Open European Location Services (Open ELS)

Guidance on implementation of cross-border harmonisation

The instruction for European Location Services (ELS) Data Providers to edge-match topographical features along borders

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1.0	27/11/2018	Saulius Urbanas	Language corrections

References

Ref.	Title/Version/Publication Date/Author
[1]	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) 14.03.2007
[2]	European Location Framework project. 2013-2016. www.elfproject.eu
[3]	Open ELS project. 2018-2019. https://openels.eu
[4]	ELF D2.3 Data Maintenance and Processing Specification. ELF project deliverable. http://www.elfproject.eu/documentation/specification/data-maintenance-andprocessing
[5]	D2.9 Data Specification Regional/Global. http://elfproject.eu/sites/default/files/D2.9%20Data%20Specification%20Regional_Global.pdf
[6]	D2.10 Data Specification Master. http://elfproject.eu/sites/default/files/D2.10%20Data%20Specification%20Master.pdf
[7]	ELF D2.7 ELF International Boundaries / v1.1 / 08.11.2013 http://elfproject.eu/documentation/specification/ib/1.1
[8]	ELF D2.3.3 Edge Matching / v1.0 / 30.01.2015 http://elfproject.eu/sites/default/files/D2.3.3_EdgeMatching.pdf
[9]	Core Reference Dataset – CRD. Specification and Technical Guidelines, v0.7. BKG / EuroGeographics, 13.06.2018.
[10]	Template for cross-border harmonisation. https://eurogeographics.org/knowledge-exchange/sbe-ken/sbe-ken-documents/

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1 Background

The purpose of this document is to guide National Mapping and Cadastral Authorities (NMCAs) in defining the connecting points or lines of the cross-border features of national geospatial data. This will assure the seamless continuity of the features across the international boundaries of neighbouring countries.

Article 10.2 of the INSPIRE Directive [1] stipulates the requirements for EU Member States in harmonising the content of geospatial data across international boundaries:

"…In order to ensure that spatial data relating to a geographical feature, the location of which spans the frontier between two or more Member States, are coherent, Member States shall, where appropriate, decide by mutual consent on the depiction and position of such common features…"

Possible solutions for achieving the edge-matched data content were prototyped during the European Location Framework (ELF) project [2]. Edge-matching of national data was organized by triggering the edge-matching tools. See the project deliverable "ELF Data Maintenance and Processing" for more details [4]. The edge-matching tools and process have been tested. 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.

Members of EuroGeographics agreed to develop a sustainable, operational European Location Service (ELS), building on the ELF Project, to deliver pan-European authoritative geospatial data content that meets market needs, and meets the needs of the European Union. This is a part of the agreed EuroGeographics Strategy 2017-2020 and the task for drafting the Guidance for Cross-border harmonisation has been addressed in the Open ELS project [3].

Results and deliverables that will be achieved by implementing these guidelines shall contribute to the harmonization of national geospatial data in European Location Services (ELS) and Open European Location Services (Open ELS).

2 Glossary

Abbreviation	Term	Definition
CF	Connecting feature	Connecting location of the geographic entities from neighbouring countries. CFs have either point or line geometry.
CBF	Cross-border feature	A feature that either crosses an international boundary or follows an international boundary and belongs to each of the neighbouring countries sharing that boundary.
ELS IB	ELS International Boundaries	ELS dataset containing agreed international boundaries and connecting features. ELS IB is defined for all levels of detail. Data of ELS IB could be used for automatic edge-matching or cartographic visualization of spatial data purposes triggered by specific applications.
	Edge matched data	Data, which has been corrected achieving harmonized positioning (no gaps or overlaps) of cross-boundary features between two countries.

IB	International Boundary	A line of demarcation between countries. International boundaries are agreed between neighbouring countries and ideally are based on treaties, and as a minimum, the agreed technical line (points) supplementing to the harmonised representation of anthropogenic features to be defined.
	Neighbouring country	A country that shares a border with the responsible country.
NMCAs	National Mapping, Cadastral and Land Registration Authorities	Public authorities, responsible for national mapping, cadastral and land registration activities, and production of authoritative geo-reference spatial data.
	Party	The responsible authority for provision of data (web-service) in ELS and/or performing the edge-matching.
	Responsible country	The country in which the responsible authority performs the edge matching of national data according to the guidelines.
ELS	European Location Services	EuroGeographics programme to develop a single access point to European geospatial data services from official national sources.
Open ELS	Open European Location Services	The project developing open pan-European data services using authoritative geospatial information and an associated business model. Open ELS is a component of ELS.

3 Requirements for cross-border representation

The activities in this document do not impact legal definitions of international boundaries. They refer only to the agreement on the technical representation of cross-border geographical features (rivers, lakes, roads, railroads, etc.) in the border area.

It is important for both authorities of the neighbouring countries to clearly select the content of the CBF that satisfies the ELS/Open ELS data specifications and harmonised presentation of the data in ELS/Open ELS web services.

Responsible Parties for the maintenance of the CBF shall designate competent expert teams and implement changes in the national dataset and web services assuring the harmonised representation of CBF.

4 ELS organisational service

4.1 Definition of edge-matching content

Edge-matching is one component of the organisational framework needed for the maintenance of the ELS and Open ELS. The general data supply chain, from national data to the ELS (previously - ELF) platform, is described in the deliverable D2.3 Data Maintenance and Processing specification [4] of the ELS.

The basic intention is to apply this edge-matching concept to national ELS/Open ELS data, arranged according to the ELS (previously - ELF) data specifications, see D2.9 Data Specification Regional/Global [5] and D2.10 Data Specification Master [6]. This generic concept can also be adapted for other types of data, and could be applied for to matching data between different partners in thematic domains and communities.

ELS data shall be matched to international boundaries, which are agreed between neighbouring countries. The data model is defined in the ELF project deliverable D2.7 ELF International Boundaries [7]. Besides the international boundaries, the data model includes connecting features (CFs). These are points or lines where edge-matched geographic entities from neighbouring countries connect. If CFs are not available, national data has to be matched across the international boundaries, taking into account the related data from neighbouring countries, if such data is available. If neither connecting features nor data from neighbouring countries are available, national data should be snapped to the international boundaries using a “best guess”.

4.2 Methods to reach the cross-border harmonization

Two approaches for achieving a cross-border harmonization of spatial data content in Open ELS have been considered based on “best practice” experience in developing pan-European datasets and regional or bilateral collaboration projects by NMCAs:

1. Bilateral agreement between authorities of neighbouring countries on CFs.
2. Centralized edge-matching.

4.2.1 Bilateral agreement on CFs

Bilateral agreement on location of CFs is the result of a mutual collaboration between the responsible authorities of neighbouring countries. The CFs might be defined following the recommendations in this document (Clause 5) or by other possible collaborative attempts.

Ideally, since the CFs are agreed, the national data shall be corrected/updated so that CBFs will be snapped to the locations of CFs without gaps or intersections. Even if national data is not (yet) correlated according to the agreed CFs, the bilateral agreement on CFs would significantly simplify possible attempts to harmonize cross-border data by triggering edge-matching applications and performing corrections of CBFs. This will achieve the harmonised representations of those features for pan-European or regional user.

Through bilateral projects in 2013-2017 NMCAs in Nordic countries (Finland, Sweden, Norway and Denmark) revised CBFs and agreed on CFs in the largest available map. IGN (France) initiated bilateral projects to agree CFs with responsible authorities of neighbouring countries in 2016-2018. Information about best practice experience in agreeing the CFs between France and Belgium is present in the Annex.

4.2.2 Centralized edge-matching

The concept of so-called “centralized edge-matching” has been elaborated in the production process of the Core Reference Dataset (CRD) [9]. The CRD serves as an easy to operate dataset of primary (base) spatial features derived from authoritative sources - INSPIRE compliant national datasets and/or web-services from NMCAs. CRD aims to deliver a dependable, and seamless large-scale

topographic reference data. Therefore, the CRD spatial features shall match across international boundaries.

Those data providers, who have already defined CFs, are asked for the corresponding CRD contributions. If national CRD source data are not matched properly (CFs have not been agreed), the edge-matching will be applied centrally by the CRD technical production team. In the case of the CBF, due to the limited time for the CRD production, the data providers concerned will be informed about the performed edge-matching results, but no detailed validation is planned in the production of the first CRD release (Spring 2019). Edge-matching in CRD concerns only the seamless interpretation of the transportation or hydrography features. It does not imply a representation of international boundaries.

In regard to the process of cross-border harmonization of ELS/Open ELS, some data providers who are also contributing to CRD can benefit by receiving the centrally defined CFs from the CRD technical coordinator (BKG, Germany). However, those CFs will be set only by a visual interpretation of geometry of two data providers in the border area. Therefore, most probably, the centrally defined CFs will not be definitive and, due to the limited capacities in operating with a rather narrow content of the spatial data and information, demand further improvement by data provider organisations of both neighbouring countries.

In conclusion, for the consent of Parties, performing the cross-border harmonization of ELS/Open ELS data according to these guidelines, the centralized edge-matching shall not be considered as an alternative to the complete edge-matching as described in the guidelines. The centralized edge-matching serves as a temporary solution for speeding up the cross-border data content from NMCAs and EuroGeographics. The results of the centralized edge-matching might also benefit certain types of pan-European applications as a backup solution in the absence of the defined CFs and harmonized cross-border ELS/Open ELS data content.

5 Recommended actions performing the cross-border harmonization and edge-matching of CFs

Checklist of the recommended actions in reaching the agreement on CF of the geographical features across boundaries.

The ordering of actions below refers to a usual workflow. In specific cases, some actions might be already solved or not needed.

A description of the completed cross-border harmonization project between France and Belgium is present in the Annex I. It serves as a practical exercise in implementing the recommended actions below. These are recommendations only and shall be adjusted according the most pragmatic way of cooperation amongst the neighbouring countries.

No	Action	Description
1.	Build the teams	The authorities in each country designate the responsible individuals for carrying the process of agreeing the CFs. The primary contact persons for communication on behalf of the Party shall be appointed. The composition of the teams depends on the complexity of maintenance for the national datasets as

		well as the required expertise. As a minimum (if the scope is small) one person might be designated to carry the edge-matching work on the Party's behalf. If Parties don't have a common language, it is advised to use English as lingua franca. This also supports reporting to EuroGeographics (see section 6).
2.	List the features to be edge-matched	Agree the geographical features (CBF) to be edge-matched. Typical features are: hydrography (rivers, watercourses, lakes), transport networks (railways, roads), constructions (buildings, bridges, pipelines, cables, others). Parties shall prioritise the features corresponding to the content of the spatial data themes of ELS/Open ELS Data specifications [6].
3.	List the datasets to be harmonized	List the datasets that contain the features to be edge-matched (Action 2). Document and exchange the information about scale, point resolution, currency between the Parties.
4.	Assess Coordinate Reference Systems	Use of a CRS based on the geodetic datum ETRS89 is highly recommended. By default, ETRS89 with geographical coordinates (EPSG:4258) should be used. The projection ETRS89 Lambert Azimuthal Equal Area (EPSG: 3035), ETRS89 Lambert Conformal Conic coordinate reference system (ETRS89-LCC) and/or ETRS89 Transverse Mercator coordinate reference system (ETRS89-TMzn) /where zn represents number of relevant meridian zone. Alternative CRS (such as Web Mercator using the ellipsoid GRS80, EPSG:3875) might be used if both Parties see a clear advantage. Both Parties shall describe the status of national coordinate reference systems (CRS) and evaluate a level of possible displacement of locations of topographical features due to the conversions from national CRS. If a transformation from the source CRS to the target CRS is needed, please also document possible positional errors (discrepancies), that impact the transformation results. The agreed CRS shall be documented and the links to other CRS defined.
5.	Consider the status of International Boundaries	Document the valid treaty(ies) on international boundaries, identify the dispute areas, exchange the representations of international boundaries, discover the mismatches. A common representation of the boundary has to be agreed at a technical level as a pragmatic solution. If a common legal boundary in the target CRS is already agreed between neighbouring countries, use this boundary as a reference frame for the edge-matching.
6.	Define common background data.	Agree on the common background data, such as scale, currency as well as other parameters of source data, such as orthophotos or satellite images in the border area.

7.	Agree tolerance in the cross-border area.	Agree the tolerance in the cross-border area for edge-matching of the CBF, build a buffer zone to consider the selection of the CBF. The tolerance (buffer zone) might also be defined for automatic edge-matching of the CBF to avoid discussions regarding small mismatches in the range of the geometric accuracy of the topographic material.
8.	Compare the CBF and investigate reasons for mismatches	Compare the gaps and overlaps of the CBF. This includes duplicate features, features stretching into neighbouring country, mismatches, missing corresponding features etc. Small mismatches may occur due to the currency and accuracy of the source data (orthophotos, etc) for mapping the features, or due to the different ways of transformation from the source CRSs into the target CRS. However, reasons for major mismatches that exceed a possible tolerance of the source data should be investigated.
9.	Finding an agreement for matching the connecting features	The agreement could be reached individually for each point/line of the connecting feature. It is recommended that discussions and investigations focus on the largest scale of the listed datasets, adjusting the agreed position of CFs accordingly to smaller scale datasets. Different status of agreements might be defined. As a matter of tactic in agreeing the CFs each Party could determine and propose candidate CFs. Both Parties will analyse the candidate CFs and bilaterally agree the definitive CFs. If necessary, field survey and/or observations on the location of connecting features.
10.	Compilation of the CF dataset	The agreed CFs shall be stored in the ELS IB dataset following the ELS IB data model. A template of it is provided in the SBE KEN webpages [10]. Each ELS data provider shall contribute by providing the national data of international boundaries and agreed CF to the responsible contact in EuroGeographics (see the clause 6). The specific template has been arranged for a smooth delivery of national data to EuroGeographics.
11.	Update the national datasets and web services according to CF	The CBF in the national datasets shall be updated and modified according to the agreed CF. To assure the consistency of the CBF in different level of details/scales, the generalization procedures to be defined. The generalization procedures shall be also communicated to the responsible data provider of the neighbouring country. CFs for different scales shall be defined if necessary, to ensure harmonization of CBF across different scales.

6 Communication, reporting and monitoring

Parties shall agree the communication plan for the cross-border harmonisation process: the responsible key contacts from each Party, a workplan with launch dates and milestones for each action and followed meeting(s).

It is highly recommended that you inform EuroGeographics Head Office and EuroGeographics State Boundaries for Europe Knowledge Exchange Network (SBE KEN) about initiatives from Parties commencing the cross-border harmonization projects with a neighbouring country. EuroGeographics, through the available resources in Open ELS, ELS programme and other aligning projects, is ready to provide support facilitating the cross-border harmonization activities of its members.

EuroGeographics SBE KEN monitors national initiatives (projects) implementing cross-border harmonization and maintains the database of CFs. If needed, SBE KEN experts could share knowledge and best practice in lessons learned on aspects related to the cross-border harmonization actions. Representatives from NMCAs are kindly asked to report on the status of cross-border harmonization activities to SBE KEN.

Contact persons to support the cross-border harmonisation activities in EuroGeographics :

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- Gert Steinkellner, Chair of EuroGeographics SBE KEN, ph. +43 1 21110-822714, email: gert.steinkellner@bev.gv.at

Annex I. Best practice example of the cross-border harmonisation project, between France and Belgium

The project period: 2014-2015

Responsible contact points:

Belgium: Nathalie Delattre, National Geographic Institute of Belgium.

France: Pierre Vergez, National Institute of Geographic and Forest Information of France.

Cross-border area: 620 km.

No	Action	Description
1.	Build the teams	**The team of experts from France.** Primary actors agreeing the CFs: 2 representatives of National Institute of Geographic and Forest Information of France (IGNF). Actors involved in communication and validation: French Cadastre, Ministry of Interior, Ministry of Foreign affairs, IGNF (other departments than the primary actors) **The team of experts from Belgium**. Primary actors agreeing the CFs: 2 representatives of National Geographic Institute of Belgium (IGNB). Actors involved in communication and validation: communication with General Administration of Patrimonial Documentation, national working group on state boundaries.
2.	List the features to be edge-matched	Administrative Units (line), Transport Networks (point, line), Hydrographic Network (point, line), Buildings (line)
3.	List the datasets to be harmonised	France: datasets – master data 1-5 m accuracy (BD TOPO, BD-UNI). Belgium: datasets - master data 1:10 000 scale (Top10Vector).
4.	Assess Coordinate Reference Systems	The agreed CRS: ETRS89, geodetic coordinates
5.	Consider the status of International boundaries	First, the interpretation of treaty information has been investigated. The available French source information related to treaty cartographic material was not accurate (30m), so as a basis the spatial information has been compiled from the following sources: cadastral data of Belgium from General Administration of Patrimonial Documentation, hydrographic data from IGNB (Top10Vector) and topographic data from IGNF (BD TOPO).

		In addition, survey results from field check and surveying of boundary marks (about 50%) have been utilised.
6.	Define Common background data.	Coordinates of border marks, photogrammetry data, lidar measurements, 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	Each Party extracted the features, exchanged geometry and sematic of candidate CFs. Comparison DB have been produced uploading data from both Parties.
9.	Finding an agreement for matching the connecting features	Several types of agreements on CFs have been reached: 1. Bilaterally agreed CFs. The agreement has been reached as a "technical agreement" without impacting any legal validation: a. Neighbour Party agrees with the line/point of the proposed CF. b. Both Parties agreed the shared line/point c. Agreed middle line/point. 2. Juridical validation of CF. The CFs as defined in state border documentation or validated/revised by State border commissions. 3. Temporal validation of CF. The temporally agreed location of CF with an intention to update it later. 4. Disagreement. Still 2 lines/points remain with overlapping representation.
10.	Field survey	No specific field survey has been performed. Some supplementing information from field check and surveying data of boundary marks have been used. However the agreement on CFs has been reached based on the background spatial data material from national products
11.	Compilation of the CF dataset	IGNF production team compiled the dataset of CFs, which was shared with both Parties and provided to EuroGeographics (SBE IB dataset).
12.	Update the national datasets and web services according to CF	The national datasets in France are updated annually and the updated CFs are considered correcting the location of the CBFs. The national product launch is scheduled according to the national maintenance plans in IGNF. The next update of BD TOPO product with the adjusted CFs is planned to be launched at Spring 2019. ELS WFS of IGNF have been already corrected according the agreed location of CFs. The national data in Belgium is planned to be updated in 2019. Currently IGNB and General Administration of Patrimonial Documentation considers the procedures on how the maintenance of the state boundary information will be maintained.