Interoperable Transit Trip Planning Services

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Transportation planning research has been fundamentally transformed by the advancement of spatial cyberinfrastructure (CI) and other planning information technologies. This is no better exemplified than by the evolution of online transit trip planning systems. This paper describes the progression of online transit trip planning systems as a result of innovations in cyberinfrastructure, from the perspective of ontology, middleware-based system interoperability and service-oriented design.

Online transit trip planning systems are widely used by transit agencies to disseminate transit scheduling, routing and itinerary information, in order to help transit users to make better informed decisions. It can not only improve customer service, but also could attract new transit riders, particularly young riders who are primarily technologically savvy, therefore increasing transit ridership numbers.

The online transit trip planning systems have evolved as web technology and CI continue to advance, from the initial proprietary system to open and interoperable systems, and from independent systems for each single transit agency, to an inter-dependent inter-jurisdictional system. The initial transit trip itinerary planning systems were developed for individual transit agencies by individual vendors, based on proprietary system architecture and technologies. Although this is a great advance from manual systems, these independent proprietary systems cannot be utilized by users to plan cross-transit agency trips, because of multiple transit agencies, even in the same metropolitan area, with each transit agency having its own trip itinerary planning system.

There are traditionally two common approaches to address this issue: data integration and application integration [1]. If transit agencies in the same or neighboring areas use the same trip itinerary planning system, a simple method of integration is used to compile the data from the different agencies. So long as trip itinerary planning systems are developed by the same vendor, this is possible, as they use the same data structure and search algorithms. For almost all existing “region-wide” trip itinerary planning systems, such as those in the Chicago and Washington, D.C. regions in the United States and the Greater Montreal Area in Canada, this is how region-wide trips are planned [2].

One of the primary problems with this data integration approach, besides the requirement of adopting the same trip planning systems, is the issue of data updating and maintenance. Transit schedules and route data are updated by individual transit agencies, oftentimes quarterly, but more frequently in some instances. These updates have to be sent or uploaded to the regional transit information center to be processed and put online. This is a time consuming and potentially error-prone process. This problem worsens as the number of transit agencies increase. Additionally, there is an issue of ontology, as
different agencies use different ontology to describe their data elements [3]. Furthermore, this approach makes it difficult to implement agency-specific search rules, such as suggesting transfers only at transit centers rather than any other potential transfer points [1, 4 and 5].

Given the limitations and problems of data integration, research has been shifting to the second approach, application integration, which uses the distributed computing model to link independent trip planning systems in a loosely coupled manner. This allows each transit trip planning system to serve individual transit agencies, yet through middleware or system mediators they can interact with each other [1]. A middleware or mediator is developed to coordinate message exchange among user requests and distributed systems. This shift is important in the transit trip planning paradigm because it offers a new method to link with vendor-dependent systems with different data structures and path-finding algorithms, running on heterogeneous hardware and software environments.

This paper intends to address the issue of data and system interoperability, from two different perspectives, using a region-wide cross-jurisdiction transit trip planning system as an example. First, we addressed the issue of cross-system coordination by developing a mediator system based on Web Services and XML technologies and the Advanced Traveler Information Systems (ATIS) standard developed by the Society of Automotive Engineers. Then, we addressed the issue of interoperable system design by developing an open and interoperable system using service-oriented design. Both have benefited greatly from the advancement of CI and, more specifically, Internet GIS [6].

The mediator is created through a virtual server, connecting all transit trip planning servers by forwarding and collecting messages. For example, if a user asks for a trip that originates from Service Area A and ends at service area B, the mediator forwards the user request to both servers, receives partial results, and assembles the results into a set of final itineraries. The mediator does not have direct access to the path-finding algorithm inside the trip planning systems. Thus, it ensures the independence of and loose coupling between systems. However, the mediator has information on all transit trip planning servers. The message exchanges between the mediator and different trip planning systems (e.g., Service Area A and Service Area B in the above example) work through a standard or mutually agreeable XML schema, e.g., the ATIS XML schema. This system framework was implemented in the City of Waukesha and Milwaukee County Transit Systems (MCTS) in the Milwaukee Metropolitan area.

The unique contribution of this system framework is the creation of a virtual service by developing a mediator that communicates and exchanges messages among distributed trip planning systems. The system is loosely coupled so that each individual entity is independently managed and updated, and changes in one system do not affect the other systems. Thus, the problems associated with the data integration approach are avoided. Furthermore, the trip planner is expandable, so that other systems can be added with minimal effort.

References


