A CONCEPT AND DEVELOPMENT OF GEO-INFORMAION WEB SERVICES FOR VOIVODSHIPS IN POLAND

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Abstract

Within the Project No. 6 T 12 2005C/06552 „Methodology and procedures of integration, visualisation, generalisation and standardisation of reference databases, which are accessible in state geodetic and cartographic resources, as well as their utilisation for development of thematic databases", the general concept of a multiresolution, topographic and thematic databases and methodology of harmonisation of reference databases, which create the resources of geodetic and cartographic data, have been developed in the period 2005–2008 in Poland. One of the final tasks within the granted Project concerned the development of geoinformation services, which distributed reference and thematic data, stored in the state resources of geodetic and cartographic data. Works performed in this area aimed both, at popularisation of valuable topographic and thematic data from the state resources, as well as at verification of the possibility to apply the, so-called, open source or free software licenses, which allows inexpensive and effective publication of geographic data via Internet.

The basic assumption was to develop simple and universal geoinformation services, which could be accessible for wide groups of individual and institutional users. An information system, consisting of several applications (GeoServer map server, Oracle Express 10g database, OpenLayers libraries, TileCache software tools) and standards of data WMS and WFS data distribution (promoted by the Open Geospatial Consortium) allowed for implementation of prototype geoservices for the area of the Lower Silesia Voivodship. Besides, original applications were developed for thematic data.

At the first stage of development, data from the VMap Level 2 database in its usable version (VMapL2u) – the only vector database developed for the entire country – were made accessible. In order to increase attractiveness of results, the functionality was amended with the possibility of hybrid visualisation of vector topographic data and satellite images, which are accessible in Google Maps. The satellite image presented in the background of the VMap enhances visual effects more than the aerial orthophotomap from the state resources, which could be an excellent background for the TBD database. General geographic data, amending topographic presentation at small scales, were also selected form the Google Maps services.

In the complete version of the system, successive components are: DTED2 elevation data, data from SOZO and HYDRO thematic databases and elements of names from the State Register of Geographic Names. Efficient integration and visualisation of those data resources in one service is possible due to the same spatial reference – military topographic maps at the scale of 1:50 000 are the sources for the majority of data.
Visualisation of the basic topographic data is based on a system of symbols developed for the usable version of the VMap L2u database. The cartographic image refers to good patterns of civil topographic cartography, and first of all, to the map at the scale of 1:50 000. The topographic map is displayed at three visual levels, and, in the case of smaller scales, the standard visualisation of Google Maps appears. Thematic section of the services include: the sozological and hydrographic maps and the DTM visualisation in the form of the hypsometric map.
For an arbitrary thematic section and for an arbitrary scale level it is possible to display both, vector information layers as well as hybrid visualisation – maps on the background of satellite images or a map amended with shaded terrain relief. It results in the possibility of composing such presentation, which meets the user demands. Utilisation of maps is facilitated by the dynamic legend, which content is integrated with the map of each type, presented by the services: the topographic, sozological, hydrographic or hypsometric map.

The content scope and the functionality of geoservices allow for simple reviewing and searching for georeference data for a voivodship. The result of database queries may be displayed in the tabular form or on a map. Besides the standard access, performed by means of a web browser, the service may be accessed by means of an arbitrary GIS tool or a geobrowser, such as ArcGIS Explorer, which reads WMS or WFS services. While the typical web browsers allow for implementation of the basic tasks, independent geoinformation applications allow to combine various data originating from external and internal sources, as well as for the advanced, usually 3-dimensional visualisation.

1. INTRODUCTION

The importance of spatial information in an everyday life has been considerably increased recently. The option of geo-locating is used by more and more installations, such as: photographic cameras which code places of taking photographs, mobile phones specify current locations of users, Internet browsers filter results of searching for information, depending on a place of connection to the global network. Internet services, where the key information component is geographic location, are also popular among wide groups of users.
Since the date when users got the possibility to easily, spatially identify objects, facts or events (Peterson, 2005), they utilise it wider and more willingly. Among Internet geo-information services, those which play the navigation and locating roles, are most frequently represented. According to expectations, importance of those services will constantly grow; the flag example of them is Google Maps with thousands of implementations, spread all over the world.
The geo-information services should guarantee, first of all, the appropriate quality of data: its timeliness and completeness, as well as usefulness. That is why it is necessary to combine various sources of data and various methods of transfer: e.g. image presentation, which are characterised by shorter times of updating and which ensure complete projection of the terrain, or vector presentation, which influences functionality of services. Unfortunately, the majority of service suppliers offer the limited, general geographical content and the low quality of cartographic presentations, and are focused on the simplicity of maintenance and availability of services. With respect to the content, besides elements of transportation and hydrographic networks, objects of POI type (*point of interest*), tourist attractions, address

points are mainly presented in such services, and typical functions include: searching for objects, defining routes of transport, adding new, user defined locations etc.
Due to initial destination, the majority of locating services are contemporary analogs of conventional road maps or city plans; however functional features, and, in particular, the simplicity of integration with other Internet services, result in consideration of those systems as reference ones (Kowalski, 2007). Usually, the level of details and the accuracy, which characterise topographic maps, is missing in the case of the discussed services. Therefore, combination of advantages of topographic databases and Internet forms of publications opens new opportunities in the field of implementation of geo-reference systems. The obvious utilisation of an Internet geo-reference system would be to make the state resources of spatial data, including topographic and thematic databases, as well as elevation data available, but in practice many derivative, geo-information services may be created.

2. OBJECTIVES OF WORK

Development of geo-information services, which would distribute reference and thematic data was one of the tasks performed within the granted project: „Methodology and procedures of integration, visualisation, generalisation and standardisation of reference databases, which are accessible in state geodetic and cartographic resources, as well as their utilisation for development of thematic databases" (Bac-Bronowicz, Kowalski, Olszewski, 2009). The works were based on intentions of popularisation of valuable topographic and thematic data, as well as propagation of the idea to utilise the so-called, open sources, enabling inexpensive and efficient publication of geographic data in Internet.
Selected reference data for Poland has been made accessible in the Internet portal of the Head Office of Geodesy and Cartography (GUGiK) (www.geoportal.gov.pl), which allows for accessing particular components of the national spatial data infrastructure. Independently on tasks performed by the central GUGiK geo-portal, high demands for those spatial data which are acquired and stored at voivodship geodetic and cartographic documentation centres also exist. Integration and distribution of such data must consider regional conditions, as well as demands of local administration (Bac-Bronowicz, Berus, Karyś, Kowalski, Olszewski, 2008).
Realizing those expectations, the authors attempted to implement example voivodship geo-services, with the use of open sources and OGC standards. The designed service becomes a new proposal with respect to popular, but thematically limited navigation services, but also to many local geo-information services, which are developed at various levels of administration. The basic assumption was to develop a simple, universal Internet publication, covering the entire country, which would be accessible for wide groups of individual and institutional users. Implementation of services at Voivodship Geodetic and Cartographic Documentation centres in Wrocław, Łódź and Zielona Góra has been scheduled for this year.

3. SOURCE MATERIALS

The basic numerical products, developed for Poland, include the moderns and updated orthophotomap and the VMap L2 database (Kowalski, Olszewski, 2008). Due to various origin of those resources, the issue concerning integration of the orthophotomap of the geometric accuracy, which corresponds to analogue maps at 1:10000 (and often higher) with the database developed basing on military analogue maps at 1:50 000 scale, had to be resolved at the very beginning. In the hybrid (vector-and-raster) services, simultaneous visualisation of VMap data of the first edition with the orthophotomap, would point to differences in the accuracy and timeliness of two basic components of the service. The issue of integration of those data with a satellite image of lower resolution – such as images

accessible in Google Maps, is different, since the VMap Level 2 database of the first edition corresponds to the conventional topographic map at the scale of 1:50 000.
Considering the above the authors of this paper have made an attempt to integrate VMap L2 data with satellite images, corresponding to those data with respect to geometric accuracy, which are distributed by means of the popular technology of Google Maps and Google Earth. In order to rationally utilise VMap L2 data of the first edition, conversion of that database to the, so-called, useful structure VMap L2u was performed (Bac-Bronowicz, Kołodziej, Kowalski, Olszewski, 2007). The VMap L2 processed to the useful form, got not only simplified attribute characteristics, localised terminology for classes and attrributes, but also became topologically coherent. On this occasion distribution materials of VMap L2u, on DVD disks, were prepared for voivodship centres, which included various versions of the database and its visualisation for three GIS environments: ESRI, Intergraph and MapInfo. Thus, the Internet page would be an excellent element of promotion of voivodship resources of data.
Cartographic evaluation of VMap L2 data was an independent task. Prepared graphical libraries allow for re-symbolise those data in environment of popular GIS tools, in accordance to the assumed methodology of cartographic presentation and systems of symbols (Bac-Bronowicz, Berus, Kowalski, Olszewski, 2007). The symbology which corresponds to outstanding cartographic patterns, developed within the frames of idea of civil topographic maps at the scale of 1:10 000 and 1:50 000, was assumed. Edited visualization became the graphical pattern for the designed Internet geo-services. Visualization from the VMap L2u database corresponds to the 1:50 000 topographic map, but the wide content of that database allows for editing arbitrary thematic sets, adjusted to the profile of Internet services and to the required level of details of the image.
In order to increase perception of VMap L2u data, as well as map plasticity in geo-information services, the option of imposing the terrain model, extracted from the DTED2 product on the reference data. The source product, used for creation of that database is, similarly to the VMap data, the diapositive of the military topographic map at the scale of 1:50 000 (Olszewski, 2007). The elevation DTED2 database was processed to the resolution and projection used in geo-services. That database is visualised as the DTM of GRID type, of 70% transparency.
Thematic SOZO and HYDRO data, developed for more than 55% of the country, were to be the third component of the service. Due to the fact that sozological and hydrographic databases have been developed on the VMap L2 background since 2002, it was possible to fully harmonise those products, as well as to commonly publish them in geo-information services (Fig. 1).
Whilst the small scale review data were attached with the use of publicly accessible software libraries, in the case of the thematic section, own application solutions were utilised. For each of more that eighty object classes of the SOZO and HYDRO databases it was necessary to assign corresponding symbol libraries, in accordance to technical guidelines. Due to the fat that the thematic database, developed for the voivodship was developed according to the K-3/4 and K-3/6 Technical Instructions (eg. The Lower Silesia Voivodship) or the GIS-3 and GIS-4 Instructions (eg. Lubuskie Voivodship), works aiming at visualisation of the SOZO and HYDRO data for particular voivodships should be performed independently. (Berus, Kołodziej, Olszewski, 2006).

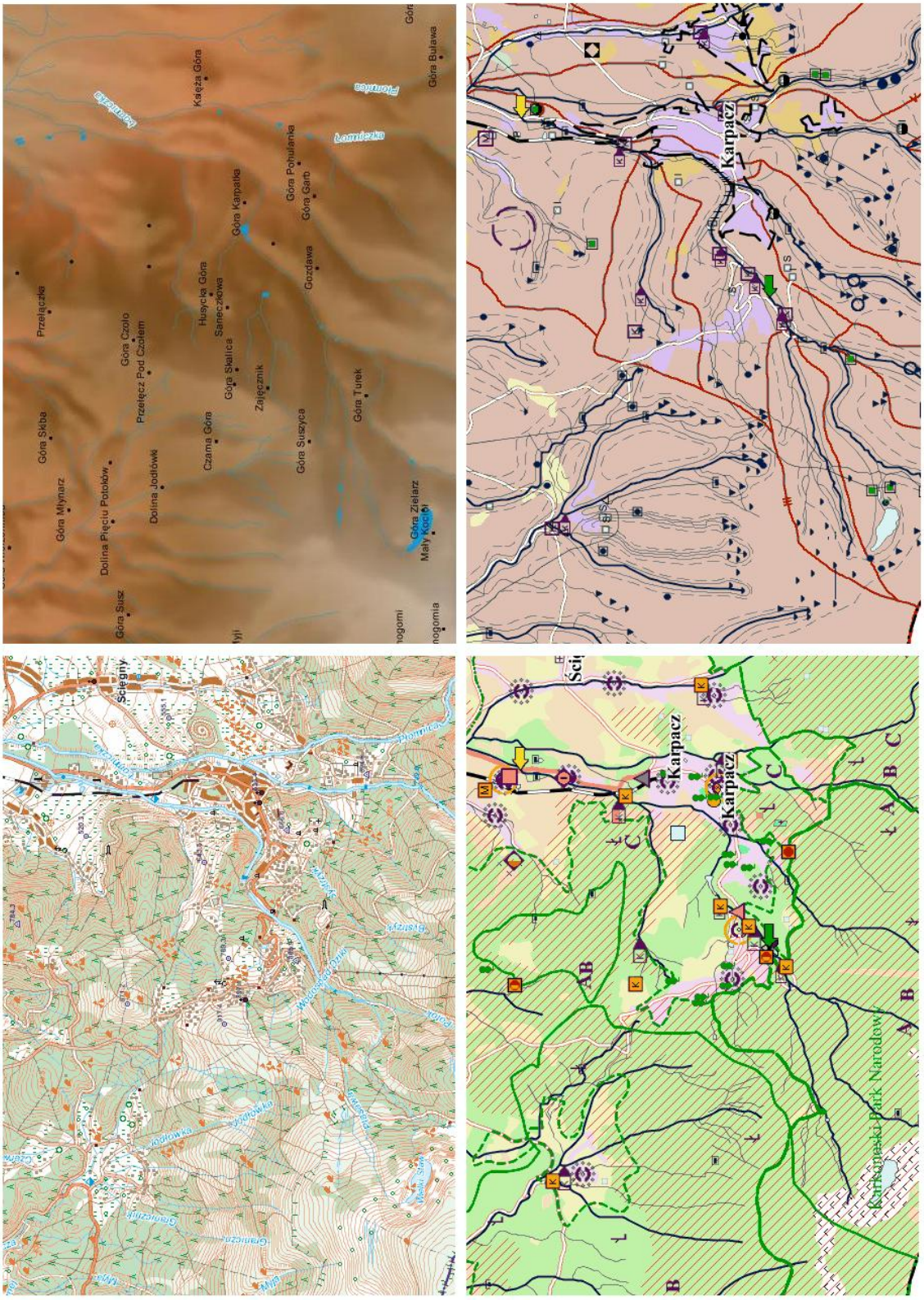

Fig. 1. Examples of maps available in Lower Silesia Geo-Services: the topographic map with shaded relief, the hypsometric, sozological and hydrographic maps.

4. CONVERSION OF THE DATABASE AND CONFIGURATION OF THE INTERNET SERVER

At present, utilisation of GIS technology for maintenance of databases and Internet servers allows for editing and publication of arbitrary cartographic works in the web, at various levels of scales and in rich graphical forms. Source materials are the most important in this case, however, the set of required tools, used for the maintenance of the map server is the most important with respect to economy and functionality of the project.

The authors made the attempt to develop the prototype voivodship geo-services with the use of the VMap L2 data for Lower Silesia, Lubuskie and Łódź voivodship, using thematic data from the state resources of geodetic and cartographic data, the DTED2 database, open sources and the WMS standard. GeoServer v.1.5.4 software tool was used in the course of the service development; it was uses as the map server; TileCache tool v.1.9 was also used, which ensured the efficient access to data. Spatial data are stored in Oracle Express 10g (Oracle XE) database, or, if necessary, in the "full" Oracle database. Fast development of the Internet application for the Oracle database was facilitated by Oracle Application Express (Oracle APEX) tools. An the map display on the browser side is maintained by OpenLayers ver.2.5 software tools (fig. 2).

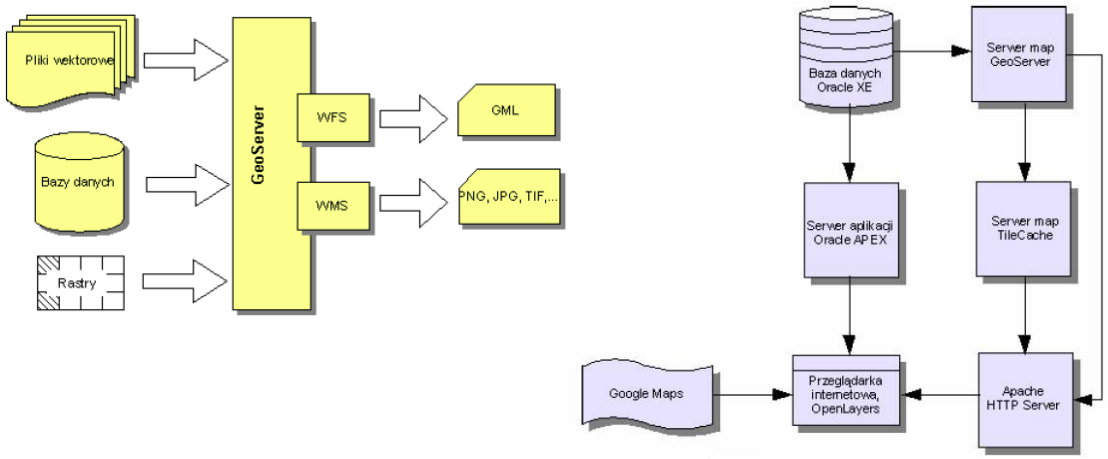

Fig. 2. The general diagram of operations performed by the GeoServer software tools (to the left)
and the diagram of data flow between applications utilised in performed geo-services (to the right)

The first stage of works comprised conversion of VMap L2 data, recorded in the MS Access format in GeoMedia Professional 6.0 to the so-called, useful structure of the VMap L2u database, mentioned above (Bac-Bronowicz, Kołodziej, Kowalski, Olszewski, 2007). Export of data to the Oracle database and then, spatial indexing, which accelerates information locating in the database, were performed in that environment. The co-ordinate system "1992" was defined for the input data.

Configuration of the GeoServer application is commenced by configuration of the data source: both, the format of notation and location. Then, data input for several dozens of object classes in the defined database system, is performed. At this moment, the defaults styles of displaying is defined for point, linear and area objects. The definition of the spatial reference system is automatically read-in from the Oracle database.

The next stage of the technological process is determination of graphical representation of object classes, which will be displayed on the final map. The map document, developed with the use of GeoMedia together with the legend included in the VMap L2u documentation has

been assumed. In the GeoServer environment, the object styles are specified in the form of an XML file, the structure of which is compliant with the Symbology Encoding 1.0 standard, issued by the OGC. After defining or reading-in the definitions of styles, they are assigned to particular object classes.
The last tas is to configure the WMS services; during that stage object classes are grouped and the sequence of displaying is specified. Finally, the data are made accessible from the GeoServer using the interface compliant with the WMS specification, in one of typical graphical formats, such as JPG or PNG, but also in PDF, SVG and KML formats, which enhances the set of map reviewing applications.
In order to improve the efficiency of the access to developed services, TileCache software tool was applied. As a result of using that application, a set of ready-to-use raster maps, at various levels of resolution, is generated; the Internet server will reference to that map set, releasing at the same time, resources of the map server.
OpenLayers software, which operates in the majority of browsers and which does not require any server components, was used for placing the interactive map on the Internet page. OpenLayers libraries allow for displaying maps from many sources, such as WMS and WFS services (basic VMap L2, as well as SOZO and HYDRO data) and from Google Maps services (auxiliary review data). Additionally, those libraries made controls used for map maintenance, such as: zooming in, zooming out, shift, as well as controls used for turning on/off the map layers accessible for users. (Fig. 3).

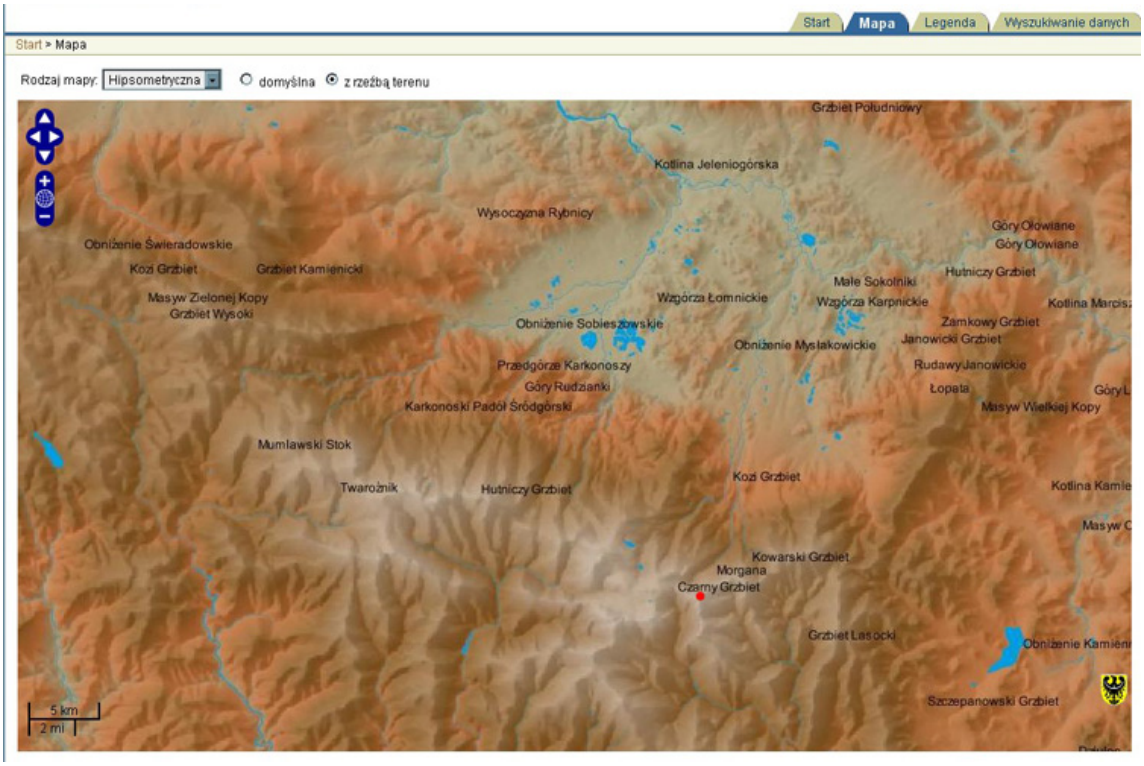

Fig. 3. Design of an interface of the Internet page with visualisation of the terrain relief from the DTED2 model.

5. STRUCTURE OF GEOSERVICES

The important feature of operations of such companies, as Google, Yahoo or MapQuest is focus on the data accessibility and technology openness. Therefore, besides the parent

information services, the growing number of mixed services are created, which are called as *mashup services*, which are developed basing on the commonly available technology and data. The essence of such services is to creatively use many, diversified sources of data.
In the case of the planned services, due to the detail content corresponding to the 1:50 000 scale, it would be reasonably to amend topographic data with review (small scale) data, which would complete presentation in small ranges of the image magnification. Therefore, cartographic resources of Google Maps (both, vector and image forms) became the amendment of visualisation of reference and thematic data. Such combination ensures the attractive and functional maintenance of the *mashup* type services. However, it should be remembered that utilisation of Google Maps technology is not the only possible solution. It would be possible to include also other Internet services suppliers – under the condition of correct spatial, time and formal integration of data.
At present, software allows for automatic conversion of various formats of data, as well as for transformation between various co-ordinate systems. However, creators of geo-information services are obliged to reasonably select data of similar geometric accuracy, which are to be displayed at one scale level. Such situation takes place in the case of selected image and topographic VMap L2 data.
It was assumed in the design of the geo-service interface that the user will initially look at the standard visualisation of Google Maps, and VMap L2u data are displayed only for the specified scale of visualisation, adjusted to the detail level of the content. The general geographical section of the service was developed by the possibility to select thematic, sozological and hydrographic data. At every scale level it is possible to display only vector information layers, as well as hybrid data – map on the background of satellite images. It is also possible to overlay the semi-transparent terrain relief model on the basic data (Fig. 4).

Fig. 4. Options of selection of the thematic content in the final version of geo-services.

A complete legend is the important element of the service. The commonly used symbols, applied in location services often results in the absence of the legend. Understanding of a map is facilitated by a small number of distinctions on a map, such as universal pictograms for point signatures, and understandable schemes of colours. However, it is difficult to realise the correct understanding of a topographic map characterised by much developed content. Thus, cartographic comments become more necessary for thematic presentations. Therefore, the thematic legend is integrated with each map type presented by the service (topographic – Vmap L2u, sozological, hydrographic and hypsometric).
Besides map reviewing, the designed scope of the geoservice functionality includes searching for objects by descriptive attributes. As a results, the object selection procedure, which

considers all attributes of the selected class of objects, displays results in the tabular form. The tabular report contains the additional column, which include hypertext references to the map. They allow for displaying a selected object on the map.

6. SUMMARY

Professional applications of geographic information systems are inaccessible for the average user of the geographic information, in its wide sense. Although free versions of such software tools exists, which are used for reviewing and visualisation of spatial data, they are used by only a few users. For many users the key role in this respect will be played by Internet applications, due to their popularity and simplicity of maintenance. Therefore, all activities aiming at popularization of the geo-information segment, which has been poorly represented in the Polish Internet.

The designed geo-information service is accessible both, with the use of Internet browser, as well as from the GIS application level, which reads the WMS and WFS services, as well as from an arbitrary browser, such as Google Earth. On the other hand, as it was mentioned in the Introduction, the graphical pattern for the designed Internet service was visualisation of VMap L2u database, which refers to the well known symbology of topographic maps at the scale of 1:10 000 and 1:50 000. This will facilitate works of those users, who know conventional printed documents.

Due to practical reasons a set of open sources, as well as Open Geospatial Consortium (OGC) standards were utilised. The software applied is characterised by the high functionality and efficiency and, at the same time, it allows for the system commissioning at low costs. The assumed scope of the content, as well as the geo-service functionality ensures the simple map reviewing and searching for geo-reference data for the Low Silesia, Lubuskie and Łódź voivodships. The developed prototype is characterised by the full functionality which allows for commissioning the similar Internet server for any set of data from the state resource of geodetic and cartographic data and for any part of the country.

The presented idea of the geo-reference information services may be implemented at each level of the central or local government administration, for the needs of all operations basing on spatial data. Neglecting the formal-and-legal issues, the simplicity and speed of implementation of such services within the structure of any Internet portal opens new opportunities of distribution of maps and spatial data. It will also accelerate implementation of tasks within the national spatial data infrastructure.

7. REFERENCES

Bac-Bronowicz J., Berus T., Karyś A., Kowalski P.J., Olszewski R., (2008). ***Czas geoportali.*** *(Geoportals now)* „Magazyn Geoinformacyjny Geodeta" nr 12 (163).

Bac-Bronowicz J., Berus T., Kowalski P.J., Olszewski R., (2007). ***Opracowanie metodyki wizualizacji bazy danych VMap L2 w różnych środowiskach narzędziowych systemów informacji geograficznej*** *(The elaboration of visualisation methods of the VMap L2 database in various GIS environments).* „Acta Scientiarum Polonorum. Geodesia et Descriptio Terrarium" no. 6 (3) 2007.

Bac-Bronowicz J., Kołodziej A., Kowalski P.J., Olszewski R., (2007). ***Opracowanie metod modyfikacji struktury bazy danych VMap L2*** *(The elaboration of methods of VMap L2 database structure modification).* „Acta Scientiarum Polonorum. Geodesia et Descriptio Terrarium" no. 6 (2) 2007.

Bac-Bronowicz J., Kowalski P.J., Olszewski R. (2009). ***A multiresolution, reference and thematic database as the NSDI component in Poland - the concept and***

management systems. Proceedings of the ICA Symposium on Cartography for Central and Eastern Europe [CD-ROM], Vienna, Austria.

Berus T., Kołodziej A., Olszewski R., (2006). ***Koncepcja harmonizacji baz danych tematycznych SOZO i HYDRO z referencyjną bazą VMap L2 drugiej edycji.*** *(A concept of harmonization of SOZO and HYDRO thematic databases with the VMap L2 reference database of the second edition).* „Roczniki Geomatyki" T. IV, Polskie Towarzystwo Informacji Przestrzennej, Warszawa

Kowalski P.J., (2007). ***Znaczenie integracji danych geograficznych w serwisach internetowych typu mashup.*** *(The role of geographic data integration in mashups web services)* „Archiwum Fotogrametrii, Kartografii i Teledetekcji" Vol. 17a, Kraków

Kowalski P.J., (2008). ***Techniczne aspekty redagowania i użytkowania serwisów geoinformacyjnych***. *(Technical aspects of designing and using of geoinforrmation web services)* „Polski Przegląd Kartograficzny" T. 40, nr 4

Kowalski P.J., Olszewski R., (2008). ***Can we just „google" it? Czy można „wygooglać" VMapę?*** „Magazyn Geoinformacyjny Geodeta" nr 2 (153)

Olszewski R. (2007). ***Synchronisation of MRDB reference database, thematic databases and hierarchical DTM within the concept of the NSDI in Poland.*** 4th International Symposium on LBS and TeleCartography. Hong Kong, China.

Peterson M.P., (2005), ***Foundations of research in internet cartography.*** In: Peterson M.P. (ed.) „Maps and the Internet". Oxford Elsevier Applied Science Publishers Ltd.

Internet sources

Geoportal GUGiK: www.geoportal.gov.pl,
GeoServer: www.geoserver.org
Google Earth: earth.google.com
Google Maps: maps.google.com
Open Geospatial Consortium Inc.: www.opengeospatial.org
OpenLayers: www.openlayers.org
Oracle: www.oracle.com
TileCache: www.tilecache.org