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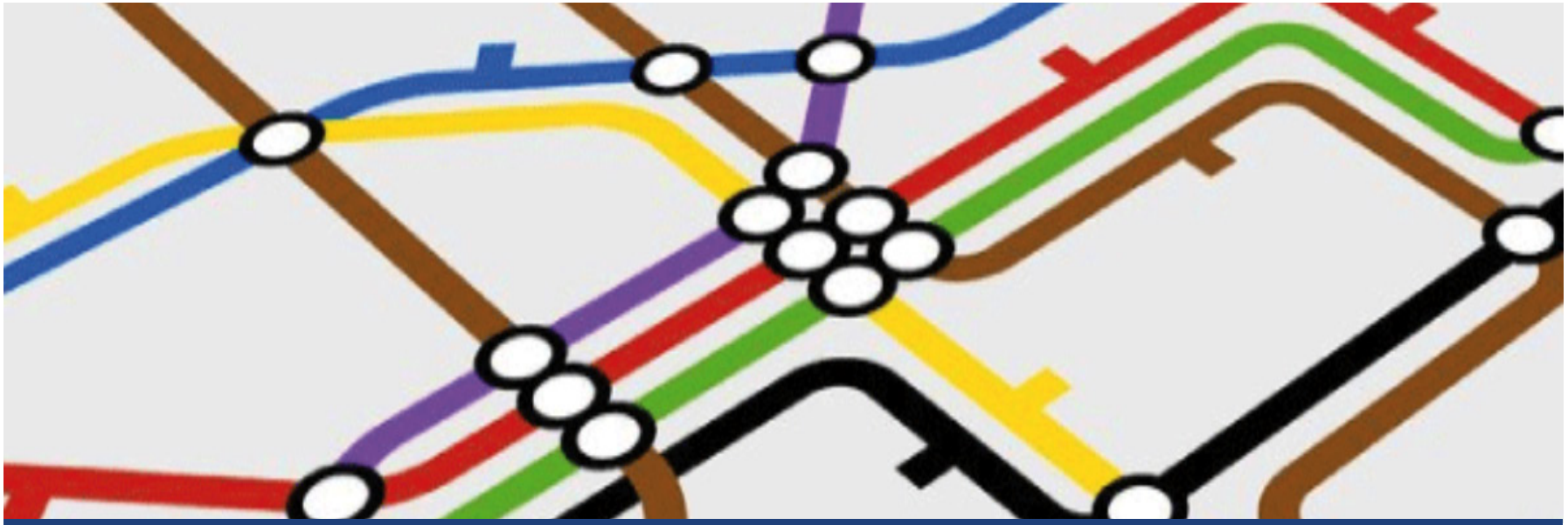


CA B1.: Integration, Operation and Optimization of Mobility Systems

Prof. Vinzenz V. Härri (FHZ), Co-Coordinator B1

SCCER Mobility: 2st. Annual Conference

August 26th 2015 – ETH Zürich, ML Halle – E12

Overview

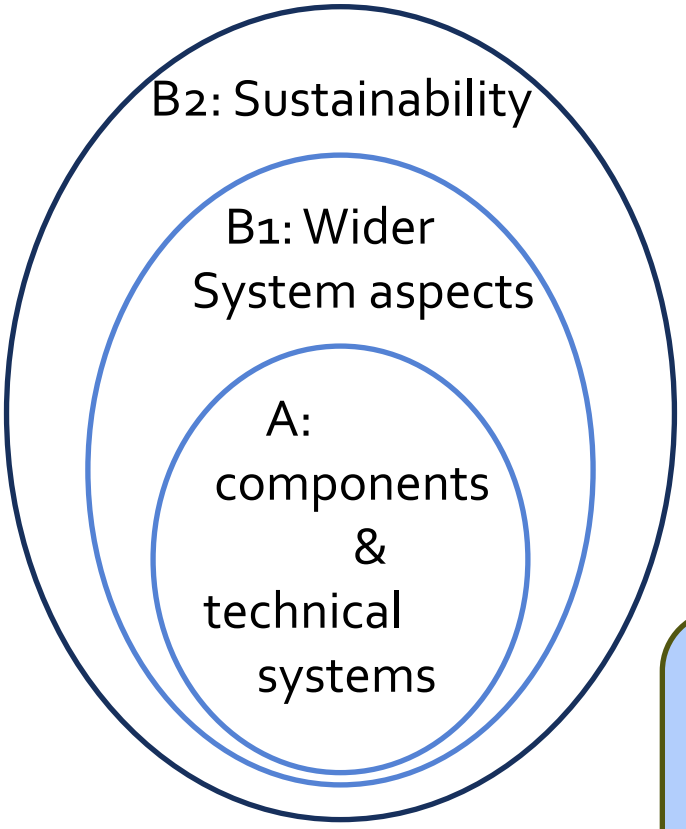
1. Reminder

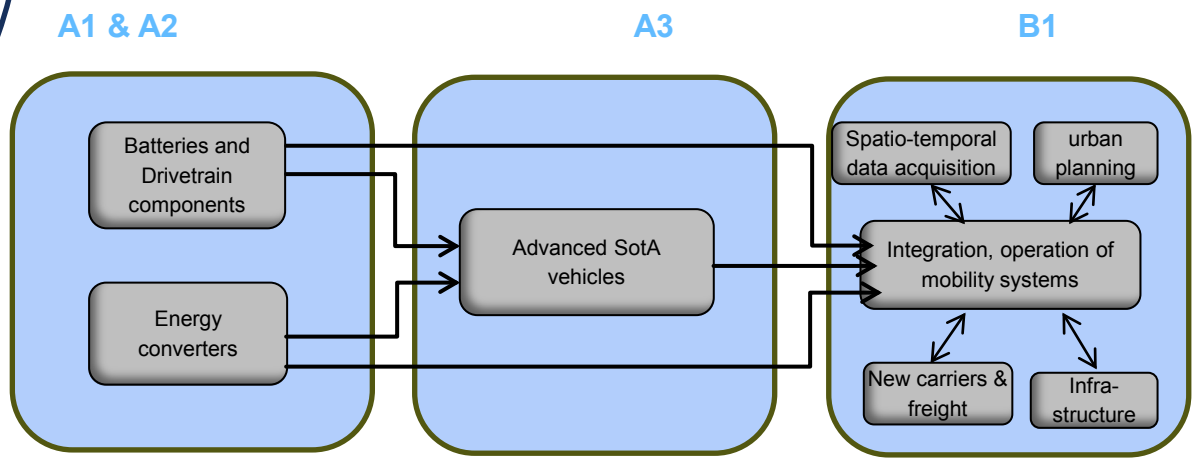
2. News

3. Perspective

Scope: Wider System Aspects of Mobility

The system shells





Overall Context

B1: Measures for optimization of efficiency by system approach

Supply:	Technologies and infrastructure integration
Demand:	Users, Linking mobility, environmental data, urban planning

Abstract B1

B1 deals with

- increasing the energy efficiency in transportation from a systems point of view: integration of new technologies, overall feasibility of mobility systems in relation to grids, buildings, users….
- To this end users, technology and the infrastructure are interfaced with each other by linking mobility patterns with urban planning and environmental data.
- This includes simulating and monitoring people's spatio-temporal behavior in near real-time with the goal of calculating and communicating energy saving options.
- Such approach will result in an optimization of mobility systems and therefore a reduction of the future energy demand.

Subtasks

- B1.1: Integration, Infrastructure & New Urban Transport
- B1.2: Spatio-temporal Data Acquisition & Analysis,

  Monitoring Devices and User Communication
- B1.3: Urban Planning & Environmental Impact

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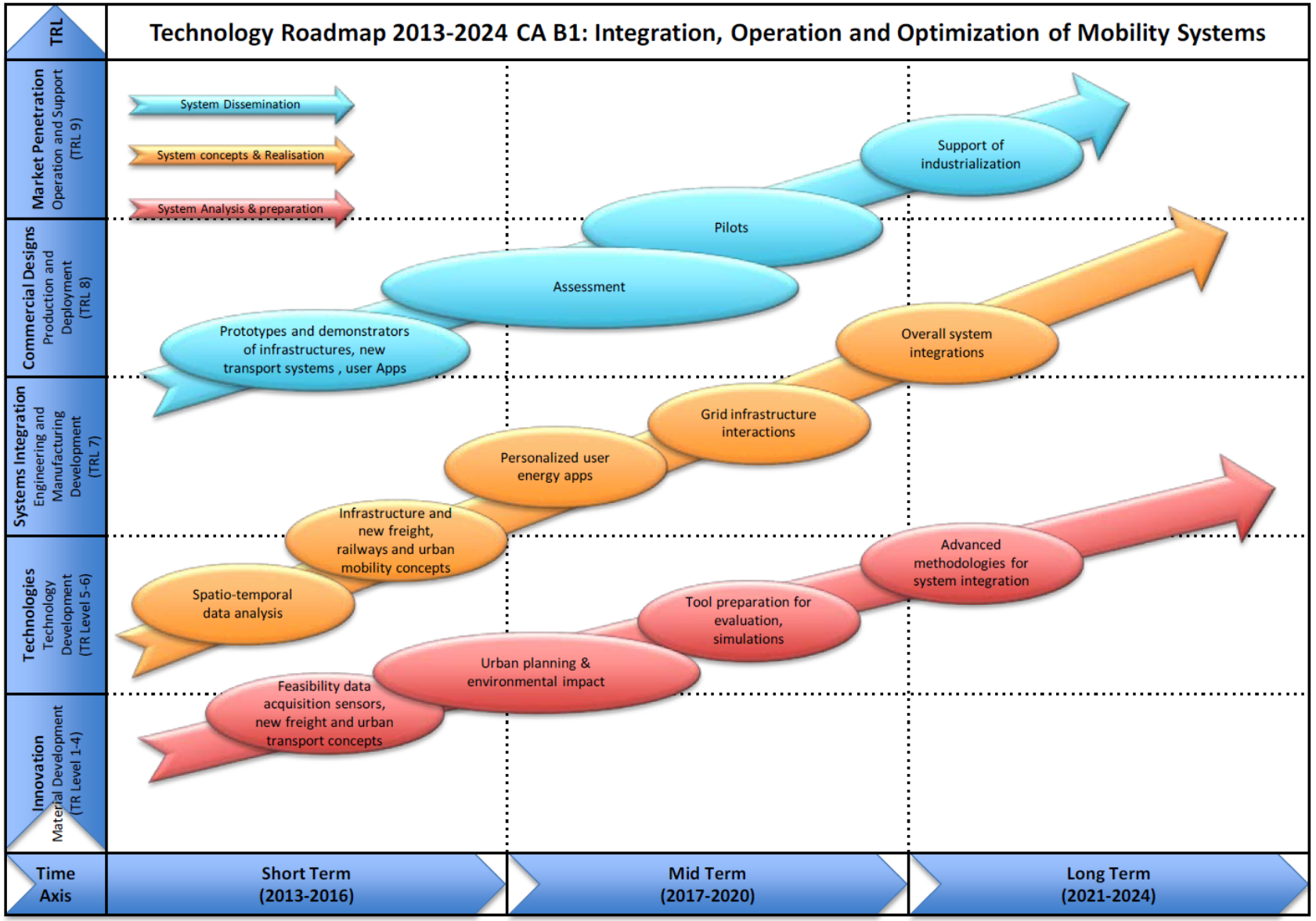
Road Map B1



Research Groups in CA B1

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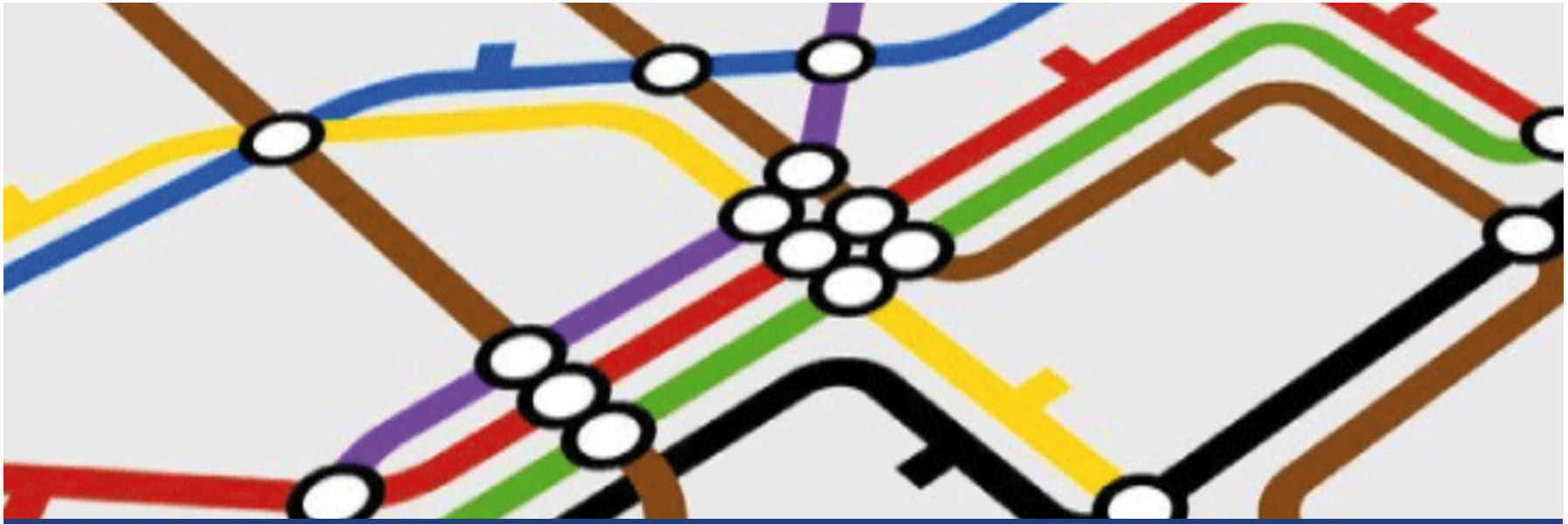

CA B1.1:
Infrastructure & New Urban Transport

Context B1.1

- Integrating technical subsystems: drive-chains, overhead-lines and pantographs, inductive or other power transfer devices, static storages, substations and decentralized renewable power supply hubs
- Overall benefits by reducing energy losses in the supply chain: planning of distributed and intelligent grid infrastructures, which satisfy the demand of dynamic control for handling the high power peaks by breaking and acceleration
- overall evaluation and optimization of the most promising transport carriers and their optimal multimodal combination from an energy efficiency point-of-view
- including advanced and new carriers: trains, LRT, elevators, escalators, people movers, cable cars….
- Taking into account operation profiles and applied in pilot transportation projects
- Lately: also topics of green ITS in the system context

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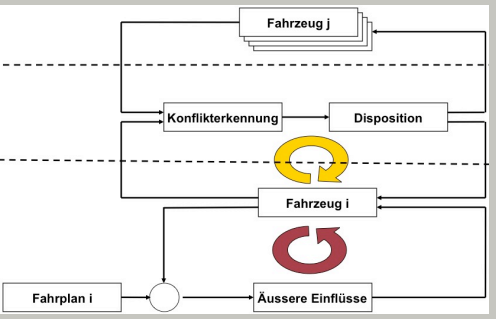
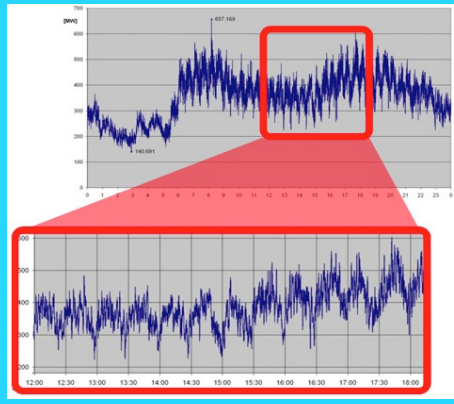
Topics IVT



Automatic train operation joint with centralized train management system
Holistic optimization of energy consumption and network capacity in rail systems

Reduction of the peak loads of energy consumption in integrated timetable systems
Energy storage on locomotives and/or new timetables with smoothed connection systems



Electromobility in urban public transport systems
Decision method for the evaluation of road-bound electric public transport systems

Enhanced flexibility and productivity in the single waggonload system
New opportunities given by hybrid diesel-electric locomotives for multipurpose operation

sccer mobility
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Efficient Technologies and Systems for Mobility

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Energy savings in rail freight by traffic flow optimization

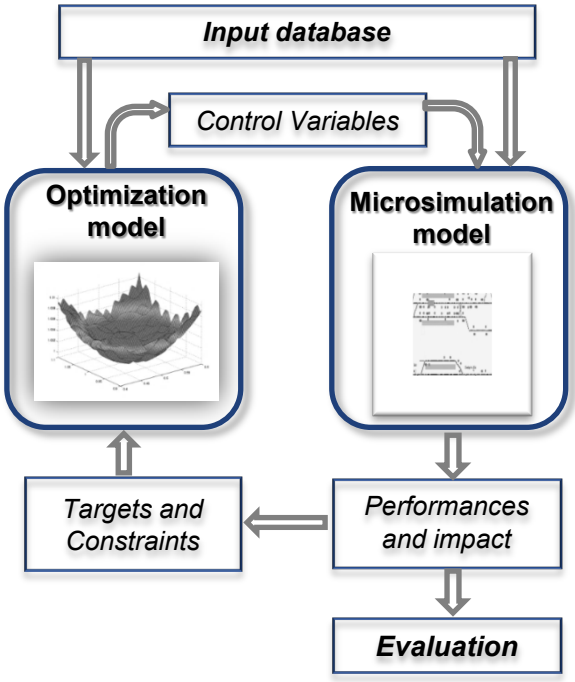
SCCER Mobility – Competence Area B 1.1 (group IVT Weidmann)

The Approach

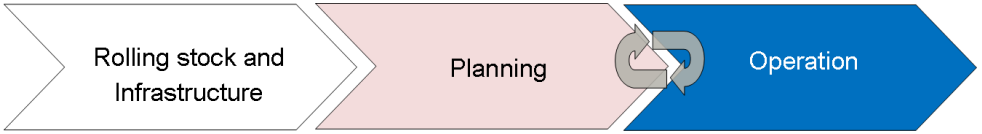
- Freight rail traffic is a non negligible % of rail traffic in Switzerland (≈ 20%)
- Energy efficiency in rail freight has not been deeply investigated so far.
- Railway operation and energy consumption aspects may benefit from energy efficiency solutions specifically dedicated to rail freight

The Framework

- Based on the supply design modeling approach
- Applications on speed profiles and rescheduling procedures.
- Optimization model built with MatLab and Cplex (IVT internal code). Simulation model built with a commercial tool (OpenTrack)



Key factors for energy efficiency implementation



- *Route choice*
- *Optimal speed profiles*
- *Path assignment*
- *Timetable*
- *...*
- *DAS*
- *Adaptive traffic control*
- *Multi objective rescheduling*
- *...*

First results

By optimizing the speed profiles of the train:

- Savings up to 14% approximatively between 2 consecutive stops (ideal condition)
- With an increased running time of 5% in average.

Additional saving can be obtained with appropriate multi objective rescheduling procedures for avoiding unplanned stops.

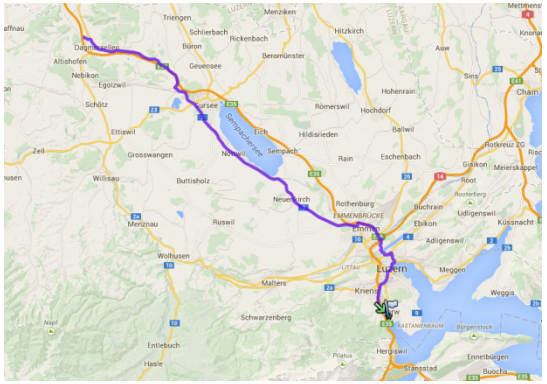
Currently, real trajectories with associated energy consumptions from onboard monitoring systems are under analysis.

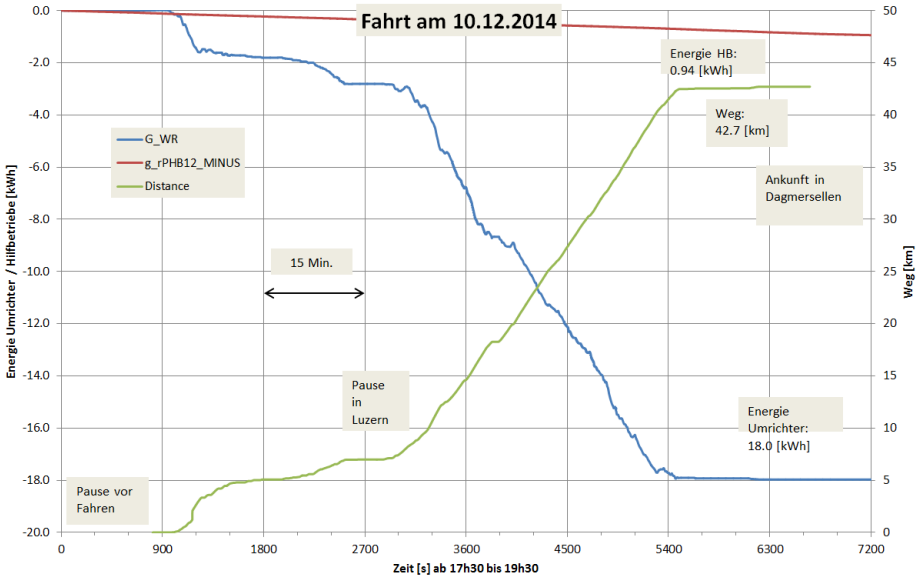
- De Martinis, Weidmann. "Definition of energy-efficient speed profiles within rail traffic by means of supply design models". *Research in Transportation Economics, Elsevier (publication within the year)*
- Toletti, De Martinis, Weidmann. "What about train length and energy efficiency of freight trains in rescheduling models?". *Transportation Procedia (publication within the year)*

Ulrich A. Weidmann, Valerio De Martinis

Achieved in 2015

- Measurement's on Switchbus (Louis Paler, Solar taxi)





Results:

⇒ 5 % for ancillary without HVAC
⇒ 92Wh/t*km
⇒ Autonomy: 220 km
⇒ Best Profile >300km!

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Micro Mobility and Grid's Intergration

E-Bike

⇒ Better Recuperation

⇒ Integration of storage

⇒ Bachelor Thesis, CTI-Check

Magic-Bike AG

CTI-Check

⇒ Optimisation of components

Mobility ⇔ Grid

FURIES WP4.5

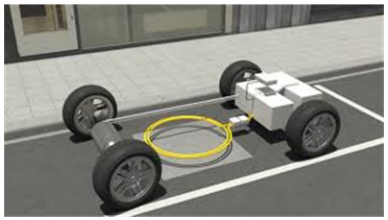
⇒ Intelligent Control

⇒ Easy integration

⇒ High autonomy

Urban Transport and Infrastructure (IVT & IIEE)

- Support of E-buses market introduction
- Cooperation with Ceekon AG (project VBZ)



Grid & Charging Infrastructure

E-Vehicle (Midi Bus)

Components

- → Specification of today's and future busses?
- → Understanding interactions of line service and charging (Grids)

Best Practice??

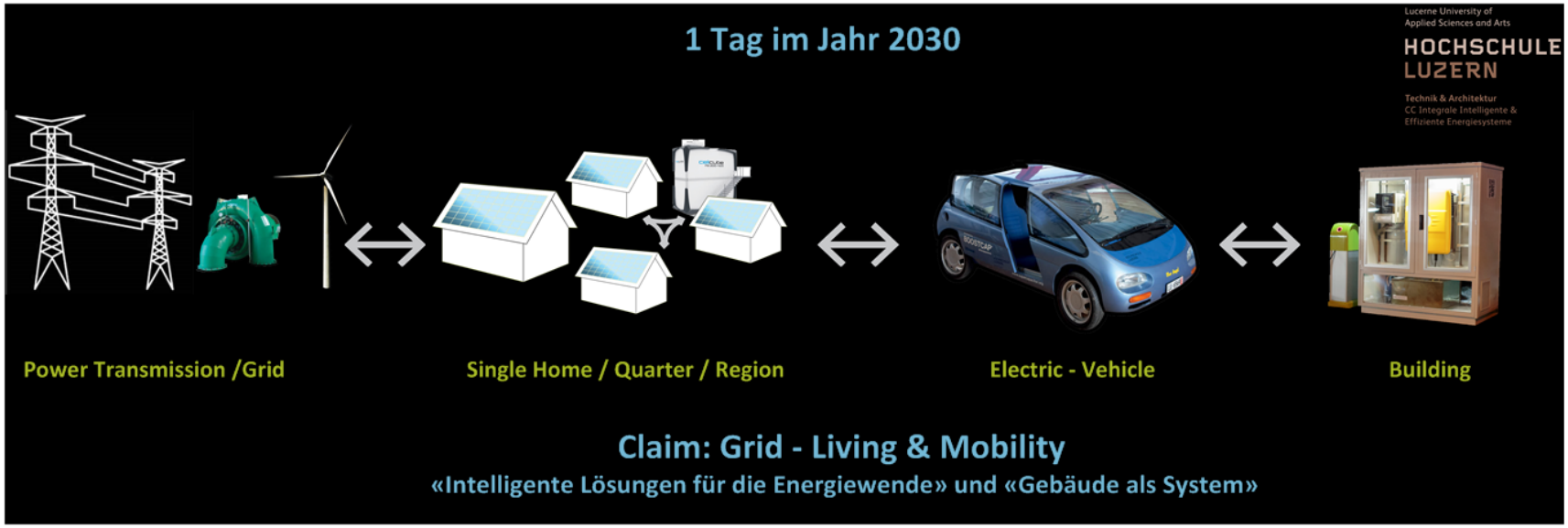
Lighthouse Project: in discussion/planning

SCCER Transportation Vision & Best Practice
in "Luzern-Süd" (Mattenhof)

- VVL and TUs
- Verkerhrsverbund Luzern
- Mobimo AG
- IVT Axhausen

Urban Transport and Infrastructure

- Interaction with SCCER (Grids) → Bridge to WP 4.5



Grid & Power Transmission

Quarter / Building & Energy Storage

E-Vehicle & Charging Infrastructure

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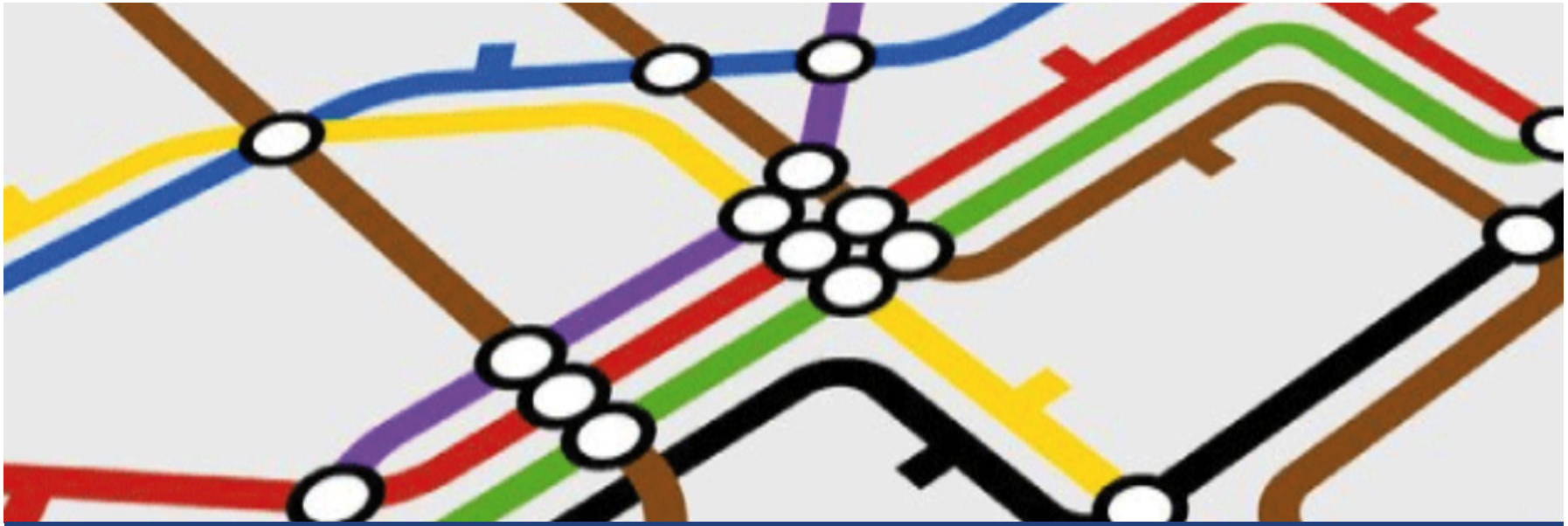

CA B1.2: Spatio-temporal Data Acquisition & Analysis, Monitoring Devices and User Communication

Context B1.2

- Novel data sources, sensors, and monitoring devices will allow us in the future to tackle the challenges of reducing CO2 emissions and energy consumption from a new perspective.
- Development of an integrative framework for utilizing ICT (Information and Communication Technologies) to acquire massive data from people regarding their daily movement patterns and energy consumption.
- Goal of calculating and communicating energy saving options, e.g., the most energy efficient route to take, through a mobile service to the individual.
- Forecasting and predicting urban traffic and corresponding energy consumption.
- Developed personalized energy mobility service/app will be tested and evaluated for a large study in the cantons of Zürich and Luzern.

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Heyko Stöber

GoEco!

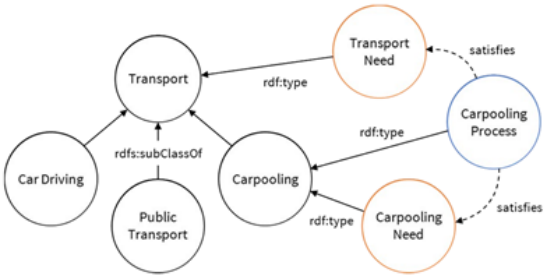
"How can we encourage people to engage in more sustainable mobility lifestyles?"

Gamification and Eco-Feedback (Poster Cellina et al.)

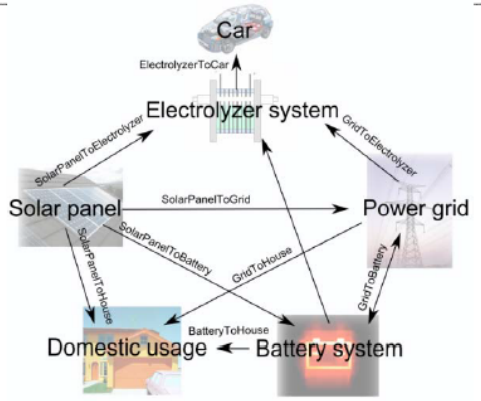
- Mobile app: Tracks trips and suggests alternative, low-impact options.
- Living Lab User Tests: Long-Term Large-Scale User study

Matching Complementary Transport Needs (Poster Bucher et al.)

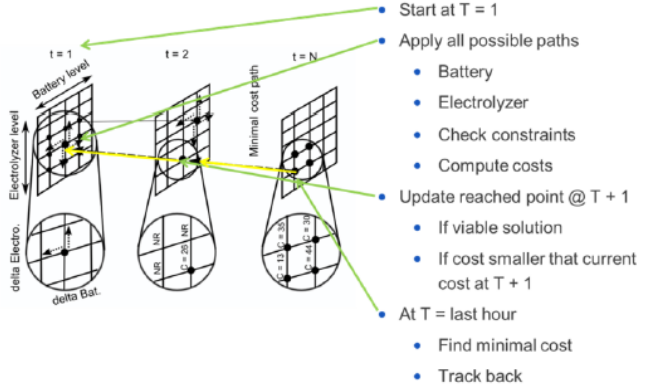
- Queries are results for others with complementary needs.
- Ex: Person A looking for car-pooling partners provides result for person B who is looking for transport options.
- Model allows to automatically match such needs.



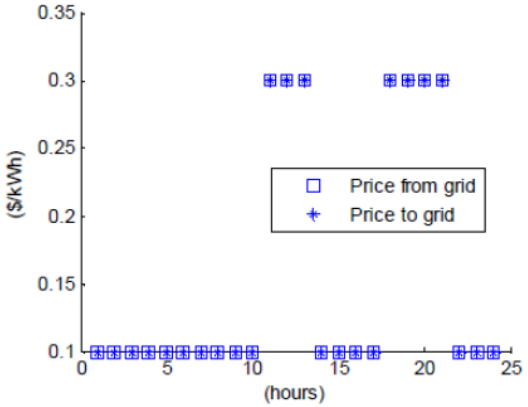
Optimization at building/district level



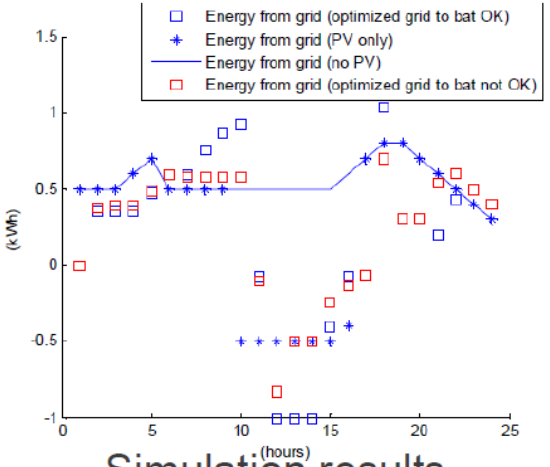
Energy flows



Optimization principle



Electriciy tariff



Simulation results

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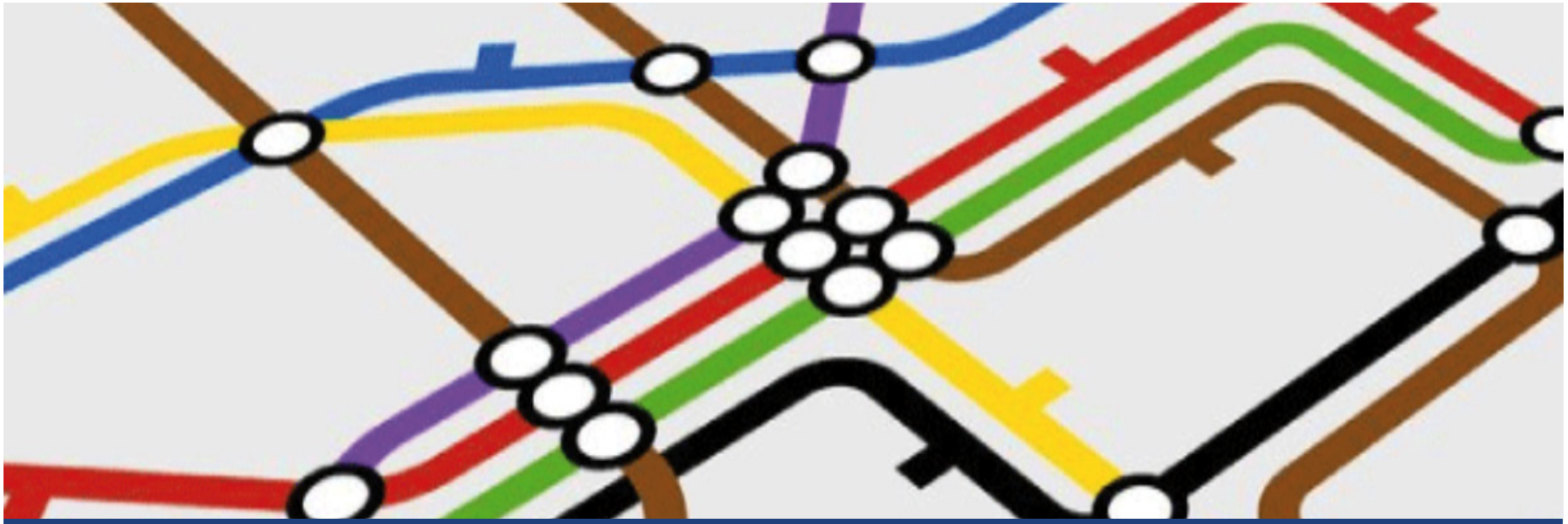

CA B1.3:
Urban Planning & Environmental Impact

Context B1.3

- The aim is to show consequences of the interaction of future (growing) mobility (public and private) on housing, settlement and community infrastructure: on life quality. The results will help communities and related organisations (public and private) to optimize urban planning and infrastructure, i.e. to optimize related opportunity costs.
- Modelling the energy demand and impacts of housing and land-based mobility for all households in Switzerland
- Cluster analysis of urban settlements: Interaction of settlements typologies and mobility behaviour in Switzerland.
- Integration of future scenarios and optimization approaches
- Economic analysis, consequences and products
- Implementation into practice

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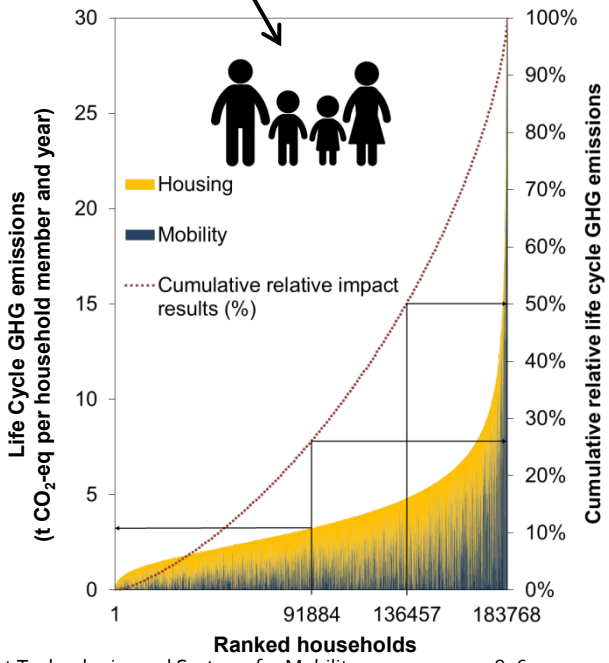
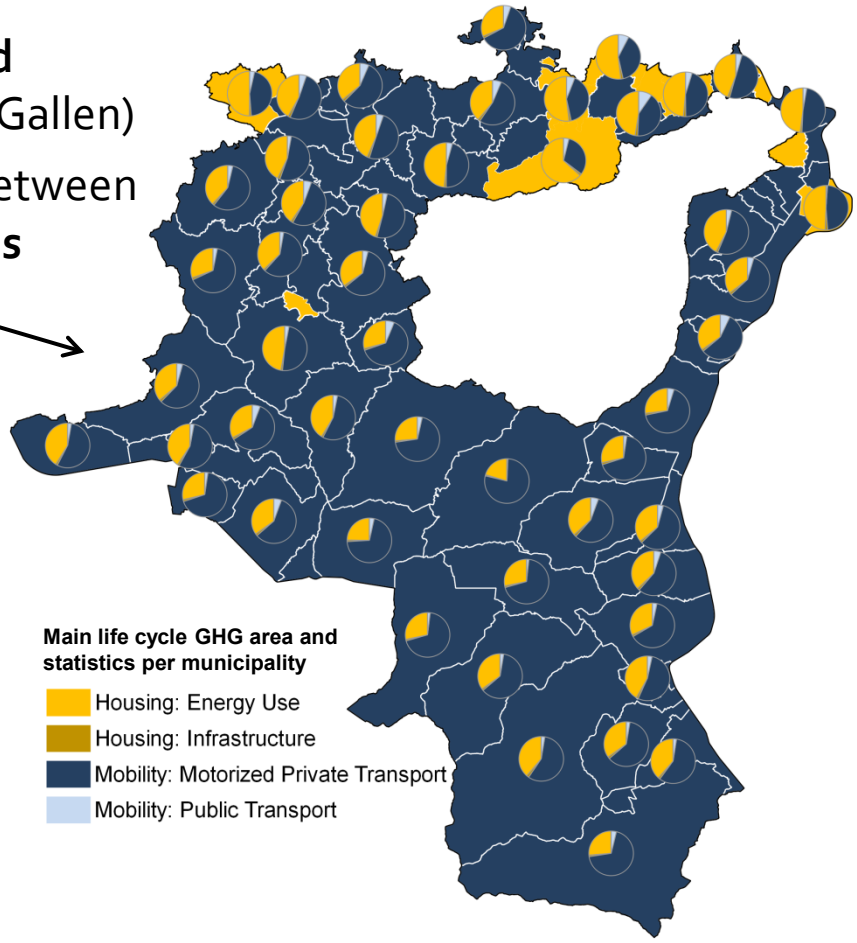
B1.3: Urban Planning and Environmental Impact

1) LCA-Household-Consumption-Model:

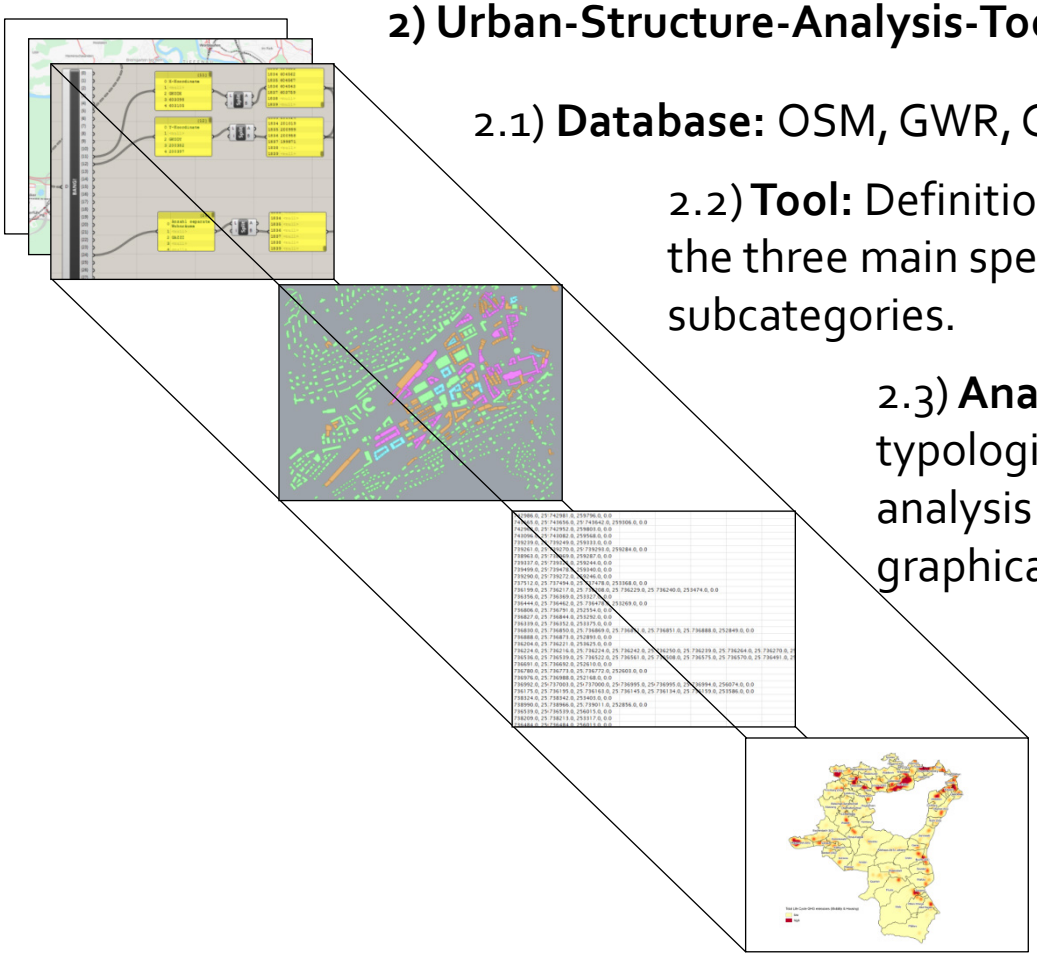
1.1) Modelling **GHG** emissions from **housing and mobility** of individual households (here: St. Gallen)

1.2) Studying differences of behavior patterns between **individual households** and **different regions**





B1.3: Urban Planning and Environmental Impact



2) Urban-Structure-Analysis-Tool:

2.1) **Database:** OSM, GWR, GWS

2.2) **Tool:** Definition of all the precise parameters to filter the three main specific architectural typologies with their subcategories.

2.3) **Analysis:** Automatic analysis of all three typologies from the field of city planning. The analysis is working for whole CH and gives a graphical feedback for each household.

3) Outlook Data-Matching:

Refined analyses of **GHG emissions** and **mobility consumption** data with regard to different **urban settlement typologies** and **urban structures**

Industry partners

ENOTRAC
VBZ Züri Linie
vbl verkehrsbetriebe
esri Schweiz
SBB CFF FFS
ALPIQ
bls
Kummler+Matter
swisscom
Verkehrsverbund Luzern
mway
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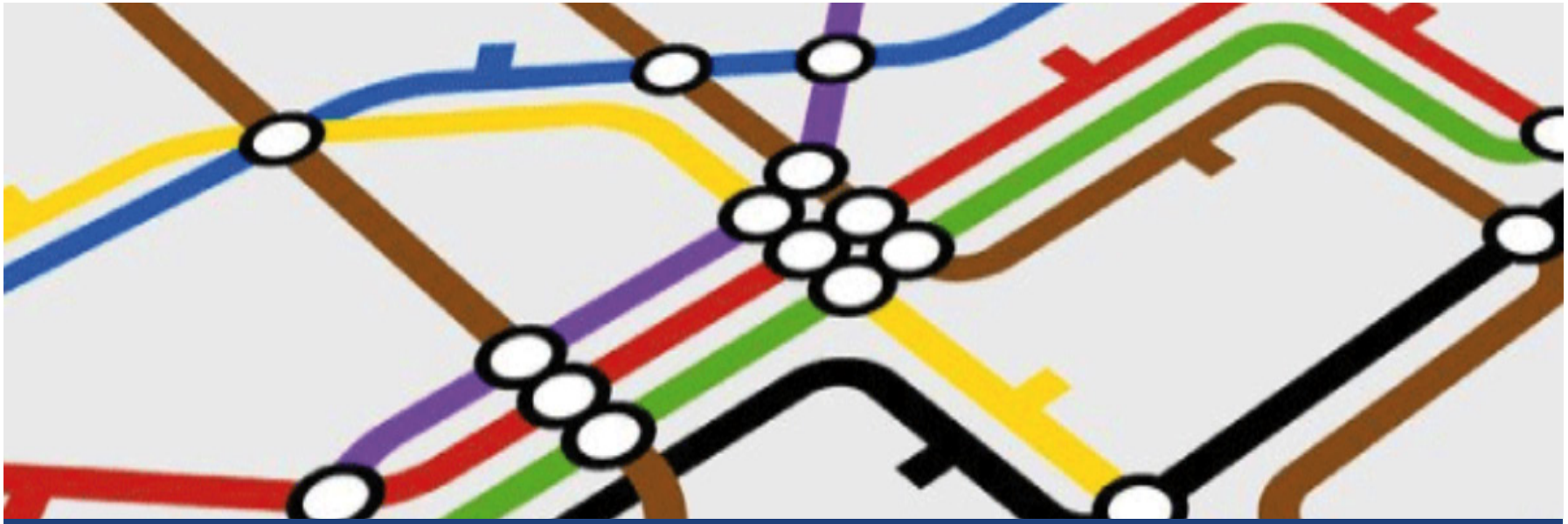

CA B1:
Scientific Exchange and Knowledge Transfer

Scientific Exchange, Knowledge Transfer: Publications

- Schwertner, Michael; Weidmann, Ulrich (2014) Elektrobusse im Linienverkehr – Standortbestimmung und Ausblick, *Verkehr und Technik*, **67** (12) 463 – 468
- De Martinis, Valerio; Weidmann, Ulrich; Gallo, Mariano (2014) Towards a simulation-based framework for evaluating energy-efficient solutions in train operation, *WIT Transactions on The Built Environment*, **135**, 721 – 732
- Haerri Vinzenz V., Lindegger Markus, Neumaier Manuel: A Novel Interior Permanent Synchronous Motor for a High End Ebike Drive Chain, in Proc. 2015 International Electrical Drive and Production EDPC conference (IEEE), Nürnberg
- Haerri Vinzenz V., Neumaier Manuel, Schwartz Philippe : The Energy-Pack APU-Replacement for Catenary Free Operation of Overhead Wired Buses, in Proc. 2015 International Electrical Drive and Production EDPC conference (IEEE), Nürnberg
- Weiser, P., Bucher, D., Cellina, F., & De Luca, V. (2015). A Taxonomy of Motivational Affordances for Meaningful Gamified and Persuasive Technologies.
- Scheider, S., Kiefer, P., Weiser, P., Raubal, M., & Sailer, C. (2015) Score Design for Meaningful Gamification. In Online Proceedings of CHI 2015. Gamifying Research: Strategies, Opportunities, Challenges and Ethics.
- Weiser, P., & Scheider, S. (2014). A civilized cyberspace for geoprivacy. In *Proceedings 1st ACM SIGSPATIAL International Workshop on Privacy in Geographic Information Collection and Analysis* (p. 5). ACM.
- Bucher, D., Weiser, P., Scheider, S. & Raubal, M. (2015) Matching Complementary Spatio-Temporal Needs of People. In Online Proceedings of the 12th Symposium on Location Based Services.

Scientific Exchange, Knowledge Transfer: Publications

- Bucher, D., Weiser, P., Scheider, S. & Raubal, M. (under review). A Model for Matching Complementary Spatio-Temporal Needs. Spatial Cognition and Computation.
- Weiser, P., Scheider, S., Bucher, D., Kiefer, P., & Raubal M. (under review). Towards Sustainable Mobility Behavior: R esearch Challenges for Lo cation-Aware Information and Communication Technology. Geoinformatica.
- Saner D, Vadenbo C, Steubing B, Hellweg S, Regionalized LCA-based optimization of building energy supply: method and case study for a Swiss municipality", Environmental Science and Technology 48, 7651-7659, 2014

Scientific Exchange, Knowledge Transfer: Others

- Course unit in "Advanced Environmental Assessments" (Hellweg)
- Poster Presentation: Assessing the Environmental Impacts from Housing and Land-Based Mobility Demand of Households on a Regional Level), Froemelt, A.; Hellweg, S. ISIE Conference 2015, Guildford, UK, 7-10 July 2015
- Courses within bachelor and MSE master modules, HSLU
- Presentations on BAV event, 23th of June 2015, ETH Zentrum (Weidmann/DeMArtinis, Raubal, Härri)

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Next Steps B1

- Definition Proposal 2015
- Increasing bridge function to other SCCER (FURIES, CREST…)
- Expanding the investigations for system aspects challenges for future transportation systems (e.g. green ITS, ..)
- Practical realization of new solutions (ligthouse projects)
- Taking part in the master course development