

SYSTEM-OF-SYSTEMS THAT ACT **LOCALLY** FOR OPTIMIZING **GLOBALY**

EU FP7 - SMALL/MEDIUM-SCALE FOCUSED RESEARCH PROJECT (STREP)
FP7-ICT-2013.3.4: ADVANCED COMPUTING, EMBEDDED AND CONTROL SYSTEMS
D) FROM ANALYZING TO CONTROLLING BEHAVIOUR OF SYSTEM OF SYSTEMS (SOS)

Traffic Use Case

Local4Global Kick-Off Meeting Aachen, 23.10.2013

Thomas Heinrich, TRANSVER GmbH

Michael Krause, Technische Universität München (TUM)

Local4Global: Idea and Objectives

- Development of learning, evolutionary and self-organizing methods for Technological System-of-Systems (TSoS)
- Optimization of autonomous, constituent systems on the basis of purely local information to optimize TSoS performance globally
- Local4Global product: embedded, web-based, “plug-and-play” software system for generic TSoS, mountable locally to optimize each constituent system
- Two Use Cases:
 - Building TSoS Use Case (RWTH Aachen)
Constituent Systems: active chilled beams, AC units, ventilation systems, concrete core activation zones, façade ventilation units
 - Traffic TSoS Use Case (TRANSVER & TUM)
Constituent Systems: Junction controllers, Cooperative Vehicles

Traffic TSoS Use Case: Objectives

- “provide first-ever traffic control mechanism which, based on pure local junction information, globally optimizes the performance of a cooperative traffic system”
- “TRANSVER will implement within the traffic signal controllers the Local4Global system and will realize the local communication between signal controllers and cooperative vehicles”
- Dynamic optimization of traffic signal control, routes and speeds of cooperative vehicles
- Usage of real-time information from throughout the whole traffic network
- Human factor as major influence (acceptance of speed/route recommendations, reactions and behaviour)

Traffic TSoS Use Case: Characteristics

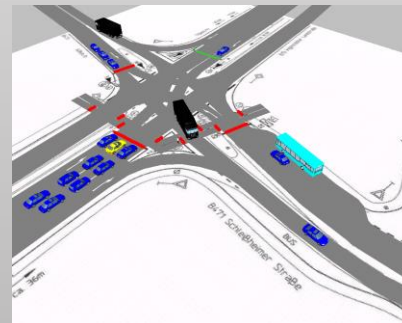
Test site Munich



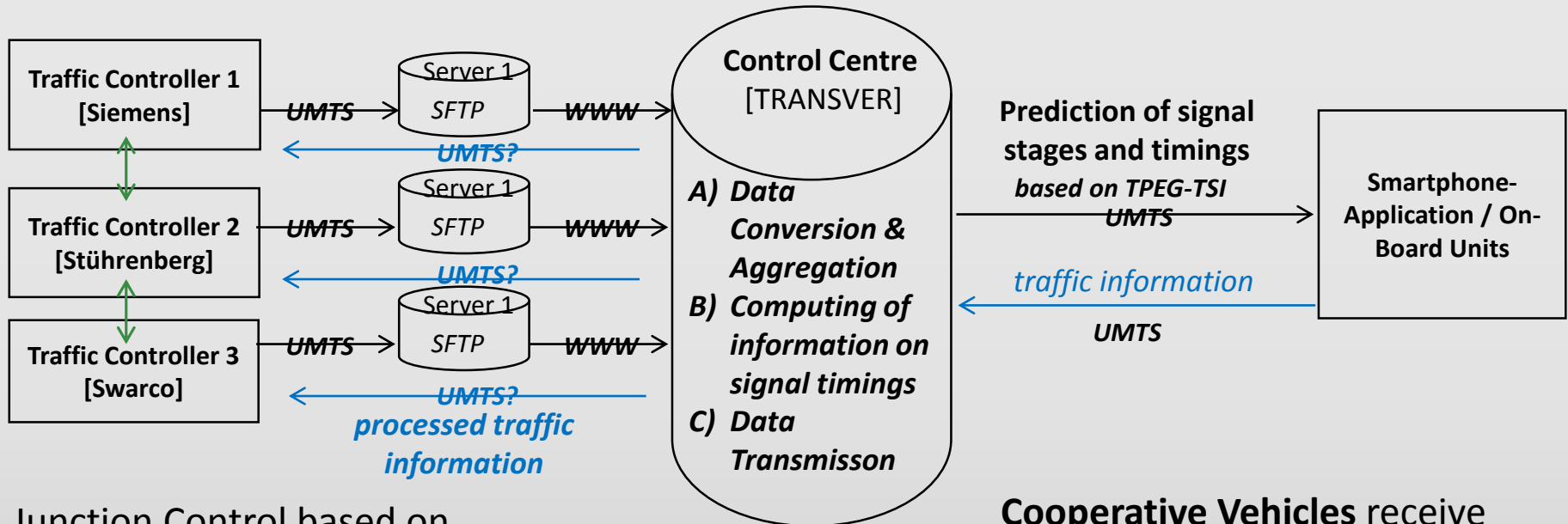
- Test bed in the north of Munich
- Section length: 5 km
- 2 lanes per driving direction
- 7 signalized intersections
- 2 constituent systems
 - **Junction controllers:** to be optimized on the basis of
 - vehicle flow
 - occupancy of detectors
 - location and speed of cooperative vehicles
 - information from adjacent controllers
 - **Cooperative vehicles:** vehicle flow to be optimized on the basis of vehicles'
 - progression speed
 - route decision

Traffic TSoS Use Case: Realization

- Realization of second-by-second traffic signal control
- Set-up of bidirectional communication between vehicles, control centre and traffic controllers
- Online adaption of traffic signal control on the basis of real time information
- Provision of speed recommendations and usage of route decisions
- Estimation of potentials by means of a microscopic traffic simulation:
 - High-speed bi-directional communication between constituent systems
 - Simulation of high penetration rates of cooperative vehicles
 - Overall Performance: network-wide assessment of control scheme



Traffic TSoS Use Case: System Architecture



Junction Control based on local measurements (detector values)

and Floating Car Data (FCD)

+ communication between controllers / coordination of controllers

Cooperative Vehicles receive information on signal control and deliver information on speed + location (traffic information)

Open Questions: Use Case Requirements

- **Local4Global web-based “Plug & Play” software:**
 - How to realize implementation in traffic signal controllers?
- **Communication between traffic controllers?**
 - Static Green Wave, dynamic Green Wave or direct communication realizable?
- **Integration of Route decision of Cooperative Vehicles**
 - Interconnection with navigation system or manual input?
- **Hardware requirements and legal framework for online control adaption**
 - How to integrate online data from cooperative vehicles in traffic signal control?
 - How to realize high-frequency signal program adaption?
 - How to realize high-speed data communication? (UMTS/LTE/WLAN)

SYSTEM-OF-SYSTEMS THAT ACT **LOCALLY** FOR OPTIMIZING **GLOBALY**

THANK YOU FOR YOUR ATTENTION!

Local4Global Kick-Off Meeting Aachen, 23.10.2013

Thomas Heinrich, TRANSVER GmbH

Michael Krause, Technische Universität München (TUM)