Indoor Spatial Data Model for Wayfinding: A Case Study of the Masaryk University

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Extended Abstract

This paper describes a process of deriving building topology from data of a Building Documentation System (BDS) maintained by the Masaryk University, Brno (Czech Republic). The BDS contains information about more than 300 buildings, 22,000 rooms, 23,000 doors and 200,000 technological devices. Its primary purpose is Facility Management and therefore it is not sufficient for wayfinding. To be able to use it for this purpose, the data model has been analyzed, adjusted and expanded for several key information with respect to IndoorGML standard (OGC 2014).

The BDS is composed of two parts: Building Passport and Technology Passport (Herman et al. 2014). The Building Passport contains most of the BDS data which is related to wayfinding. It includes geometry of buildings and their parts (floors, rooms, doors and windows). *Figure 1* presents an example of Building Passport data visualization (Kozel et al. 2014). The data is stored in a geodatabase in separate feature classes. Each object in the database has its unique location code. This location code consists of a part determining building, a part determining floor of the building and finally a part determining particular room, door or window. Based on the location code, every room, door or window is assigned to one floor of a building.

Rooms are represented by polygon geometry. Rooms on one floor are connected through doors or free space passages, together referred to as passages in this paper. The passages are essential for deriving floor topology.

A door in the database has polygon geometry, unique location code (not always filled in), floor location code and location codes of rooms it connects (not always filled in, not always correct). Free space passages in the data were created artificially by cutting too long corridors or too large rooms with complex geometry into several smaller rooms. In the current data model, free space passages are not considered. However, a free space pas-

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sage geometry and information which rooms it connects can be derived by analyzing rooms geometry.

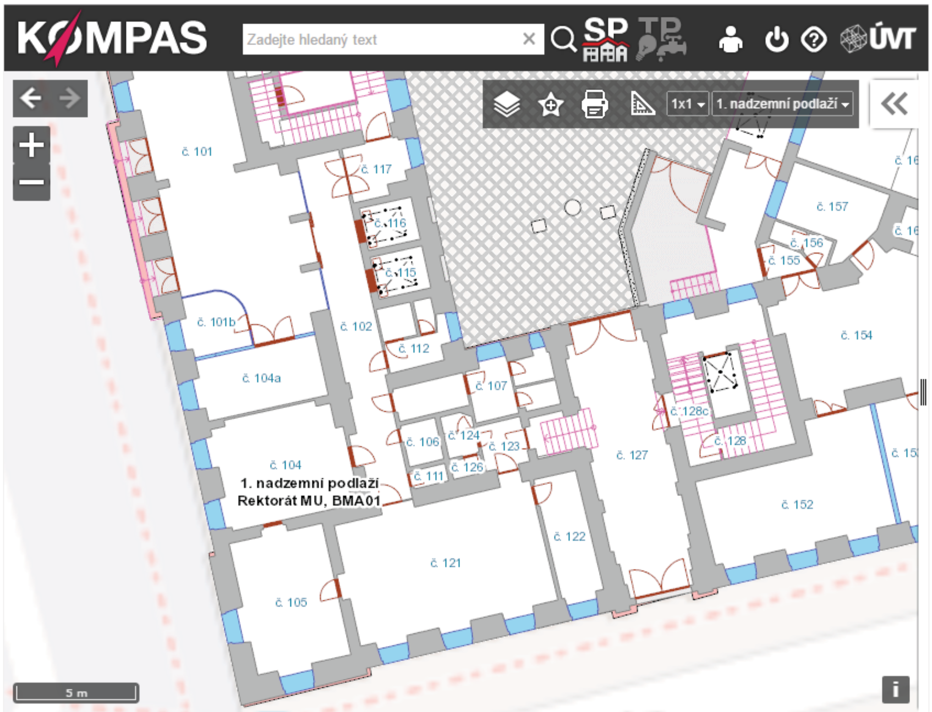

Figure 1. Visualization of Building Passport data in the Kompas web GIS (Kozel et al. 2014).

The current data model lacks information about connections between floors. In case of the Masaryk University buildings, floors are connected by elevators or staircases. Elevators are part of the Technology Passport data that provides information about devices of electrical installation, water supply etc. and relations between devices (Kroutil 2012). The information about elevators can be used to find out which rooms (elevator shafts) the elevator goes through and so can be used to define one part of floor connections.

In case of staircases, the current state of the database isn't sufficient to derive floor connection automatically. A separate feature class is used to store staircases. The feature class contains a multiline geometry (see *Figure 2*), where each stair of the staircase is represented by a line. The upward direction of the staircase is marked with an arrow (perpendicular to stair lines). As attributes, the feature class should provide location codes of rooms the staircase goes from and leads to. However, values of the location codes' attributes aren't filled in at all. The incompleteness doesn't allow to derive staircase floor connection automatically.

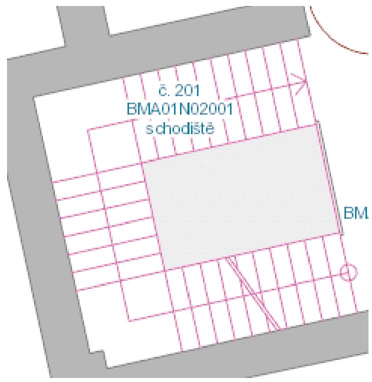

Figure 2. Multiline representation of a staircase.

In this case study, a topology of the Masaryk University headquarters was derived. At first, passages between rooms at the same floor were defined by a Python script using ArcPy library. A new feature class was created to store passages. It contains a passage geometry and location codes of rooms the passage connects. Doors were processed prior to free space passages. The longer axis of the door polygon was used as passage geometry. Location codes of rooms connected by the door were found by intersecting room layer with points drawn in a given distance from the door.

The script processes rooms' geometry to identify free space passages between rooms. Rooms of interstorey staircases cause problems during the processing because of their overlays with other rooms on the same floor. It would be better to treat them separately, but unfortunately it isn't possible to distinguish interstorey stairs and levelling stairs. Therefore, manual corrections of the result had to be performed.

Floor connections were automatically derived from the Technology Passport data of elevators. In the Technology Passport, even elevator shafts are considered as devices. Each elevator has several elevator shafts, one in each floor it goes through. The relation between elevator and its shafts is referred to as inner-outer devices' relation. Based on this knowledge, a table of elevators and rooms they go through was prepared using SQL and was used to define "vertical passages" of building topology. Due to the incompleteness of the staircase data, the rest of floor connections was added manually to complete whole topology of the building.

The result of the process described above provides information about room adjacency and will be used as an input for Door-to-Door algorithm (Liu & Zlatanova 2011) to define a path network useable for indoor routing. The derivation of the building topology was significantly affected by the primary purpose of the input data which differs from wayfinding and navigation. This study depicts necessary changes in the Masaryk University BDS data to be applicable for wayfinding purposes.

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