PROACTIVE REAL-TIME TRAFFIC
INFORMATION AND DECISION SUPPORT
SYSTEMS

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SUMMARY

The paper considers the problem of real-time traffic information in ITS environment. Possible solutions of enormous computational complexity related with on-line processing and real-time decision making are associated with multiresolutional representation and intensional logic. Systems Integration (SI) methodology is proposed for the design, procurement, installation and operation of real-time services.

INTRODUCTION

Traffic control, incident management, route guidance demand management, traveler information and several Intelligent Transport Systems (ITS) Services have to be based on real-time traffic information. Decision-making tasks related with real-time information are reactive or proactive scheduling problems where new schedules of "traffic entities" (vehicles or others) are developed according to actual network state and expectations of decision makers. In general, it is very hard to find analytic (optimized) solutions because the size of search space increases exponentially within the number of vehicles and system states.

During the last decade Dynamic Traffic Assignment (DTA) models (including optimal control DTA formulations and variational inequality) tend to be focused on the user equilibrium and stable behaviors [1], [2]. Simulation-based DTA models require substantial computational capacity where the choice of resolution level (macroscopic, microscopic or mesoscopic) has significant implications for the real-time simulation tractability.

In our research we use multi-model and cooperative method which can be adapted to various real-time ITS problems. The systems integration methodology provides workable approach to carry out effective design, management and deployment of complex dynamic system. We want to demonstrate that travel planning, traffic control and ITS learning are joint processes.
The decisions support systems, including efficient fuzzy logic, evolutionary algorithms and multiagent systems are considered in references [5], [6].

**GENERALIZED STRUCTURE OF REAL-TIME SYSTEM**

A fundamental ITS paradigm is the collection, fusion and distribution of traffic information which influence traffic system behaviors. Traffic data can be collected by various sensors, video cameras and from in-vehicle radio navigation receivers. Several public or private organizations add value to the collected data by data fusion, situation analysis or scene descriptions. Calculation of traffic control variables are based on network state representation and behavior generation. Basic illustration is given in Figure 1.

![Generalized structure of real-time system](image)

Data processing and fusion module process sensor signals and accumulate information about objects in the world and their dynamic states which are relevant to traffic information and control tasks.
Most of the existing drivers' information and related services are provided by the centralized systems using mobile telephone links or GSM/GPRS transmission. We can expect that (in the near future) relevant information will be generated, distributed and shared between traffic entities (vehicles or others) using short-range wireless communication and ad hoc links. Higher level user-centric services will use all kinds of lower level services and exploit data collected from embedded sensors. To exploit these services in proactive way the advanced user agent solutions can be used.

**MULTIRESOLUTIONAL DESCRIPTIONS AND LEARNING PROCESSES**

To describe the behaviors of a real traffic system we need complexity reduction. Successive reduction of the state-space volume results in substantial reduction of computational complexity. The theory of multiresolutional analysis and learning enable more usable information & knowledge representation. Any temporal activity (motion) in the real world ("state-space") can be characterized by the time-tagged trajectory of motion along:

- "initial state"
- "working point"
- "present state"
- "goal state".

Real-time traffic information, planning and control process require multiresolutional representation and decision-support process including mechanisms of MR knowledge processing, implication statements, etc. Intentional logic predicates various traffic situations and related sub-situations by purposes or goals.

The real-time traffic information, planning and control are inseparable parts of the same decision-making process. Problems of planning/control in behavior generation are often associated with robotics and automated control systems, although they are equivalent in all other application domains.

Learning performed via successive multiresolutional processes of computations include two kinds of learning processes:

- learning related to states, objects and situations,
- learning related to generalized experiences.

The learning process and the traffic knowledge have to be implemented as important parts of real-time traffic information, planning ad control subsystems of ITS.

The current telecommunication and in-car information equipment often demand significant attention from the driver, therefore, new user interfaces represent an important task. The personalized proactive systems "learn" the driver's profile and autonomously filter information, evaluate options and make decisions.
SYSTEMS INTEGRATION

Many different information, communication and decision support (knowledge engineering) technologies are required to enable real-time traffic information related to ITS services such as traffic control incident management, demand management, policing/enforcing traffic regulations, etc. Many end-user products and services will be developed by the private sectors, but they will often rely on infrastructure provided by public sector.

Deploying proactive real-time traffic information, planning and control systems require systems integration (SI) engineering methodology. SI provides suitable methodology that encompasses the entire integration program – from requirements and feasibility analysis to deployment and maintenance.

At the strategic level, the systems integration of proposed system is concerned with the overall performance needs and insurance that the system requirements are met. At the tactical level, systems integration has to insure that specific components fit together in the stated configuration.

The basic framework applicable to almost all the decision making problems is illustrated in Fig. 2 [3]. It can be used for discussing real-time data and decision-level fusion.

![Fig. 2 Real-time data and decision-level fusion](image)

The nature of transport and traffic real-time decisions determines the data to be collected and the real-time fusion & analysis to be undertaken to obtain the required information for making the real-time decisions. Decision-level fusion includes processing of sensory information and reasoning that use prior knowledge.

Many situations (such as accidents) in the traffic system cannot be predicted. While it is impossible to predict accidents, it is often possible to forecast:

- the impacts that partial accidents have on traffic,
- the accident-caused delays,
- when the accidents will be cleared,
Adaptive traffic-dependent route guidance uses real-time-traffic-dependent information to estimate the fastest routes from origins to destination, and to provide turn-by-turn instructions along the route. When traffic situations change while drivers are on the route, the rerouting functionalities are required. The navigation computers search for faster routes and reroute drivers to the fastest available route to the driver's destination from their current positions.

CONCLUSION

Deployment of ITS technologies has motivated further research toward the development of methodologies and solutions for advanced proactive real-time traffic information and decision support systems. Existed DTA methodological and algorithmic constructs represents mostly an off-line development perspective without proper system integration of real behaviors and context information. The computational complexity associated with the use of a simulator as part of an iterative mechanism is operationally restrictive.

In this paper we consider parts of the basic problem and system requirements for proactive and personalized real-time traffic information and decision support systems. One of the possible solutions for enormous computational complexity in such problems can be based on multiresolutional representation and intensional logic. User agent solution support personalized proactive service where information and decisions are adapted to specific driver’s profile.

The proposed systems integration methodology provides workable approach to carry out effective design, management and deployment of complex dynamic (real-time) system.

REFERENCES