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Chapter 56
Urban Mobility Observatory

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Abstract The Urban Mobility Observatory (UMO) will gather, store, and disseminate empirical multi-modal traffic, transport and mobility data, using a well-balanced set of innovative data collection methods. It will make these comprehensive data available for scientific research to develop and test new theories and models to better understand, predict and facilitate multi-modal mobility in large urbanized regions. UMO is located in the Netherlands, being one of the densest urbanized countries in the world, facing severe accessibility problems and environmental pressures from transport.

56.1 Introduction

Urban transport systems are becoming increasingly complex. At the same time, transport technologies and services are developing rapidly, which changes travel behaviour. The Netherlands is one of the densest urbanized countries in the world, facing severe accessibility problems and environmental pressures from transport, while having a strong interdisciplinary and multi-stakeholder collaboration tradition. This combination demands new and integrated observation, analysis and modelling approaches. The Urban Mobility Observatory (UMO) will collect, integrate and store empirical and experimental multi-modal traffic and transport data and make these available for scientific research in order to better understand and facilitate multi-modal mobility in large urbanized regions.

UMO will be realised by a dedicated academic consortium of 6 universities (Delft University of Technology (lead), Vrije Universiteit Amsterdam, Eindhoven University of Technology, University of Twente, University of Groningen and Utrecht University) and 2 research institutes (Centre for Mathematics and Computer Science (CWI) and Amsterdam Institute for Advances Metropolitan Solutions (AMS)) that together with the Dutch Research Council will invest 3.2 million Euro. The

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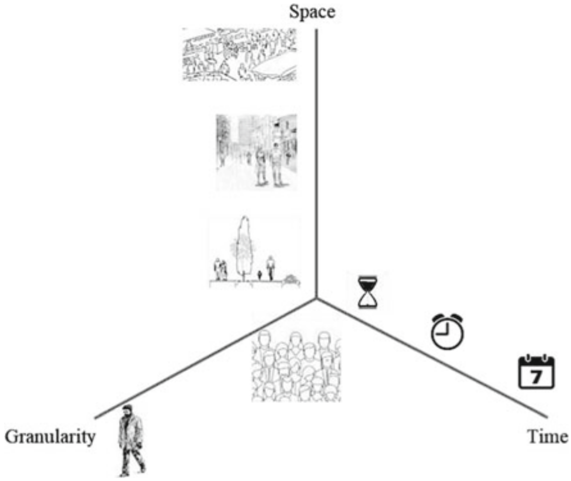

Fig. 56.1 Three dimensions to structure data and data sources: time, space and granularity

development of UMO will be based on experience gained in earlier projects including mass pedestrian movement observations during large events in Amsterdam, experimental observations in the Green Village living lab in Delft and spatial analysis and modelling in the SPINlab in Amsterdam.

In the remainder of this paper, we will first address different types of data, that will be collected by UMO. Then, we show the detailed design of the UMO facility, followed by an example of one of the living labs in de Delft University of Technology Campus (the Leeghwaterstraat). We end with conclusions.

56.2 Data Types

A wide variety of data sources describing mobility, transport and traffic exists. We structure these data sources along three dimensions: time, space and granularity, see Fig. 56.1. The time scale ranges from several microseconds (e.g. delay in propagation of information in autonomous vehicles) to multiple years (e.g. household composition). The spatial scale ranges from a cross-section (e.g. lateral distance between bicycles) to a whole city (e.g. origin-destination patterns). Finally, the granularity scale relates to the information available on the individual travellers. Low granularity implies little information (e.g. for social media data), while high granularity implies a lot of information per person (e.g. for people participating in a driving simulator experiment). In a way, this granularity is linked to the distinction between microscopic (individual) and macroscopic (aggregate or flow) perspectives.

Fig. 56.2 Combinations of different data collection methods, covering the whole range of the three dimensions time, space and granularity

A specific sensor or data collection method collects data within a limited range of each of the three dimensions. To provide data on the whole range of all dimensions, we typically combine different data sources, see Fig. 56.2.

56.3 Components of UMO

The UMO facility consists of five components, namely sensor networks (Sect. 56.3.1), population sampling (Sect. 56.3.2), simulators (Sect. 56.3.3), a coupling module (Sect. 56.3.4) and the data module (Sect. 56.3.5). Figure 56.3 shows the relations between these components. Each component is further detailed in the following sections.

56.3.1 Sensor Networks

Sensor networks support distributed data collection for real life and on-site controlled experiments. These sensor networks consist of instruments to permanently observe real-life situations in a broad range of urban conditions, and functionalities for flexible observations. It also includes a moving sensor network of instrumented vehicles and instrumented bikes and portable devices for additional observations. State-of-the-art sensor technologies include cameras, radars, LIDARs, BT/Wi-Fi trackers, PIR sensors, and cell phone apps. All sensors are used to collect data on, for example, traffic conditions/traffic/driver state, drivers' and vehicle behaviour, bicyclists and pedestrian strain and fitness. Depending on the type of sensors, they collect data on individuals, individual vehicles (human driven, partially or fully automated, or remote controlled) or traffic flows (groups of individuals, vehicles) in a range from very local (area directly surrounding the vehicle, bicyclist, pedestrian) up to spatial and temporal aggregated (area, network) level. In addition, situational data may include weather conditions (temperature, precipitation, visibility, wind, lighting conditions), environmental conditions (air quality, noise) and characteristics of the geographic setting.

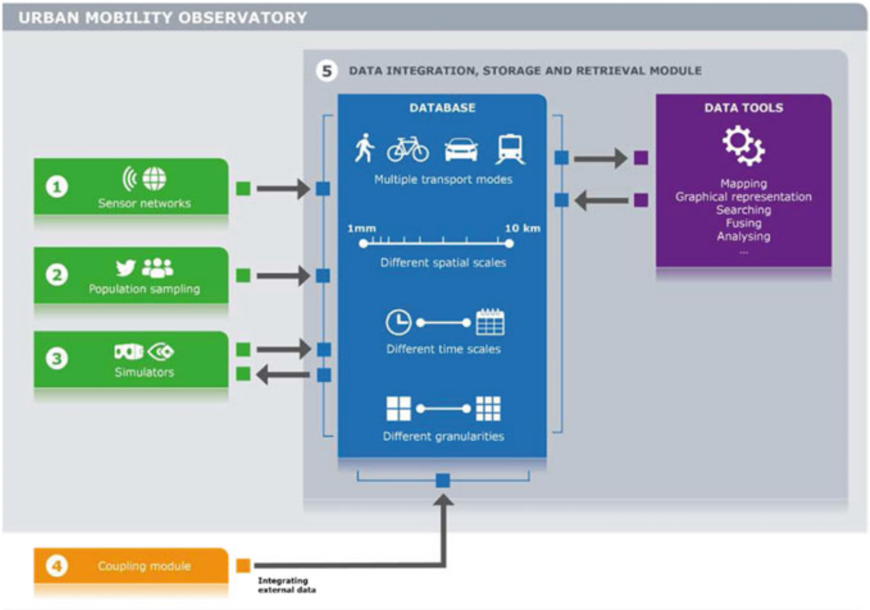

Fig. 56.3 Overview of UMO and its five components

56.3.2 Population Sampling

Traffic observation techniques alone cannot give a complete picture of current travel and mobility behaviour, for example because motivations of behaviour cannot be observed, choice alternatives are not discovered, and the observation systems only cover a part of the complete network/area. Furthermore, behaviour in exceptional and dangerous situations or behaviour in interaction with new technologies and systems, such as automated vehicles and Mobility-as-a-Service, is difficult or even impossible to observe in real life. This module therefore consists of crowd sensing and panel data gathering abilities. The panel data collection platform collects data from a representative sample of the Dutch population. It gathers self-reported behaviour and preferences of individuals, combining tested and validated questionnaires and app-based polling approaches. Crowd sensing is performed via crowd sourcing, social media and public fora data harvesting.

56.3.3 Simulators

The virtual reality (VR), augmented reality (AR) and simulator environments aim to closely observe (individual) human behaviour and experiences in specific experimental traffic conditions, such as potentially dangerous, not-yet existing, or rarely occurring situations With the VR, AR and simulator environment interactions between different traffic participants can be observed, including human-human as well as human-machine interactions (in cases of semi- or fully automated vehicles). Also, reactions of drivers to infrastructure modifications, various methods of information provision, and driver assistance approaches can be tested. This part of the facility is used in an iterative way. First, the collected data are used to generate realistic scenarios, which can be used to construct a virtual world: a VR/AR/simulator experimental setting. Second, the reactions and responses (behaviour or their evaluations of travel contexts) of the participants are observed, and as such provide input to the database.

56.3.4 Coupling Module

The Urban Mobility Observatory will functionally connect to existing data sources and living labs such as MobiliteitsPanel Nederland (MPN; set up by the Netherlands Institute for Transport Policy Analysis), National Datawarehouse (NDW; road traffic information sourced from Dutch road authorities), TomTom data, KPN data, Google data, OV Chipcard data (i.e., public transport data sourced from the Dutch national public transport payment and tariffing system). UMO will also link to existing facilities operated by consortium partners such as the datalabs DiTTlab, SPINlab and Urban Mobility Lab, and data collection facilities including Living Lab Smart Mobility, RADD and Social Glass6. This will, among others, enable a full integration of traffic and mobility behaviour on the one hand, and spatial data on for example land use, urban densities, land and real-estate prices, locational choice on the other.

56.3.5 Data Integration, Storage and Retrieval Module

The data gathered through the sensor networks, population sampling and simulators are all conveyed to different, spatially separated, but—as far as possible—federated databases, together with associated metadata (and essential tools) to keep the data retrievable and usable for a long period. These data have a variety of time and spatial characteristics, as well as different granularity, see Sect. 56.2. The backbone of UMO will complement the data with contextual information, either derived from the observation systems or from external, coupled data sources.

56.4 Leeghwaterstraat: Example of a Living Lab in UMO

To collect data within the UMO project a number of living labs will be initiated. One of these living labs will be on the campus of the Delft University of Technology, starting with the Leeghwaterstraat. It is a 450 long so-called bicycle street ('fietsstraat' in Dutch), where mixed traffic exists between cyclists and cars, while cyclists have priority. As this type of street is relatively new, it provides an excellent opportunity to investigate this co-existence of cars and (large) bicycle flows: when do car drivers overtake cyclists, who gives priority at an intersection, how many cyclists cycle next to each other, where do pedestrians cross the bicycle street? Eight poles in the Leeghwaterstraat have been equipped with cameras. These cameras focus on the road, and do not reveal any information on the entrances and the neighbouring buildings. The images are only stored the moment experiments takes place. This is announced through traffic signs mounted at the Leeghwaterstraat entrances. Two types of cameras have been installed, see Fig. 56.4. The oversight cameras are suitable to observe the manoeuvres of the cyclists, while the Star light cameras can be used to derive trajectories.

Figure 56.5 shows a screenshot of camera A, an oversight camera. Persons and license plates have been blurred for privacy reasons. We see that the street is wide enough to let two cars pass, and it also gives sufficient space for cars to overtake cyclists.

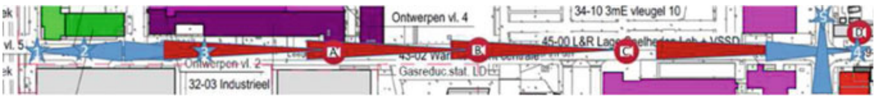

Fig. 56.4 Overview of the Leeghwaterstraat. Red: oversight cameras with a range of about 100m. Blue: star light cameras with a range of 55 m

Fig. 56.5 Screenshot of camera A on the Leeghwaterstraat

56.5 Conclusions

UMO will offer the possibility to collect, store and disseminate data from a wide variety of sensors and data sources representing different time and geographic scales, transport modes, and different settings (real life, experimental, virtual). UMO will provide accurate, quantitative, real-time as well as off-line, large scale tracking opportunities of people and vehicles. The data will be acquired in research projects covering a range of research methodologies, including exploratory research, theory development, hypotheses testing, model identification, model calibration, and model validation. At the same time, UMO will provide enriched (real time) data, as the basis for insights and models to unveil possibilities for the development of new transport services, transport related product-market combinations, traffic management concepts, transport policy options, transport mode and infrastructure development options and even land-use strategies.

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