SABRON: A Storage and Application Based Routing Overlay Network for Intelligent Transportation Systems

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Abstract. This poster paper presents the SABRON, a distributed service platform for the intelligent transportation system (ITS) based on P2P and tuple-space technologies. Our aim is to create a system that can evolve advanced self-organization features, taking into account also regulatory constraints inherent to ITS. In the current phase we focus on the distributed infrastructure-side storage and dissemination of centrally supplied safety and traffic messages to vehicles. Ultimately, the built overlay can pervade vehicles as well; it can store complex structured data and support dynamic coordination of ITS services (applications). The paper outlines the motivation for introducing advanced self-configuration features into ITS, and the details of the proposed architecture.

Keywords: Intelligent Transportation Systems (ITS), service platform, P2P, space-based computing

The vision and the promises of Intelligent Transportation Systems (ITS) [1] has stimulated research on a variety of topics ranging from efficient communication in the presence of mobility, including car-to-infrastructure (C2I) and car-to-car (C2C) communication, efficient context capture, context-aware service management, and advanced human computer interfaces (HCI) for appropriate service content representation. Essentially, ITS are decision support systems that offer assistance in terms of instructions and recommendations to drivers, specially tailored to a particular dynamically changing context describing road and traffic conditions. Hence, their effectiveness depends on their ability to collect contextual data from many different sources, e.g., sensors, cameras or personnel, and appropriately generate and transport comprehensible, reliable and timely content to users.

ITS are inherently complex in terms of the number of involved entities and interactions, including vehicles, on-board and road-side equipment, complementary communication technologies, producers and consumers of ITS data, distinguishable ITS services of different types. Therefore, ITS share challenges and requirements of the pervasive / ubiquitous computing [2], e.g. scalability, context awareness, context management, heterogeneity, mobility, interoperability, survivability, security, adaptability and self-organization. Adaptability through self-organization lends itself as a central concept at many functional levels, and particularly as a means to deal with frequent disruption of connectivity due to vehicle mobility and heterogeneous and sparsely deployed infrastructure. At the communication level, adaptability is required

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in the selection of the best available communication technology based on context variables. At the networking level, information sources, relays and users may need to organize in an overlay for flexible data gathering and forwarding, utilizing also opportunistic routing and carry and forward techniques via the infrastructure and the vehicular network. At the application level publish and subscribe paradigm facilitates service and resource discovery and content-based dissemination. At the management level self-organization deals with outages and application-driven reconfigurations.

These different aspects of self-organization are central for building SABRON, an evolutionary ITS distributed platform, a work that started within the Austrian research project REALSAFE currently focusing on safety-related infrastructure-based ITS services. Taking into account general characteristics of self organizing systems [3] regarding boundaries, operational closure, independence of identity and structure, maintenance, feedback, criticality and emergence, on the one hand, and on the other hand the regulative aspects of intelligent transportation systems, we aim to create a system that can evolve self-organization features with most relevant benefits. In the current phase we focus on the distributed infrastructure-side storage for complex structured data that facilitates timely dissemination of centrally supplied safety and traffic messages to the vehicles. Ultimately, the overlay can pervade vehicles as well; and can support dynamic coordination of distributed ITS services/applications.

To support efficient and dynamic application-based storage and routing of spatio-temporal structured data, we propose a novel architecture which unifies the query expressiveness and coordination support inherent to a space based computing paradigm, with the adaptability of a P2P approach: the extended (virtual) shared memory (XVSM) middleware technology [4] is used to store, replicate and query data objects in a space that can be shared among many ITS services; these tuple space entities are uniquely addressable via the Distributed Hash Table (DHT) [5] overlay that is used as an underlying location and mediation layer. The implementation details are hidden behind a simple API. Based on this API ITS services acting as ITS data producers and consumers can connect to the overlay to share data and coordinate their execution. Self-organization function currently supported is seamless storage re-configuration in case when infrastructure nodes either join or leave the overhead. Next step concerns performance-optimizing overlay adaptation in case when different ITS services (data consumers or producers) join or leave the system.

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