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Conceptual foundations for publishing web map services of topographic databases in Poland

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Abstract:
In 2021, the Polish government enacted new regulations concerning the specifications of topographic data at a scale of 1:10,000, known as BDOT10k. This legislative change prompted the Head Office of Geodesy and Cartography to commission the development of a new version of services for publishing topographic data in a revised application schema. While efforts to optimize graphical composition remain ongoing, universal principles defining the project's foundations have already been established. This paper presents the conceptual basis for this project, focusing on cartographic principles rather than technical implementation aspects such as database management or synchronization.

After the data is updated in the database (BDOT10K schema), a dedicated mechanism detects changes in the tables and triggers the update of the BDOT10K_PROXY1 schema. Simultaneously, a process is launched to update the BDOO data (nominal scale 1:250,000), populating the BDOO_PROXY1 schema. In the PROXY schemas, materialized views are created to generalize the geometries of spatial objects for various map scales. In the USLUGI schema, access views have been created, which use only simple SELECT queries to retrieve data for display from the PROXY schemas. There are no data processing mechanisms in the USLUGI schema, which ensures very fast performance of the views. After the update in the BDOT10K schema, the BDOT10K_PROXY2 and BDOO_PROXY2 schemas are populated. Once the data in these schemas is processed, the views in the USLUGI schema are switched to use the PROXY2 schemas. During the next update, the PROXY1 schemas are populated again, and the process repeats. This approach ensures continuous access to topographic data, even during data processing. The database views in the USLUGI schema are used as the data source for publishing WMS/WMTS services. The overall architecture of this process is illustrated in Figure 1.

The principles adopted for the project purpose are as follows. (1) The critical factor influencing the preparation of WMS/WMTS services is the resolution of source data. Expressing this resolution as the denominator of scale, as specified in ISO 19115 standard, provides only a partial understanding of the "density" of source data. To address this limitation, the project adopts a method developed in the research by Bielawski (2018). This methodology introduces concepts such as actual geometry resolution, nominal geometry resolution, and densitative resolution. (2) In the context of spatial data services, the concept of scale takes on a distinct meaning, referring to levels of detail rather than traditional cartographic scales. These levels, denoted as LV1 (nominally corresponding to 1:8,000,000) through LV13 (nominally corresponding to 1:1,000), are employed to reflect varying levels of data specificity. To design visualizations capable of effectively representing data across levels LV1 to LV13, object geometries must undergo generalization tailored to screen-based visualization (Ostrowski 2002, 2004; Karsznia at al., 2020). The initial step involved determining nominal resolution, defined as the expected vertex density for data at specific levels. Nominal resolution for this project corresponds to the minimum spatial distance between the centres of two adjacent pixels on a Full HD screen for a given level of detail. This calculated geometry density was subsequently applied to generate accuracy levels optimized for visualization at specific scales. The values were implemented to prepare vector data for each defined level. (3) A significant focus was put on defining quantitative generalization thresholds for individual detail levels. The selection of database objects for visualization at specific detail levels considered additional attributes of individual instances. For example, the selection of settlements displayed at different detail levels accounted for administrative significance, historical relevance, and population size (Karsznia 2018).

These characteristics were quantified using the IWB coefficient, which determines a settlement's inclusion on levels LV1 through LV7. This article outlines the methodology for calculating the coefficient. (4) Quantitative generalization further incorporates instance-specific attributes. For road visualizations, road class and management category were used, whereas for watercourses, the length of the named feature served as a selection criterion. It is assumed that only watercourses exceeding a defined length should appear in a given level.

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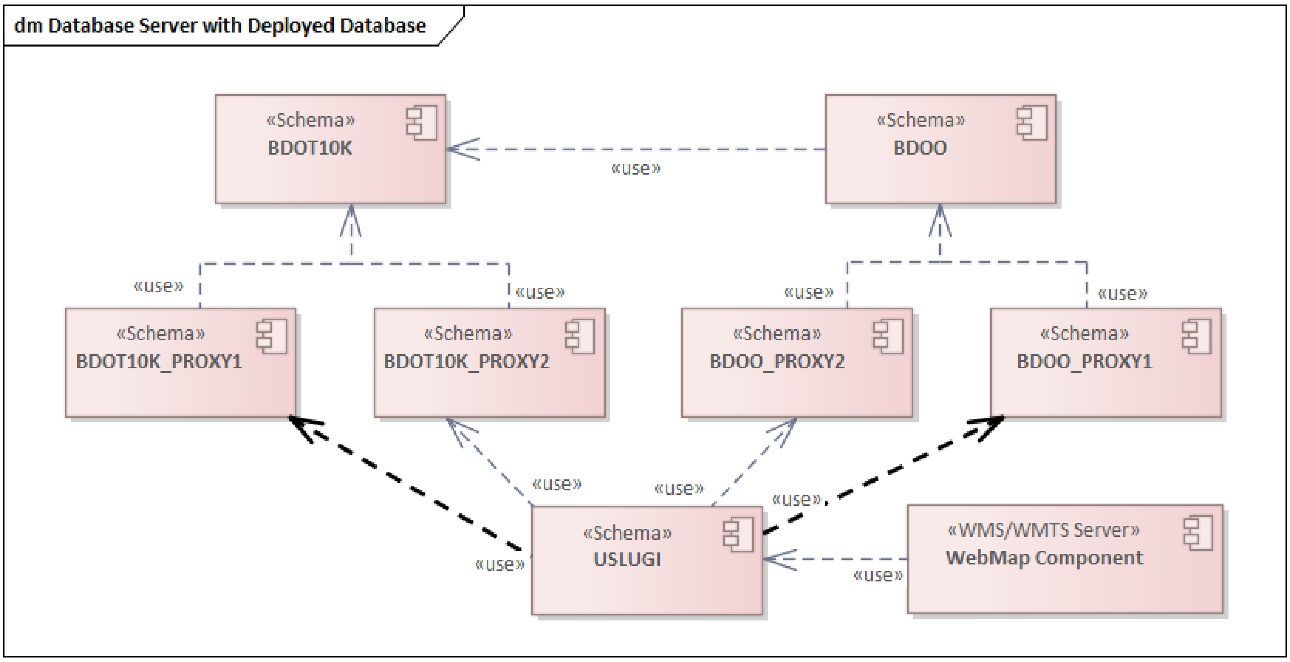

Figure 1. Data Architecture for the Web Map Service

The greatest challenge was selecting the appropriate content to display at each scale using generic rules. A significant difficulty lies in consciously managing the visibility of individual layers in a way that ensures appropriate object density in the cartographic presentation at every scale, from 1:8,000,000 to 1:1,000. Another major challenge was determining the optimal level of geometry generalization for each scale level.

Last but not least, a critical aspect of the project involved automating label placement. Labels are statically stored and can be manually edited. A key issue was the fixed positioning of labels, which remains unchanged following data updates. This was achieved through the use of the Label EZ application by MapText, a specialized tool for automated label editing. The Label EZ software implements principles described in Aleksander Wolf's dissertation (1999). Additionally, Label EZ algorithms were employed to generalize label placement for various levels of detail.

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