User-centric flexible transportation systems
User-centric flexible transportation systems

1) Concepts
   • Demand
   • Supply

2) Challenges
   • Technologies
   • Integration
   • Optimization
   • Business model

3) Research @ EPFL
Supply and demand
Supply

Before

Now

M. Bierlaire
Demand

Before

Now
# Supply and demand

## Multimodality

<table>
<thead>
<tr>
<th>Station/Stop</th>
<th>Time</th>
<th>Platform</th>
<th>Travel with</th>
<th>Occupancy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1360 Orbe, Chemin des Coteaux 61</td>
<td>dep 08:18</td>
<td>BUS 685</td>
<td>BUS 685 91100</td>
<td>Direction: Orbe, gare</td>
<td></td>
</tr>
<tr>
<td>Orbe, hôpital</td>
<td>arr 08:21</td>
<td>walk</td>
<td>11 min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orbe, gare</td>
<td></td>
<td>walk</td>
<td>1 min., Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orbe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orbe, Chavornay</td>
<td>dep 08:26</td>
<td>Pl</td>
<td>R</td>
<td>Regio 26629</td>
<td>Direction: Chavornay I1</td>
</tr>
<tr>
<td>Chavornay</td>
<td>arr 08:35</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Renens VD</td>
<td>dep 08:38</td>
<td>3</td>
<td></td>
<td>Urban train 1 12123</td>
<td>Direction: Lausanne</td>
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<tr>
<td>Renens VD</td>
<td>arr 08:57</td>
<td>4</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Renens VD, gare</td>
<td></td>
<td>walk</td>
<td></td>
<td>3 min., Y</td>
<td></td>
</tr>
<tr>
<td>Ecublens VD, EPFL</td>
<td>dep 09:02</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Duration: 1:01; runs 31. May until 1. Jul 2016 Mo - Fr</td>
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</tbody>
</table>

## Last mile

![Image of a bicycle and people]
Supply and demand

Demand

User-centric

Supply

Flexible
User-centric flexible transportation systems

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Challenges: technology

Load freight...

... or passengers at the train station...

... and take-off!

- Innovative aircraft with detachable load units to adjust capacity to demand
- Capsules: clipped on the flying wing, or carried on trains or trucks

→ Partners@EPFL: TRANSP-OR lab, ICOM Lab, mechanical engineering labs and LIV Lab
Challenges: technology

- Advanced “Detection & Tracking” and collision-avoidance algorithms for unmanned aircrafts.
- New methodologies to inspect infrastructure

→ Partners: CVLAB Lab, DISAL Lab, REACT Lab

Switch inspection

Catenary inspection

Construction sites

Drones
Challenges: integration

Enable freight operations using ...

... flexible modular logistics units

- Iso-modular logistics units of size adequate for real modal and co-modal flows of fast-moving consumer goods.
- Design robust collaborative scheduling and routing schemes for interconnected logistics.

→ Partners: PTV, Procter&Gamble, ARMINES, CIRRELT, TU Berlin, Italian Posta and EPFL (TRANSP-OR Lab)
Challenges: optimization

- “Big data”
- Choice modeling
- Customized services

►►► Learn preferences and tastes... ... for user-centric optimization
Défis : optimisation

Objectives:

- Develop a **decision-aid tool** for the **dimensioning** and the **design** of a bus system operated with a fleet of “catenary-free” electric buses.

- Optimize the **operational costs** and the **electricity consumption** of the system.

- Conduct a **pilot study** on the bus line 5 between Geneva Airport and Geneva’s Hospital.

> PI & Lab  Prof. M. Bierlaire, TRANSP-OR

Partners:  

| ABB | stpg |

Collaboration HE-ARC
Challenges: optimization

- Timetabling design
- Minimize the costs
- Maximize user satisfaction
- Trade-off between the two

\[
\max \sum_{\ell \in L} \sum_{v \in V} \sum_{s \in S} \omega_{vs} \cdot e_s - \sum_{\ell \in L} \sum_{v \in V} (\alpha_v \cdot f \cdot k^\ell + \mu_v \cdot o \cdot k^\ell)
\]

►►► Calculate the best timetable...
...account for supply and demand
Challenges: business model

Who pays?

Who receives the money?

Reconcile cooperation and competition

How to use the revenues?

►► Generate, deliver and capture value
Challenges: business model

- Mobility pricing
- Tool for demand management
- Heterogeneity of needs
- Different willingness to pay

►► Mobility Pricing

Singapore

London

Stockholm
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Transportation Center @ EPFL
TRACE

Our three main divisions

- Mobility behavior & transportation needs
- Conception of transportation systems
- Vehicles & infrastructures
A demand-orientated axis

To understand mobility needs and individuals' mobility behaviors.

- Demand modeling & prediction
- Pedestrian flow modeling
- Mobility behaviors
To optimize transport systems and to coordinate policies for transportation, land use, housing, etc.

A system-orientated axis

✅ Modeling of transport systems

✅ Intelligent Transport Systems

✅ Operation Research for optimization
To improve safety, efficiency, sustainability of vehicles and infrastructures.

- Sensing & Intelligent vehicles
- Smart Grids concept solutions
- Energy efficiency / Energy recovery systems
CONCLUSION

User-centric
New technologies – “big data”

Flexible
Standardization – optimization

Research is more and more important