Real-time traffic forecast by means of macroscopic models for Dynamic Traffic Assignment: theory and practice

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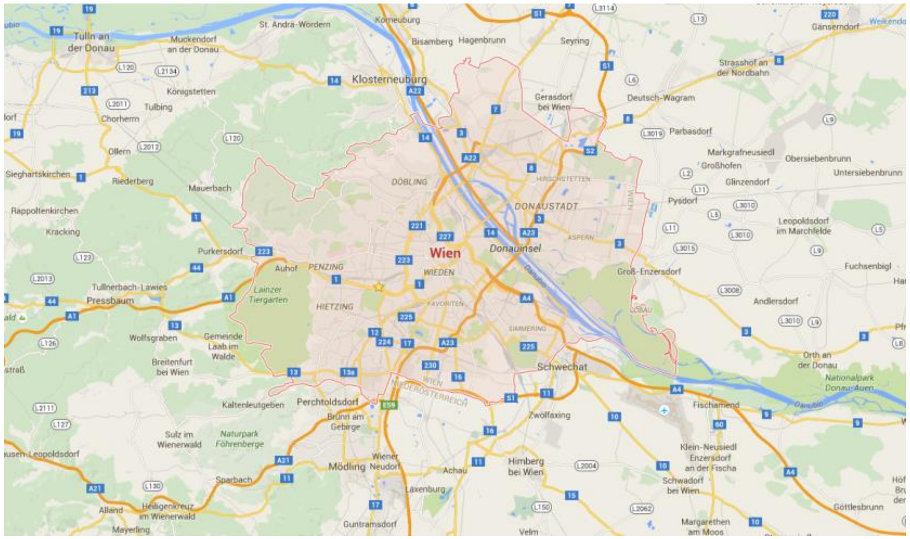
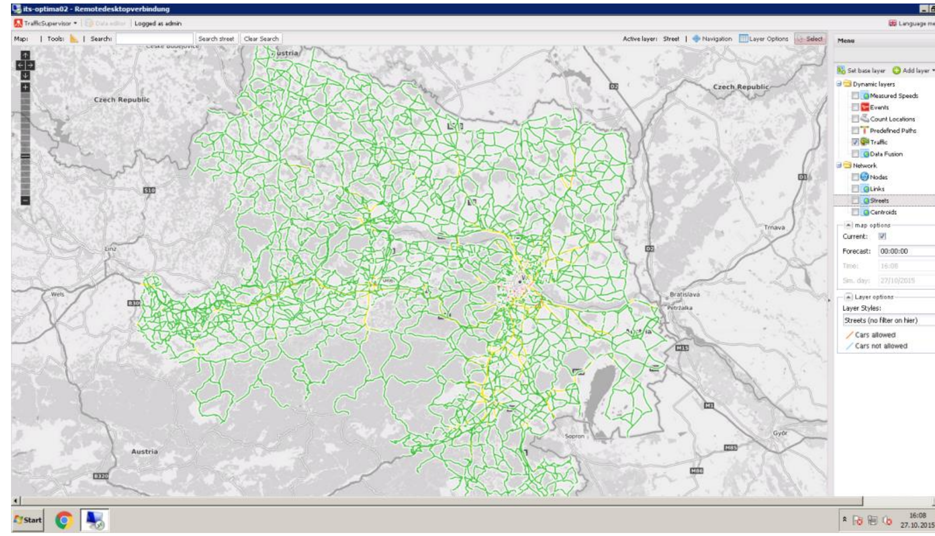
Summary

- Let’s start with the use case: requirements and delivery
- Use of Dynamic Traffic Assignment models in mobility management centres
- Formulation and solution of Dynamic User Equilibrium to obtain route choice probabilities
- Dynamic Network Loading via General Link Transmission Model for Rolling Horizon simulation in real-time
- Towards more data and model integration
- Some real world application
- Open issues

A USE CASE:
REQUIREMENTS AND DELIVERY

Optima and HyperPath for the Wien Region





ITS Vienna Region
Intelligent Transport Systems

	Regional Supervisor
Extension	27,000 square km
Demand zones	1096
Demand matrices	Hourly O/D matirces, 3 day types
Network model	50,000 link > 70,000 km
Assignment model	Dynamic Network Loading 5 min Dynamic User Equilibrium 20 min

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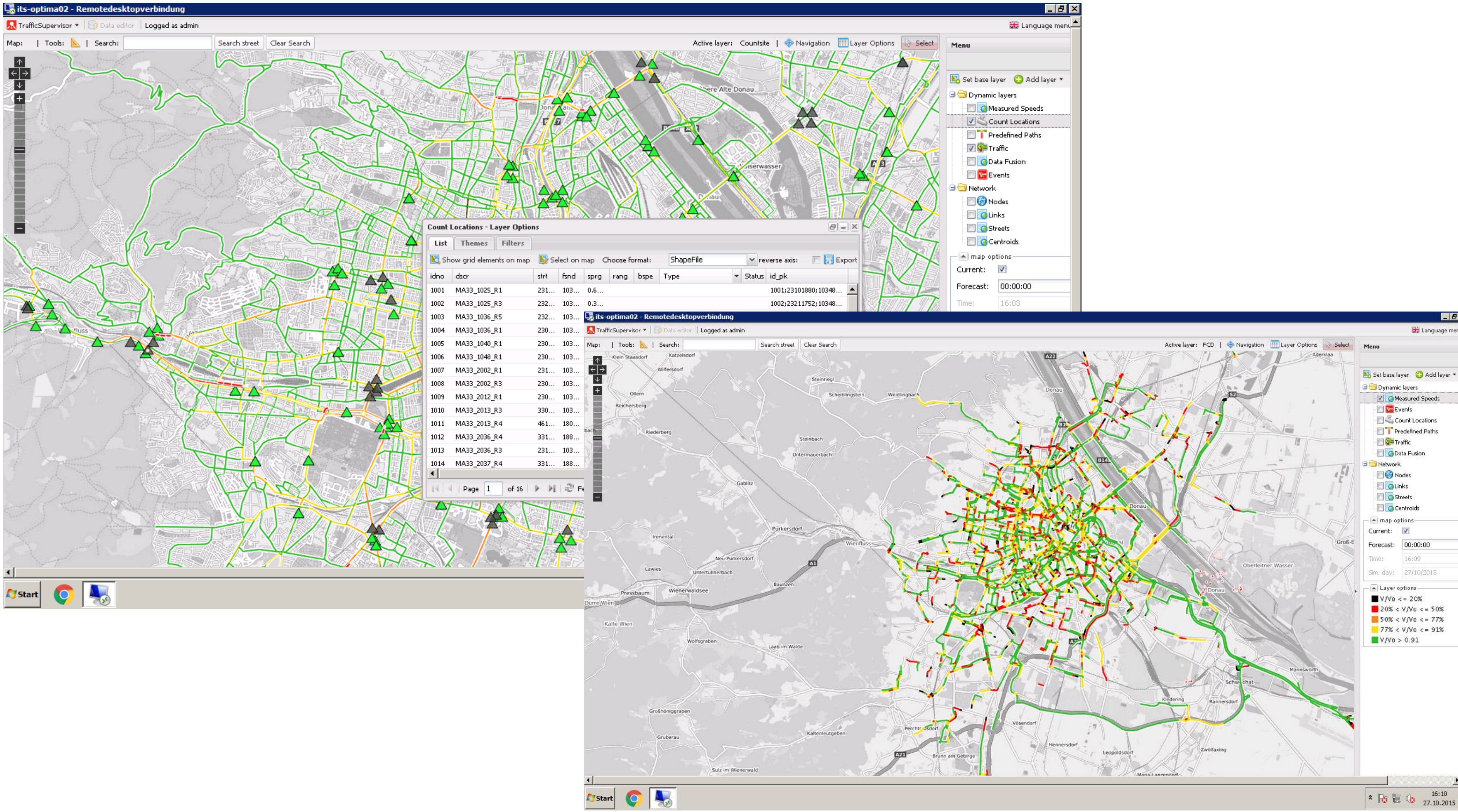
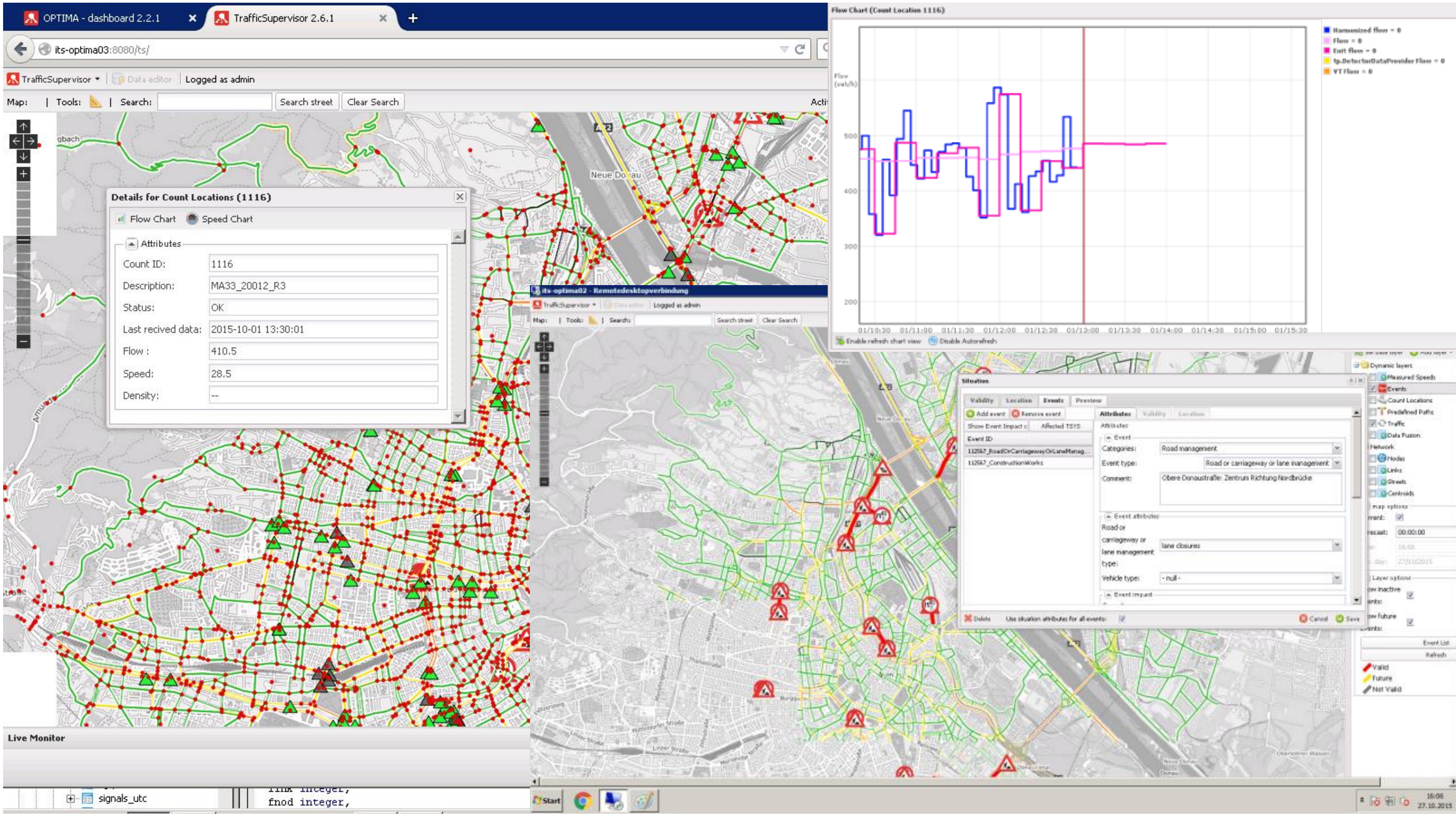
Goal of the project
traffic prediction and infomobility

- Real time traffic monitoring of flow and speed
- Real time traffic forecast
- Simulation of events
- Parallel simulation of interventions
- Provide current and forecasted speeds to the national journey planner of the VAO project -> HyperPath

Real-time feeds
FCD and loop detectors



Real time monitoring and event management



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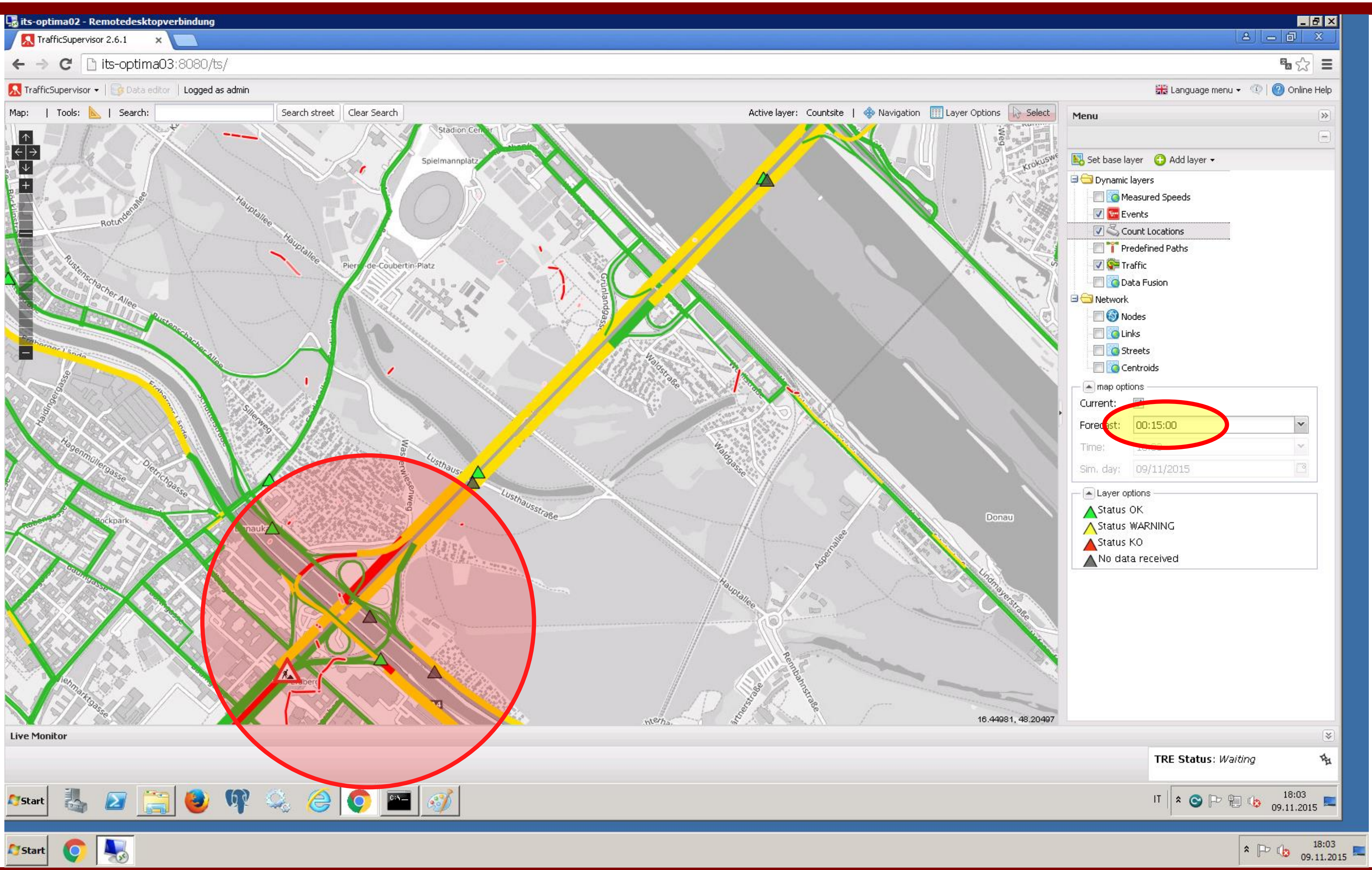
Challenges and solutions

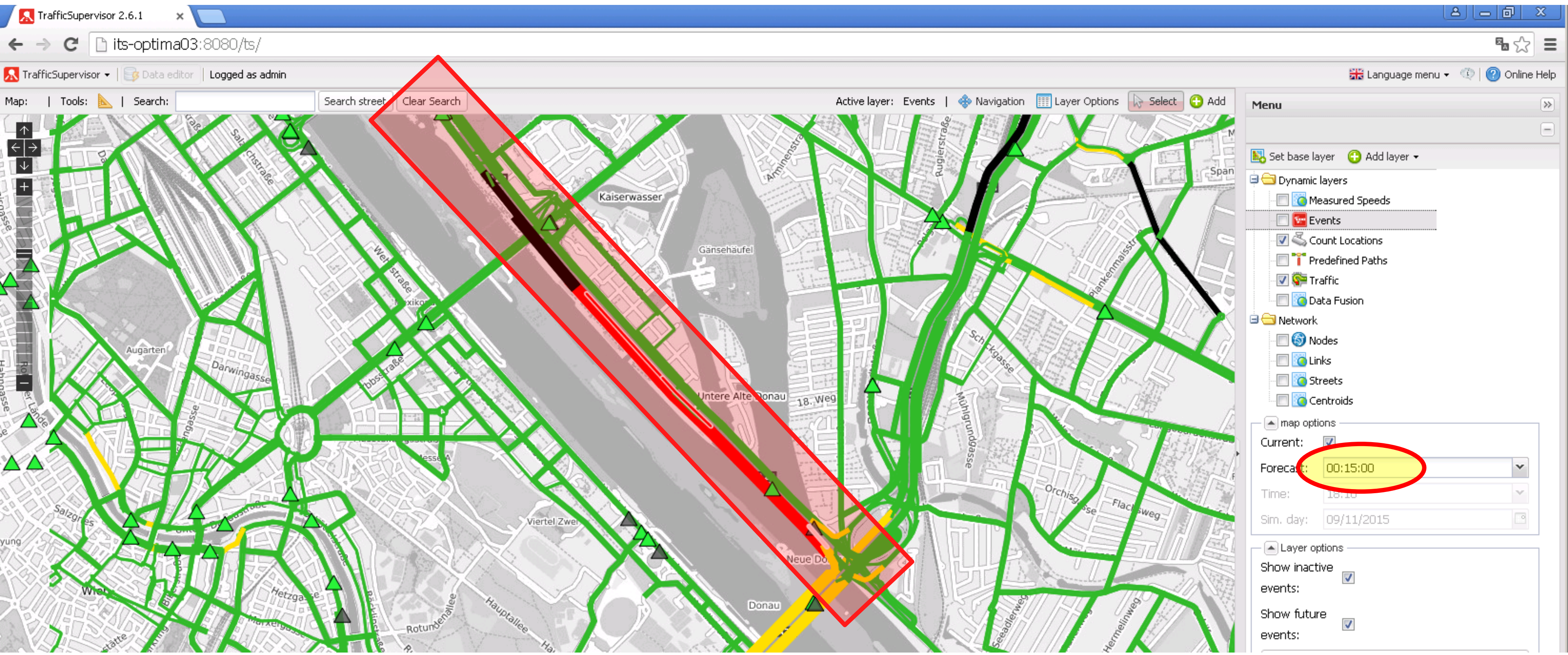
- Very large network
  - Half-automatic methods to build, update, simplify and calibrate
  - The DNL in 1 minute on the "assignment" network
- Traffic events received in standard EU format (DATEX2) and geo-referentiated to the national graph called GIP
  - Automatic calculation of event impacts starting form the type of the event and its standardized description
- Data fusion of FCD coming from city cabs (about 3000) and loop detectors (about 1000)

Unexpected congestion detected on the bridge

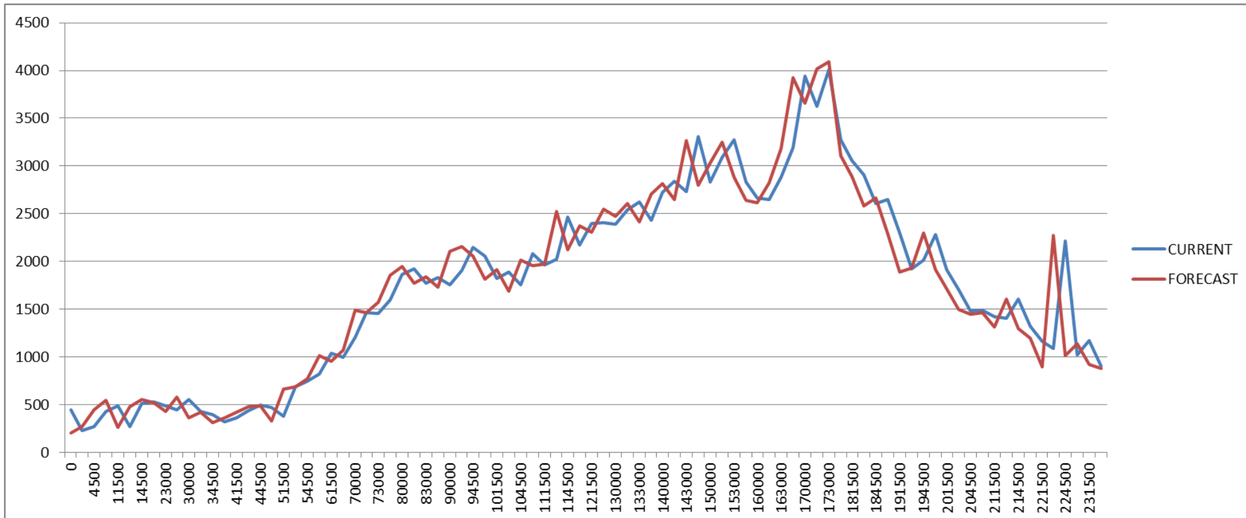
Congestion downstream
15 min forecast

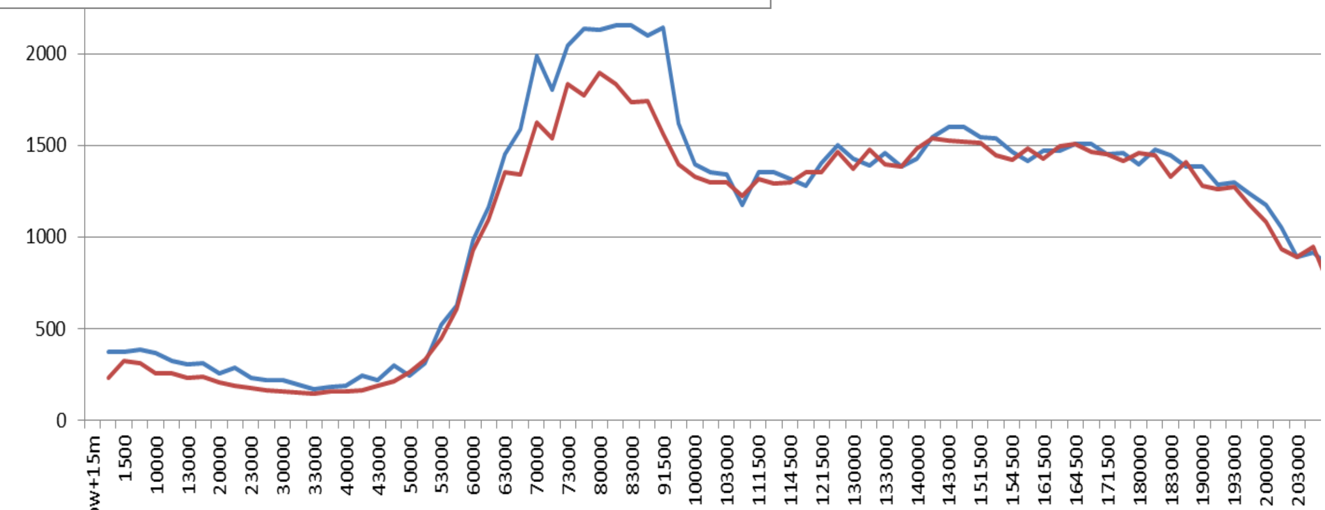


Congestion upstream 15 min forecast



Validation through comparison of detector measure and forecast 15m





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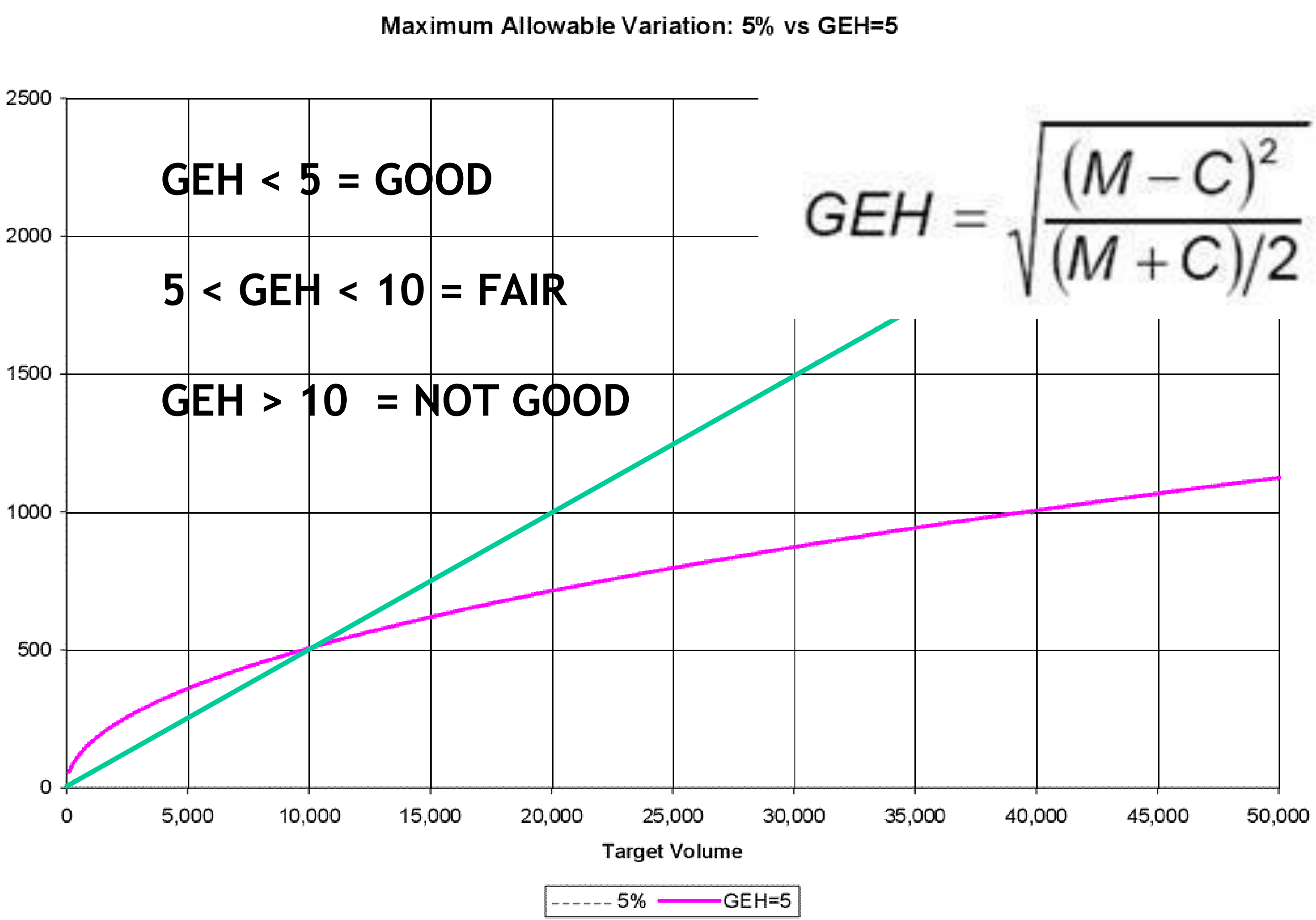
GEH statistics to monitor and evaluate the prediction



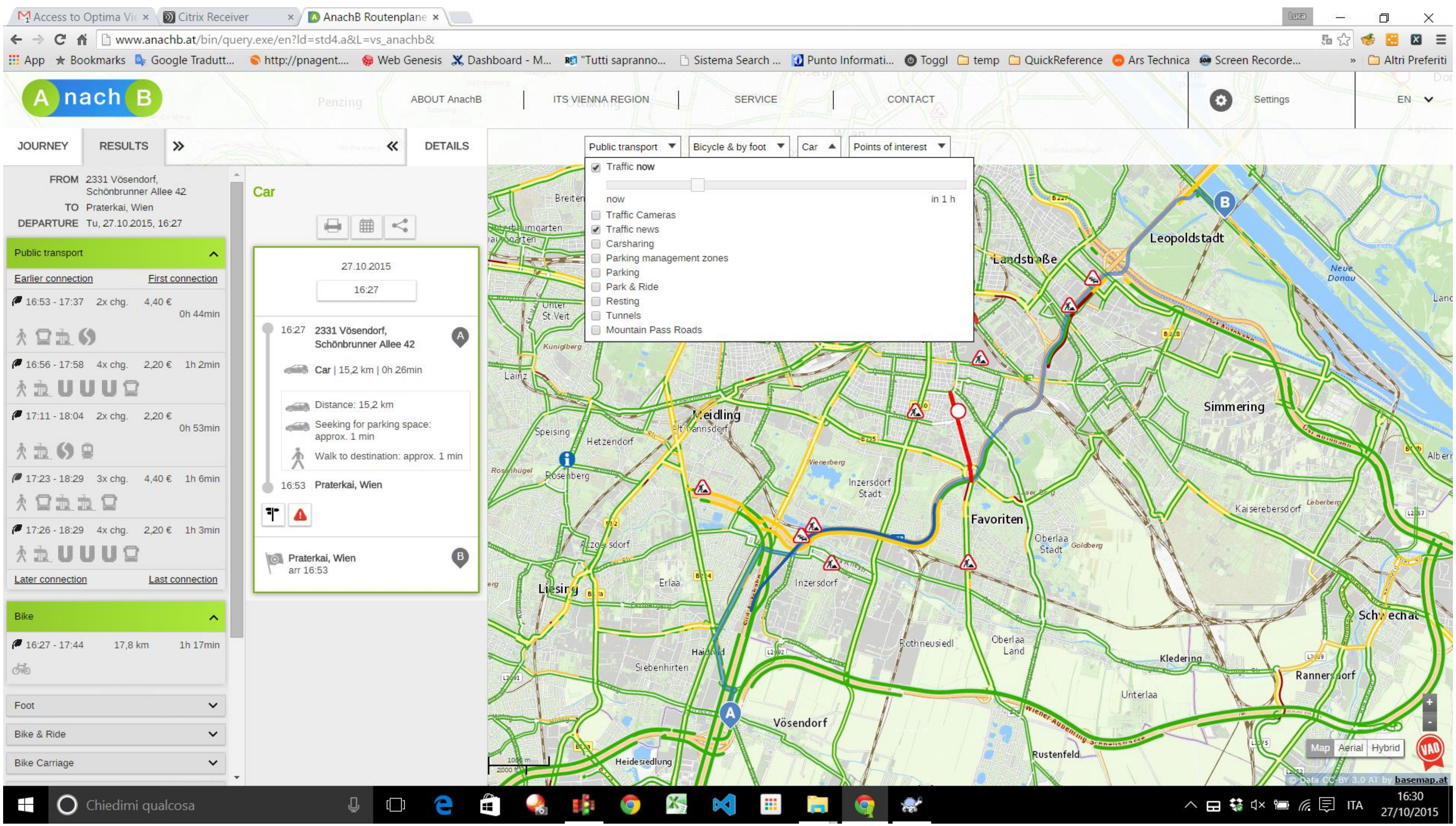
GEH < 5 = GOOD

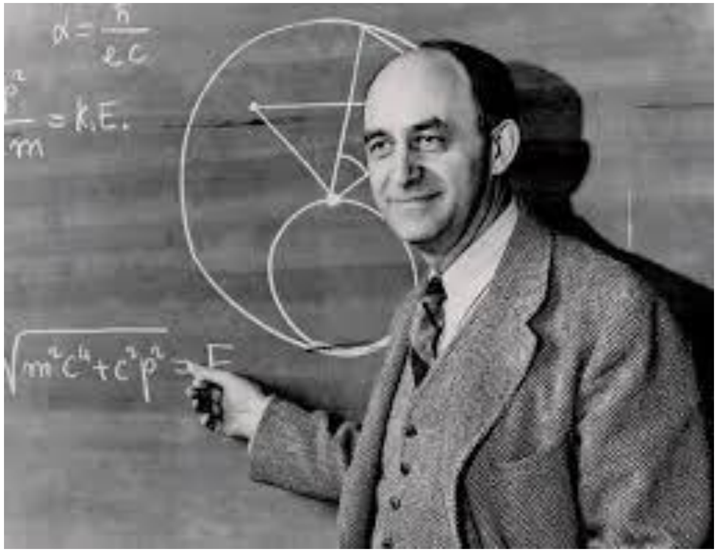
5 < GEH < 10 = FAIR

GEH > 10 = NOT GOOD

$$GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$$

Forecast used by HyperPath in VAO to improve journey planning





USE OF DTA MODELS FOR TRAFFIC MANAGEMENT

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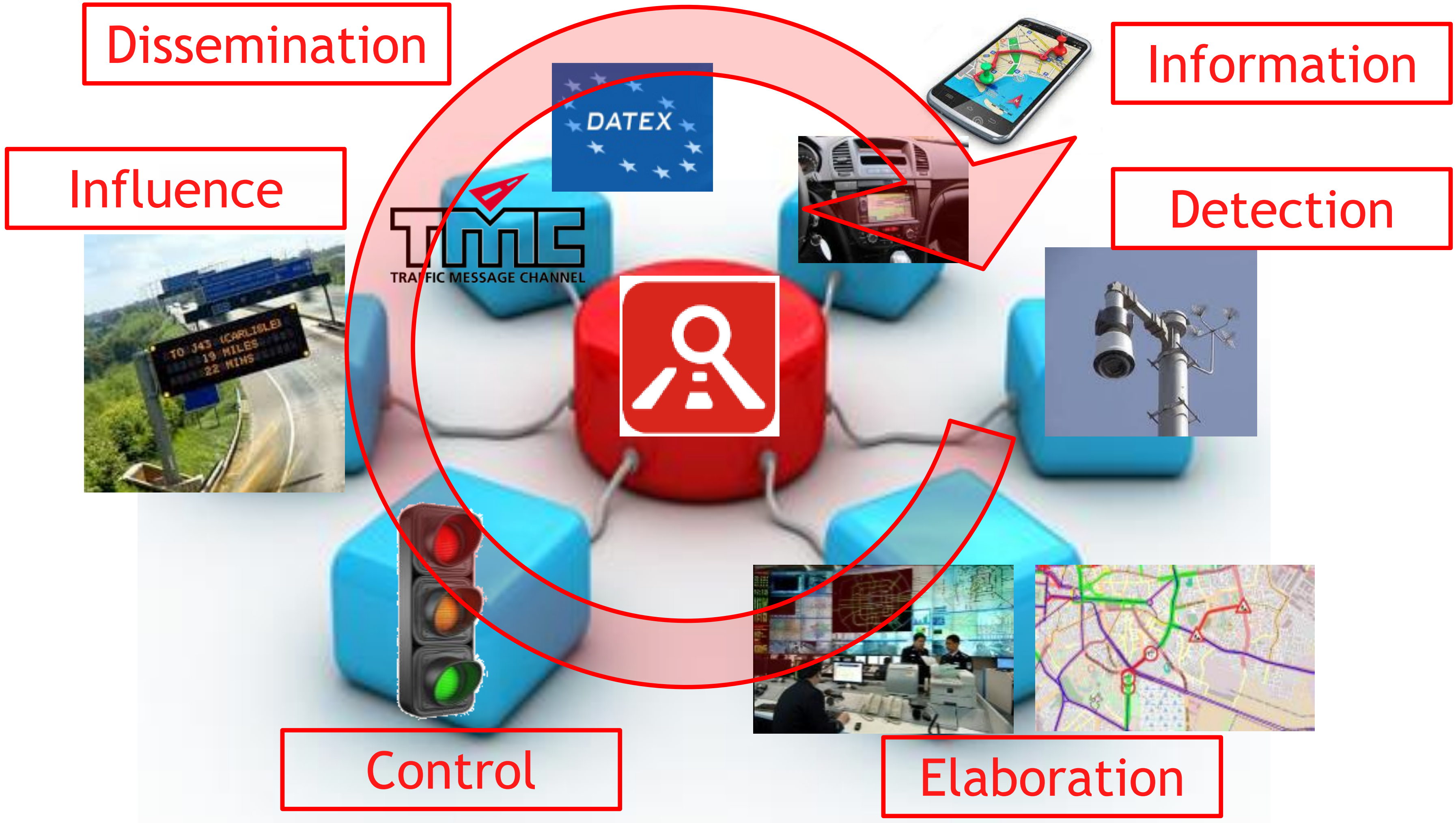
An operative system for mobility management and traffic control



Why models in a control room: from data to information

- Traffic data Amplifier
- Real time Decision Support

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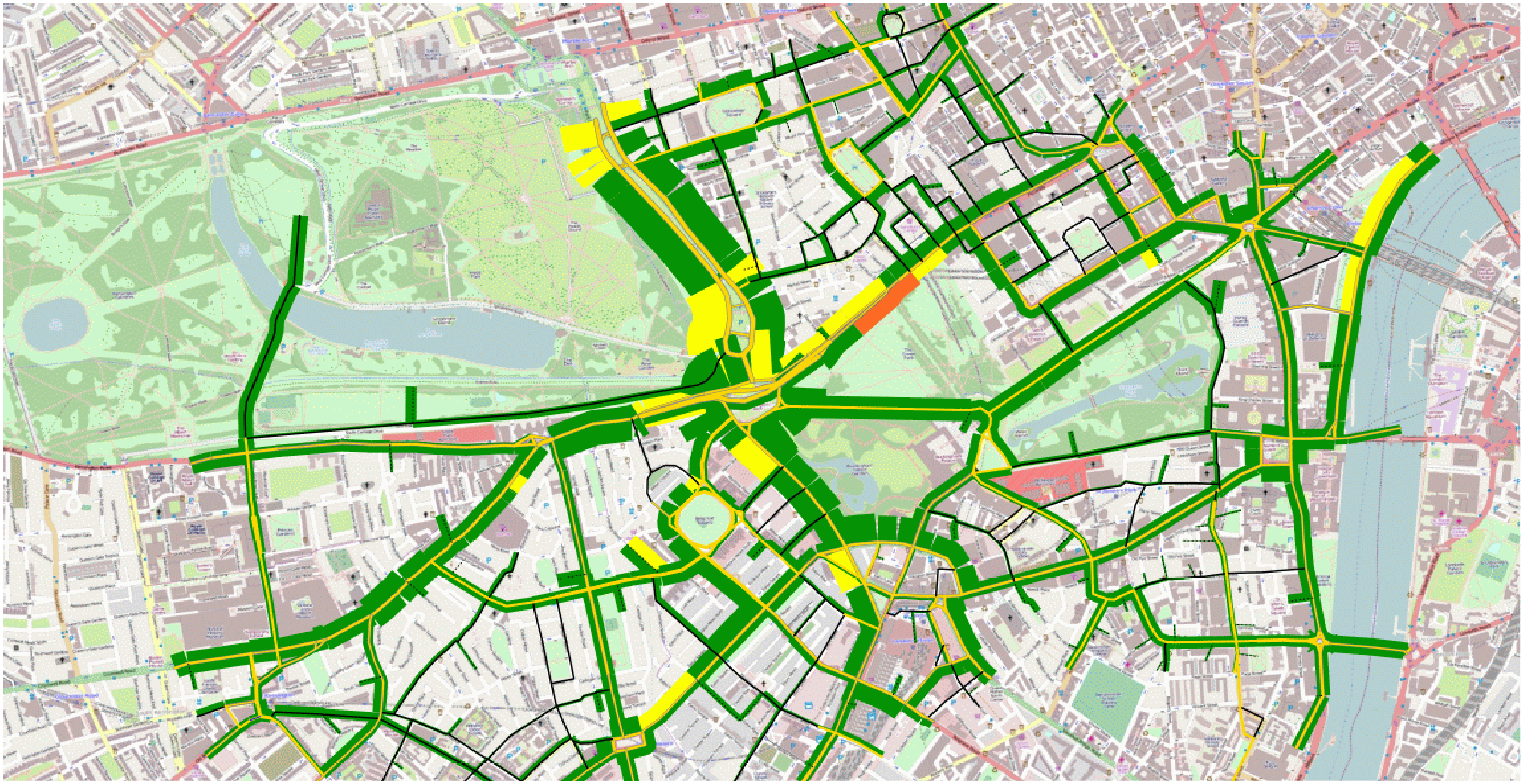
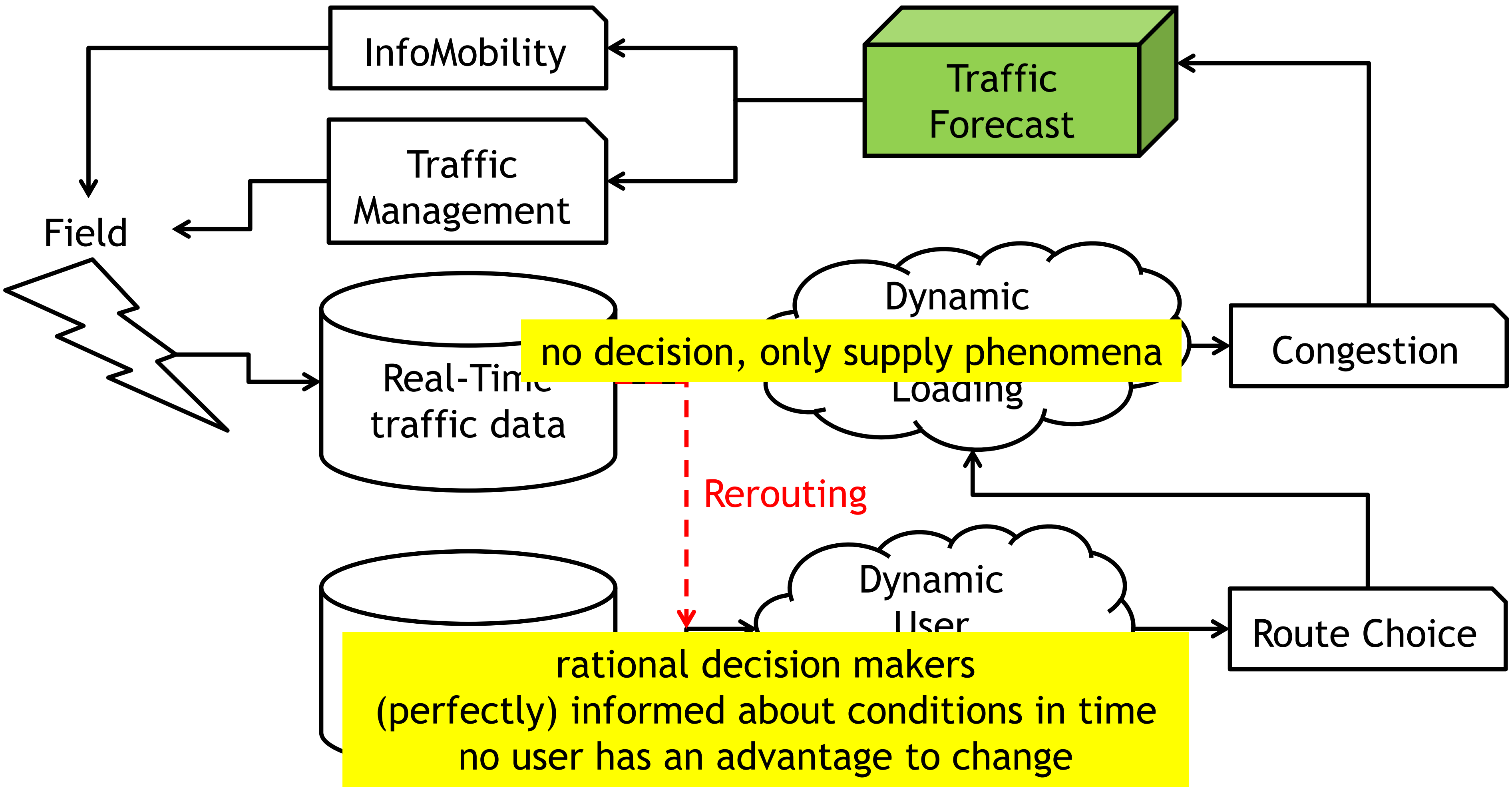
Augmented infomobility in space and time

FORECASTING FOR 7:30 AM FROM DTA MODEL



- Use cases of DTA models
  - transport planning and management through off-line equilibrium
  - traffic monitoring and control through real-time network loading
- Main advantage
  - explicitly reproduce vehicle queues along links and their spillback at intersections
    - thus overcoming the weak representation of congestion by volume delay functions in static assignment models
  - react to unpredicted events (accidents, road works) and control countermeasures (vms, traffic lights)
    - thus overcoming the weak sensitivity of pattern recognition models

DTA models for traffic forecast: DNL and DUE



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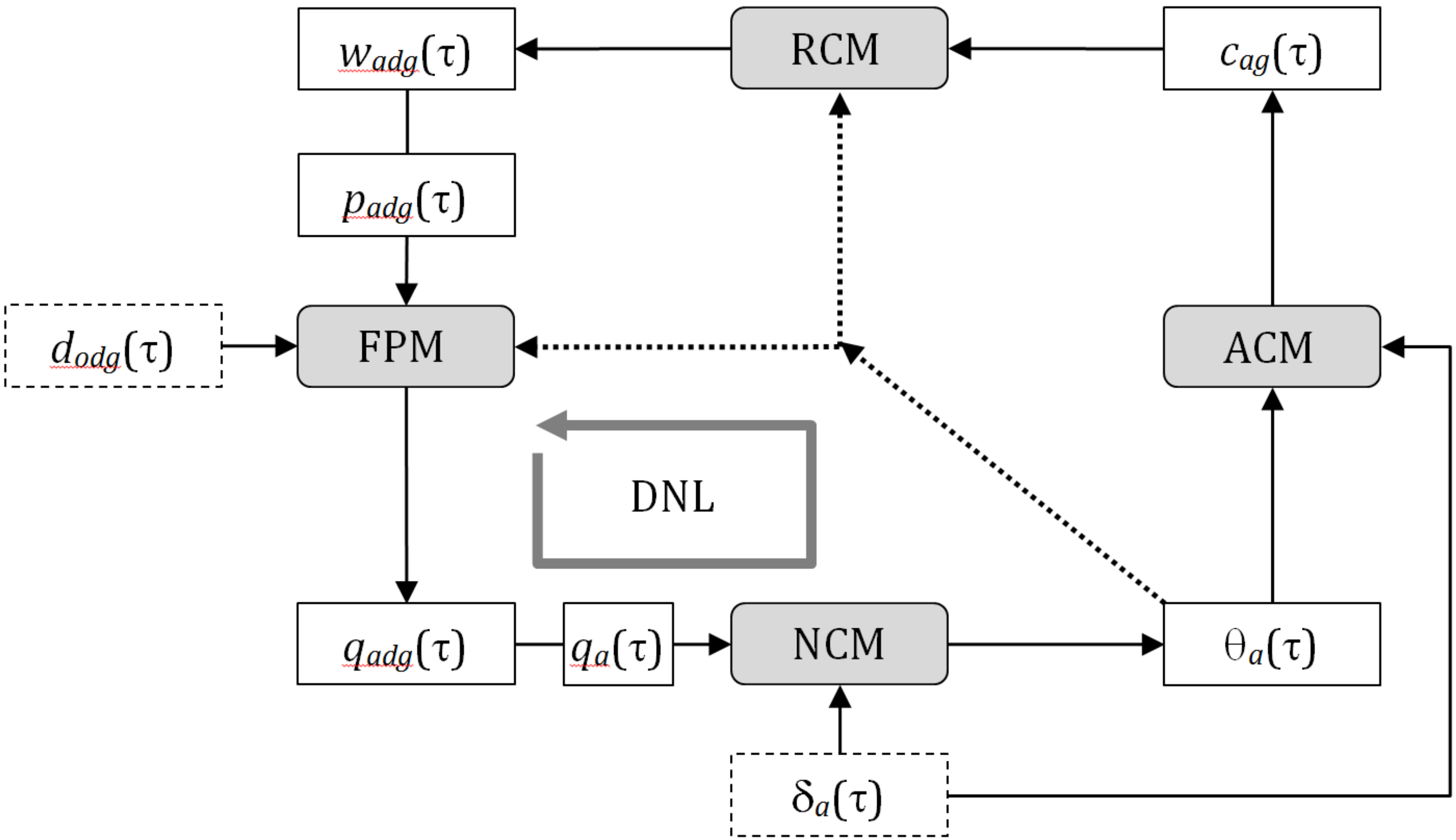
FORMULATION AND SOLUTION OF DUE BASED ON ARC PROBABILITIES

Fixed-Point schema of DTA model with implicit path enumeration



DUE = NCM → ACM → RCM → FPM → [MSA] → NCM

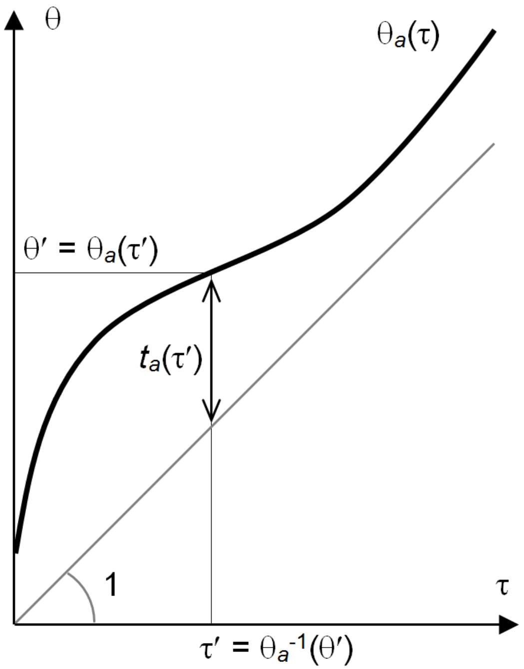
DNL = NCM → FPM → [MSA] → NCM

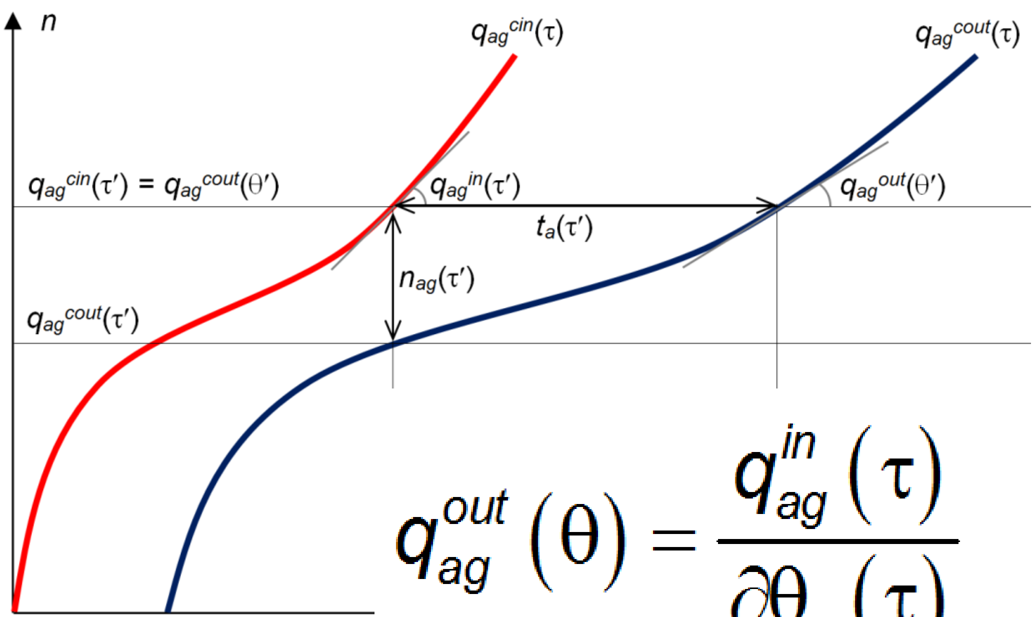
Variables: functions of time

- $p_{agd}(\tau)$ probability that, at time $\tau \in \mathrm{T}$, users of class $g \in G$ directed toward $d \in Z$ choose to enter arc $a \in A$ conditional on being at its tail
- $d_{odg}(\tau)$ demand flow of class $g \in G$ travelling from origin $o \in Z$ to destination $d \in Z$ and departing at time $\tau \in \mathrm{T}$
- $\delta_a(\tau)$ characteristic vector of arc $a \in A$ at time $\tau \in \mathrm{T}$
- $q_{agd}(\tau)$ flow of class $g \in G$ users entering arc $a \in A$ at time $\tau \in \mathrm{T}$ directed to destination $d \in Z$
- $q_a(\tau)$ volume entering arc $a \in A$ at time $\tau \in \mathrm{T}$
- $\theta_a(\tau)$ exit time of arc $a \in A$ for users entering at time $\tau \in \mathrm{T}$
- $c_{ag}(\tau)$ cost of arc $a \in A$ perceived by class $g \in G$ users entering at $\tau \in \mathrm{T}$
- $w_{agd}(\tau)$ expected disutility perceived by users of class $g \in G$ entering arc $a \in A$ at time $\tau \in \mathrm{T}$ and directed toward destination $d \in Z$

Travel times and vehicle flows in dynamic macroscopic models

$$t_a(\tau) = \theta_a(\tau) - \tau \qquad \text{FIFO} \qquad q_{ag}^{cout}(\theta) = q_{ag}^{cin}(\tau) \quad , \quad \tau = \theta_a^{-1}(\theta)$$





$$q_{ag}^{out}(\theta) = \frac{q_{ag}^{in}(\tau)}{\dfrac{\partial\theta_a(\tau)}{\partial\tau}}$$

derivatives (chain rule and inverse)

Sequential Route Choice Model based on random utility e.g. DSP

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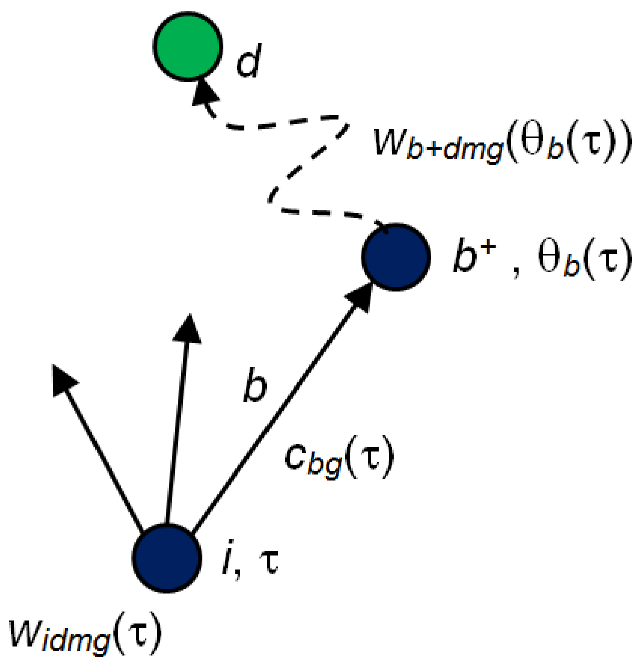
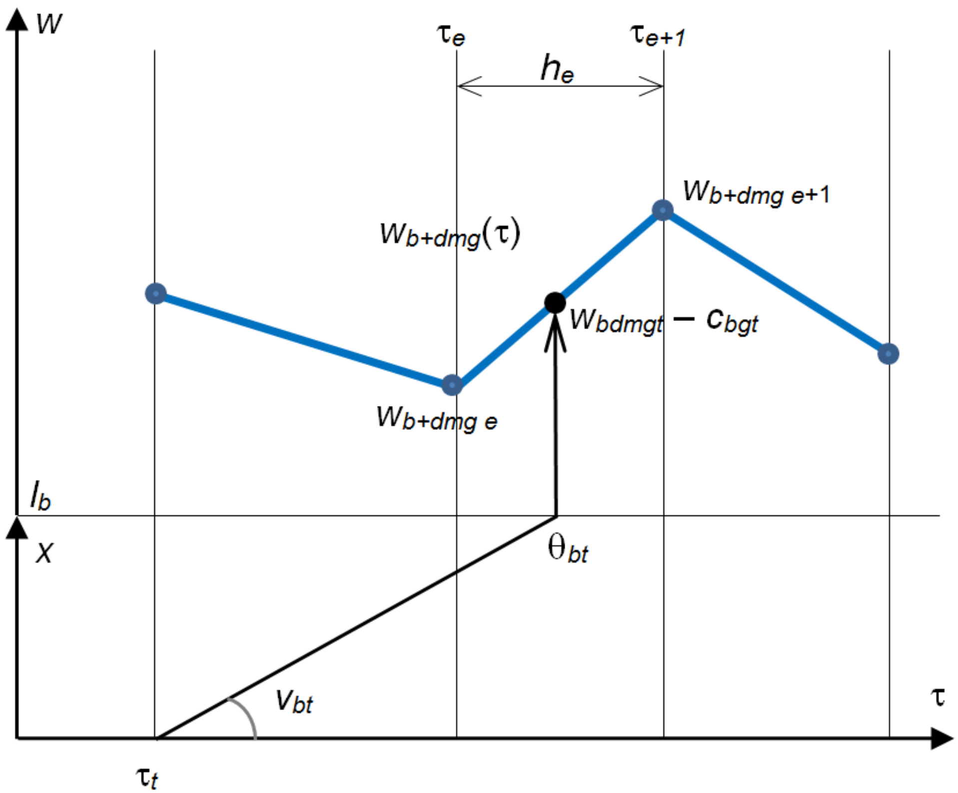
$$w_{bdmg}(\tau) = c_{bg}(\tau) + w_{b^+dmg}(\theta_b(\tau))$$

$$w_{bdmgt} = c_{bgt} + w_{b^+dmge} + (\theta_{bt} - \tau_e) \cdot \frac{w_{b^+dmg\,e+1} - w_{b^+dmge}}{h_e}$$





$$p_{admg} = \begin{cases} p_{admg}\left(w_{bdmg}, \forall b \in i^+ \cap A_m\right), & \text{if } a \in A_m \\ 0, & \text{otherwise} \end{cases}$$

$$w_{idmg} = w_{idmg}\left(w_{bdmg}, \forall b \in i^+ \cap A_m\right)$$ solve system in reverse chronological order

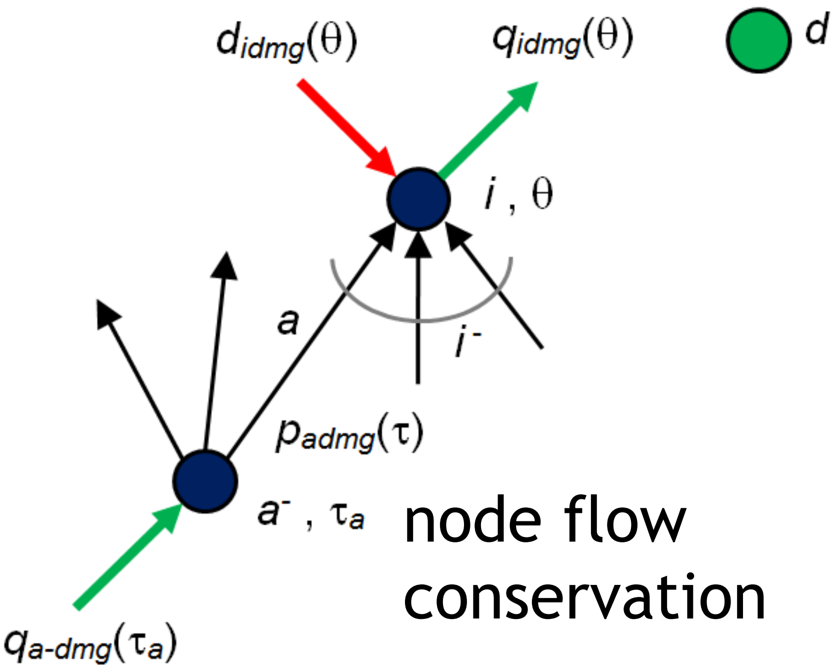
Flow Propagation Model based on arc probabilities

$$q_{idmg}(\theta) = d_{idmg}(\theta) + \sum_{a\in i^-} \frac{q_{a^-dmg}(\tau_a)}{\frac{\partial\theta_a(\tau_a)}{\partial\tau}} \cdot p_{admg}(\tau_a)$$

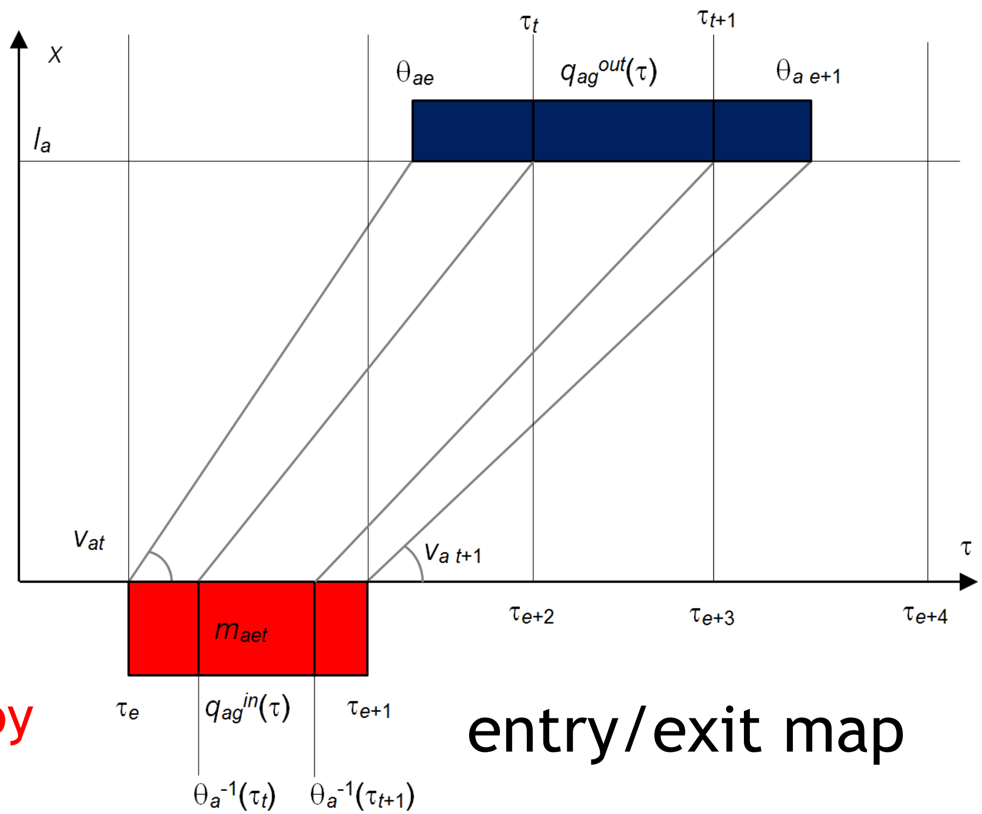
$$\tau_a = \theta_a^{-1}(\theta), \forall a \in i^-$$

$$q_{idmgt} = d_{idmgt} + \sum_{a\in i^-}\sum_{e<t} q_{a^-dmge}\cdot\frac{h_e}{h_t}\cdot m_{aet}\cdot p_{admge} + \sum_{a\in i^-} q_{a^-dmgt}\cdot m_{att}\cdot p_{admgt}$$

$$m_{aet} = \frac{Min\left(Min\left(\theta_a^{-1}(\tau_{t+1}),\tau_{e+1}\right) - Max\left(\theta_a^{-1}(\tau_t),\tau_e\right),0\right)}{\tau_{e+1}-\tau_e}$$



node flow conservation



entry/exit map

BiCGstab with preconditioning by efficient triangularized solution

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Functionals of the fixed point problems

- ACM – Arc Cost Model

$$c_{ag}(\tau) = c_{ag}^{toll}(\tau) + \beta_g^{voft} \cdot \left(\theta_a(\tau) - \tau\right)$$

- RCM – Route Choice Model

$$w_{idg}(\tau) = Min\left(w_{adg}(\tau), \forall a \in i[+]\right)$$

$$w_{adg}(\tau) = c_{ag}(\tau) + w_{a[+]dg}\left(\theta_a(\tau)\right)$$

$$\left(w_{adg}(\tau) - w_{idg}(\tau)\right) \cdot p_{adg}(\tau) = 0$$

- FPM – Flow Propagation Model

$$q_{idg}(\tau) = d_{idg}(\tau) + \sum_{a \in i[-]} q_{adg}\left(\theta_a^{-1}(\tau)\right) \cdot \frac{\partial \theta_a^{-1}(\tau)}{\partial \tau}$$

$$q_{adg}(\tau) = p_{adg}(\tau) \cdot q_{idg}(\tau)$$

- NCM – Network Congestion Model

$$\theta_a(\tau) = \theta_a\left(\mathbf{q}_A, \tau\right)$$

Variational Inequality problem for deterministic route choices

- Focus on local choices at each node $i \in N$ among its forward star made by users of class $g \in G$ directed toward each destination $d \in Z$
- VI problem defined on probabilities
- Feasible set is a simple polytope
- Cost functional does includes the solution of DNL

$$\sum_{d\in Z}\sum_{g\in G}\sum_{i\in N-d}\sum_{a\in i^+}\int_{\tau\in T} w_{adg}\left(\mathbf{p}^*_{ADGT},\tau\right)\cdot\left(p^*_{adg}(\tau)-p_{adg}(\tau)\right)\cdot d\tau \le 0 \quad ,\forall \mathbf{p}_{ADGT}\in S_p^{ADGT}$$

$$S_p^{ADGT}=\left\{\begin{array}{l}\mathbf{p}_{ADGT}\in\Re^{ADGT}: p_{adg}(\tau)\ge 0\,,\forall a\in A\,,\forall d\in Z\,,\forall g\in G\,;\\ \sum_{a\in i^+} p_{adg}(\tau)=1\,,\forall i\in N-d\,,\forall d\in Z\,,\forall g\in G\end{array}\right\}$$

proved to be equivalent to path based formulation of DUE

$$\sum_{k\in K}\sum_{g\in G}\int_{\tau\in T} c_{kg}\left(\mathbf{p}^*_{KGT},\tau\right)\cdot\left(p^*_{kg}(\tau)-p_{kg}(\tau)\right)\cdot d\tau \le 0 \quad ,\forall \mathbf{p}_{KGT}\in S_p^{KGT}$$

$$S_p^{KGT}=\left\{\begin{array}{l}\mathbf{p}_{KGT}\in\Re^{KGT}: p_{kg}(\tau)\ge 0\,,\forall k\in K\,,\forall g\in G\,;\\ \sum_{k\in K_{od}} p_{kg}(\tau)=1\,,\forall od\in Z\times Z\,,\forall g\in G\end{array}\right\}$$

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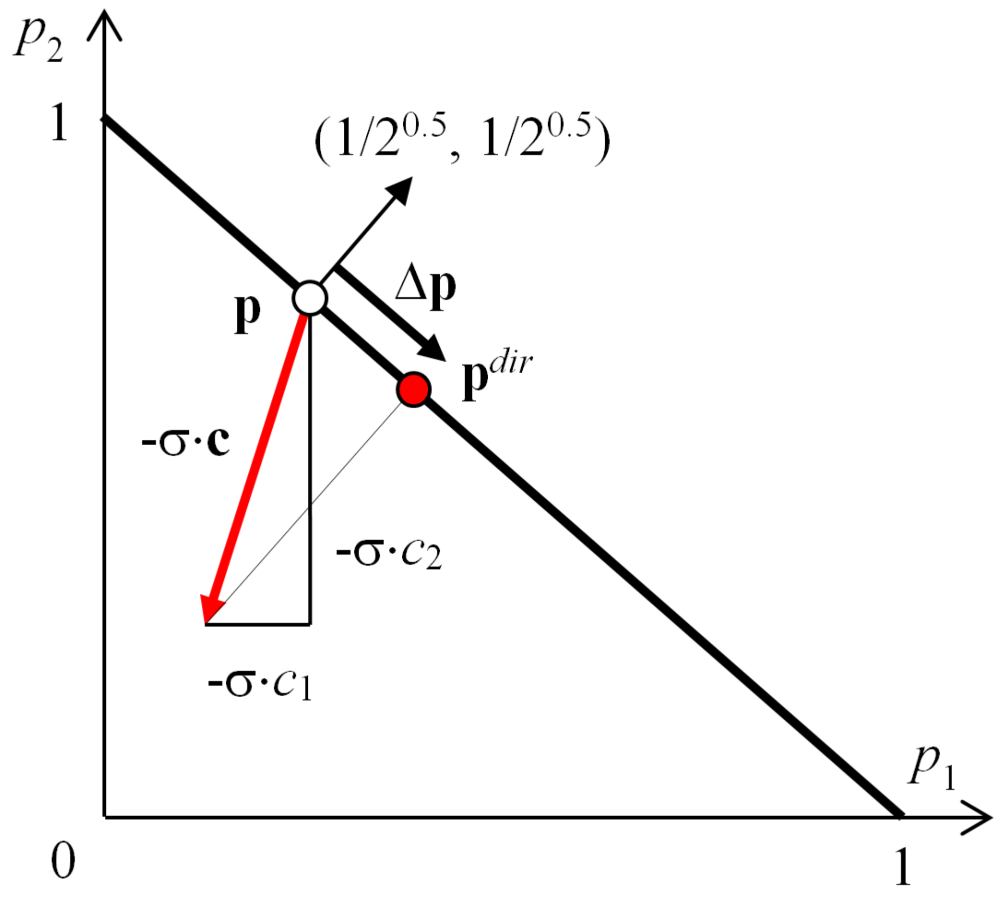
Gap function: revisit the classical convergence

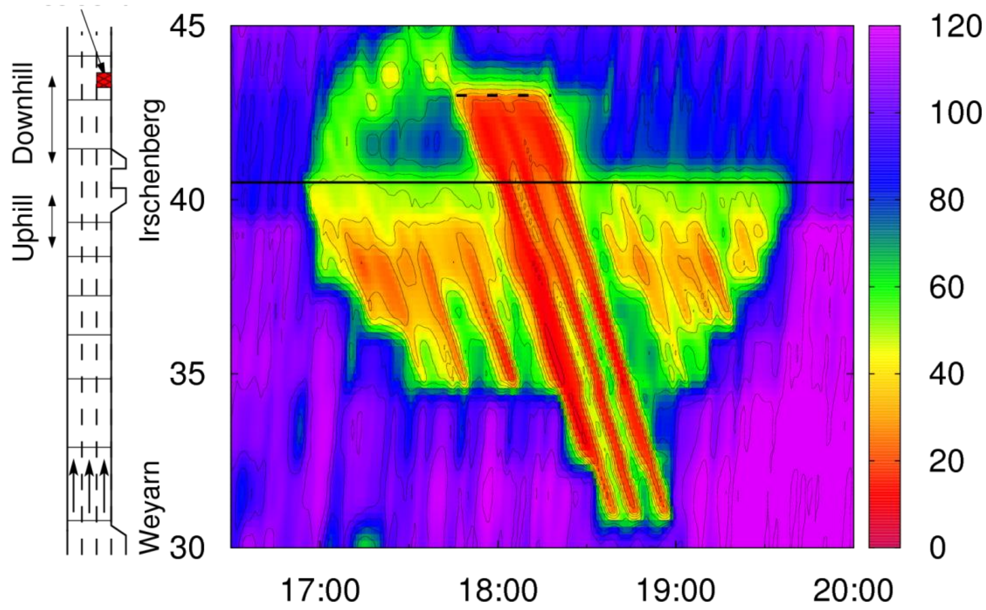
- Measures how close we are from a dynamic user equilibrium
- Ranges from 1 to 0 (equilibrium)
- How much better users can do if they could choose again their local route without changing costs
- Small cost variations can imply large flow variations
- Local equilibrium implies global equilibrium

$$\gamma\left(\mathbf{p}^{*}_{ADGT}\right)=1-\frac{\sum_{d\in Z}\sum_{g\in G}\sum_{i\in N-\{d\}}\int_{\tau\in T} w_{idg}\left(\mathbf{p}^{*}_{ADGT},\tau\right)\cdot d\tau}{\sum_{d\in Z}\sum_{g\in G}\sum_{i\in N-\{d\}}\sum_{a\in i^{+}}\int_{\tau\in T} w_{adg}\left(\mathbf{p}^{*}_{ADGT},\tau\right)\cdot p^{*}_{adg}\left(\tau\right)\cdot d\tau}$$

Search probability direction with Gradien Projection

- If c_1 and c_2 are equal, then we have equilibrium and the search direction is null
- When heading towards the equilibrium we do smaller moves
- Proper scaling e.g. with $\sigma = 1/c_{min}$
- No derivatives available for Quasi-Newton
- The cost operator is a (macroscopic) simulator



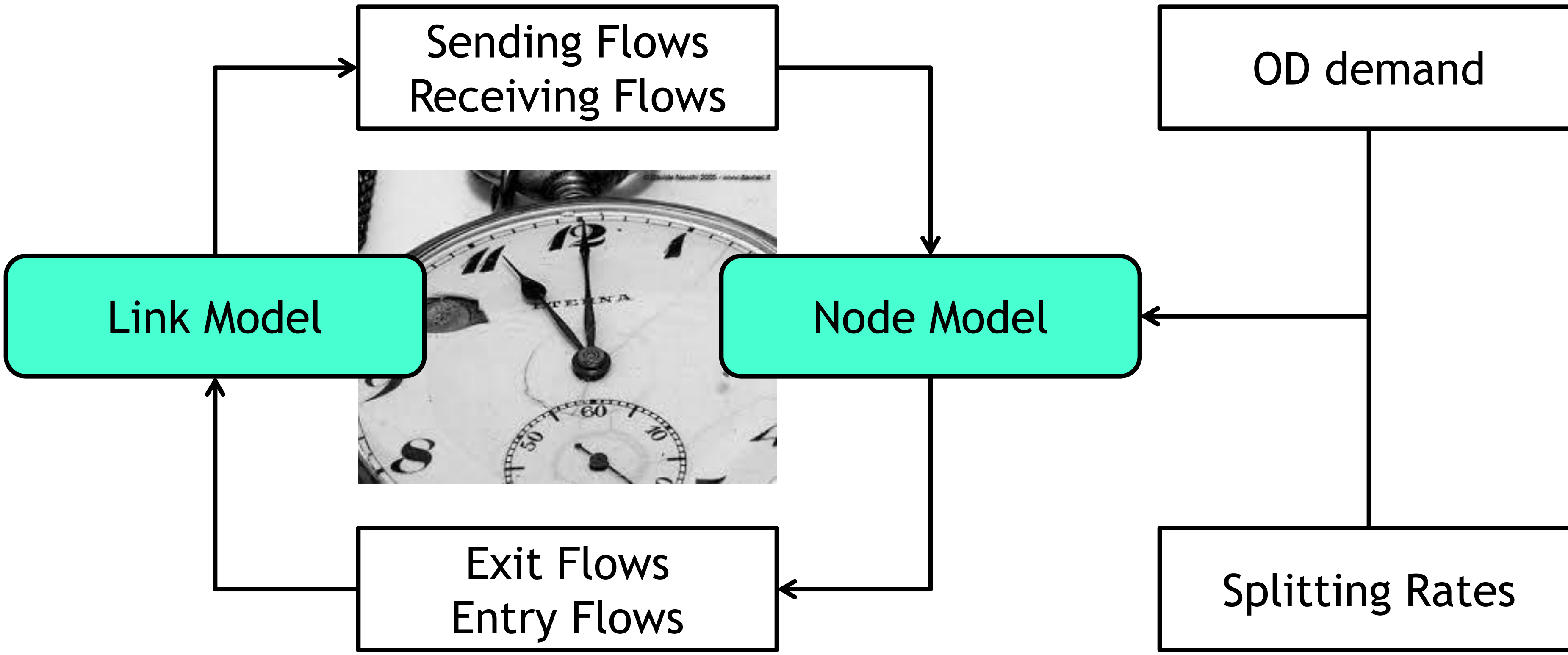


GENERAL LINK TRANSMISSION MODEL FOR DNL

Critical modelling choice: supply
How does traffic look like?

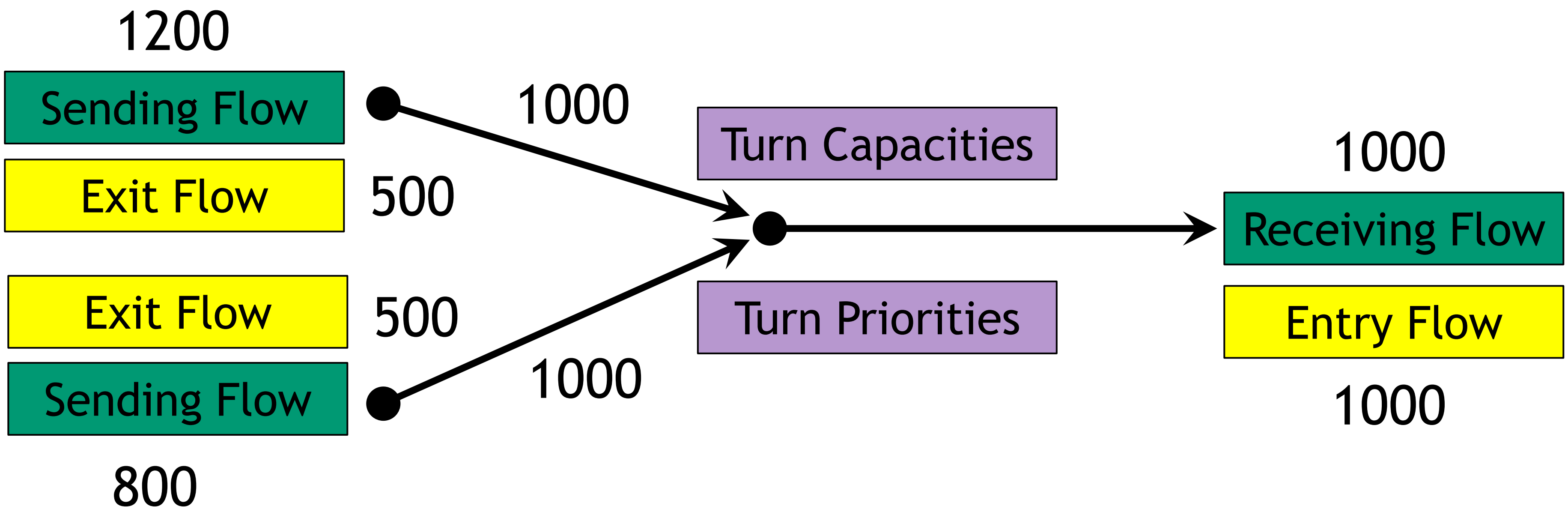
- Traffic model (types of congestion)
  - Under saturation - queues only in front of signals, but vanishing every cycle
  - Over saturation on the link - persistent queues
  - Spillback - queue spillovers to backward links
- Granularity (time and space)
  - Microsimulation, Mesoscopic, Macroscopic
- Several possible compromises can be useful depending on the use case to address

Link Transmission Model for DNL with fixed splitting rates



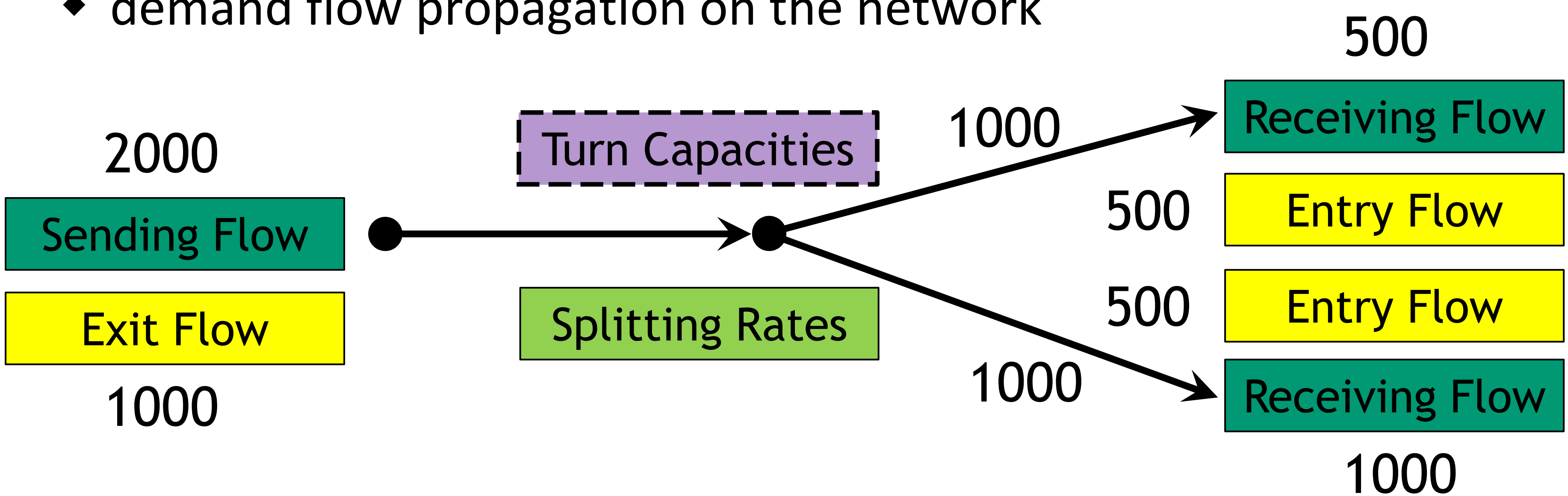
Node Model Merging

- Partition of scarce resource (receiving flow) among BS links, based on turn capacities and priorities
- If a sending flow does not fully exploit the assigned resource the rest is shared among hungry links

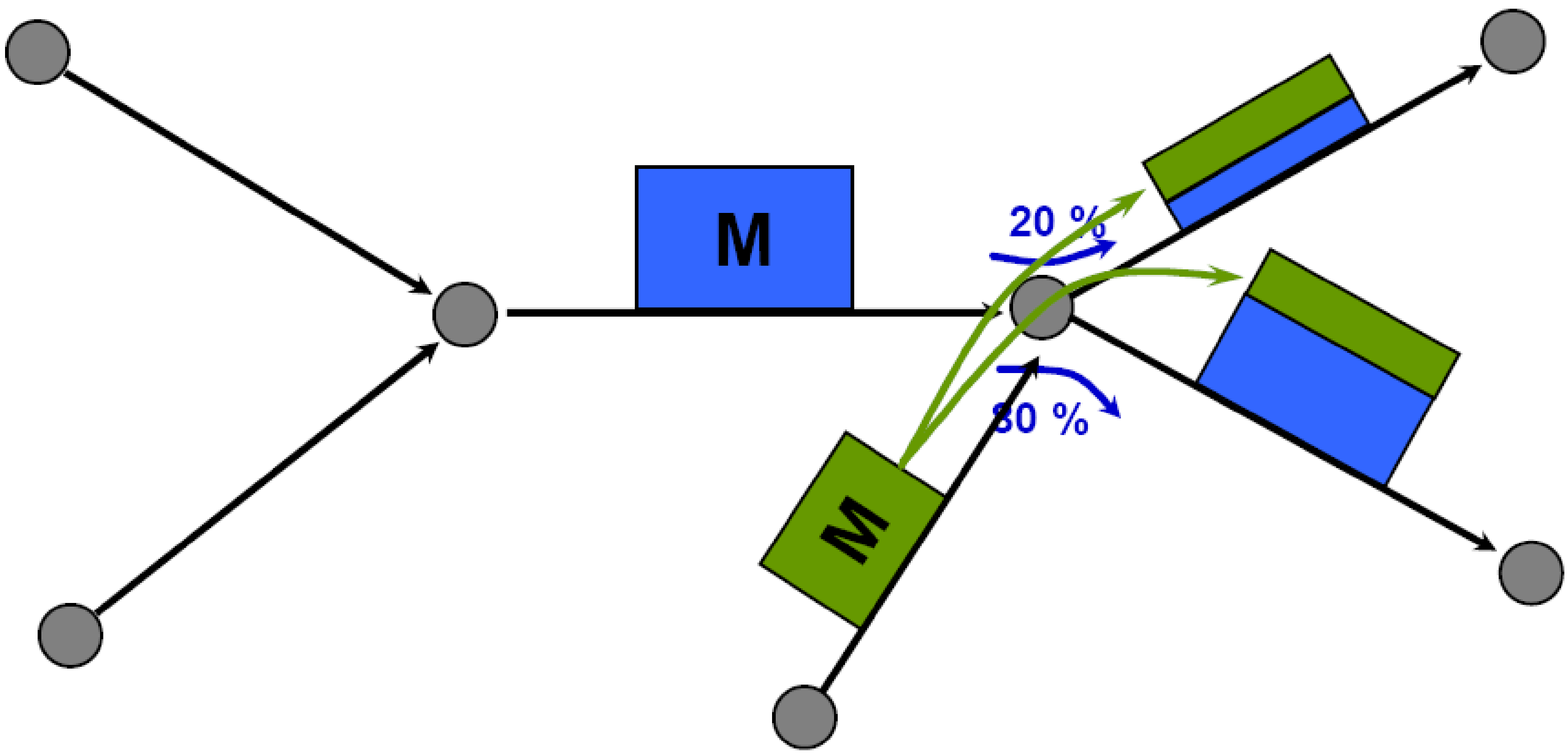


Node Model Diversion

- Assuming FIFO
- Min ratio between receiving and splitted sending
- Splitting rates (not destination specific) come from
  - route choice, for each destination
  - demand flow propagation on the network



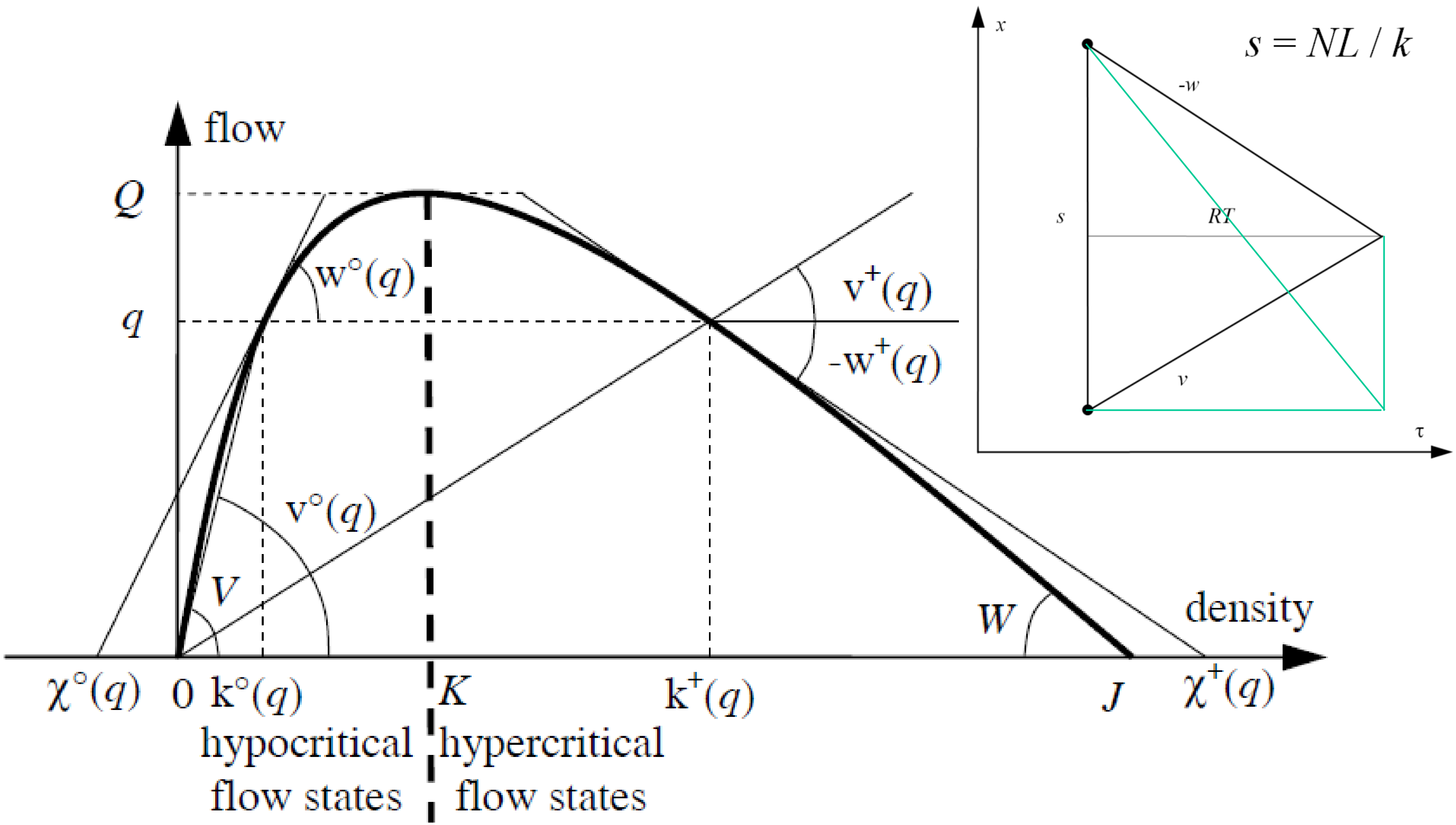
Splitting Rates: aggregation of route choices



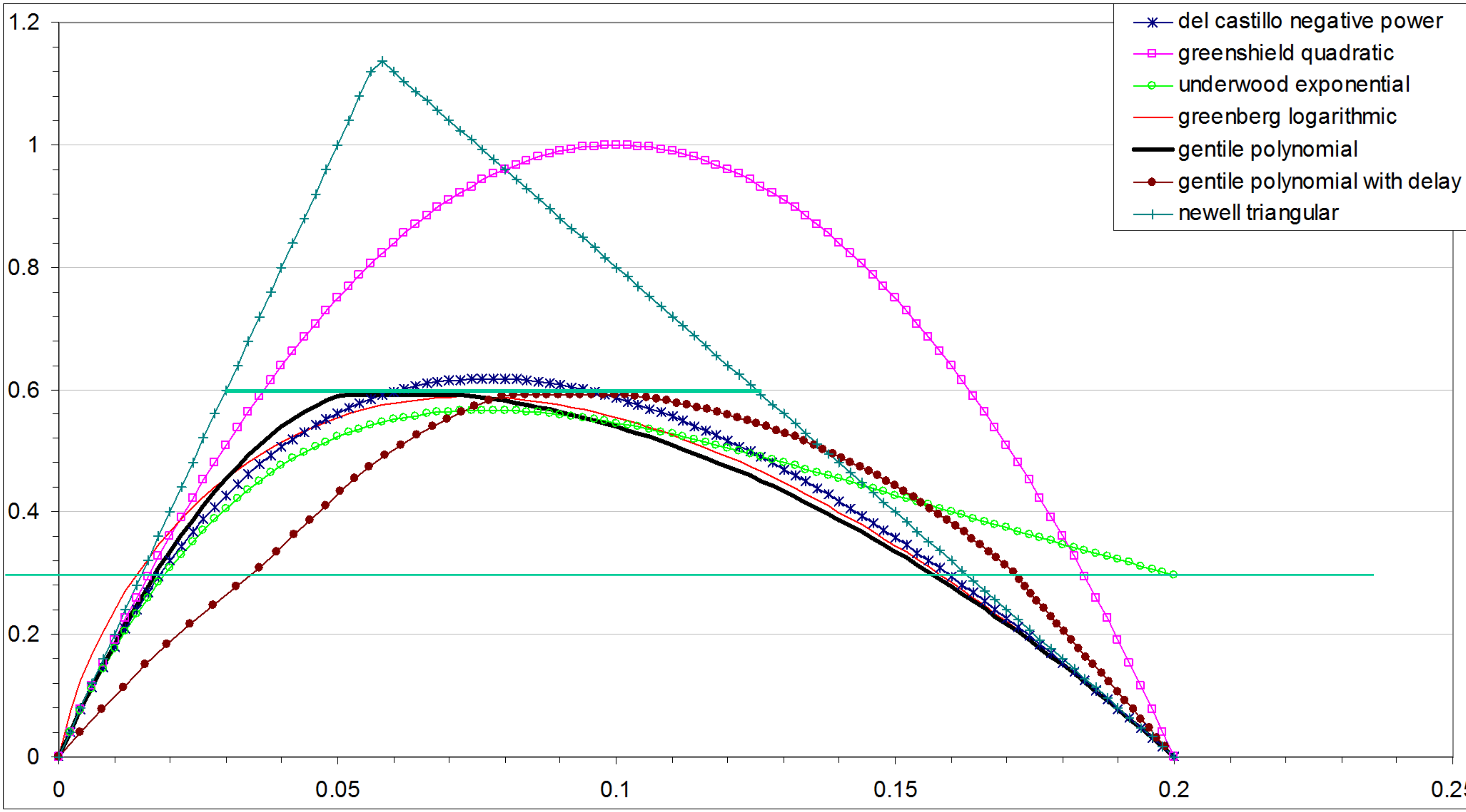
Necessary extensions of the node model for real applications

- Generalizations
  - Mixed merging and diversions
  - Lane intersection topology
  - Traffic signals
- Conflicting maneouvers
  - Solved as merging plus diversion
- Partial FIFO violation at diversions to match microsimulator
  - Early lane change by blocking vehicles (smart polite)
  - Late lane change by blocked vehicles (sneaking)
  - Compressed virtual lanes

Concave Fundamental Diagram heterogeneous speed reaction time

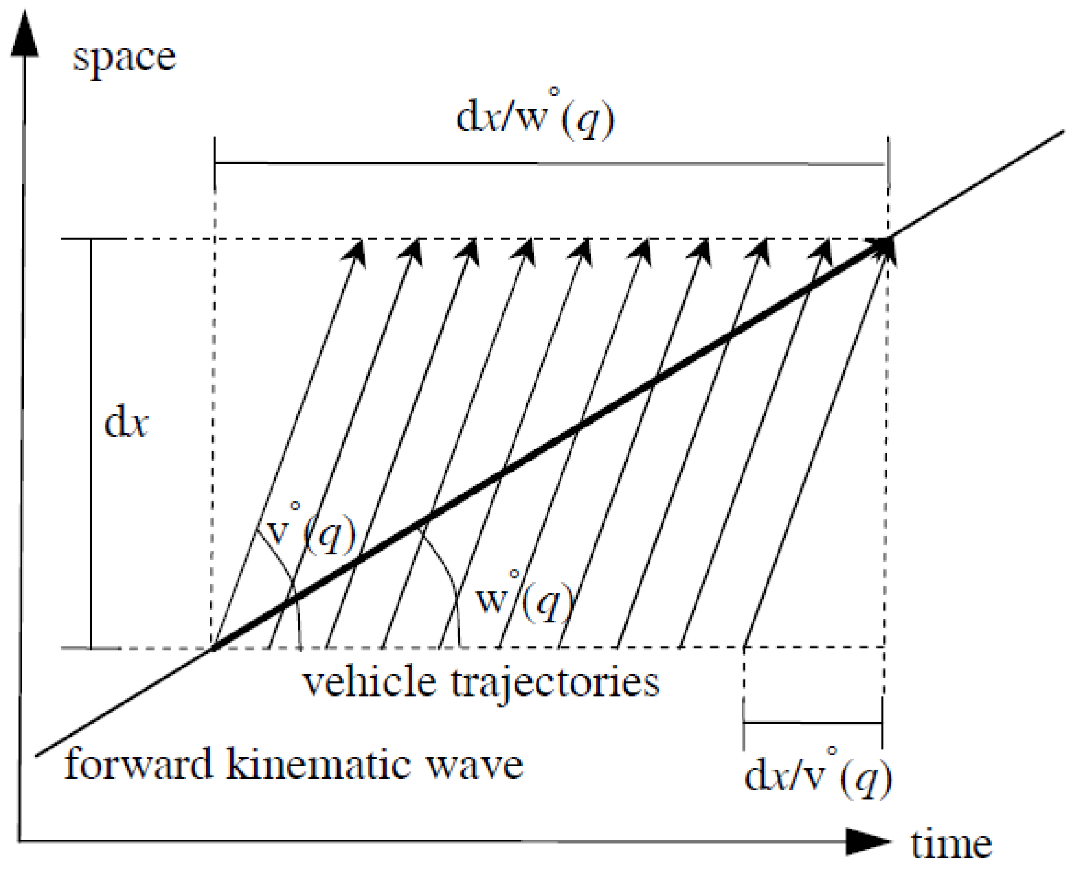


Fundamental diagrams with different shapes and parameters



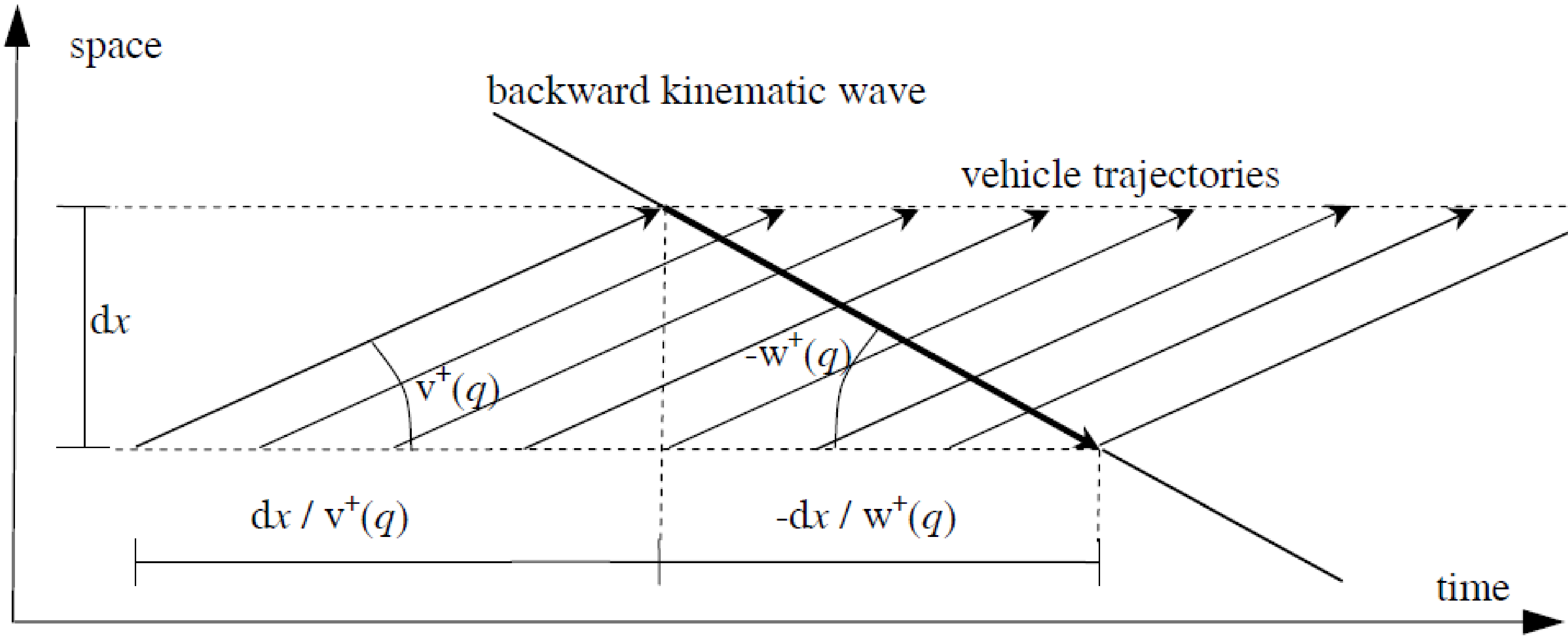
Forward wave propagation of hypocritical flow states

$$\hat{H}(x,\tau) = F(\tau) + f(\tau) \cdot x \cdot (1 / w^\circ(f(\tau)) - 1 / v^\circ(f(\tau))) = F(\tau) - x \cdot \chi^\circ(f(\tau))$$

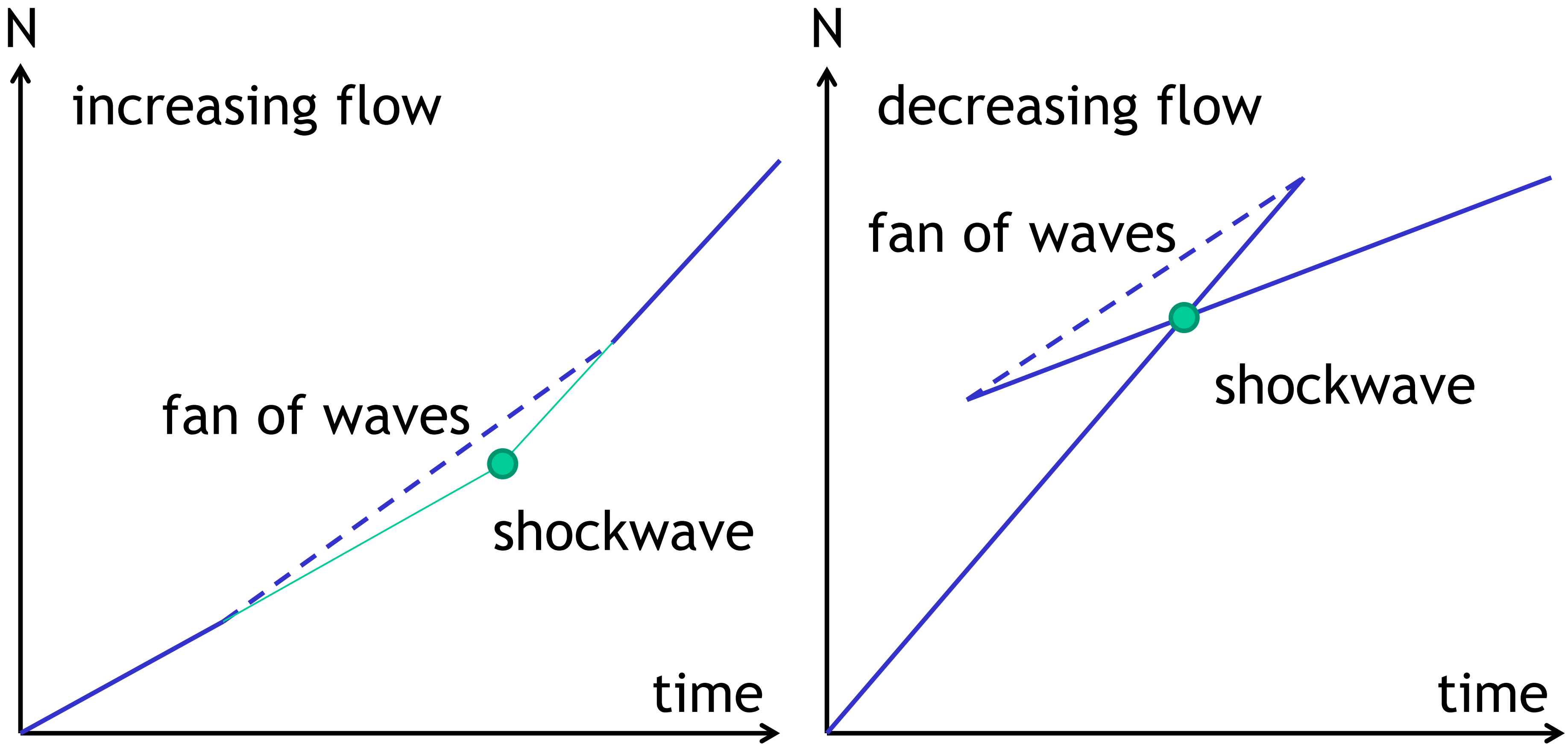


Backward wave propagation of hypercritical flow states

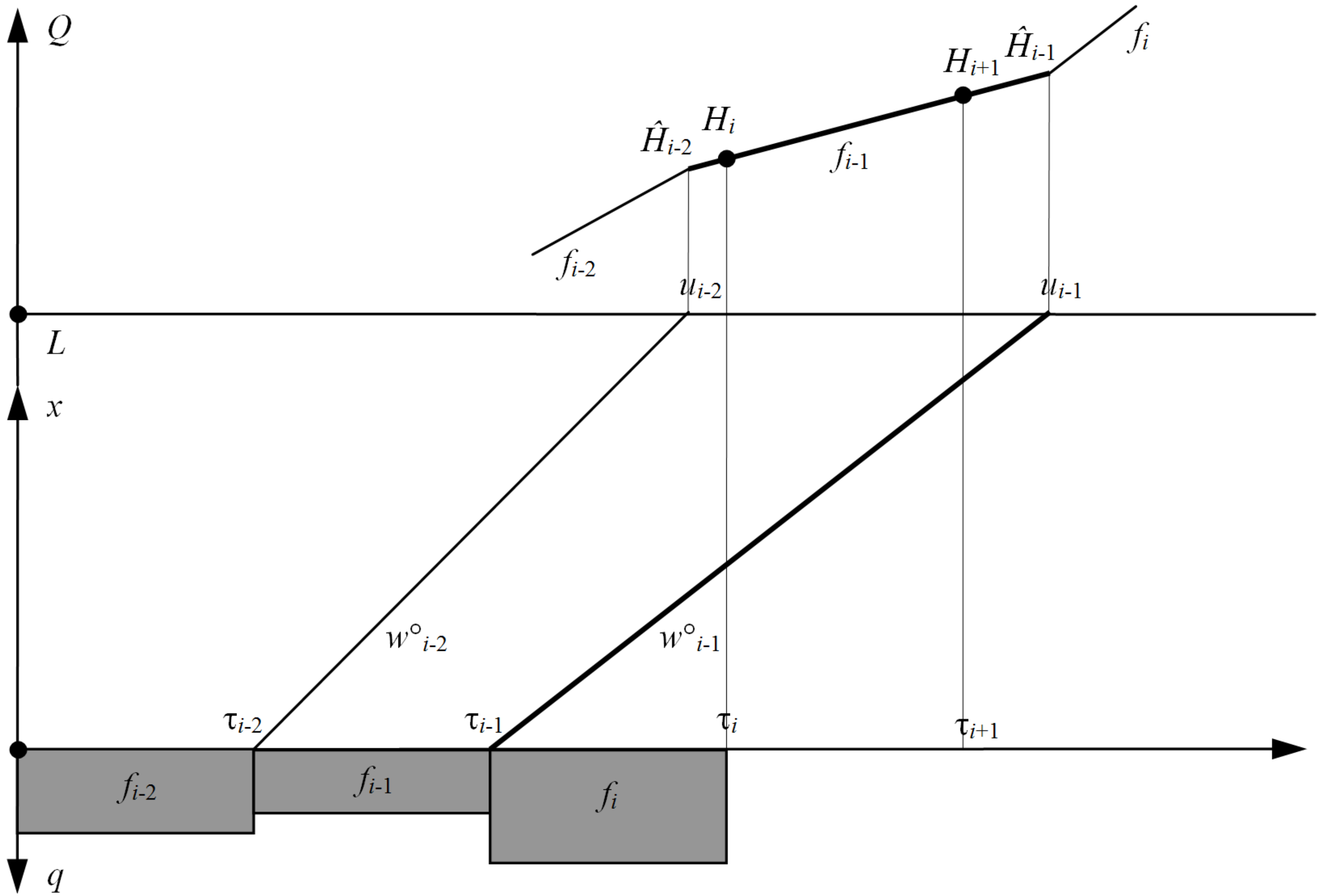
$$\hat{G}(x,\tau) = E(\tau) + (L - x) \cdot e(\tau) \cdot [-1 / \mathrm{w}^{+}(e(\tau)) + 1 / \mathrm{v}^{+}(e(\tau))] = E(\tau) + (L - x) \cdot \chi^{+}(e(\tau))$$



Newell Luke Minimum Principle: lower envelope of cumulative flows

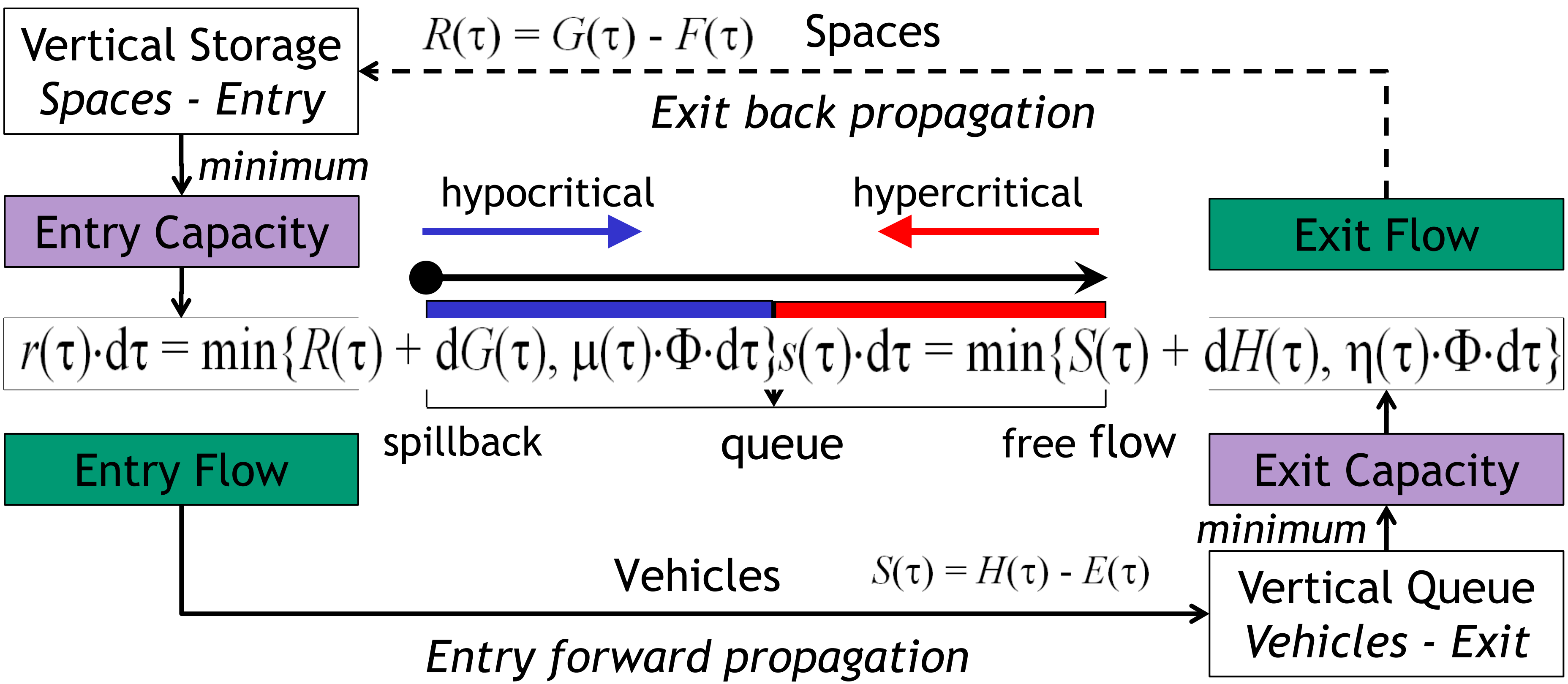


Shockwave based algorithm for piecewise constant flows



Link Model yields sending and receiving flows

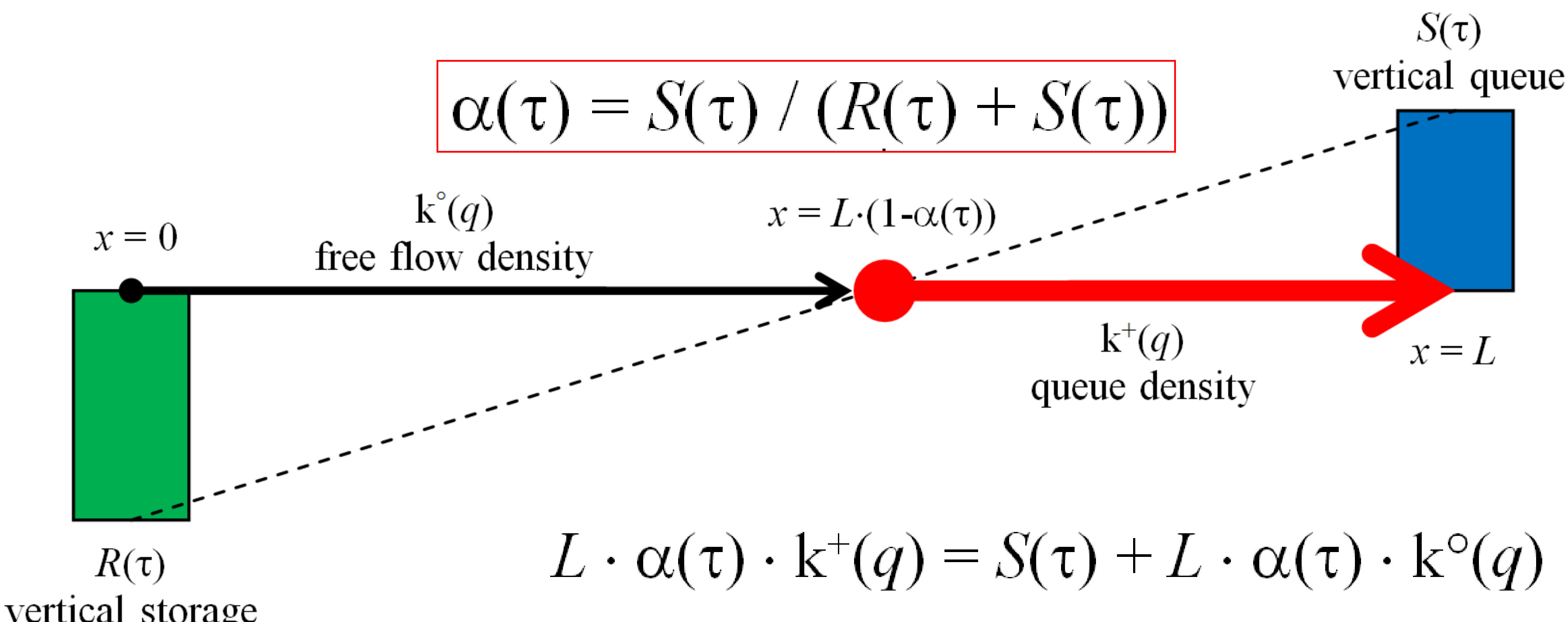
- Newell's solution of Kinematic Wave theory



Estimate of the queue length assuming a constant flow

$$N(\tau) = F(\tau) - E(\tau)$$

$$S(\tau) = H(\tau) - E(\tau)$$



$$\alpha(\tau) = S(\tau) \,/\, (R(\tau) + S(\tau))$$

$$L \cdot \alpha(\tau) \cdot k^{+}(q) = S(\tau) + L \cdot \alpha(\tau) \cdot k^{\circ}(q)$$

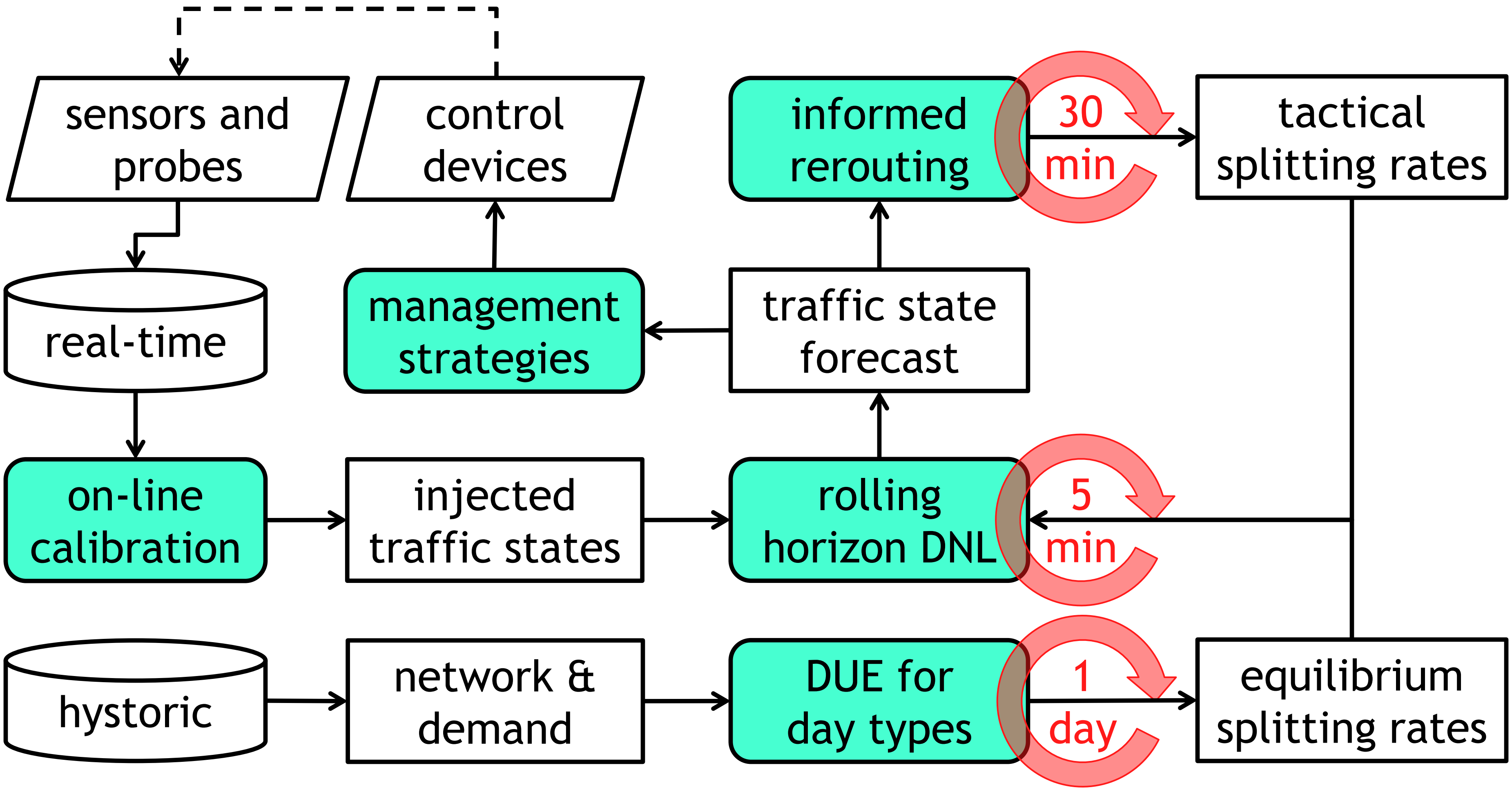
$$R(\tau) = G(\tau) - F(\tau)$$

$$N(\tau) + R(\tau) = L \cdot k^{+}(q)$$

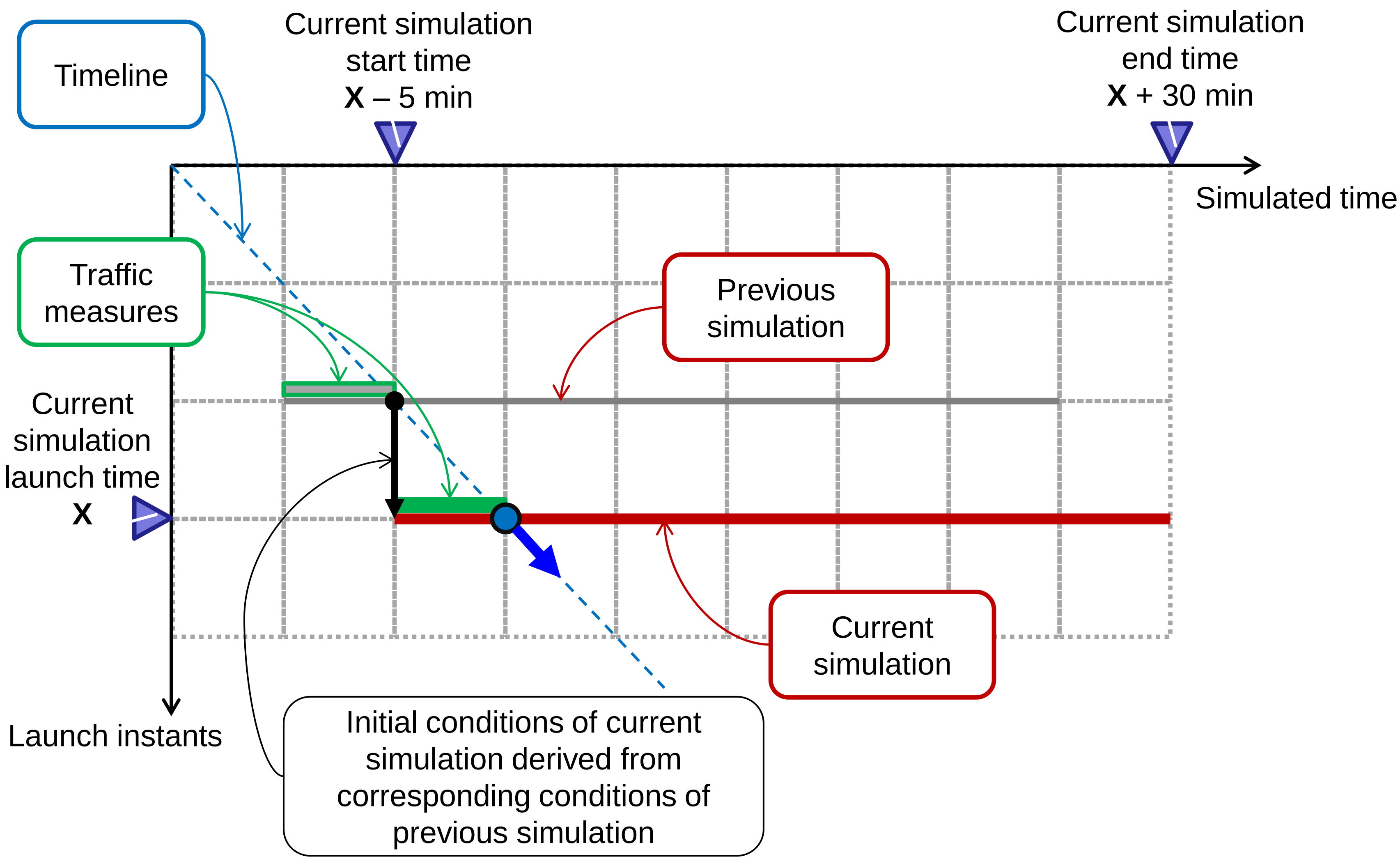
$$N(\tau) - S(\tau) = L \cdot k^{\circ}(q)$$

HOW TO USE DUE AND DNL OFF-LINE AND IN REAL-TIME

Different simulations for Traffic Forecast and Management



Rolling horizon approach with sequential simulations



NUMERICAL EXAMPLES

Dipole with bottleneck

The first battery of tests is performed on the simple dipole network of Figure 4, where it is possible to have expectations on the solution. All links share the following characteristics: free flow speed of 90 km/h, link capacity of 1800 veh/h, jam density of 150 veh/km, jam wave speed of 30 km/h, parabolic hypocritical branch of the fundamental diagram, linear hypercritical branch. All links have a base length equal length of 1 km. Travel demand is constant for 40 min with entry: d_{14} = 1500 veh/h.

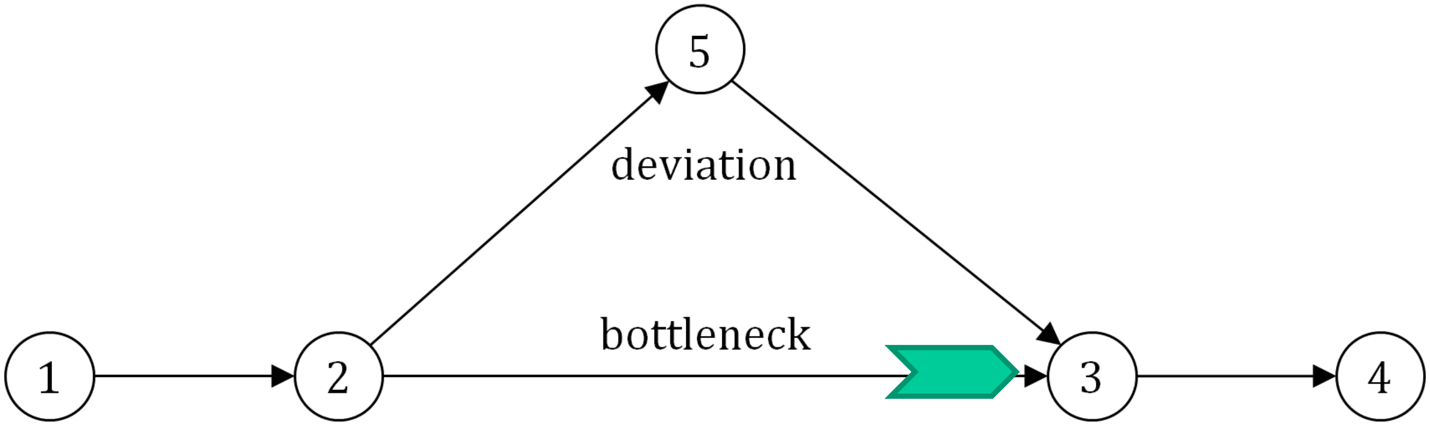
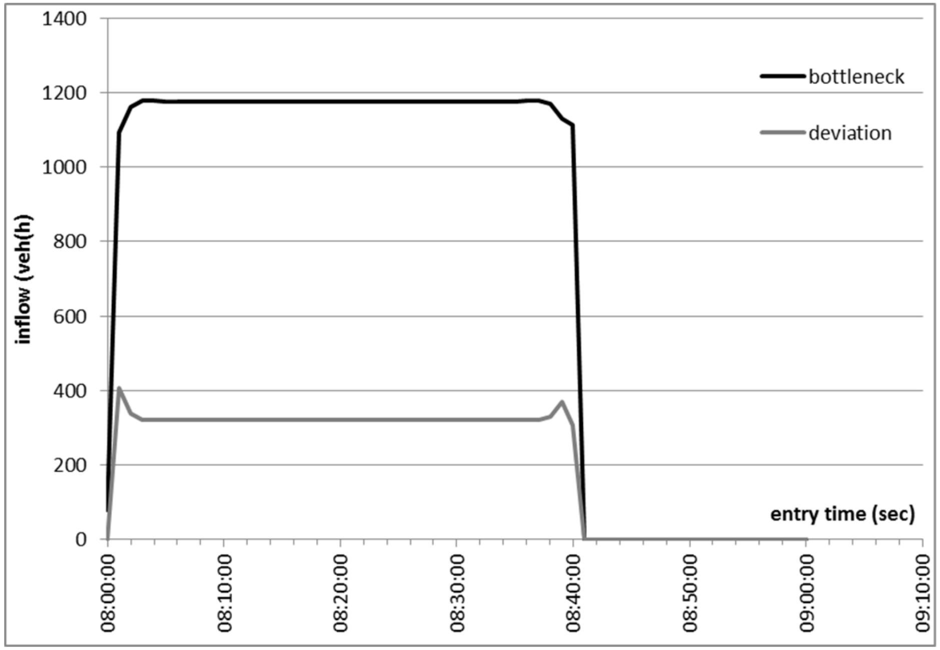


Figure 4. Topology of the dipole network.

Hypocritical congestion



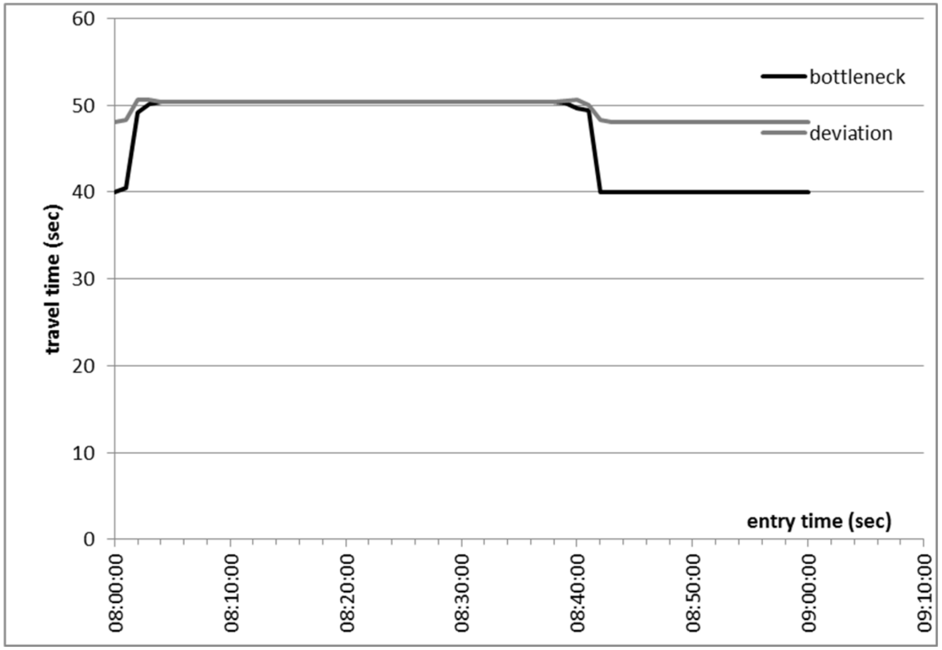


Figure 5. Dipole network with hypocritical congestion. The links of the deviation 2-5 and 5-3 have length of 600 m each. The bottleneck 2-3 has exit capacity of 1200 veh/h.

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Queue congestion

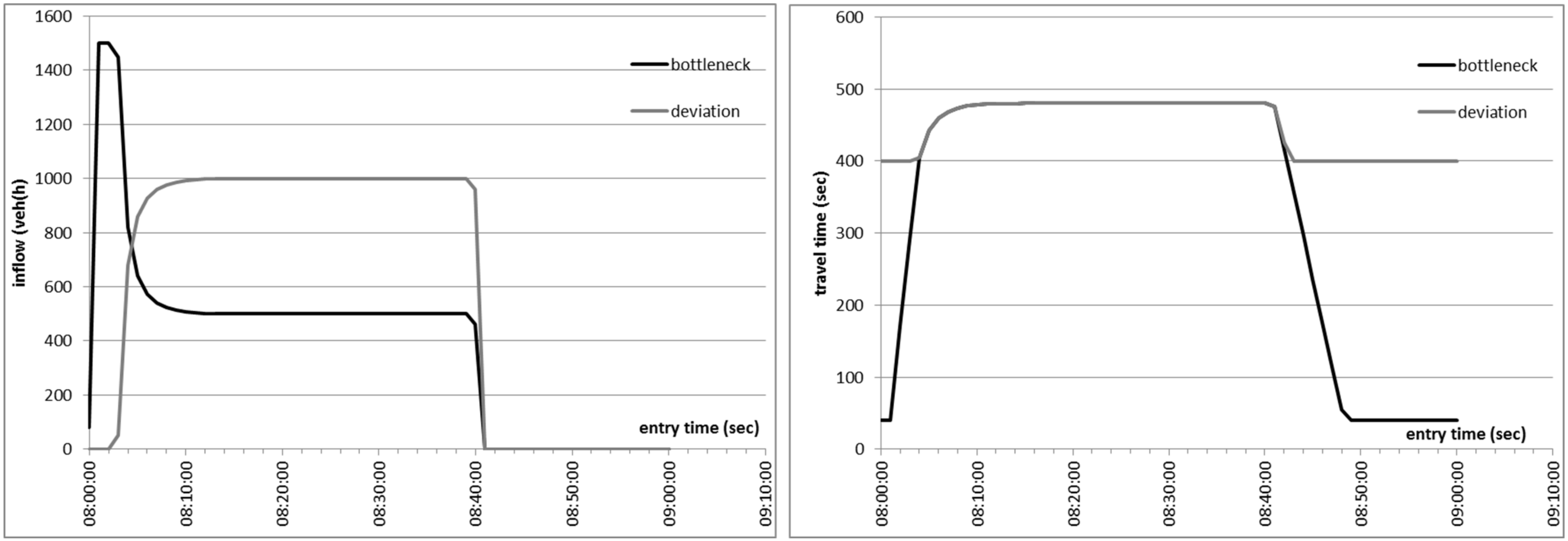
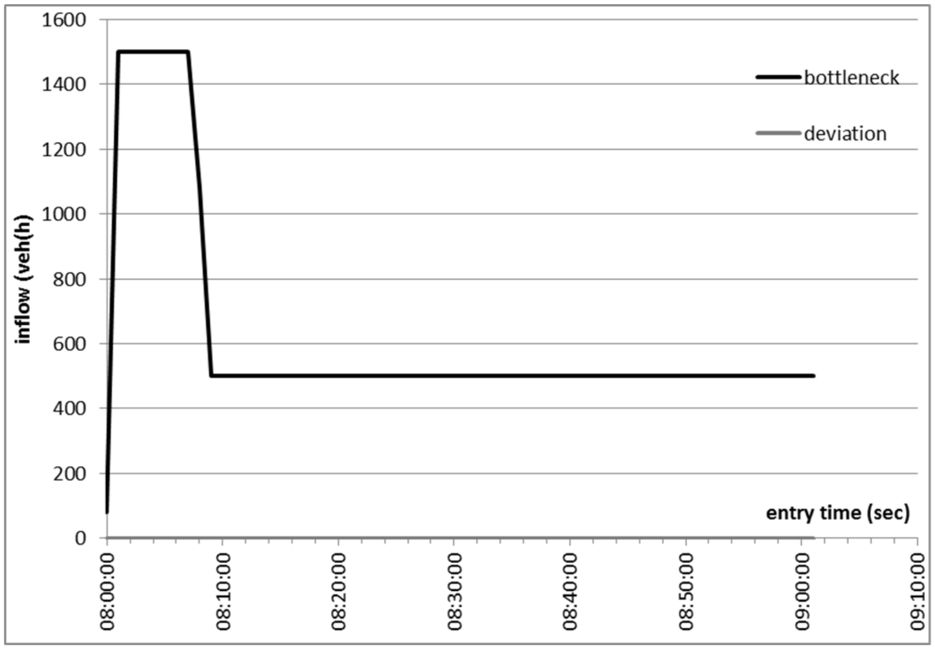


Figure 6. Dipole network with queue. The links of the deviation 2-5 and 5-3 have length of 5 km each. The bottleneck 2-3 has an exit capacity of 500 veh/h.

Spillback congestion



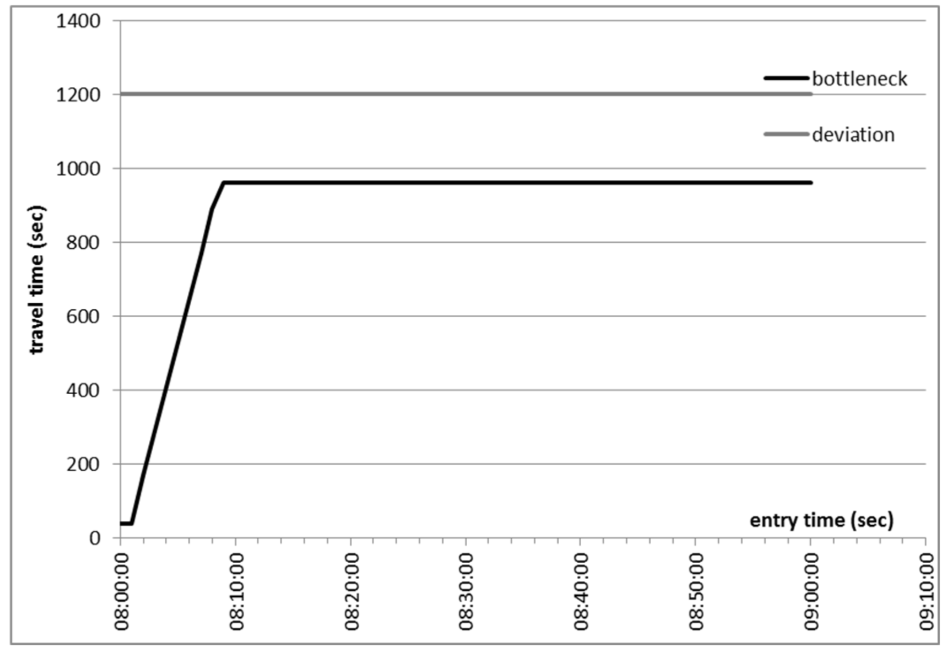


Figure 7. Dipole network in spillback. The links of the deviation 2-5 and 5-3 have length of 15 km each. The bottleneck 2-3 has an exit capacity of 500 veh/h.

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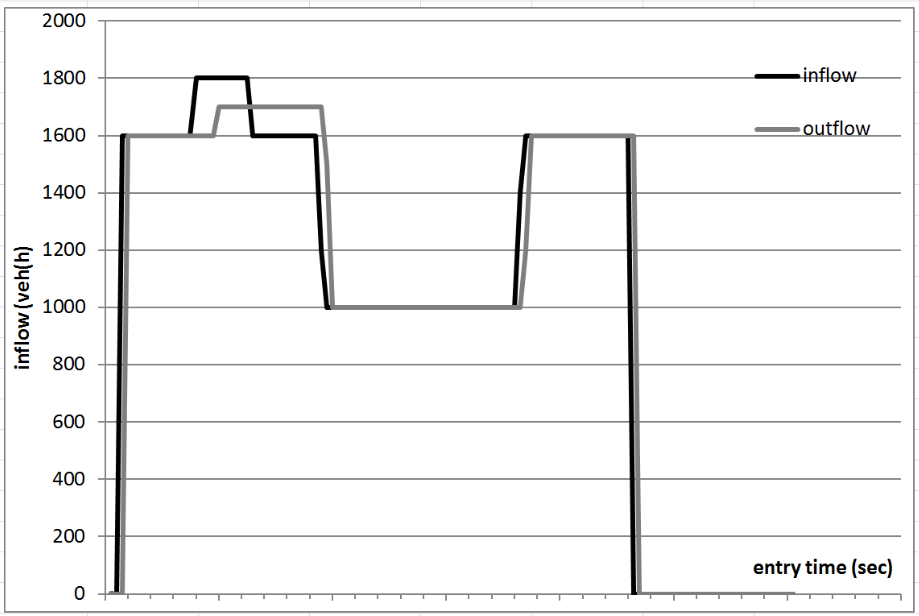
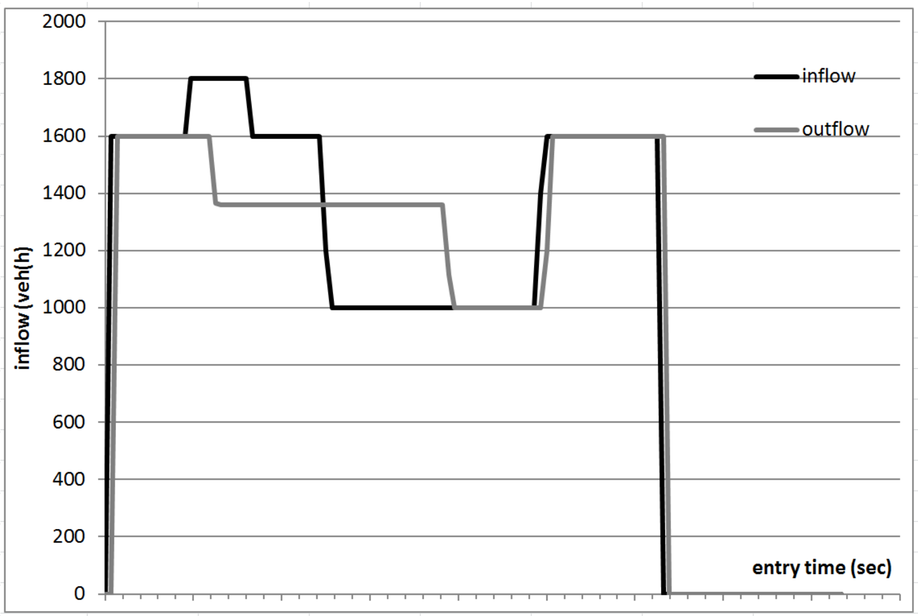
The effect of capacity drop

without



with (20%)



Convergence results for different congestion level

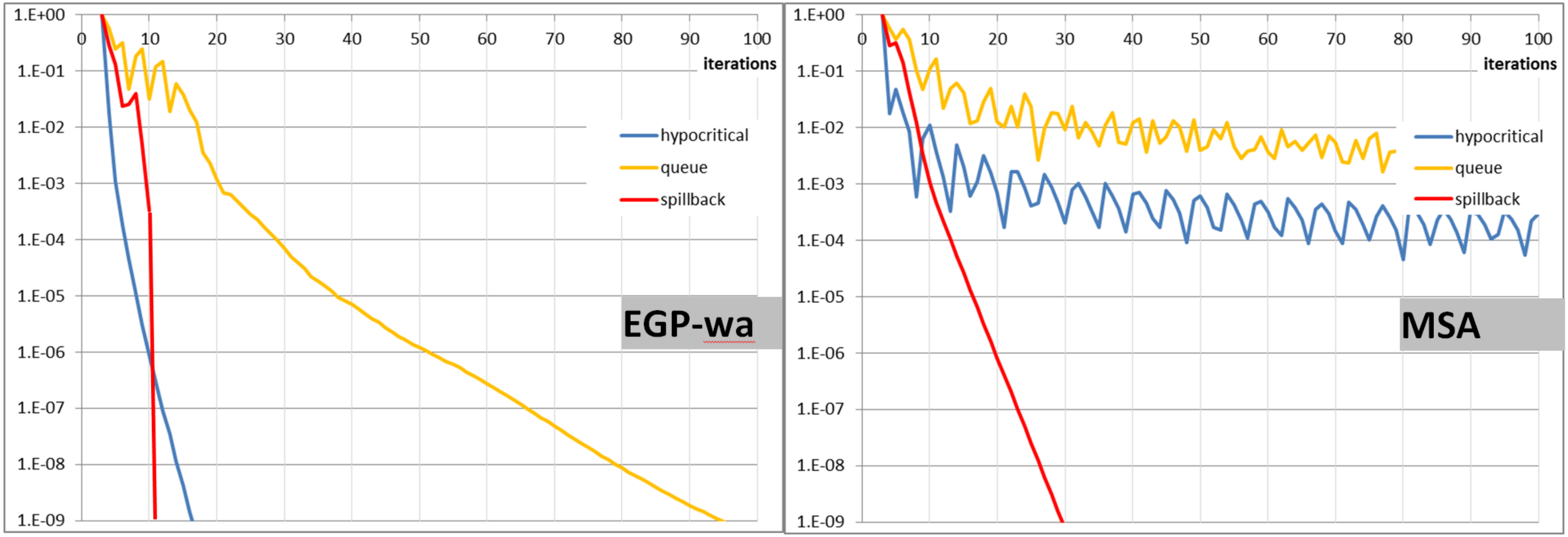


Figure 8. Convergence pattern for the dipole network – EGP outperforms MSA.

TOWARDS MORE DATA AND MODEL INTEGRATION

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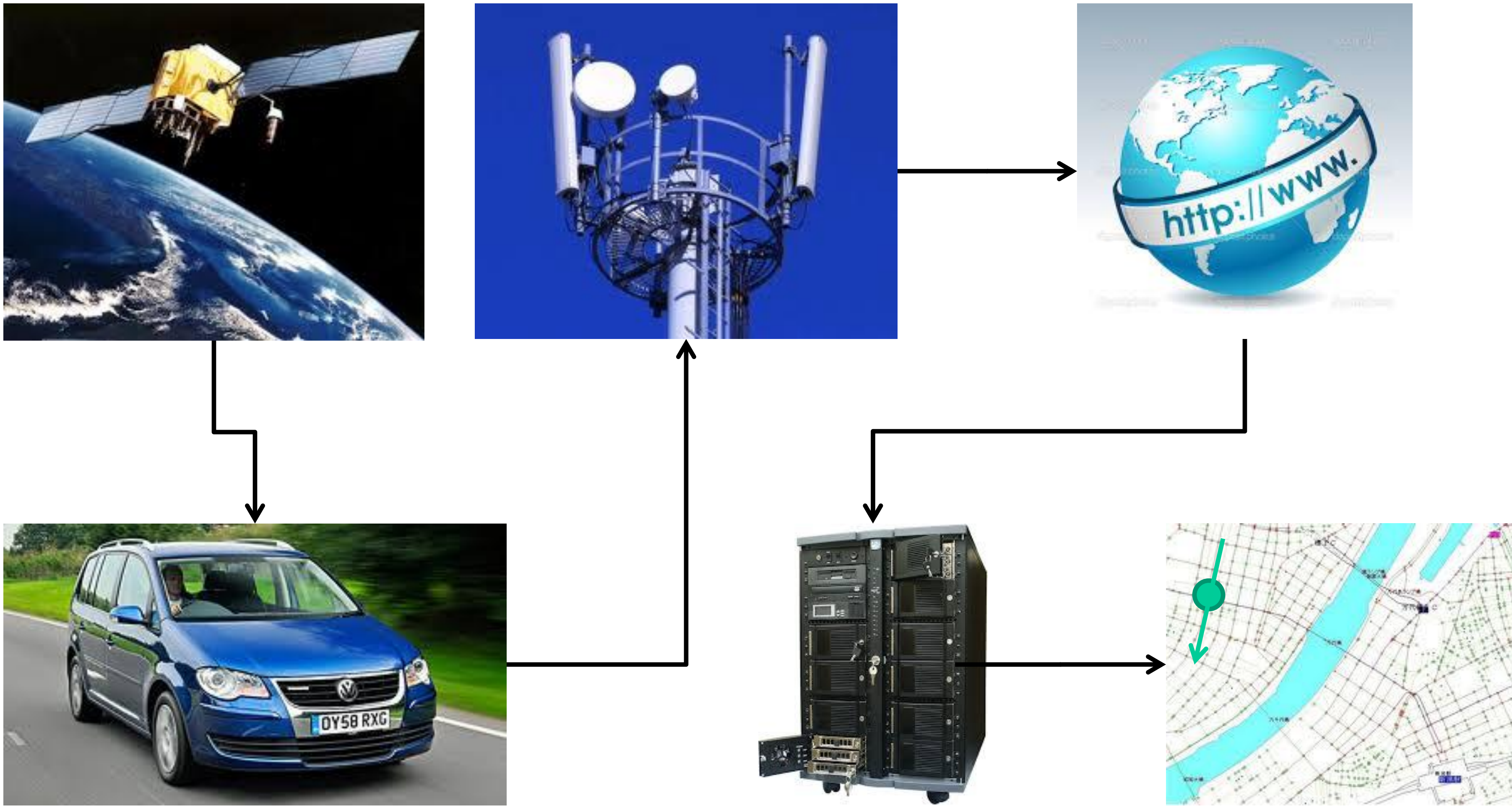
Key technology for ITS: GPS + Wireless TC → Map Matching



Big Data for modelling 2.0

Big Data (historical) on traffic

Computer Science
Operation Research

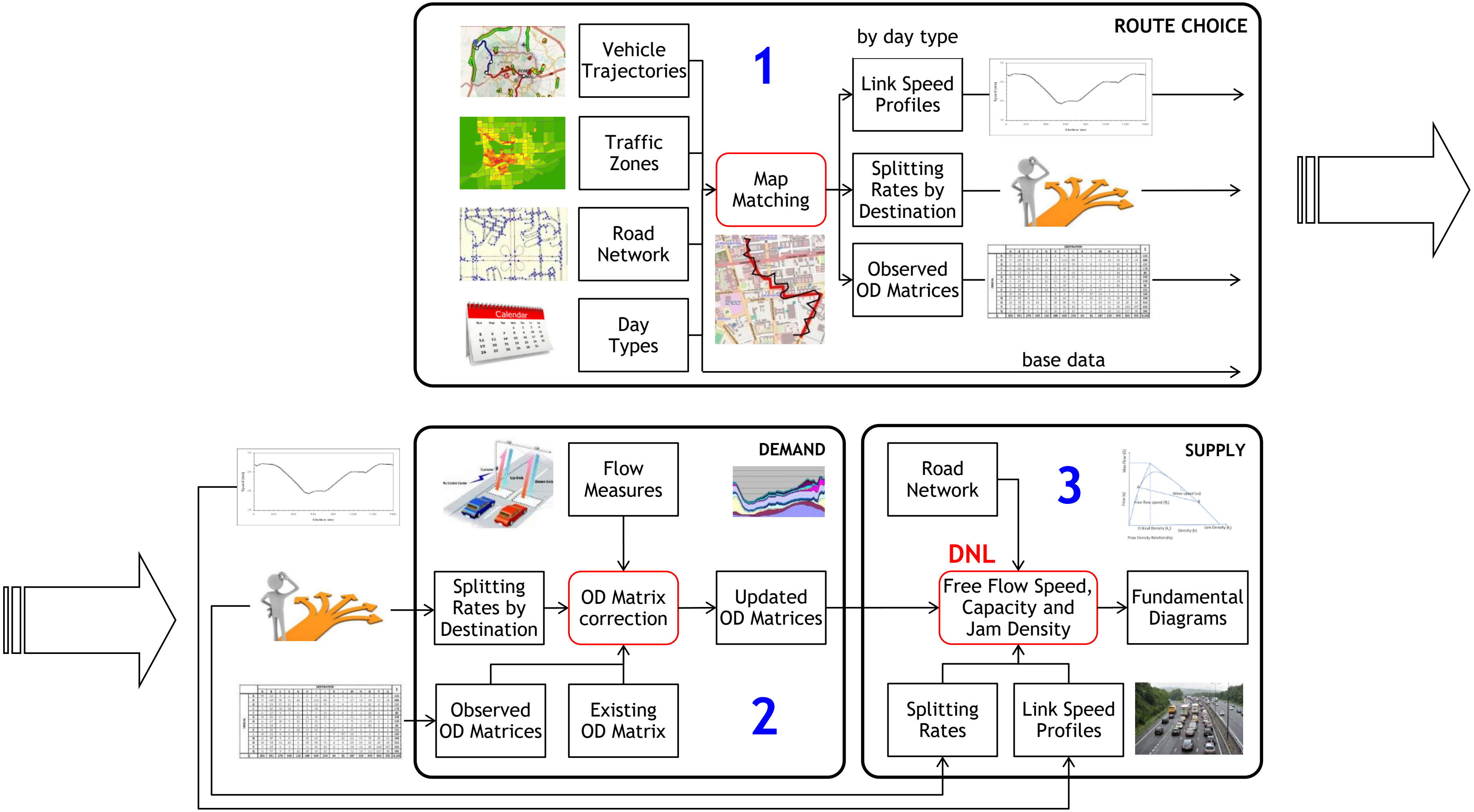
"statistical/machine learning" approach

Transportation Engineering

"modelling" approach + calibration

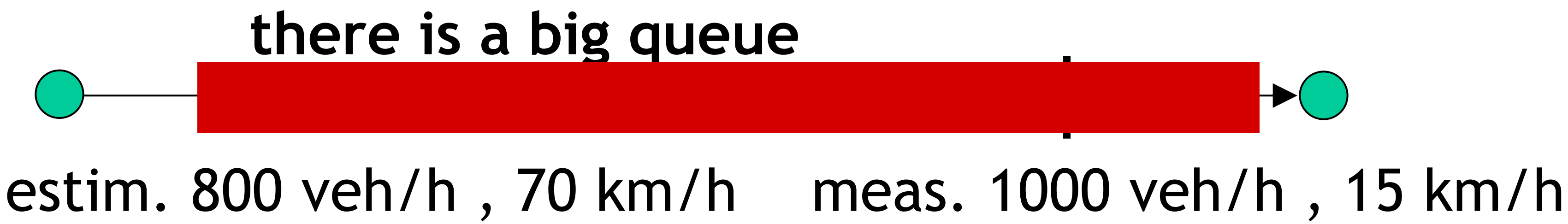
Modelling 2.0

Data driven model offline: 3 steps functional overview



Calibration issue: why measured traffic states differ from estimates?

- What is going on here?

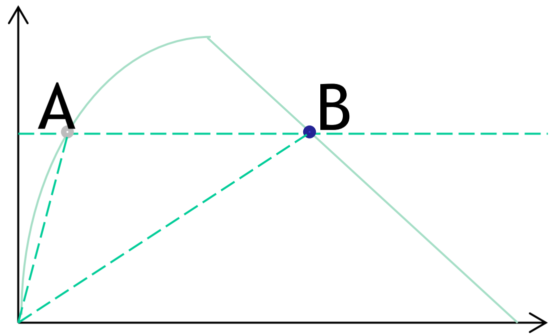


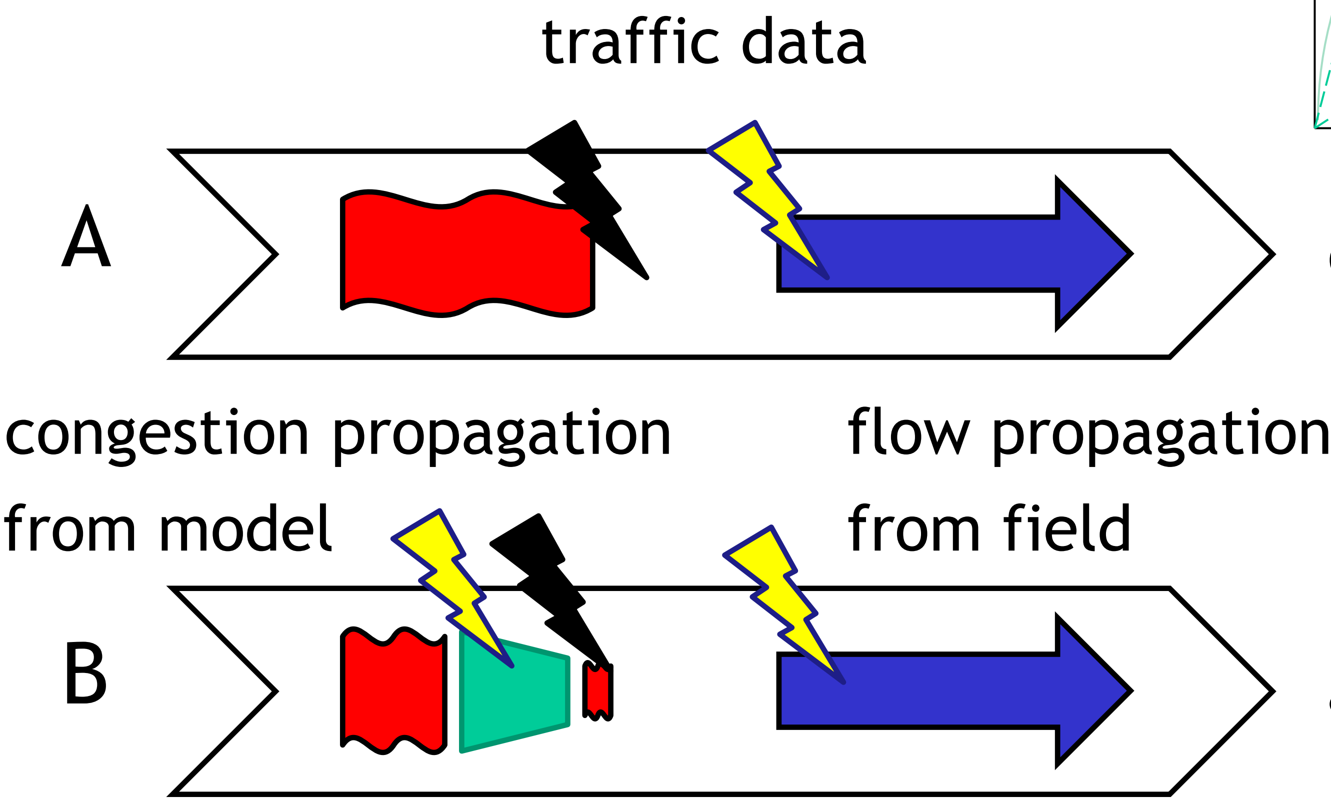
- We are reading the downstream capacity instead of demand flows
- To calibrate OD flows in DTA through an assignment matrix we shall use the number of vehicles on links
- Or we should re-run (at least) the DNL for each demand vector
  - Derivative free algorithms can help (SPSA, Nelder-Mead, …)
  - Not many shots available (e.g. 1000)

Calibration of the DTA model in real-time: measure injection

- Static models
  - can be easily calibrated with respect to flows (not time)
  - have a hard time in simulating networks with heavy congestion
- In dynamic models
  - vehicle counts maybe almost uncorrelated with the demand flows
  - not really interested in a complete reconstruction back in time
  - want to forecast what happens next, for different scenarios
- We adopt a simpler approach
  - Measure injections in the network loading model
  - Modify flow, speed and density directly on links

Flow correction: injection and propagation

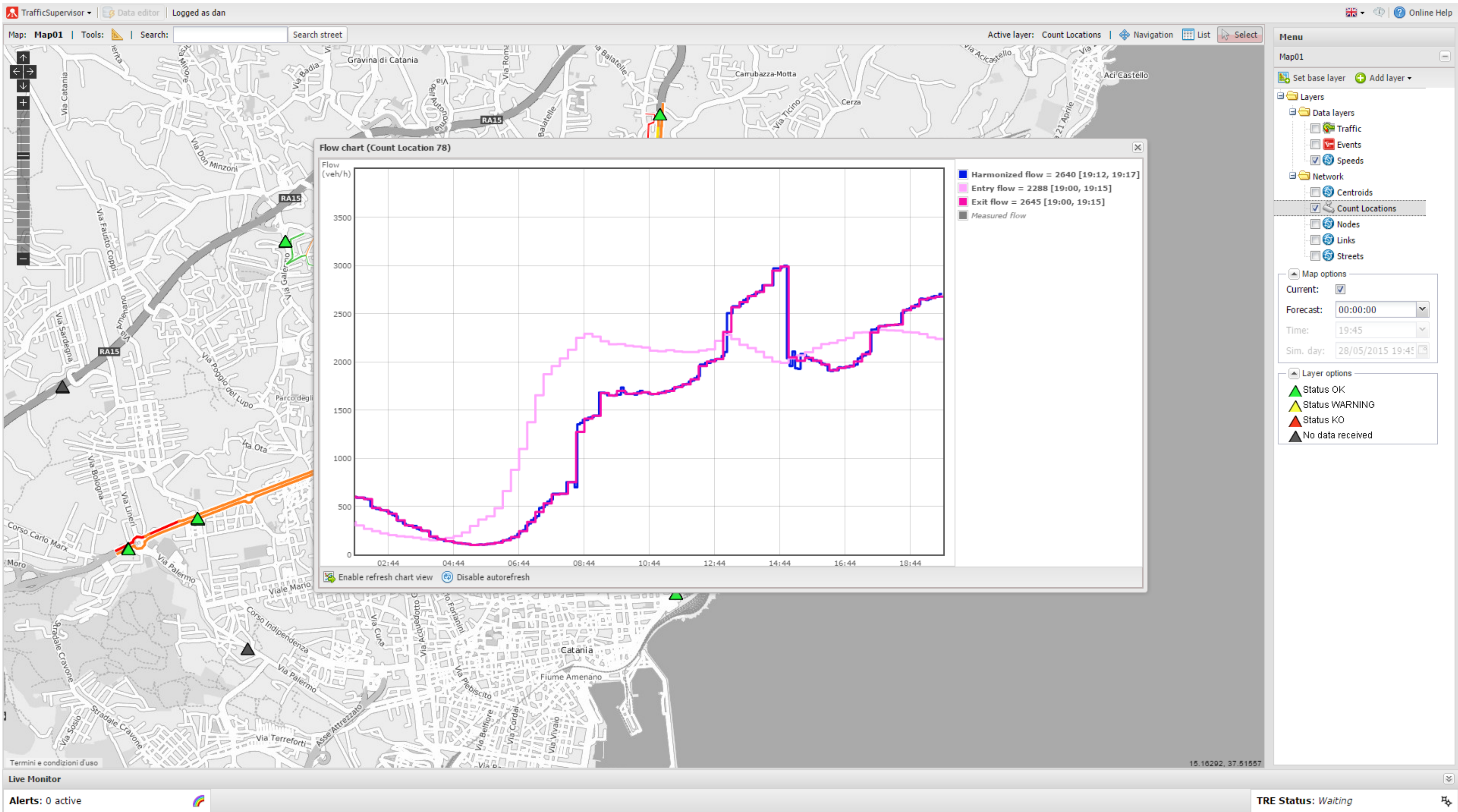




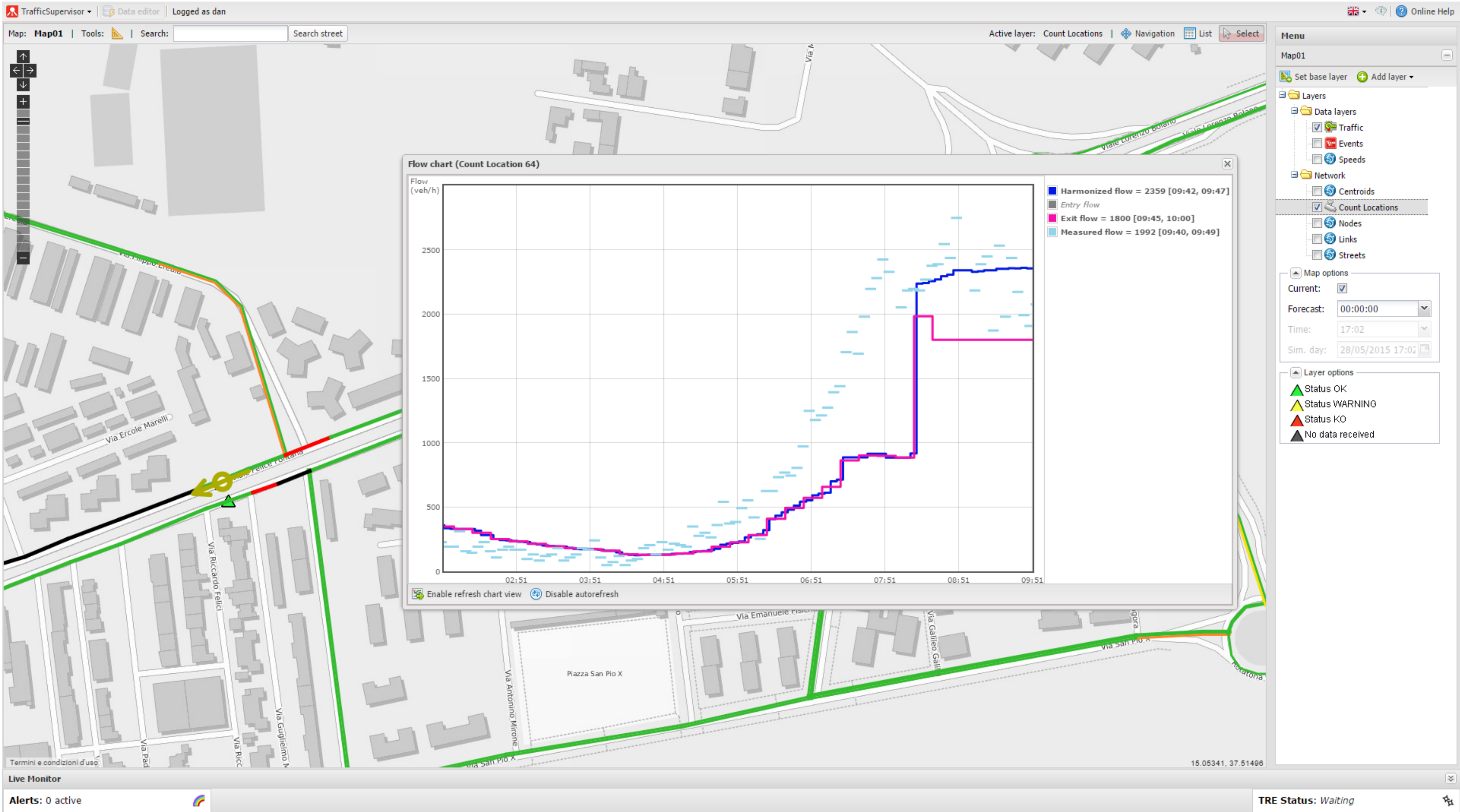
hypocritical flow
only forward
propagation

hypercritical flow
also backward
propagation

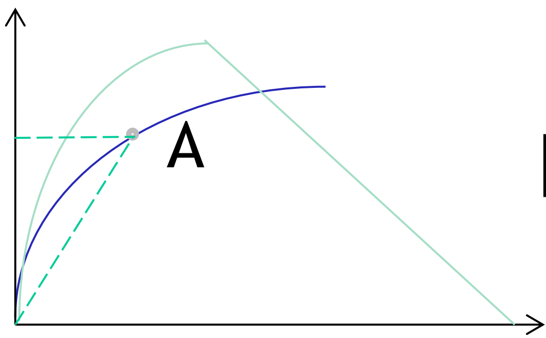
Exit flow consistent with measure disregarding entry flow



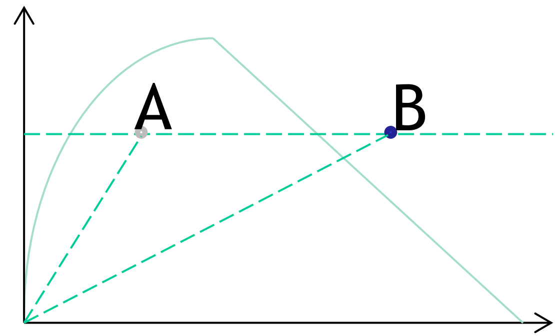
Matching is not always possible e.g. due to spillback in the model



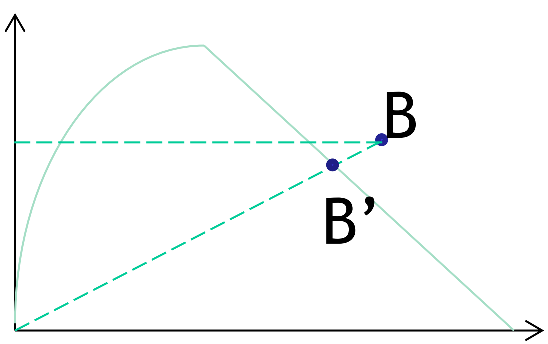
Speed correction: fundamental diagram distortion



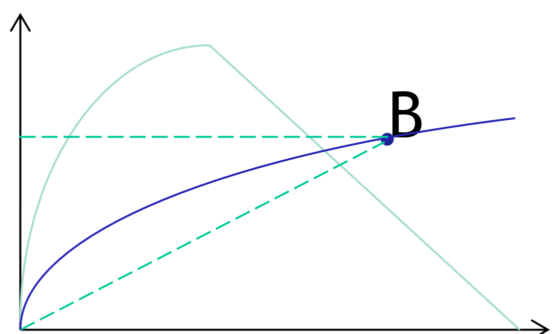
hypo state



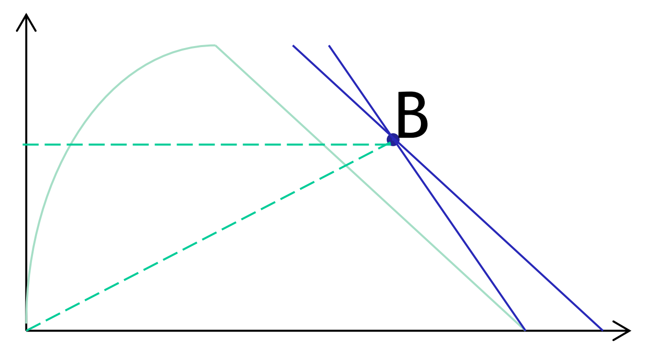
hyper state



1.



2.



3.

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Shall model speed follow the measured speeds?

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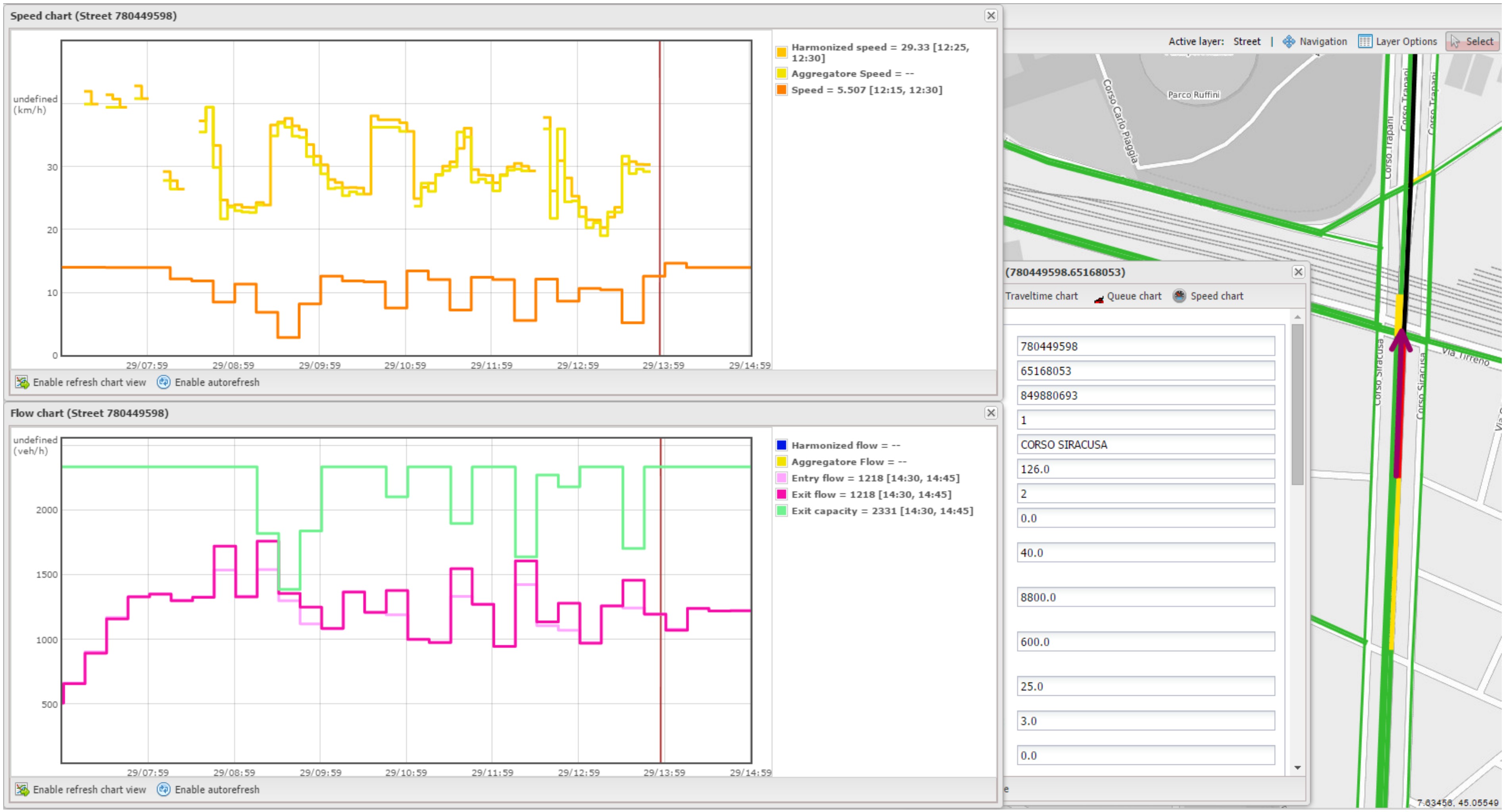
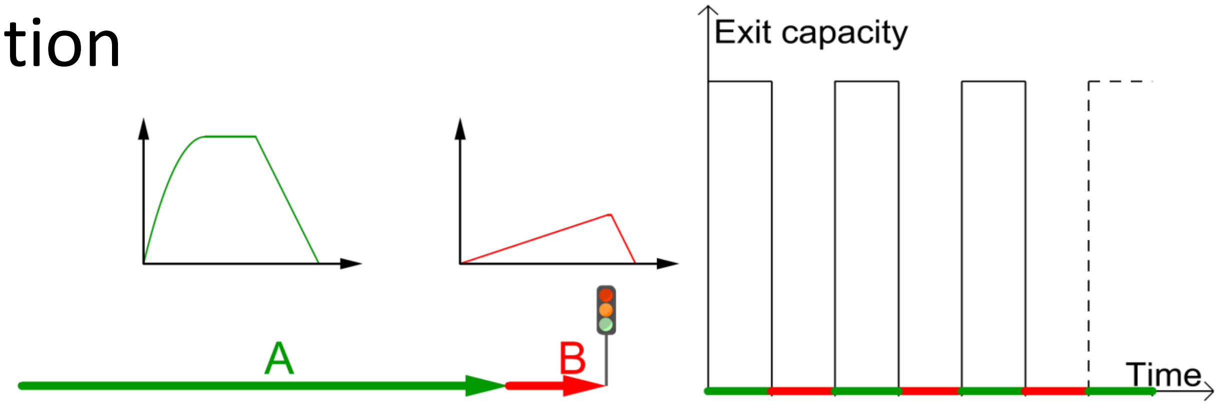
When spillback is simulated in front of a measure it is not possible

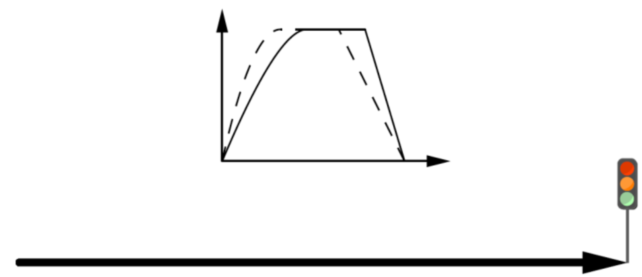


How to represent traffic lights and node delays

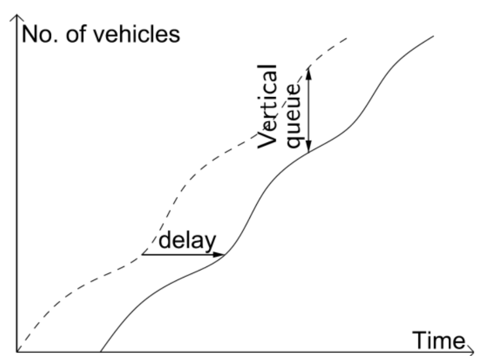
- Explicit representation
  - Arc splitting
  - Pulsing



- Fundamental diagram distortion
  - include in the equation of the speed the additional travel time

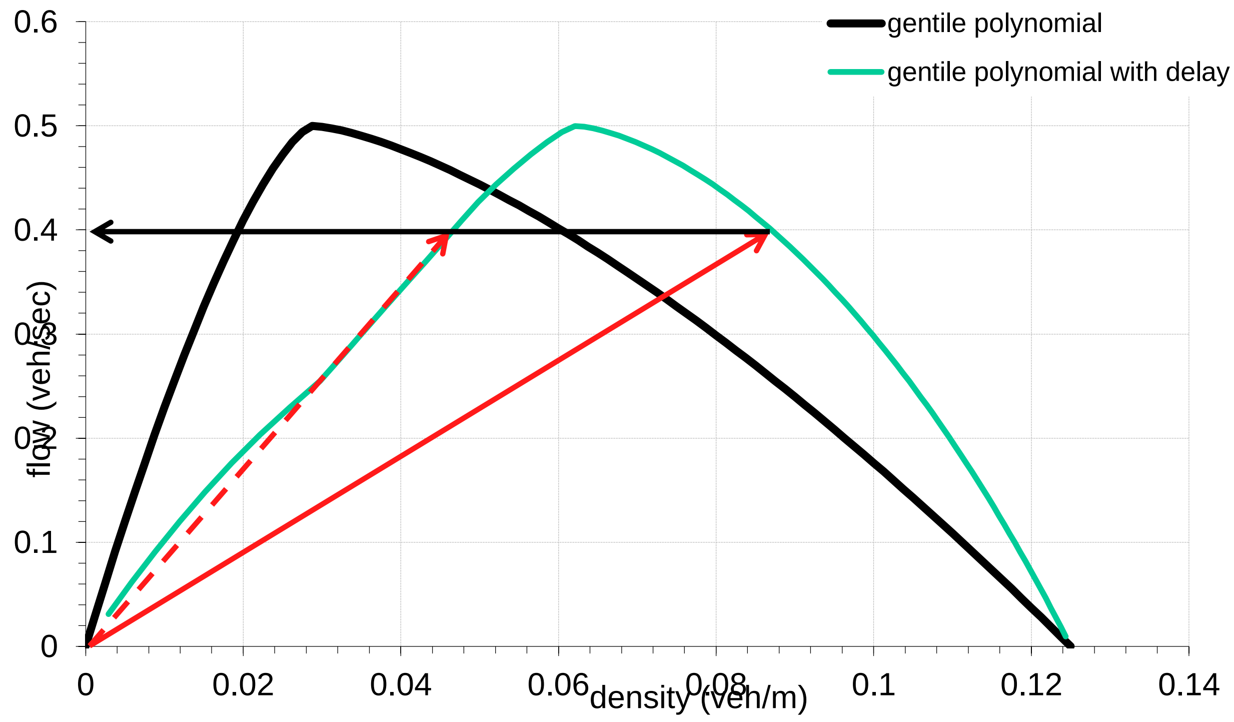


- Profile shifting
  - Theory violation

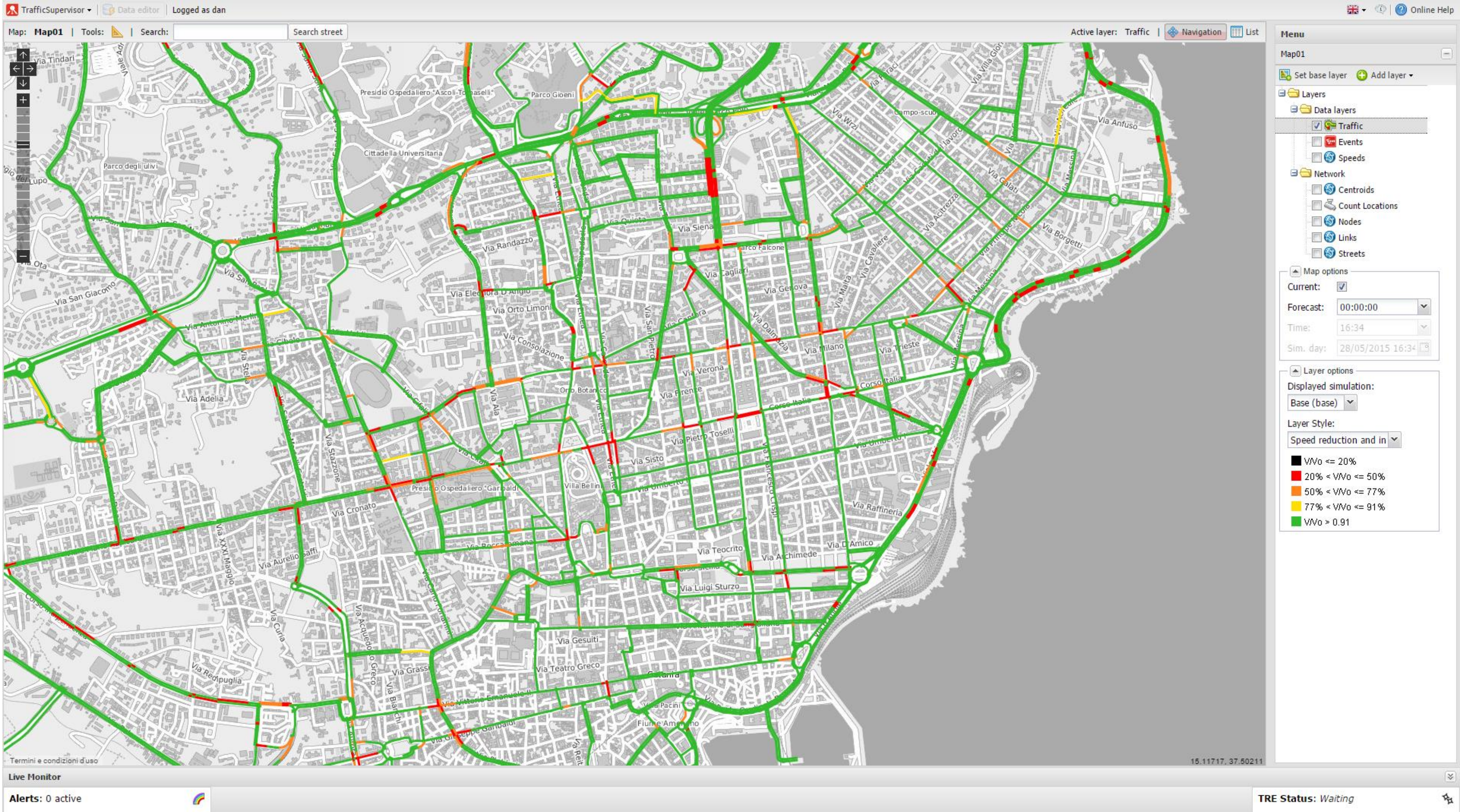


Flow from harmonized speed on the urban fundamental diagram

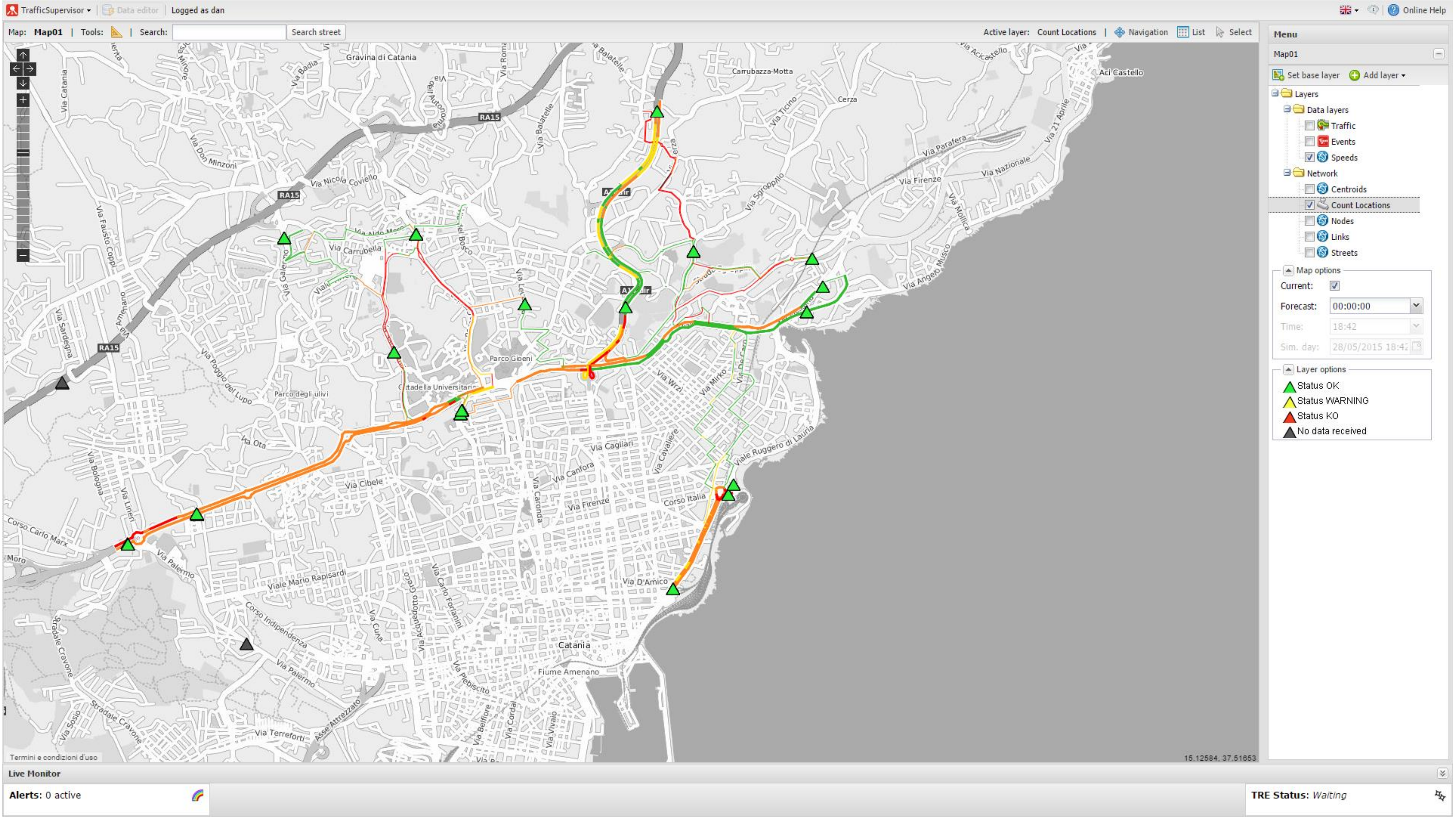
- Consider only hypercritical flows
  - otherwise too unstable
- Urban FD distortion
  - Fixed delay
  - Signal delay
  - Max speed



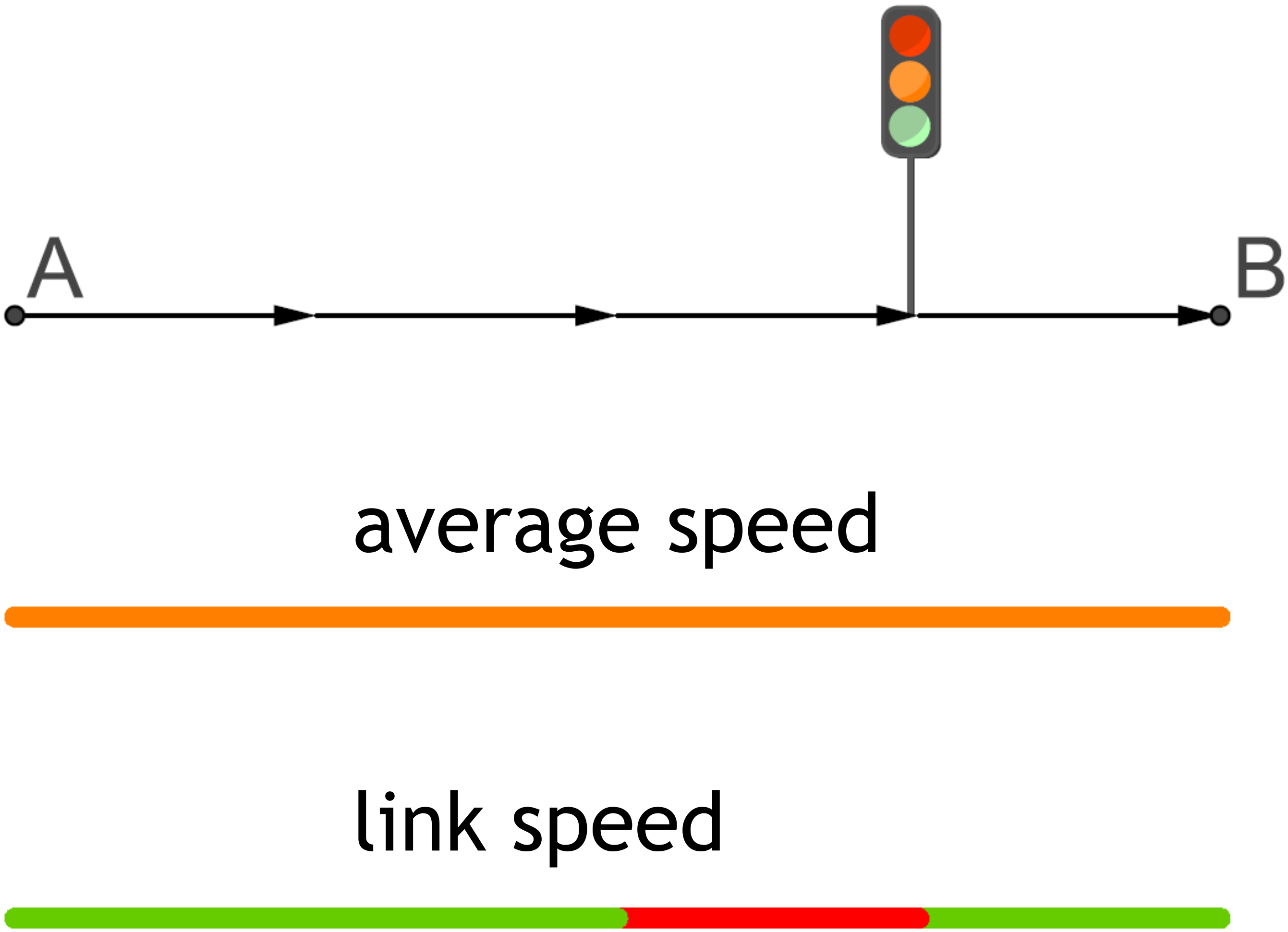
Effects of traffic signals lower speeds



Travel times via Bluetooth portals

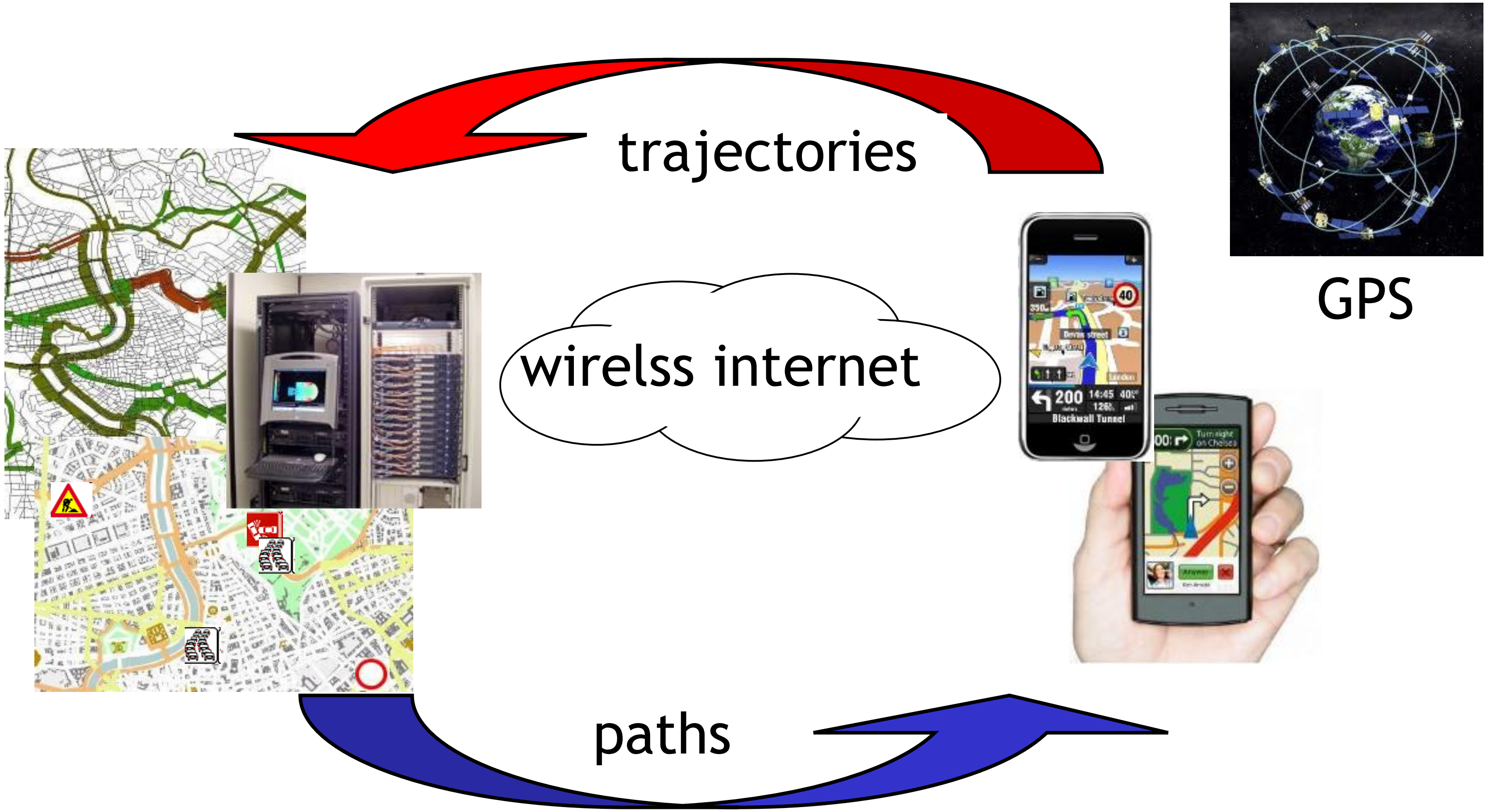


The presence of traffic lights in travel time measures



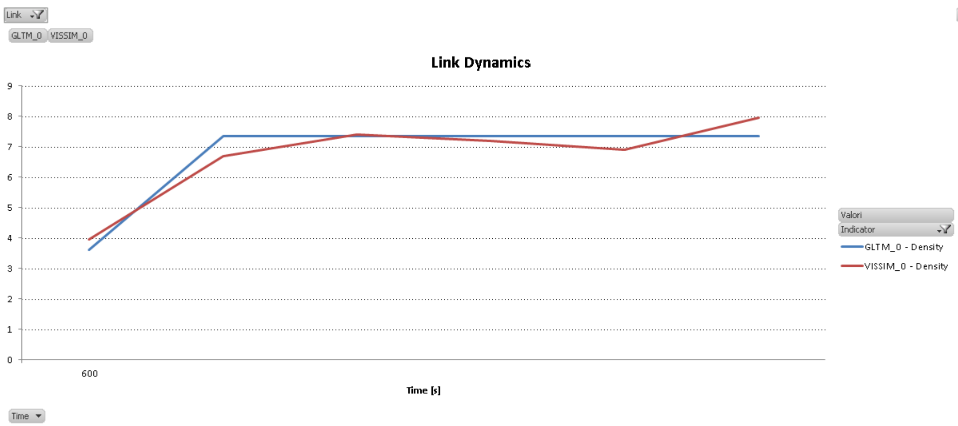
REAL WORLD APPLICATIONS
HISTORY OF OPTIMA

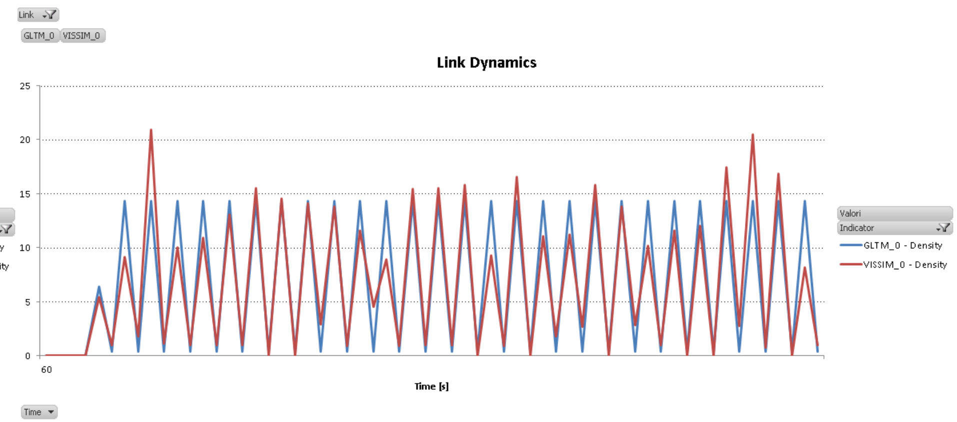
The Cooperative Navigator… simple only in principle

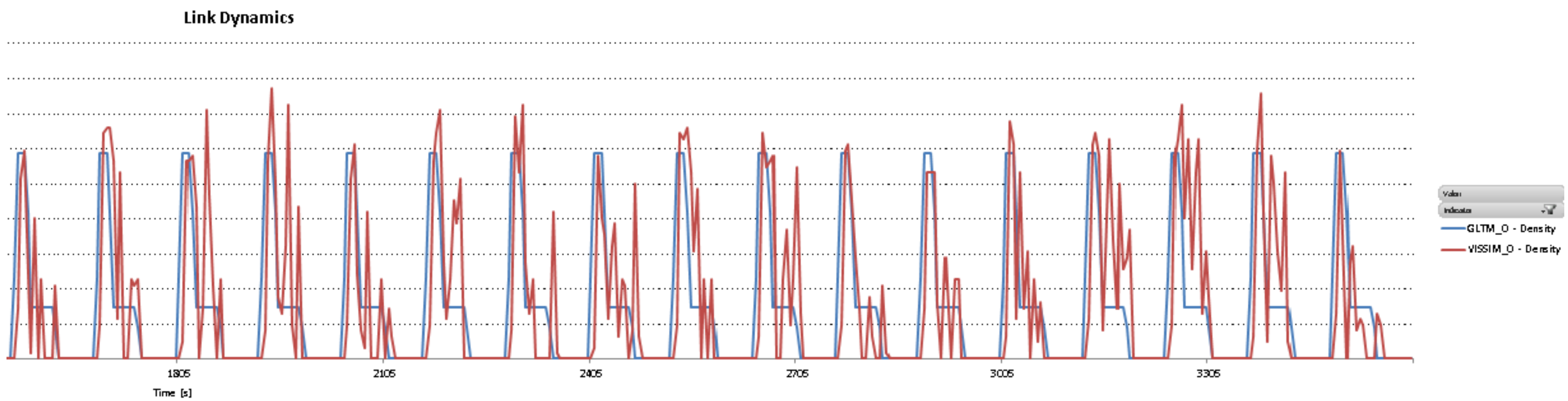


VISSIM
link with ending signal

- Average density (number of vehicles)







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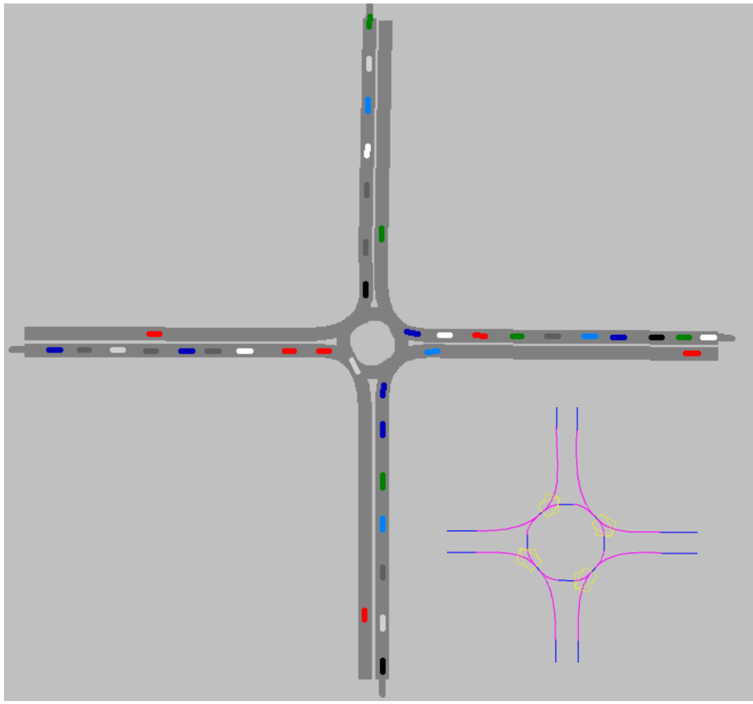
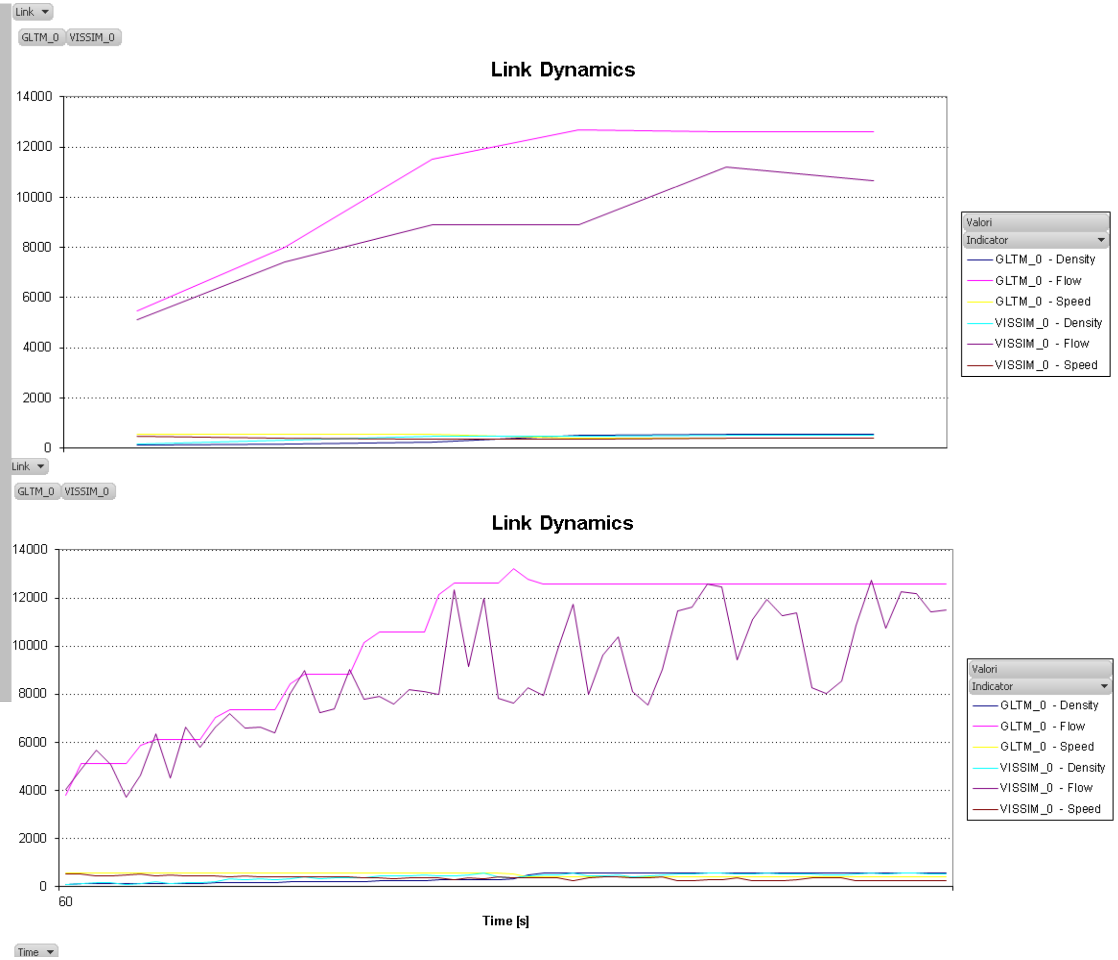
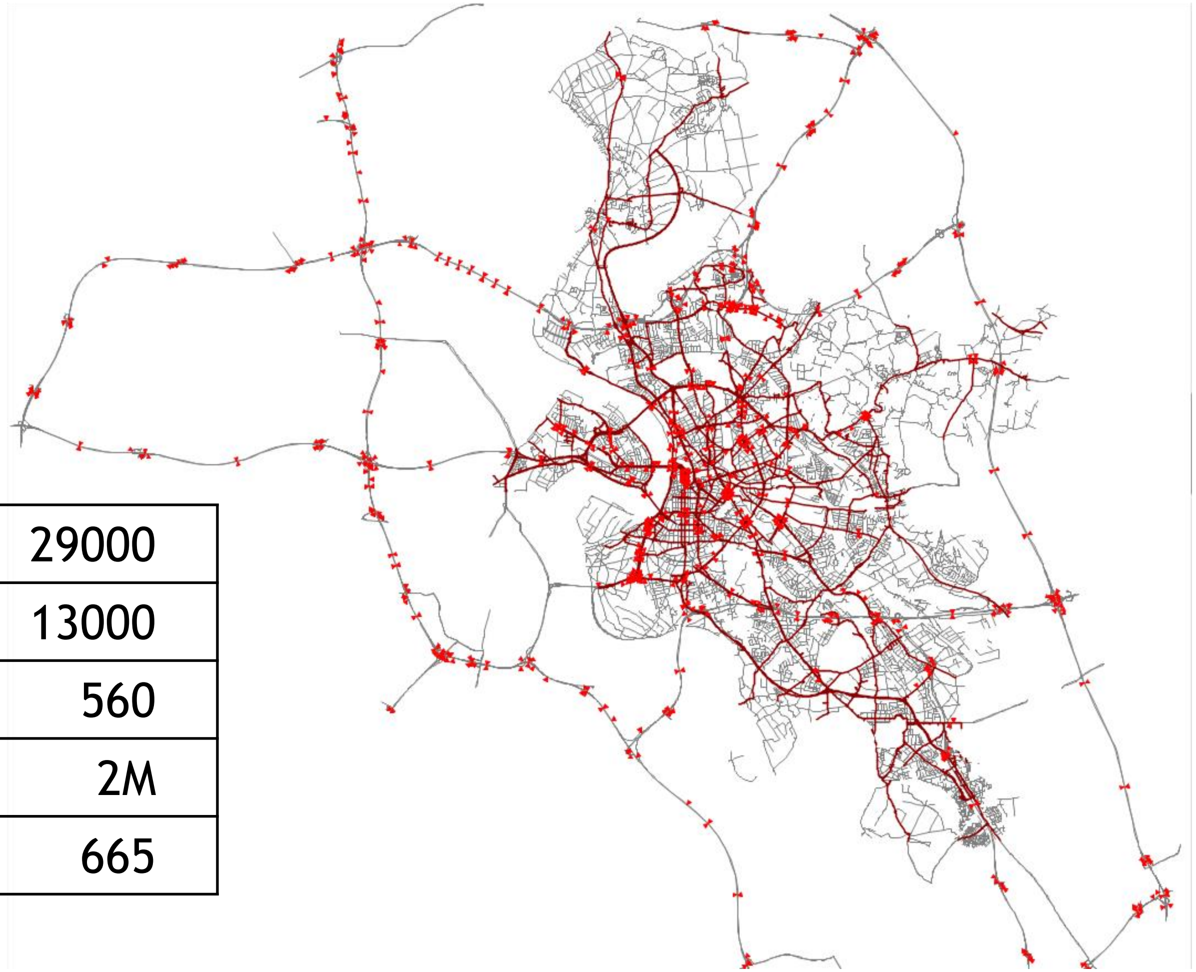
VISSIM link with roundabout





- New phenomena were added in the DTA simulation

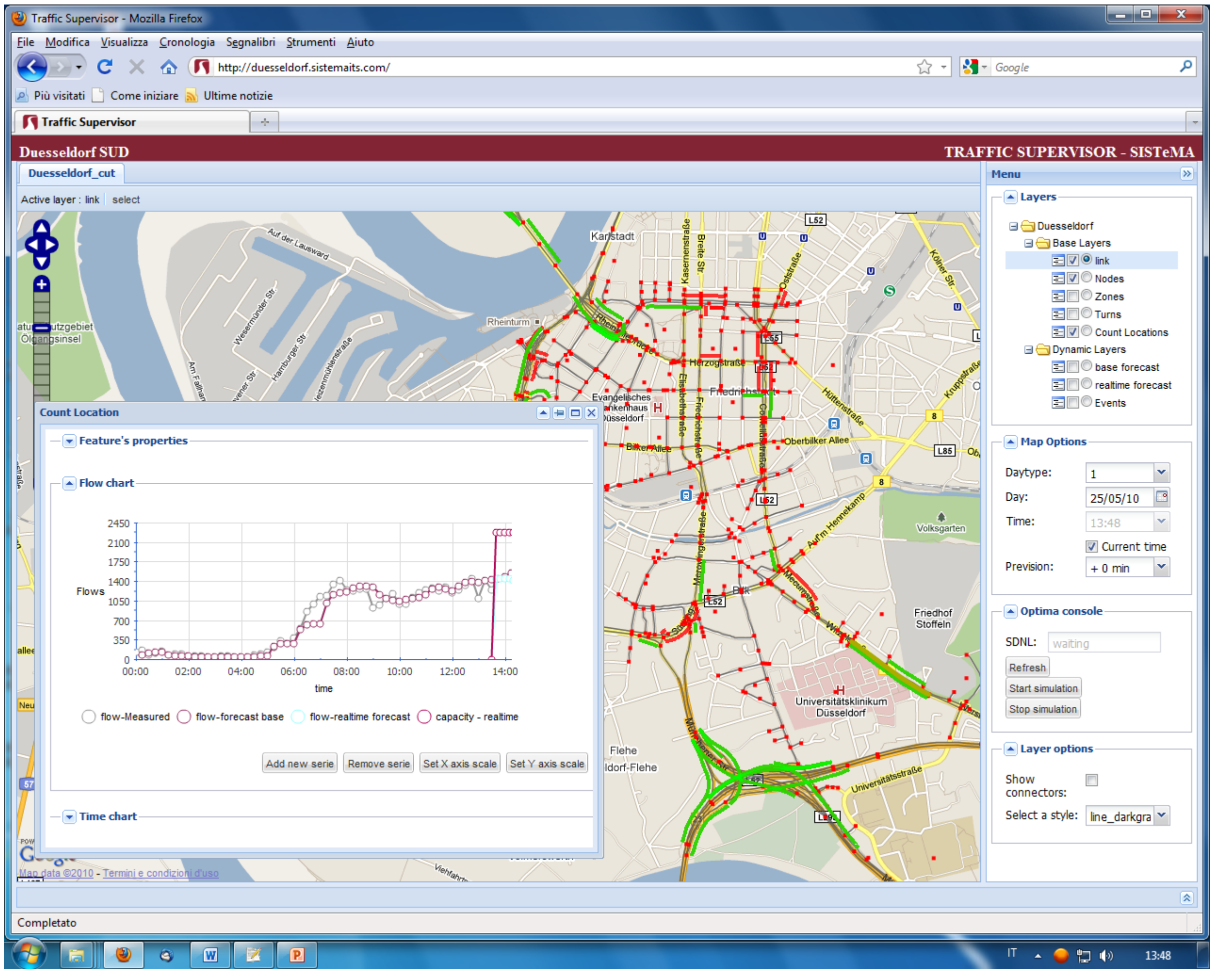
Dusseldorf Test validation of base functionalities



Links	29000
Nodes	13000
Zones	560
OD components	2M
Count locations *	665

* with some counts

Realtime monitoring with loop detectors and FCD



- Fixed (and moving) probes
- Don't cover the whole network
- Allow forecast only when easy
- They can be integrated with transport models
- For realtime data completion and traffic forecast

Day-type based forecast with Dynamic User Equilibrium

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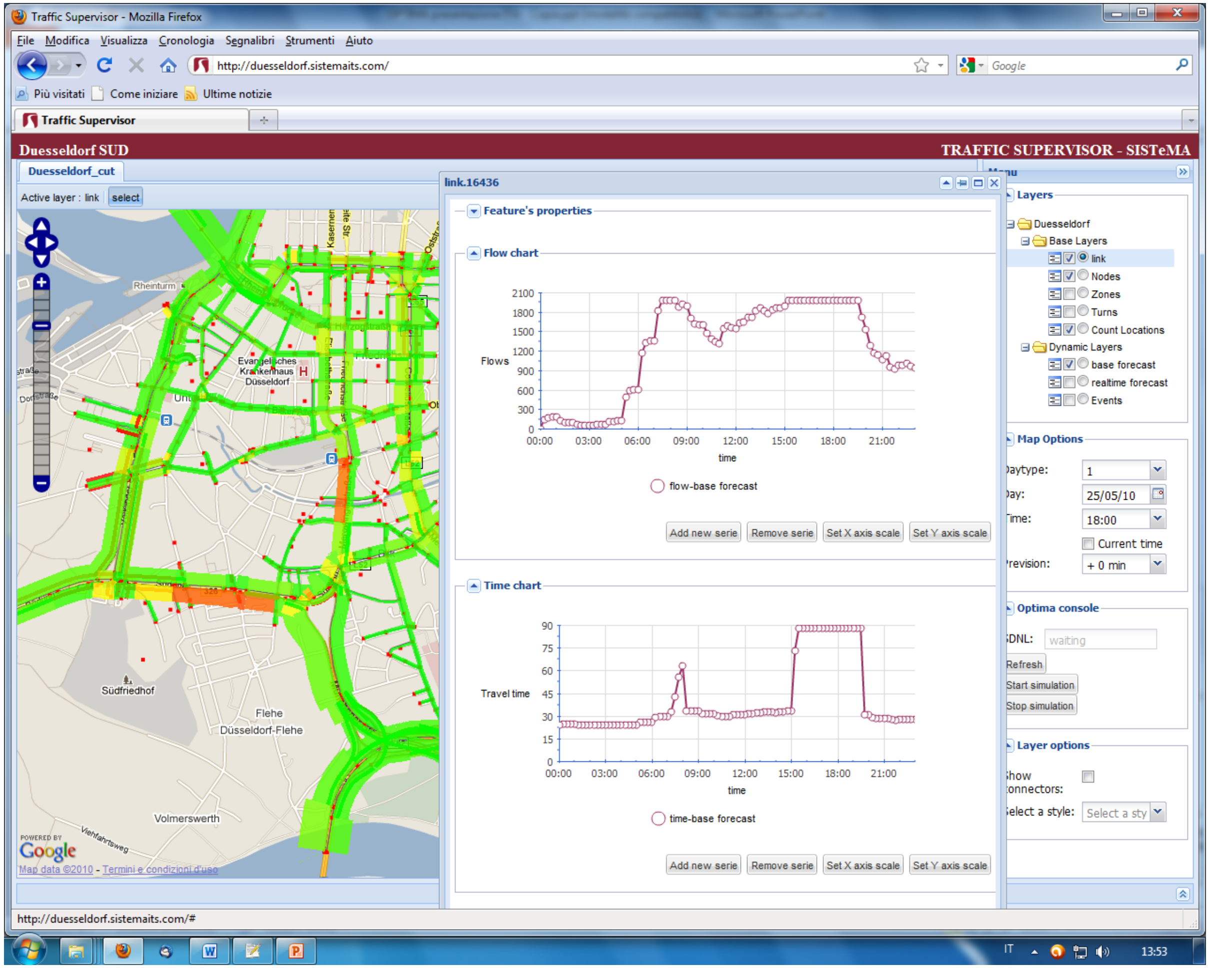
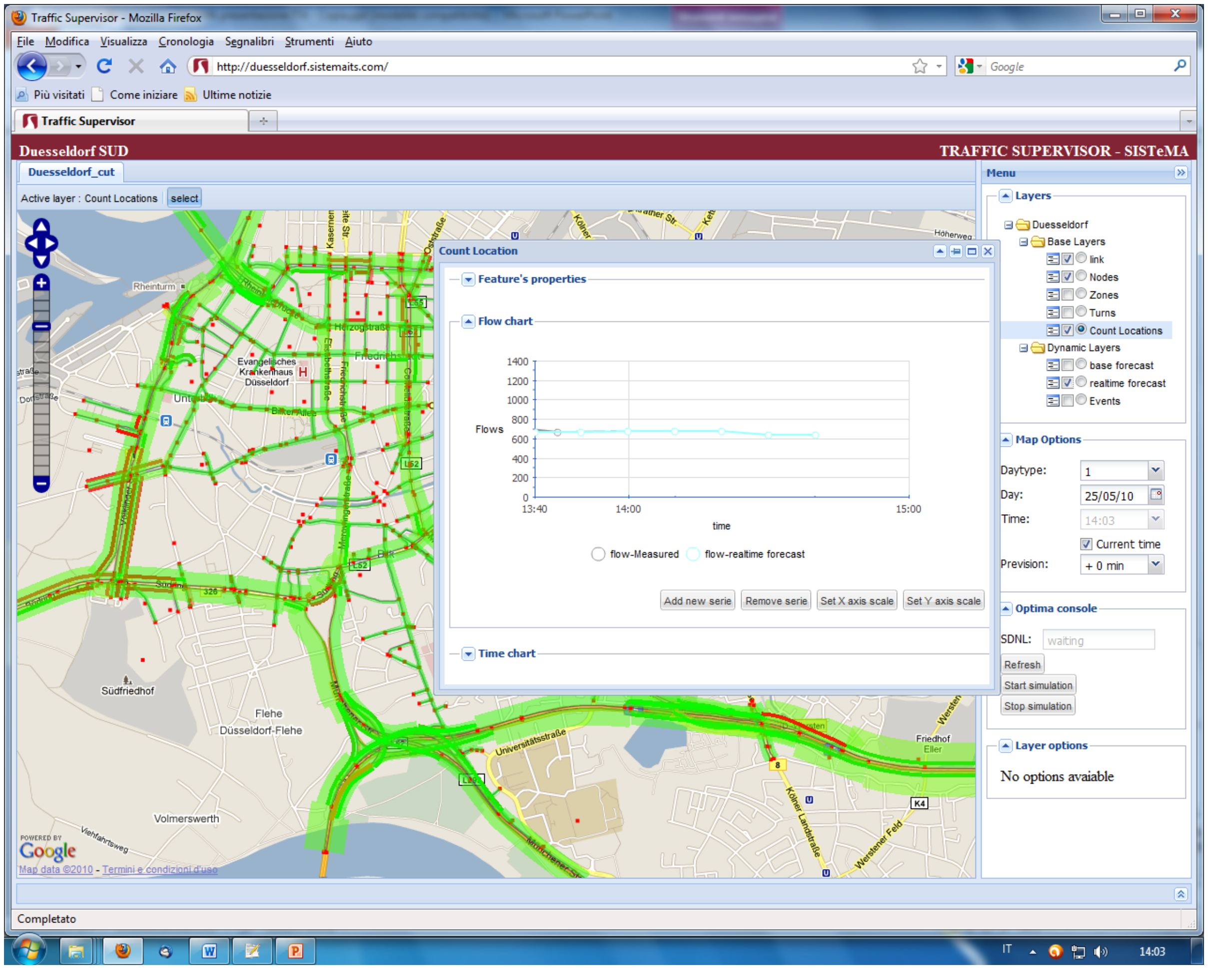


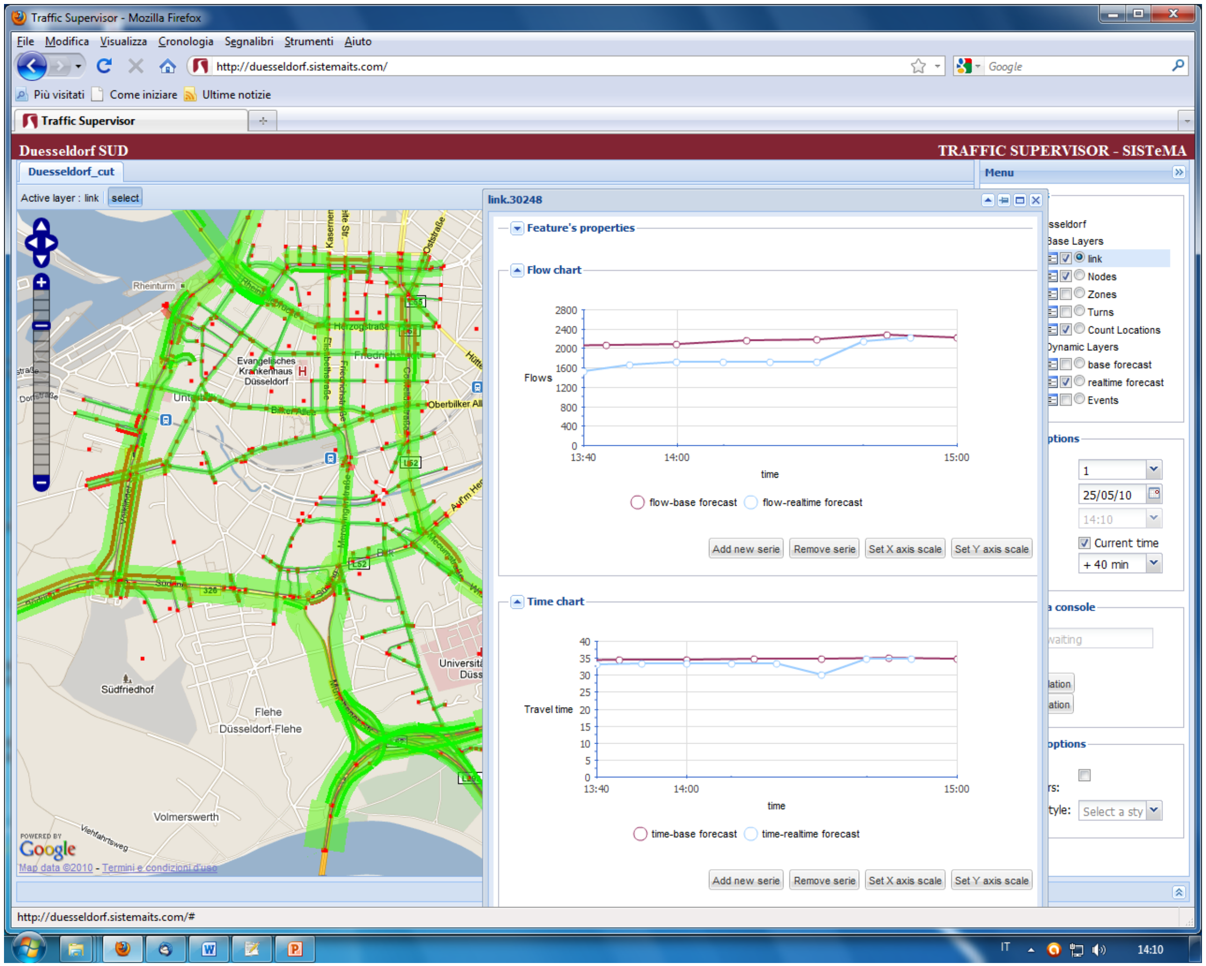
- Variables are functions of time
- Travel demand Origin-Destination matrices
- Road network with speeds and turn capacities
- Macroscopic flow model can reproduce queues and spillback
- Yields route choice as splitting rates

Realtime data completion



- Flow and queue corrections on monitored links wrt base forecast
- Propagate on the network based on daytype time varying splitting rates
- This allows to estimate congestion on all links

Realtime traffic forecast



- Rolling horizon simulation
- This allows for within day forecast
- Queues are persistent and last more than vehicle travel times

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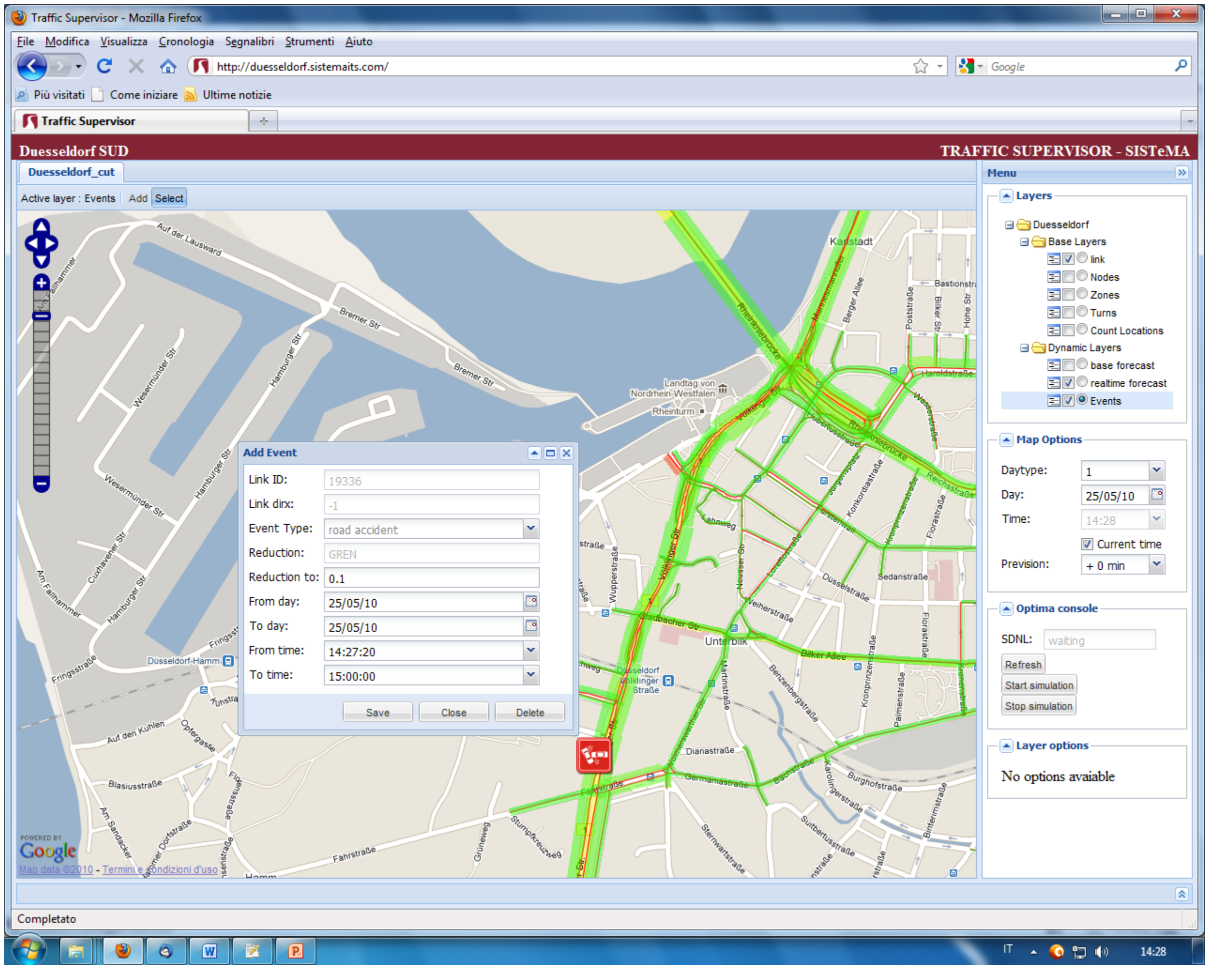
Event manual insertion



- Click on the link
- Insert
  - Event type
  - capacity reduction
  - from day and time
  - to day and time
- In this case, 30 minutes block
- Then click start simulation

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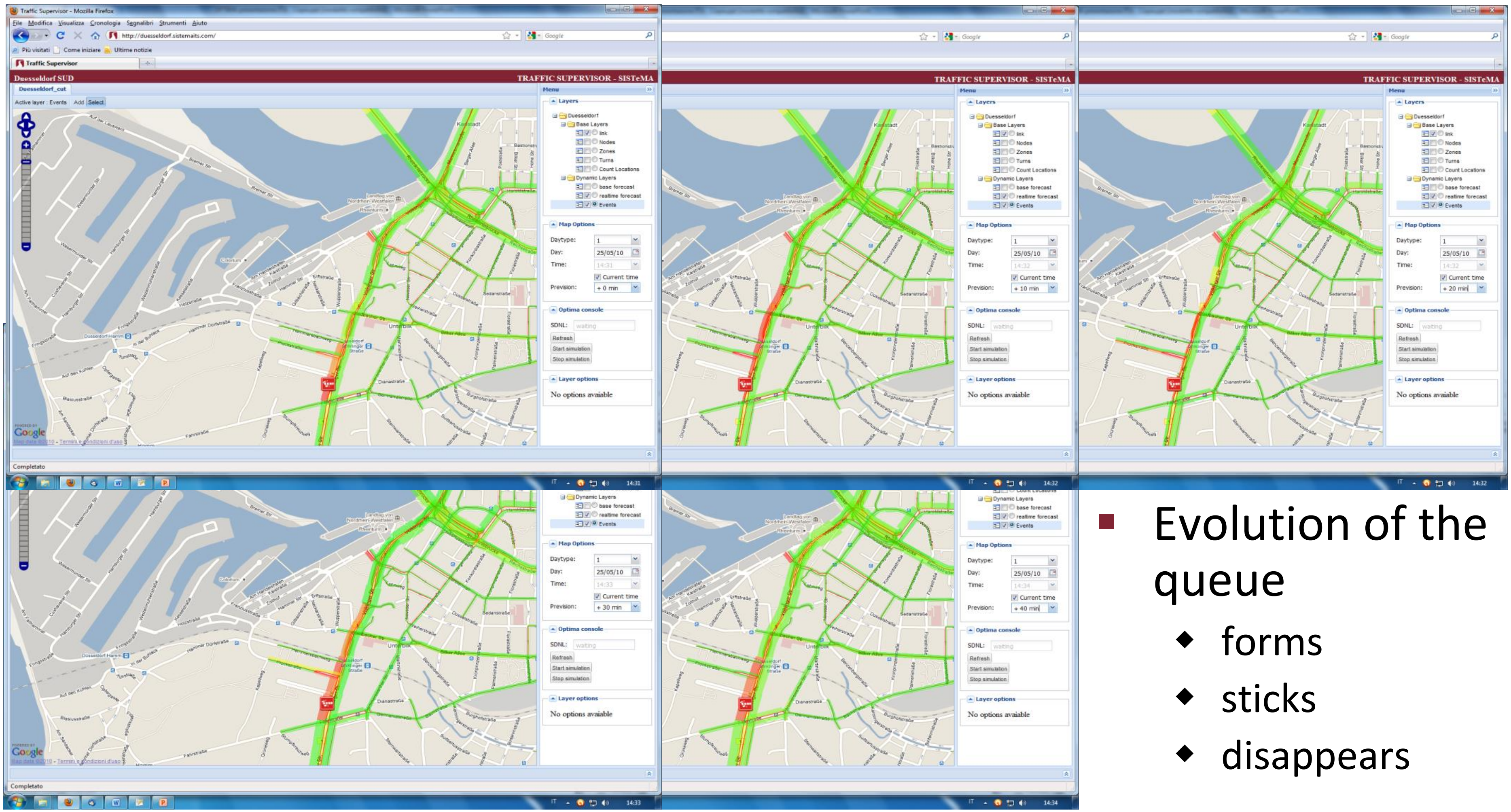
Forecast the effects of events



- Evolution of the queue
  - forms
  - sticks
  - disappears

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Dusseldorf Test performance evaluation

- Traffic state forecasts
  - up to 1 hour ahead every ten minutes

RAM requirements	
Simulation	0,5 Gb
DB	4,7 Gb
Calculation times	
Input & Initialization	4’39”
Import & Process Vehicle Counts	10”
Perform Dynamic Network Loading	1’39”
Export results into DB	19”
Total for a single run	**2’08”**

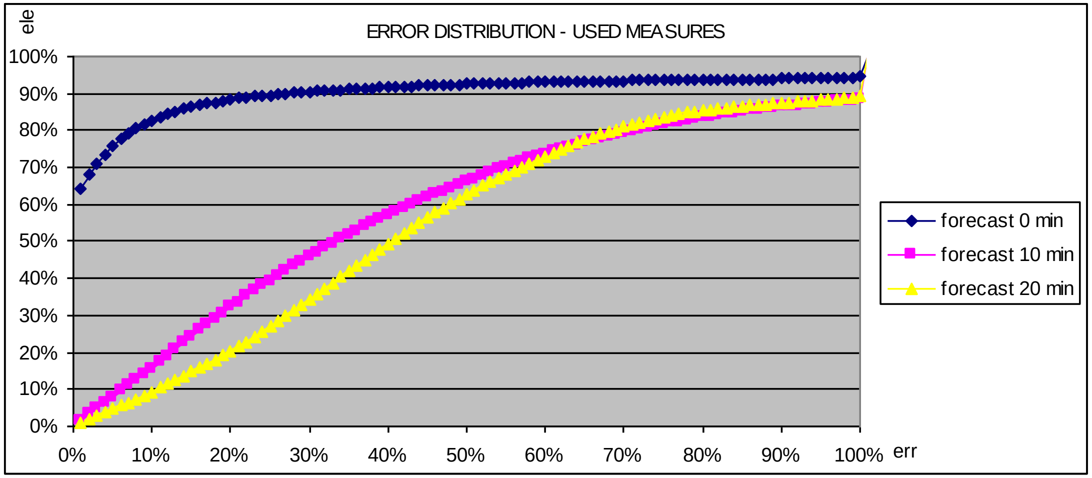
Dusseldorf Test aggregated quality evaluation

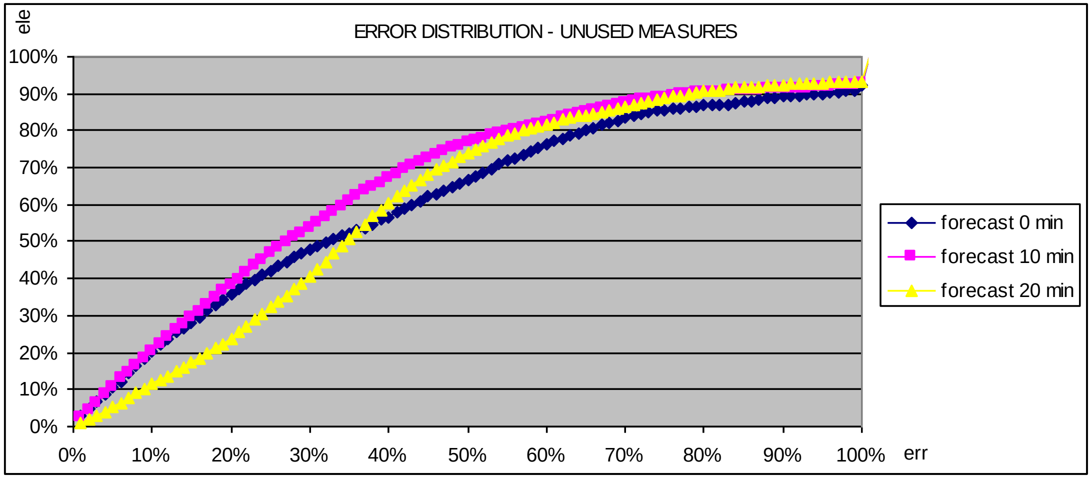
USED MEASURES

forecast	ro square
0 min	0.95
10 min	0.70
20 min	0.55

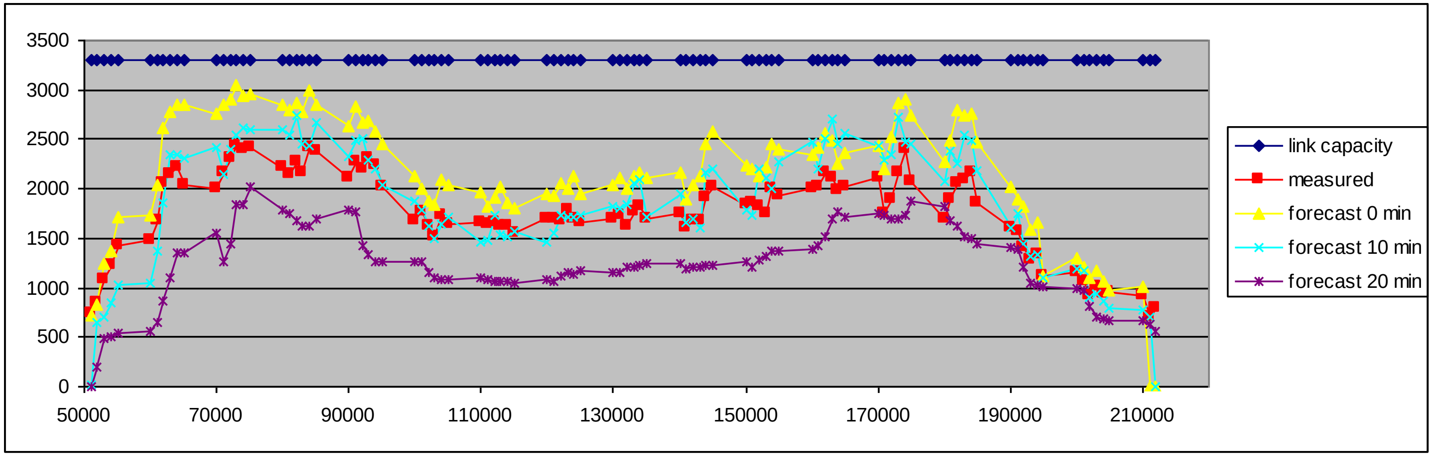
UNUSED MEASURES

forecast	ro square
0 min	0.81
10 min	0.85
20 min	0.59

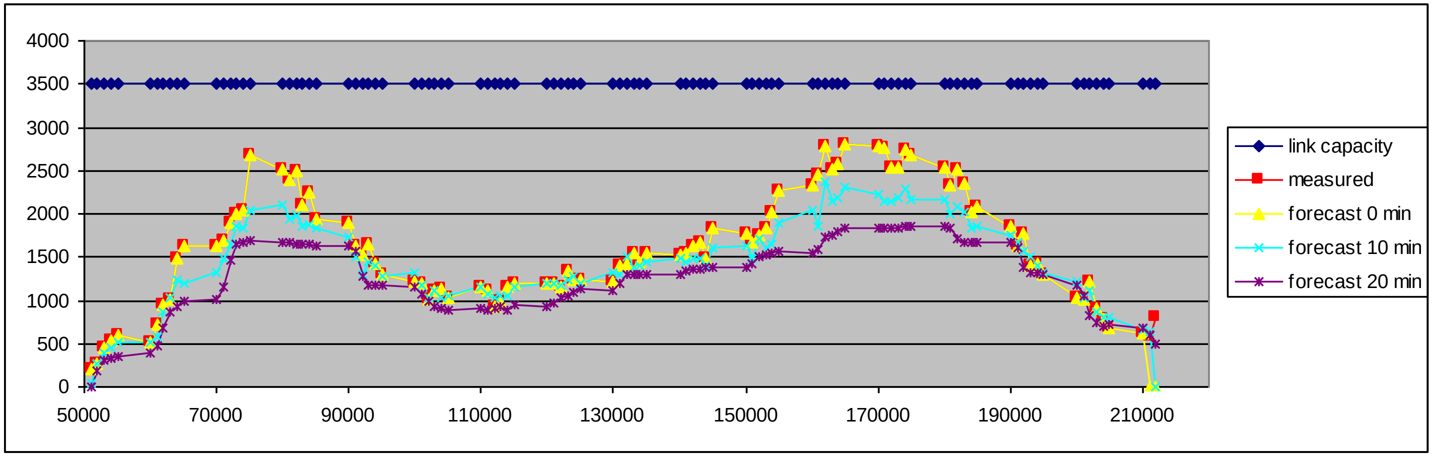




Dusseldorf Test quality evaluation by link

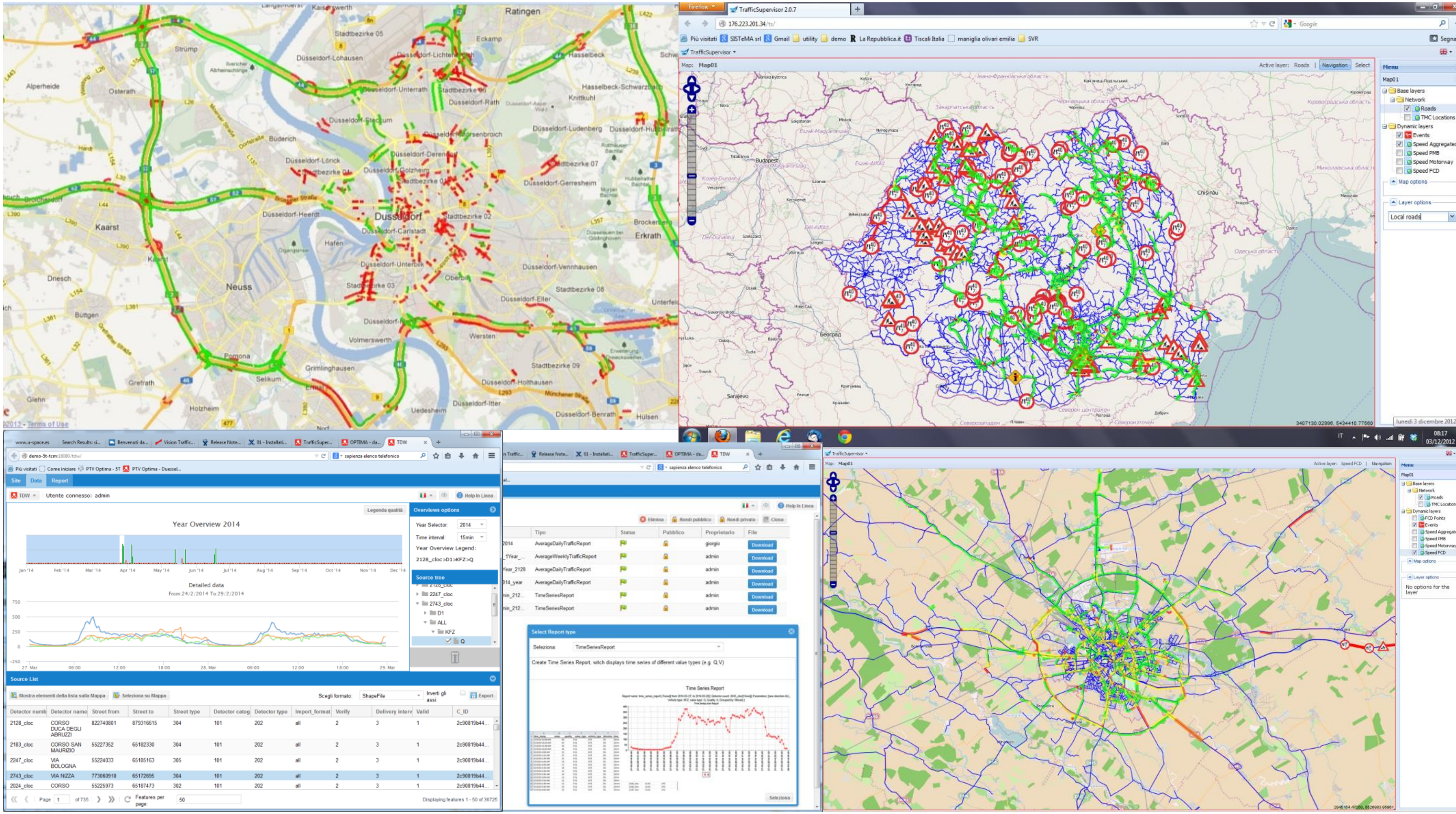


Unmonitored location



Monitored location

Traffic Information in Romania – Data Fusion and Warehouse



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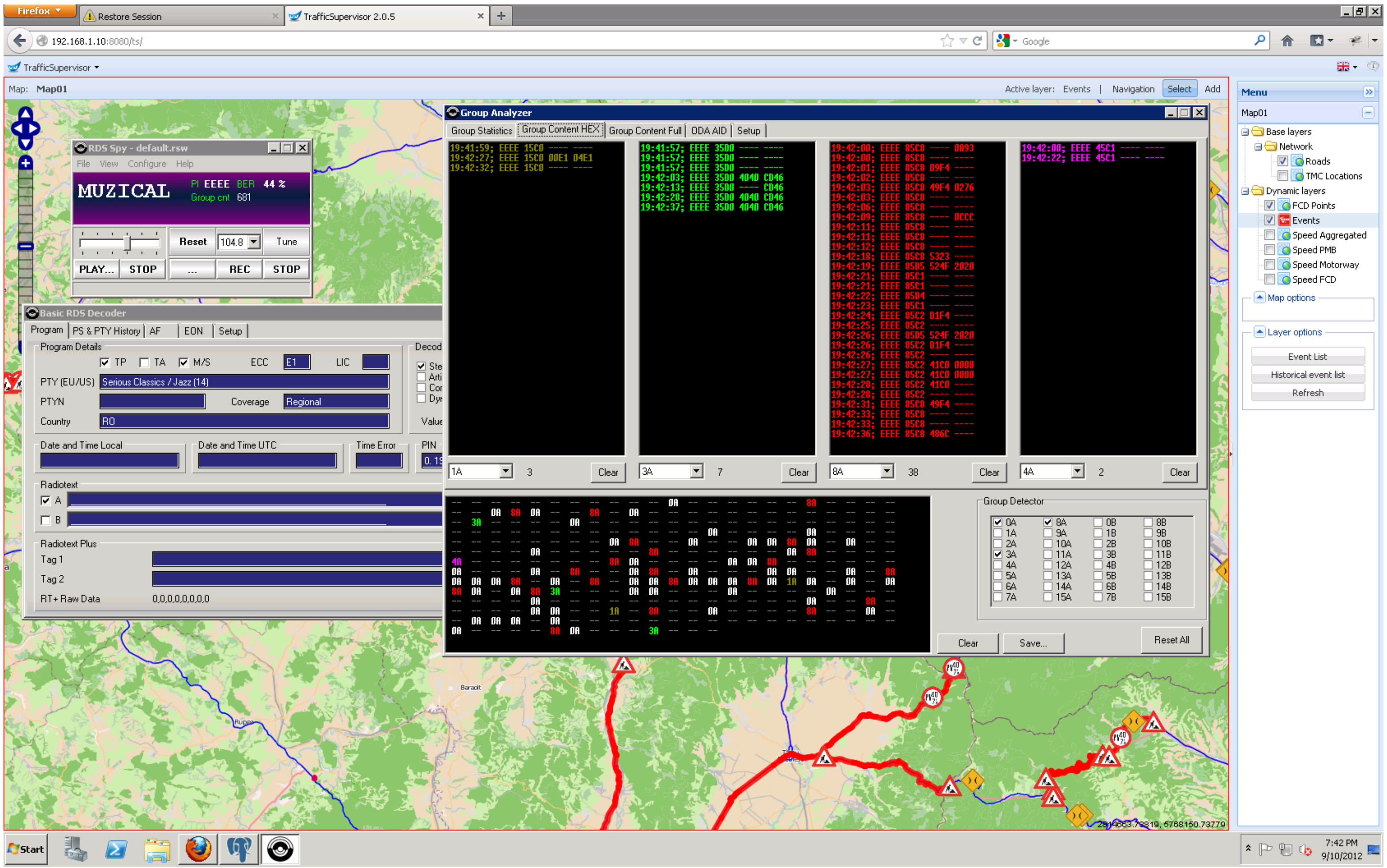
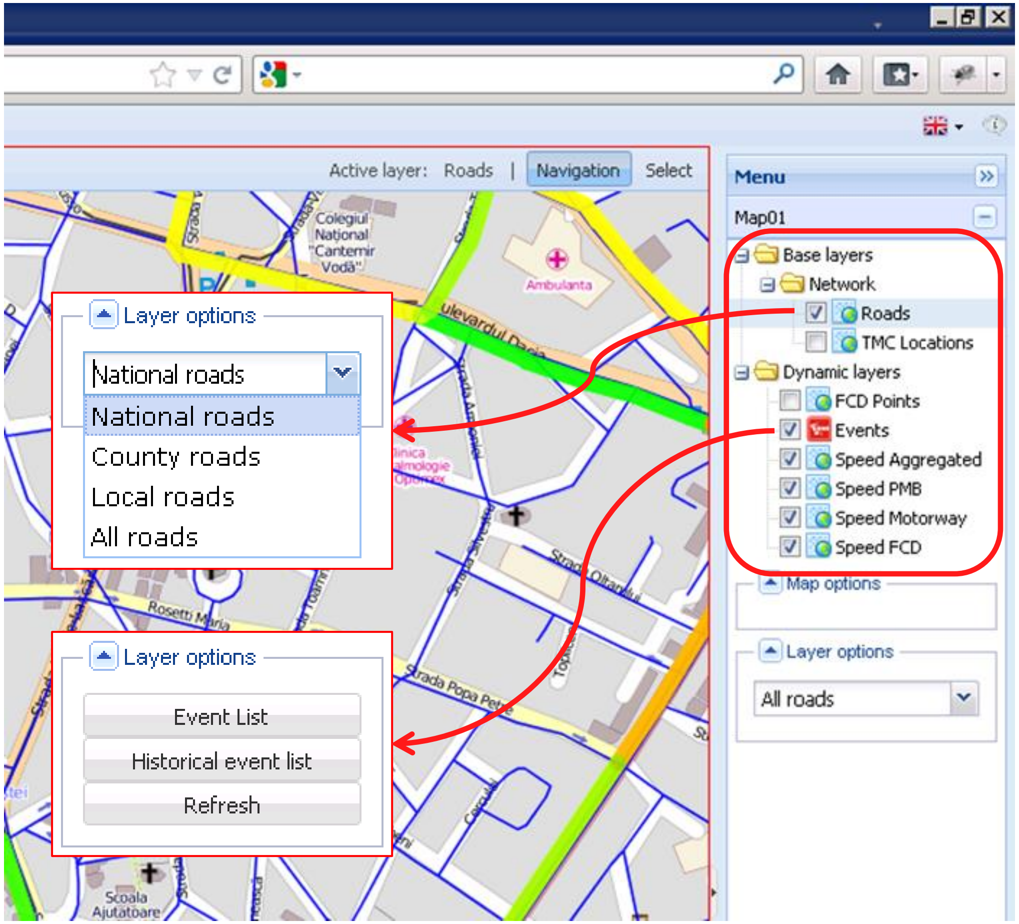
Broadcasting informations

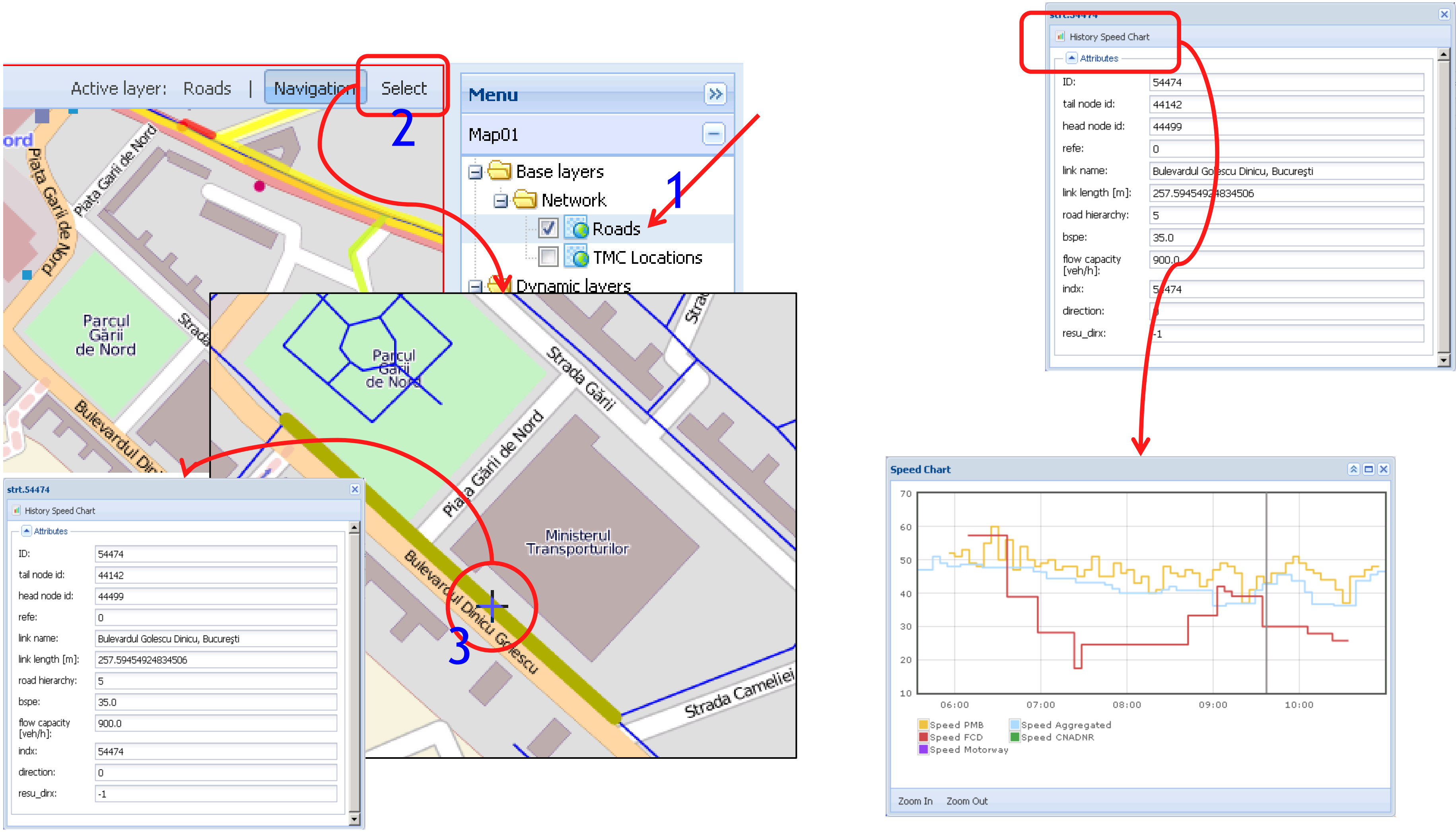


Map interface with GIS layer tree

- Static layers
  - Roads
  - Traffic signals
  - TMC locations …
- Dynamic layers
  - FCD points
  - Events …
- LOS layers
  - Harmonized Speeds
  - FCD speeds …



Road layer: link attributes and speed chart



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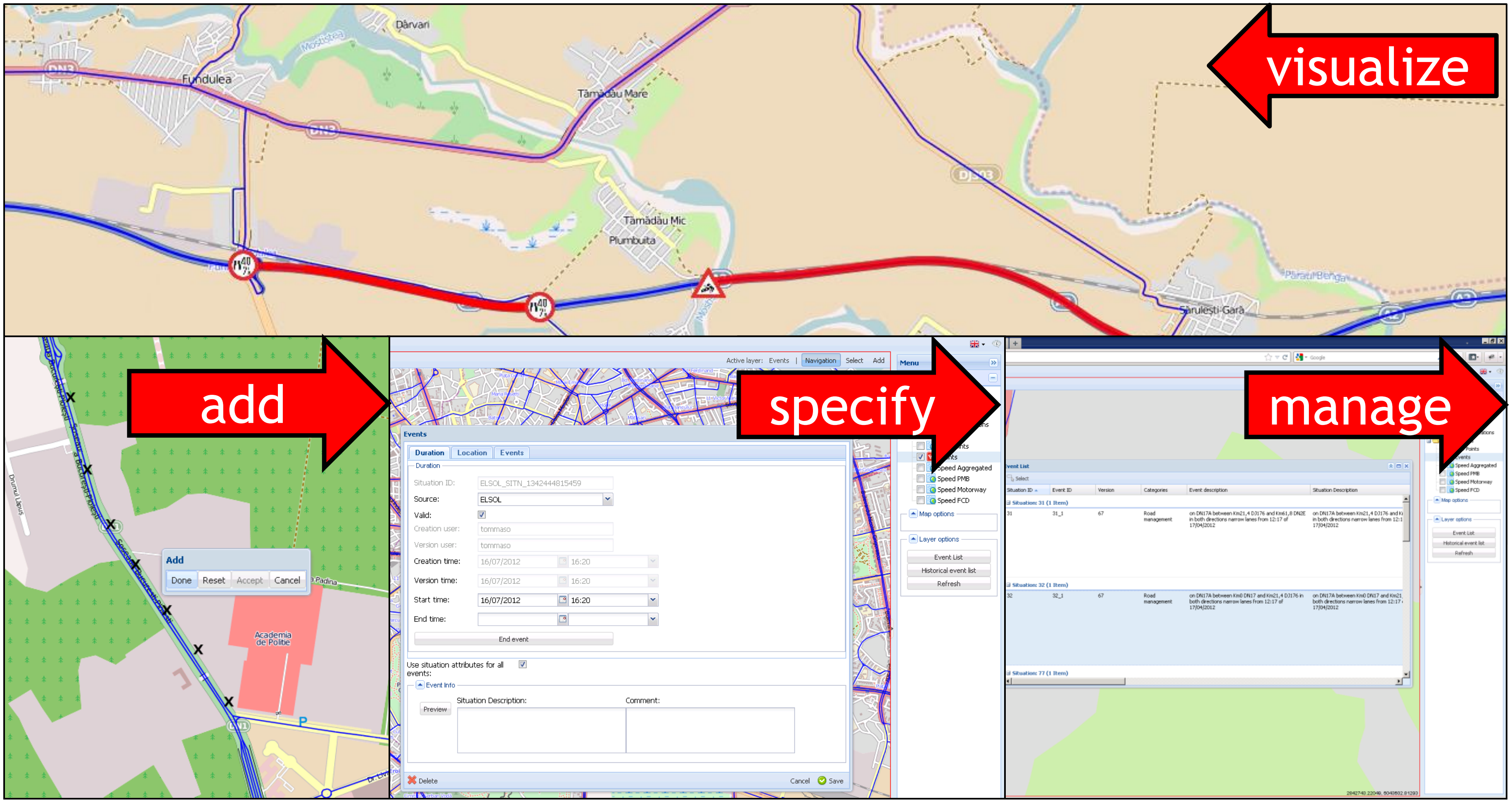
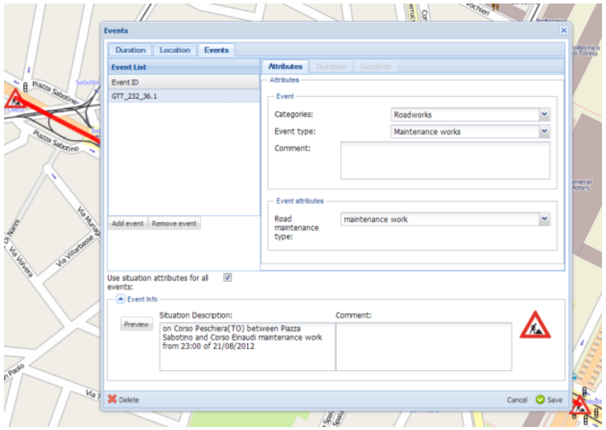
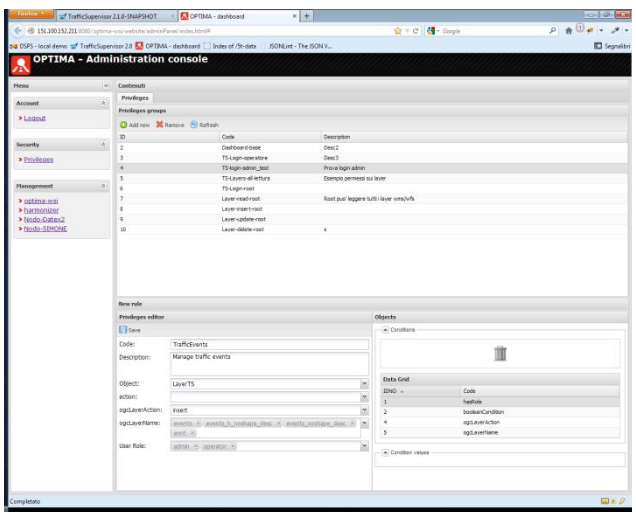
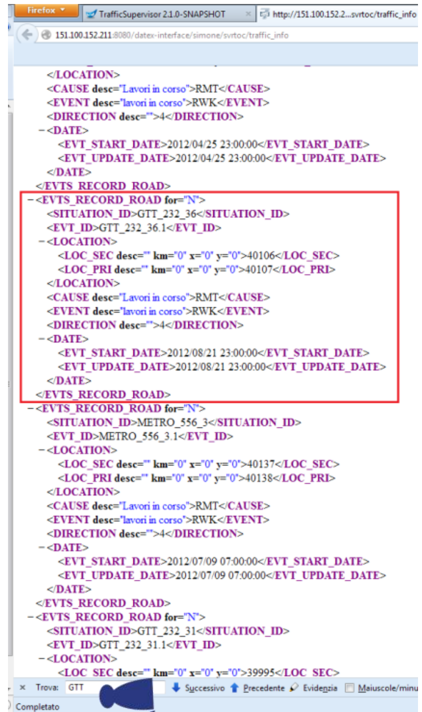
Event processing

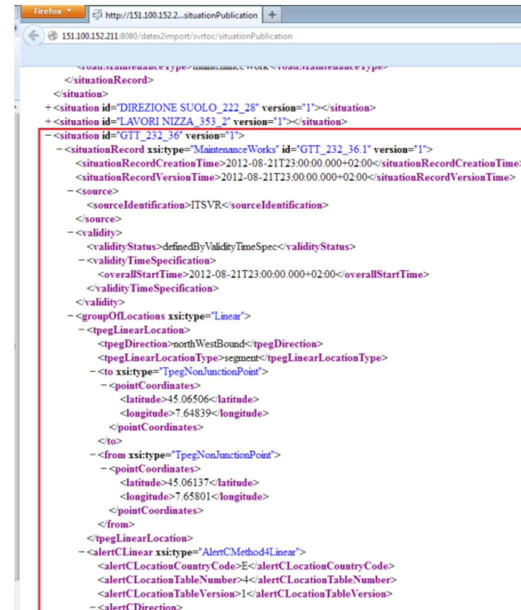


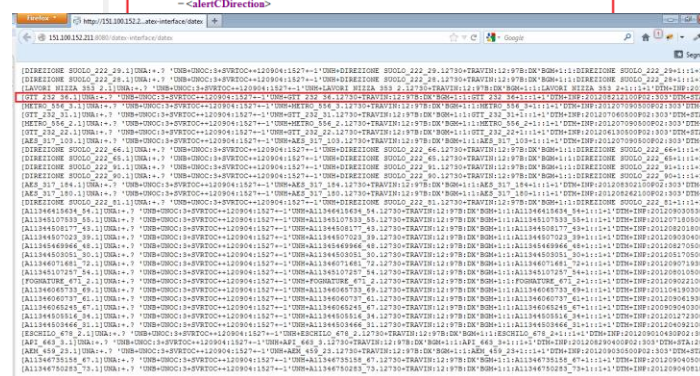
Data exchange among different formats



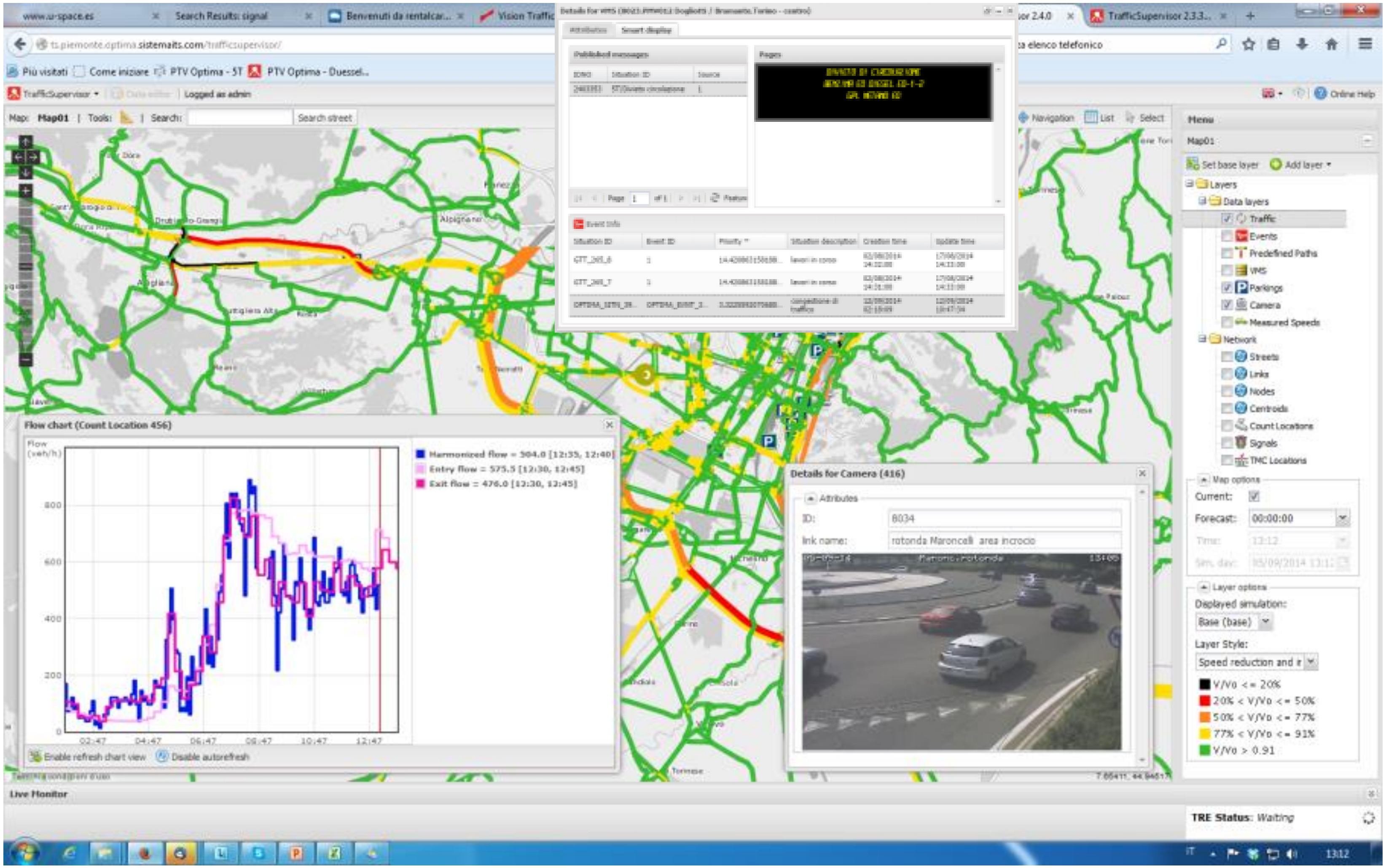








5T Regione Piemonte
a comprehensive project



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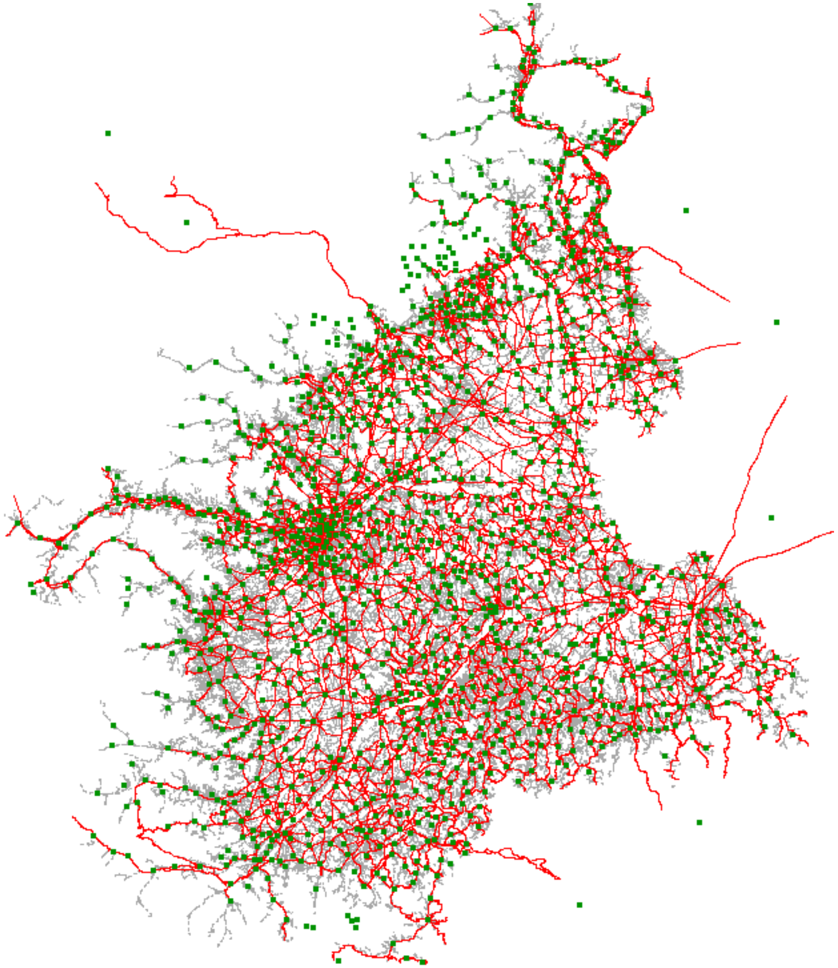
On a large network



Number of Navteq Links	795.000
Model Links	268.000 (80.000 after graph simplification)
Zones	2.000 internal zones 8 cordon zones

Tecnologie
Telematiche
Trasporti
Traffico
Torino

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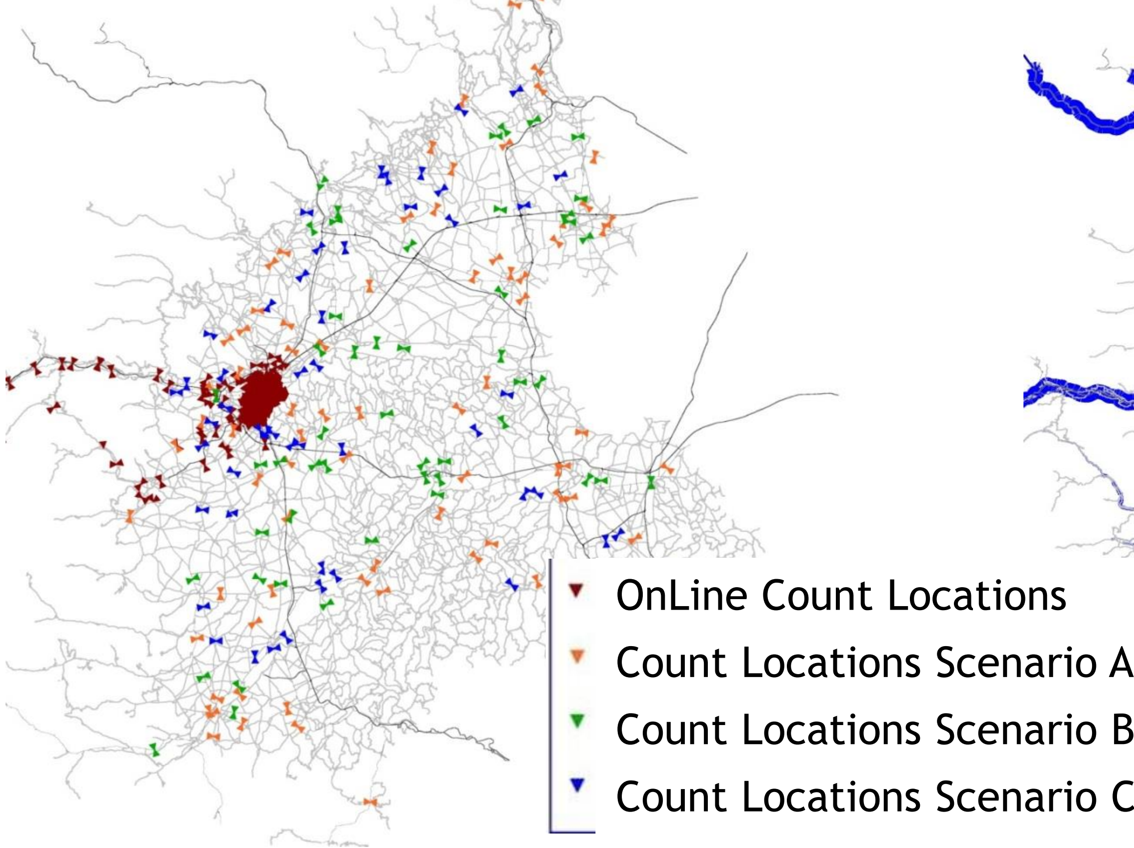
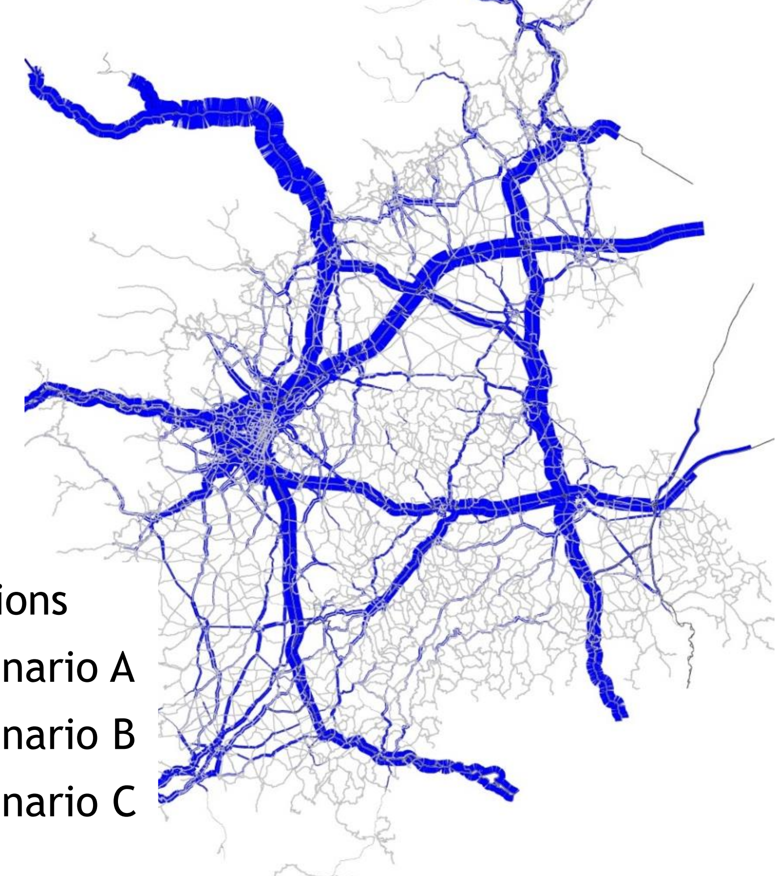
Network Sensor Location Problem

COUNT LOCATION POSITION

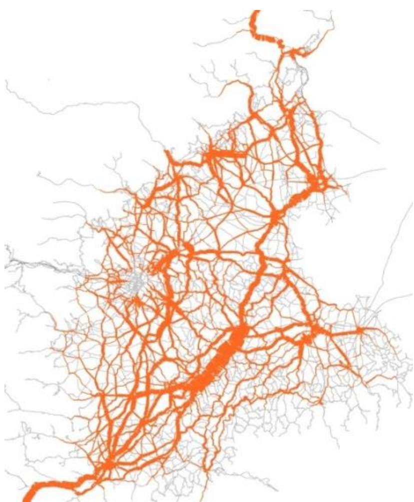


DAILY TRAFFIC SIMULATION

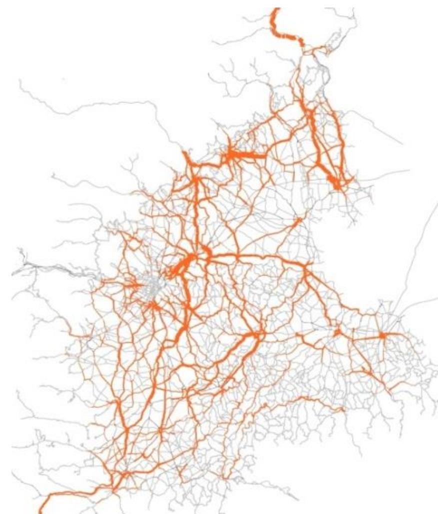


Network Sensor Location Problem

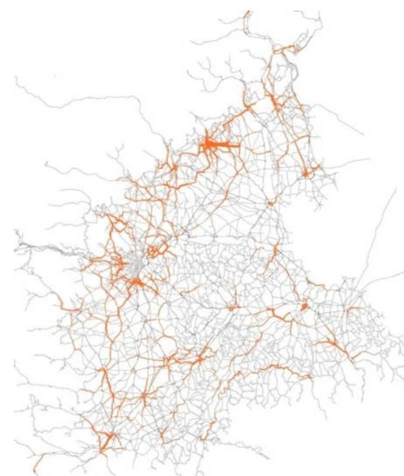
Scenario	% monitored link flows	% monitored OD flows	% monitored OD relations
Current	1.10%	24.21%	66.36%
A	1.20%	36.60%	78.60%
B	1.30%	44.20%	86.30%
C	1.37%	49.38%	90.62%



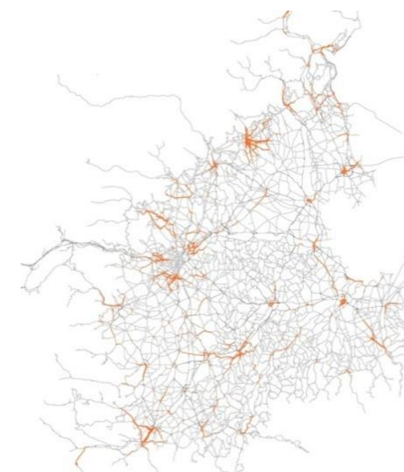
CURRENT SCENARIO



SCENARIO A

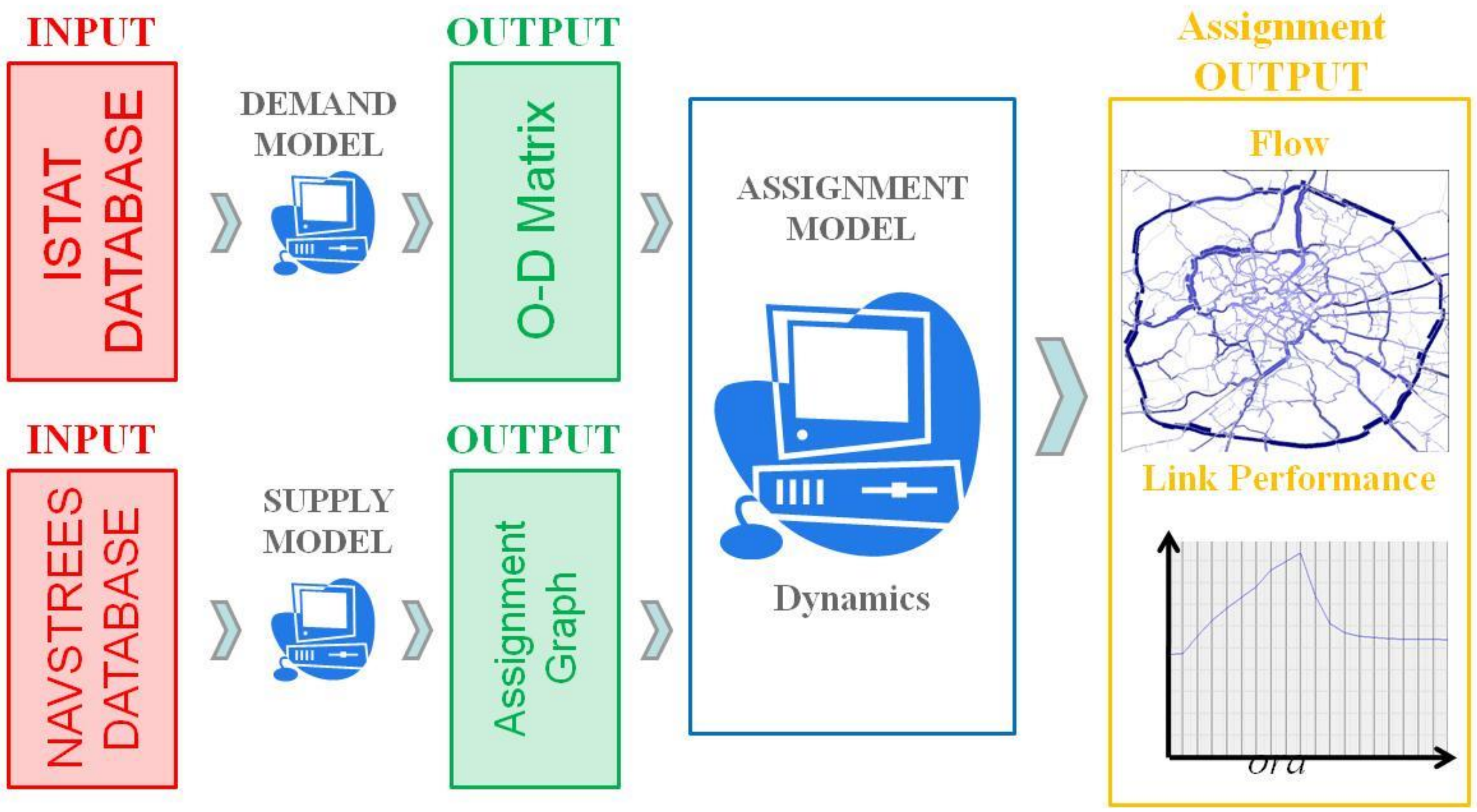


SCENARIO B

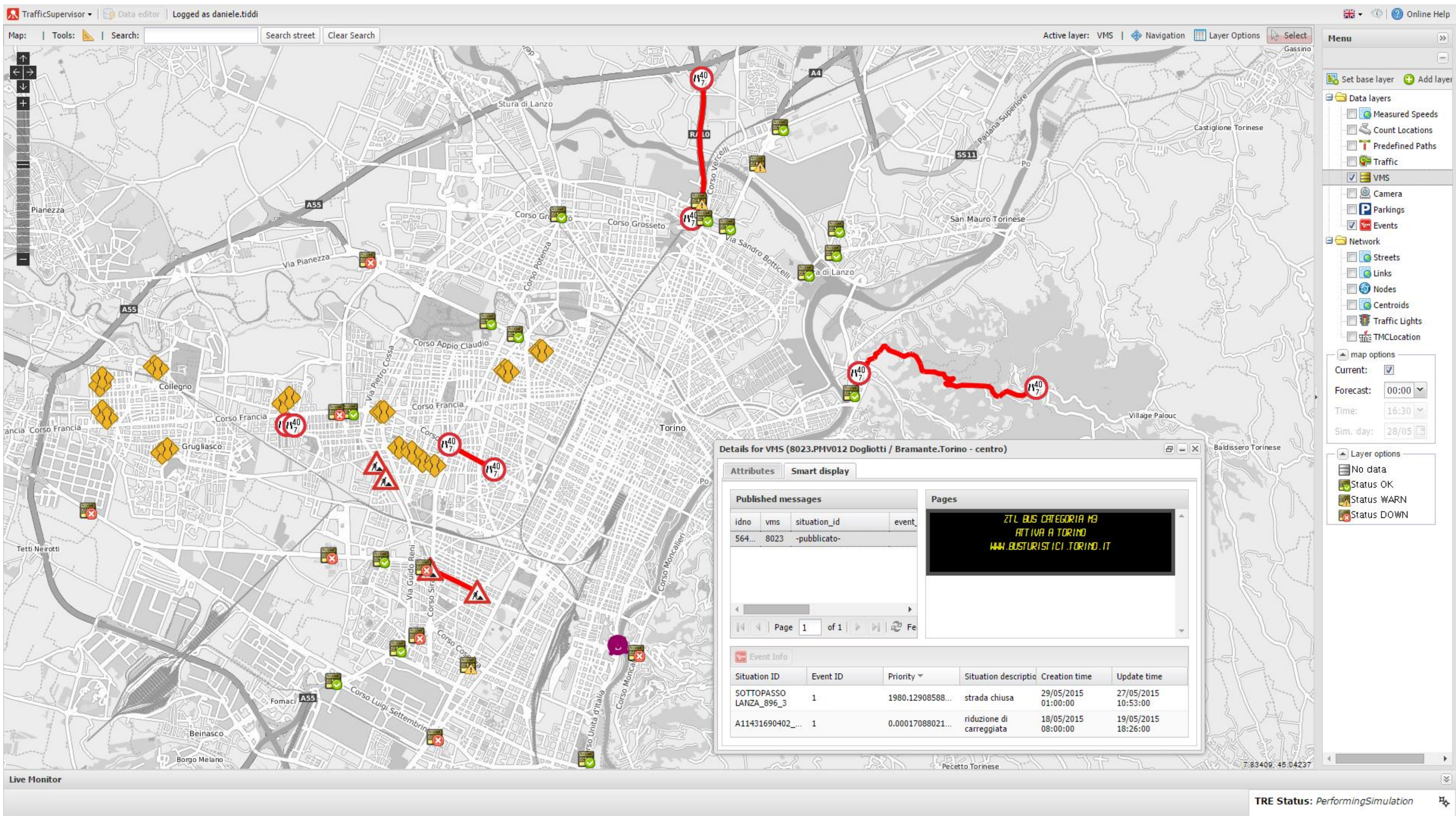


SCENARIO C

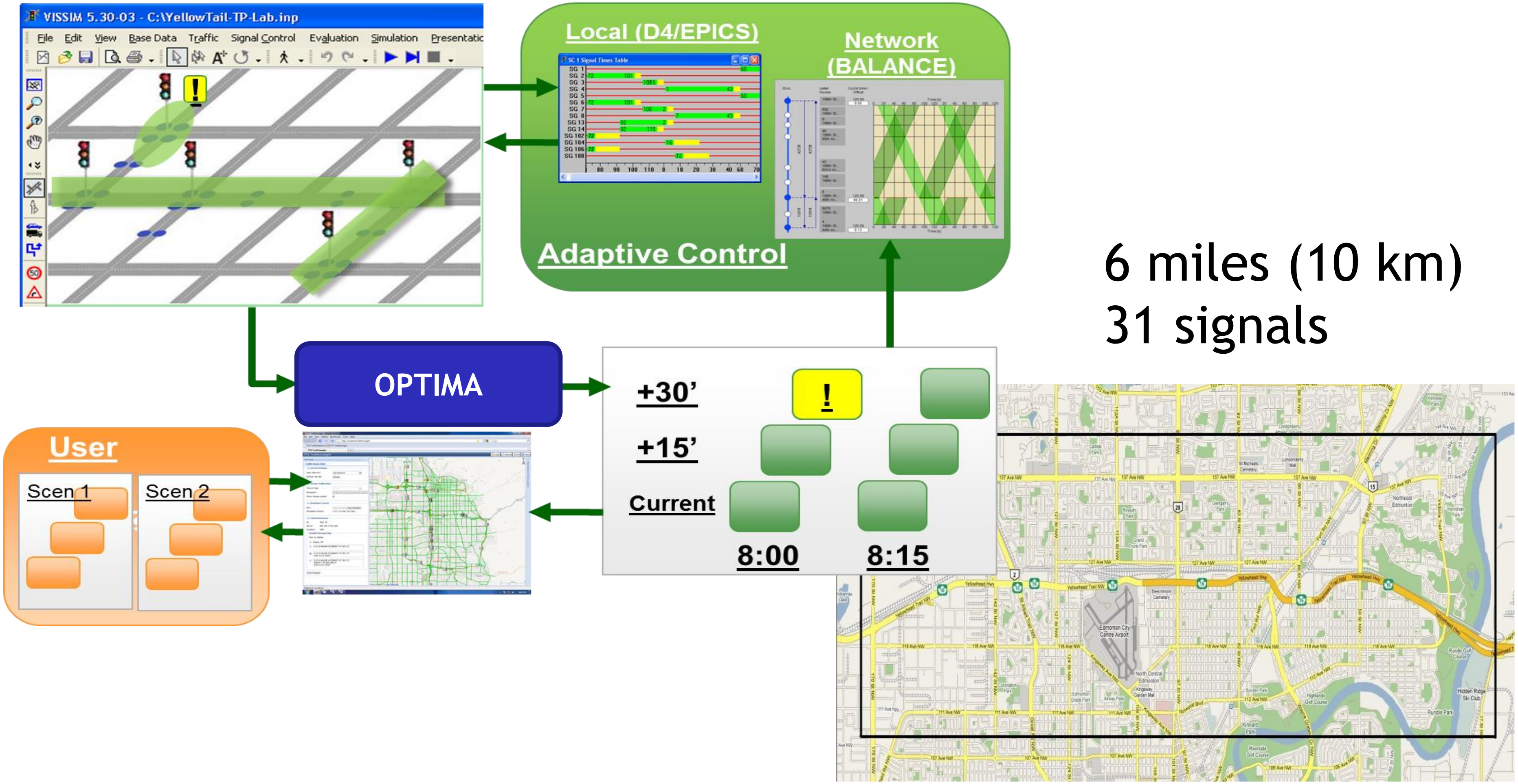
Transportation Model Builder with guided map updates



VMS
Virtual Message Sign



Edmonton Lab (VISSIM) OPTIMA + BALANCE



6 miles (10 km)
31 signals

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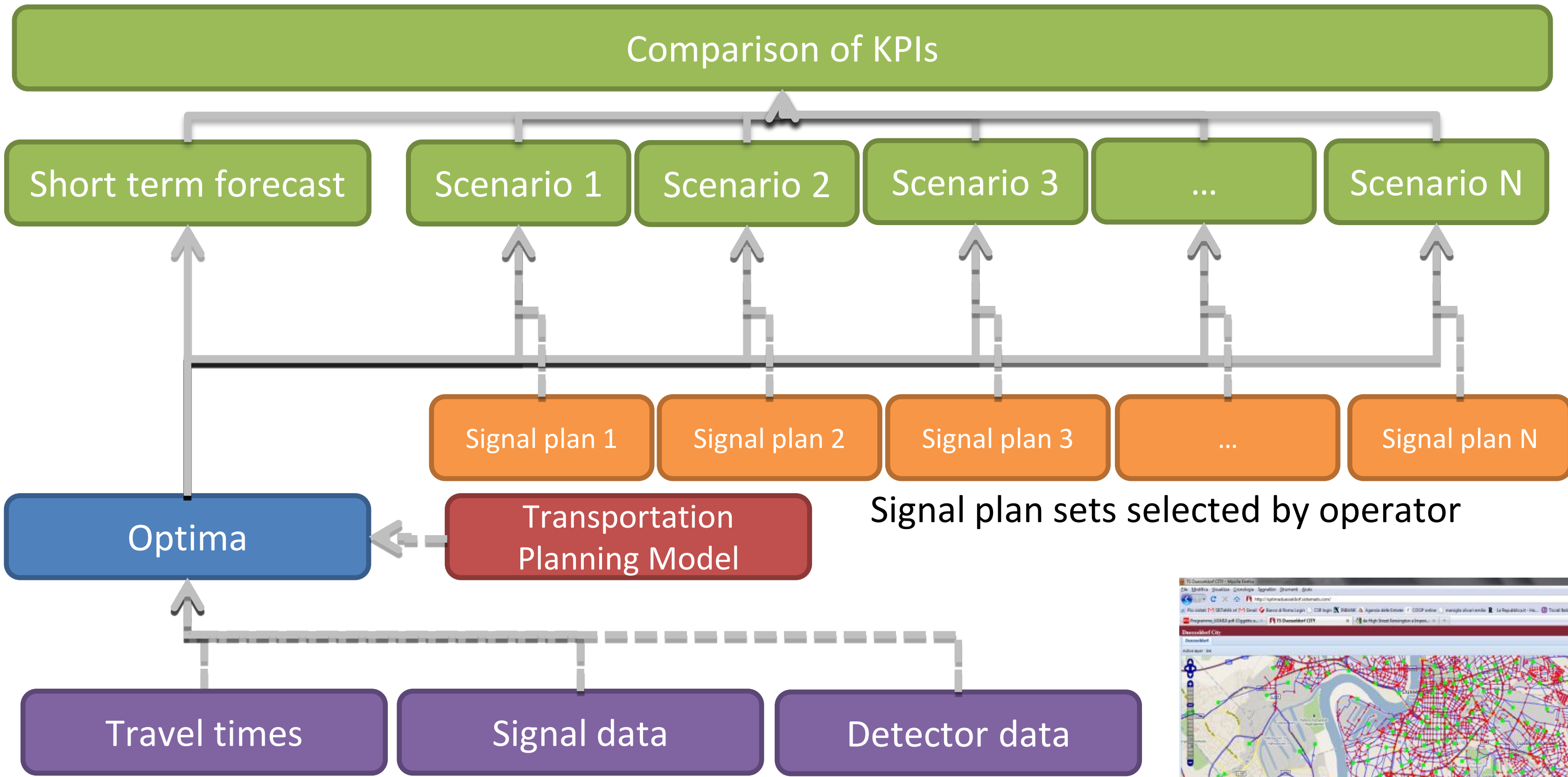
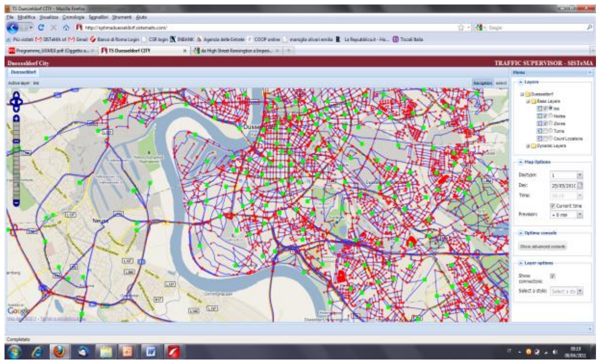
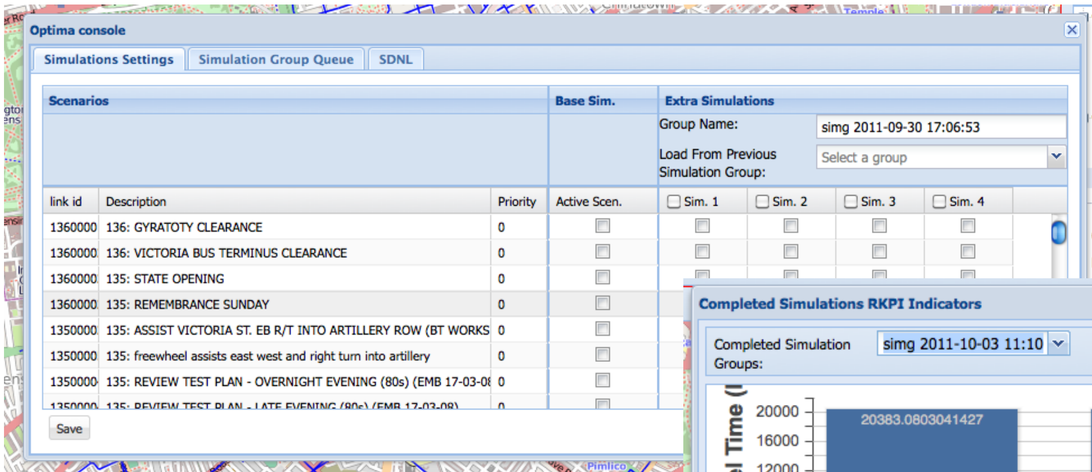
London Pilot
OPTIMA to drive SCOOT

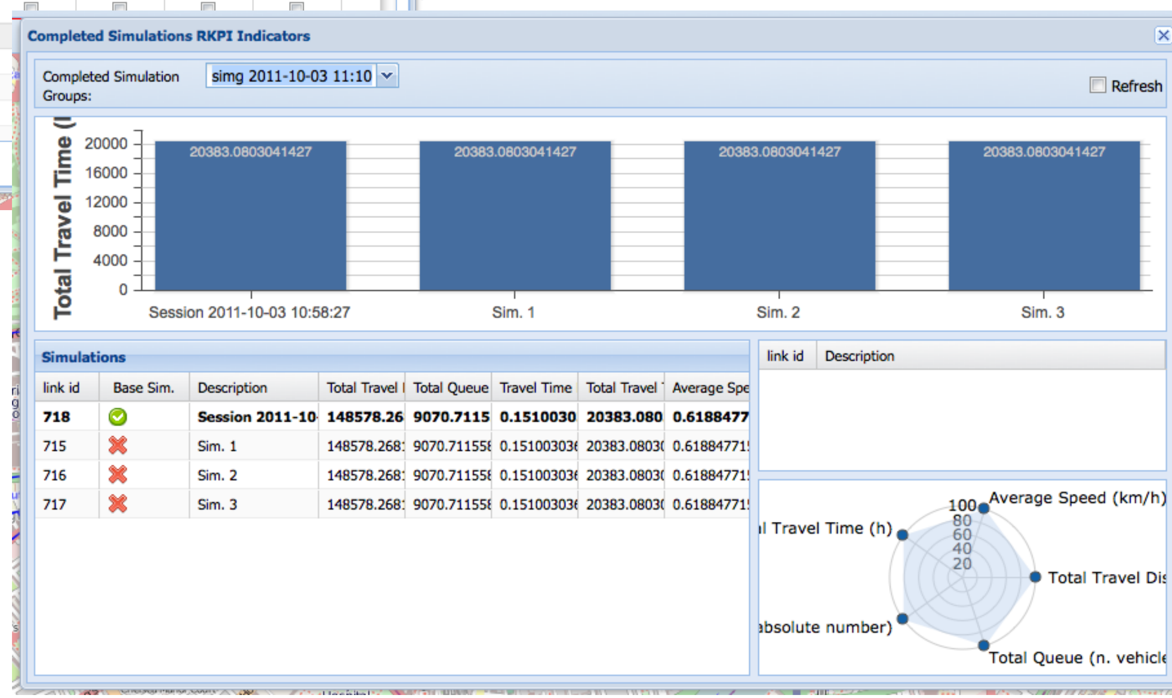




Scenario evaluation and comparison with KPI

- Build alternative scenarios
- Run multiple simulations in real time
- And "do nothing" situation

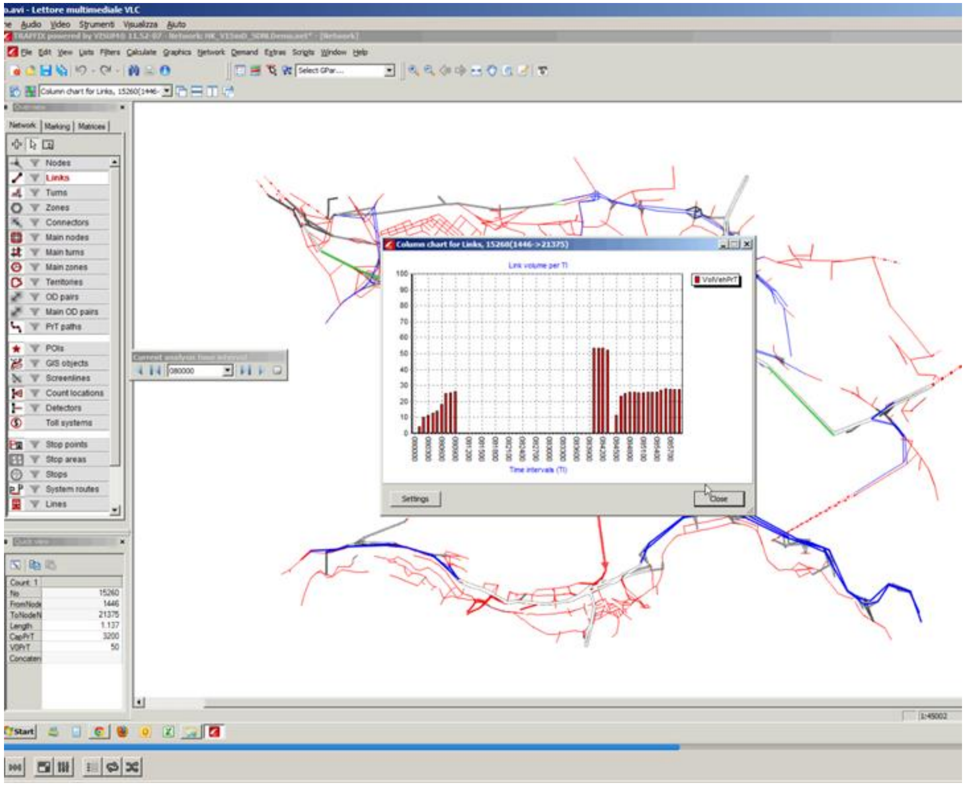




- Evaluate KPI
- Compare and rank alternative solutions
- against "do nothing"

Hong Kong Off-line Event Impacts

- Real network
  - 30.000 links, 2000 zones
- Manual insertion of events
  - link closure, capacity reduction, speed reduction
- Simulation with drivers rerouting each 5 minutes
- Comparison of traffic situation with respect to
  - no-incident situation
  - no-rerouting situation (drivers are unaware of the incident until they stuck in it!)



Infomobility portal subscribe for allerts on forecast

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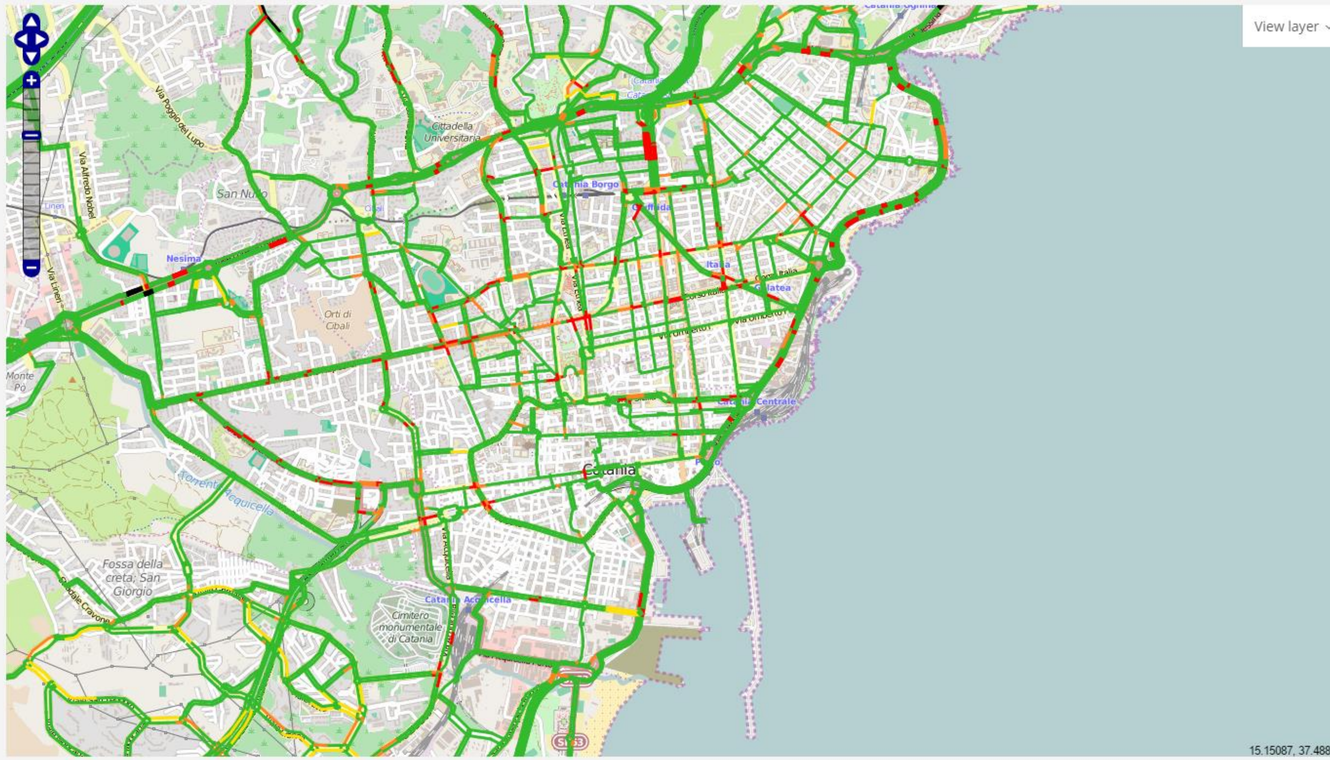
Oggi a Catania
17°C poche nuvole

T. max 17°C | T. min 17°C | Umidità: 74 % | Vento: 1.52 km/h

Events reported

Nessun evento presente per le tipologie selezionate



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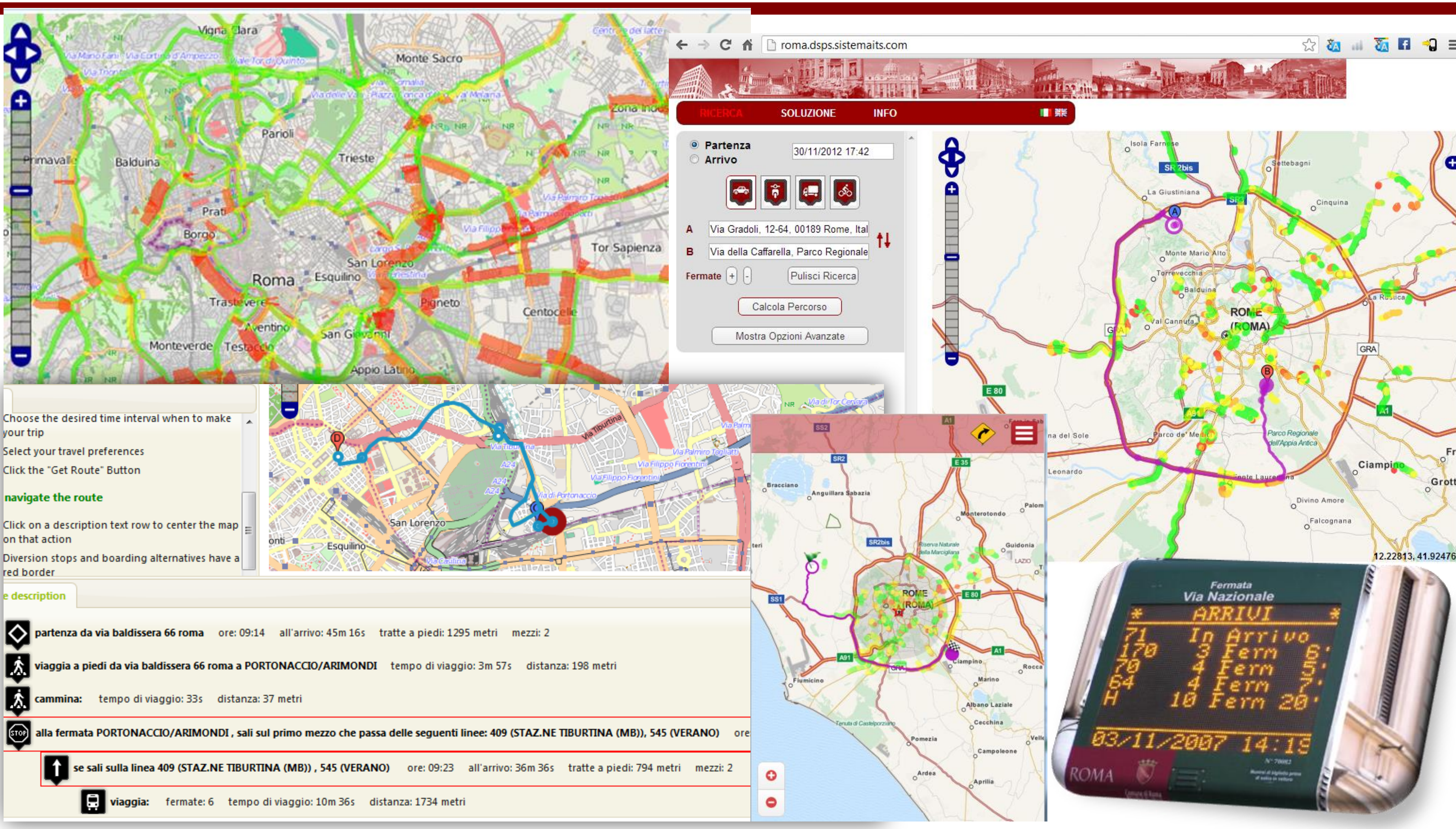
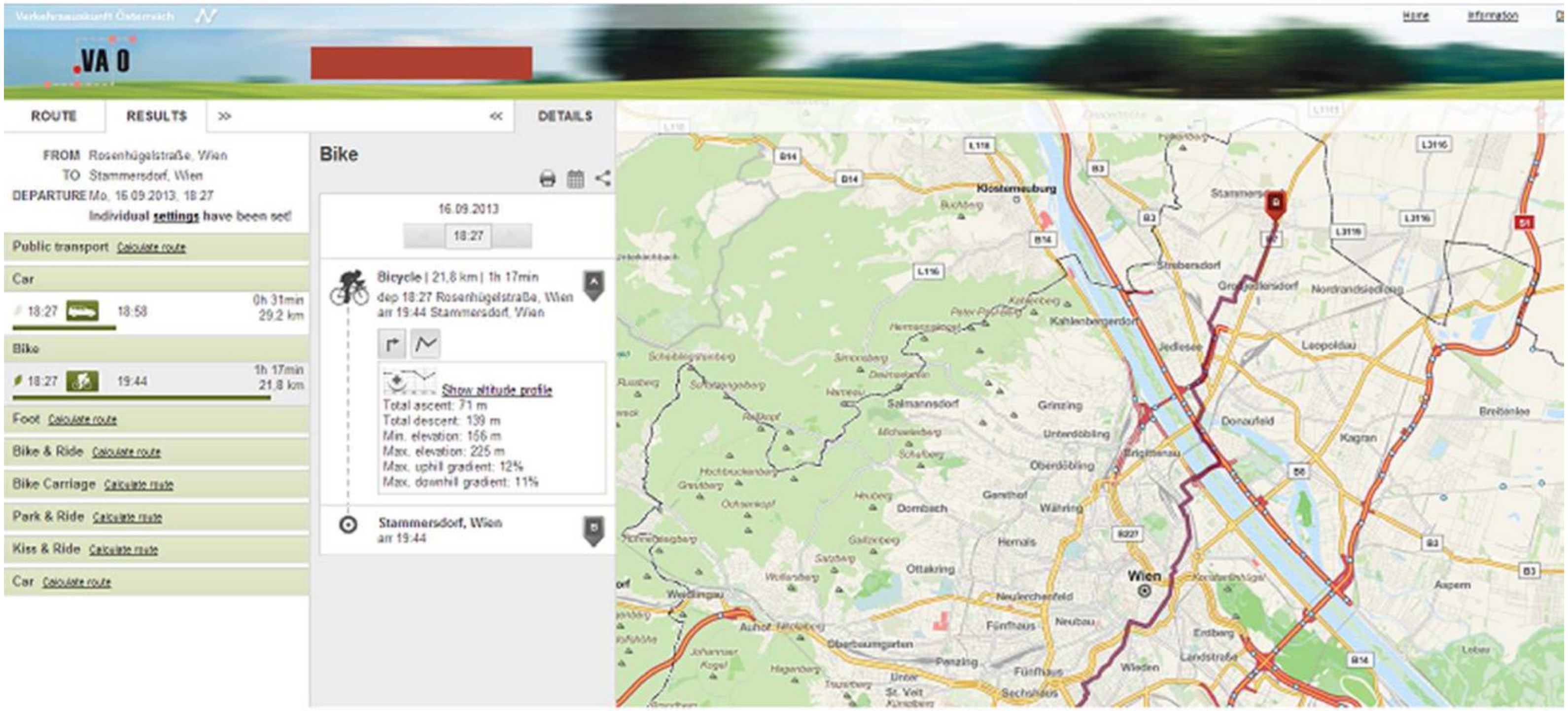
Articolo di prova di Daniele Tiddi.

Dynamic Journey Planning of Rome with HyperPaths



VAO Multimodal Trip Planning of Austria



CONCLUSIONS AND OPEN ISSUES

Some open issue in DTA applied to real-time forecast

- Many types of data and models are available
  - how to exploit big data in construction and calibration of offline models?
  - can the machine learning approach be used to also extend measures?
  - How to best integrate real-time data to correct the DNL model?
- DUE and DNL are robust paradigms
  - how much does traffic information play a role in elastic demand?
  - what actually happens in real time with rerouting?