Chapter 10
User–Centric Vehicular Ad–Hoc Networks and Roadside Units for Public Transports Systems

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ABSTRACT
Public transportation is becoming more and more importance in big urban centers, as it is a key ingredient to sustainable cities. Still, richer and more diverse public transport services imply increased complexity to the users of such services. In this chapter, the authors address the problem of journey planning for public transport users. This problem can be described as finding the best route between two given points in a city taking into account the available public transport services. The authors describe and compare traditional approaches that are already deployed in most cities. They then focus their attention on new and promising alternatives that become possible with the emergence of user-centric vehicular ad-hoc networks, complemented with roadside infrastructure. The authors discuss the benefits and challenges behind this new approach for journey planning in public transportation, and propose directions for possible solutions.

INTRODUCTION
With the growing population densities in big urban centers, sustainable mobility is assuming more importance. Gradually, more public transport alternatives are made available to citizens. While this change substantially improves one’s mobility, it also makes it more complex to take advantage of public transports efficiently.

The central question that public transport users repeat routinely is “what is the best way to get from A to B by a combination of public transports?” Finding an adequate answer to the question in a reasonable amount of time is crucial to the perceived quality of the public transport...
service. Let us denote the problem of journey planning in public transport systems.

Given two points in a city, there are typically several ways to travel from one point to the other. Alternatives can vary in many ways, like means of transportation (e.g., subway, train, tram, bus, ferry), operators, estimated durations, prices, number of tickets needed to completion, etc. All those aspects are important for public transport users and they can have a massive impact on the success (or failure) of the journey planning choices that one makes every day.

Any suitable solution to help users with journey planning should fulfill two main requirements. First, it should provide the user with the best route in terms of duration, price, and number of changes, or a possible conjugation of these factors, according to specific user requirements. Second, it is fundamental that the solution is available when the user needs it. Ideally, a journey planning system should be ubiquitous relatively from the user’s point of view: whenever the user needs to determine the best route to a target destination, no matter where the user is, the journey planning system should be available to provide a prompt and correct answer.

To fulfill these requirements, journey-planning systems need to overcome some fundamental challenges. The information that drives journey planning is typically complex. It ranges from static information sources, such as maps, timetables and fare information; to dynamic information, such as real-time information about accidents and other events that disturb the transport services.

Furthermore, as public transport networks grow, the larger becomes the above information. Hence, delegating the responsibility of finding the best option to the user is not a good choice.

For example, if a user is standing in Piccadilly Circus and she wants to go visit the Big Ben, we want to provide her with the quickest, the cheapest, and/or shortest alternative, between those two points of the city of London. Furthermore, we pretend this information to be of easy access to her in the starting point, and if possible, that it can move with the user for pervasive and ubiquitous use. It is far from trivial how to achieve these goals. The complexity and amount of information needed are challenges, because in this example the user has a minimum of eight alternatives, using public transports, to travel between those two points (Journey Planner, 2011).

Information dynamism is also an issue due to unpredictable events (e.g., accidents, service interruptions) or abnormal traffic affluences (higher or lower than normal). For example, even if the user chooses the best route option, it can become an invalid “best option” due to these unpredictable events, which can have negative consequences to that option and may invalidate the characteristics that influenced the user’s choice.

Sometimes information is not available where it is most needed (i.e., the place where the user currently stands) due to few available information sources. Other times the corresponding information sources are located in far points, from which information needs to be transmitted. In our example, an accident in the best option between Piccadilly Circus and Big Ben is often perceived only when something starts to go wrong (e.g., the user stands in an abnormal traffic jam), and this can be a problem. If the user had received information about the interruption earlier better options could have been made by the user.

To ensure that relevant information is available where public transport users need it, solutions such as electronic panels or on-line Internet-based services are very popular nowadays. Still, these typically incur substantial costs to the operator and, possibly, the user.

Finally, information is often from different operators, which typically do not cooperate between them to provide the user the best information, but the one that best fits their interests. For example, when standing in Piccadilly Circus, the user should know the different alternatives from different operators to travel to the Big Ben. This is a great challenge because existing and already