The Integrated Wireless and Traffic Platform for Real-Time Road Traffic Management Solutions

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V2X communications for Traffic Management

- Distributed Traffic Jam Detection
- Travel Time Estimation based on (Extended) Floating Car Data
- Contextual Bus Lane Management (e.g. for electric vehicles)
- Limited Access Control (e.g. road closure)
- Regulatory and Contextual Speed Limit Information (e.g. green light speed advice)
- Traffic Light Adaptation (e.g. based on queue length)
- etc.
Problems of Evaluation

Problems:

- Local-scope geographic analyses shift problem to adjacent uninspected areas
- Short-term analyses shift problem to a later point in time

→ Large-scale (whole city-area), long-term (1-2 hours) analyses are required
- Field-operational tests are too expensive and not reproducible
- Theoretical analyses use abstractions which reduce accuracy

→ Large-scale long-term simulations are required
iTETRIS targets large-scale long-term evaluations of performance and effect of V2X communications for traffic management.

- Development of a holistic closed-loop simulation environment
- Development of general traffic management strategies
- Development of data distribution strategies for V2V+V2I communications
- Evaluations with realistic traffic flows
Project Details

Partners

- Peek Traffic B.V. (The Netherlands)
- CBT Comunicacion & Multimedia (Spain)
- City of Bologna (Italy)
- German Aerospace Center – DLR (Germany)
- Hitachi Europe SAS (France)
- Innovalia Association (Spain)
- Eurecom (France)
- Thales Communications (France)
- Universidad Miguel Hernandez (Spain)

Project details

- Duration: 30 months (07/2008 – 12/2010)
- Budget/EC Funding: 4.42 M€ / 2.96 M€
- Website: www.ict-itetris.eu
- Contact: Thales Communications coordinator@ict-itetris.eu
ITS standards compliance

- ITS architectures
  - Use the open architectures defined in COMeSafety and ETSI TC ITS as basic reference

- Compliant implementations
  - IEEE 802.11p, ETSI TC ITS (5GA)
  - UMTS, WiMAX and DVB-H

- Contributions
  - Provide inputs to C2C-CC WG and ETSI TC ITS
Microscopic open-source traffic simulator **SUMO** (http://sumo.sourceforge.net)

Simulation of realistic traffic flows with multiple vehicle classes (cars, busses, electric vehicles, etc.)

SUMO allows simulation of up to 500,000 vehicles in real-time

iTETRIS extensions:

- Emission modeling: $\text{CO}_2$, $\text{NO}_x$, particles, noise, fuel consumption, etc.
- Adaptive Vehicle Rerouting/ Traffic Light Control: closed-loop simulations
Network Simulation

- Discrete-event network simulator **ns-3** ([http://www.nsnam.org/](http://www.nsnam.org/))
- Free and open-source software project
- Good scalability, modularity and multi-technology support (ns-2 not capable of simulating more than 8000 nodes)
- Ongoing NSF funded project
- iTETRIS optimizations:
  - More effective interfering packet list management
  - Interference range reduction
  - Packet rate reduction
iTETRIS Control System (iCS)

- Synchronizes the individual simulators in time and space
- Integrates information-related facility layer components
- Provides interfaces to applications to:
  - Retrieve information from ns-3 (e.g. CAM, DENM) and SUMO (e.g. ego vehicle position, traffic light status)
  - Control ns-3 (e.g. send DENM) and SUMO (e.g. vehicle rerouting)
Traffic Management Scenarios

- City of Bologna
- ~373,000 inhabitants
- ~170 controlled intersections
- ~1000 induction loops
- Realistic traffic flows from OD-matrices and induction loop data
Traffic Management Scenario 1

Pasubio – A. Costa

Problems:
- Events such as a football match or a concert
- Reachability of the hospital

Goals:
- To manage the traffic in an area that offers few alternative routes
- Emergency vehicle priority

Strategies:
- Adaptive Traffic Light Control
- Adaptive Rerouting
- Regulatory and contextual speed limit information
- Bus lanes management
- Limited Access
Traffic Management Scenario 2

Irnerio - Open Market Fair

**Problems:**
- Traffic condition analysis when road traffic is modified due to open market fair
- Induction loop malfunctioning or road yards

**Goals:**
- Traffic congestion detection in real time
- Travel time estimation

**Strategies:**
- Adaptive Traffic Light Control
- Adaptive Rerouting
- Regulatory and contextual speed limit information
- Bus lanes management
- Limited Access
Traffic Management Scenario 3

**Inner city ring-way**

**Problems:**
- Traffic condition analysis
- Induction loop malfunctioning or road yards

**Goals:**
- Traffic congestion detection in real time
- Travel time estimation

**Strategies:**
- Adaptive Traffic Light Control
- Adaptive Rerouting by covering the ring way clockwise or anti-clockwise
- Regulatory and contextual speed limit information
- Bus lanes management
- Limited Access
Traffic Management Scenario 4

Orbital + Highway

Problems:
- Orbital (free) and Highway (toll)
- Multiple exits to the city center

Goals:
- Travel time reduction
- Optimization of the orbital congestion
- Travel time estimation

Strategies:
- Adaptive Rerouting
- Regulatory and contextual speed limit information
Data Dissemination for V2V/V2I communications

- Development of next generation reliable & contextually dynamic vehicular communication protocols for V2V+V2I
- Delay- and Disruption-Tolerant Networks (DTN) with store-and-forward functionality over multiple radio access technologies
- Geo-unicast, geo-anycast and geo-broadcast communication protocols
iTetris Exploitation Potentials

- Provide contributions to C2C-CC (SIM WG) and TC ITS for protocols and ITS simulation framework definition
- Could help the future FOTs for planning in their preliminary phase
- Provide road authorities with a tool to
  - Evaluate potential exploitation of cooperative V2X communications
  - Provide input to smart policy strategies creation through simulated traffic control policy evaluation, eg. based on pollution traces
- Extend the SUMO or ns3 simulator to cover new emerging use cases and scenarios, or even replace either of them with another simulator, as interoperability is a key objective of the development of the iCS.
Future usage of the iTETRIS platform:

- Performance evaluations of communication protocols
- Evaluation of the effect of traffic management applications
- Simple integration of novel applications and scenarios
- Open to future enhancements (open-source)

Feel free to visit our website http://www.ict-itetris.eu or contact one of the project members directly
Thank you for your attention!
Questions?

www.ict-itetris.eu