Data Requirements

Traffic data (hourly)

traffic volume: values per lane or direction in vehicles per hour. For streets without online data, values for the current hour can be derived from MDT (mean daily traffic).
fraction of heavy trucks and other vehicle types (optional): If no online data is available section-specific average values are used
traffic situation according to HBEFA[1] (optional): traffic situation for the current time step; if not available dynamically, a static characterisation of the traffic situation will be used

[1] HBEFA = German/Swiss/Austrian Handbook of Emission Factors of Road traffic

Meteorological data (hourly)

temperature (°C)
wind direction (°)
wind speed (m/s)
dispersion class (Klug-Manier)

Meteorological data are available from climate stations nearby or from internet weather sources such as METAR

Concentration measurements (e. g.: PM_{10}, $PM_{2.5}$, NO_X, NO_2)

Data from background stations (optional) to calculate background values for each time step
Data from traffic stations (optional) to calculate NO_2/NO_X fractions for each time step

Road Network and Street Canyon Data (static)

road network data with number of lanes and information about adjacent building structure.

Emission Data (yearly)

Location and annual emissions of other sources (e. g. industry, domestic combustion) within the area of interest, available from emission cadastres data.

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Internet

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ESRI partner++

IMMIS^{mt}

Citywide Monitoring System of Air Pollution and Noise

IMMIS^{mt} is a real time monitoring system for air pollution and noise. Based on online traffic data, measurements of air quality stations and weather data, IMMIS^{mt} calculates traffic induced emissions, background and total pollutant concentrations as well as noise levels within the streets as, e. g., hourly mean values. To do so, IMMIS^{mt} combines various models which are validated and widely used in air quality planning.

Environmental Traffic Management

With the possibility to determine the impact of traffic on air quality within the streets in real time, IMMIS^{mt} can be used to extend traffic control leading to an optimised, environmental sensitive traffic management. If defined pollution levels are reached, IMMS^{mt} can e. g. raise warnings initiating traffic control measures. IMMIS^{mt} can monitor the effect of the applied control measures on the entire road network. Operated in planning mode, IMMIS^{mt} can be used to assess the effects of intended control scenarios, thus offering important assistance in the search for suitable and effective control measures.

Modules and Scalability

IMMIS^{mt} consists of several modules that can be combined according to specific requirements. Due to its design, IMMIS^{mt} can be connected to a variety of data interfaces (e. g. OPCI) within existing IT-infrastructures. IMMIS^{mt} is scaleable, thus able to process data for a few streets as well as extensive road networks of lager cities or conurbations. Within IMMIS^{mt}, all input and output data is stored in a database. Depending on specific requirements, the database can be both file-based or a client/server database management system.

Visualisation and Analysing

Results like traffic emissions, background and street concentrations or noise levels can be displayed with the IMMIS^{mt}-Viewer software or be published using a web mapping service for a cartographical representation in the internet and/or intranet. As all data is stored in a database, it can be used directly for reporting or analyses, e. g. of statistical parameters, not requiring advanced investigation or external expertises.

Validated Air Quality Models

The modelling process calculating the total concentration at a hot spot in a street canyon needs to account for regional background caused by long distance transport, urban background caused by the urban emission sources and the "additional concentration" caused by the road traffic in the street canyon itself. The data flow of the modelling process for each time step is described as follows: Based on incoming traffic data, the emissions of the major roads are determined by the emission model IMMIS^{em} (IVU Umwelt 2008a). Together with emissions of other urban sources the citywide spatial distribution of air pollution is calculated using the urban dispersion model IMMIS^{net} (IVU Umwelt 2008b). This provides the urban background concentration for each section and for the location of the air quality monitor stations. The regional background can then be determined as difference between the observed concentration at the background station and the urban concentration modelled for the station. Finally the micro scale model IMMIS^{cpb} (Yamartino, R. J., Wiegand, G. 1986) is applied to assess the additional concentration within each street canyon by the Canyon Plume Box approach using meteorological and local emission data. To determine NO_2 values out of the NO_x results, IMMIS^{mt} is able to provide different methods ranging from simple rational techniques based on measurements to complex photochemical models.

System Design

The system design is illustrated in the figure on the right side and shows that IMMIS^{mt} consists of several co-ordina ted models (modelling chain) which are controlled by the software component mt-Core. The mt-Scheduler controls the workflow of the overall system including tasks like

- data supply,
- start of the modelling chain,
- data transfer to archive,
- or data transfer to map service for e. g. city-wide pollution maps.

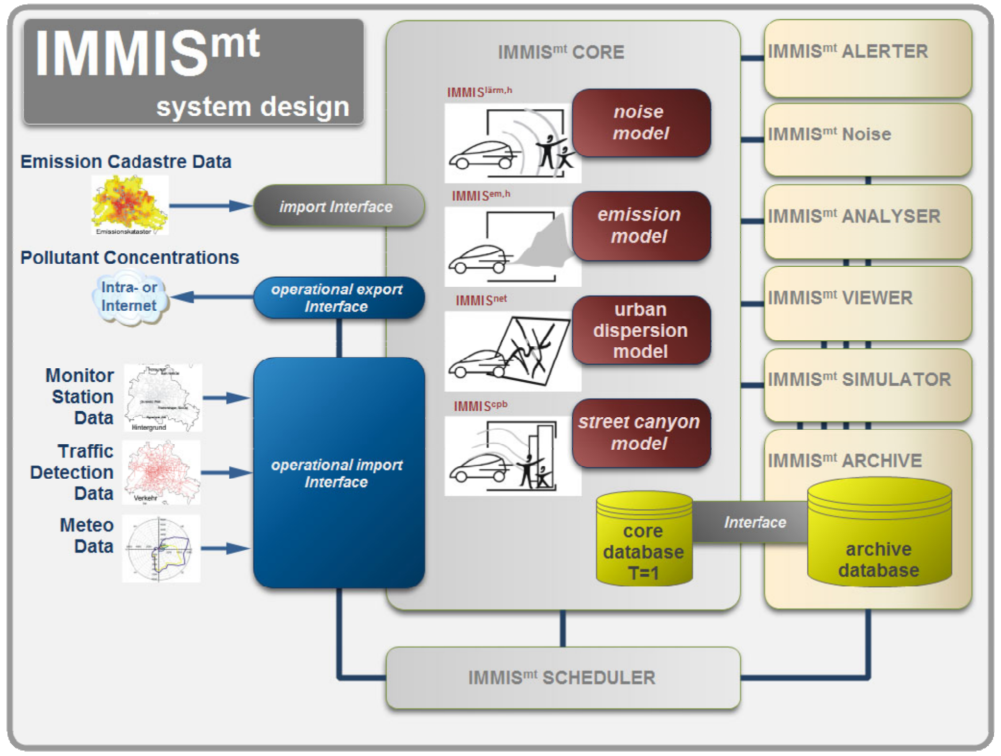
All input and output data is passed to and from IMMIS^{mt} using an adjustable data interface (e. g. OPCI, SOAP, HTTP, ASCII). For data storage within the mt-Core a file based RDBMS database system (e. g. Oracle, MSAccess) is used. This core database holds static data such as the road network as well as dynamic data for the current time step like traffic values or station measurements. The mt-Archive runs on a high performance client/server database (e. g. Oracle) and stores input and result data for each calculation. Together with the mt-Simulator all calculations can be repeated, if desired with adjusted parameters for scenario analyses.

mt-Scheduler (base system)

The **mt-Scheduler** controls single processes within the scope of the IMMIS^{mt} model system in a time- and state-dependent manner. It controls data supply, modelling chain and data publication. Additionally, the scheduler controls the data pre-processing of various interfaces.

mt-Core (base system)

mt-Core represents the core functionality of IMMIS^{mt} and is triggered by the **mt-Scheduler** to carry out the calculations for a single time step. Within a time step, **mt-Core** controls all necessary model runs (traffic emissions, background concentrations, additional and total concentrations as well as NO_2-calculations). For a successful model run, current data on traffic, meteorology and pollutant concentrations need to be provided. In operational mode, mt-Core can be run without a user interface reporting in log files. For manual calculations or in simulation mode (recalculating from archive) **mt-Core** offers a windows based user interface to control single processes.



mt-Archive (optional)

The **mt-Archive** stores all data of a model run. The database stores input data (traffic, meteorological and measurement data), intermediate results (emissions) and results for each model run. Data from the archive is available for the **mt-Simulator** to be used as input data for scenarios. The archive also provides modelled data for statistical analyses with **mt-Analyser**.

mt-Simulator (optional, only with mt-Archive)

The **mt-Simulator** offers the possibility to re-calculate single or several consecutive time steps. Data stored in the **mt-Archive** database can be used to simulate different scenarios in order to assess the impact of traffic control measures. Results will also be saved in the archive and tagged with a unique run_ID, distinguishing operational data from simulation data. Results of the simulations can be visualised with the **mt-Viewer.**

mt-Viewer (optional, only with mt-Archive)

The **mt-Viewer** is a tool to visualise the IMMIS^{mt} data, showing times series, charts and spatial concentration distributions on the entire network for a selected point in time.

mt-Analyser (optional, only with mt-Archive)

The **mt-Analyser** is a workbench to analyse the archived data statistically. The methods covers all main statistical parameters and can be applied to user defined time spans and selected road sections.

mt-Alerter (optional)

The **mt-Alerter** warns in case a pollutant exceeds a threshold value. Hence it can be used to initiate traffic related measures to prevent violations of limit values. Threshold values can be defined for individual receptors, sections, streets, or for the entire road network. Exceedances will be displayed on screen and/or can be transmitted by email or SMS to relevant personnel.

mt-Noise (optional)

The module **mt-Noise** calculates noise levels within the streets based on RLS90 and Schall03. For calculating noise emissions additional data will be requested:

- average frequencies of trains (streetcars or subway)
- corrections for maximum speeds
- corrections for pavement type, conditions of roads and tracks
- additions for slopes
- corrections for the influence of single reflection

For the calculation of the noise rating level the method of the long straight line is applied requesting following parameters:

- additions for traffic signal controlled crossings and junctions
- distances and air absorption
- ground and meteorological absorbability
- multiple reflection of street canyons