Urban Informatics for Sustainable Cities

Challenges and Opportunities in HCI, Visual Analytics and Knowledge Management for the development of Sustainable Cities.

EGC'15
Thomas Baudel, IBM France Lab & Efficacity Institute
31/01/2015

Agenda

Energy Efficiency & Sustainability: where we're at.

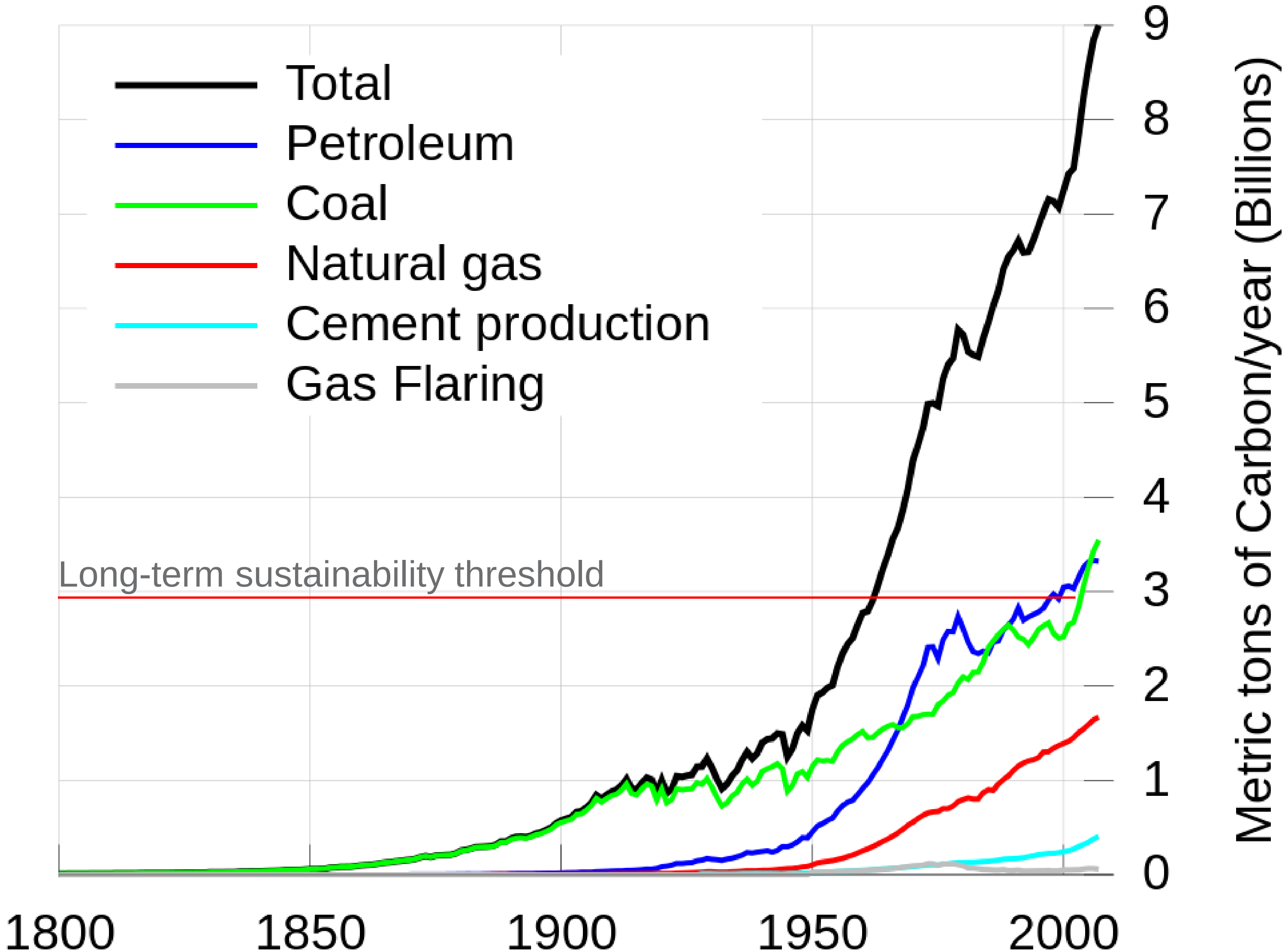
Urban Informatics & the Efficacity Institute : what it's about

– Computer-aided Urban Planning

– Urban Knowledge Discovery & Analytics

– Social-Urban Computing (or Social-System mediated interaction)

Smart Deliveries: a use case in Urban Informatics



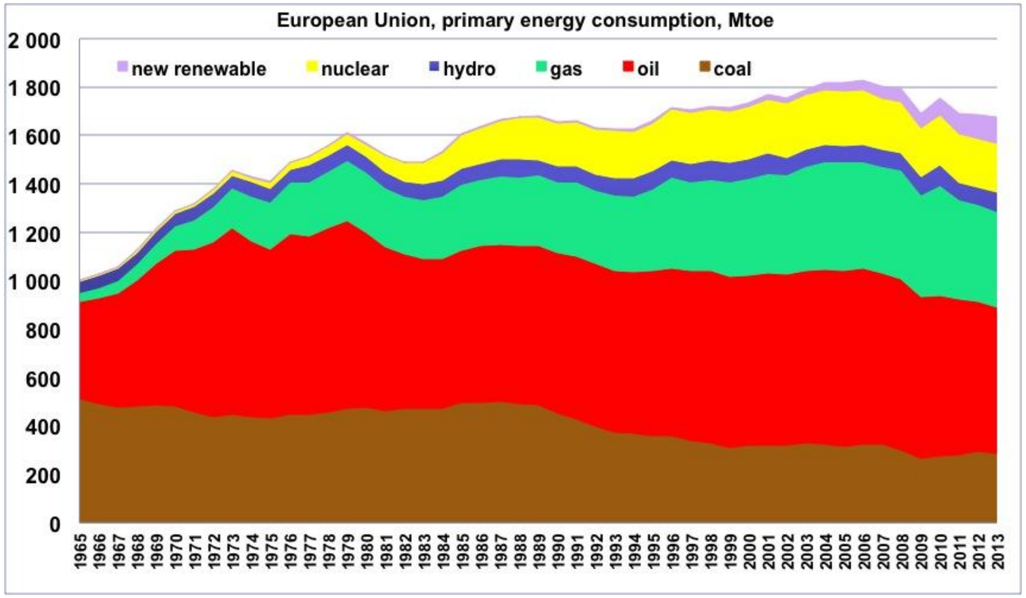
WW anthropic greenhouse gas emissions

Energy Consumption

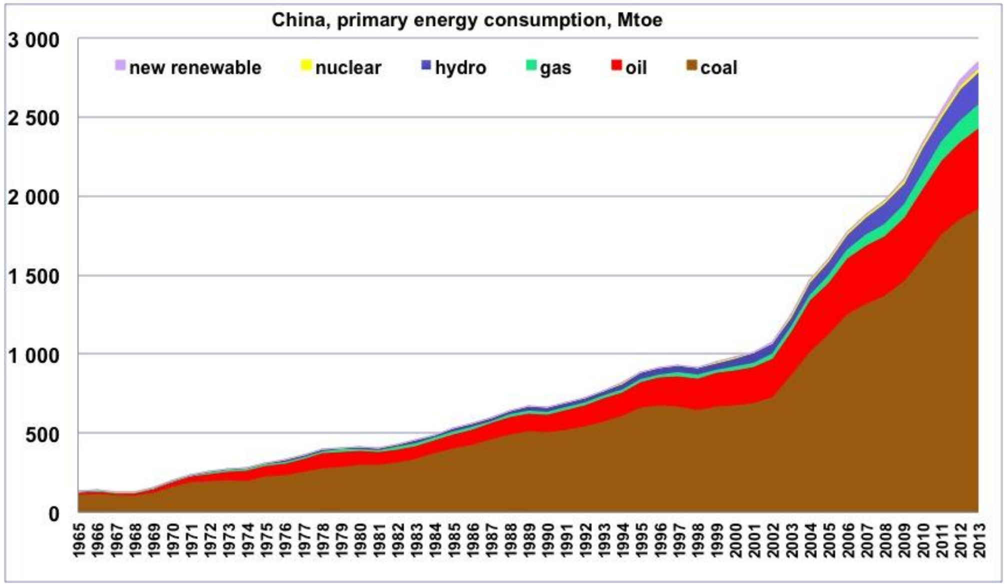
Energy use is, in itself, a good thing.

Tied to economic growth (productivity)

Tied to population growth



Life is Energy Use.



… Life may not be eternal

At the political level…

Kyoto, Rio, global climate summits… small commitments from most of the world. Europe sets the example with goals that appear *almost* reachable.

2020: 20-20-20 energy targets

- 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- 20% improvement in the EU's energy efficiency.

2050: Facteur 4:

Reduce emissions to 3/4th of 1990 levels (+ similar goals)

Lever: energy efficiency can/should also become a growth factor and a competitive advantage for the EU.

In France

ADEME, since the 70’s, + many other agencies.

Agence Nationale de la Rénovation Urbaine (ANRU)

16 B Euros in aids to renovate urban habitats.

Investissements d’avenir (35 B Euros): various types of investments ventures to join private and public expertise on priority axis: environment, information technologies, education…

-> But where to direct the investments?

Where to act (in France)

In the cities

70% of the population

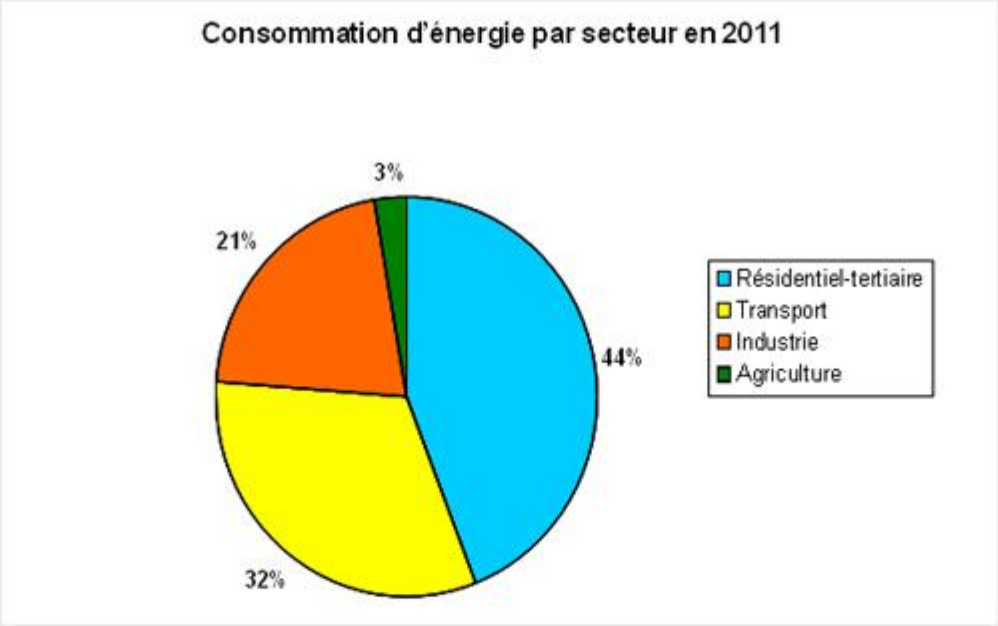
50% of greenhouse gas emissions

2/3rd of Energy consumption

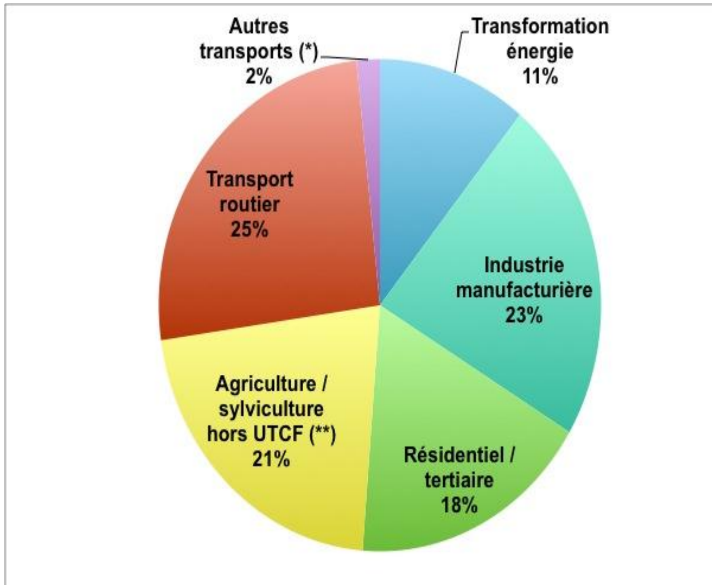
-> cities are still relatively efficient compared to country-side

On housing, transportation and their interaction

Housing and mobility costs structure are not favorable (contrary to industry)



Greenhouse gas emissions per sector



EFFICACITY: Institute for the Energy Transition of the City

A novel approach

Systemic approach: take into account the urban systems globally, acknowledging their complexity (infrastructure, buildings, networks…).

Address both technologies and usage: include the citizen in the process to induce awareness and appropriation of the changes

Business-oriented approach: the scientific, political and business objectives must be aligned for results to reach outside of the Labs.

A novel methodology

Beyond public-private collaborative research

… a new national research institute

Gathers the main public and private actors of the city fabric.

Critical mass of 100 researchers (40 full time positions) now, 250 (100 full time) in the mid-term.

To carry research projects *and* consulting missions with city project owners on innovative projects, experiments or demonstrations.

-> « action-based » research

Urban Energy Transition and Information Technologies

Many challenges of city energy transition can be addressed by Information Technologies.

This opens a new research area: « Urban Informatics ».

Thesis: this research area can be structured around 3 main focus area:

increasing impact

– Urban Knowledge Discovery & Analytics

– Computer-aided Urban Planning

– Social-Urban Computing (or Social-System mediated interaction)

Urban-scale Knowledge Discovery and Analytics

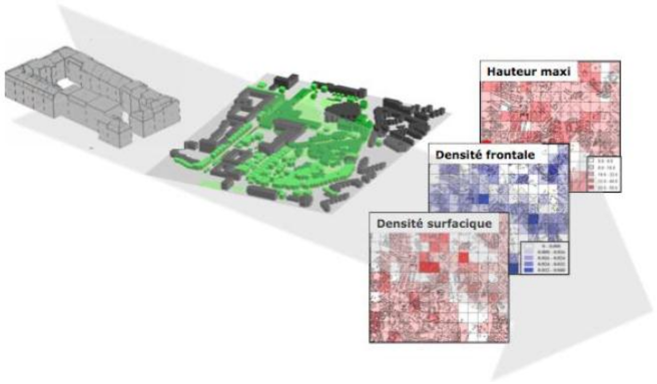
Data acquisition on the city is a huge challenge with plenty of ongoing work and future prospects. Data is available and, in part, free!

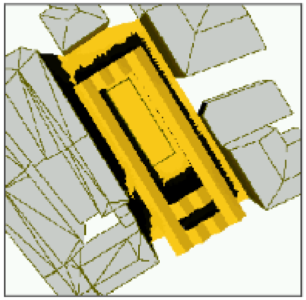
Transportation : every day, 200000 vehicles enter a 1M inhabitants city.

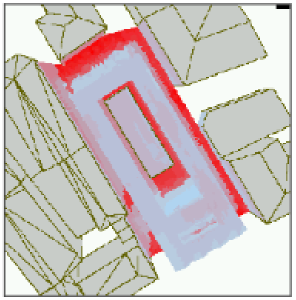
- Where are they going, What are they doing?

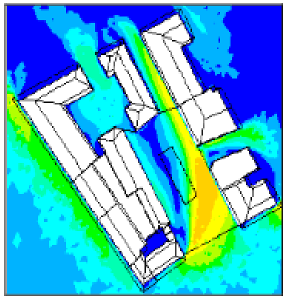
Building: assessing energy efficiency of whole neighborhoods non-intrusively

- Data acquisition, reconstruction, numerical model assessment, simulation









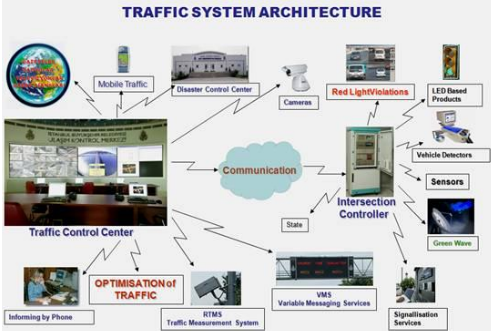
An integrated Urban Fabric

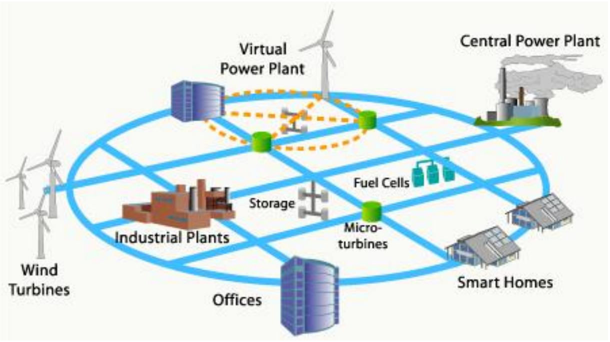
Sector by Sector, Information Technologies are transforming industries

- **Building** (Superstructure): « Building Information Modeling » (BIM) : a unique digital chain from the project owner to the operator, via the designers and builders.

- **Transportation** (Infrastructure) : « Intelligent Transportation Systems (ITS)» introduce agility and foresight in mobility management

- **Energy** (flows): « smart grids », micro-generation, co-generation…





An integrated Urban Fabric (2)

Computer-aided Urban Planning requires:

1.- Full-scale City Information Modeling

2 - Tackling the complexity of decision process, crossing sectorial boundaries

Social-Urban computer mediated interaction

Interactive information technologies enable radical behavior changes towards a sustainable way of life, with a gain in convenience.

Buildings : smart metering, positive energy buildings: make sure they're usable!

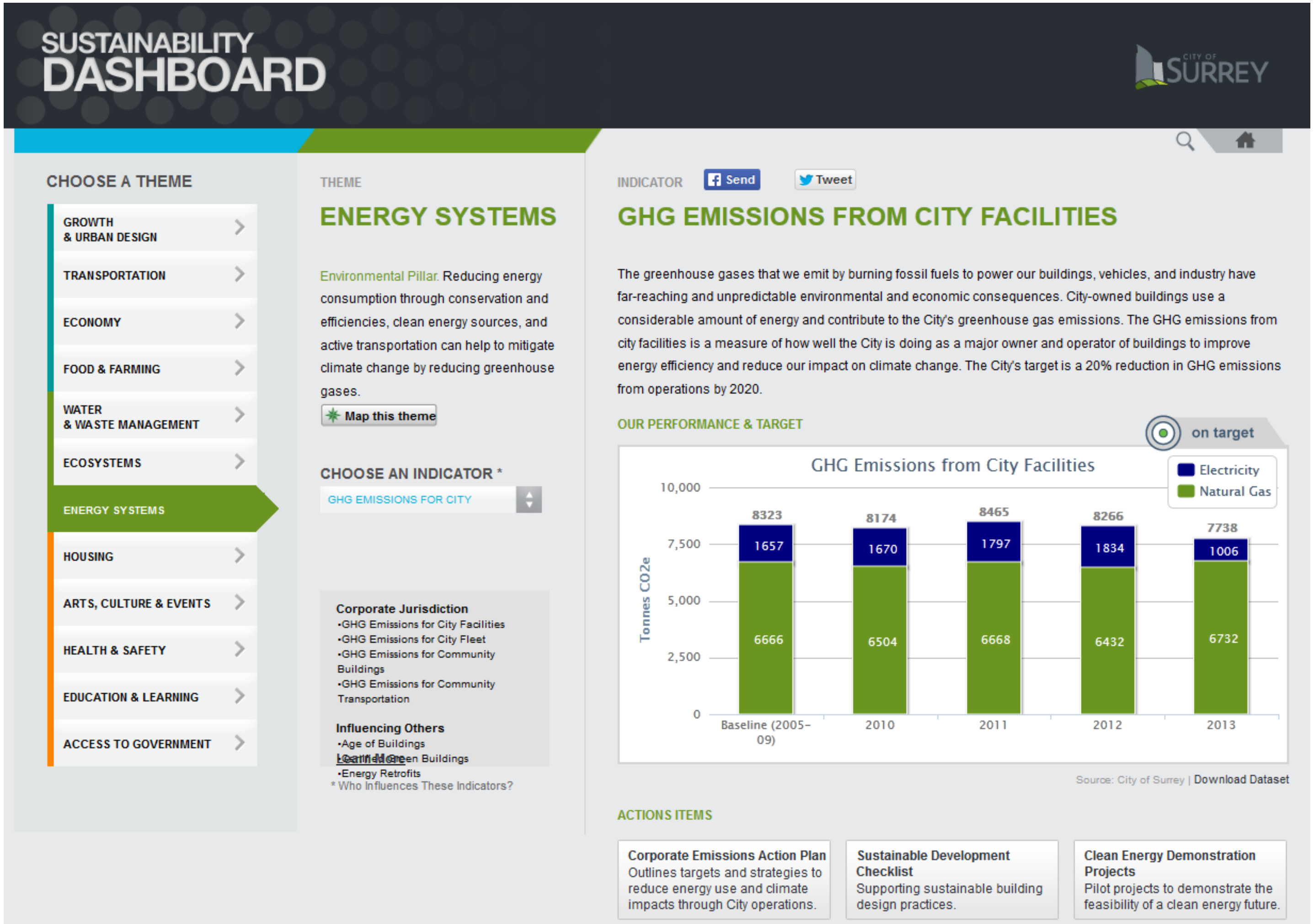
Covoiturage.fr

Transportation : carpooling, car sharing, travel information (AutoLib, Velib, BlaBlaCar, OptimodLyon, Waze…) … or even better: telepresence

Velib'
MAIRIE DE PARIS

Social-Urban computer mediated interaction (2)

“Computer-supporter Governance”: sharing goals and data to help prioritize actions, inform, involve and engage citizen.



OPTIMOD'LYON

INVESTISSEMENTS D'AVENIR

ADEME Agence de l'Environnement et de la Maîtrise de l'Energie

GRANDLYON communauté urbaine

Develop high-value services, with self-sustaining business models

3 axes of development

Novel real time data gathering systems (traffic and parking)

Mobility portal

Centralized data warehouse

Optimizing traffic regulation Through 1h prediction

Real-time, multimodal, accessible travel planner

Optimizing freight and professional moves

Urban professional mobility

Cities’ goals: fighting saturation, pollution, costs… without sacrificing economic activity

- Freight represents 35% of urban mobility
- Even more (60%) is *professional* mobility
    - Goods deliveries, but also field visits, maintenance works, construction…

Transportation weights in the balance of businesses

- Fuel = 18% of the total costs of a regional transporter with 200 employees
- 20 minutes lost in traffic = 1 delivery = 8 euros = raw margin of the transporter

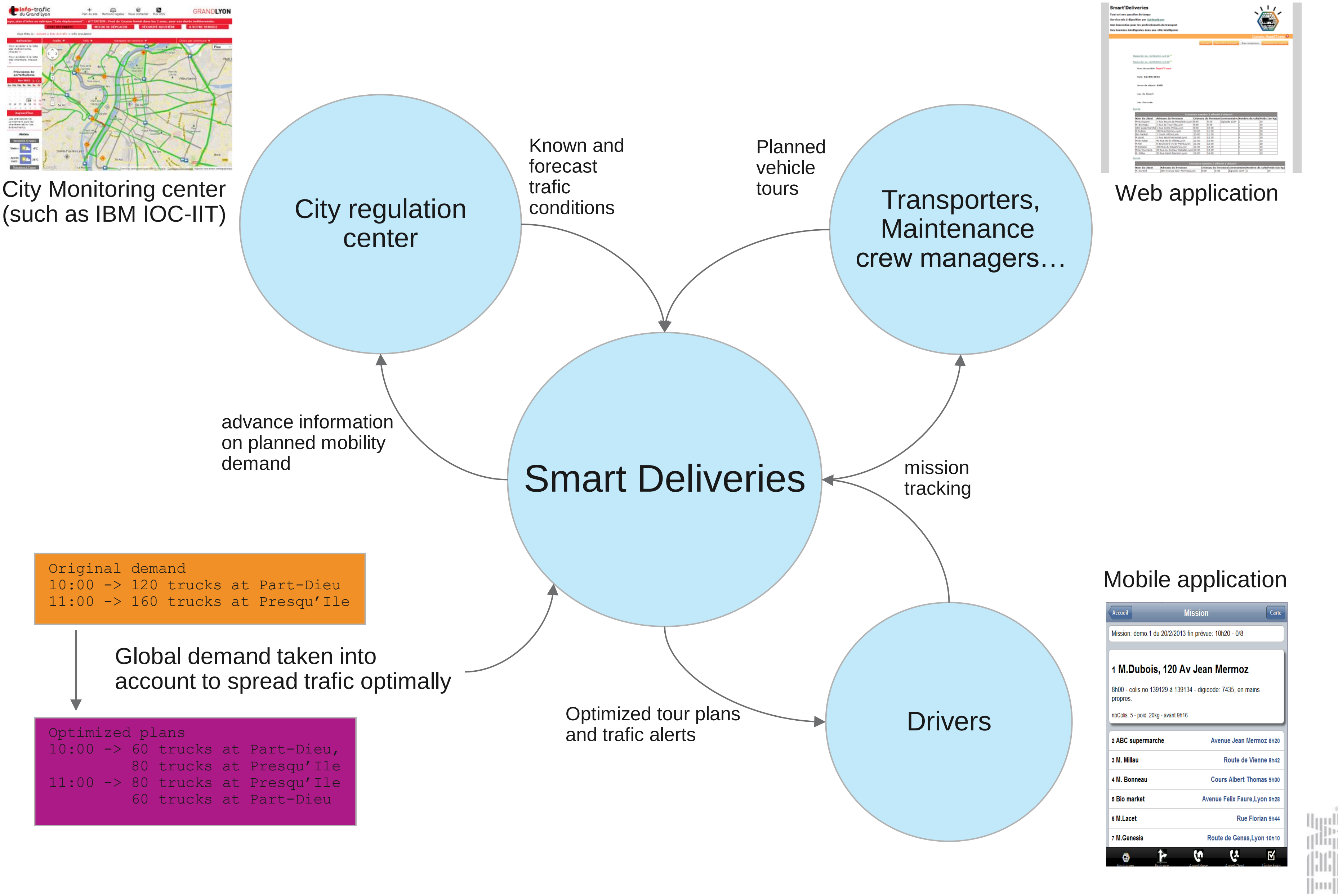
Professional mobility is most often planned

- The mobility intent is known in advance, stored within reach of an internet connection

Optimizing mobility is as much a stake for businesses as it is for cities

Smart Deliveries is about creating a synergy to satisfy both needs.

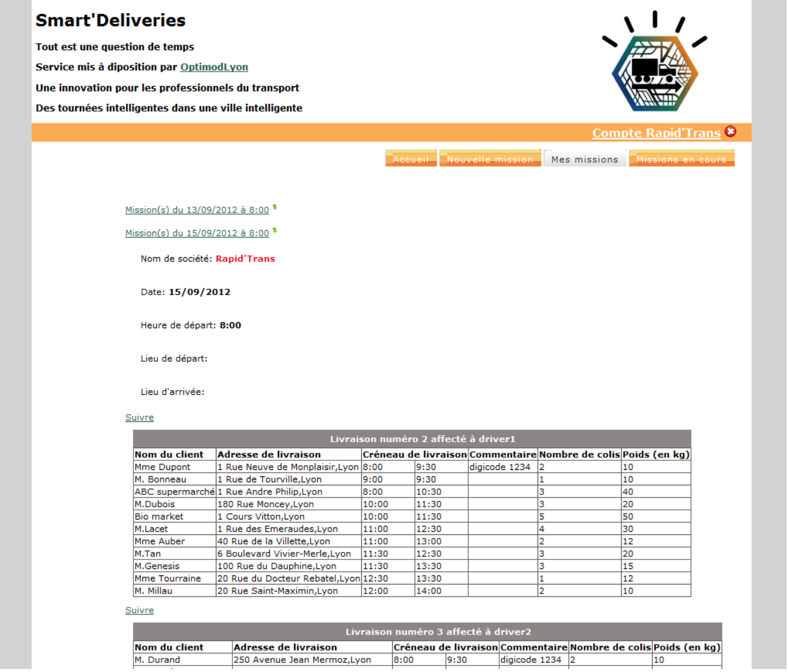
IBM Smart Deliveries for Optimod'Lyon



Smart Deliveries' Vision

Paul manages a fleet of 20 delivery vehicles.

Every morning, he uploads the planned delivery tours for the day, generated by his company's IT system, onto the Smart Deliveries web site, a service provided by the city.



Smart'Deliveries

Tout est une question de temps

Service mis à diposition par OptimodLyon

Une innovation pour les professionnels du transport

Des tournées intelligentes dans une ville intelligente

Compte Rapid'Trans

Accueil | Nouvelle mission | Mes missions | Missions en cours

Mission(s) du 13/09/2012 à 8:00

Mission(s) du 15/09/2012 à 8:00

Nom de société: **Rapid'Trans**

Date: **15/09/2012**

Heure de départ: **8:00**

Lieu de départ:

Lieu d'arrivée:

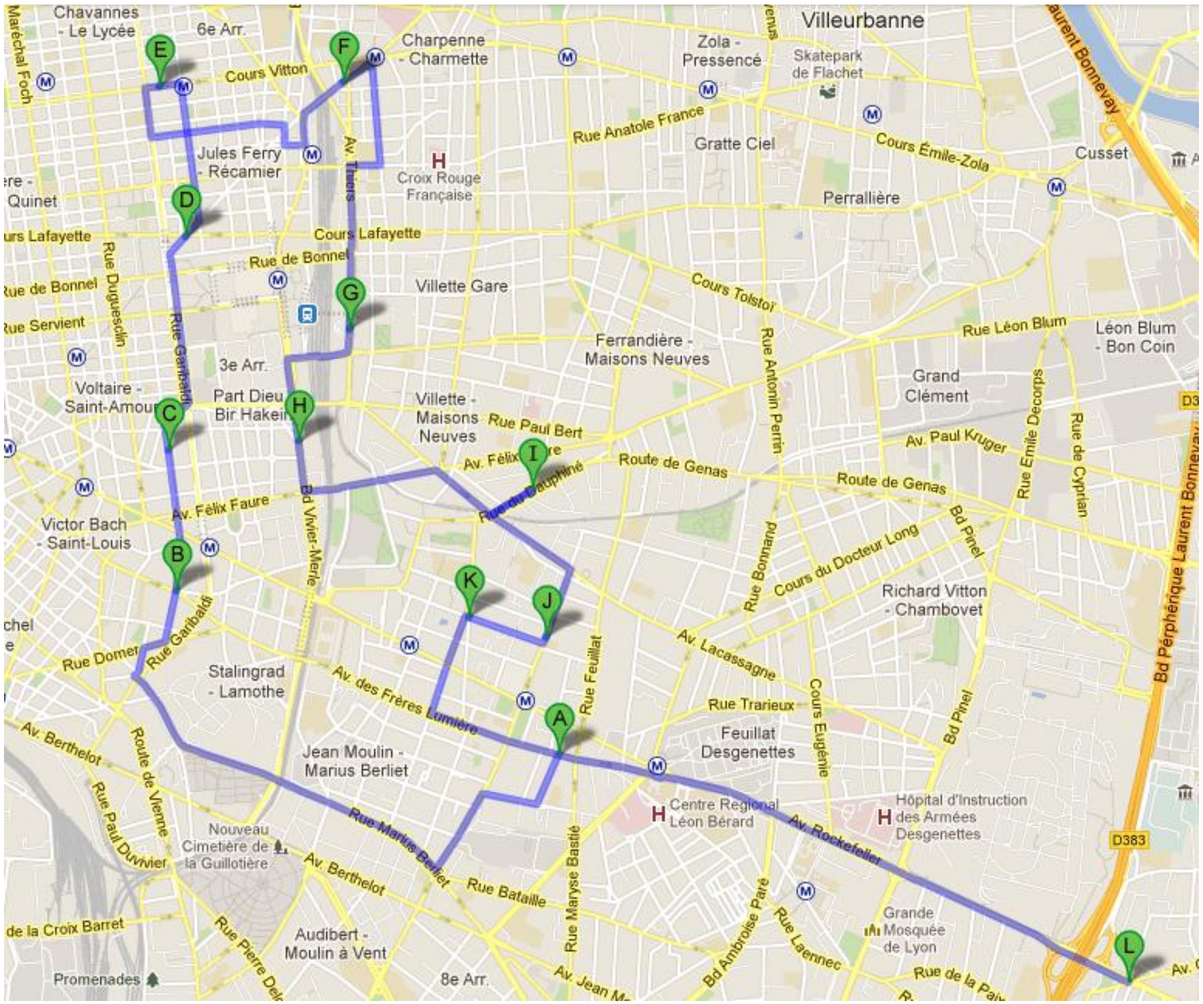
Suivre

Livraison numéro 2 affecté à driver1						
Nom du client	**Adresse de livraison**	**Créneau de livraison**		**Commentaire**	**Nombre de colis**	**Poids (en kg)**
Mme Dupont	1 Rue Neuve de Monplaisir,Lyon	8:00	9:30	digicode 1234	2	10
M. Bonneau	1 Rue de Tourville,Lyon	9:00	9:30		1	10
ABC supermarché	1 Rue Andre Philip,Lyon	8:00	10:30		3	40
M.Dubois	180 Rue Moncey,Lyon	10:00	11:30		3	20
Bio market	1 Cours Vitton,Lyon	10:00	11:30		5	50
M.Lacet	1 Rue des Emeraudes,Lyon	11:00	12:30		4	30
Mme Auber	40 Rue de la Villette,Lyon	11:00	13:00		2	12
M.Tan	6 Boulevard Vivier-Merle,Lyon	11:30	12:30		3	20
M.Genesis	100 Rue du Dauphine,Lyon	11:30	13:30		3	15
Mme Tourraine	20 Rue du Docteur Rebatel,Lyon	12:30	13:30		1	12
M. Millau	20 Rue Saint-Maximin,Lyon	12:00	14:00		2	10

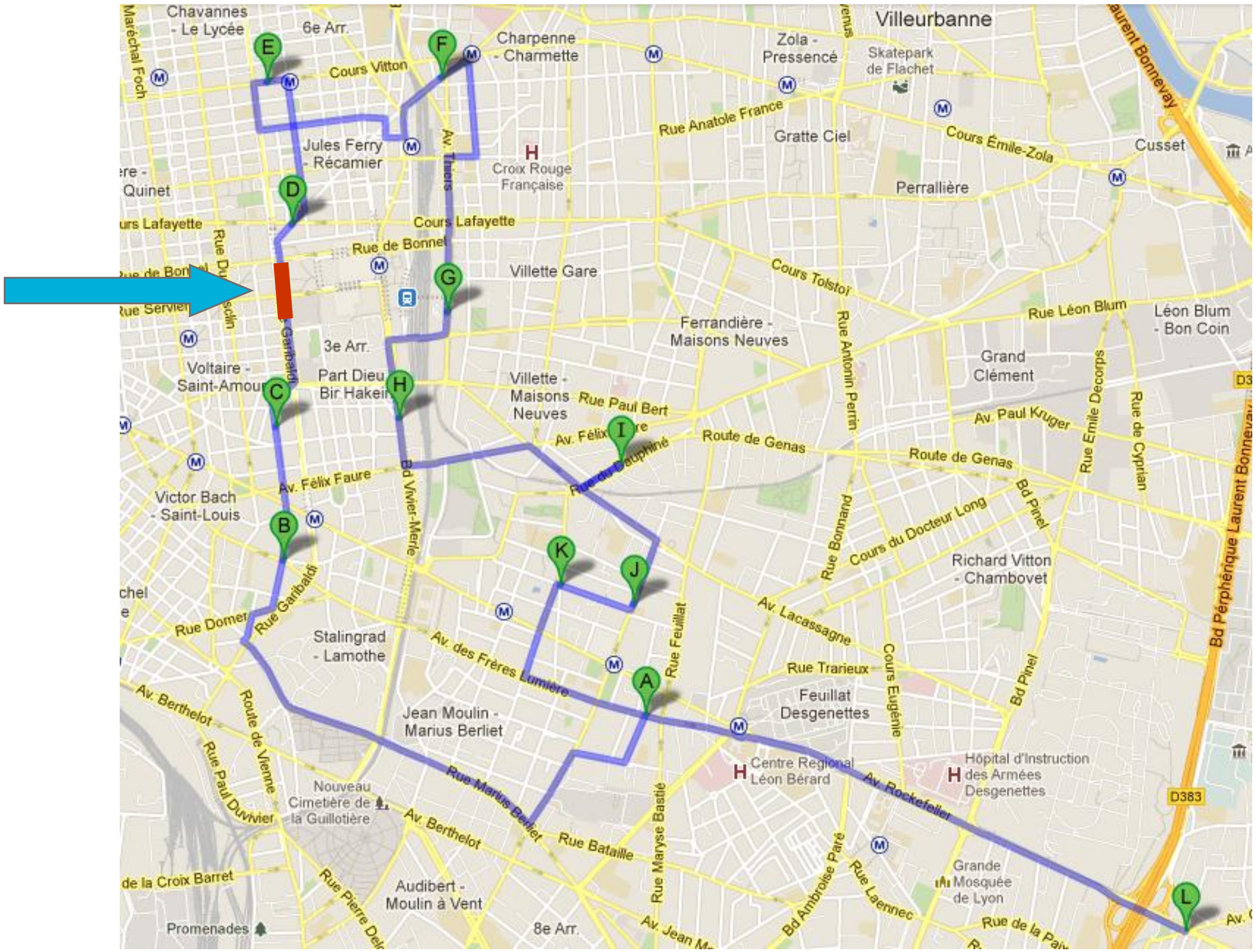
Suivre

Livraison numéro 3 affecté à driver2						
Nom du client	**Adresse de livraison**	**Créneau de livraison**		**Commentaire**	**Nombre de colis**	**Poids (en kg)**
M. Durand	250 Avenue Jean Mermoz,Lyon	8:00	9:30	digicode 1234	2	10

This is a typical, tour done by Albert, one of Paul’s drivers.
12 stops, 10 minutes at each stop, 15,4 km, 3 hours total.

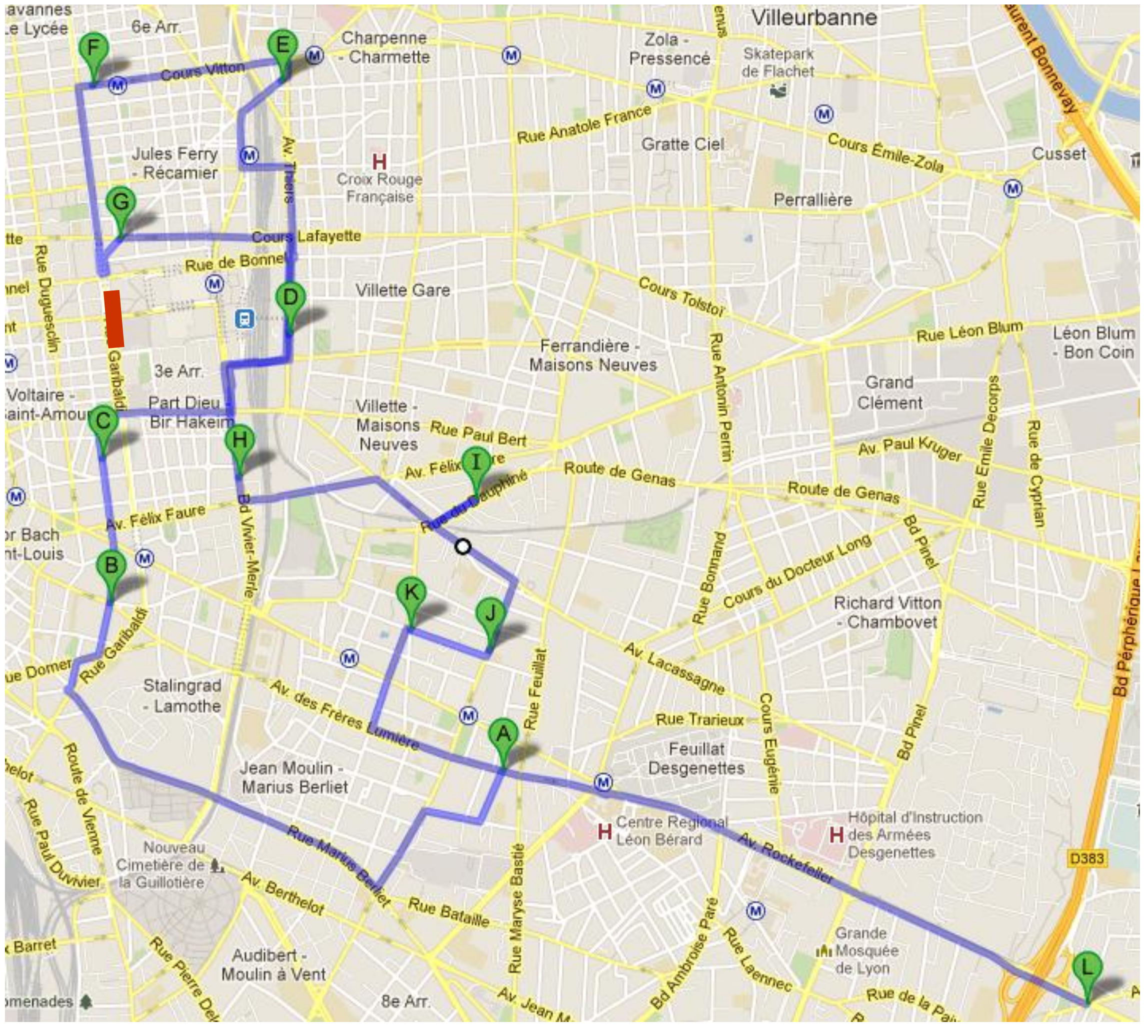


Yet today, some public works will reduce rue Garibaldi to one lane at busy times. The city, which delivers public works authorizations, publishes it and we leverage it.



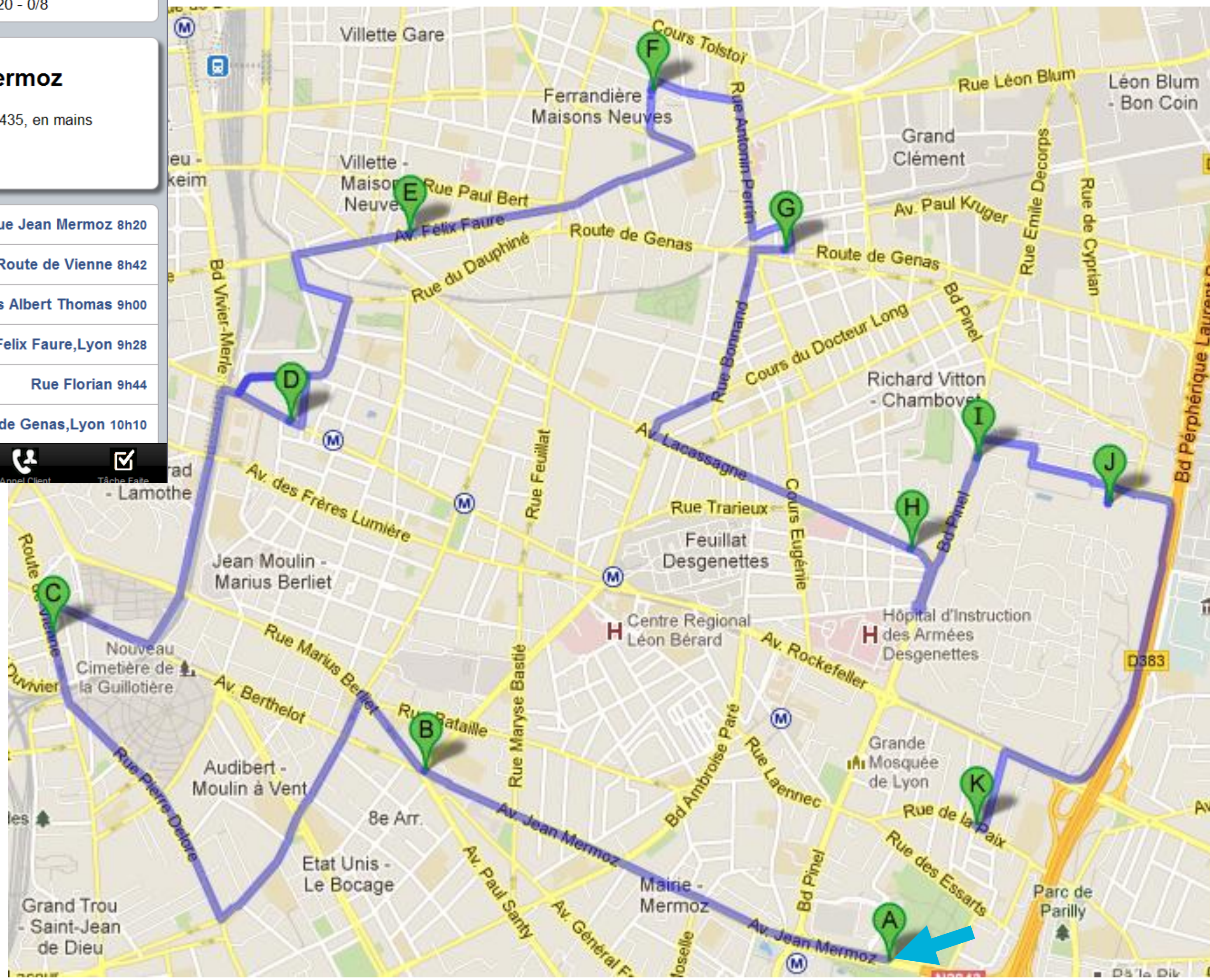
Rather than finding out too late and suffer 20 minutes of slow-down, Albert follows our recommendation to change the tour, and loads his truck in accordance. The tour will be 800m longer, but take the same time. Savings generated: ~20 minutes, or 8 €

.

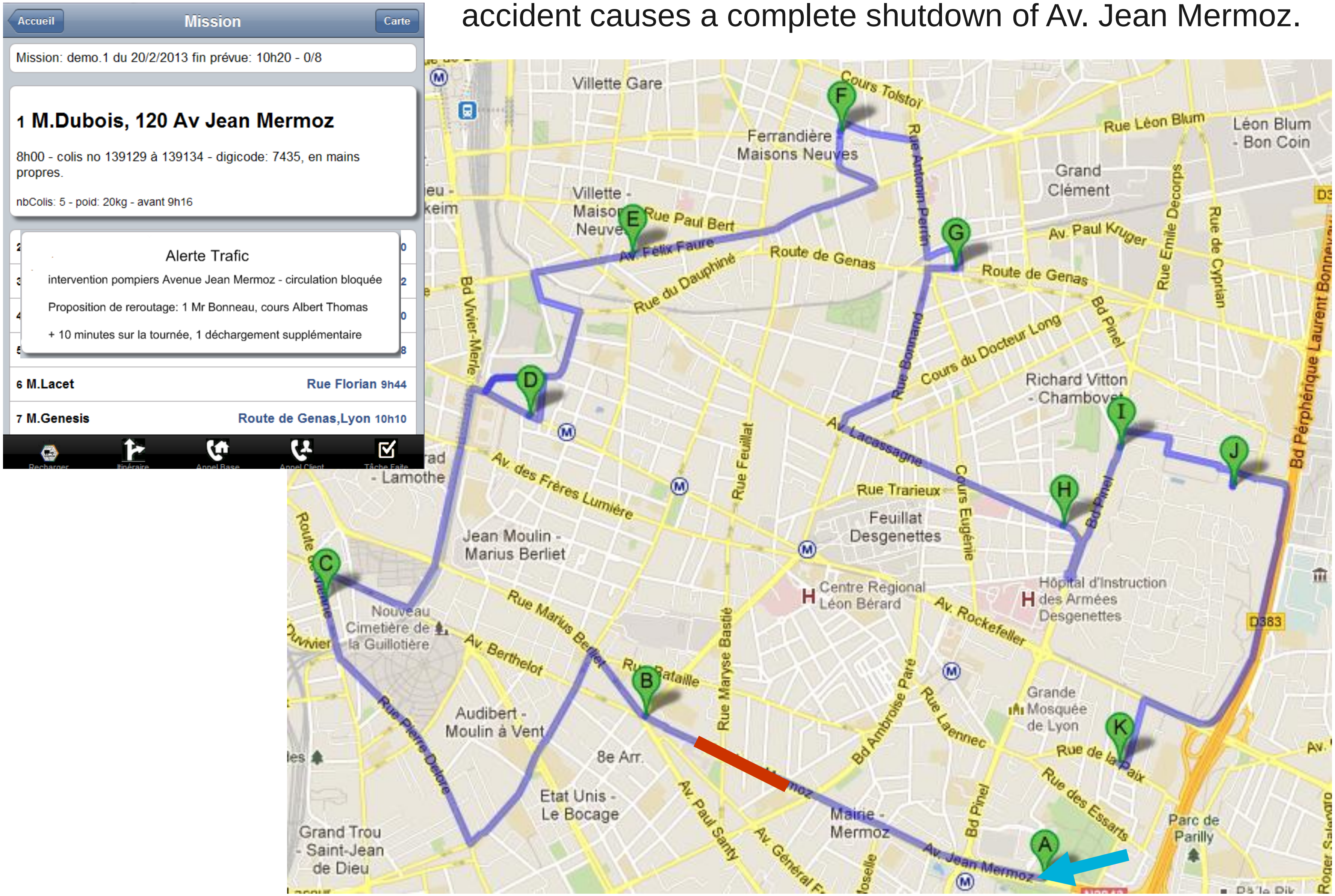


For the city, this is one less truck going through this overloaded road segment. Our service may be able to reach out to 35% of total day traffic

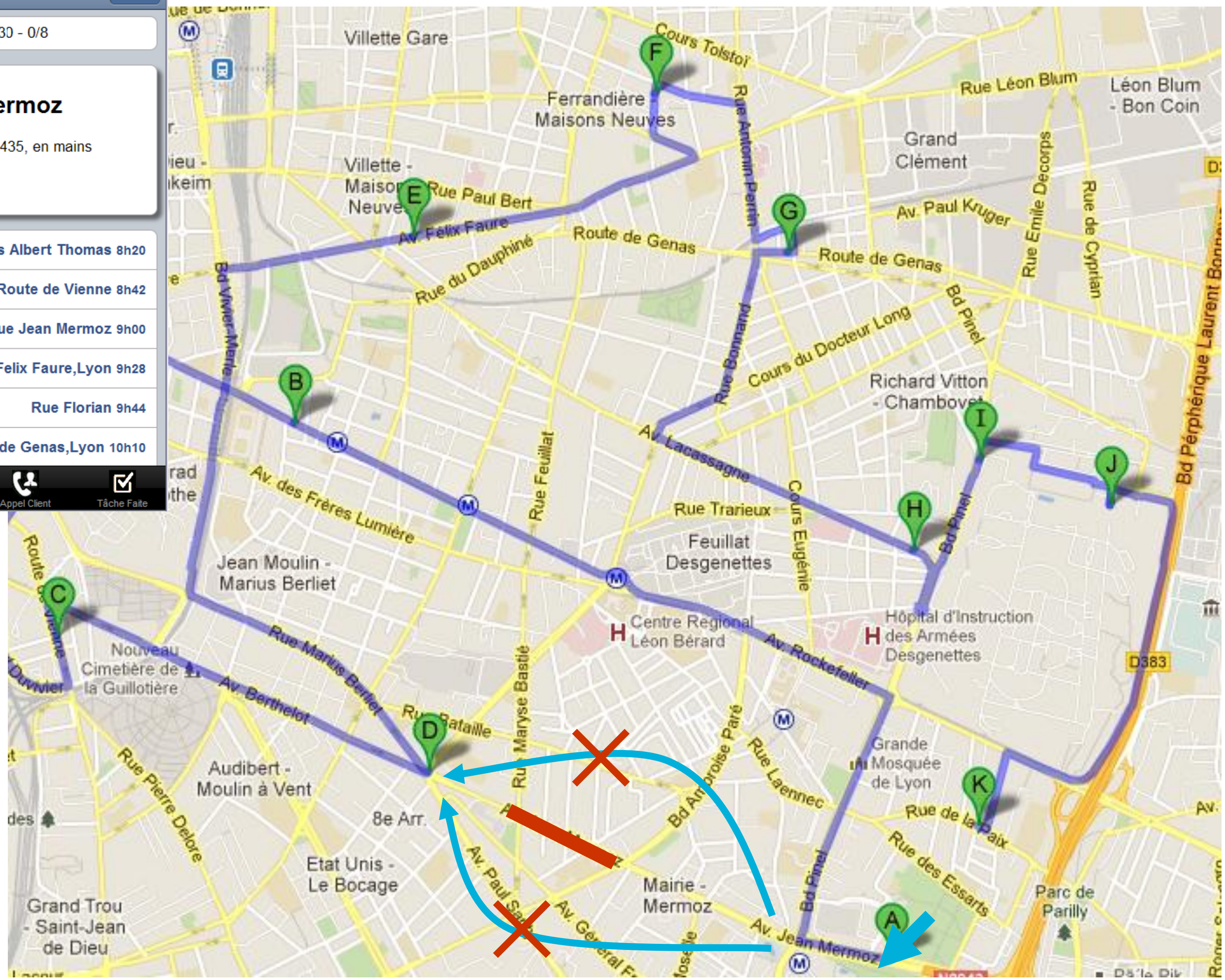
Example 2: another tour for Albert. He is at (A), has 10 stops, 17km, 2:40 hours to go.



The traffic regulation center sends an alert to his mobile: an accident causes a complete shutdown of Av. Jean Mermoz.



Rather than proposing a detour (unworkable, + 30 minutes), an alternate route is proposed, involving some shuffling of the truck's payload (+ 10 minutes) and changing the order of the stops.



Once again, the city is winning too, as less trucks are engaged on the blocked road and its surroundings.

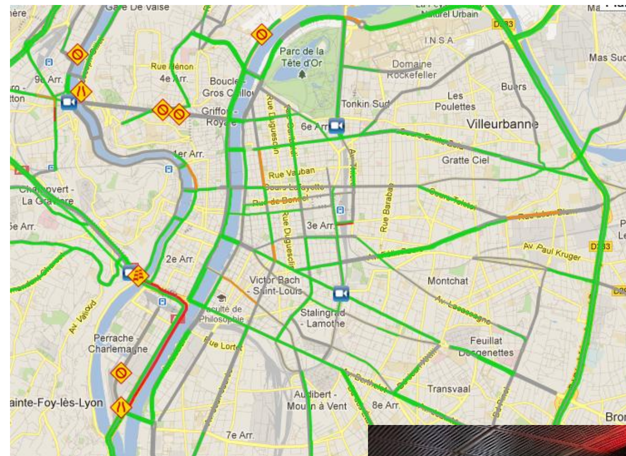
8 € does not seem much, but it's the company margin for this tour that has been saved.

Smart Deliveries for the city

A new traffic information source: planned moves. 35 to 60% of daytime traffic: Allows traffic regulators to see and plan ahead

A new regulation tool: orient the flow of professional vehicles. If we notice that all deliveries are planned at the same place at a certain time (creating parking issues), we can spread the traffic.

Potential revenue source to amortize urban instrumentation: optimize a professional service. 1 minute in traffic saved = 0.40 **€**



The Challenges

Technical challenges

- Can we understand the mobility intent?
- Can we model travel time with enough accuracy to optimize it?
- Can we optimize a tour in a urban context? (Time Dependent Robust Traveling Salesman problem. Answer is yes, pending PhD thesis results)

Business challenges

- Is the ecosystem ready for such a solution?
- Can the present solution be inserted in current workflows at a reasonable cost?
- Privacy and security challenges.

Challenge 1 : Can we understand the mobility intent?

Turns out to be the main challenge

- 40% of addresses provided are denormalized;
- 16% are wrongly located (Google: 20%)
- 8% can only be resolved by a search at or near the estimated location,
- 1-2% are undeliverable

Example of addresses provided: “06 34 02 49 04”, “construction site in front of the Bakery, Street XXX”. Other times, delivery location is *not* the postal address.

This problem is well-known by transporters. For the major transporters, all addresses are progressively geocoded, which may lower the number of unknown addresses to 1-4%.

Challenge 2: Travel Time estimation

Transporters are ready for in-vivo experimentation only if we can provide travel time estimates within 20% of actual time, for 80% of the tours.

Comparable to the rate of experienced drivers.

First result using estimators provided by the LET research Lab and the City where within acceptable range only for 40% of the tours.

Final results for travel-time estimation

Model	Error on routes	Error on rounds
Static	46%	18%
Regression	50%	25%
Origin-destination	**42%**	**13%**

83% of the tours have an error below 20%: goal reached

Challenge 2 - lessons learned

After distance, the most important factor to predict travel time is not the traffic, but some endogenous factors:

- Vehicle type
- Driver experience
- Driver motivation (in a hurry or not)
- Local circumstances not captured by the simulation model…

Simulation-based travel time estimators cannot provide good estimates by aggregation of local travel times.

- Standard deviation on 8 minute trips is likely to stay around 40%
- Simulation-based models introduce systematic biases that prevent error distribution from following a normal law: the law of large numbers does not apply anymore to reduce the aggregated error on full rounds estimation.

Technical Results

Challenge 3: Can we optimize a tour in a urban context? (Time Dependent Robust Traveling Salesman problem). Answer is yes, pending PhD thesis results

The results on optimization are however very encouraging: we show the possibility of winning **18%** in distance and **12%** in time.

If this system can be generalized at the scale of the city (35% of traffic, 75% being in rounds), this opens the potential of

- **Reducing total urban traffic by 5%**
- **Reducing Greenhouse gas emissions from traffic by ~10%** (3600 TeCO2/year)

This is what Urban Informatics can provide to reach toward sustainable cities.

After Boris Vian:

We are not so much interested in designing the city that fits *all* as we are in designing what suits *each* individual.

Efficacity Consortium

6 major industry partners

7 engineering partners

15 academic partners

Business challenges

Is the ecosystem ready for such a solution?

Along the past 2 years, all transporters have moved towards adopting mobile solutions, and invested significantly. Currently, the adopted solutions provide tracking functionalities, but no tour optimization nor management of traffic alerts.
-> timing appears about right for a proposition

Can the current solution be seamlessly integrated in existing workflows?

60% of deliveries performed by small companies, those have little capacity to invest in IT: the SaaS solution we propose appears suited.
Large companies already have a full IT chain in place. We propose a recommender system, functioning as a simple, facultative, helper service.

Security and privacy concerns

Issue #1: large companies do not (yet) want to trust a public service such as SmartDeliveries with their clients database (which is indirectly available via the addresses). Our solution May require separate hosting of part of the solution for large customers.