Development and Performance Evaluation of Urban Mobility Applications and Services

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Summary of Ph.D. dissertation

Urban Mobility studies are necessary for the examination of metropolitan traffic patterns, the evaluation of new traffic policies, the testing of future vehicular applications, and the construction of efficient public transportation networks, among other purposes. 5G mobile network technology has promoted the creation of services with ultra-low latency requirements, which has facilitated, among other areas, the development of automotive applications. Concepts that have been investigated for several years, such as self-driving automobiles, vehicular communication, and real-time mobility services, are now on their way to becoming a reality. Mobility services for real-time traffic information and navigation systems play critical roles in vehicular applications, and they are becoming increasingly popular.

Mobility simulations are required for all automotive applications in order to evaluate the efficacy and reliability of the systems proposed. As is often the case, the larger the data set, the better. As a consequence, numerous projects in the disciplines of mobility and vehicular communication have sought new traffic simulators with expanded investigation regions, which could include an entire city and its surrounding suburbs. This thesis introduces TuST (Turin SUMO Traffic), a city-wide simulator for modeling traffic in Turin that makes use of the SUMO (Simulation of Urban Mobility) tool. The whole collection of vehicle traces collected over the course of 24 hours was created using TuST and made publicly available for other investigations. In fact, any vehicular simulation relies on a realistic mobility environment in order to prove its reliability and precision.

Vehicular applications that could benefit from the use of realistic traces from the TuST simulator include those that investigate micro-mobility at junctions. V^3TL (Vehicle-to-Vehicle Virtual Traffic Light) is a model of this type presented in this thesis for scheduling priority at uncontrolled intersections. The service offered by V 3 TL can be offered to self-driving and connected cars at crossings that are not controlled by a traffic light in a totally distributed way. Applications based on Vehicle-to-Network (V2N) communication are another example of mobility services that might be envisioned in the near future for any connected car. In such scenarios, the flow of messages created by any automotive entity must be processed and dispatched by a cloud node, which is often a Broker server. In this thesis, we illustrate the technique that was used for the development of two use cases that make use of V2N communication in real-world testing settings.

Besides automotive applications, urban mobility studies are essential for local municipalities in order to offer suitable infrastructure and services to their citizens. Knowing the number and shape of customer flows permits a local authority to correctly scale an already existing service or to propose a new one that is tailored to the needs of the community. By installing a specialized sensor on a public bus, we were able to construct an Automatic Passenger Counting System (APCS). By utilizing a complex software procedure, we are able to provide GTT, the Turin public

transportation agency, with a real-time counting system that is useful for determining ideal bus frequencies on public transportation lines and for complying with the capacity limits imposed by COVID-19 restrictions. Eventually, we examined the prospect of creating a new application that would be targeted at pedestrians who were walking through a train station or metro station. Specifically, the model described in this thesis is a content sharing system that operates in a micro cloud environment. As a result of cashback or discounts offered by the transportation authority or by the store owners, we demonstrate how users may distribute information that is beneficial to others, such as train timetables and service delays, as well as special deals offered by coffee shops and stores.