Distributed Simulation Test Bed for Intelligent Transportation Systems Design and Analysis

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1. Introduction

There has been increasing interest in the exploitation of advances in information technology (e.g., mobile computing and wireless communications) in surface transportation systems. Classes of applications that could benefit from such an infrastructure include:

- Driver assistance and safety applications: Traffic information or hazardous road conditions may be disseminated to avoid congestion and improve safety.
- Commercial applications: Information systems of roadside businesses (hotels, restaurants, gas stations, etc.) can be made accessible to travelers to disseminate up-to-date information (e.g., availability, pricing), or provide services (e.g., reservations, Internet access) to travelers.
- Entertainment applications: Passengers may be able to communicate with other, nearby travelers.

An area of increasing interest concerns the use of vehicle-to-vehicle (V2V) communication rather than relying completely on roadside infrastructures that are expensive to realize and maintain. In such a system, vehicles exchange information with others within their radio range, and ad hoc wireless networks are used to propagate information. V2V networks exhibit some unique characteristics that warrant re-visiting fundamental research issues, such as:

- Communications. It is imperative to understand the fundamental performance limitations of V2V networks in order to understand their feasibility for specific applications, and design suitable resource allocation algorithms. We have developed analytical models for spatial propagation of information as a first effort in this direction.
- Data services. Data dissemination algorithms, data caching mechanisms, and data fusion algorithms are needed to support higher level application services. We are currently designing a set of basic data dissemination algorithms.
- Application design. We are planning to design and evaluate a set of applications, e.g. traffic information propagation and peer-to-peer file-sharing.

Test bed environments are needed to evaluate new techniques and system designs and architectures. Experimentation in operational transportation systems is costly, can be dangerous, does not scale well, and often does not provide sufficient means of control for comprehensive experimentation. Virtual (simulated) systems that include detailed models of transportation and communication systems help to overcome these limitations. Toward this end, a distributed simulation prototype has been developed to explore issues such as the above, and has been populated with traffic data in the Atlanta metropolitan area obtained from government partners.

2. Test Bed Architecture

Our simulation test bed integrates transportation and communication simulation applications. Distributed simulation techniques are used to improve scalability. The federated simulation architecture for the test bed is shown in Figure 1. Simulators interact with each other (shown as arrows in Figure 1) via interoperable simulation services provided by runtime infrastructure (RTI) software. The federated simulation environment offers general-purpose distributed simulation functionalities while the Simulated Intelligent Transportation Environment (SITE) is customized specifically for intelligent transportation system simulation. Their functionalities include:

- **Federation Management** (creation, joining, leaving, synchronization, fault policies, etc.)
- **Event Management** (subscriptions, publications, sending, receiving, etc.)
- **Time Management** (regulating, constrained, lookahead, advancement, etc.)
- **Object Management** (subscriptions, publications, instantiation, updates, ownership, etc.)

- **Utility Management** (data repositories, state management, monitoring, logging, etc.)

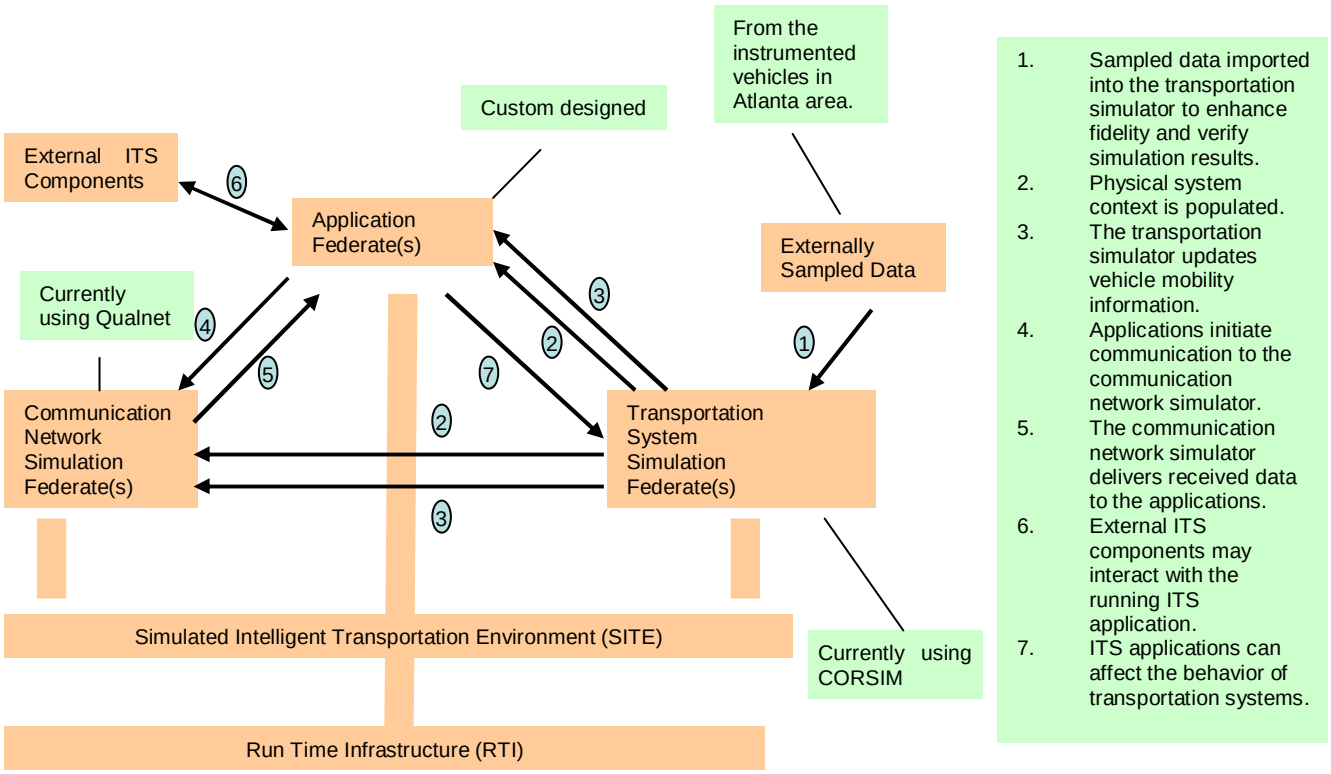

Figure 1. Test bed architecture.

3. Demo Design

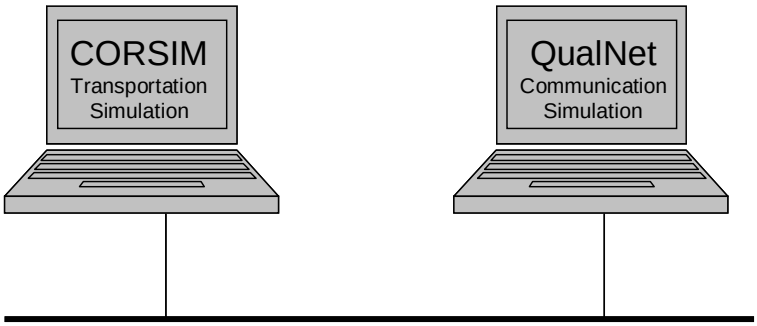

Figure 2: Demo Configuration

We will show a distributed simulation of a transportation simulator (CORSIM) and a communication network simulator (QualNet). The demo will utilize data corresponding to the Atlanta metropolitan area obtained form government partners. As shown in Figure 2, CORSIM and QualNet will execute on two laptops connected via LAN. The CORSIM laptop will show a traffic simulation of the Atlanta area and the information exchange between vehicles are shown in the QualNet laptop. Vehicles in CORSIM will be mapped to mobile nodes in Qualnet, whose movement will follow the simulated vehicle movement in CORSIM. Data will flow between mobile nodes as directed by our data dissemination algorithms.

4. Acknowledgement

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