Enabling Decentralised Road Traffic Management

Keywords

Cyber-physical systems (CPS), traffic management, traffic management systems (TMS), Overture modelling technology and tools

Introduction

TEMPO (*T*MS *E*xperiment with *M*obility in the *P*hysical world using *O*verture) is a project that will develop technology to assist a move to decentralised and distributed control for Traffic Management Systems (TMSs). TEMPO will create a basis for new approaches to distributed traffic management, contributing to smarter, greener and more integrated transport and facilitating the introduction of cooperative vehicles without sacrificing vehicle safety or the robustness of the traffic network. Improvements traffic management will have direct impacts on commerce and on the environment.

Vision and Innovation

TEMPO envisions a Europe in which traffic management is decentralised, enabling reliable journeys door-to-door and reducing economic loss and pollution due to congestion. Decentralised traffic management will also enable future traffic systems where a TMS can communicate with in-car devices. In-car devices, if widely adopted, would produce a population of drivers capable of making well-informed decisions about environmental impact and transport costs.

TEMPO will enhance tools and methods for designing distributed TMSs, allowing TMS providers and integrators to demonstrate resilience and safety properties of distributed TMSs before costly implementations. TEMPO aims to influence the future of traffic data standards such as DATEX II and DVM-Exchange by making recommendations to accommodate decentralisation and distribution of control. TEMPO will develop a TMS demonstrator and create the basis of a new ecosystem and value chain targeting more sustainable road transport support.

Background

Many European countries, such as The Netherlands, have dense road networks and significant traffic problems. Crowded roads have a negative effect on both the economy (the time and cost of transporting goods and workers are increased) and the environment (fuel is burned unnecessarily and air particle pollution is generated when traffic jams arise). The flow of traffic on Europe's roads is managed by a series of Traffic Management Systems (TMSs) that are owned and controlled by various local and national authorities. A TMS consists of a collection of distributed devices installed along the roadside, either sensors that collect traffic data (e.g. cameras, radar detection systems, induction loops), or actuators that give instructions to road users.

Current TMS architectures are heavily centralised around regional control centres and are not scalable. Centralisation also hinders efficient management of traffic problems that straddle boundaries between authorities, because TMSs cannot communicate between regions. While cooperation between various road authorities has improved recently, technical barriers for decentralised and distributed TMSs are still in place. TEMPO aims to demonstrate the feasibility of a TMS with a decentralised and distributed control architecture and of future traffic systems where a TMS can communicate with in-car devices.

A TMS is an example of a Cyber-Physical System (CPS). A CPS is composed of diverse components (software, hardware and communications technology) that must collaborate to achieve a global goal.

Each TMS must interact with neighbouring TMSs that will often have different owners, and vehicles will move around, communicating with a different TMS depending on their location. These factors mean that new, innovative approaches to engineering such cyber-physical systems are required.

Approach

TEMPO will use the Overture technology as a basis for its work. Overture is a platform for modelling and analysing systems. Models can demonstrate the correctness of designs prior to costly implementation. TEMPO will use Overture to model existing traffic management networks, then demonstrate the feasibility of decentralised designs that communicate with in-car devices.

To achieve these results, the Overture technology needs to be extended to support modelling of components that can move, such as vehicles. The movement components will change the topology of the system as they travel. TEMPO will extend Overture with 2D and 3D visualisation libraries that will enable modellers to assign a physical appearance and location to objects. TEMPO will also investigate dynamic reconfiguration of networks of vehicles and adaptive control strategies. These extensions will enable communication with stakeholders who have a less technical background and be applicable to other domains such as agriculture.

The TEMPO project's objectives are:

1. To produce well-founded models that can be used to demonstrate the value of a distributed CPS controlled TMS solution to the various decision makers enabling new services;
2. To increase the maturity of the existing Overture platform with localisation and visualisation libraries enabling better understanding of the models; and
3. To develop a TMS demonstrator in order to create the basis for forming an eco-system with a value chain targeting more sustainable road transport support.

Duration

TEMPO runs from 1 October 2015 – 1 October 2016.

Partners and Funding

TEMPO is coordinated by West IT Solutions (http://www.west.nl/), whose contribution is led by Dr. Nico Plat. Their consortium partner is Aarhus University (http://eng.au.dk/), whose contribution is led by Prof.dr. Peter Gorm Larsen. The TEMPO project is funded by CPSE Labs (http://www.cpse-labs.eu/), a network of Design Centres across Europe. TEMPO is supported by the CPSE Labs UK Design Centre at Newcastle University (http://research.ncl.ac.uk/cplab/). CPSE Labs provides funding through open calls for innovative, industry-driven projects such as TEMPO, along with expertise and platforms for engineering cyber-physical systems. Further calls will open in Q4 2015 and Q2 2016.

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