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AIM Data Services

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Abstract: AIM Data Services as a *virtual facility* provides virtual 3D reference tracks for simulation applications in the domain of automotive and railway systems. It offers tools for management and analysis of experiment data and a platform for survey and processing of vehicle data in the public transport domain. Collected spatial data is bundled in a database cluster and published through common web mapping interfaces.

1 Introduction

The purpose of the research facility Data Services is to combine the major data pools developed in context of the "Application Platform for Intelligent Mobility" (AIM) (Schnieder & Lemmer, 2012, 2014). Raw and processed data are bundled and published as services for connected applications. Serving mostly data and tools for data management/analysis it can be considered a virtual facility. It encompasses four mayor components from different research fields which are

- a *virtual automotive reference track* (section 2.1) for automotive applications,
- a *virtual railway reference track* (section 2.2) for rail systems applications,
- a *driver assessment database* (section 2.3) for automotive applications and
- a *public transport data framework* (section 2.4).

AIM develops continuously and additional data and services are added to this facility to be exposed to other projects. As the focus lies on spatial data, the geodata services (section 2.5) will play a crucial role in the future.

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2 Technical description

The research facility Data Services is divided into five components which are described in detail throughout this section.

2.1 Virtual automotive reference track

The virtual reference track for automotive applications (Virtuelle Referenzstrecke Automotive) (Richter et al., 2015) is a virtual 3D model of Braunschweig's inner city ring. It serves as a base for automatic generation of virtual worlds for the domains of driving and traffic simulation and is composed of geodata as

- the 3D street topography with its topology,
- street infrastructure like traffic lights, signs, signals and
- city housing.

Figure 1 depicts the area of the automotive reference track. The street network of around 10 km was surveyed through mobile mapping in 2012 with a maximal error in x/y of 2 cm within the street area. The raw data is available as OpenDRIVE® in revision 1.3 and is also queryable through PostgreSQL/PostGIS (see section 2.5). Through the DLR project Virtual World (Virtuelle Welt) (Friedl & Richter, 2012) it was made accessible as Java object model for comfortable computational processing.
The other geodata sources consist mainly of cadastral geodata which have been accordingly processed to be fused with this road network. The base is a raster-based, textured digital terrain model with a spatial resolution of 1 m in x/y. The city model is automatically generated through certain rule files depending on defined attributes. All described components are exported into textured 3D models and fused into one paged 3D database to be consumed by common 3D rendering libraries (OpenGL, OSG).

Figure 1: Braunschweig‘s city ring (grey) as overlay on OSM/Stamen.

2.2 Virtual railway reference track

The virtual railway reference track for railway systems applications (Virtuelle Referenzstrecke Bahn) is a virtual 3D model of the railway track between Braunschweig and Gifhorn (see Figure 2, left) including the main station of Braunschweig. Its modelling is based on real geodata but was accomplished mainly manually. The raw rail network data of around 30 km length is available as railML in version 2.1 and contains

- tracks,
- switches,
- signals/control and safety systems and
- a large amount of crossings

for related research topics. Through a special track editor the resulting railML network can be modified and enriched with additional data. The finally exported virtual 3D model can be consumed by the same simulation software as the virtual automotive reference track (section 2.1).

Figure 2: Virtual railway reference track as overlay on OSM (left), with signals and crossings (right).

2.3 Driver assessment database

The driver assessment database is a platform to support the management and evaluation of experiment data obtained from driving simulations or naturalistic driving studies (NDS). The DLR-institute of Transportation Systems develops and uses a software framework called DOMINION (Gacnik et al., 2008) for experiment conduction. The experiment states and variable values are written into the DOMINION Data Sore which is integrated into the AIM Backend. On top of this, the tool DOMINION Data Store Control Center (DDSCC) as main part of the driver assessment database, serves for the visualisation and manipulation of this data (Figure 3).
DDSCC is developed in Java, implements the OSGi-framework and offers a modular graphical interface. Through the use of VLC it supports playback of various recorded audio/video formats. Spatial data as GNSS (global navigation satellite system) positions can be overlaid on maps (Figure 4), where the map viewer supports common Web Mapping Services (WMS) and the rendering of geo-referenced OpenDRIVE road networks.

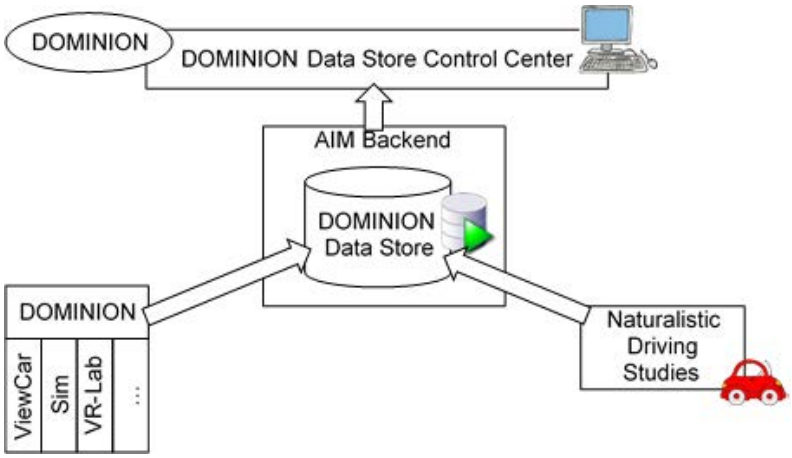

Figure 3: Dominion Data Store Control Center.

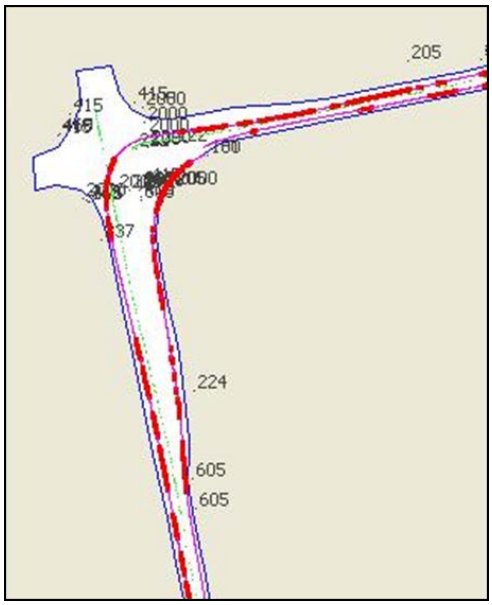

Figure 4: Plotting of GPS positions in DDSCC.

2.4 Public transport data framework

The public transport data framework represents an infrastructure for survey, processing and evaluation of vehicle data in the public transport domain. It offers the possibility to collect operational information and vehicle states/conditions of busses or trams (Schnieder, 2014). The core data providers may be

- An Integrated Board Information System (IBIS) which mostly available on public transport vehicles.
- A Fleet Management System (FMS) available through the vehicle's CAN-bus.
- An automatic passenger counter (automatische Fahrgastzählanlage, AFZ).

These inputs can be connected to the DLR service platform (Fahrzeugdatenplattform, FDP) which offers additional localisation through GNSS (global navigation satellite system) and various communication interfaces for data transmission. The service platform FDP can be deployed on the low-budged hardware cutie which uses a Linux operating system. Its modular design (Figure 5) allows easy adaption to individual experiments and applications. Recorded data can be examined in real-time as well as used as historical pool for later analysis. It is stored in a database with import/export capabilities over UMTS. Further communication standards as Bluetooth will be implemented in future.

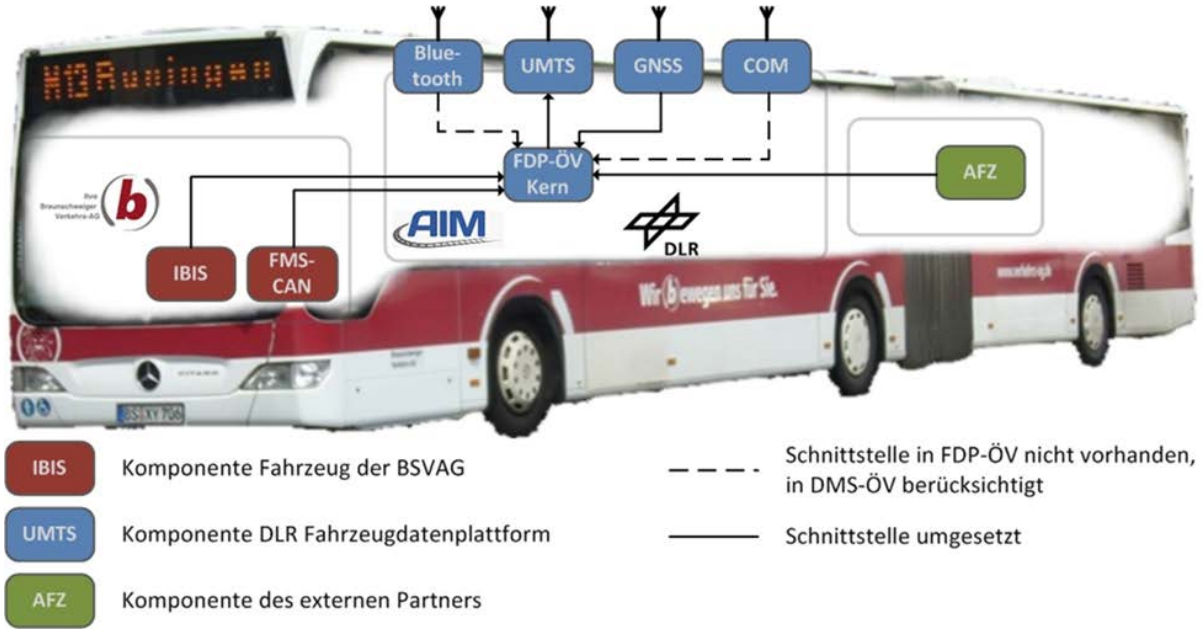

Figure 5: Architecture of the public transport data framework, status in 2014.

2.5 Geodata services

Projects in AIM provide a huge amount of spatial data, either acquired during the span of a project, or resulting as processed data. AIM Data Services uses a collection of spatial databases (Oracle Spatial, PostGIS) for storage and publishes the data as common web-services (WMS, WFS, WMS-C, WMTS, etc.). GeoServer (Figure 6) and QGIS Server are used as publishing tools. This combines easy raw data access with quick map designing and authoring for visualisation purposes. Furthermore custom map tiles can be styled and published for internal access.

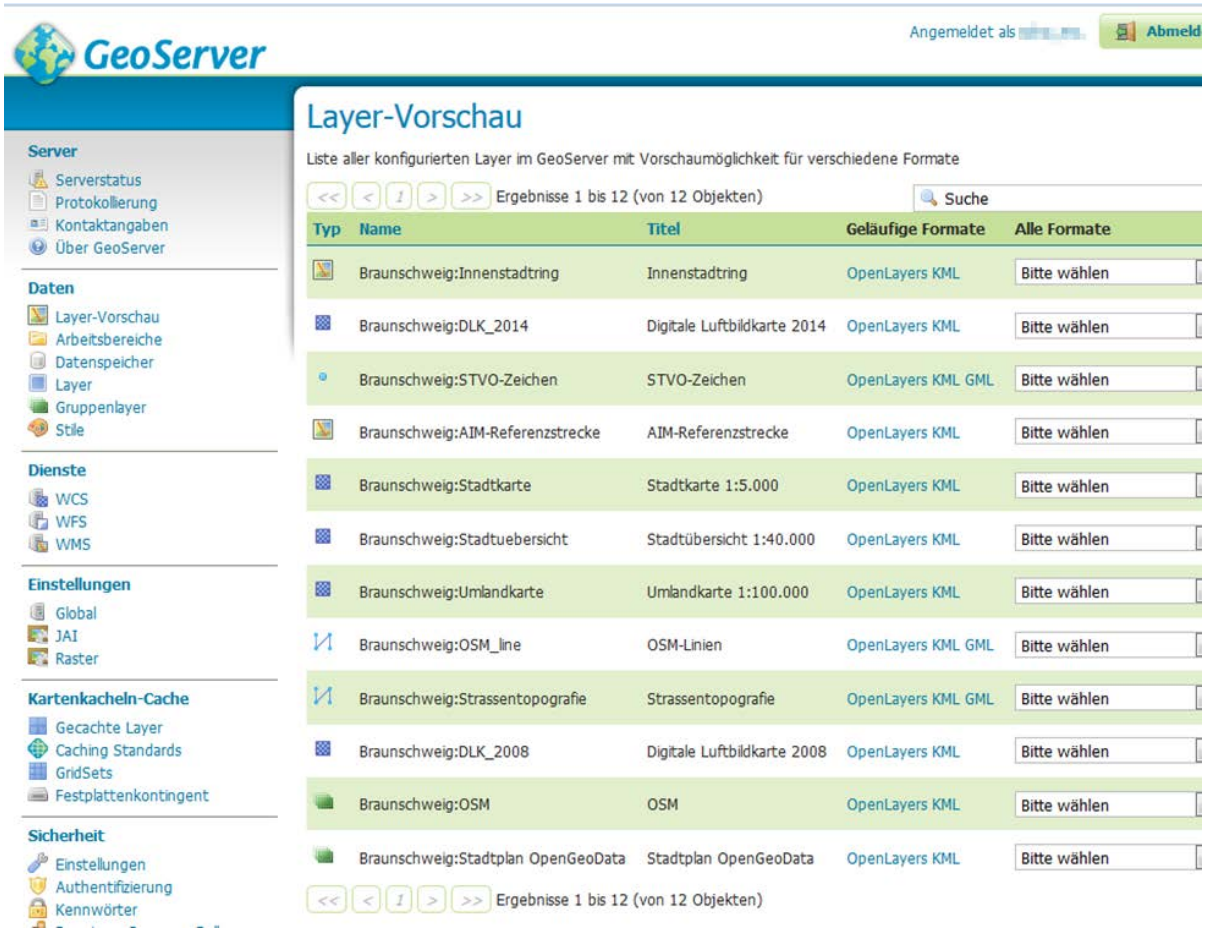

Figure 6: Preview of spatial data services.

3 Project application examples

3.1 Virtual automotive reference track in automotive applications

Main applications of the 3D virtual automotive reference track are the driving and traffic simulation. Currently it can be used in the DLR MoSAIC laboratory (Fischer et al., 2014; Lorenz et al., 2011), the Dynamic Simulator and the VR (virtual reality) laboratory, for example. The main objectives comprise development of driver assistant systems in urban settings as well as the simulation of Car2X communication and cooperative systems in realistic environments. Figure 7 shows a 3D rendering of the complete virtual world as used within a driving simulation setting. The simulation supports weather phenomenon and different lighting situations. Further possible applications for the geometric 3D model are noise distribution simulation, real-time simulation of GPS signals and virtual camera simulation.

3.2 Virtual railway reference track in railway systems applications

The main applications of the virtual railway reference track are rail-human-factors-studies and usability-studies as conducted at DLR in Braunschweig. Figure Figure 8 shows an exemplary simulation setup in the DLR RailSET (Railway Simulation Environment for Train Drivers and Operators) (Naumann et al.,

Figure 7: Braunschweiger‘s Hagenring towards the south.

2013) for this purpose. The simulation also supports peripheral characters like pedestrians and covers weather phenomena (fog, rain, back light, etc.), shading and a detailed sound simulation (rolling, wind, engine). The raw data can be enriched using an editor and converted to be also used in the DLR RailSiTe (Railway Simulation and Testing) laboratory (Asbach et al., 2013; Busse et al., 2012). Figure 2, right, shows the processed track with control components. This allows extensive simulations of control and safety systems and a coupling of existing ETCS/PZB (European Train Control System/Punktförmige Zugbeeinflussung) simulation with the 3D visualisation.

3.3 Driver assessment database in automotive applications

The main application is exploratory data analysis of recorded experiment data from driving simulation and naturalistic driving studies. As the DOMINION Data Store Control Center (DDSCC) is connected to a database, the experiment data can easily be browsed, as shown in Figure 9. In future a direct integration with the DLR Naturalistic Driving Platform (Noyer et al., 2013) will be implemented.

3.4 Public transport data framework

The public transport data framework delivers data which is obtainable by traffic companies, passengers and research facilities, for example. Its core applications encompass

- the survey of empirical data,
- a sensor platform for field studies and
- enquiry of the current vehicle condition for real-time applications.

Figure 8: Virtual railway reference track in a simulation setup in DLR RaiSET.

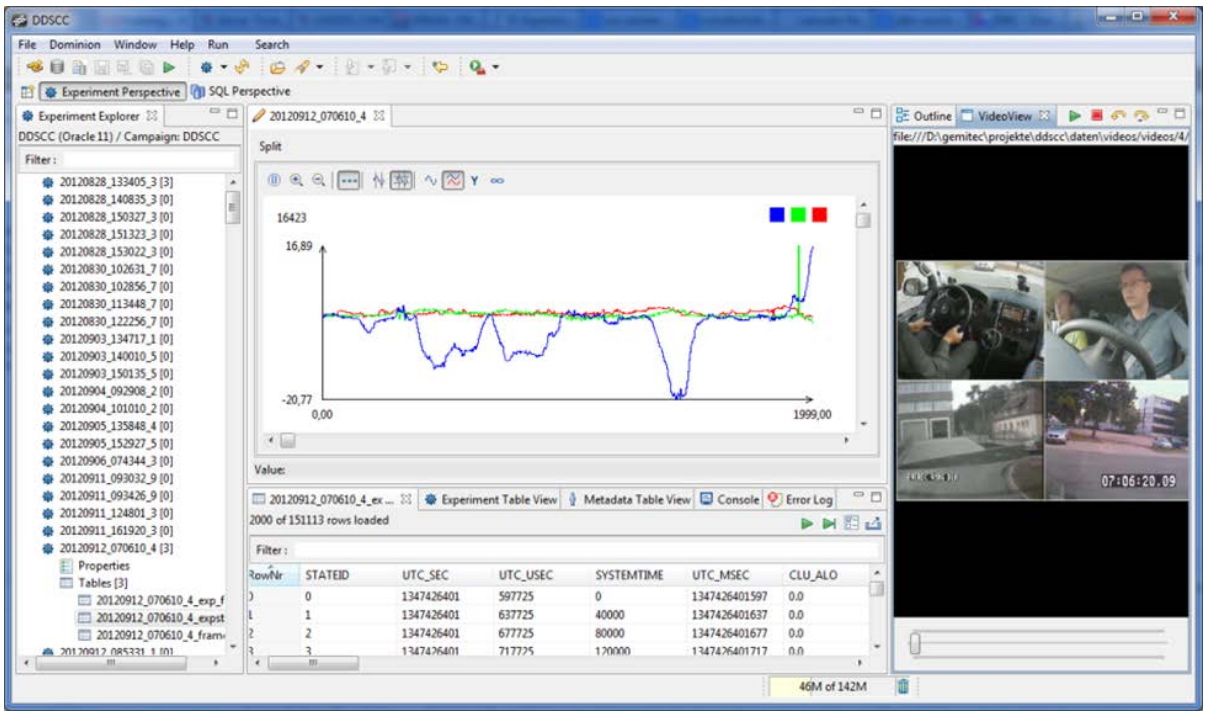

Figure 9: Data plot and synchronous video rendering in DDSCC.

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