

KEY PERFORMANCE INDICATORS FOR INTELLIGENT TRANSPORT SYSTEMS

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www.conduits.eu

Aims and objectives

- Main output of CONDUITS:
 - Coherent set of Key Performance Indicators (KPIs) for urban traffic management and ITS
 - Objectives
 - to define KPIs evaluation framework for identifying best practices and technologies
 - to test the KPIs through application to Paris, Rome and Barcelona

Roles of KPI (Cities Req.)

- Assess benefits
 - Cost vs. benefit of investment
 - Assess the usefulness of ITS as a whole
 - Identify the limits of ITS
- Assist traffic managers to make decisions
- Contract Monitoring
- Promote cities' interests

Selection criteria for KPIs

- Make use of existing data, not collect new
 - Measurability (costs, tools, accuracy)
- Easy to use and communicate to public
 - Clarity (general public, policy makers, professionals)
- Consider individuality of cities
 - Geographical scale (local-national-international)
 - Control (ability to change characteristics)

Selection criteria for KPIs (Cont.)

- Be of value, not cause problems!
 - Usefulness (corresponding to dimensions)
 - Temporality (ability to compare over time)

KPI Req.

Benefit Assessment

Mode Share

Terrain characteristics

City Size

Population characteristics

CONDUITS
Findings

Goals & Objectives

Objectives-goals-performance

Goal : Improve attractiveness of public transport

Objective : Reduce public transport waiting times in junctions

Objective : Improve reliability of public transport

PI : Average waiting time at stop line

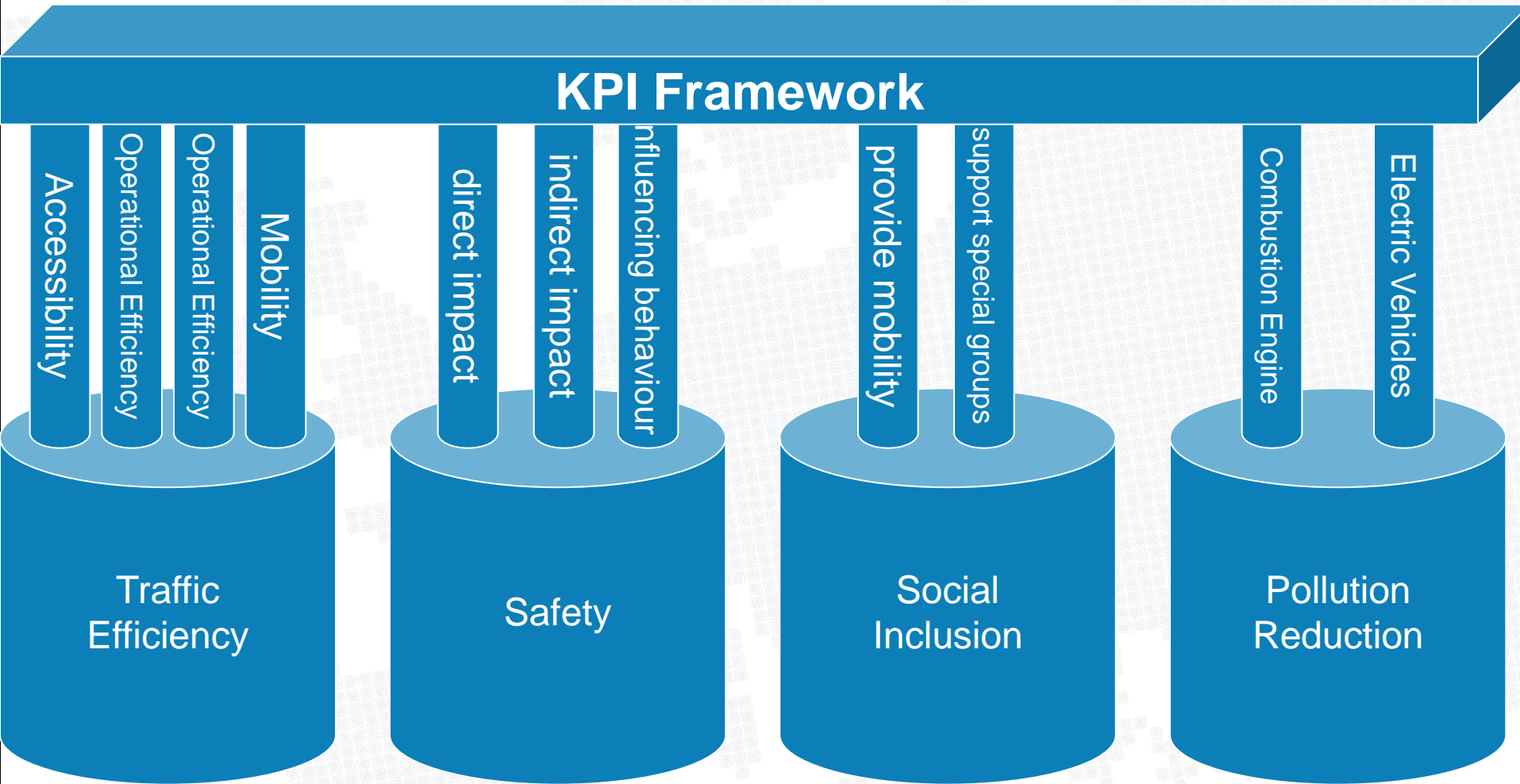
PI : % of vehicles stopping at Stop Line

PI : Variance of headway between consecutive vehicles at the station

PI : % of vehicles arriving at the station on time

Performance Measure : Vehicle's momentary location

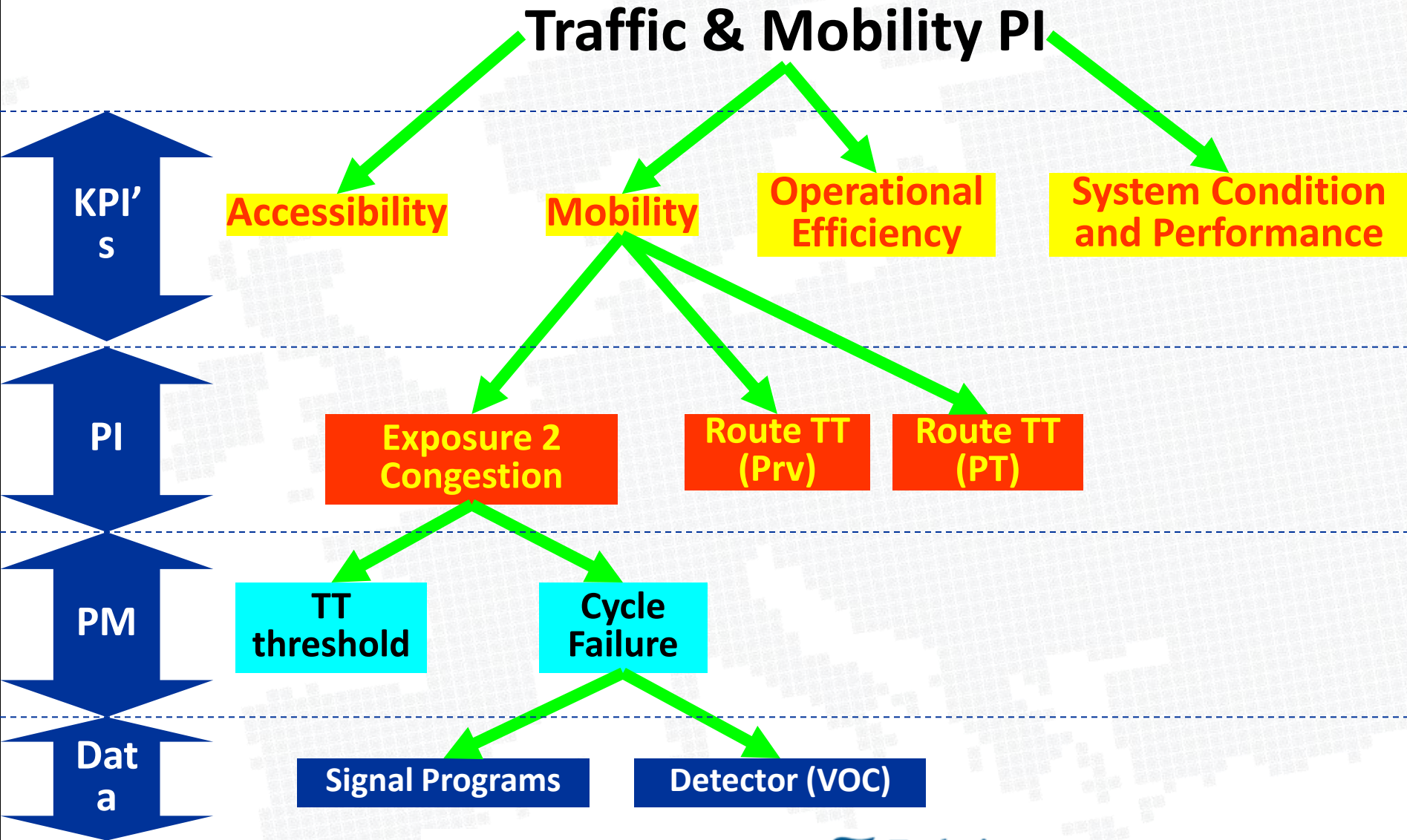
KPI Sliced to Categories



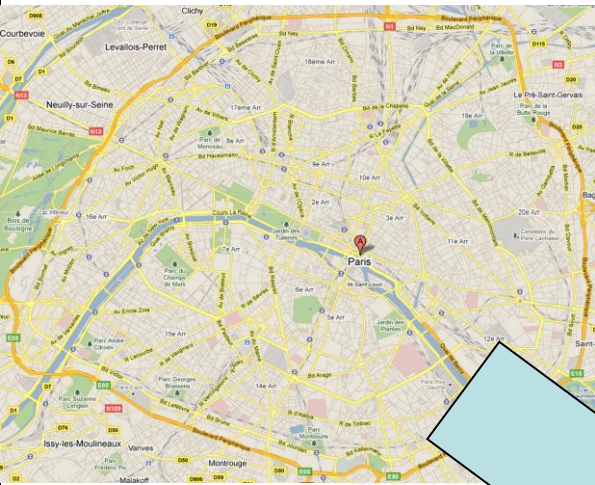
Traffic Efficiency

- **Accessibility**
 - Ease of access to jobs, recreation, shopping, intermodal transfer points, and other land uses
- **Mobility**
 - Easiness of people and goods to perform their trips
- **Operational Efficiency**
 - Evaluation of the competency of systems from a financial, operational, time and user's perspective
- **System Condition and Performance**
 - physical condition of the transportation infrastructure

Traffic Efficiency KPI



Traffic Efficiency KPI

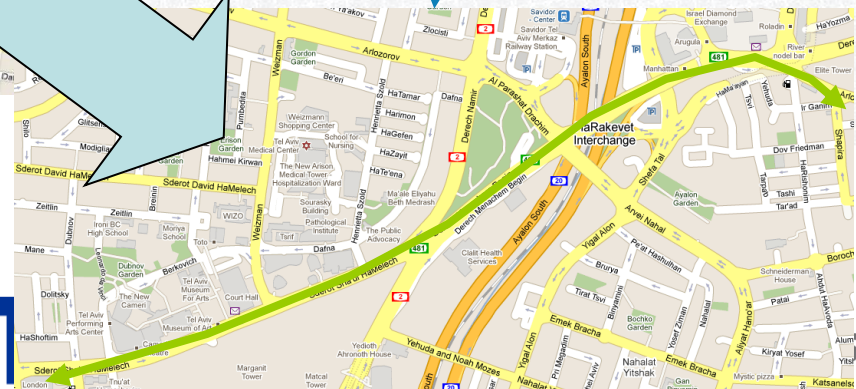
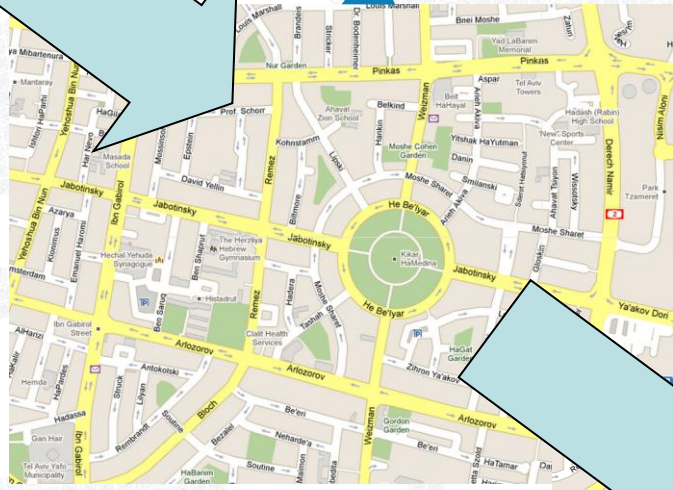


Traveler Information System

Parking Enforcement System

Assess benefits

PT Priority Strategy Selection



Traffic Efficiency KPI Data Sources

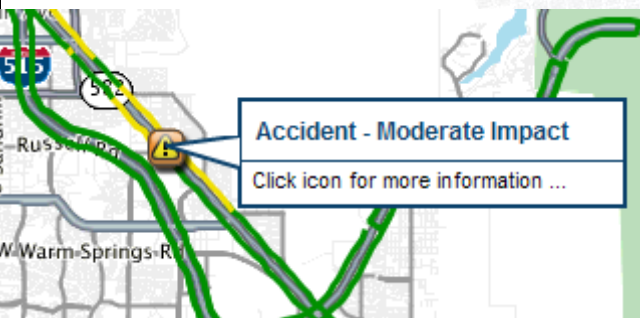


Excellent
 Good
 Average
 Poor

Query the dashboard asking what areas on map are residential.
 Areas that are residential are highlighted in yellow on the table and on the map.

ELECTRONIC FARE COLLECTION

28 Apr 01:05
202 L202W E of 40th St (c) www.az511.gov



KPI Traffic Efficiency Pilot

- Tel Aviv

→ Performance Measure

- Congestion Duration
- New Traffic Management Strategies

February



36%

April



...

December



KPI Traffic Efficiency Pilot

Exposure to congestion ratio is calculated based in congestion ratio for public transport and private traffic, over all the links, and the weights assigned to every link.

The exposure to congestion ratio value ranges from 0-1

$$\begin{aligned} TExpT &= \frac{\sum_{Links} (w_{pt} T \exp T_{pt} + w_{pv} T \exp T_{pv})}{\sum_{Links} (w_{pt} + w_{pv})} \\ &= \frac{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} T \exp T_{pt}^{li} + w_{pv} \sum_{pv} w_{li} T \exp T_{pv}^{li} \right)}{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} + w_{pv} \sum_{pv} w_{li} \right)} \end{aligned}$$

KPI Traffic Efficiency Pilot

$$TExpT = \frac{\sum_{Links} (w_{pt} T_{expT_{pt}} + w_{pv} T_{expT_{pv}})}{\sum_{Links} (w_{pt} + w_{pv})}$$

Where:

$$= \frac{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} T_{expT_{pt}^{li}} + w_{pv} \sum_{pv} w_{li} T_{expT_{pv}^{li}} \right)}{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} + w_{pv} \sum_{pv} w_{li} \right)}$$

TExpT Exposure to congestion ratio.

TExpT_{pt} Congestion ratio for public transport.

TExpT_{pv} Congestion ratio for the private traffic.

w_{pt} The weight of public transport.

w_{pv} The weight of private transport.

w_{li} The relative importance of the link.

KPI Traffic Efficiency Pilot

$$TExpT = \frac{\sum_{Links} (w_{pt} T_{exp} T_{pt} + w_{pv} T_{exp} T_{pv})}{\sum_{Links} (w_{pt} + w_{pv})}$$

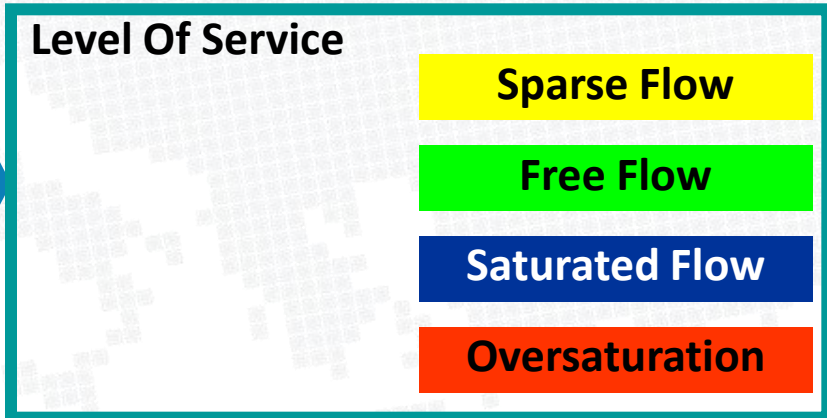
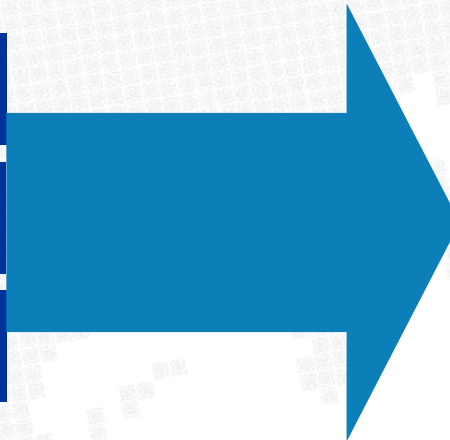
$$T_{exp} T_{pv} = \frac{T_{Congestion}}{T} = \frac{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} T_{exp} T_{pt}^{li} + w_{pv} \sum_{pv} w_{li} T_{exp} T_{pv}^{li} \right)}{\sum_{Links} \left(w_{pt} \sum_{pt} w_{li} + w_{pv} \sum_{pv} w_{li} \right)}$$

$$T_{Congestion} = LOS(Saturation) \vee LOS(Oversaturation)$$

Actual Signal Timings

Detector (Occupancy)

Detector (Volume)



KPI Traffic Efficiency Pilot

- Weighting Methodology

- Time Frames

- 5 time frames to reflect the typical traffic demand patterns

- Link Categories

- Arterial
- Streets

- Direction Categories

- Inbound (to the city centre)
- Outbound (out of the city centre)



KPI Traffic Efficiency Pilot

Weighting Principals

	Inbound			Outbound		
	Morning Peak	Afternoon Peak	Off Peak	Morning Peak	Afternoon Peak	Off Peak
Arterial	5	3	5	3	5	5
Local Streets	4	2	3	2	4	3

The new Strategies were implemented during the Afternoon Peak

KPI Traffic Efficiency Pilot

Results:

- Comparing the index during afternoon peak hours two months prior to the improvement of the signal program to two months following the improvement indicates an average reduction of 36% in the index value.
- General perception of representative travellers supported this figure.
- Within few months the decrease tendency of the index value stopped and within one year the index value became stable.

KPI Traffic Efficiency Pilot

- $T_{Congestion}$ measurement Options

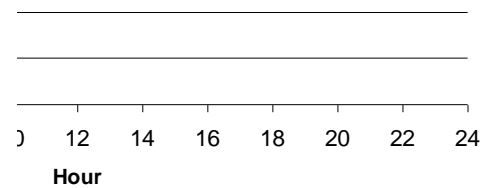
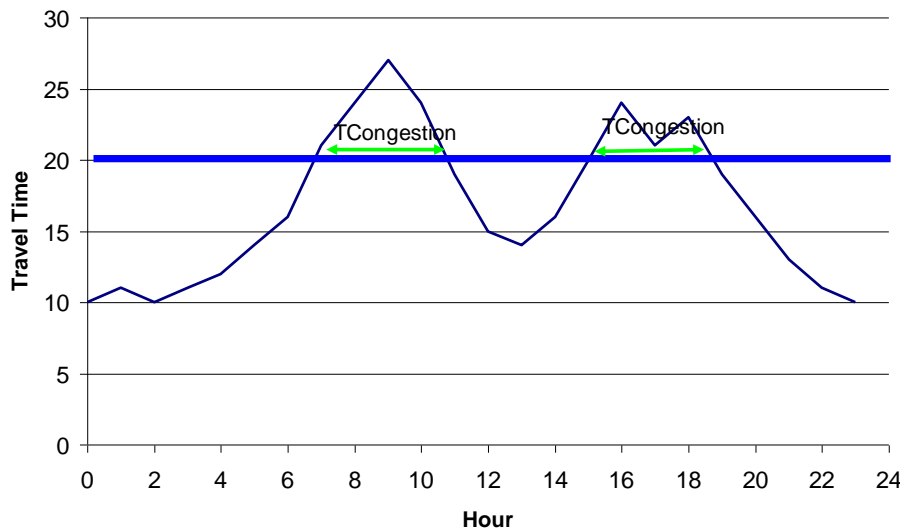
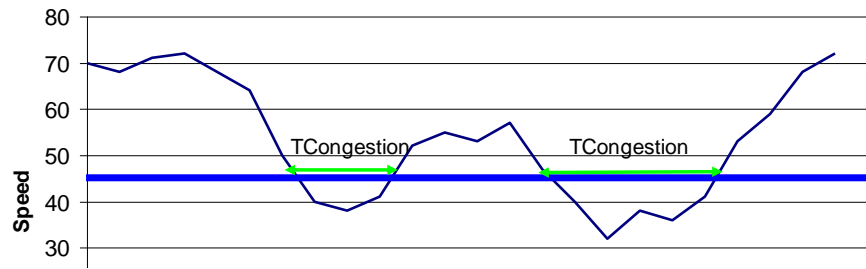
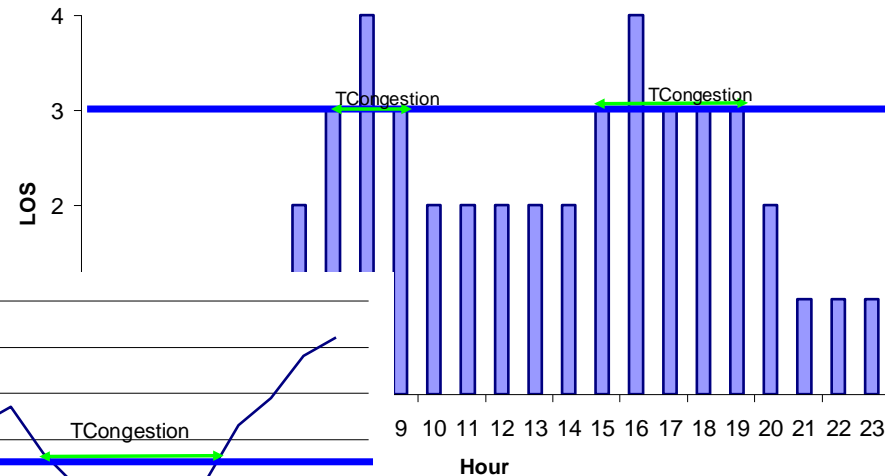
→ LOS

→ Speed

→ Travel Times

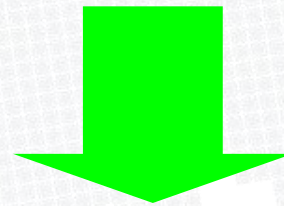
→ ...

$$T_{exp} T_{pv} = \frac{T_{Congestion}}{T}$$

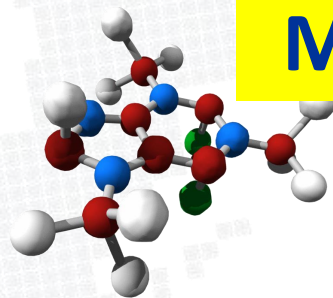


Pollution Estimation - The need for a model

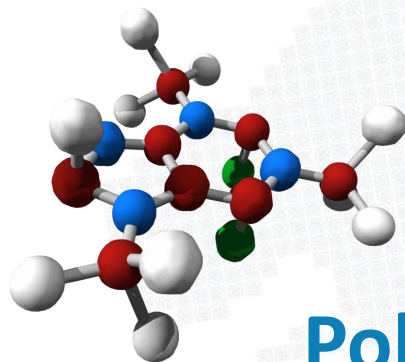
- Pollution can be measured
 - Monitoring stations
 - Provide information of air pollution in general but not source specific
 - Monitoring Devices
 - Spatial coupling is complicated



MODEL



Work Outcomes



Total Emission Indicator

Pollution Evaluation Method

List of Pi's

Concept Development for Quantifying Pollution Reductions through ITS

To establish KPI to evaluate transportation-related pollution

Estimating ITS effect on Pollution

ITS
Data

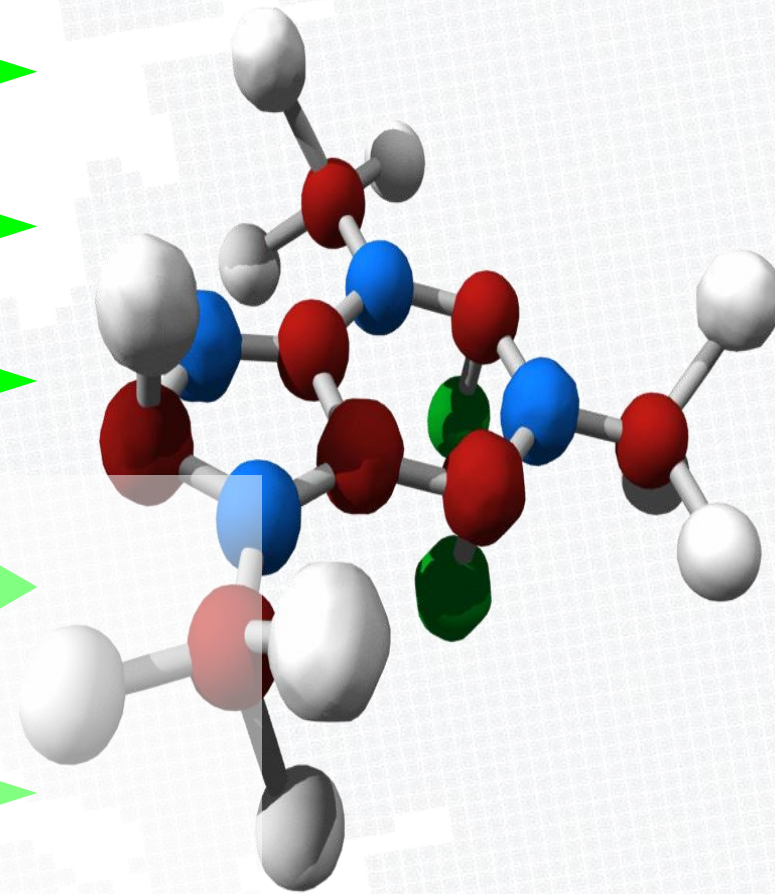
Traffic conditions

Route data

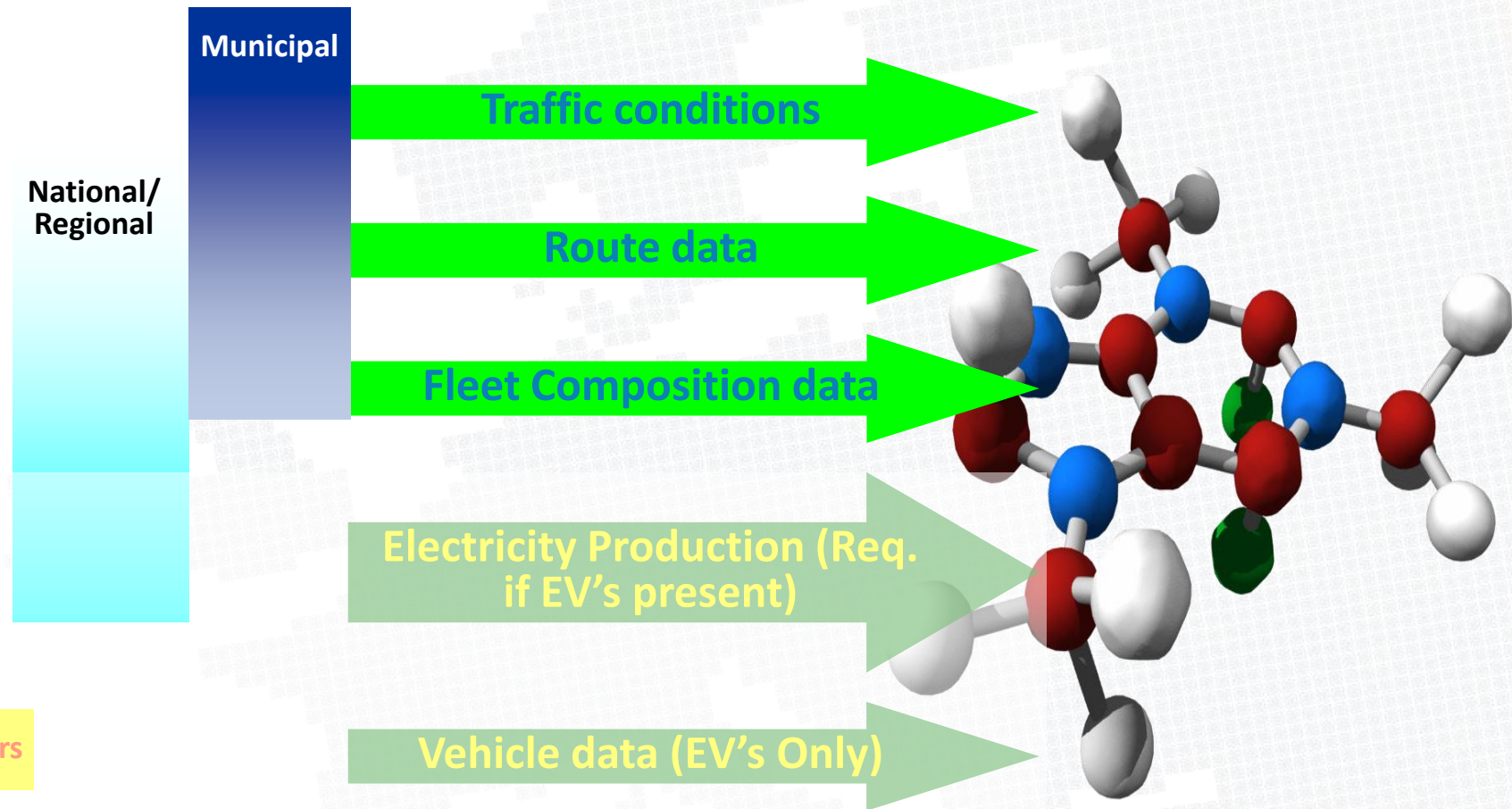
Fleet Composition data

Electricity Production (Req.
if EV's present)

Vehicle data (EV's Only)



The Challenge - Data



manufacturers

Traffic safety

- Safety related ITS
- System outcome: accident reduction
- System output:
 - direct impact by intervention in critical situations
 - indirect impact by preventing dangerous traffic conditions
 - influencing driving behaviour by providing driver assistance

Traffic safety

- With how much intensity do ITS take safety-related action
 - The actions can be:
 - interventions
 - warnings
 - information
 - ITS provide most of the necessary data
 - number of actions of the systems
 - traffic volumes
 - assessment in short and long periods possible

Traffic safety

- How often do certain events take place

→ The events can be:

- congestion
- oversaturation of intersections
- conflict situations between traffic participants
- accidents

→ ITS provide most of the necessary data

- number of detected events
- traffic volumes

→ For accidents statistical data is necessary

Social inclusion

- How many opportunities for a certain activity can be reached within X min?
 - geo-referenced data necessary
 - structure: land use, population, points of interest
 - transport system(s): networks, travel times, timetables
 - calculations via GIS
 - travel time isochrones by different modes
 - assessment of land use within the isochrones
 - assessment for longer periods

Social inclusion

- Is the mobility rate of impaired people similar to the average of the population?
 - survey data necessary
 - number of trips per day for different purposes
 - ITS can provide user data
 - assessment for longer periods

General conclusions

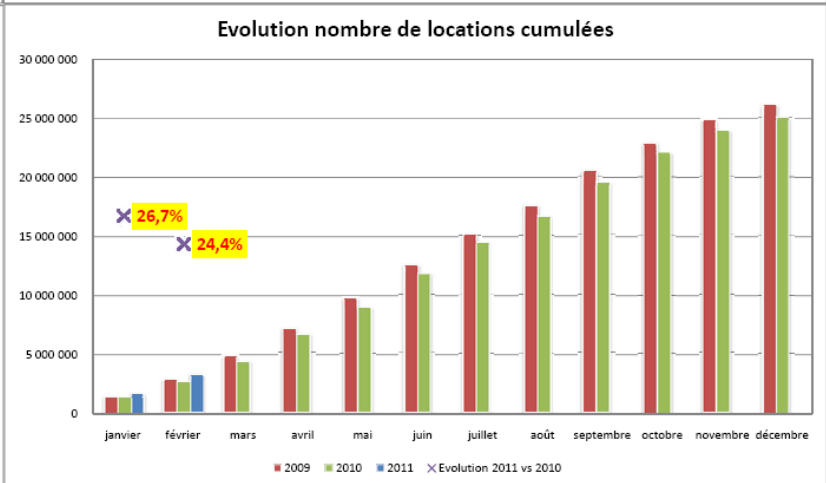
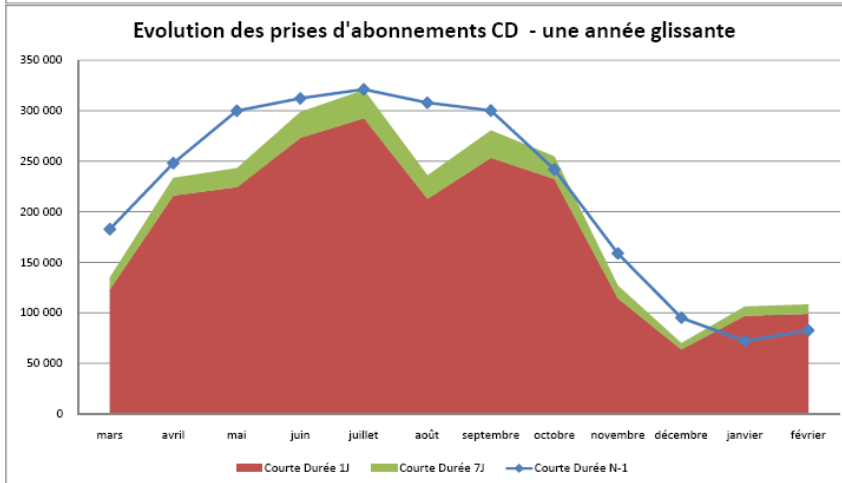
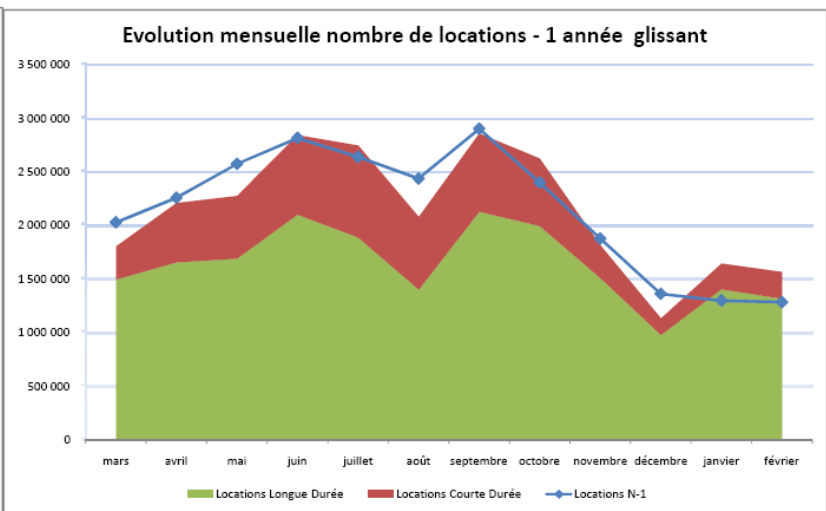
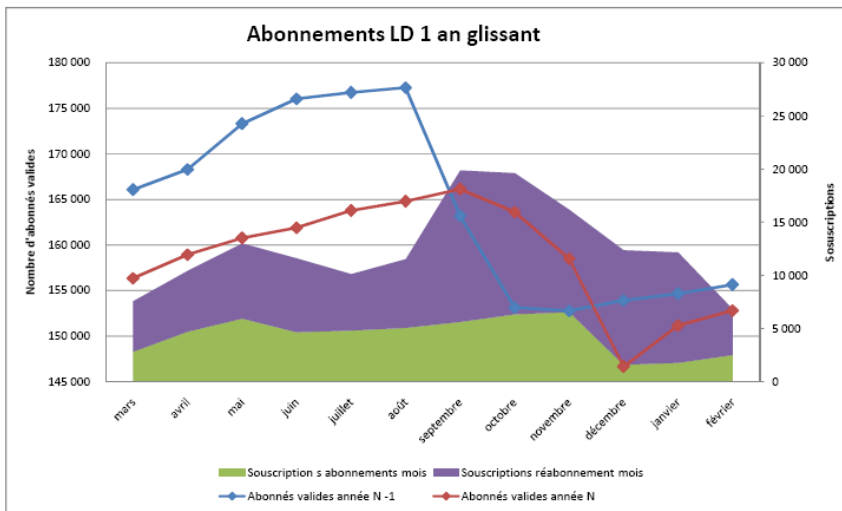
- The List of KPI is initially validated
- Initial examination of the usefulness of the Traffic Efficiency KPI has shown realistic results
- KPI can promote cities' interest
 - selecting the most appropriate ITS application
 - avoiding less suited ITS solutions

Next steps

- Thorough usefulness demonstrations
 - Rome – Pollution Reduction
 - Barcelona – Safety
 - Paris – Mobility Efficiency

KPi ex: VELIB' Paris

- Working criteria : 1) Empty stations— 2) Full stations— 3) Disconnected stations -4) Bike safety 5) cleanness of bike and stations -6) Maintenance effectiveness
- Users criteria: 7) Call centre (Time response rate) - 8) Complaints (time to answer, amount of letters, internet forms)
- Penalty and profit rates based on critical threshold
- Number stations, bike lock and bikes available
- Number of subscriptions (by kind, by periods)
- Rent: Number of rent in and outside suburbs
- Average time of use by categories (0-30min, 31-60min, etc...)



Discussion

- Is it feasible to facilitate a voluntary benchmarking KPI database?
 - Identify the limits of ITS
 - Promote cities' interests
- Why KPI in Economics are exposed and how can we achieve that?
 - Types of incentives
 - Mobility Information is “available” (TomTom, Google...)

Thank you!

For further enquiries:

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- CONDUITS website: www.conduits.eu