UDP_HH

URBAN DATA PLATFORM HAMBURG

Interfaces and further specifications

URBAN DATA PLATFORM HAMBURG

Hamburg

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1 Aim of the Document

This document is intended for

- departments within the Free and Hanseatic City of Hamburg (FHH) and IT service providers commissioned by them. The aim is to bundle the general requirements in connection with the Urban Data Platform (UDP_HH), for example for tenders, in one document.
- Interested parties who would like to find out more about the technical details of the UDP_HH.

For general information about the UDP_HH, please visit our website: https://www.en.urbandataplatform.hamburg/

2 Introduction

The importance of data is emphasized in the digital strategy for Hamburg from 2025 where the role of the Urban Data Platform Hamburg is highlighted: The collection, provision and use of data is an indispensable and natural part of modern Hamburg and nowadays an essential prerequisite for a functioning community. This requires a wide range of technical, organizational, regulatory and cultural prerequisites to be met. In many areas, it is possible to build on existing strategic cornerstones that have supported Hamburg's data-related path for many years. These include in particular, the Urban Data Platform Hamburg, the Urban Data Hub, the Transparency Portal and the Transparency Act, urban data governance and cooperation with the City Science Lab at HafenCity University. (Link to the Digital Strategy for Hamburg, in German)

The UDP_HH follows the general reference architecture of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) on Urban Data Platforms and the DIN specification 91357 Open Urban Platforms (Link to DIN SPEC 91357). The LGV is also involved in DIN SPEC 91377: Data models and protocols in open urban platforms. It specifies all the essential requirements for standards that make up the interoperability of a UDP and is expected to be published in 2025/2026. As a spatial data infrastructure node, the UDP follows the specifications of SDI-DE (Spatial Data Infrastructure Germany) and INSPIRE (Infrastructure for Spatial Information in Europe). The legal basis for INSPIRE and SDI-HH is the HmbGDIG (Hamburg Spatial Data Infrastructure Act), while OpenData is legally anchored in the HmbTG (Hamburg Transparency Act).

The following figure (Figure 1) describes the architecture of the UDP_HH from a generalized technical perspective. It shows the approach of UDP_HH as a system of systems. Starting from existing (specialist) systems (external systems) in which data is available, the UDP_HH uses interfaces (inbound interfaces and APIs) and various formats to store data in an information data storage (data storage) and makes it available to other systems (internal and external) in machine-readable form via open and standardized interfaces (outbound interfaces and APIs). The UDP_HH is based on standards of the Open Geospatial Consortium (OGC), which in many cases have also been further qualified as standards of the International Standards Organization (ISO).

The following describes,

- how data can be integrated into the UDP_HH (Chapter 3),
- how data can be made available for use in other systems via the UDP_HH (Chapter 4)
- the content specifications and requirements for file formats and spatial reference systems (Chapter 5).

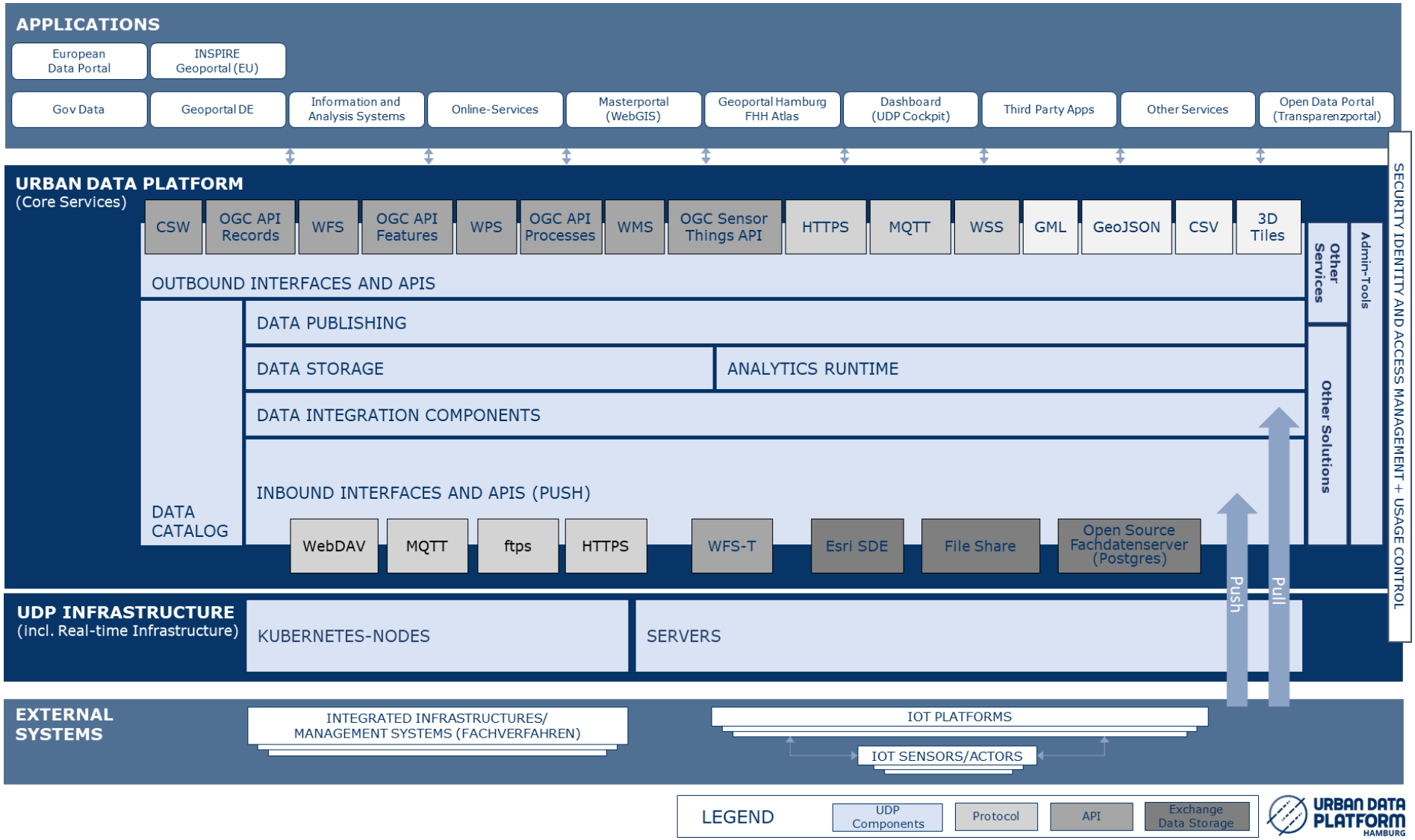

Figure 1: Architecture of the Urban Data Platform Hamburg (UDP_HH)

3 Integrate Data

Specialist data which is generated in FHH IT systems and is subject to the HmbTG must be integrated into the UDP-HH, so that it can be used in other systems and applications via standardized interfaces. This takes place in addition to storing the data in the internal data storage of the specialist systems.

The UDP_HH has the ability to connect systems in different ways and extract their specialist data in the desired update cycle. The publication process and the modalities for updating data are described in more detail on our homepage (https://www.urbandataplatform.hamburg/mitmachen). The following technical implementation options are available in the UDP_HH – referred to as **Inbound Interfaces and APIs** in the graphic:

3.1 Transferring Data to the UDP_HH via Web APIs

It is possible for external systems to use a web-based interface of UDP_HH for the direct transfer of data. This is the Web Feature Service (WFS) specified by the OGC. The WFS offers the option of carrying out write transactions (WFS Transactional, WFS-T for short). The versions currently used in the UDP_HH are WFS1.1 and WFS 2.0. Further details can be found in the OGC's WFS specification (Link to the WFS specification).

3.2 Setting up Read Access for the UDP_HH

UDP_HH can use Extract-Transform-Load (ETL) tools to extract data directly from external systems and integrate it automatically and regularly into UDP_HH (Data Integration Components).

3.2.1 Tables or Views in Databases

In the simplest case, the data storage component of your system is located in the FHHNET and is directly accessible for UDP_HH:

- You can provide us with the necessary database tables with read access via a database connection.
- If you have the option of creating database views, this simplifies the integration process: In this way, you can compile your data extract 1:1 as it is for transferring it to UDP_HH.

3.2.2 APIs

The next best option is a (possibly web-based) interface to your data. In order to ensure a smooth process, please note the following aspects:

- Up-to-date documentation is essential. Many modern web APIs are now designed in such a way that their self-description is generated automatically and therefore remains up-to-date even when changes are made. The Open API Standard (Link) is decisive here. Depending on the protection requirements of the data or the specialist system, the documentation can also be provided with access protection and/or exclusively on the intranet.
- Ideally, your interface should follow a manufacturer-independent standard. This offers you the greatest possible flexibility in the further development of your specialist system. In addition, integration into the UDP_HH is greatly simplified. For (relatively) static data, we recommend OGC API Features. Real-time or event-based data transfer is addressed separately under 3.4. If you would like to extend your specialist system in this respect, we will be happy to advise you.

3.2.3 Tips for Optimizing the Compatibility of your APIs

Investing in a standardized interface is particularly worthwhile if your system provides or is to provide many different data records for the UDP_HH. If the number of data records is manageable, you can significantly increase the compatibility of your web APIs with the UDP-HH (and in general) with the following minimum requirements:

- One API endpoint for each data table (or entity) to be transferred
    - One additional API endpoint per table/entity, which breaks down the associated data schema according to the standard json schema (see also https://json-schema.org/)
- The encoding GeoJSON (https://geojson.org/) of type FeatureCollection as data format (Link to further information on the Feature Collection)
    - This can also transport data without a spatial reference - in this case, the "geometry": field is set to the value "zero".
    - The OGC API Features interface of the UDP_HH provides data in this format and can serve as a reference (link to the metadata of the interface). This format validator provides further helpful orientation (link to GeoJSON validator).

- Simple paging mechanism (see also OGC API Features as reference implementation)
    - Parameters for limiting and skipping entries (usually referred to as “limit” and “offset”)
    - Link to the next page in each response document
- Self-documentation according to the Open API standard (see 3.2.2)

3.3 File-based Data Transfer via Exchange Server

If there is no possibility for direct data exchange (see 3.1 and 3.2), file exports are the next best option. The transfer takes place via the regular storage of files on exchange servers (e.g. FTP server, WebDAV or file share). UDP_HH can automatically and regularly integrate this data into UDP_HH using ETL tools. For a robust, efficient and sustainable transfer, we recommend manufacturer-independent file formats, in particular:

- GeoJSON (https://geojson.org/)
- Geopackage (https://www.geopackage.org/)
- Geography Markup Language (GML) (https://www.ogc.org/standards/gml/)

GeoJSON is a particularly handy format that is suitable for databases with a simple or non-existent spatial reference (“simple” here means point coordinates, lines and areas). CSV files are also common in this context – however, the format is not standardized. If your export options are limited to CSV, please follow common best practices from the data engineering/data science domains. In particular:

- For German-language data: semicolon as separator (avoids problems with decimal numbers)
- Include column headings
- Consistent data and number formatting
- No excess spaces at the beginning and end of cell values
- No nested structures

Similar considerations also apply to Excel. However, Excel brings additional complexity due to the many formatting options - such as linked cells, which are extremely problematic for machine processing. Care should therefore be taken to use a structure that is as simple as possible and designed for machine readability. If none of the above alternatives other than Excel and CSV are available, CSV is to be preferred. Further

information on the best possible preparation of files for import into the UDP_HH is explained in the data integration handout. (Link to the handout data integration, in German)

Regardless of the file format, only UTF-8 should be used as character encoding.

3.4 Real-time Data Connection

Real-time data can be integrated into the UDP_HH on an event basis or at regular intervals via ETL methods such as SensorThingsAPI:

- The preferred way to integrate real-time data into the UDP_HH is event-based provision via a MQTT broker.
- In addition, other protocols that enable event-based data provision can be used in exceptional cases by individual agreement.
- As a rule, data is provided via the SensorThingsAPI interface standard, which is used specifically for the provision of real-time data.
- For selected static attributes of the data set to be provided, the use of the standard UDP interfaces (see 3.1, 3.2 and 3.3) is also possible after individual consultation and evaluation.

3.5 Continuation of Geodata in the Central Geodata storage

This method is currently primarily suitable for geoinformation systems and is therefore a special case. Data managers are given secure access to their own area in the central geodata storage (QGIS specialist data server or ESRI specialist data server) at UDP_HH. Following coordination with the UDP_HH operations team, data is automatically and regularly transferred from the central geodata repository to the UDP_HH information area.

4 Use Data

Hamburg's IT systems must obtain specialist data from other systems via the UDP_HH if it is available there. The availability of data in the UDP_HH can be checked via

- the Hamburg Transparency Portal (https://suche.transparenz.hamburg.de/),
- the Geoportal Hamburg (https://geoportal-hamburg.de/)
- or the metadata catalog MetaVer (https://metaver.de/freitextsuche?provider=hh)

With the Outbound Interfaces and APIs, UDP_HH has a layer that provides data for other systems and applications via standardized web services. Comprehensive tutorials in German are available for web developers and data analysts in particular: https://www.urbandataplatform.hamburg/daten-finden

4.1 Data

Domain data and vector data are provided in the UDP_HH via both the WFS interface specified by the OGC and the OGC API Features (OAF) interface. OAF is a modern and user-friendly solution that can replace the WFS in the future: it offers the same range of functions but relies on modern web standards (including REST).

The versions currently used in the UDP_HH are WFS 1.1, WFS 2.0 and OAF 1.0. Further details can be found in the current OGC specifications (link to WFS specification, link to OAF specification) or for OAF in the central metadata entry (link to OAF entry in MetaVer).

The typical output formats of both specifications are GML and/or GeoJSON. Both can be displayed directly in a map or GIS client and processed cartographically. However, there are other API specifications that have been optimized for cartographic visualization. They are discussed below.

4.2 Maps

Geodata is made available as map images via the WMS interface. The versions currently used in the UDP_HH are WMS 1.1.1 and WMS 1.3. Further details can be found in the current WMS specification of the OGC (link to WMS specification).

4.3 Metadata

Metadata - i.e. data *about* data, services or applications - is provided via the Catalogue Service for the Web (CSW) specified by the OGC. The version currently used in the UDP_HH is CSW 2.0.2. In order to ensure the interchangeability of

metadata, a standardized format is used, which is defined in the OGC specification “OpenGIS® Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile” in version 1.0.0. Further details can be found on the OGC website (link to website).

4.4 Real-time Data

Depending on the application, real-time data is provided in real time or with as little latency as possible via the SensorThings API (STA) specified by the OGC. The current real-time data is published event-based, i.e. with every update, via an MQTT broker.

4.4.1 MQTT Protocol and the MQTT Broker of the UDP_HH

MQTT (see https://mqtt.org) is a protocol from the Internet of Things used to make event-based data available via a publish-subscribe service. The MQTT broker of UDP_HH has its own entry in the MetaVer catalog (link to metadata entry STA MQTT broker).

4.4.2 Sensor Things API: MQTT and REST/JSON-Download

In parallel to the MQTT broker, the real-time data is also provided via a REST interface of the STA in (Geo)JSON format. The data can also be provided in extracts as static data via WMS, WFS and OAF - however, the STA offers more flexibility in requesting specific data extracts and compilations (see https://www.urbandataplatform.hamburg/daten-finden, in German). In addition, time series are stored in pre-agreed cycles for a specific period in the UDP_HH depending on the use case and made available via the STA and in its data model. The STA version used is 1.1. Further details can be found on the OGC website (link to website).

The available real-time data sets and instructions for usage are broken down in the description of the STA service in the metadata catalog (link to the SensorThings API (STA) metadata entry).

4.5 File download: CSV and GeoJSON

For most datasets that are available via the UDP_HH, download resources also have a link to the respective metadata entry of the dataset: usually in CSV and GeoJSON formats. Both formats enable particularly easy and quick access to the data, e.g. for integration into spreadsheet programs.

For permanent integration into applications, ETL pipelines or analyses, we recommend our standardized APIs (see 4.1 to 4.4) instead of one-time downloads.

The download option for CSV and GeoJSON is limited to datasets with a “flat” schema (i.e. without hierarchical substructures in the data); complex datasets cannot be downloaded in this way.

5 Further Specifications

After the technical interfaces, this chapter describes content-related specifications and requirements for file formats and spatial reference systems.

5.1 Content Specifications

This chapter provides an overview of the frequently recurring requirements for data provided via the UDP_HH.

5.1.1 Background Maps

Various background maps are available for the Hamburg city area, which can be selected for use in map-based applications. The background maps can be selected in Hamburg's Geoportal (https://geoportal-hamburg.de/) at the bottom left of the map image. All specialist data can be viewed under "Add themes". In the following, reference is made to the description of the underlying data set in the MetaVer metadata union catalog (https://metaver.de/), which is displayed via one or more WMS services. The WMS addresses can be found on the linked dataset descriptions in the References tab under the heading Further references:

- Link to Internetstadtplan Hamburg
- Link to basemap.de Web Raster Farbe
- Link to GeoBasisKarten Hamburg
- Link to ALKIS - ausgewählte Daten Hamburg (Amtliches Liegenschaftskatasterinformationssystem)
- Link to Digitale Orthophotos Hamburg
- Link to Digitale Orthophotos (belaubt) Hamburg
- Link to Digitale Orthophotos hochauflösend – FHHNET (only available on the FHH intranet)
- Link to Digitale Orthophotos hochauflösend (belaubt) – FHHNET (only available on the FHH intranet)

For background maps that extend beyond Hamburg, the Federal Agency for Cartography and Geodesy provides WMS.

5.1.2 Addresses

For the Hamburg city area, the daily updated addresses of the Zentraler AdressService Hamburg dataset (link to dataset description), which is provided as a WFS service (link to metadata entry WFS Zentraler AdressService Hamburg), should be used.

For a simplified access to the most important address information, there is a reduced data schema that can be queried via OAF (link to Zentraler AdressService Hamburg - simplified). Further details can be found in the data record description provide above.

For addresses outside Hamburg and in the Hamburg metropolitan region, a WFS service of the Federal Agency for Cartography and Geodesy (link to documentation, pdf; link to metadata) can be used. Access to this service can be set up via the LGV (kstgdi-hh@gv.hamburg.de).

5.1.3 Metadata Catalog

Data sets, services (web services) and applications must be described in the Hamburg metadata catalog as part of the data integration process. The catalog is a central entry point for the UDP_HH.

UDP_HH metadata can be searched on the Internet via the MetaVer metadata network (link to catalog). The Get Capabilites request of the CSW interface on the Internet can be found here.

The internal view of the data catalog can also be accessed from the FHH intranet (FHHNet) at https://hmdk.metaver.de/. HMDK stands for the Hamburg Metadata Catalog - in contrast to MetaVer, only Hamburg data is listed here. The Get Capabilites request of the internal CSW interface can be found here.

5.2 Data Formats

Manufacturer-independent, standardized file formats should always be used for the exchange of geodata. These include the Geography Mark-Up Language (GML, version 3.2.1), JSON for real-time data and GeoJSON (link to the documentation of the GeoJSON format).

5.3 Reference System

The ETRS89 reference system has been adopted by the AdV (Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland). For 2D applications with spatial reference, it is recommended to work in the ETRS89/UTM 32 spatial reference system (EPSG code: 25832).

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