Open European Location Services (Open ELS)

Report on Cross-border harmonisation

Activity report of Open ELS project Task 3.2

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Change Summary

Version	Date	Author/Editor	Change Summary
1.0	19/04/2019	Saulius Urbanas	1:st draft
1.1	29/04/2019	Saulius Urbanas	Comments from Eva Pauknerova and Marcus Bruhl

References

Ref.	Title/Version/Publication Date/Author
[1]	Guidance on implementation of cross-border harmonization, v1.1. Open ELS project. 16.04.2019.
[2]	Template for cross-border harmonization (v1.1, April 2019, zip archive, ESRI ArcGIS Geodatabase v10.3).
[3]	European Location Framework project. 2013-2016. www.elfproject.eu
[4]	ELF D2.7 ELF International Boundaries / v1.1 / 08.11.2013 http://elfproject.eu/documentation/specification/ib/1.1
[5]	Core Reference Dataset – CRD. Specification and Technical Guidelines, v0.7. BKG / EuroGeographics, 13.06.2018.
[6]	Documentation on Open ELS requirements: specifications, schema, feature catalogue, etc (for EuroGeographics Members Only). https://eurogeographics.org/products-and-services/european-location-services/documentation/

Contents

1 Background

The report provides an information about the completed activities performing the tasks 3.2 in the Open ELS project.

Aim of the task 3.2 “Cross-border edge-matching” was to facilitate National Mapping and Cadastral Authorities (NMCAs), Open ELS data providers, in harmonisation of geospatial data features across international borders. The project team developed the Guidance on implementation of cross-border harmonisation [1], a template for cross border harmonisation [2], supplementing documentation [6], promoted and supported the NMCAs activities utilising the guidance, provided consultations and methodological support.

The utilisation of the guidance and the arranged documentation have been performed in the two use cases:

1. Cross-border harmonisation between France and Germany;
2. Cross-border harmonisation between Czech Republic. and Poland.

In addition, the useful findings on cross-border harmonisation between neighbouring countries, following the principles as described in the guidance, have been recorded during the production of the prototype of Core Reference Dataset (CRD). The experience and findings from the CRD production demonstrated a range of typical issues and very practical cases finding solutions for achieving a cross-border harmonisation. The lessons learned during the CRD production will possibly help others for better performance in further bilateral projects on cross- border harmonisation of national spatial data utilising the guidance. The listed issues and the way solving them demonstrate the complexity of the cross-border harmonisation and supplement the available documentation for more efficient operational processes.

2 Development of the Guidance on implementation of cross-border harmonisation

2.1 Production of the Guidance

The guidance on implementation of cross-border harmonisation has been developed by the small project team of the task 3.2. Possible solutions for achieving the edge-matched data content were prototyped during the European Location Framework (ELF) project [3]. Edge-matching of national data was organized by triggering the edge-matching tools during the ELF project. However, the tools could operate only if the connecting points or/and lines are defined (agreed). There is no other way of implementing the comprehensive harmonization of national geospatial data across boundaries without the agreed connecting point/lines of the cross-border features and maintained as a part of master data (fundamental / source databases).

Therefore, the project team followed the concept and data model from the ELF project deliverables [4] for collection of the agreed cross border features, but decided to specify as much as possible the procedures helping data providers from two neighbouring countries to agree on those connecting features and connecting points.

The first version of the guidance has been drafted at September 2017. It was introduced and discussed at the EuroGeographics State Boundaries of Europe Knowledge Exchange Network (SBE KEN) meeting in Florence, 23-24 November 2017.

The revised version of the guidance considering the received comments from the SBE KEN meeting has been circulated to boundary experts from NMCAs using the SBE KEN network, and evaluated compared with the actual attempts by some of NMCAs to reach agreements edge-matching spatial features in cross-border areas. Especially useful experiences have been shared by Pierre Vergez from IGN-France presenting the processes and achievements in cross-border harmonisation of national data between France and Italy, France and Switzerland, France and Belgium.

Final discussion and validation of the updated version of the guidance was organised at the SBE KEN plenary meeting in Brussels, 8-9 November 2018.

The guidance [1] were presented to all members of EuroGeographics by organising the specific webinar at 10th December 2018.

2.2 Content of the Guidance

It was agreed that the activities on the tackled cross-border harmonization task do not impact legal definitions of international boundaries. The presented procedures and action plan in the guidance refer only to the purpose of reaching an agreement on the technical representation of cross-border geographical features (rivers, lakes, roads, railroads, etc.) in the border area.

The most important part of the Guidance is the list of recommended actions performing the cross-border harmonization and edge-matching of Connecting Features (CFs). The 11 steps actions serve as a template for achieving the agreement on CFs and updating the national datasets accordingly.

NMCAs have been encouraged to initiate bilateral projects amongst the responsible authorities of neighbouring countries for finding agreement on CFs. Best practice use case on cross-border harmonisation between France and Belgium is presented as an attachment to the guidance [1]. Two practical cases implementing the guidance are present in the clauses below:

- Between France and Germany,
- Between Czech Republic and Poland.

As a temporal alternative to a bilateral agreement of neighbouring countries agreeing the CFs along borders the concept of “centralized edge-matching” has been elaborated in the production process of the Core Reference Dataset (CRD) [5] and presented in the guidelines. Such centralised edge-matching allows to achieve the harmonised content or a visualisation of seamless spatial data along borders by triggering specific edge-matching tools. Project team prototyped the centralised edge-matching approach in development of CRD. Best practice achievements on this are presented in the clause 5 “Cross-border harmonisation developing Core Reference Dataset (CRD)”.

3 Cross-border harmonisation between France and Germany

3.1 Scope of the work

The task to harmonise the basic topographic data between France and Germany has been considered urgent due to the national obligation of implementing the INSPIRE directive. In fact, national topographic databases have not been harmonized bilaterally in the past. In case of Germany, three agencies of the German Länder are involved, because France borders to Saarland, Rhineland-Palatinate and Baden-Wurttemberg. The cross-border harmonization work was organised by specifics teams, set by each of the German Länder.

In case of Baden-Wurttemberg, the international boundary is located along the river Rhine with a number of bridges for roads and railways. Those features are the most relevant for edge-matching. The team for this boundary section has agreed that the Open ELS guidance document [1] is very helpful to accommodate the harmonisation work. The team practically implemented the recommended actions (the checklist). The following the filled checklist documents the status of work as of 08.01.2019. Please note that some personal information has been cleaned from the original version.

3.2 Records of actions applying the Guidance

No	Action	Description
1.	Build the teams	**France** Responsible authority: National Institute of Geographic and Forest Information of France (IGNF) Main point of contact: *name not listed here* Authorities involved in communication and validation are: French Cadastre, Ministry of Interior, Ministry of Foreign affairs **Germany (Baden-Wuerttemberg)** Responsible authority: Landesamt für Geoinformation und Landentwicklung Baden-Württemberg (LGL) Main point of contact: *name not listed here*
2.	List the features to be edge-matched	**Priority 1: cross-border features** Features which have to be connected cross the boundary: roads, railway lines, ferry crossings, dams or wires, utility links These features shall be connected on connecting feature points. **Priority 2: fictitious axis of river Rhine** Identical representation of the objects representing this fictitious axis of the watercourse Geometry has to be identical with the international boundary and the objects have to be split according to national watercourse flowing into river Rhine. Objects in French dataset shall link to objects in German dataset (and vice versa) via unique identifiers. **Priority 3: national features linked to boundary** National feature, which are linked to the boundary but not connected cross the boundary: administrative units/boundaries, watercourses, land use/coverage features

		These features shall be properly snapped to the boundary. Creation of connecting feature points is optional. *An additional table lists the features with the names according to the national data models.*
3.	List the datasets to be harmonised	**France** BD TOPO, BD-UNI **Germany (Baden-Wuerttemberg)** Amtliches Topographisch-Kartographisches Informationssystem (ATKIS) Digitales Basis-Landschaftsmodell (Basis-DLM)
4.	Assess Coordinate Reference Systems	ETRS89, geodetic coordinates
5.	Consider the status of International boundaries	The boundary between France and Germany (Baden-Wurttemberg) is defined in the middle of river Rhine as moving boundary. The section between Breisach and Iffezheim (113 km) was defined by coordinates in a treaty dating 13th April 2000. The coordinates were measured in national coordinate reference systems (Germany: Gauß-Krüger). Meanwhile those coordinates were transformed into ETRS89/UTM for Germany and integrated into the German cadastre (ALKIS). Recently, the representation of the border in ATKIS Basis-DLM was harmonised with ALKIS. This representation of the border in ATKIS Basis-DLM is accepted by France as technical line for edge-matching.
6.	Define Common background data.	Coordinates of border marks, georeferenced cadastral data, orthophotos
7.	Agree tolerance in the cross-border area.	Agreed tolerance between the mismatched features of both Parties – ± 3m
8.	Compare the CBF and investigate on reasons of mismatches	*Not filled yet, work ongoing*
9.	Finding an agreement for matching the connecting features	*Not filled yet, work ongoing*
10.	Compilation of the CF dataset	*Not filled yet*
11.	Update the national datasets and web services according to CF	*Not filled yet*

4 Cross-border harmonisation between Czech Republic and Poland

4.1 Scope of the work

Czech Office for Surveying, Mapping and Cadastre (CUZK) and Head Office of Geodesy and Cartography of Poland (GUGiK) initiated the campaign for harmonising national topographic datasets along Czech and Polish border area and to consider relations between cross-border harmonisation of topographic and administrative data. The project has been implemented at 2019.

Figure 1. Czech-Polish state boundary.

The overall targeted amount of work:

- Review topographic data of the entire CZ-PL cross-border line of 796 km and 4 100 point features that may require edge-matching along the boundary.
- All 4 100 points shall be checked again by both sides in the master scale datasets BDOT10k (Poland) and in ZABAGED (Czech) during the harmonization process.
- All rectifications have to be done in both production databases in accord with the both-sides agreement.
- Both sides could keep an oscillating and border concurring features (ConnectinFeatureLine) as an identical geometry in both BDOT10k and ZABAGED databases.

According to the initial observation and comparison of the national datasets the following findings have been identified and specific tasks assigned:

- 3927 points out if 4100 (96%) are within the distance of 15 cm from the technical borderline.
- 173 points (4%) are more than 15 cm far away.These 173 points represent:
    a. 5 connecting points (CP)
    b. 6 start and end of boundary concourse sign (CP_SBC, CP-EBC);
    c. 4 end points (EP);
    d. 5 fix points (FP);
    e. 153 points out-of-border under control (OB) like eg. edge of bridges.

Types of features to be checked and possibly edge-matched:

- Transport networks (roads, paths, footpaths, streets, rails) – 872 points.
- Watercourses – 987 points.

- Technical buildings (bridges, footbridges, dam, weirs, culverts, walls) – 236 points.
- Power lines – 11 points.
- Boundaries of administrative units – 440 points.
- Vegetation – 1554 points.

Summary of the experience applying the Guidance [1]:

- The applied Open ELS project Guidance on implementation of cross-border harmonization fit for purpose and has been successfully used for performing the campaign for harmonising national topographic datasets along Czech and Polish border area. However, the documentation of the methodology may be extended in the following areas:
  1. Currently, technical teams performing edge-matching have to look for a relevant information in several documents. Ideally, documentation of the connecting features data model should be included into a main document - Guidance on implementation of cross-border harmonisation (v1.0, Nov 2018).
  2. There should be statement in the documentation allowing and even encouraging the interested parties performing the edge-matching to extended connecting features data model in the areas they find suitable for their cross-border cases.
  3. Finding optimal agreement on the location for connecting features in some cases can be very challenging. Therefore, the documentation could be supplemented with more examples of different solutions of how the agreement on CFs could be reached.

4.2 Records of actions applying the Guidance

No.	Action	Description	Comment
1.	Build the teams	**The team of experts from CZ** There were experts from 6 different departments of CUZK (and its Land Survey Office) represented in this OELS team. Primary actors agreeing the CFs: CUZK/ZU[1], CZ WG on state boundary (CUZK and Ministry of Interior - MoI) Contact person: Eva Pauknerova (Eva.Pauknerova@cuzk.cz) **The team of experts from PL** Primary actors agreeing the CFs: GUGiK IT and Development of State Geodetic and Cartographic Resource Department team. Contact person: Marcin Grudzień (Marcin.Grudzien@gugik.gov.pl)	This OELS activity complements the formally established processes and teams as regards cross-border harmonisation from the INSPIRE view(s). Therefore the CUZK INSPIRE/ELS team coops, too.

[1] Czech Office fir Surveying, Mapping and Cadastre (CUZK) and its specialized Land Survey Office (ZU)

2.	List the features to be edge-matched	AU (line), TN (point, line), HY (point, line), BU (line)	At this pilot stage only INSPIRE TN data was used
3.	List the datasets to be harmonized	**CZ:** source data – ZABAGED (topographic master data, 1:5K) and its interoperability with the RUIAN Base Registry (admin master data in 1:2K) **PL:** source data – BDOT10k – 10k national topographic database It is important to mention that for pilot the representation of aforementioned dataset in INSPIRE data model was chosen.	INSPIRE/ELS DSs: AU (related to CP); TN (Road and Rail), HY; CIM WMS (+BU, AD); At this pilot stage, selected sample areas were chosen for some of the cross-border comparisons: e.g. Broumovsko for the INSPIRE TN data
4.	Assess Coordinate Reference Systems	The agreed CRS: ETRS89 *(EPSG:4258)*, geodetic coordinates Comments on level of possible displacement of location of topographic features due to conversions from national CRS (transformation related positional errors): **CZ:** mean square error of transformation from S-JTSK to ETRS89 is 3,5 cm.	National CRSs: CZ: S-JTSK (EPSG::5514 for GIS) PL: PUWG 1992 (EPSG::2180)
5.	Consider the status of International boundaries	CZ has been technically revising its IBs with its neighbouring countries (step by step) since 1993. This formal cooperation of CUZK/ZU and GUGiK and the CZ and PL WG on state boundary re-starts in 2019. The established contact persons are:Jan Reznicek (jan.reznicek@cuzk.cz) and Marcin Grudzien (marcin.grudzien@gugik.gov.pl)	INSPIRE and the ELF project dealing with LoD 0 and 1 turned attention to new aspects and relations between topographic and administrative data (as Cadastre). It was agreed at OELS, that technical (approximate) ETRS89 boundary line will be used for the edge matching process. Two versions of CZ-PL state boundary lines were compared (taken from ZABAGED resp. BDOT10k): Real positional differences of these two technical boundaries differ from 0 to 80 cm, mean difference is 15 cm. It was agreed, that the Czech version of technical boundary

			line will be used as a common background for the pilot edge-matching.
6.	Define Common background data	Mainly coordinates of border marks and orthoimagery, but also cadastral data *(for the OELS activity);* LIDAR measurements, other photogrammetry data etc.	
7.	Agree tolerance in the cross-border area	Agreed tolerance between the mismatched features of both parties. The CZ-PL OELS team proposed a positional tolerance to be 1 meter.	Most of data compared (AU, border lines used by CZ and PL show a difference of cca 10 cm; specific issues relate to some water streams/areas Only few areas were identified where the difference is greater than 1 meter.
8.	Compare the CBF and investigate on reasons of mismatches	The processes planned and started are similar to those of France and Belgium. For initial CZ-PL CBF comparison results the established contact persons are: **CZ:** Milada.Javurkova@cuzk.cz **PL**: Katarzyna.Chalka@gugik.gov.pl	The OELS C-B pilot activity provided a basic overview and statistics of the state-of-art; use case preparations turned attention to thematic data and related edge-matching needs. For details see chapters4.3-4.5.
9.	Finding an agreement for matching the connecting features	This will be a part of further official activity mentioned in step 5.	
10.	Field survey	To be considered later in 2019	
11.	Compilation of the CF dataset	To be done later in 2019	
12.	Update the national datasets and web services according to CF	To be done later in 2019	

4.3 Details finding a common technical boundary line

Currently, there is no common CZ-PL precise (legal) boundary line defined in ETRS89. Such boundary line has been in preparation within the boundary commission. Final results are expected to be

available at the end of the year 2019 and stored into the SBE (State Boundaries of Europe) database after that.

Therefore, the CZ-PL OELS pilot team agreed to use the technical (approximate) ETRS89 boundary line for edge matching purposes.

Two versions of CZ-PL state boundary lines were compared:

- Polish version identical with the boundary line stored in BDOT10k,
- Czech version identical with the boundary line stored in ZABAGED.

From the comparison of identical points, we obtained following results:

Positional differences of relevant boundary points differ in 98% cases (random error) from 0 to 80 cm, average positional difference is 15 cm. We assume, that different ways of global (approximate) coordinate transformation from national coordinates reference systems to ETRS89 were the cause of these errors.

Gross errors were identified in 2% cases having positional differences up to several meters. Nevertheless, these errors relate to different ways of numbering of boundary points and did not influence real positional differences of the both boundary lines (Fig 2).

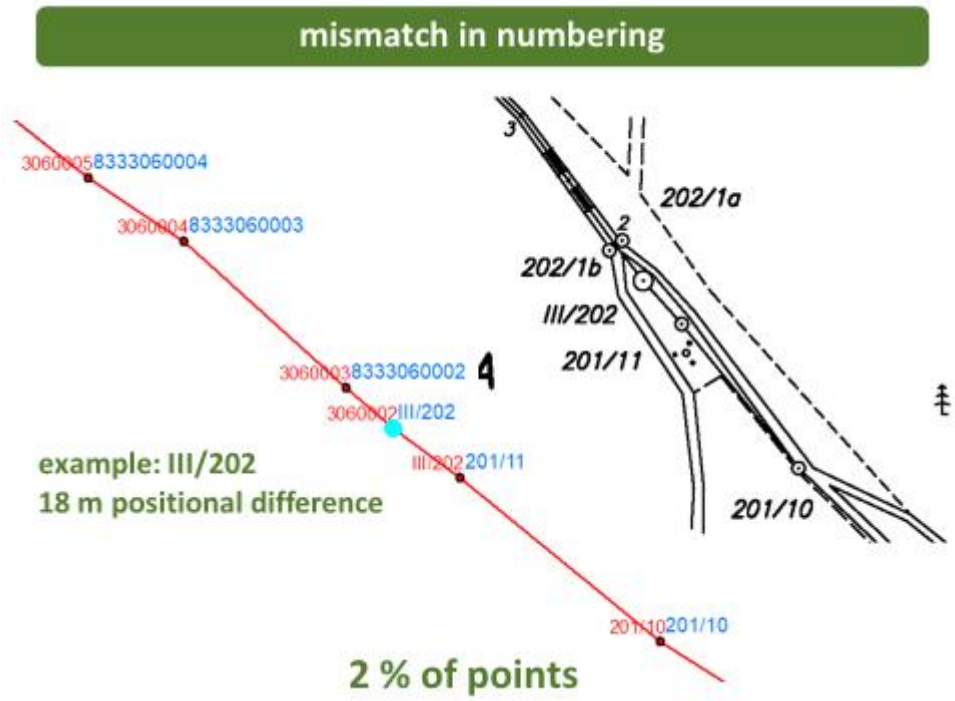

Fig. 2. Example of the mismatch of numbers along the borderline.

9 cases were identified (Fig 3-6), where positional differences between both boundary lines is **higher than 1m**, which had been detected by Polish team. Czech team evaluated, that these differences are caused by the different versions of boundary lines in the relevant 9 areas (probably caused by the generalization of boundary line in these areas). Nevertheless, the Czech version of boundary line corresponds with the state boundary maps. Therefore, it was agreed, that the Czech version of technical boundary line will be used as a common background for the further edge-matching in a pilot project.

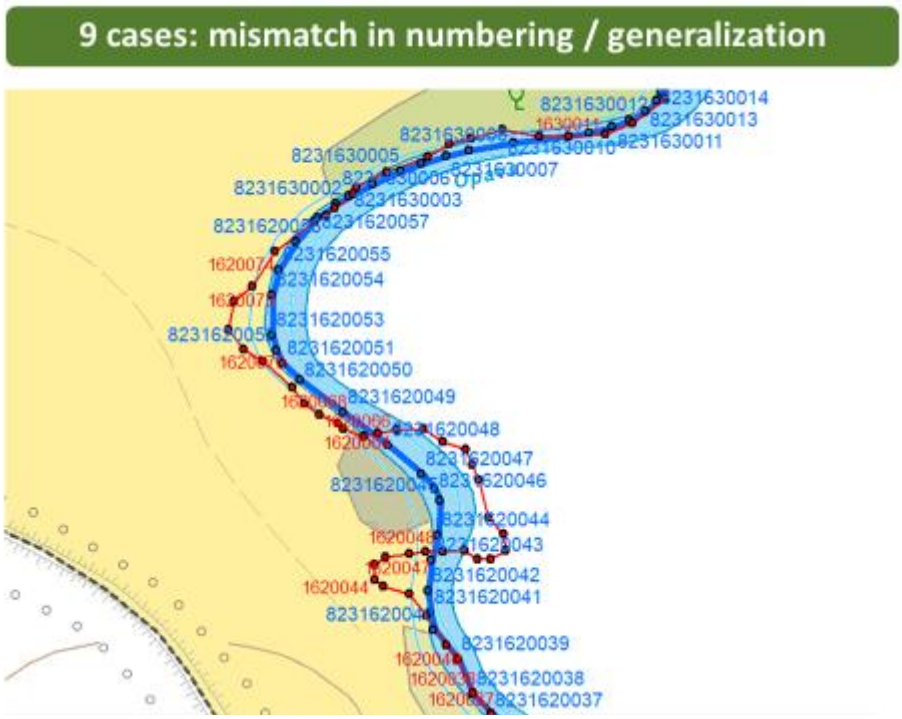

Figure 3 Example of mismatch in numbering and generalisation.

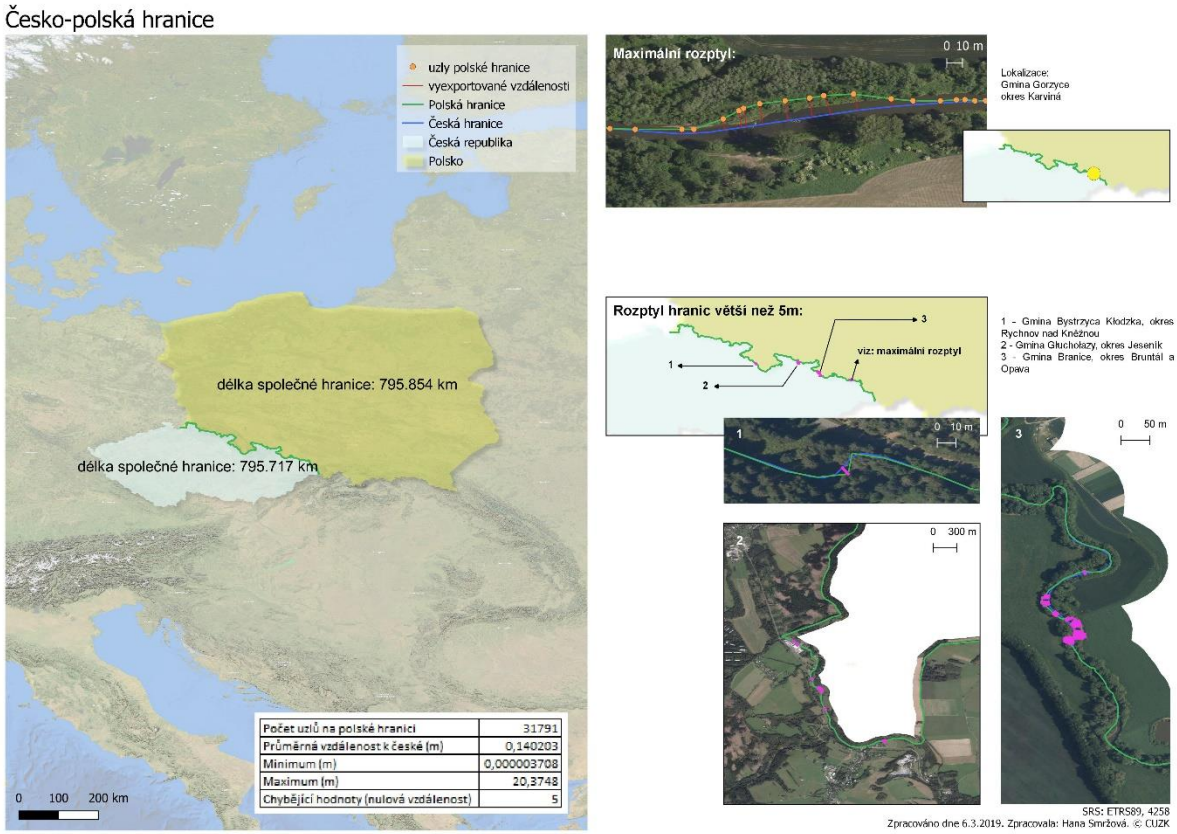

Figure 4. Differences in international boundary geometry (1)

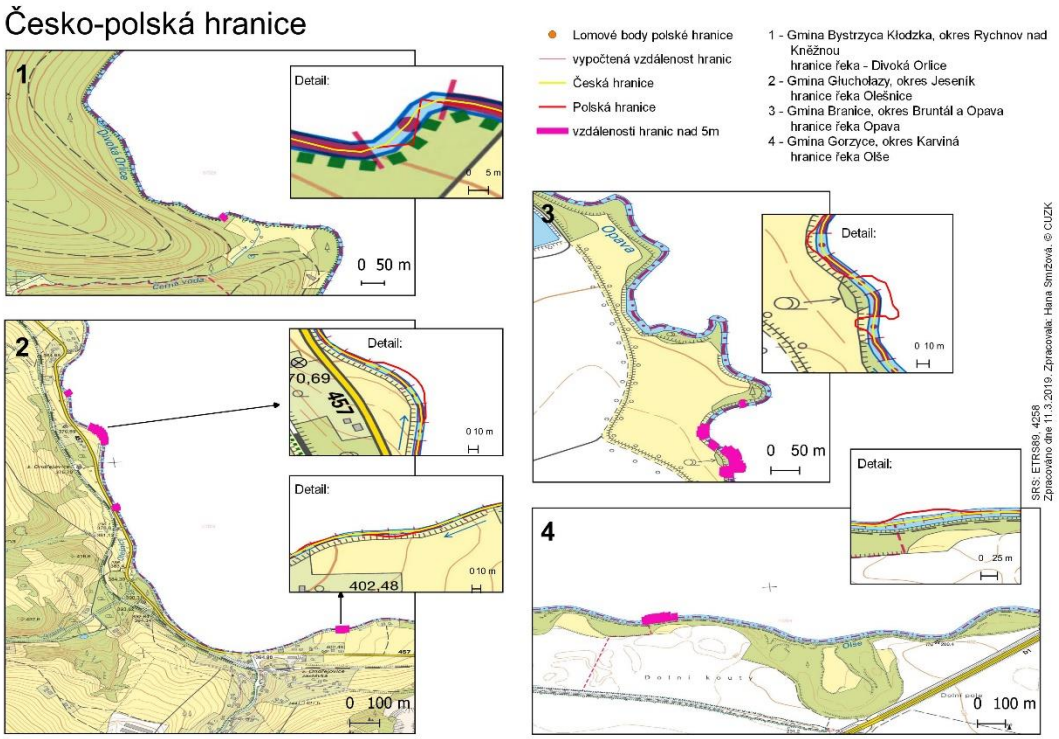

Figure 5. Differences in international boundary geometry (2)

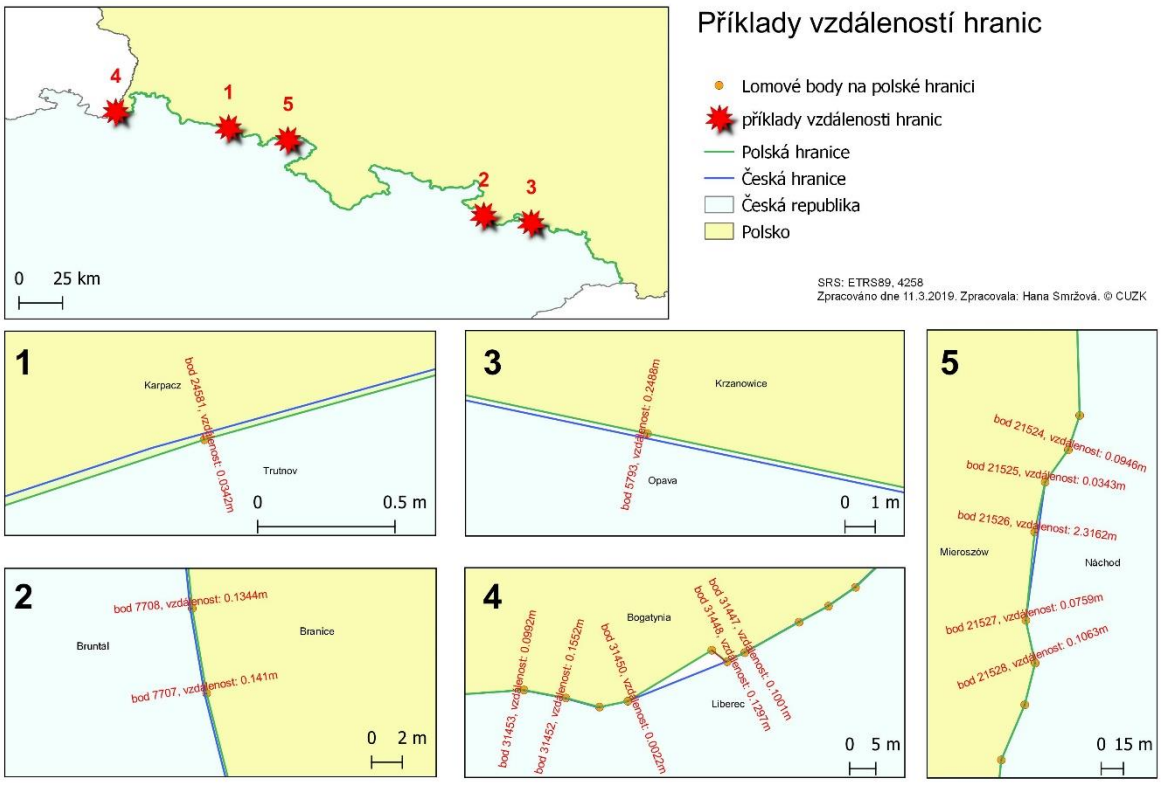

Figure 6. Differences in international boundary geometry (3)

4.4 Selection of national data

Both sides decided to use INSPIRE datasets covered by the transport networks (TN) theme. This is justified mainly by two reasons:

- TN dataset was identified as crucial for cross-boundary use cases.
- TN allows to verify both types of connecting features point and line.

Two feature types were edge-matched: RoadLink and RailwayLink.

Data for edge-matching was acquired from following network services:

- Czech
  - WMS: http://geoportal.cuzk.cz/WMS_INSPIRE_TN/WMService.aspx
  - WFS Road: http://geoportal-inspirewfs.cuzk.cz/WFS_INSPIRE_TN_ROAD_ELF/WFService.aspx
  - WFS Railroad: http://geoportal-inspirewfs.cuzk.cz/WFS_INSPIRE_TN_RAIL_ELF/WFService.aspx
- Polish
  - ATOM: http://mapy.geoportal.gov.pl/wss/geosrv/atom_web/atom/SieciTransportowe
  - WFS: http://mapy.geoportal.gov.pl/wss/geosrv/tn/wfs
  - WMTS: http://mapy.geoportal.gov.pl/wss/geosrv/wmsTN/gwc/service/wmts
  - WMS: http://mapy.geoportal.gov.pl/wss/geosrv/wmsTN/wms

4.5 Detailed analysis and an identification of cross-border issues in two regions

Both teams decided to perform detailed studies of cross-border issues in two areas:

- Broumovsko region. Analysis has been performed by the Czech team;
- Śląskie voivodeship / Ostrava region. Analysis has been performed by the Polish team.

The findings and typical cases of issues are presented in the sub-clauses below.

4.5.1 Study area of the Broumovsko region

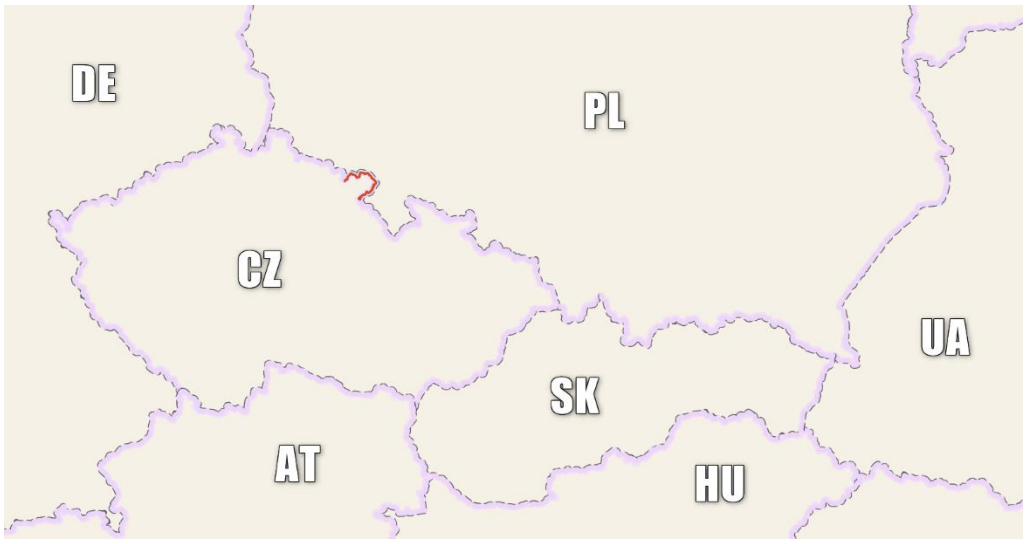

Figure 7. Location of international boundary in the Broumovsko region

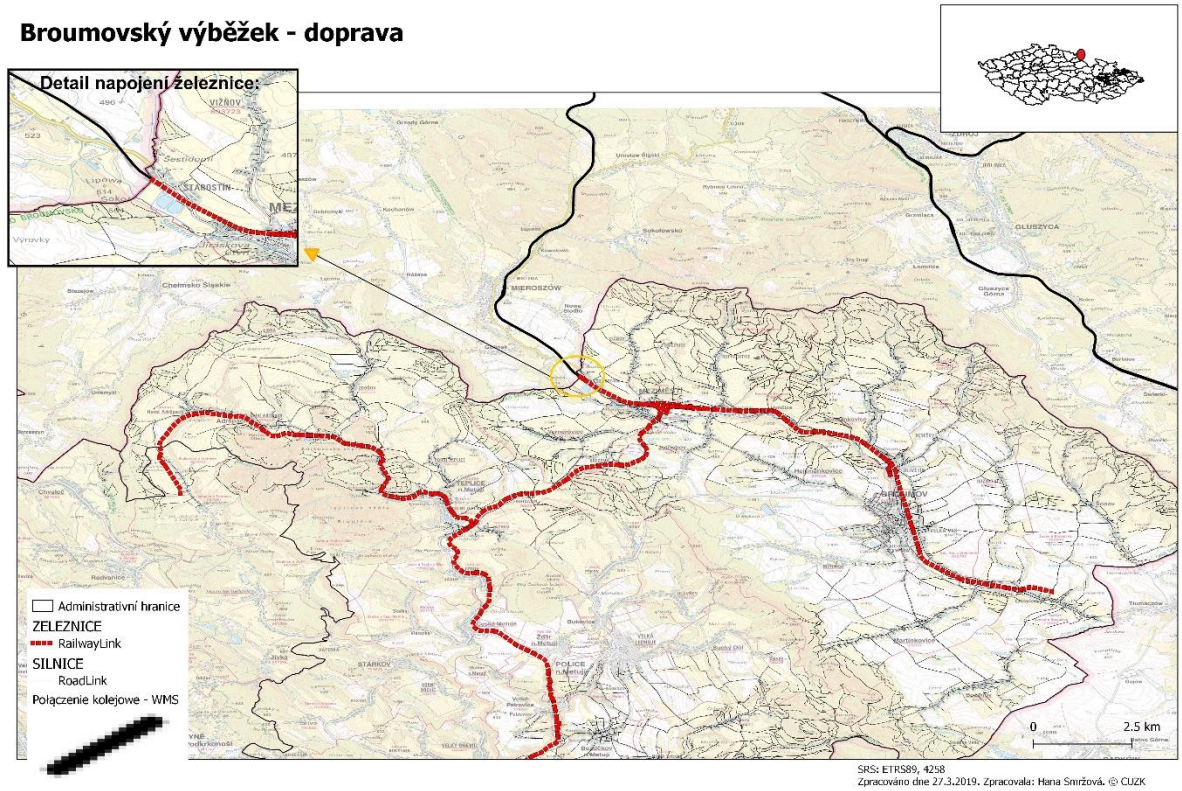

Figure 8. Medium scale map of Broumovsko region

The distance between endpoints of road links and railway links varies from 0.1 m to 2 m.

In several cases the roadlink ends on the border and there isn't any related feature in the other state. This situation occurs in case of unimportant roads as bike paths, unpaved roads…

There is only one railway cross border point in the studied area – Meziměstí/Mieroszów. The distance between endpoints is about 0,4 m there.

The edge-matching in CZ-PL cooperation (see part Edge-matching) is going to improve current results.

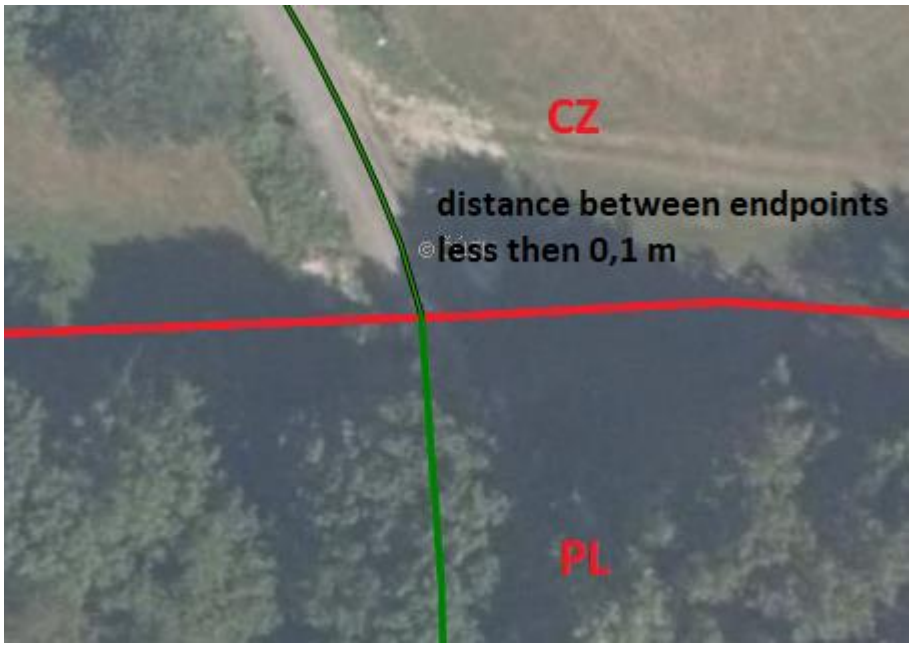

Figure 9. Minimum distance between endpoints of road links was detected at border crossing point Machovská Lhota and it measures less than 0,1 m.

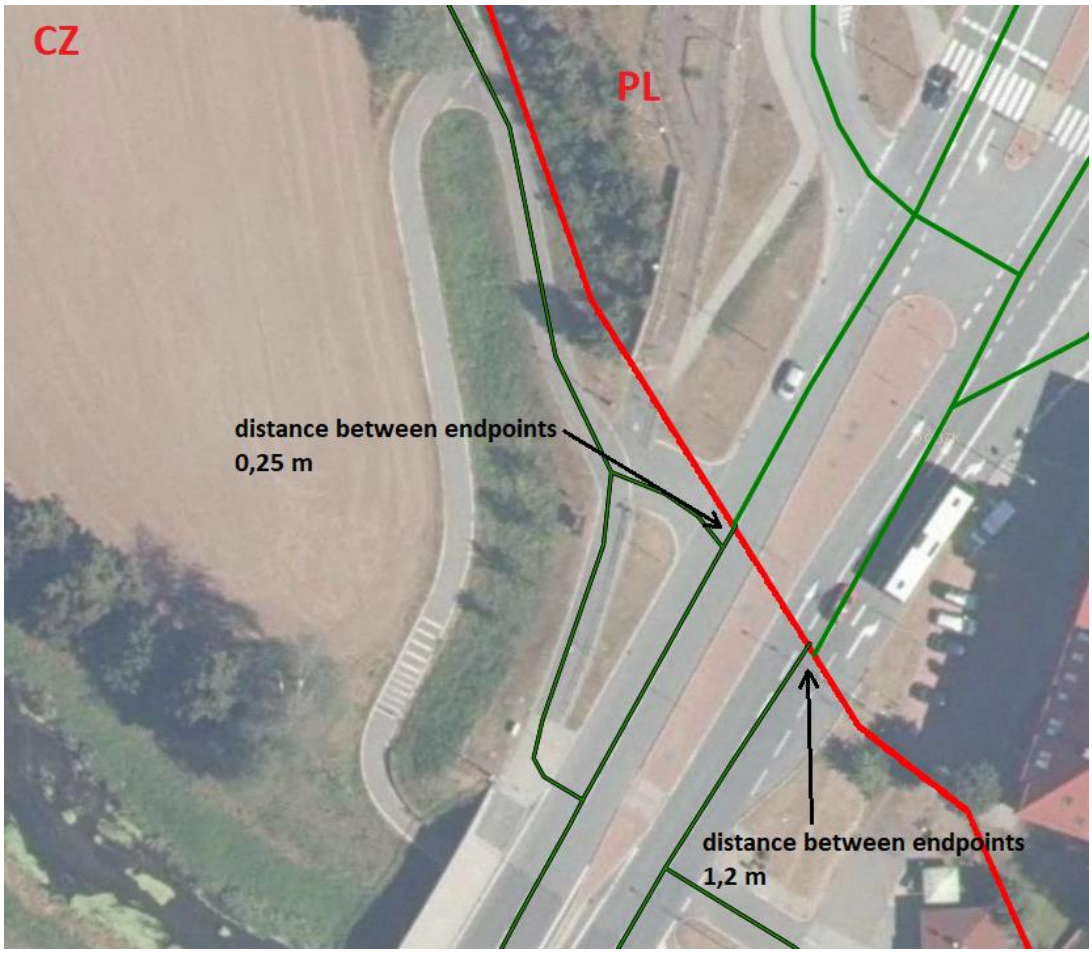

Figure 10. Connection of road links at border crossing point Náchod/Kudowa Słone.

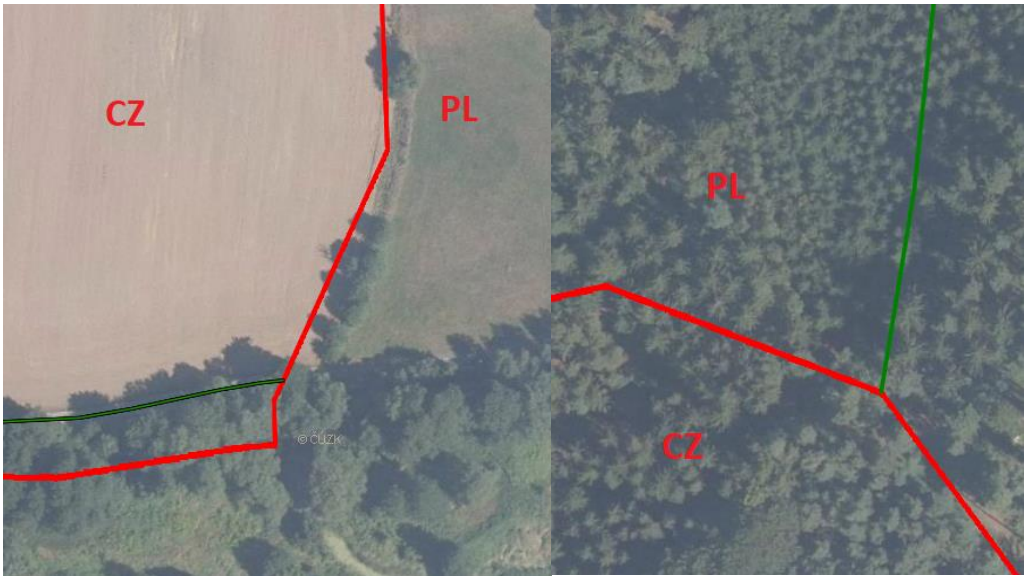

Figure 11. Examples of road links ending on the state border without related feature in the other state (on the left- bike path; on the right- unpaved road).

4.5.2 Study area Ślaskie voivodeship / Ostrava region region

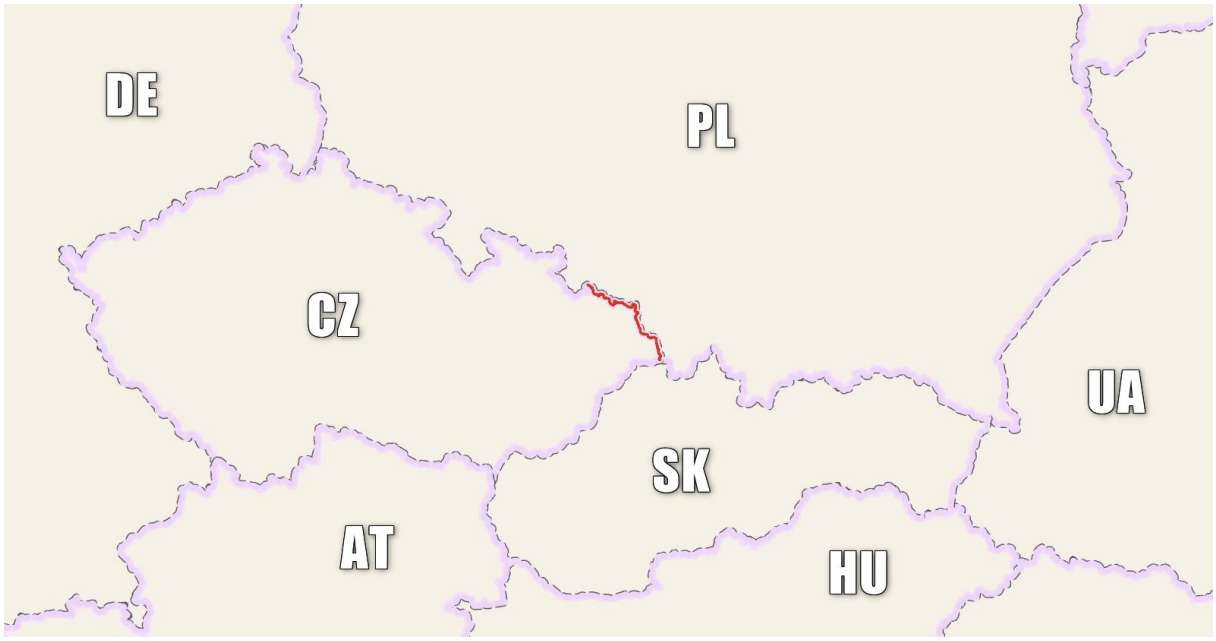

Figure 12 Location of international boundary in Ślaskie voivodeship / Ostrava region region

All together the Polish team identified:

- 68 point connecting features,
- 31 line connecting features.

Distance between Czech and corresponding Polish cross boundary features varies from 0.05 to 36,97 meters. However, in 60% of cases the distance doesn't exceed 1 meter (see Figure 13). In most cases where the distance is higher it is because there is no directly corresponding feature on one side of

the boundary (see Figure 2). Therefore, the distance was measured to a closest available corresponding feature.

In most cases identification of connecting features is rather easy and straight forward (see Figure 13 and Figure). However, sometimes it can be complex and would require substantial analysis of a background material (mainly orthoimagery) and ideally field examination (see Figure 1 and Figure 49).

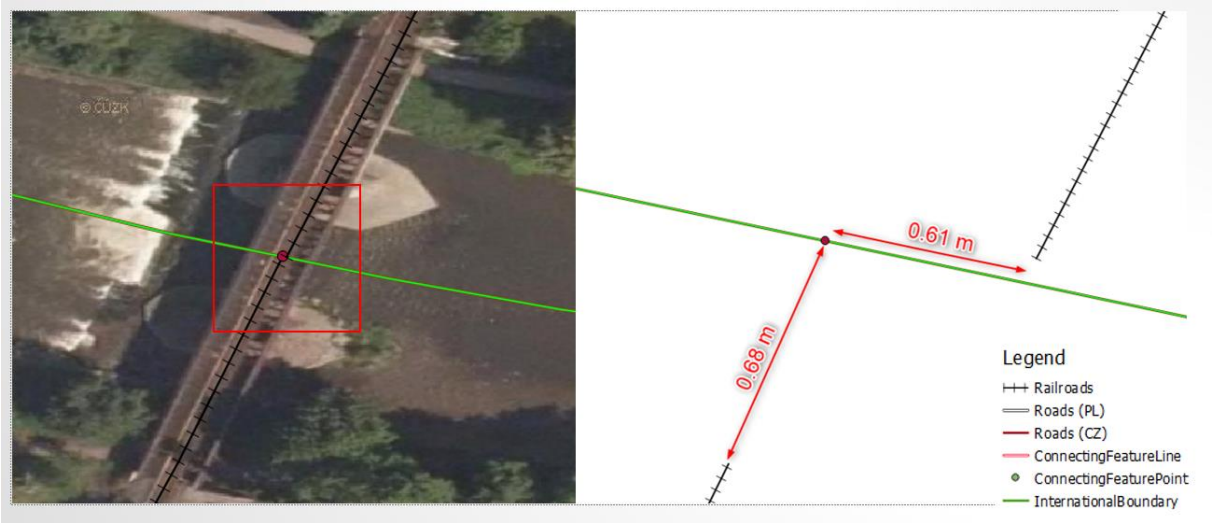

Figure 13. Typical railroad cross-boundary feature exmple

Figure 14. Typical road cross-boundary feature exmple

Figure 15. The street crossing the boundary

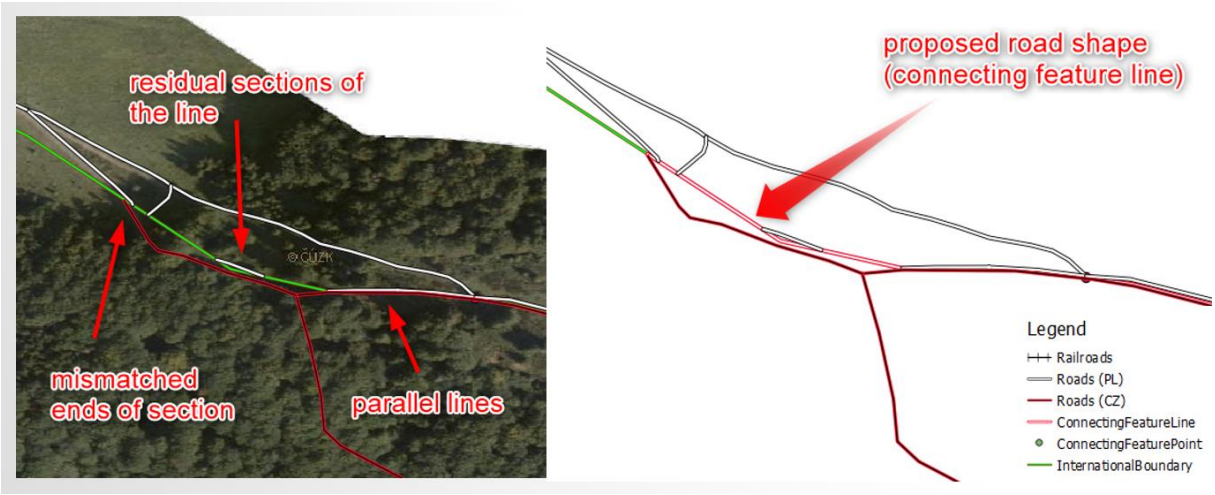

Figure 16. Roads features parallel to the boundary line.

Figure 2. Missing cross-border features.

Figure 3. Different roads representations

Figure 4. Missing cross-border feature along the boundary

4.6 Summary of the experience

Summary of the experience applying the Guidance [1]:

- The applied Open ELS project Guidance on implementation of cross-border harmonization fit for purpose and has been successfully used for performing the campaign for harmonising national topographic datasets along Czech and Polish border area. However, the documentation of the methodology may be extended in the following areas:
  - Currently, technical teams performing edge-matching have to look for a relevant information in few documents. Ideally, documentation of the connecting features data model should be included into a main document - Guidance on implementation of cross-border harmonisation (v1.0, Nov 2018).
  - There should be statement in the documentation allowing and even encouraging the interested parties performing the edge-matching to extended connecting features data model in the areas they find suitable for their cross-border cases.
  - Finding optimal agreement on the location for connecting features in some cases can be very challenging. Therefore, the documentation could be supplemented with more examples of different solutions of how the agreement on CFs could be reached.
  - Reaching a consistency between topographic and administrative data requires a range of systematic works (technical arrangements need to be supported by inter-ministerial communication, legal or methodical up-dates, awareness raising etc.)

5 Cross-border harmonisation developing Core Reference Dataset (CRD)

5.1 Scope of the work and it's relevance to the implementation of the Guidance

As described in section 4.2.2 of the Open ELS guidance document [1], the production process of the Core Reference Dataset (CRD) was organized applying the centralized edge-matching approach. Although this approach deviates from the primary purpose of the Open ELS guidance document [1], the issues and results of the cross-border harmonization for CRD are worth to be considered, sharing best practice in dealing with specific issues in reaching the harmonized spatial data content. Up to now, CRD has prepared a prototype of three countries, which consists the spatial data themes of Transport (road and railway network) and Hydrography (watercourses, standing waters). Complex cross-border issues, which have been discovered and solved during the production of the prototype, are provided in the sub-clause 5.3. Those issues and possible solutions for solving them are important and in most of the cases arise performing bilateral projects between neighboring countries aiming to harmonise the cross-border data content according to the recommended procedures of the Guidance [1].

5.2 Organisation of the edge-matching work

The basis for the prototype were taken the international boundaries, as collected from data providers (NMCAs) during the ELF project [3], which are suitable for a harmonization of spatial data in master scale level of detail (large scale). Additionally, boundaries from the State Boundaries of Europe database were used. The edge-matching work was carried in semi-automatic way triggering the specific tools, and by manual work after received the edge-matched results. The workflow was the following:

1) Automatic analysis of cross-border features,
2) Manual improvement of the analysis results,
3) Automatic creation of connecting features,
4) Automatic edge matching,
5) Manual quality check of edge matching results.

The usual and simple edge-matching case is presented in the Figure 20.

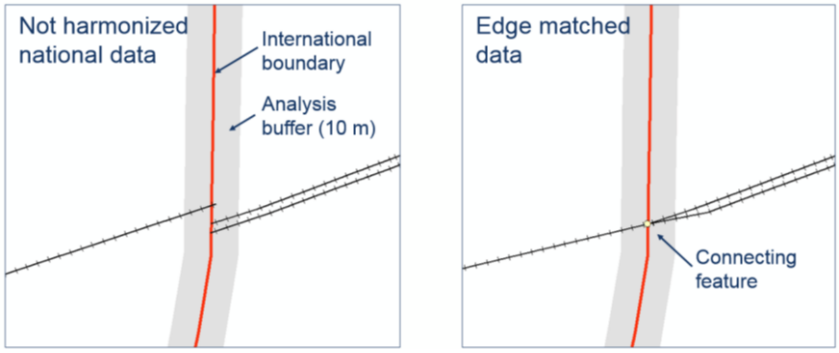

Figure 20. Typical example of the cross-border harmonization.

The applied edge-matching tool selects the concerned national objects with a buffer. The process fails if the national data contains very short objects. It's recommended to avoid any unneeded nodes and to merge adjacent objects wherever possible. The following example (Figure 21) contains a short

road line, which is split from the adjacent road line because it has a different attribution (road on bridge). Furthermore, the picture (Figure 21) shows an object in the neighboring country, which has not been selected because it's out of the buffer. In this case it's even difficult to decide if this is an edge-matching issue, as the distance between the features is rather large.

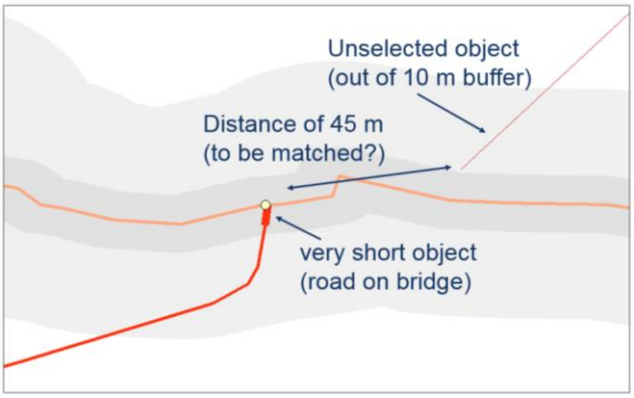

Figure 21. An example of complexity harmonizing spatial data of two countries.

5.3 Findings on typical data harmonization issues and examples to solve them

Further issues are:

- National objects go beyond the origin's country coverage,
- National objects are not split at the border,
- Course of national road lines (ways, paths) is very close to the border,
- Wrong attribution,
- Watercourses on the border are difficult to match,
- Areal watercourses on the border are not split at the border (whole watercourse polygon in each of the national dataset),
- Areal watercourses on border are sometimes very narrow.

An example of complex road lines close to the border is given in the Figure 22. In this case, there are tractor tracks which are not connected cross-border. Although those paths will be selected by a tool using a buffer, there is no need for edge-matching. The only issue is to ensure that those objects don't touch or cross the boundary line.

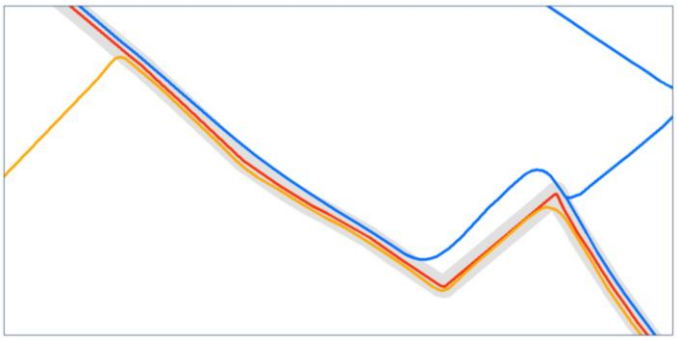

Figure 22. An example of complex road lines along the border line

Another example (Figure 23) visualizes a complex area where a motorway with several lanes crosses the border. Obviously, the most southern lane (or road) is located directly on the boundary. In this case, a connecting feature a line shall be created.

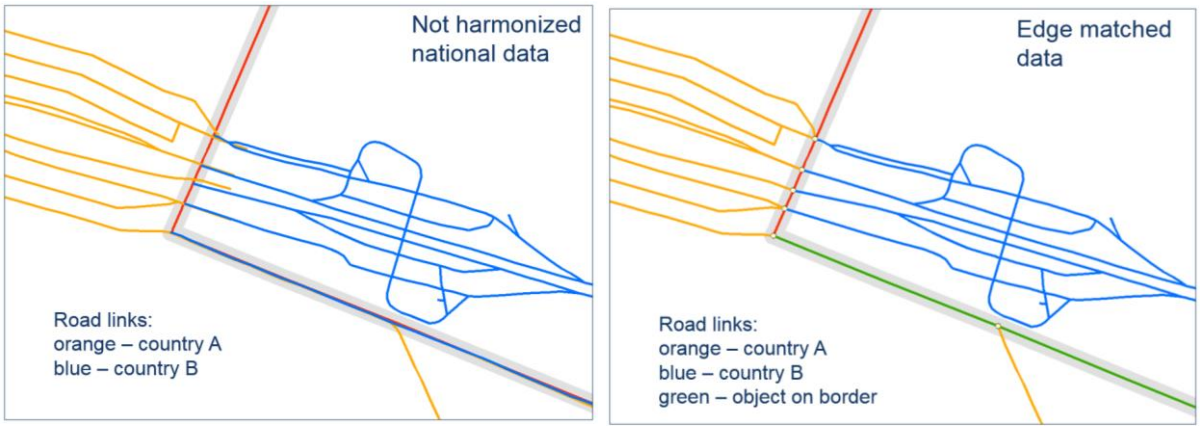

Figure 23. An example of a harmonization of the complex area of transport network along the border line

The last example (Figure 24) visualises a border triangle with areal watercourses. In this case, the objects from country A and B have to be split first with the international boundary, and the spare polygons, located in the neighbouring country, have to be deleted.

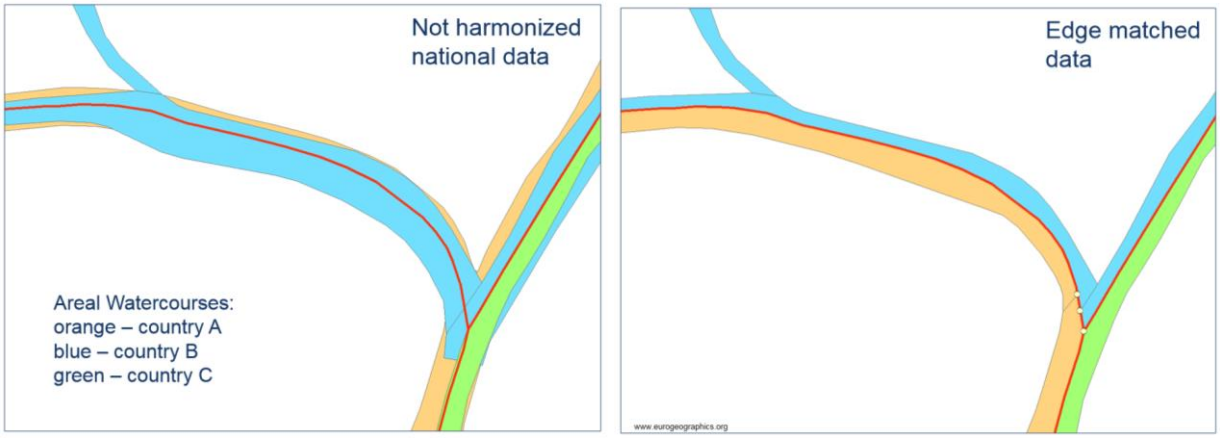

Figure 24. An example of the border triangle along watercourses.

6 Conclusions

- National responsible authorities shall take efforts agreeing the connecting features for making national spatial data interoperable. The Guidance on implementation of cross-border harmonization are needed for facilitating the attempts achieving the cross-border interoperability and could be considered as a standardised procedure to further national and international projects.
- The practical attempts implementing the Guidance [1] in the two bilateral projects harmonising national topographic data in cross border areas between France - Germany and Czech Republic - Poland proved the concept and usefulness of the recommended procedures.
- Experience and lessons learned applying the cross-border harmonisation, following the principles as described in the guidance, in the production of the prototype of the Core Reference Dataset (CRD) will benefit further bilateral projects on cross- border harmonisation of national spatial data utilising the guidance.
- Based on the findings from national projects the documentation of the guidance [1] and the template [2] have been updated with recommended data model specification and supplemented descriptions.
- Support from Open ELS project partners and EuroGeographics significantly helped National Mapping and Cadastral Authorities both in initiation and progress in cross-border harmonisation activities.
- More practical attempts and documented experiences in edge-matching of spatial data along national borders would benefit to the quality and cost of further projects.
- There are demand for a maintenance of cross-border information at European level assuring the developments of seamless and high quality pan European products and web-services.