seconds to 69 sec average network delay is observed from balance model.
- Overall network speed has been increased from 19 mph to 24 kmph





RESULT COMPARISON – SPEED PROFILE-DELHI





RESULT COMPARISON – EMISSION ANALYSIS-DELHI

- The vehicles are classified into Light, Medium and Heavy Duty vehicles.
- Air quality in Delhi can be improved by 10%-15% by smart signaling.
- Predominant AQI like Co2, Nox and PM10 has a significant reduction.

Emission per Km

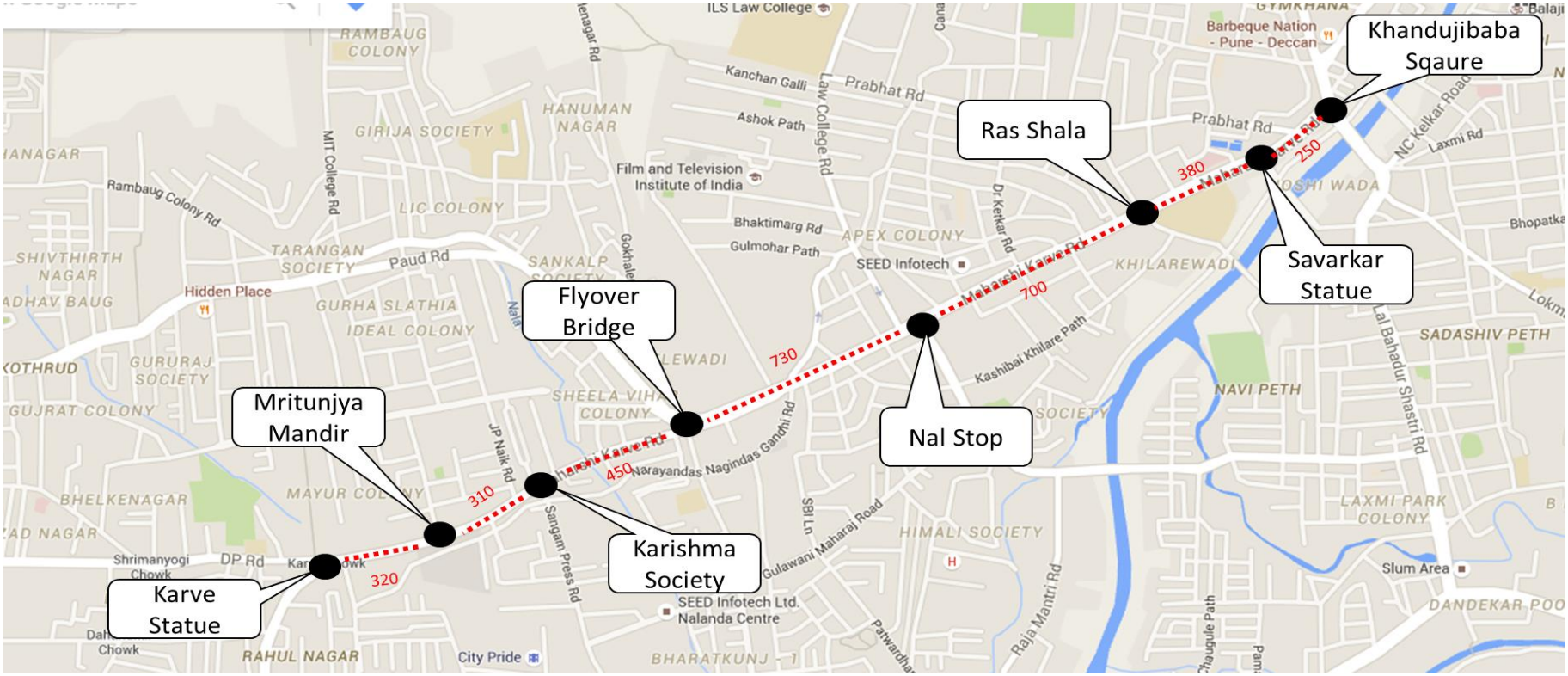
Classes	Vehicles	Co2 (Kg)	Nox (g)	PM10 (g)
Light Duty City 2013	Private Vehicles	▼13.6%	▼11.3%	▼14.9%
HD Medium City 2013	Buses	▼8.3%	▼8.6%	▼7.1%
HD Heavy City 2013	Commercial Vehicle	▼6.5%	▼2.7%	▼10.7%

PROJECT BACKGROUND - PUNE

- Pune is the second largest city in the state of Maharashtra next to its Capital Mumbai. Pune is spread over an area of 479 km^2
- Vehicle density in Pune is 1014 vehicle/km.
- Total length of road in Pune is same as Chennai 1800 km within its boundary.
- Pune have 2.8 million registered vehicles. Two-Wheeler accounts 8% annual growth rate followed by Car.
- Pune have more than 350 signalized intersections with fixed time for different peaks and non-peak hours.

DEMO STUDY SECTION - PUNE

- Karve Road was selected for a Demo study on Adaptive Traffic Signal Control.
- It is one of the major daily commuting road in Pune.
- A stretch of 3.2 km covering 10 signalized intersection is selected.
- The predominant land use along the corridor is commercial.



DEMO STUDY SECTION - PUNE

DATA COLLECTION

- The primary traffic survey have been conducted for 16 hour time frame.
  - Turning Movement Count
  - Travel Time
  - Speed and Delay
  - Signal Timing (Morning, Afternoon and Evening peak and Non-peak)
- Sample Videos at Every intersection for Driving Behaviour Parameter.

DATA COLLECTION – JUNCTION LEVEL SUMMARY - PUNE

- Nal Stop Junction holds maximum traffic with 1,62,848 Vehicles during 12 hours.
- The maximum peak hour share of 11.6% was observed at Nal Stop.

Junction Name	Total Junction Volume	Peak Hour Junction Volume	Peak Hour Share
Khandujibaba Square	82,067	9,538	11.6%
Prabhat Road	86,829	7,641	8.8%
Savarkar Statue	63,538	5,953	9.3%
Ras Shala	1,03,075	9,586	9.3%
Swatantra Chowk	1,28,029	13,888	10.9%
Nal Stop	1,62,848	17,403	11.1%
Flyover Bridge	1,37,758	13,293	9.6%
Karishma Society	95,189	9,537	10.0%
Mrityunjay Temple	1,00,475	11,237	11.1%
Karve Statue	88,826	9,265	10.5%

BASE MODEL - PUNE

- Model was coded between 1800-1915 with 15 minutes buffer time and results are extracted from 1815 to 1915 and it was validated with observed data.

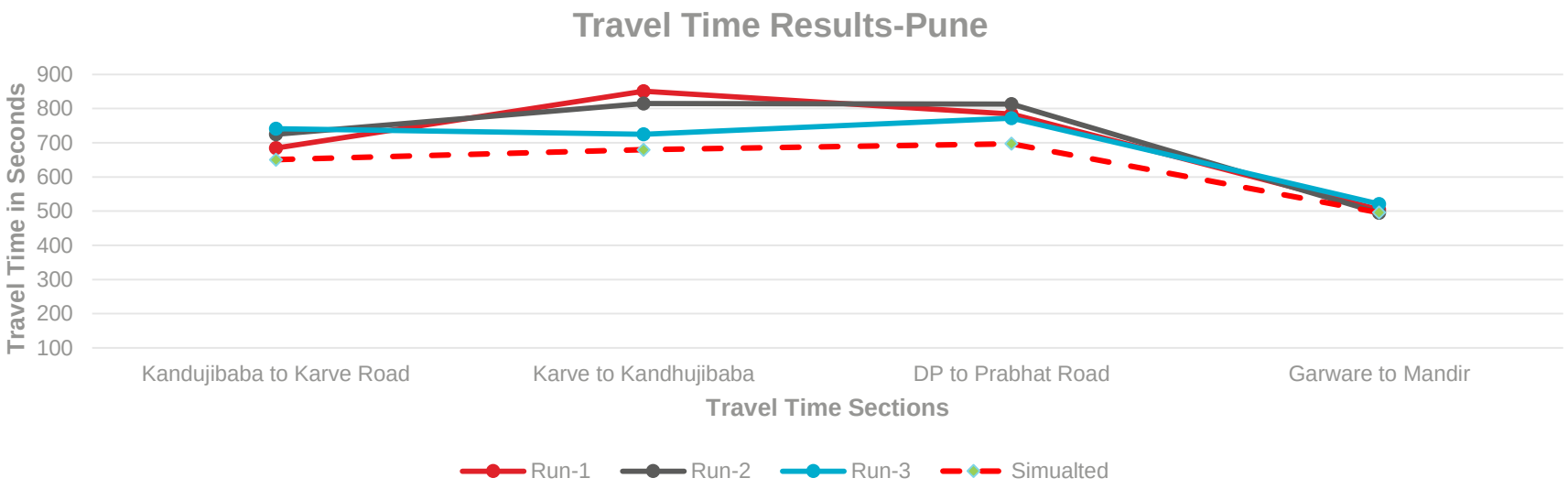
BASE MODEL- VALIDATION (TRAFFIC VOLUME) - PUNE

- The data are extracted every 15 minutes (900 seconds) from the simulated model and it is observed that 92.3% of the flow was under <5 GEH value.

GEH Value	Percentage
< 5	92.3%
> 5 to < 10	6.2%
> 10	1.5%

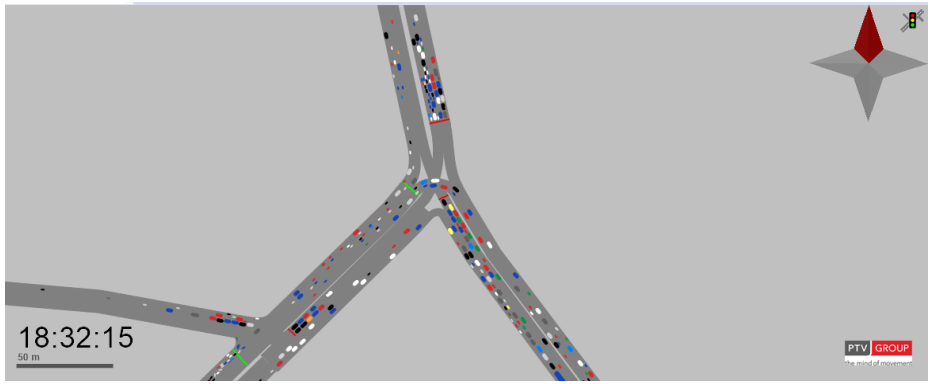
BASE MODEL- TRAVEL TIME-PUNE

- 4 routes with section wise travel time are observe and compared with the simulated model.
- It is observed that more than 75% of the travel time data are under 15% difference in travel time.

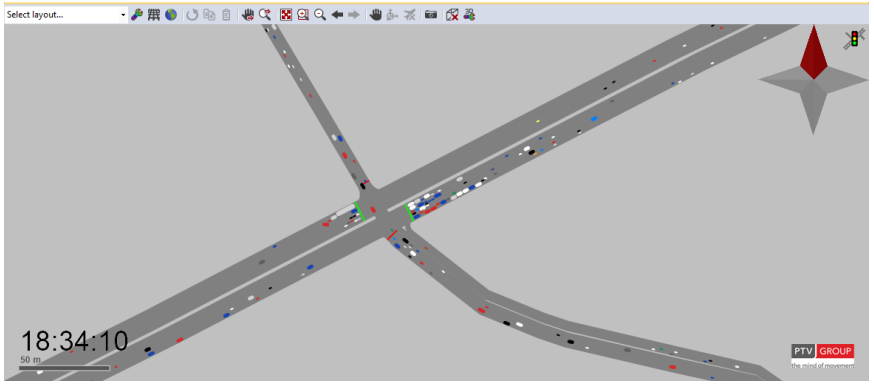


BASE MODEL- SNAPSHOTS-PUNE

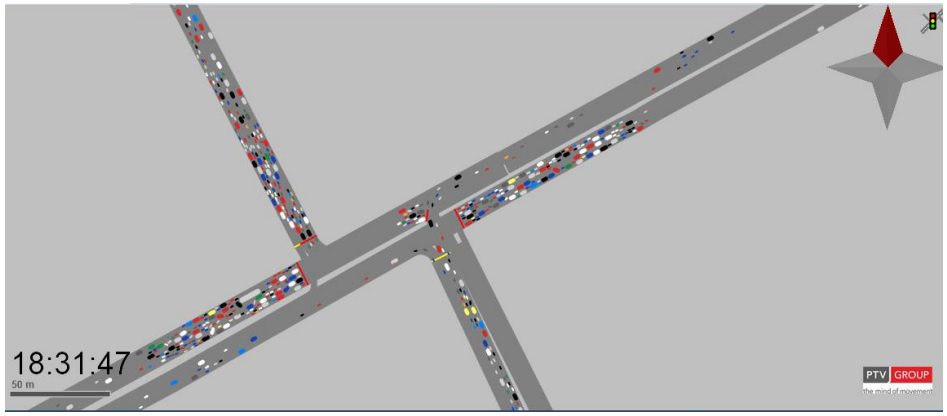
Kandujibaba square Junction



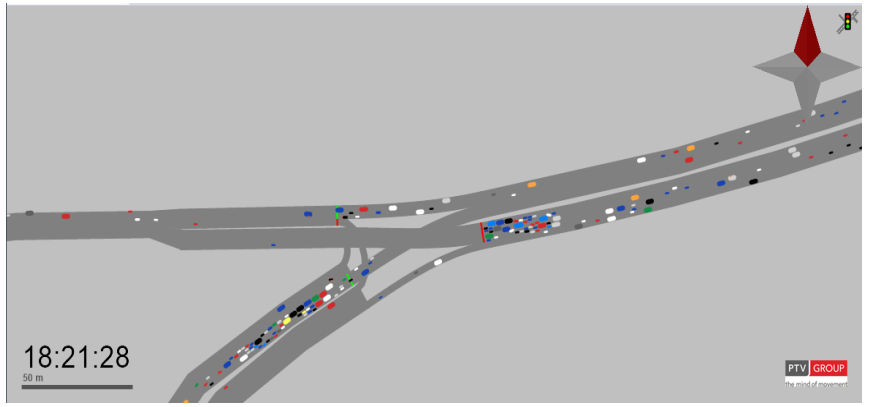
Ras Shala Junction



Nal Stop Junction



Karve Statue Junction



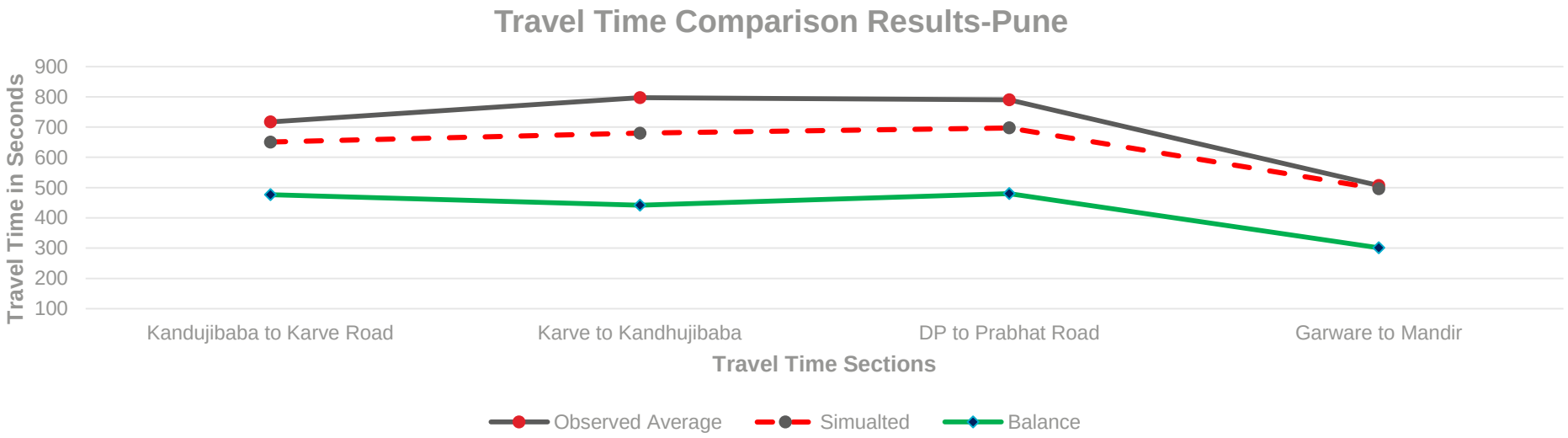
RESULT COMPARISON – FIXED TIME (BASE MODEL) VS BALANCE / EPICS - PUNE

- The traffic congestion is reduced compared to Fixed Time Controller.
- Travel Time, Queue Length, Delay are reduced by around 35-55%.

Parameters	Changes
Travel Time (Seconds)	▼ 33%
Queue Length (Meters)	▼ 35%
Journey Delay (Seconds)	▼ 56%
Average Network Speed (Kmph)	▲ 53%
Average Network Delay (Seconds)	▼ 45%

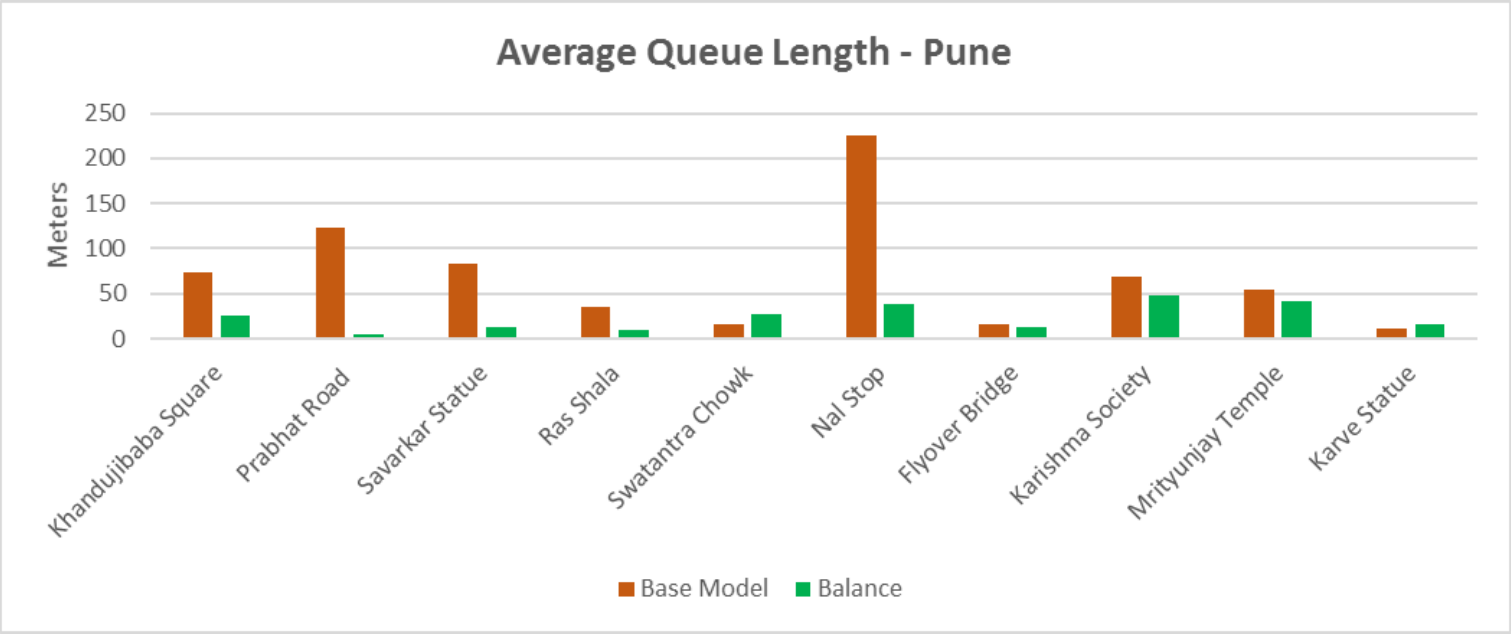
RESULT COMPARISON – TRAVEL TIME-PUNE

- Travel Time from all the observed journey routes are decreased by 33% compared to Fixed Time Controller.



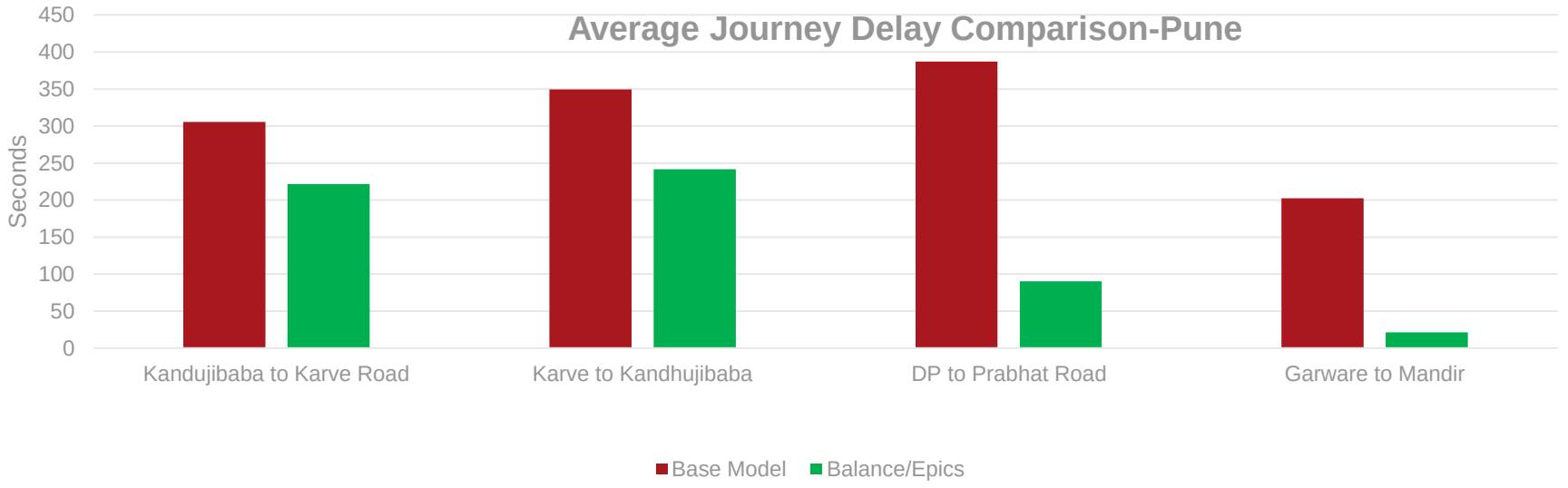
RESULT COMPARISON – AVERAGE QUEUE LENGTH-PUNE

- An average queue length is decreased by 35% compared to base model.
- At Nal Stop Junction queue lenght has significantly reduced which is one of the major juction on Karve Road.



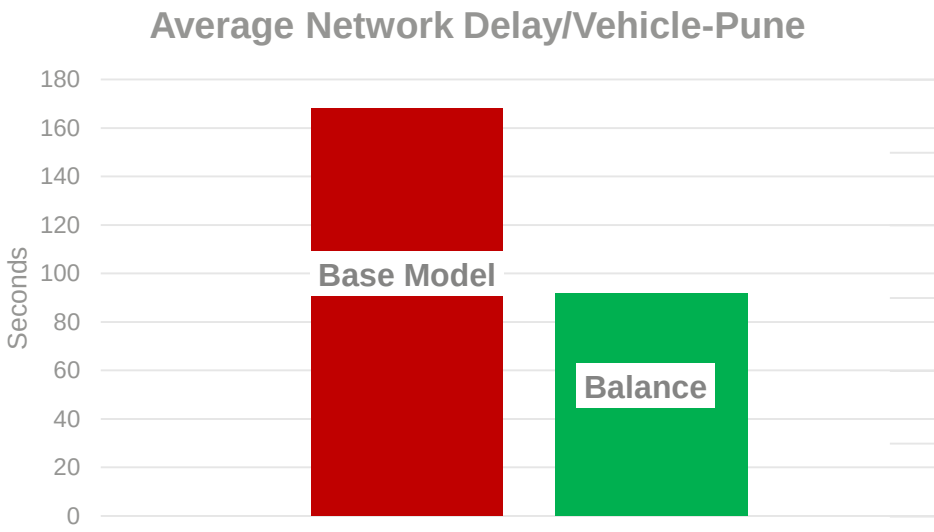
RESULT COMPARISON – AVERAGE DELAY-PUNE

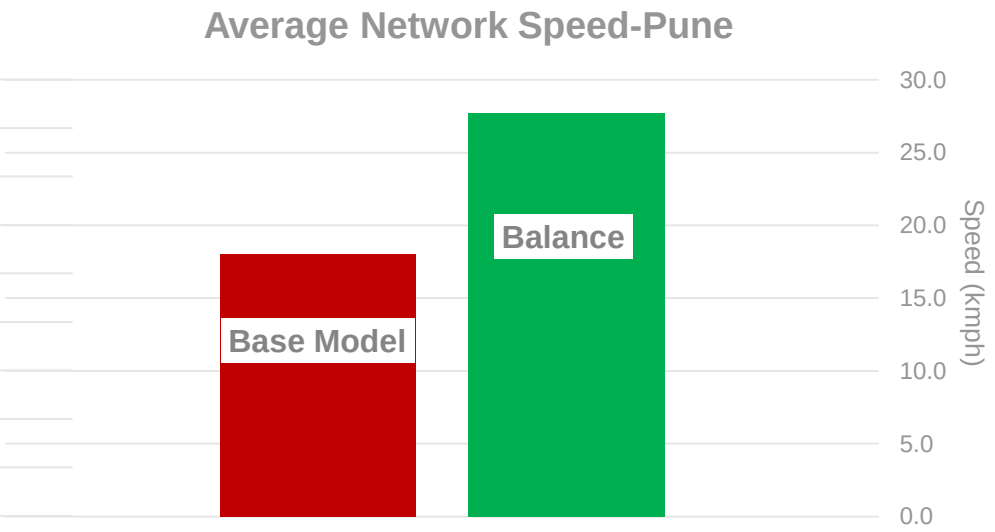
- The average journey delay from the Balance model is 55% decrease from the base model.



RESULT COMPARISON – NETWORK PERFORMANCE-PUNE

- From 160 seconds to 90 sec average network delay is observed from balance model.
- Overall network speed has been increased from 18 mph to 28 kmph





RESULT COMPARISON – FIXED TIME (BASE MODEL) VS BALANCE / EPICS

DELHI

Parameters	Changes
Travel Time (Seconds)	▼ 26%
Queue Length (Meters)	▼ 37%
Journey Delay (Seconds)	▼ 45%
Network Speed (Kmph)	▲ 27%
Network Delay (Seconds)	▼ 30%

PUNE

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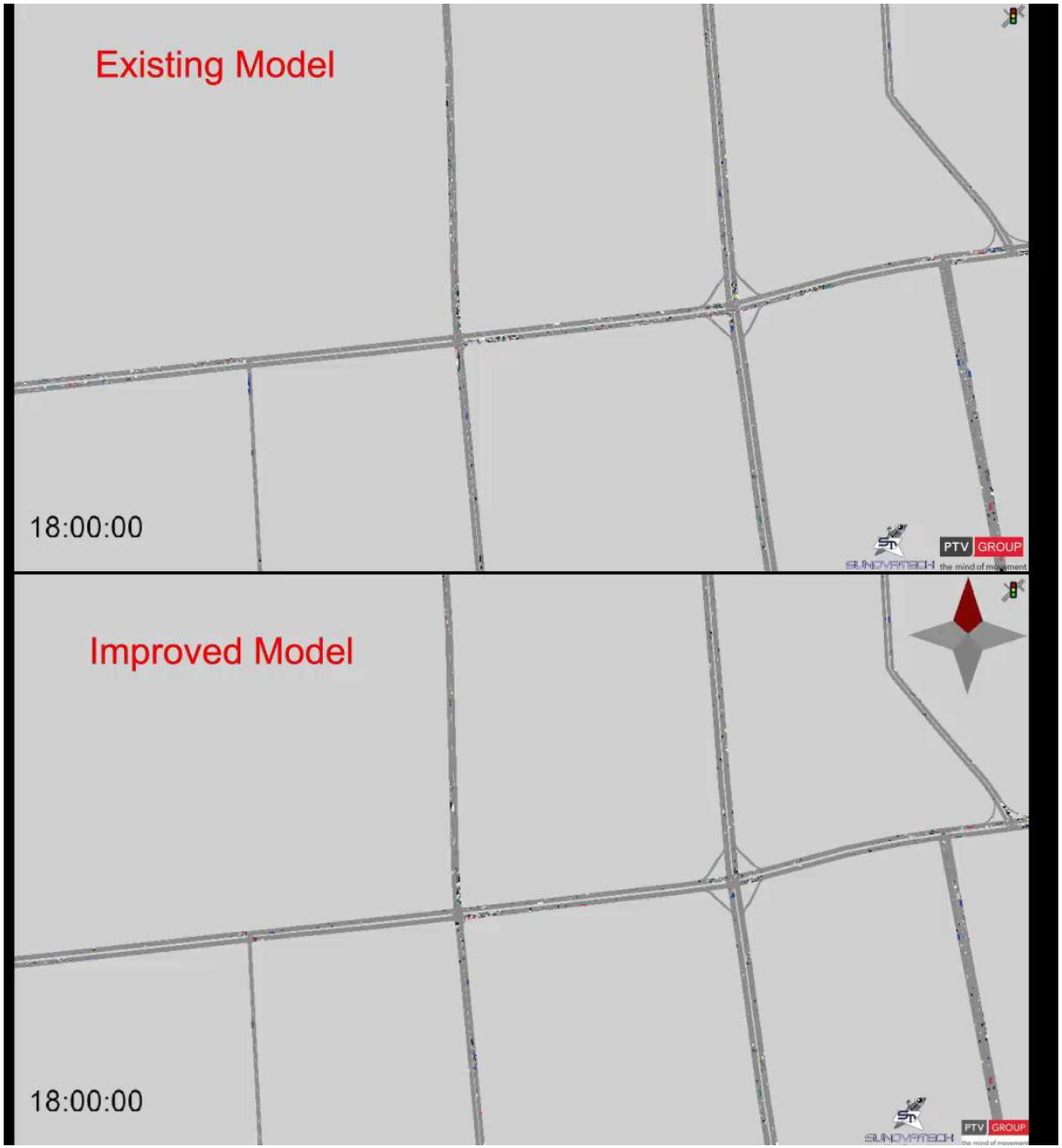
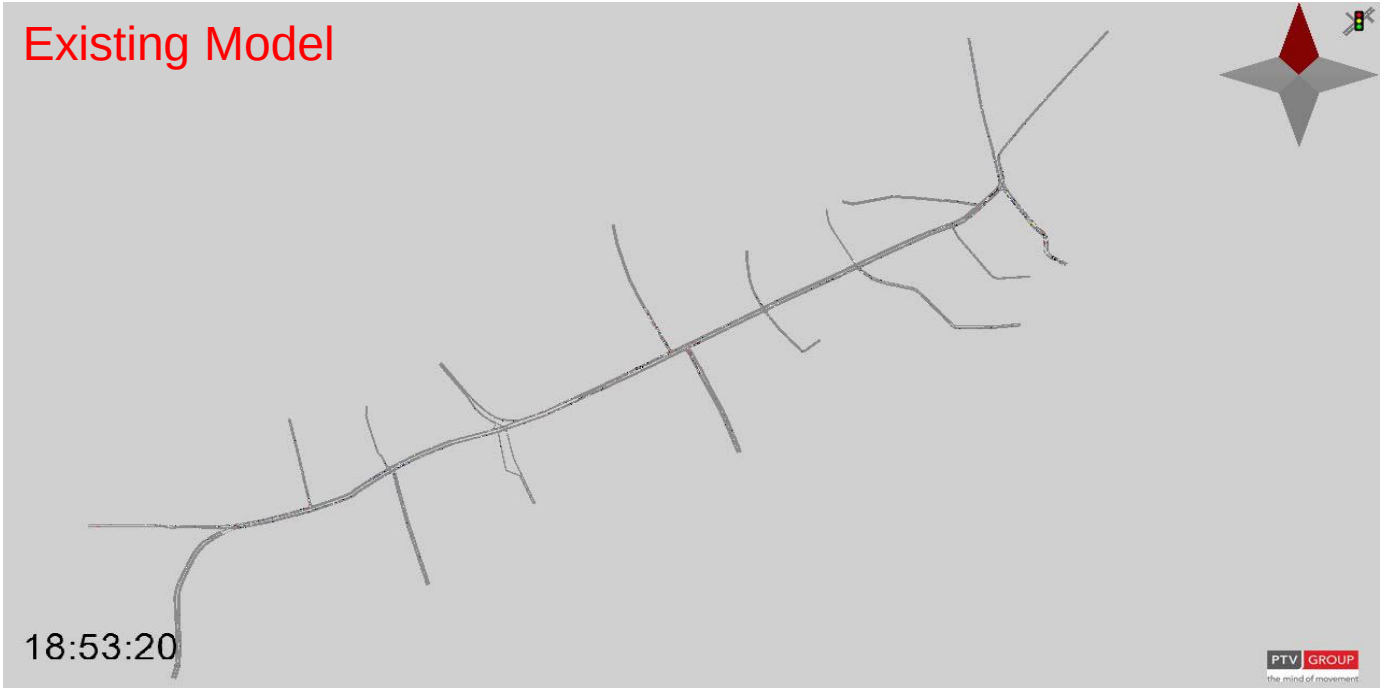
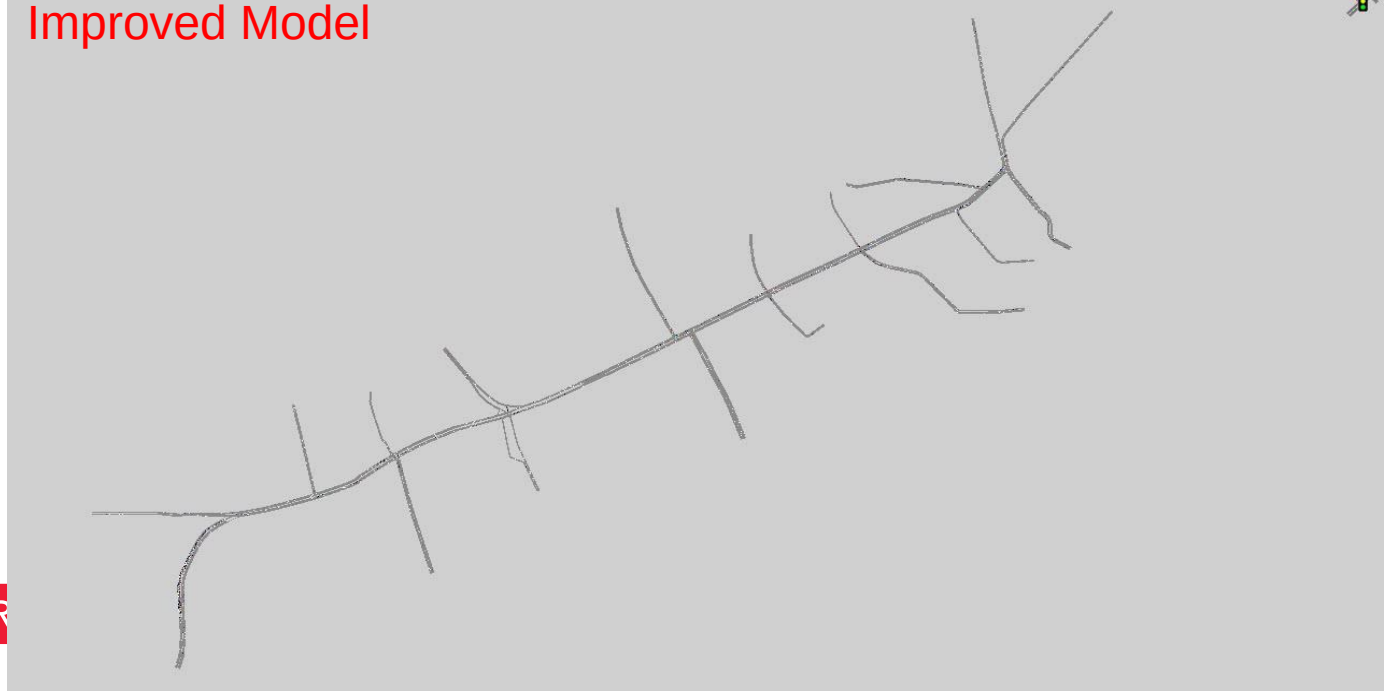

Existing Model
18:00:00
Improved Model
18:00:00

Existing Model



Improved Model



TOTAL COST SAVINGS IF PTV BALANCE + EPICS IS IMPLEMENTED IN DELHI

- Economic benefits of implementing such a signal optimisation system are significant
- Using the results obtained in the Lodhi Road pilot corridor, the economic impact of PTV Balance+Epics system being implemented across 857 signalised junctions in Delhi can be estimated
- Annual CO2 savings across the network is estimated to be **USD $66 million** or **INR 440 Crores per year.**
- Yearly Savings of **US$2.7 Billion or INR 1,800 Crores per year** in reducing traffic congestion including travel time congestion for Citizens

PTV SOFTWARE
SMART TRAFFIC SOLUTIONS FOR SMART CITIES