UTOPIA – Urban Traffic Control System Architecture
System Overview

UTOPIA: Actual innovation in Traffic Control

- Private traffic overall time minimisation
- Selective and absolute priority to Public Transport vehicles
UTOPIA in Europe

- In several countries:
  - Sweden (Goteborg, Uppsala)
  - Norway (Oslo, Trondheim)
  - Denmark (Copenhagen, Aalborg)
  - The Netherlands (Eindhoven, Den Haag, Den Bosch, Helmond, Rhenen...)
  - Belgium (Brussels)
  - Poland (Lodz, Gdansk, Malbork...)
  - Romania (Bucharest)
  - Ukraine (Kiev)
  - Russia (Moscow, Kazan)
  - Ireland (Galway)
  - ...

... for more than 30 cities
UTOPIA in Italy

- In large cities...
  - Roma
  - Milano
  - Torino
  - Bologna
  - ...

- ... and in small cities
  - La Spezia
  - Bergamo
  - Cremona
  - Verona
  - Trento
  - Udine
  - Perugia
  - ...

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The basic principle of UTOPIA is to perform a real-time optimization of the signal settings in order to minimize the total socio-economic cost of the traffic system, in terms of the avoidance of congestion and emissions, and the reduction of travel time both for private traffic and for priority vehicles.

UTOPIA has a HIERARCHICAL and DISTRIBUTED architecture consisting of a higher level (Center), which is responsible for setting the overall control strategies, and a lower level (controlled junctions) where the traffic light control is implemented by means of the SPOT software.

Physical and functional architectures meet the requirements of the UTOPIA system architecture.
Physical Architecture – Overview

Three system components:

- Central system
  - LAN architecture
  - Modularity

- Communication Network
  - Flexible
  - WAN architecture
  - Support for TCP/IP protocol
  - Support for proprietary protocol

- Roadside Units
  - Intelligent controllers
  - Can connect other devices
System Architecture: Central System

UTOPIA higher level calculates the network-wide optimisation strategy and reference control strategies. Based on a LAN of standard computers (servers and workstations), it provides for scale-ability and modularity of all the functions: control, diagnostic, PT priority, monitoring and user interface.

Basic functions carried out by central level software are:

- Traffic Network Monitoring
- System Diagnostic
- Traffic Control and PT Priority
- Co-operative Monitoring and Control
- Graphical and Interactive User Interface
System Architecture: Roadside Unit

The UTOPIA lower level is based on a network of Roadside Units, equipped by industrial computers running the SPOT software, intersection by intersection.

Basic functions carried out by intersection level software are:

- TRAFFIC LIGHT CONTROLLER INTERFACE (ACTUATION)
- INTERSECTION CONTROL (ADAPTIVE AND PLAN SELECTION)
- INTERSECTION STATUS ESTIMATION
- PUBLIC TRANSPORT PRIORITY
- LOCAL LEVEL DIAGNOSTIC
In order to operate properly, the Roadside Unit needs data from the Central System and data from the adjacent Roadside unit. On the other hand, each Roadside Unit locally data (traffic volume and planned control strategy) must be distributed to the adjacent Roadside Unit and to the Control Centre.

- **Centre ⇒ Local:**
  - Configuration data (including PT priority data)
  - Control parameters (weighting factors, reference plan, co-ordination criteria,……)
  - PT priority forecast
  - Centre Operator direct commands

- **Local ⇒ Centre:**
  - Actuated control strategy data (Cycle length and offset, stage length,……)
  - Traffic Measures (traffic volumes, detectors occupancies,……)
  - Traffic estimates (clearance capacity, turning proportions, queues estimation……)
  - Diagnostic data

- **Local ⇒ Local:**
  - Traffic counts and traffic forecasts
  - Planned control strategy
UTOPIA General Characteristics:
Hierarchical

Goal co-ordination
- The central system co-ordinates the intersection control units providing them with optimisation criteria and network wide reference control strategies.
  Each junction then is controlled independently but the local optimisation is performed according to the global goals.

Co-operative control
- The central system can apply co-operative control strategies when integrated with other traffic management systems.
  The hierarchical architecture provides for the central system to receive desired control strategies from a third control level.
System Overview

Innovation with clear results from the field

- Savings in travel time for private cars: 15%
- Savings in travel time for Public Transport: Up to 28%
- Savings in delay for pedestrians

Roma, Torino, Oslo...
System Overview: Overall Results

Savings higher than 15% in travel times
System Overview: Overall Results

PT Priority and private traffic optimized together

cars: -17%
buses: -14.4%
Communication Spot roadside unit - controller

- Spot to controller
  - Second by second signal command

- Controller to Spot
  - Second by second detector data

Spot runs normally on industrial pc, linux environment, but it is also available for tests running on Windows

All the communications are TCP/IP, allowing physical network independence
Dynasim supports Utopia protocol and connects to the Spot units as it was a set of controllers.

This is a TCP/IP socket communication, allowing to run on different Windows machines, if necessary.

Everything can run on a Windows pc, up to 10 intersections.
Simulation applications

Simulations allow to compare and calibrate solutions before to implement them on street.

Simulations allow to evaluate travel times on all the routes, for private cars as well as for buses, and also pedestrian waiting time. The video of a simulation itself provides a visual impression of traffic control performance.

Simulations for new installations
- A new area where Utopia is proposed can be simulated, in order to calibrate Utopia and to compare the control efficiency respect to other control systems, in terms of travel time reduction.

Simulations for road works or topology changes
- Utopia operators can simulate road changes and see effects in advance.
Simulation applications

As an example, we are going to see the video of a simulation for a temporary change of road use, caused by road works on a bridge in the city of Verona.

The area under test is equipped with Utopia control.

Simulation made by the municipality of Verona, traffic control department.
Thank you for your attention

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