Intelligent Traffic Management

Increasing mobility and traffic demands lead to serious congestion problems. Intelligent traffic management systems try to alleviate this problem with optimised traffic light systems and dynamic route guidance.

One approach is Organic Traffic Control (OTC), offering a self-organised, decentralised system founded on the ideas of Organic Computing. Adaptive traffic light controllers (TLC) allow for an establishment of distributed progressive signal systems and an optimisation of the signalisation of existing traffic streams.

Dynamic Route Guidance

The fully decentralised self-organised route guidance system calculates the fastest routes to prominent places based on current and future traffic flows.

The routing component (RC) of each TLC has to perform the following tasks:
- Communicate its current local traffic situations to neighbouring intersections (turning delay and the estimated travel times for outgoing sections)
- Determine locally the best routes (lowest travel time)
- Manage routing tables

Temporal Distance Vector Routing

In contrast to the basic DVR protocol, the Temporal DVR protocol tries to cover the time-dependent traffic conditions for future time steps in considering traffic flow forecasts:

1) Estimate arrival time starting from the previous RC. Make forecasts for turning’s delays and travel times for outgoing sections to neighbouring prominent destinations for this time step.
2) Forward the updated request to nearby RCs until a cycle is detected. Return discovered routes to the sender.
3) Update routing tables: Add a new route or update an existing one if the new costs are lower.

CHALLENGES

Only current traffic flows are considered for the route proposals: Drivers can be confronted with several route changes which might reduce the acceptance of the system.

- Time-dependent route guidance protocols consider upcoming traffic flows before drivers traverse the network.

Temporal Link State Routing

The LSR protocol is a known protocol from the Internet domain, here applied to urban road networks:

1) Estimate local delays + flow forecasts for future points in time for each turning and outgoing section of the intersection.
2) Communicate those to other RCs using broadcast messages (so-called advertisements) which contain link states (path from a source to a sink and its estimated travel time).
3) Having received all advertisements from other RCs, each RC builds a network graph representing the topology and the current and future traffic flows within the network connecting the subgraphs obtained from the link states.
4) Locally compute the best routes to all reachable destinations with the Dijkstra algorithm based on the previously generated graph.
5) Update the interior routing table entries with the determined best paths to all reachable destinations.

Prediction of traffic flows

The traffic prediction works in the steps:
1) The Observer on Layer 1 receives raw traffic data from sensors located on Layer 0, and processes them (Figure 1).
2) Processed data is passed on to the Prediction Component (which forecasts traffic flows for future points in time) and the Situation Analyzer (derives performance measures for the intersection’s signal plan).
3) The description and the forecasts are combined by the Situation Descriptor based on the accuracy of previous forecasts (higher accuracy → higher influence).

NOTE: Combining different forecasts results in average in lower forecast errors than single forecasts.

References

