NIVA – NEW IACS VISION IN ACTION

WP3 - Harmonisation and Interoperability

D3.4 Recommendations for IACS data flows

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1. Introduction

1.1 Technical interoperability

1.1.1 Definition of interoperability

https://www.ccs.gr/products/hl7-gateway/interoperability/?lang=el

Interoperability is the ability to transfer and use information in a homogeneous and efficient way between information systems of one or more organizations. Interactivity requires the existence of open, standardized data exchange structures, communication protocols as well as the adoption of common vocabulary and terminology in all interoperable systems and organizations.

In interoperability, standards are needed to determine how systems work together and how to distribute data across multiple and different databases. The exchange of information between systems requires the existence of a network interconnection network with specific terms and conditions.

1.1.2 Definition of technical interoperability

https://ec.europa.eu/health/sites/health/files/ehealth/docs/ev_20121107_wd02_en.pdf

Technical interoperability means the ability of two or more information and communication technology applications, to accept data from each other and perform a given task in an appropriate and satisfactory manner without the need for extra operator intervention.

https://www.tandfonline.com/doi/abs/10.1080/02681300309414760?journalCode=rwhi20

Technical interoperability includes connectivity between communication and information systems but also some other services.

A major constraint on achieving technical interoperability among systems is that of legacy interoperability problems between old and newer systems. It may not be possible to modify systems employing old or minimal IT to be capable of interfacing with new systems to archive interoperability goals earlier that their programmed disposal dates.

https://books.google.gr/books?id=ptP2-i99SoIC&pg=PA107&lpg=PA107&dq=achieving+technical+interoperability&source=bl&ots=p1SDqk8YVs&sig=ACfU3U2JHXTsPMYEHgkqvI1l90GX_P3ORg&hl=en&sa=X&ved=2ahUKEwihvvPl9rDqAhVxnVwKHafoAY4Q6AEwBnoECAwQAQ#v=onepage&q=achieving%20technical%20interoperability&f=false

https://books.google.gr/books?id=etDxCwAAQBAJ&pg=PA114&lpg=PA114&dq=achieving+technical+interoperability&source=bl&ots=pDUWUfRpfu&sig=ACfU3U1fYmrhKoLu4D1P8tdQa4WQO4rZEg&hl=

en&sa=X&ved=2ahUKEwihvvPl9rDqAhVxnVwKHafoAY4Q6AEwBHoECAcQAQ#v=onepage&q=achieving%20technical%20interoperability&f=false

1.2 Scope and objectives

1.2.1 General objective

The objective of this deliverable is to provide recommendations on technical interoperability, i.e. to provide recommendations for standardized data exchanges (formats, Web standards, security …). The task T3.4 includes:

- Investigate the requirements for IACS data exchange, including those related to data security, authentication and authorization of users and applications;
- Propose a set of guidelines to ensure a basic framework for data exchange;
- Propose relevant solution for standardisation of IACS data flows. Investigate and adopt best practices and harmonization produced by the Connecting Europe Facility (CEF)

In the initial work plan, this deliverable was targeting mainly the data flows between national IACS systems and the EU concerned systems.

1.2.2 Scope

There are 2 NIVA deliverables related to technical interoperability: D3.4 Recommendations for IACS data flows and D3.5 Recommendations for standardised connections between IACS and other applications.

From their titles and from their initial description, it might be understood that both these 2 deliverables deal with recommendations about IACS data exchange between IACS and external systems. In order to clarify the scope of each deliverable, the following decision has been taken:

- Deliverable D3.4 deals with the technical issues (data formats, web services, etc) that are common to internal and external IACS data exchanges
- Deliverable D3.5 will focus on the technical issues that are specific to the exchanges between IACS and the new data sources necessary for implementing the new CAP:
    - connections between IACS and EO processing systems (mainly Sentinel images and derived products)
    - Connexions between FMIS and IACS.

1.2.3 Target readers

This deliverable targets mainly Paying Agencies with the objective to present and recommend them a small set of standards for data management and data exchange.

This deliverable targets also technology providers with the objective to make them aware of the exchange protocols in use among Paying Agencies and so to make them able to propose tools that may fit easily most IACS .

1.3 Glossary

API: Application Programming Interface

BDTI: Big Data Test Infrastructure

CAP: Common Agricultural Policy

CEF: Connecting Europe Facility

CRS: Coordinate Reference System

CSV: Comma Separated Values

CHAFEA: Consumers Health Agriculture and Food Executive Agency

COTS: Commercial off-the-shelf

CPVO: Community Plant Variety Office

GeoJSON: Geographic JavaScript Object Notation

GIS: Geographical Information System

GML: Geography Markup Language

GSAA: Geo Spatial Aid

DSI: Digital Service Infrastructures

EASME: Executive Agency for Small and Medium-sized Enterprises

ECW: Enhanced Compression Wavelet

EEA: European Environment Agency

EFSA: European Food Safety Authority

ECA: European Court of Auditors

ECEF: Earth-Centered, Earth-Fixed

EIONET: European Environment Information and Observation Network

EIB: European Investment Bank

EPSG: European Petroleum Survey Group

ETRS89: European Terrestrial Reference System 1989

ETS: Executable Test Suit

EXIF: Exchangeable Image File Format

EU: European Union

GDAL: Geospatial Data Abstraction Library

HTTPS: Hypertext Transfer Protocol Secure

IACS: Integrated Administration and Control System

INSPIRE: Infrastructure for Spatial Information in Europe

ISO TC211: International Standardisation Organisation Technical Committee on geographic information

JPEG: Joint Photographic Experts Group

JSON: JavaScript Object Notation

IUT: Implementation Under Test

IXIT: Implementation eXtra Information for Testing

KML: Keyhole Markup Languagef

LPIS: Land Parcel Identification System

MrSID: MultiResolution Seamless Image Database

NetCDF: Network Common Data Form

OGC: Open Geographic Consortium

OWASP: Open Web Application Security Project

PDF: Portable Document Format

PNG: Portable Network Graphic

SAML: Security Assertion Markup Language

SQL: Structured Query Language

SME: Small Medium Enterprices

TJS: Table Joining Service

TIFF: Tagged Image File Format

TLSO: Trusted List Scheme Operators

UTF-8: Unicode Transformation Format - 8

WCS: Web Coverage Service

WGS: World Geodetic System

WFS: Web Feature Service

WKT: Well-known text

WMS: Web Map Service

WMTS: Web Map Tile Service

XML: Extensible Markup Language

2. Context and methodology

2.1 General principles

The proposals presented in this text are governed by the following basic principles:

- Reminding INSPIRE instructions and promoting their implementation.
- Encouraging wide adoption of open standards and solutions for data exchanges (OGC standards, CEF building blocks, etc).
- Taking into account the technologies already successfully used by Member States in their national IACS systems. Typically, this document doesn't prohibit technologies that are widely used even if they are commercial and non-open solutions.
- Taking into account the experience of the NIVA Use Cases and their choices regarding IACS data flows.

NOTE : Regarding the last point, it should be noted that, for this deliverable, a step-wise approach focusing on the common NIVA tools developed in the project has been chosen.

A more ambitious objective would be to enable the harmonisation and standardisation of current IACS elements, hence allowing Member States to exchange them or to do shared procurement, thus lowering costs and burden. It would have also be a benefit for IT providers, who could develop industrial-level components, hence lowering their unit cost.

However, this higher ambition would require significantly more work (such as require a detailed analysis of the IACS components in all European Paying Agencies) for potential but uncertain benefits as Paying Agencies may prefer more expensive but more tailor-made solutions. The results of the Multi Member State testing of NIVA tools will provide interesting feed-back about the willingness of Paying Agencies to adopt common tools. In case the Paying Agencies appetite for common IACS elements is confirmed, the more ambitious objective might be one of the topics to be considered in a follow-up project.

This chapter reminds the standardization context (with focus on INSPIRE and on the CEF Building blocks), describes the survey conducted among Paying Agencies and clarifies the concerned data flows.

2.2 INSPIRE rules

The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries. The Directive was voted in 2007.

The INSPIRE directive covers geospatial datasets that are in electronic format, that relate to the territory of a Member State, that are held by or on behalf of a public authority and that relate to at least one of the themes listed in annexes I, II or III. In addition, INSPIRE is about existing data as the Directive doesn't mandate capture of new data.

The Directive is organized according several components, three of them dealing with the technical conditions of data sharing: Metadata, Data Specifications (interoperability), Network Services. The Directive provide the objectives and general principles, it is complemented by more practical documents: Implementing Rules (that are binding) and Technical Guidelines (that are only recommendations). These practical documents are widely based on existing standards, mainly those of ISO TC 211 dealing with geospatial information and of the OGC (Open Geospatial Consortium).

In order to adapt to changing situation (e.g. changes in standards) and to implementation issues, the European Commission has set up the Maintenance and Implementation Group that is composed of representatives from each Member State and whose role is to ensure the evolution of the wide set of INSPIRE documentation (mainly the Technical Guidelines). The MIG has a work plan over a 4 year period that is updated when necessary and holds regular meetings.

Some parts of the IACS data are clearly under the INSPIRE scope. This isat least the case of the land use and land cover information generally carried by the reference or agricultural parcels. Farms, building, fields and installations are also part of the INSPIRE specifications under the theme "Agriculture and aquaculture facilities". In addition, according to a discussion paper prepared by DG AGRI, Ecological Focus Areas should also be considered as under INSPIRE scope.

As general principle, this document promotes the implementation of the INSPIRE rules for the concerned IACS data and it also proposes to apply as much as possible the same rules for the whole set of IACS data (even though there might be no legal obligation).

2.3 CEF Building blocks

2.3.1 Definition

Connecting Europe Facility (CEF) gives access to free tools, support and funding to help you build digital services, whether you are a European citizen, business or government. In doing so, CEF program is funding a set of generic and reusable Digital Service Infrastructures (DSI), also known as Building Blocks. The CEF Building Blocks offer basic capabilities that can be reused in any European project to facilitate the delivery of digital public services across borders. Thus, it may be useful for the LPIS and GSAA projects.

CEF's building blocks can be used to explore and experiment with various data sources, software and methodologies, while having a safe environment to work with data. Technical specifications and standards are provided, along with services to allow projects to create a network of nodes for secure digital data exchange. CEF's components enable the mutual recognition of national electronic

identification schemes and an automated translation tool available to translate text excerpts or complete documents. CEF's set of free standards, tools and services also helps public administrations and businesses to accelerate the creation and verification of electronic signatures that are legally valid in all European Member States.

2.3.2 The eID component

eID is a set of services provided by the European Commission to enable the mutual recognition of national electronic identification schemes (eID) across borders. It allows European citizens to use their national eIDs when accessing online services from other European countries. The eID Building Block ensures legal, organizational, semantic and technical interoperability. The high levels of assurance, possible with eIDAS eIDs, result in a reduced risk of identity theft and misuse of personal information. CEF eID ensures the legal validity of cross-borders transactions, providing the same legal status as traditional paper-based processes. The solution drastically reduces the administrative burden, in terms of time, expenses and effort, associated with the use of foreign public services.

2.3.3 The eSignature component

E-signature can ensure the legal recognition and cross-border interoperability of the electronic signatures. The CEF eSignature is a set of free standards, tools and services which is ideal to accelerate the creation and verification of electronic signatures. The deployment of solutions based on this building block in a Member State facilitates the mutual recognition and cross-border interoperability of e-signatures, so that their legal value can be recognized in countries other than the country of origin of the signer. The scope of the CEF eSignature Service Desk is to provide overall user support concerning the eSignature Building Block and its service offering to anyone with an interested as well as to directly support the implementation and use thereof by e-signature implementers and Trusted List Scheme Operators. The purpose of the CEF eSignature Service Desk is three-folded, as it provides support to e-signature implementers, Trusted List Scheme Operators (TLSO) as well as to anyone interested in the EU Trust Scheme as defined in the eIDAS Regulation (910/20140). CEF gives to users an indisputable advantage on troubleshooting as anytime that an issue is encountered by an above-mentioned user, the CEF eSignature Service Desk investigates and delivers corrections, improvements or clarifications.

2.3.4 The ETranslation component

eTranslation is an automated translation tool available to translate text excerpts or complete documents. It is also a Building Block which can be integrated into digital systems, if you need to embed them with translation capabilities, to make your digital content and services multilingual and accessible to anyone in the EU. The tool is designed to translate from and to more than 24 languages in different domains, including Russian and simplified Chinese. The feature is free and safe, and you keep ownership of your data at all times.

2.3.5 eDelivery

eDelivery provides technical specifications and standards, installable software and ancillary services to allow projects to create a network of nodes for secure digital data exchange. Every participant becomes a node using standard transport protocols and security policies. This way it enables the exchange of documents and data among heterogeneous information systems using a standardized protocol, thereby laying the foundation for cross-domain and cross-project interoperability. In order for all necessary data to be as secure as possible, eDelivery ensures data integrity and confidentiality in every transmission through the use of digital signatures and encryption and guarantees legal assurance and accountability by mandating that the recipient of a message must send a digitally signed acknowledgement of receipt for every message received. Also, eDelivery has a built-in system that supports multiple types of data exchanges and is easy to adjust to each organization's needs, since it can be configured using parameters and doesn't solely rely on programming.

2.3.6 Big Data Test Infrastructure (BDTI)

BDTI is a set of services to help explore and experiment with various data sources, software and methodologies. One of its implemented services provides a catalogue of open-source analytical software tools that users will be able to download for implementing big data solutions. All of these will result in gaining insight from the added value of big data and analytics tool in the public sector.

2.4 Survey among Paying Agencies

It was agreed to develop a Questionnaire, which was sent to the Paying Agencies participating in the NIVA Program. The main reason that led to the Questionnaire was to gather all the necessary information of how the Paying Agencies deal technically with their systems, what methods and technologies they use for each part, in order to take them under consideration while issuing technical recommendations.

The Questionnaire had a detailed structure according to the main IACS components (LPIS, GSAA, audit data, sub-systems) in order to obtain as much information as possible on important elements of the practices and systems being implemented, such as file format, data storage, communication and interoperability of systems, interaction with existing platforms and protocols, etc. The received answers provide input for proposed solutions on each issue.

Replies were received both from the Member States' Paying Agencies and from some States that were invited to fill this questionnaire during the first NIVA Stakeholder Forum.

The Paying Agencies that have answered the questionnaire are:

- NIVA partners : Denmark, Estonia, Lithuania, Netherlands, Ireland, Italy, Spain and Greece
- Other paying Agencies : Finland, Germany (Saxony), Spain (Catalonia), Sweden, Austria

The questionnaire and the analysis details may be found in Annex 1.

2.5 IACS data flows

2.5.1 Overview

The IACS system is composed of various data components and tools (for instance, the tools developed by the NIVA project). The IACS system is managed by Paying Agencies and has strong links with farmers who provide data through the GSAA component and who received data about controls and payments. The IACS system receives input from external data providers, for instance orthoimages and data on regulated areas. The IACS system is also exporting data towards EU systems and other users. One of the objectives of the NIVA project is to enlarge the reuse of IACS data and technical interoperability is expected to contribute to this goal.

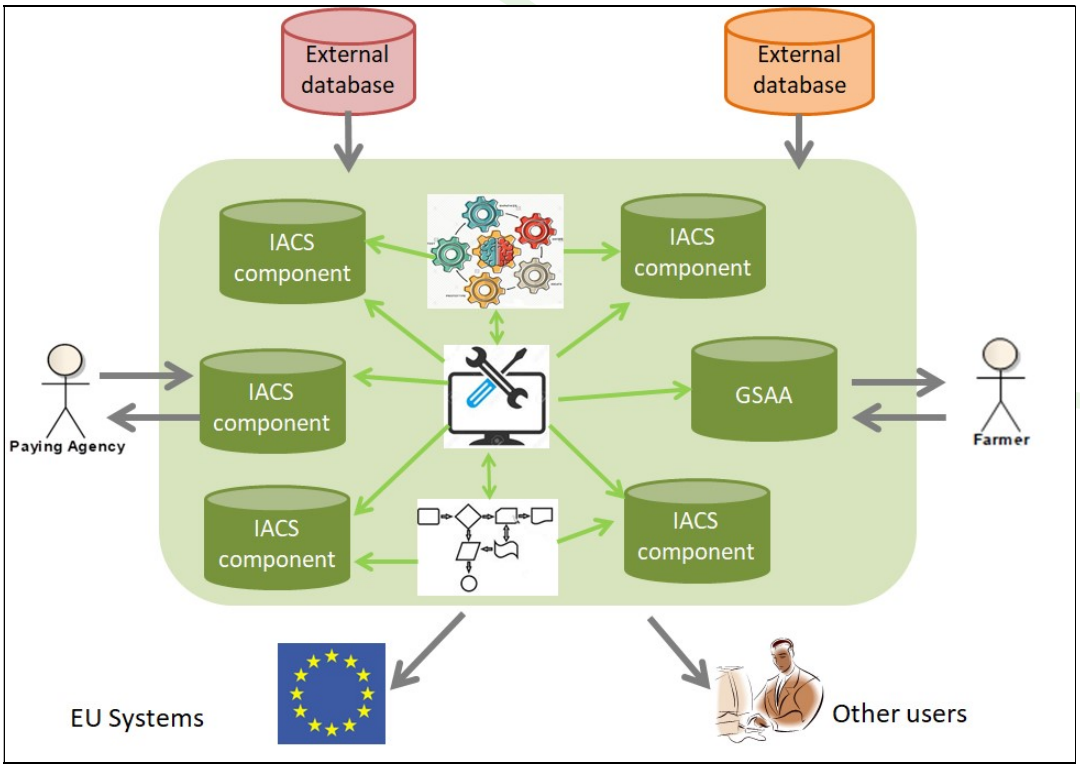

Figure 1 –Overview Concerned IACS data flows

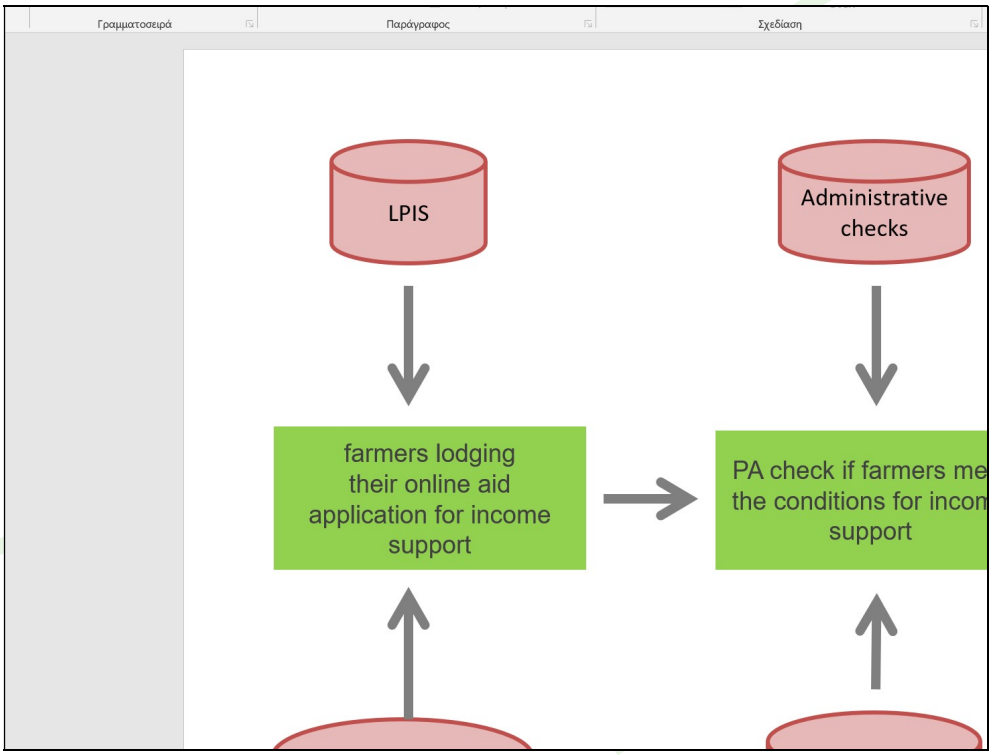

Figure 2 –**Zoom on internal IACS data flows**

2.5.2 Data flows with EU systems

EU systems that are collecting IACS data from various Member States would be the main beneficiaries of standardised data flows.

Until now, the data flows are decentralised, with each Paying Agency sending specific IACS data to the concerned EU system, typically data for statistics to Eurostat and data for quality control to JRC (through the G4CAP portal), as illustrated by figure below.

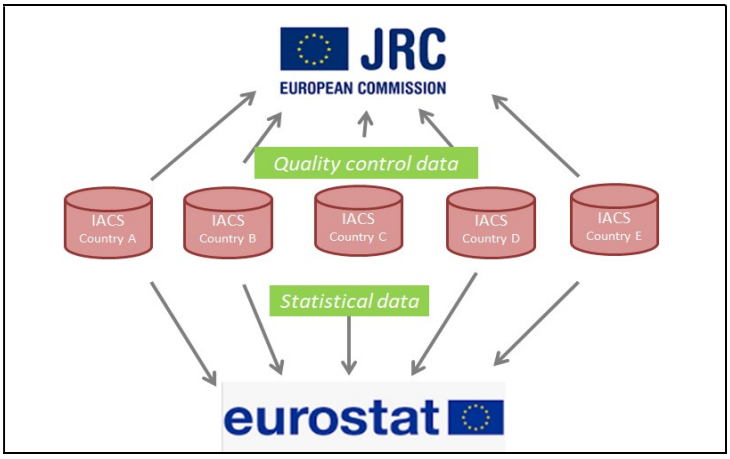

Figure 3 - Current data flows with EU systems

However, there are trends to organise more centralised data flows at European level, as illustrated by figure below.

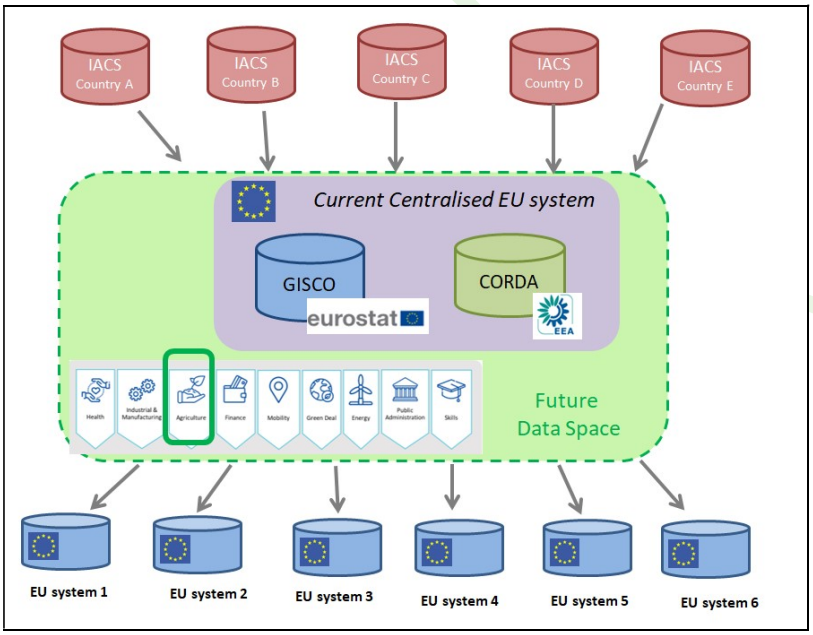

Figure 4 –Potential data flows with EU systems

In practice, Eurostat and EEA (European Environment agency) are collecting data from Member States and integrating it at pan-European level. Eurostat is managing GISCO (Geographic Information System of the Commission), a database that contains core geographical data covering the whole of Europe whereas EEA is managing CORDA (Copernicus Reference Data Access), that aims to integrate

INSPIRE data. A priori, this integration and redistribution is not yet done for IACS data or only on small pieces of information.

In addition, the EU is willing to set up a Common European Green Deal data space, to use the major potential of data in support of the Green Deal priority actions on climate change, circular economy, zero pollution, biodiversity, deforestation and compliance assurance. The IACS data would be very useful to feed the future Data Space on Agriculture.

The paragraphs below describe some of the EU stakeholders who are current or potential IACS data users. The list doesn't pretend to be exhaustive.

- **Eurostat**

Eurostat is the statistical office of the European Union, responsible for publishing Europe-wide statistics and indicators that enable comparisons between countries and regions. Its responsibilities are to develop harmonized standards for the production of European official statistics, to calculate aggregate data for the European Union and eurozone, using data collected by national statistical authorities and to make European statistics freely available to decision-makers and citizens via the Eurostat website and other channels. Eurostat is already collecting some IACS data from Paying Agencies.

- **European Environment Agency**

The European Environment Agency (EEA) is an agency of the European Union, whose task is to provide information on the environment. EEA brings together environmental information from individual countries. This knowledge is made widely available through the EEA website. This information serves to support environmental management processes, environmental policymaking and assessment, as well as citizen participation. EEA will likely gather first the land use and land cover data from IACS but more detailed data such as organic crop growth, cultivation techniques, application of fertilizers and pesticides, etc might also be of interest.

- **Joint Research Center**

The Joint Research Centre (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. One of its units coordinates the quality control of LPIS. An important data flow happens between a MS and the DG JRC for control data, through the G4CAP portal.

- **Court of Auditors**

The European Court of Auditors (ECA) is one of the institutions of the European Union, established in order to improve EU financial management. The role of the ECA is to externally check if the budget of the European Union has been implemented correctly, in that EU funds have been spent legally and with sound management. The control of CAP payments is under its scope.

- **European Food Safety Authority**

The European Food Safety Authority (EFSA) provides independent scientific advice on existing and emerging food risks, including animal health and welfare, plant protection and plant health and nutrition. EFSA supports the European Union and EU member states in taking effective and timely risk management decisions that ensure the protection of the health of European consumers and the safety of the food and feed chain. The data that may be useful input, are the same environmental data reported above for EAA. Additional data such as: the spatial distribution of crops, the trend of increase or decrease, and more generally their changes in soil cover from crops, are of interest since all food and their safety are inextricably linked to primary production.

- **Consumers Health Agriculture and Food Executive Agency**

The Consumers, Health, Agriculture and Food Executive Agency (CHAFEA) is an executive agency of the European Union, set up by the European Commission to manage four programs on its behalf, in the domains of: health, consumer protection, food safety and the promotion of European agricultural products. The data described above for EFSA could also be useful for this specific agency too.

- **Community Plant Variety Office**

The CPVO is a self-financed European Union agency, which manages the European Union system of plant variety rights covering the 27 Member States. Its task is to administer plant breeders' rights, a form of intellectual property right relating to plants. Plant variety rights allow plant breeders to protect new plant varieties and were created to encourage the creation of new plant varieties in the European Union. Information on crop variety is contained in the farmers' Aid Declaration. Therefore, for this specific agency, the data of the change of the areas per variety could be available, as well as the spatial distribution and the tendency of every cultivation variety.

- **Executive Agency for Small and Medium-sized Enterprises**

The Executive Agency for Small and Medium-sized Enterprises (EASME) has been set-up by the European Commission to manage on its behalf several EU programs in the fields of SME support, innovation, environment, climate action, energy and maritime affairs. Among its scopes is to create a more competitive and resource-efficient European economy based on knowledge and innovation by providing high quality support to beneficiary SMEs. Many farms are managed by SME.

- **European Investment Bank**

The European Investment Bank (EIB) is a publicly owned international financial institution whose shareholders are the EU member states. Its activities focus on the following priority areas: climate and environment, development, innovation and skills, small and medium-sized businesses, infrastructure and cohesion. The Bank's mission is to fund infrastructure projects in Europe and it

favors Public-private partnership funding models. The spatial distribution of crops, the trend of change (increase or decrease) as well as the ownership status (individual farmers or enterprises), are some of the basic data that would be useful for the planning of investments in relation to small and medium enterprises but also in in relation to infrastructure (road network, ports, etc.) which are key elements for the commercial development of agricultural products.

3 Coordinate Reference System

3.1 Different types of Coordinate Reference Systems

Text There are various types of coordinates; most widely used are geographic coordinates (latitude, longitude) and projected coordinates (for mapping).

There are also various reference systems, some more adapted for global use, some more adapted to specific areas (e.g. Europe or countries). The figure below provides an illustration of the various kinds of Coordinate Reference Systems , the last column indicating the ones to be used for INSPIRE.

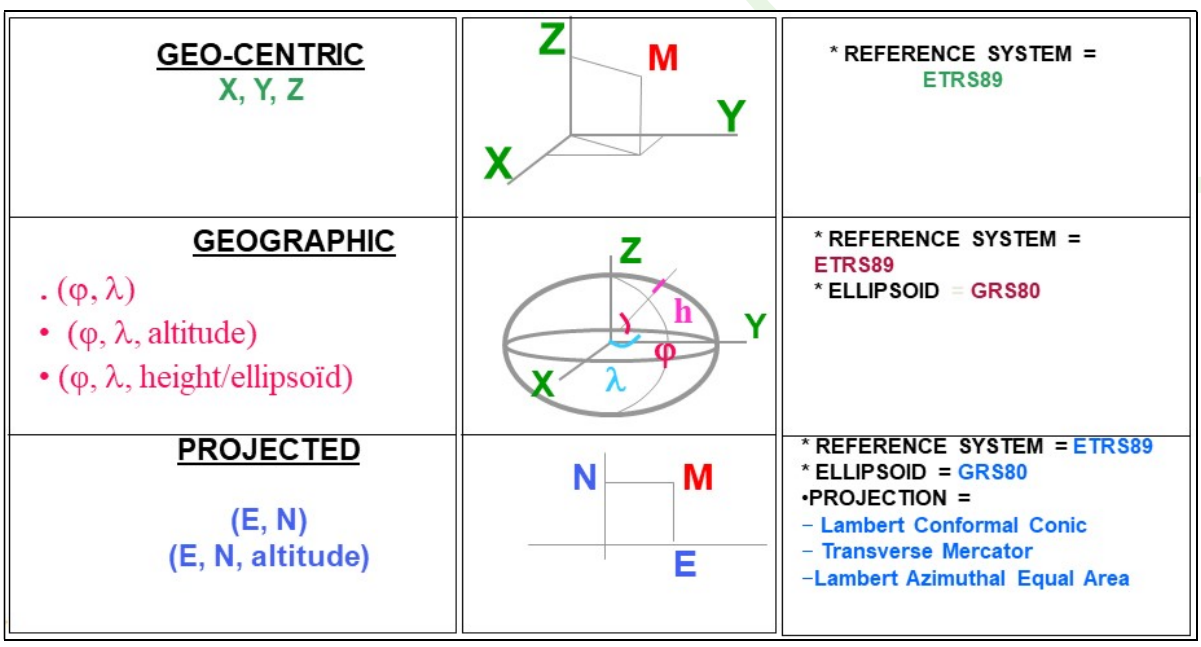

Figure 5 - Different kinds of Coordinate Reference Systems with INSPIRE example

A projection is a mathematic function transforming the geographic coordinates (on the ellipsoid) into coordinates on a given plan. No projection can keep the distances but some of them keep angles (conformal projections) and some of other ones can keep areas (equivalent projections).

Description of WGS 84

The World Geodetic System (WGS) is a standard mainly used for satellite navigation including GPS. This standard includes the definition of the coordinate system's fundamental and derived constants, the ellipsoidal (normal) Earth Gravitational Model (EGM), a description of the associated World Magnetic Model (WMM), and a current list of local datum transformations.

The latest revision is WGS 84 (also known as WGS 1984, EPSG:4326), established and maintained by the United States National Geospatial-Intelligence Agency since 1984, and last revised in 2004.

Description of ETRS 89

The European Terrestrial Reference System 1989 **(ETRS89)** is an ECEF (Earth-Centered, Earth-Fixed) geodetic Cartesian reference frame, in which the Eurasian Plate as a whole is static. The coordinates and maps in Europe based on ETRS89 are not subject to change due to the continental drift.

On the European continent, ETRS89 is the standard choice. People who use DGPS with differential stations on the European continent, obtains positions in ETRS89. Coordinates in ETRS89 are closely related to the Dutch national RD system.

3.2 Coordinate Reference Systems in IACS data flows

Paying Agencies will have to deal with several Reference Coordinate Systems:

- National one(s) for internal data management, for traditional exchanges with farmers through GSAA and likely for data delivery towards national users.
- Global ones(s) due to the new Area Monitoring System: Paying Agencies will have to import data coming with the CRS used for satellite images, for geotagged photos and for machine data. Most of these CRS are based on WGS84. Typically, mobile devices are only working with WGS84, hence the geotagged photos applications shall take care of this requirement.
- European ones as Paying Agencies will have to provide their IACS data in conformity with the INSPIRE rules and as the interoperability rules mandate at least one CRS among the small set of “INSPIRE” CRS.

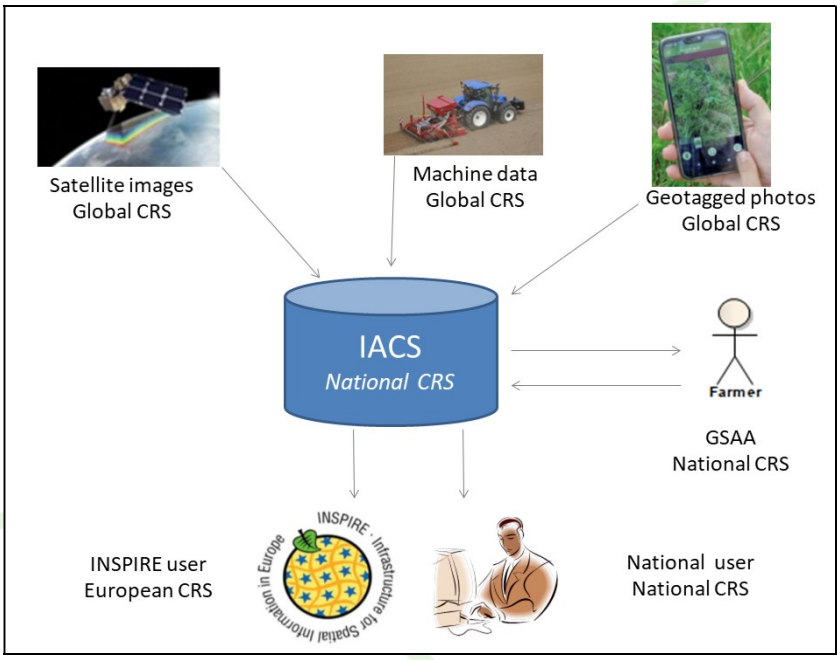

Figure 6 - Coordinate Reference System in IACS data flows

3.3. Recommendations about Coordinate Reference Systems

- **Unambiguous identification of CRS**

The Coordinate Reference System used for IACS data flows must be identified without any ambiguity, enabling to know the reference system, the kind of coordinates, the ellipsoid and if relevant, the projection. For instance, e.g. the mention of the projection or "WGS84" is not enough.

The best way is to reference the CRS using a code in the EPSG (European Petroleum Survey Group) register. This register is worldwide used.

Ex : http://www.opengis.net/def/crs/EPSG/0/4326

- **Reliable coordinate transformation processes**

There may be several tools or services offering coordinate transformation processes; however, all these tools don't offer same accuracy in the transformation. A good way to choose relevant process is to ask advice to the geodetic national service.

Once relevant process has been decided, tools should be present to convert between CRS when needed (for example when sending or receiving data to mobile devices or to/from other systems requiring specific CRS). The process shall be replicable and providing the same results

A possible solution is to use OGC Coordinate Transformation Service: The OpenGIS Coordinate Transformation Service Standard (CT) provides a standard way for software to specify and access

coordinate transformation services for use on specified spatial data. This standard addresses a key requirement for overlaying views of geodata ("maps") from diverse sources: the ability to perform coordinate transformation in such a way that all spatial data are defined relative to the same spatial reference system.

Coordinate transformation of vector data doesn't raise significant issue (if a reliable process is available) whereas coordinate transformation of raster data implies some resampling (as pixels won't have the same geometry), entailing some loss in image quality. Therefore, if raster data has to be combined with vector data, it is better to work in the native CRS of raster data.

- **Respect of INSPIRE obligations**

INSPIRE (Infrastructure for Spatial Information in the European Community) is a European Directive with the goal to create a European Spatial Data Infrastructure. For data publication, INSPIRE guidelines require conversions from local CRS of the European countries to Europe-wide uniform CRS, based on the Reference System ETRS89. The European legislation INSPIRE proposes for different applications and scales various CRS; the most relevant for publishing IACS data are the following:

- Geographic coordinates (ETRS 89 – GRS 80)
- ETRS-TMzn: ETRS89 Transverse Mercator Coordinate Reference System (UTM)
- ETRS-LCC: ETRS89 Lambert Conformal Conic Coordinate Reference System
- ETRS-LAEA: ETRS89 Lambert Azimuthal Equal Area Coordinate Reference System.

- **Native use of ETRS 89 from Paying Agencies**

Paying Agencies should adopt as much as possible the European Terrestrial Reference System 1989 (ETRS89). This Reference System is getting more and more implemented by most Member States for the European areas. National CRS may be based on the European datum (ETRS89) while using a projection adapted to their territory and minimizing the distance discrepencies.

However, the native adoption of ETRS 89 will make easier the coordinate transformations for INSPIRE, if needed (e.g. if the national projection is not among the ones recommended by INSPIRE).

NOTE: ETRS 89 is not adapted for oversea areas (Canarian islands, Martinique ….). In these areas, use of ITRS (International Terrestrial Reference System) is recommended.

4. Data formats

4.1 Vector data

4.1.1 Consideration about vector data

Vector data is used for features having a geometry and possibly attributes. In practice, the geometry is provided through a list of points with their coordinates in a given Coordinate Reference System and by the interpolation function to be used between two consecutive points.

ISO 19107 about Geometry and Topology provides a wide range of possible geometries however most tools are only able to deal with a limited set of geometries (such as points, lines, polygons).

There are various profiles of ISO 19107 called Simple Feature, allowing only the simplest and most widely used geometries. According to INSPIRE, the value domain of spatial properties shall be restricted to the Simple Feature spatial schema as defined in Herring, John R. (ed.), OpenGIS® Implementation Standard for Geographic information – Simple feature access – Part 1: Common architecture, version 1.2.1, Open Geospatial Consortium.

In practice, the specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear and surface interpolations are performed by triangles.

The formal topology of ISO 19107 is rarely implemented because it increase data complexity for limited benefits as most software don't exploit it.

4.1.2 IACS vector data flows

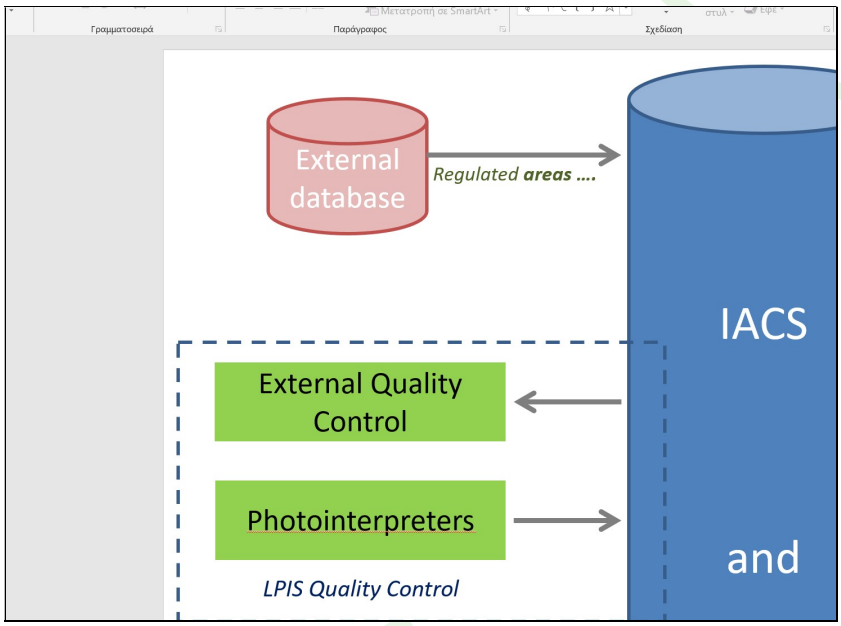

Figure 7 - Vector data in IACS data flows

The geographic vector data exchanged from each IACS system, is divided into three major groups:

(1) Data generated by non-IACS organizations and related areas (e.g. Natura or areas vulnerable to nitrate pollution, etc).

(2) Agricultural reference parcels, created from LPIS update every year.

(3) Aid Declaration parcels, declared to GSAA by the farmers each year, as well as the data produced during the on-the-spot checks using GPS, tablets, etc.

The regulated areas, are used as input to every IACS system.

The agricultural reference parcels are "internal" product of every IACS system.

The vector data of the 3rd group are input and output between farmers and IACS system and only output from IACS to INSPIRE users, relevant EU authorities and other 3rd part users (e. FMS systems).

4.1.3 Possible formats

In the evolution of GIS over time many types of spatial data have been used. Each type has relative advantages and disadvantages depending on the use and volume of data. This chapter provides a description of the formats that are the most widely used or that are recommended by INSPIRE. More detailed explanation about INSPIRE rules are provided in next chapter.

- **Shapefile**:

Shapefile is a geospatial vector data format for geographic information system (GIS) software. It is developed and regulated by Esri as a mostly open specification for data interoperability among Esri and other GIS software products. The shapefile format can spatially describe vector features: points, lines, and polygons, representing, for example, water wells, rivers, and lakes. Each item usually has attributes that describe it, such as name or temperature. The main file (.shp) contains the geometry data. The binary file consists of a single fixed-length header followed by one or more variable-length records. Each of the variable-length records includes a record-header component and a record-contents component. A detailed description of the file format is given in the ESRI Shapefile Technical Description. This format should not be confused with the AutoCAD shape font source format, which shares the .shp extension.

Advantages of the shapefile

- It's a defacto standard and well established
- It's the most common spatial data file
- It has a well structured table data file (*.dbf) for storing the attributes

Disadvantages of the shapefile

- It is not an open standard format
- It's relatively sluggish
- It's a multifile format (.shp,.dbf.,.shx,.prj, encoding, other indexes, etc.)

- Attribute names are limited to 10 characters
- File size is restricted to 2 GB
- Can only contain one geometry type per file

- **GeoJson**

GeoJSON is a format for encoding a variety of geographic data structures. GeoJSON supports the following geometry types: Point, LineString, Polygon, MultiPoint, MultiLineString, and MultiPolygon. Geometric objects with additional properties are Feature objects. Sets of features are contained by FeatureCollection objects. GeoJSON uses a geographic coordinate reference system, World Geodetic System 1984, and units of decimal degrees. GeoJSON comprises the seven concrete geometry types defined in the OpenGIS Simple Features Implementation Specification for SQL [SFSQL]: 0-dimensional Point and MultiPoint; 1-dimensional curve LineString and MultiLineString; 2-dimensional surface Polygon and MultiPolygon; and the heterogeneous GeometryCollection.

There are several advantages to GeoJSON that make it a good option for encoding geographical data. It is text-based, editable in a text editor, uses common English words, utilizes a very simple data structure, and is easy for both humans and machines to read. Moreover, GeoJSON is a single file, unlike compressed geospatial data formats. As a result of its simplicity and versatility, it could be a recommended format both for consuming and producing geospatial data.

<u>Advantages of GeoJson</u>

1. GeoJSON is Fast: Its syntax is very easy to use. Since its syntax is very small and light weighted that's the reason that it executes the response in the faster way. It is well adapted for work on the Web.

2. Schema Support: It has the wide range of supported browser compatibility with the operating systems so the applications made with the coding of GeoJson doesn't require much effort to make it all browser compatible.

<u>Disadvantages of JSON</u>

1. GeoJson has no error handling for GeoJson calls. If the dynamic script insertion works, you get called and will get the response perfectly.

2. Another major drawback of GeoJson is that it uses only WGS84 CRS.

- **GML (Geographic Markup language)**

A GML file format, also known as a Geography Markup Language is an XML like format that is defined by the Open Geospatial Consortium (OGC), and is optimized to express geographical features. GML serves as an open interchange format for geographic transactions on the Internet and can be utilized to integrate all forms of geographic information, including not only conventional "vector" or discrete objects, but coverages and sensor data. GML format is an XML based format adapted for geographical purposes; GML files can be opened by the most common GIS software (QGIS, Arcgis and Mapinfo).

GML encodes the GML geometries, or geometric characteristics, of geographic objects as elements within GML documents according to the "vector" model. The geometries of those objects may describe, for example, roads, agricultural fields and wells.

GML 2.0 may be used for the wide range of geometries of ISO 19107.

GML 3.0 and higher also includes structures to describe "coverage" information, the "raster" model, such as gathered via remote sensors and images, including most satellite data.

Advantages of GML

1. GML is platform independent and programming language independent, thus it can be used on any system and supports the technology change when that happens.

2. GML supports Unicode. Unicode is an international encoding standard for use with different languages and scripts, by which each letter, digit, or symbol is assigned a unique numeric value that applies across different platforms and programs. This feature allows GML to transmit any information written in any human language.

3. GML is a well-documented format; it is flexible and may be used to transfer data according to complex hierarchical models (not only table data)

Disadvantages of GML

1. GML syntax is verbose and redundant compared to other text-based data transmission formats such as GeoJson. GML file sizes are usually very large due to its verbose nature, which causes higher storage and transportation cost

3. GML document is less readable by human beings compared to other text-based data transmission formats such as GeoJson.

- **GeoPackage**

A GeoPackage is an open, standards-based, platform-independent, portable, self-describing, compact format for transferring geospatial information. The GeoPackage standard describes a set of conventions for storing vector features, tile matrix sets of imagery and raster maps at various scales, attributes and extensions within a SQLite database. A GeoPackage is the SQLite container and since a GeoPackage is a database container, it supports direct use. This means that data in a GeoPackage can be accessed and updated in a "native" storage format without intermediate format translations. It was devised to be a convenient, efficient container for geospatial information, to enable operations in all computing environments, including those with Disconnected, Degraded, Intermittent, or Limited (DDIL) network connectivity and to be extensible, allowing it to evolve to meet future operational needs. Thus, making them particularly useful on mobile devices such as cell phones and tablets in communications environments where there is limited connectivity and bandwidth.

Advantages of Geopackage

Geopackage is a file that holds both rasters and vectors and styles them.

It is an open OGC standard format.

Drawbacks of GeoPackage

This format is not (yet) widely used by geographic data community .

4.1.4 INSPIRE rules

The INSPIRE road map distinguishes two main phases regarding the Directive implementation. In the first phase, data should be published "as-is": no change is expecting on existing data but data producers have to adapt their delivery process in order to conform to the INSPIRE rules about metadata and network services. In the second phase, the data has to be published as interoperable data: in practice, in addition to requirements on metadata and services, existing data has to be made conform to the interoperability rules, which generally implies data transformation (mostly data model and coordinate transformations).

- **As-is data**

INSPIRE doesn't mandate any specific data format.

- **Interoperable data**

Strictly speaking, the Implementing Rule doesn't mandate any format but only to document the encoding rules, i.e., the matching between the item of the INSPIRE conceptual schema and the physical schema used in the data format. However, in practice, the Technical Guidelines recommend use of GML (ISO 19136 standard). Some practical tools have been developed, for instance physical schema (that may be used in the transformation process) and an official validator for GML data.

There have been difficulties in use of INSPIRE data, due to two main issues: the fact that INSPIRE schemas use a hierarchical and rich structure (e.g., attributes composed of sub-attributes, attributes with multiple values) that is i.e., always accepted by the current client tools and the big data volume induced by this rich structure and by the verbosity of GML.

To improve the situation, the INSPIRE MIG (Maintenance and Implementation Group) has decided to propose alternative and additional encodings:

- An alternative encoding enables to exchange the whole expected content of the INSPIRE data model and may be used in replacement of GML
- An additional encoding enables to exchange the key content of the INSPIRE data model (but with some simplification); it is encouraged to be provided in addition to GML in order to enlarge use of INSPIRE data.

The data formats currently envisaged for these alternative or additional encodings are GeoPackage and GeoJSON.

4.1.5 Conclusions and recommendations

- **Use simple geometries**

As much as possible, Paying Agencies should use natively the Simple Feature profile recommended by INSPIRE for vector geometries. In practice**,** use of points, lines and polygons (or multi-polygons) is

enough to represent the IACS features and will ensure that IACS vector data can be easily used by any client application.

Use of formal topology is not recommended as it raises data complexity for very limited benefits (if any).

- **Use widely spread formats to exchange as-is IACS data**

For operational reasons, Shapefile is currently the best candidate for the exchanges within the IACS system as it is widely used by Paying Agencies and convenient both as exchange and as working format; it is the format chosen by most the NIVA Use Cases for their tools However, Use Cases should as much as possible offer an open format (such as GeoJSON or GeoPackage) in addition to shapefile.

Regarding the publication of IACS data to external users, shapefile is also a good candidate as it is a de facto standard accepted by most client applications.

However, shapefile is not ideal solution (not an open standard, various limitations). Paying Agencies might envisage to provide their IACS vector data using GeoPackage (for GIS users) in replacement of shapefile.

In addition, Paying Agencies may also envisage to provide their IACS vector data using GeoJSON format that is well-adapted for Web applications, this would contribute to enlarge use of IACS data.

- **Keep aware of what is going to exchange IACS interoperable INSPIRE data**

Until now, most data producers have provided their INSPIRE interoperable data using GML. Until now, this is probably the safest and easiest way as there is wide experience about this encoding choice together with lots of related tools for data transformation and an official validator to check conformity. At short term, this is likely the option to be preferred, the use of alternative or additional encodings such as GeoPackage and GeoJSON being still experimental.

However, though, according to the INSPIRE road map, all data under INSPIRE scope should have been made interoperable before end 2020, in practice, due to many implementation issues, there have been significant delays and many data providers (including very likely most of Paying Agencies) are not yet ready.

Paying Agencies are encouraged to keep aware on the evolutions in the technical recommendations about INSPIRE encoding (e.g., by regular contacts with their national representative in the INSPIRE MIG). In addition, in the context of its IACS data sharing initiative, DG AGRI is also planning experimentations of interoperability through various pilots. Paying Agencies are strongly encouraged to keep informed about the progress in these pilots or even better to contribute to them. Contribution is a good way to influence the recommendations coming from these pilots (in order to ensure they will be feasible in the PA context) and to gain competences.

4.2 Alphanumerical data

4.2.1 General considerations

According to the questionnaires, the majority of responding National Paying Authorities do not store descriptive data along with spatial data, but in separate files in databases. However, every spatial database system offers technical means to handle spatial information and textual information inside the same record.

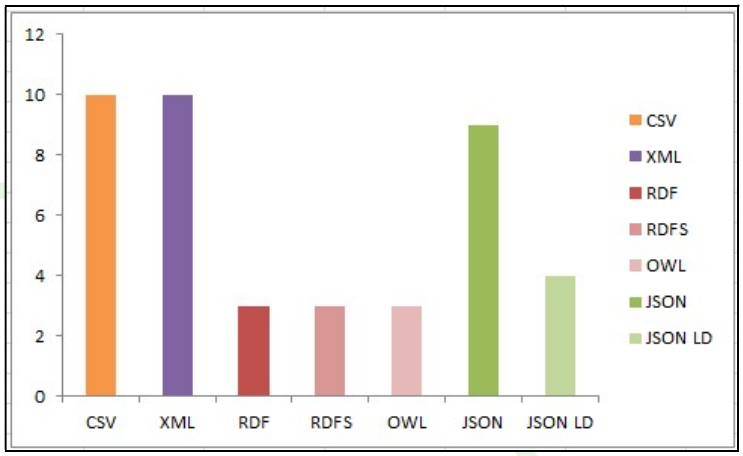

Figure 8 - Paying Agencies awareness regarding data formats and modelling approaches

4.2.2 Possible formats

There are many formats that could be used to store alphanumeric data. The criteria for selecting the most appropriate are:

- Suitability for different data structures, such as tabular data, flexible structures, or the triples of Linked Open Data.
- Openness: Formats that belong to open data, are preferred because they can be available to everyone without special requirements in commercial software for the user to access them.
- Popularity: Formats that are widespread among users (public authorities, private companies and individuals) both in Europe and around the world, could be chosen without the fact that they belong to the category of commercial formats.
- Size: The size of the generated files to store a data set is important in the case of IACS data. This, because they consist of a large amount of data and therefore, we are interested in not requiring very large volumes of files.
- Internet access: As access to files by everyone is becoming more widespread over the Internet, it would be preferable to have data formats that have a suitable structure to be easily accessible through web services.

- Special character support: The alphanumeric data, contain information in each national language, therefore the ability of the format to properly store the special characters of each national language, is a necessary element for its selection or rejection.

Below is the list of possible file formats.

- **CSV**

A comma-separated values (CSV) file is a delimited text file that uses a comma to separate values. Each line of the file is a data record. Each record consists of one or more fields, separated by commas. The use of the comma as a field separator is the source of the name for this file format. A CSV file typically stores tabular data (numbers and text) in plain text, in which case each line will have the same number of fields. The CSV file format is not fully standardized. The basic idea of separating fields with a comma is clear, but the situation gets complicated when field data also contain commas or embedded line breaks. CSV implementations may not handle such field data, or they may use quotation marks to surround the field. Quotation does not solve everything: some fields may need embedded quotation marks, so a CSV implementation may include escape characters or escape sequences.

- **Excel**

Files with XLS extension represent Excel Binary File Format. Such files can be created by Microsoft Excel as well as other similar spreadsheet programs such as OpenOffice Calc or Apple Numbers. File saved by Excel is known as Workbook where each workbook can have one or more worksheets. Data is stored and displayed to users in table format in worksheet and can span numeric values, text data, formulas, external data connections, images, and charts. Applications like Microsoft Excel lets you export workbook data to several different formats including PDF, CSV, XLSX, TXT, HTML, XPS, and several others. The XLS file format was replaced with a more open and structured format, XLSX, with the release of Microsoft Excel 2007. The latest versions still provide support for creating and reading XLS files, though XLSX is the first choice of use now.

- **ODS**

An ODS file is a spreadsheet created by the Calc program included with the Apache OpenOffice suite. It stores data in cells that are organized into rows and columns. ODS files are formatted using the OASIS OpenDocument XML-based standard.

Calc is one of several programs available in the OpenOffice suite and is similar to the Excel program available in the Microsoft Office suite. The ODS file is the main file used by Calc to save spreadsheets the same way that Excel saves spreadsheets in the .XLSX file. Although Microsoft Office is the most popular productivity suite many users download the OpenOffice suite as a free alternative.

OpenDocument spreadsheet files can be opened and edited with any OpenOffice-compatible program, including: NeoOffice (Mac) and LibreOffice (Mac & Windows). ODS files can also be opened in Microsoft Excel and saved as .XLS or XLSX files.

- **JSON**

JavaScript Object Notation (JSON) is an open standard file format, and data interchange format, that uses human-readable text to store and transmit data objects consisting of attribute–value pairs and array data types (or any other serializable value). It is a very common data format, with a diverse range of applications, such as serving as a replacement for XML in AJAX systems. JSON is a language-independent data format. It was derived from JavaScript, but many modern programming languages include code to generate and parse JSON-format data. The official Internet media type for JSON is application/json. JSON filenames use the extension (.json). JSON grew out of a need for stateless, real-time server-to-browser communication protocol without using browser plugins such as Flash or Java applets, the dominant methods used in the early 2000s.

- **JSON LD:**

JSON-LD is a lightweight Linked Data format. It is easy for humans to read and write. It is based on the already successful JSON format and provides a way to help JSON data interoperate at Web-scale. JSON-LD is an ideal data format for programming environments, REST Web services, and unstructured databases such as Apache CouchDB and MongoDB.

- **XML**

Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The World Wide Web Consortium's XML 1.0 Specification of 1998 and several other related specifications—all of them free open standards—define XML. The design goals of XML emphasize simplicity, generality, and usability across the Internet.[6] It is a textual data format with strong support via Unicode for different human languages. Although the design of XML focuses on documents, the language is widely used for the representation of arbitrary data structures such as those used in web services. Several schema systems exist to aid in the definition of XML-based languages, while programmers have developed many application programming interfaces (APIs) to aid the processing of XML data.

- **RDF**

RDF is a standard for data interchange that is used for representing highly interconnected data. Each RDF statement is a three-part structure (triple) consisting of resources where every resource is identified by a URI. Representing data in RDF allows information to be easily identified, disambiguated and interconnected by AI systems.

RDF stands for Resource Description Framework and is a standard for data interchange, developed and agreed upon by W3C.

It was a part of the Semantic Web stack, but currently, it is used more generally where there is a need for representing connected data. Representing data in RDF, in an integrated way, allows information to be identified, disambiguated and interconnected by software agents and various systems to read, analyze and act upon.

RDF is a general method for describing data by defining relationships between data objects. It allows effective data integration from multiple sources and enables detaching data from its schema. This allows multiple schemas to be applied, interlinked, queried as one and modified without changing the data instances.

4.2.3 Conclusions and Recommendations

- **Recommended formats**

Below is a table comparing the features of the formats. Regarding the file size, a reference size of 1MB file xls was used and in relation to this the sizes of the other formats produced for the storage of the same volume of data are mentioned.

Alphanumerical format comparison			
Format	Open format	Data structure	Data volume – sample size
Excel	no	Tabular data	Small file size 1,0 MB (reference volume)
CSV	yes	Tabular data	Medium file size 2,1 MB (relative volume)
ODS	yes	Tabular data	Small file size 1,21 MB (relative volume)
XML	yes	Flexible structure	Very Large file size 7,68 MB (relative volume)
JSON	yes	Flexible structure	Medium file size 2,47 MB (relative volume)
JSON LD	yes	Flexible structure	Medium file size 2,47 MB (relative volume)
RDF	no	Triples Flexible structure	Large file size 5,12 MB (relative volume)

Table 1 - Comparison of formats for alphanumerical data

Most of IACS data is being available as traditional relational databases, i.e., as tabular data. In case NIVA Use Cases have to import or export IACS alphanumerical data through files, they should use a format adapted to tabular data.

- Excel, as it is the most common format and also every user has access to the related MS software for viewing and managing the files.
- The second option is the ODS format, because it is an open format, can store large volumes of data in a relatively small file size

NOTE: Use of web services should be adopted as much as possible, instead of "manual" file exchanges.

In addition, if Paying Agencies are willing to enlarge the potential use of their IACS data to Web developers and Web applications, they might use formats that are adapted for Linked Data, such as JSON LD or RDF. More simply, publishing IACS data in the open CSV format is a first step towards Linked Data.

- **Special characters – UTF8**

All texts in IACS databases are stored in the national languages. Given that almost all languages contain special characters, the need arises to use a common encoding for the purpose of interoperability of databases. One possible solution is to use UTF8 encoding.

A Unicode-based encoding such as UTF-8 can support many languages and can accommodate pages and forms in any mixture of those languages. This significantly reduces the complexity of dealing with a multilingual site or application.

A Unicode encoding also allows many more languages to be mixed on a single document than any other choice of encoding.

4.3 Documents

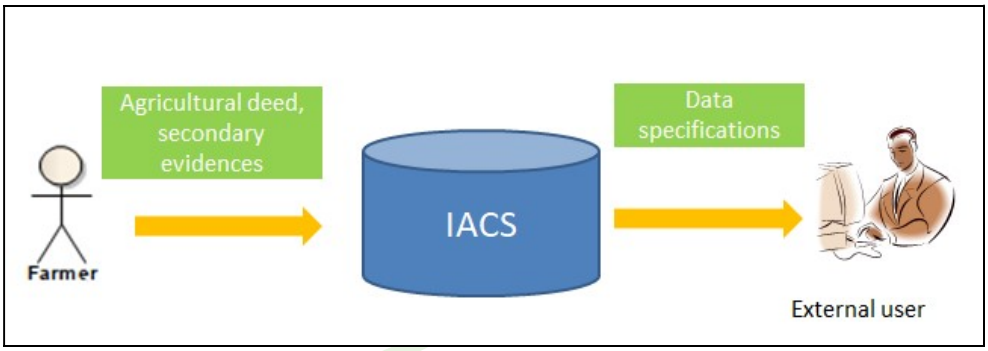

Figure 9 - Example of document exchange in IACS data flows

Agricultural deeds may have to be recorded in the Entitlement registry. In case of yellow light, after first phase of EO monitoring, secondary evidences such as bills, receipts may be supplied by farmers to confirm their declaration.

The most common formats of documents are Word(.docx) and Pdf(.pdf) and the most common programs are Microsoft Word and Adobe Acrobat respectively.

https://www.soliddocuments.com/pdf/_word_format/170/1?id=170&tag=1

- **Word format**

The Word format is better in Word Processing and Editing. Microsoft Word is a word processor, but Adobe Acrobat is not. Word is a powerful document editor. It contains intuitive formatting and compositional tools that allow the formatting of a document as creating, e.g., change of font sizes and styles. Pdf has very limited editing options. When it comes to editing documents, Word is a much more powerful and pliant format than PDF.

- **PDF format**

The Pdf format is better in Archiving, Business and Legal Documents, Combining Multiple Formats, File Exchange and sharing. When compressed, PDF files can be very compact, so it is ideal for storage. File layout is retained and can be viewed on all platforms. Plus, PDF files are searchable, making archived documents and items much easier to find, categorize, and organize. PDF's are essential for business and legal documents and forms that must retain their exact appearance. These important documents must retain their integrity and security. With the PDF format, you can secure your documents so that no one can change the wording of an application or the terms of an agreement.

PDF allows you to import text from a Word document, images of various formats, Excel® spreadsheets, vector graphics, and more into a single PDF document.PDF is ideal for document exchange between users. Not only is it a compact format, but it can also store metrics and information about its own appearance (layout, fonts, content, color, etc.) within the document itself. This means that it may not have to rely on the fonts and settings that may or may not be installed on a user's computer to display properly. To view a Word document, you must have proprietary software (Microsoft® Office) installed on your computer. On the other hand, a PDF can be viewed by anyone who has the free Adobe® Acrobat® Reader, which is easy to download and which comes standard on many computers running Windows operating systems. This makes PDF the preferred format for creating a document that many can view.

- **ODF format**

Open Document Format (ODF) is an international family of standards that is the successor of commonly used but deprecated vendor specific document formats such as .doc, .wpd, .xls and .rtf.

ODF is not software, but a universal method of storing and processing information that transcends specific applications and providers.

Files in the OpenDocument Format (ODF) are platform independent and do not rely on any specific piece of software whatsoever. Every software maker can implement without having to pay royalties.

- **Format comparison**

Comparing these two formats, the results are as follows:

The Word Format may be more useful for the farmer, but, because it is editable, doesn't offer the required security. A Word document can easily change form to Pdf format either by the Microsoft Word itself or by free software provided in the internet. Plus, the .pdf format has almost half the size of the same doc format.

Regarding the characteristics mentioned above, the proposed format between these two, is clearly the Pdf format.

https://www.shutterstock.com/blog/jpg-vs-png-vs-pdf#:~:text=JPG%20images%20are%20ideal%20for,without%20much%20overall%20quality%20loss.&text=PNG%20is%20also%20a%20top,design%2C%20posters%2C%20and%20flyers.

Another way of attaching documents is by photographing or scanning them. The outcome of scanning is Pdf format or Jpg format or Png format.

- **JPEG images**

JPG images are ideal for posting photos and images online, as they keep file size down without much overall quality loss. They are also great for emailing preview images to clients, and for printing artwork and photographs at high resolution. JPEG is widely used for photos.

- **TIFF images**

Tag Image File Format, is a computer file format for storing raster graphics images, popular among graphic artists, the publishing industry, and photographers. TIFF is widely supported by scanning, faxing, word processing, optical character recognition, image manipulation, desktop publishing, and page-layout applications.

- **PNG images**

PNG images are ideal for web graphics, especially logos, illustrations, and graphs. They can shrink to very small file sizes when colors and elements are limited, which is another plus. The greatest advantage of a PNG is that the image can be fully transparent, allowing you to place illustrations and designs atop backgrounds effortlessly. PNG is also a top choice if images will be edited and saved multiple times.

PDF images are ideal for printing, especially for graphic design, posters, and flyers. PDF images are also an ideal choice for storing images online when you intend them to be downloaded. PDFs keep your images in one packet so viewers can print and save designs and booklets easily.

The recommendation of the format of the attached documents is two formats: PDF (document format) and JPG (image format).

NOTE: Regarding software documentation, there is a specific case. It is a recommended practice in all source code that is published, to include a README.md file, and in most cases people expect to find one. README.md it is the standard file one sees if when trying to visit a public repository with a browser such as Chrome, Firefox etx.

It is the standard welcome page in public repositories such as gitlab, github etc and it cannot be changed (at least not in a straightforward matter). For anything else, e.g. a PDF file, the user will have to click upon it in order to see its content. README.md is what you will see if you just visit the page, without having to click anywhere.

However, this practice is more about a file (README.md) and not generally about a format. It just happens that the particular file is written in this format

4.4 Photographs

Geo-referenced photos are used by two categories of users in IACS procedures:

- Farmers, can send photos from their smartphones in order to prove evidence of their Aid Application.
- Inspectors can save to the devices they use and send georeferenced photos to demonstrate the result of their on-the-spot checks.
- In both cases the following applies regarding the photographs:
- They are the proof of the type of crop present in the field,
- They are georeferenced based on the GPS coordinates of the smartphone to prove the location of the photo
- They are sent for storage on the central server of each national payment authority
- They are associated in the database with a specific Aid Declaration

The most common format of photographs is .JPG and JPG is the format that the mobile phones have as an outcome.

JPEGs are widely applied for the processing and storage of full-color images with realistic elements, creating an optimal combination of tile formats for most uses. JPEG is the most common and recognizable format, that allows any user to store images of sufficient quality, while taking up minimal space. JPEG is a 24-bit color format that provides great compression, reducing the storage required for the tileset. JPEG's algorithm is smart at discarding information over smooth gradients and areas of low contrast. The smart compression in JPEGs generally results in a smaller file size for complex images, thus making them more easily shared and conveyed electronically, taking into

account users having access to lower bandwidths. JPEG allows high controlled degree of compression. The user independently selects the ratio quality/file size. This format is compatible and it is displayed correctly in any browser, text and graphics program, on all computers, tablets and mobile devices while it is suitable for full-color realistic images with a lot of color and contrast transitions. Furthermore, the given picture quality is high with small degree of compression. All these features provide tremendous popularity of the format of JPEG. JPEG format can also be georeferenced.

As described above, JPG images are ideal for posting photos and images online, as they keep file size down without much overall quality loss.

The difference that needs to be taken into account between documents and photographs recommendation is also the farmer's facilitation. In the case of attached documents, the farmer can process them in various ways even from home, while in the case of photographs e.g., his/her fields (geotagged photos), there must be an inexpensive, widely used solution (e.g., from a mobile phone or a low-value camera and widely used).

The recommendation of the format of the attached photographs is JPG because it has all the positive features required: image quality - size ratio, recognizability from all software and browsers, image quality so that users can easily recognize the proofs in the photos.

4.5 Orthoimages

4.5.1 IACS data flow

Paying Agencies are dealing or will have to deal with 2 main kinds of orthoimages:

- Fine resolution ones, generally coming from aerial images and used for as background representation for the delimitation of reference and agricultural parcels in LPIS and GSAA. These ortho-images are coming from a data provider (e.g., national mapping agency). Paying Agencies may be in charge of delivering orthoimages to external users, for instance if they are owners of the orthoimages.
- Coarse resolution ones coming from satellite images and used to monitor farmers activities in the context of the new Area Monitoring System.

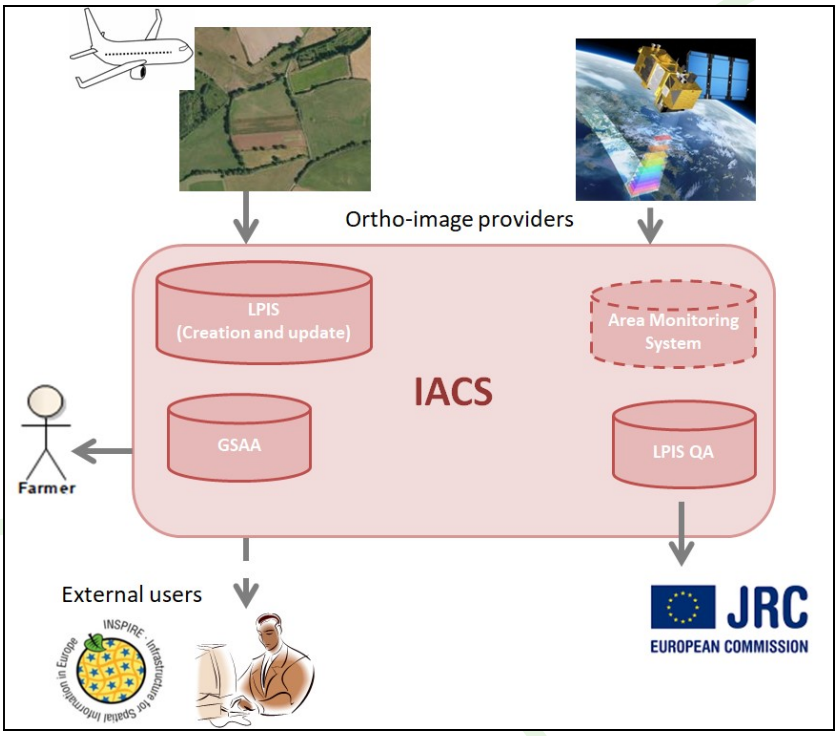

Figure 10 – Overview of IACS data flows for orthoimages

4.5.2 Current practices of Paying Agencies

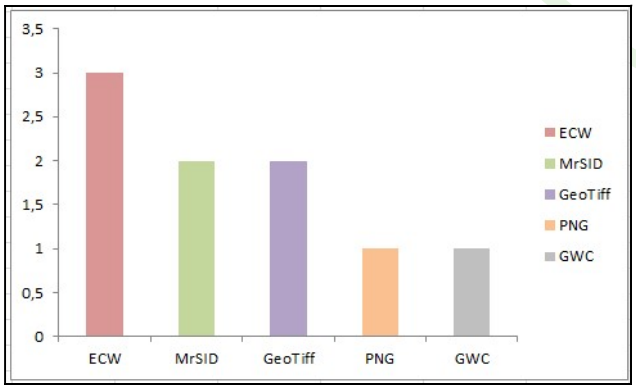

Figure 11 - Current practices of Paying Agencies regarding orthoimage formats (LPIS)

NOTE: More details about practices of Paying Agencies may be found in Annex A.

National Payment Authorities mainly use orthoimages for LPIS correction and satellite data to verify farmers' Aid Declarations. Regarding the cell size and the tile, there is nothing given and each PA uses different dimensions. Most authorities use ECW, MrSID and GeoTIFF formats. Usually, the owner of the images is not the payment authority itself but some other national mapping service.

4.5.3 Orthoimage formats description

The main characteristics of an orthoimage formats are the following:

- The format may include the georeferencement or the format is just an image format requiring an accompanying georeferencing file. The first option is preferable
- The image may be compressed or not. The compression enables to reduce the image volume but some compression algorithms reduce the quantity of information; a compression may be with or without loss.
- The format is open or proprietary. As general principle, the NIVA project encourages use of open formats.
- The format is more or less widely adopted, i.e., there are more or less tools able to open and work with this format.

- **JPEG (Joint Photographic Experts Group)**

JPEG is an image compression format for storing image data. A georeferenced JPEG is a JPEG file that has georeferencing information embedded in it and georeferenced JPEG file components generally include .jpg and .jgw files.

https://library.carleton.ca/help/image-formats

- **JPEG 2000**

JPEG 2000 (JP2) is an image compression standard and coding system. JPEG 2000 is also based on Wavelet compression. It was developed from 1997 to 2000 by a Joint Photographic Experts Group committee. The standardized filename extension is .jp2 for ISO/IEC 15444-1 conforming files and .jpx for the extended part-2 specifications, published as ISO/IEC 15444-2. The registered MIME types are defined in RFC 3745. For ISO/IEC 15444-1 it is image/jp2.

JPEG 2000 code streams are regions of interest that offer several mechanisms to support spatial random access or region of interest access at varying degrees of granularity. It is possible to store different parts of the same picture using different quality.

JPEG 2000 is a discrete wavelet transform (DWT) based compression standard that could be adapted for motion imaging video compression with the Motion JPEG 2000 extension.

There are 2 mechanisms / standards to include Georeference into JPEG 2000 :

1- GeoTIFF Box in JPEG 2000, sometimes called Geo JPEG 2000 (option widely supported)
2- GMLJP2 (OGC standard). GMLJP2 v2.0.1 is the recommended version for orthoimages, with an ETS (executable test suite) available and several software (COTS + GDAL) in support.

- **MrSID (Multi-resolution Seamless Image Database)**

MrSID is an image compression format developed by Lizardtech for storing image data. MrSID file components generally include .aux, .sdw, and .sid files.

- **TIFF (Tagged Image File Format)**

TIFF is a widely used format for storing image data. A georeferenced TIFF is a TIFF file that has georeferencing information accompanying it, and components include .tiff (image) and .tfw (georeferencement) files.

- **GeoTIFF**

geo tags and image data can be encoded into the same file, in lines with the TIFF format. The geo tag can include map projection, coordinate systems, ellipsoids, datums, etc.

The GeoTIFF format is fully compliant with TIFF 6.0. Due to this, programs incapable of reading and interpreting the specialized metadata will still be able to open a GeoTIFF format file.

GeoTIFF is now an OGC standard, as GeoTIFF 1.1 (backward compatible with GeoTIFF 1.0 (see https://www.ogc.org/standards/geotiff). It is supported by GDAL library and support by COTS is under progress.

There is an emerging exploitation mode called Cloud Optimized GeoTIFF (COG): the principle is to compute a pyramid of images at coarser resolutions (generally by using successively a factor 2) in order to enable quicker display of images. This exploitation is not a compression process; in opposite, it increases the data volume to be stored. Its advantage is for client-server solutions, where the client may benefit of fast display of orthoimagres whereas the extra data storage is managed on the server side.

www.cogeo.org

- **ECW (Enhanced Compression Wavelets)**

https://www.file-extension.org/extensions/ecw

https://www.safe.com/convert/ecw/tiff/

Files with the .ECW extension contain compressed WAV wavelet images for use with geospatial data. The Enhanced Compression Wavelet (ECW) format was developed by Earth Resource Mapping and is currently being maintained by ERDAS.

The table below summarizes the formats more widely used or more relevant for exchanging orthoimages.

Orthoimage format comparison			
Format	Compression	Open format	Possible tools (examples)
GeoTiff	Not natively but TIFF allows JPEG compression (and others not of interest for orthoimages), and there is a TIFF compression tag.	yes	Any GIS, CAD, Image Processing, Desktop Mapping and any other types of systems that use geographic images Examples - ArcGIS Desktop (ArcMap, ArcScene, etc.) - ArcGIS Pro - Global Mapper - QGIS
JPEG2000 (GMLJP2)	yes	yes	- Global Mapper - QGIS - ArcGIS
JPEG2000 (GeoJP2)	yes	yes	- Global Mapper - QGIS - ArcGIS
ECW	yes	no	- FME Desktop - TatukGIS Viewer - Falcon View - IrfanView - XnView - ArcGIS
MrSID	yes	no	- ArcGIS Desktop (ArcMap, ArcScene, etc.) - ArcGIS Pro - Global Mapper - QGIS

Table 2 - Comparison of formats for orthoimages

4.5.4 Recommendation

- **Orthoimage export**

In case Paying Agency is in charge to ensure the delivery of orthoimages to external users, a good solution might be to provide orthoimage data both in a format without compression and in a format

with compression. For instance, GeoTIFF may be used for non-compressed orthoimages whereas geo-enabled JPEG2000 and GMLJP2 may be used for compressed orthoimages. Geo-enabled JPEG2000 formats include GMLJP2 (that is an OGC standard) and GeoJP2 (that is a de facto standard).

NOTE: These recommendations are extracted from the UN-GGIM: Europe Working Group on core data. The GeoTIFF and geo-enabled JPEG 2000 formats are also recommended by INSPIRE. GeoTIFF is also one of the formats accepted for the exchanges of orthoimages (togaether with ECW and ERDAS Imagine) with JRC for LPIS Quality Assurance.

- **Use of orthoimages on mobile devices**

The JPEG compression is quite efficient when performed on local site (off-line) but unfortunately, it is not supported by all mobile devices. This is the case of Chrome that is the basic browser for Android exploitation systems (Google has not integrated the JPEG 2000 drivers) or of Firefox. In opposite, the Apple devices may work natively with images using JPEG compression.

In order to deal with this issue on Android devices, the following solutions may be envisaged:

- Ask the client to download and install a viewer such as QGIS or Global Mapper
- Use the Cloud Optimized GeoTIFF exploitation mode
- Use the WebP compression of Google that is supported by Chrome / Android, Firefox (since v68) and by Opera (since 12.1) / Safari (since v14) / iOS 14. It is a Google solution but it is published as open-source.

https://web.dev/uses-webp-images/

https://www.keycdn.com/support/webp-support

https://en.wikipedia.org/wiki/WebP

In future, a potential candidate for browsers and mobile devices is HTJ2K (High Throughput JPEG 2000); it is a version of JPEG 2000 that has been simplified and optimized in order to increase performance during decompression phases. It is ISO 1544- part 15 standard. https://jpeg.org/jpeg2000/htj2k.html

It has Kakadu support and opensource (see https://openjph.org/), as well as a javascript demo at https://openjph.org/javascript/demo.html compatible with most browsers. Implementation testing is planned by the Defense sector.

5 Data Base Management System

The national IACS and LPIS systems handle large volumes of data: raster (orthophoto maps, geotagged photos, etc.), vector (LPIS or GSAA polygons, etc.) and alphanumeric data (farmer personal data, crop data, etc.). According to the EU CAP regulation, all of the above shall be stored in appropriate databases, so that they can be easily accessed, queried from decision makers and can also be easily delivered to other relevant European Authorities.

The two main requirements for data storing systems are data storing and data sharing

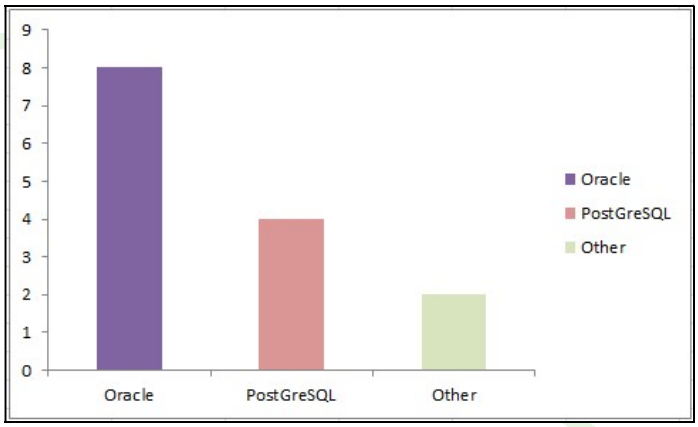

Figure 12 - Database Management Systems used by Paying Agencies

5.1. Oracle

The Oracle Database is among the most advanced and widespread database, including native location capabilities and is fully integrated in the kernel. Oracle's extended support means that its releases have backward compatibility and it is so widespread and used that proficient staff is relatively easy to find. Oracle's compatible operating systems extend to Microsoft Windows, Linux, Oracle Solaris, IBM AIX and HP-UX.

For fast, scalable, reliable and secure spatial applications, the geospatial data features of the Oracle Spatial and Graph support complex geographic information systems, enterprise applications and location service applications. Oracle Spatial extends the special query and analysis features and provides a foundation for applications that require spatial analysis and processing, plus it supports all major spatial data types and models. Oracle Spatial increases performance in common vector data operations. There are several technical solutions about Oracle spatial component such as Oracle Spatial/SDO_GEOMETRY or Oracle with ArcSDE/SDE_GEOMETRY.

Oracle Spatial vector performance build, generally, favors these areas:

- Caching of index metadata
- Concurrent update mechanisms
- Optimized spatial predicate selectivity

While the above-mentioned optimizations enable more efficient use of CPU, memory and partitioning.

Once the spatial data is stored in Oracle database, it can be processed, retrieved and related to all the other data stored in the database, such as spatial information or location. Relevant features of Oracle Spatial are, the ability to access spatial data through SQL statements. Above all, Oracle Spatial facilitates leveraging the full added value of spatial information, which becomes an integral part of the information assets of organizations.

The alphanumeric data in LPIS are linked to the vector data, and both of them are included in the same Oracle Database. By using the same Oracle Database, which is a structured language, for storing all alphanumeric data with the database used to store the LPIS vector data and on the same server, ensures practicality and better organization. One combined database consisting of all vector data and their alphanumeric data makes it easier to be accessed and organized, using Oracle SQL. That with the combination of Oracle Spatial and Graph makes them easily and freely combined without having to use multiple applications and combining different databases, due to both being produced by the same vendor. Storage location and format are also important if you want to keep all the information compacted. Thus, you can use, for the alphanumeric data, the same server as the LPIS vector data server.

5.2 Posgre/Post GIS

PostGIS is an open source software that adds support for geographic objects to the PostgreSQL object-relational database, allowing location queries to be run in SQL. PostGIS follows the Simple Features for SQL specification from the Open Geospatial Consortium (OGC) and In addition to basic location awareness, it offers many features which are rarely found in other spatial databases, such as Oracle Locator/Spatial and SQL Server. PostGIS adds extra features (geometry, geography, raster and others) to the databases, along with functions, operators, and index enhancements that apply to these spatial types. These additional functions, operators, index bindings and types augment the power of the core PostgreSQL DBMS, making it a fast, feature-plenty, and robust spatial database management system.

Some of its more prominent features are:

- Processing and analytic functions for both vector and raster data for splicing, dicing, morphing, reclassifying, and collecting data.
- Raster map algebra for fine-grained raster processing.
- Spatial reprojection SQL callable functions for both vector and raster data.

- Packaged command-line for importing raster data from many standard formats: GeoTiff, NetCDF, PNG, JPG to name a few.
- Rendering and importing vector data support functions for standard textual formats such as KML, GML, GeoJSON, GeoHash and WKT using SQL.
- Rendering raster data in various standard formats GeoTIFF, PNG, JPG, NetCDF, to name a few using SQL.

5.3 Recommendations

DataBase Management System is an internal tool whose choice is clearly up to the Paying Agency.

The situation is different for the NIVA context as the NIVA tools should be open source software. Therefore, the NIVA tools requiring a DataBase Management System shall work, at least, in connection with an Open Source database. As PostGre/PostGIS solution is already used in at least some Paying Agencies, it is the solution to be prefered.

Most Paying Agencies are mainly using Oracle or PostGre/PostGIS. Both theses DBMS are using the SQL (Standardised Query Language). In theory, the use of this standard should ensure easy exchanges between the DBMS handling IACS data and other systems or tools. In practice, for the NIVA tools importing or exporting directly data from or to the DBMS, it might be careful to test if the import/export procedure is working without any issue both with Oracle and with PostGre/PostGIS.

However, regarding the use of Oracle DB, there are two possible implementations: Oracle with Oracle Spatial/SDO_GEOMETRY or Oracle with ArcSDE/SDE_GEOMETRY. The use of Oracle with ArcSDE, may result to limited interoparebility flexibility. It is not advised to build NIVA tools on such configuration.

6 Metadata

6.1 Metadata definition and roles

Metadata is "data about data", such as description of data content, data extent, data format, data delivery (coordinates of data provider, conditions of access), etc.

Metadata has three main roles: search (discovery), evaluation and use.

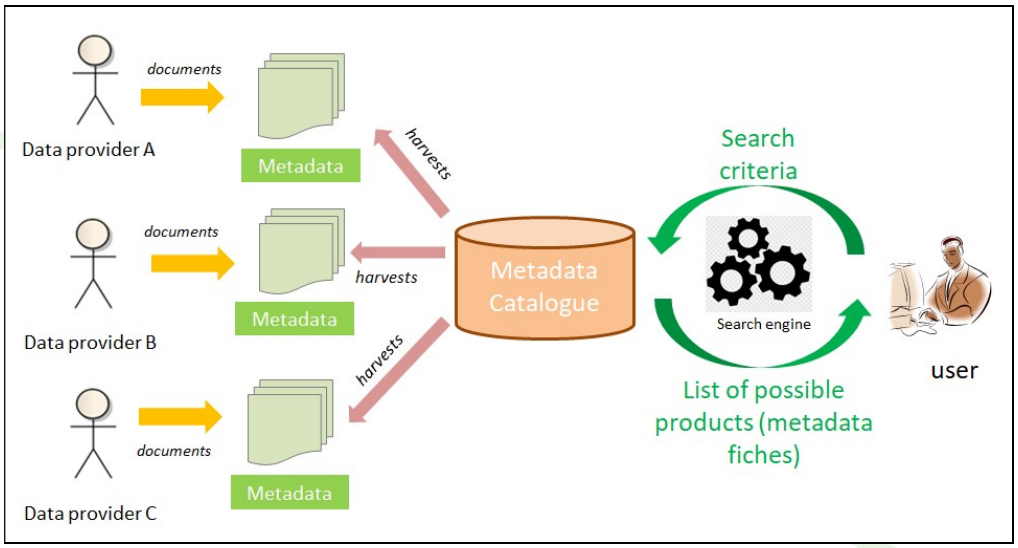

Figure 13 - Role of metadata for discovery (and evaluation)

In first phase, user sends a query to a search engine, indicating its search criteria, such as data theme (e.g. agriculture) and geographic extent (e.g. a given country). The search engine will request the metadata catalogue(s) in order to find the relevant data products corresponding to the search criteria indicated by the potential user. The metadata catalogues, generally at national or European levels, are fed by the metadata harvested from various data providers. The search engine should provide metadata for discovery, i.e. metadata that enables the potential user to know at minimum what is the data product (title, abstract …) and where to find it (coordinates of data provider).

This data finding task can, in many cases, be performed by the way of metadata portals. INSPIRE requires each Member State within the European Union to set up a metadata portal with this task.

In second phase, the user has got a list of potential products and requires metadata for evaluation in order to decide of the most suitable product. Metadata for evaluation may include for instance information about data quality, data formats, data CRS, conditions of access and use.

As metadata for discovery and evaluation is coming from various data providers and has to be managed by common tools, there is a clear and strong need for standardisation. The role of

metadata in modern spatial data systems reporting is extremely important as they are the basis of any integrated environment for the exchange, of geographical information. Metadata is the main tool for infrastructure development.

In last phase, user has chosen the relevant data product, has made agreement with the data provider (if required) and has access to the data; now, user is requiring metadata for use, such as detailed documentation about the data content and structure or advices about how to integrate data in his/her tool.

6.2 Metadata standards

A number of metadata standards have been created by various organizations and Geographic Information Infrastructures around the world.

- **CEN - ENV 12657**

This European prestandard establishes a conceptual schema for metadata. This includes data about the content, representation, extent (both geometric and temporal), spatial reference, quality and administration of a geographic dataset. This European prestandard also identifies those data which are mandatory for describing geographic datasets, the minimum set of metadata. CEN is now promoting the replacement of existing ENV standards by their equivalent coming from ISO/TC211.

- **ISO 19115 standards (by ISO / TC 211)**

ISO 19115:2003 is the first generation of the ISO GI-metadata standards. It was built with a core level of metadata elements to allow one to answer the basic questions: what? where? when? and who? For example, the core level of metadata elements can answer question such as where is the data located?

It is applicable to the cataloguing of all types of resources, clearinghouse activities, and the full description of datasets and services, geographic services, geographic datasets, dataset series and individual geographic features and feature properties. It is encoded in ISO 19139.

In 2014, the standard was revised into ISO 19115-1, which is detailed in the next section. Although, ISO 19115:2003 has been withdrawn from the ISO catalogues since the publication of ISO 19115-1, its resources (UML schemas, XML schemas, ontologies, etc.) are still available, and the standard is still and widely used and implemented.

In this new version of the ISO GI-metadata standard, a vocabulary shift can be observed from “dataset” to “resource.” Resource is recognized as a more general term to address any kind of geographic information such as vector and grid data and any kind of access, distribution, transformation mechanism including encoding, services, and Web services.

The first edition of ISO 19115-2 published in 2009 was named "Extensions for imagery and gridded data." When revised recently (2019), it was renamed "Extensions for acquisition and processing" to address other processes such as lidar, topographic surveys, spatial analysis, and so on.

ISO 19115-1 and ISO 19115-2 define conceptual models for GI-metadata content that are encoding-agnostic. ISO 19115-3 is the current XML encoding for ISO 19115-1 and 19115-2. Essentially, it defines XML encodings enabling automated validation and interchange of GI-metadata. It supersedes the part of ISO 19139:2007 that handled the XML implementation of ISO 19115:2003.

- **Dublin Core**

Dublin Core metadata provides cross domain resource descriptions and is not limited to specific resources, i.e. not limited to geographic information. The core metadata elements were defined by the Online Computer Library Center, a library consortium meeting in Dublin, Ohio. The standardization activities on the Dublin Core metadata resulted also in ISO standards.

The Dublin Core focuses on a simple set of metadata elements providing common semantics for web metadata defined by 15 terms covering broad categories of metadata. It was designed to be used alongside other metadata standards that offer more domain-specific semantics, such as ISO 19115 that was developed in the geospatial community and provides a broader set of metadata, with many metadata elements specifically focused on geospatial data.

- **DCAT and GeoDCAT**

Data Catalog Vocabulary (DCAT) is an RDF vocabulary designed to facilitate interoperability between data catalogs published on the Web. It is a metadata standard that is grounded in the foundations of Dublin Core. In practice DCAT is mainly used for the open data, for instance by the European Data Portal.

GeoDCAT-AP is an extension to the "DCAT application profile for European data portals" (DCAT-AP) for the representation of geographic metadata.

In addition to these generic metadata standards adressing wide range of data, there are more specific metadata standards or guidelines addressing specific pieces of IACS data. This is typically the case of the metadata for geotagged photos and of the metadata for LPIS Quality Assessment.

- **EXIF and JRC guidelines for orthoimages**

Exchangeable Image File Format (EXIF) stores technical metadata about capture, image characteristics and more. Digital cameras embed technical metadata, called Exif data, into image files (primarily JPEG and TIFF formats) they create.

EXIF's primary feature is its ability to record camera information in an image file at the point of capture. Some common data fields include the camera make and model, its serial number, the date and time of image capture, the shutter speed, the aperture, the lens used and the ISO speed setting.

EXIF metadata often includes other technical details, such as white balance and distance to the subject.

To assist Member States, JRC has developed a general method about how to collect geotagged photos. These guidelines are available on:

https://marswiki.jrc.ec.europa.eu/wikicap/images/f/ff/Geotagged_JRC_ReportV5b.pdf

EXIF

Make	Apple
Model	iPhone 6
Orientation	Horizontal (normal)
ResolutionUnit	inches
Software	11.3.1
ModifyDate	2018:06:11 09:53:27
ImageDescription	LUCAS 2018, 35303726, Potatoes for LC1, Not relevant for LC2, null for LU1, Not relevant for LU2
Artist	UKSU005
Copyright	(c) European Union, 2015 - Reuse authorised - The reuse policy of European Commission documents is regulated by Decision 2011/833/EU (OJ L 330, 14.12.2011, p. 39) - The reuser has to acknowledge the source of the documents; has the obligation not to distort the original meaning or message of the documents; guarantee the non-liability of the Commission for any consequence stemming from the reuse.
ExposureTime	1/169
FNumber	2.2
ExposureProgram	Program AE
ISO	32

DateTimeOriginal	2018:06:11 09:53:27
CreateDate	2018:06:11 09:53:27
ShutterSpeedValue	1/169
ApertureValue	2.2
BrightnessValue	6.897630332
ExposureCompensation	0
MeteringMode	Multi-segment
Flash	Auto, Did not fire
FocalLength	4.2 mm
SubjectArea	1631 1223 1795 1077
SubSecTimeOriginal	895
SubSecTimeDigitized	895
XPTitle	[illegible]
XPSubject	[illegible]
ColorSpace	sRGB
ExifImageWidth	1600
ExifImageHeight	1200
SensingMethod	One-chip color area
SceneType	Directly photographed
ExposureMode	Auto
WhiteBalance	Auto
FocalLengthIn35mmFormat	29 mm
LensInfo	4.15mm f/2.2
LensMake	Apple

LensModel	iPhone 6 back camera 4.15mm f/2.2
GPSLatitudeRef	North
GPSLatitude	56.004222
GPSLongitudeRef	West
GPSLongitude	2.748719
GPSAltitude	26.94140127 m
GPSTimeStamp	08:53:28
GPSSpeedRef	km/h
GPSSpeed	0
GPSTrackRef	True North
GPSTrack	67.8515625
GPSDateStamp	2018:06:11
GPSHPositioningError	5 m

Figure 14 – EXIF Metadata profile for the geotagged photos used in the LUCAS survey

According to the recommendations from the Wikicap Common Technical Specifications (CTS), the following metadata should be recorded together with a photo:

- Time and date of the photo capture, preferably obtained directly from the GNSS antenna,
- Geographical location of the camera at the time of photo capture, also preferably obtained directly from the GNSS antenna
- Orientation (heading) of the camera at the time of photo capture,
- The identification of the operator that can be realised by personalised access to the app (login),
- Basic information on the mobile device and inbuilt camera, such as mobile device brand and model number. Such information can help to retrieve e.g. the original image dimensions or

focal length of the photo, or to assess the quality of provided measures of camera position and orientation.

The guidelines also recommended to register the elevation and the Dilution Of Precision (DOP) that can qualitatively indicate the positioning precision. Although most of the above listed metadata can nowadays be automatically recorded by modern photo cameras, a dedicated app for mobile devices should be developed to ensure information integrity and security of transferred geotagged photos. This way, the information content cannot be altered.

- **LPIS QA Metadata**

During the process of the LPIS QA, a series of metadata are created and used by the involved bodies. The main systems of this procedure are:

System metadata for vector/thematic datasets

Relevant vector/thematic datasets in the IUT, are the theme of reference parcels, as well as optional source datasets. Each LPIS must hold a theme with the assembled reference parcels, each of which holds a maximum eligible area for direct payments, as it used during the crosscheck. This theme delivers the population of reference parcels that is subject to the ETS data value inspection.

System metadata for ortho datasets

Relevant ortho image data sets are the 1/5000 or larger scale ortho-image dataset(s), aerial and/or satellite, that, as a combination covers the whole territory and provides the most recent capture for a given site. It is in use for the graphical processes (application, LPIS upkeep) of the direct payments. If two or more distinct datasets cover the entire territory of the IUT, a separate metadata record for each is appropriate.

Metadata reporting requirements

For each separate spatial dataset identified or mentioned in the IXIT, whether vector, raster or imagery, an individual system metadata record is required. By consequence, for any given IUT, at least two metadata records are expected

1.One vector metadata record for the assembled reference parcels (IXIT-qualifier “D”). 2.One image metadata record for the latest image coverage.

3. Depending on the use of ancillary data, the state of the image coverage and the dates of the last systematic update of the datasets, additional metadata records have to be delivered.

6.3 INSPIRE rules about metadata

Metadata is an important component of the INSPIRE Directive and a first key step in the practical implementation of the European Spatial Data Infrastructure.

Rules about metadata may be found in various documents:

- Implementing Rules and Technical Guidelines about metadata that provide requirements and recommendations about metadata for discovery (and first evaluation)

- Implementing Rules and Technical Guidelines (data specifications) about interoperability that provide additional requirements and recommendations about metadata evaluation and use.

https://inspire.ec.europa.eu/metadata/6541

https://inspire.ec.europa.eu/document-tags/data-specifications

The Implementing Rule about metadata defines the metadata elements to be documented by data providers. The list of these metadata elements is a profile of ISO19115: in practice, it is both a subset (extraction of most relevant metadata elements) and an adaptation of the standard (e.g. by adding or in opposite relaxing some constraints). The list of the required elements may be found in the following figure.

Reference	Metadata elements	Multiplicity	Condition
1.1	Resource title	1	
1.2	Resource abstract	1	
1.3	Resource type	1	
1.4	Resource locator	0..*	Mandatory if a URL is available to obtain more information on the resource, and/or access related services.
1.5	Unique resource identifier	1..*	
1.7	Resource language	0..*	Mandatory if the resource includes textual information.
2.1	Topic category	1..*	
3	Keyword	1..*	
4.1	Geographic bounding box	1..*	
5	Temporal reference	1..*	
6.1	Lineage	1	
6.2	Spatial resolution	0..*	Mandatory for data sets and data set series if an equivalent scale or a resolution distance can be specified.
7	Conformity	1..*	
8.1	Conditions for access and use	1..*	
8.2	Limitations on public access	1..*	
9	Responsible organisation	1..*	
10.1	Metadata point of contact	1..*	
10.2	Metadata date	1	
10.3	Metadata language	1	

Figure 15 - INSPIRE metadata for data sets and data set series

The metadata elements to be added, due to the interoperability related documents may vary according to the INSPIRE theme. However, there are a few elements that are common to all themes, namely:

- Coordinate Reference System
- Encoding (format)
- Spatial Representation type (vector, grid, textTable …)
- Temporal Reference system (if different than the default one, i.e. Gregorian calendar)
- Character encoding (if different than the default one, i.e. UTF-8)

The Technical Guidelines about metadata recommend the encoding of INSPIRE metadata in XML using the ISO 19139 standard.

The European Commission has set up a number of tools aiming to facilitate the metadata management:

- Validator : data providers should use it to ensure that their metadata are conformant to INSPIRE requirements
- Translation in different languages: data providers may produce their metadata only in national language, the automatic translation into other official European languages being ensured by the European infrastructure
- Automatic transformation from the INSPIRE /ISO 19115 metadata profile to the GeoDCAT standard (that should facilitate reuse of INSPIRE data in the open data community).

6.4 Conclusions and recommendations

- **Respect European rules for data under INSPIRE scope**

Some parts of IACS data are clearly under the INSPIRE scope. Therefore, Paying Agencies should document this concerned data by metadata conformant to the requirements and recommendations stated in the INSPIRE Implementing Rules and Technical Guidelines.

In addition, DG AGRI has launched an IACS data sharing initiative, based on the INSPIRE legal framework and has issued a set of documents, including Technical Guidelines on metadata for IACS data. These guidelines have also to be respected by Paying Agencies.

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC121450/technicalguideline_iacsspatialdatasharing_part1_finalwithids.pdf

DG AGRI has also provided a discussion paper that might and should be used by Paying Agencies to have common interpretation of the matching between IACS components and INSPIRE themes and so, to decide which IACS data is under INSPIRE scope.

https://inspire.ec.europa.eu/forum/file/view/265990/iacs-inspire-discussion-paper

- **Use INSPIRE profile for whole set of IACS data**

This deliverable recommends to Paying Agencies to document their whole set of IACS data with metadata using the INSPIRE profile, though there may be some pieces of IACS data that are not under the INSPIRE scope, e.g. if not matching with one of the 34 themes. Choosing a common solution will make metadata processes easier and simpler for Paying Agencies.

Some pieces of IACS data may be exchanged without a dedicated geometry (e.g. aggregated data about beneficiaries or payments); however, they are related to a given territory and the mandatory metadata elements of figure 13 might be filled without significant issues. For instance, the geographic bounding box may be the bounding box of the Member State (or of the smaller administrative unit covered) by the data set.

- **Provide metadata for use**

The metadata elements mandated by INSPIRE fulfill the requirements for discovery and evaluation. However, users require more information to be able to use IACS data, such as detailed description of data content, clear licensing conditions, etc. These documents are considered as metadata for use.

The ISO standard on Data Product Specification (ISO 19131) provides useful guidelines to document the data content and other technical characteristics. Data content can be described in a more formalized way using ISO 19110 (Methodology for feature cataloguing).

Paying Agencies are invited to take these standards into account to document their IACS data. In practice, the introductory parts of ISO 19131 may be simplified but the key topics (data content and structure, CRS, quality, metadata, data delivery) should be addressed.

Ideally, these documents should be publicly available and their electronic location should be referenced from the metadata fiche, by using the metadata element Resource Locator.

These documents should be provided at least in national languages. To facilitate the use of IACS data more widely in Europe or at global level, Paying Agencies are encouraged to provide also an English version of these accompanying documents. The CEF building block eTranslation (CEF) might contribute to make this work more automatic.

Land Cover and Land Use are key information of the IACS system but users may have difficulties to understand the specific classifications used by the Paying Agencies. The minimum solution is to describe carefully this classification (e.g. with enough details) in order to make it understandable to users. A more ambitious solution would be to use the ISO 19142 standard , called LCML (Land Cover Meta Language) that offers a standardised way to describe a Land Cover classification.

- **Apply the specific rules about IACS data**

The standards and guidelines dedicated to IACS data, such as the JRC guidelines for geotagged photos or the rules for LPIS Quality Assurance with their related recommendations about metadata should of course be applied by Paying Agencies.

7. Data exchange standards

7.1 Introduction

The possible services for data exchange are:

- View services are used to display geospatial data;
- Access services enable users to query data and to get access to the requested data
- Download services are enabling copies of spatial data sets, or parts of such sets, to be downloaded

For many years, OGC has provided standards for the above services; these standards were dedicated to the geographic community and mainly based on XML language. They have been widely implemented and are in current use.

OGC is developing a new generation of services : the principle is to use the same technologies as the Web community in order to make the OGC services adapted to a wider range of users. This new generation of services will be based on a REST architecture, answers will be provided in JSON or HTML and the interface description via OpenAPI.

7.2. Data exchange services

7.2.1 View services

- **Web Map Service (WMS)**

It is a standard protocol developed by the OGC in 1999 for serving georeferenced map images over the Internet. These images are typically produced by a map server from data provided by a GIS. The service may be consumed by GIS clients or APIs.

WMS provides a standard interface for requesting a geospatial map image. The benefit is that WMS clients can request images from multiple WMS servers, and then combine them into a single view for the user. The standard guarantees that these images can all be overlaid on one another as they actually would be in reality. Numerous servers and clients support WMS.

The images are computed on-the-fly depending on user request. The advantage is that it is quite flexible and the server may offer a wide range of possible projections (CRS) and styles. User may also be offered to apply his/her own style by using Style Layor Descriptor (SLD) standardThe on-the-fly computation ensures that the digital map is updated according to the update of its source data

The drawback is the on-the-fly computation takes time and the response time may become too long in case of many requests. It is not adapted for resources that are widely requested.

If a layer is marked as 'queryable' then the user can request data about a coordinate of the map image.

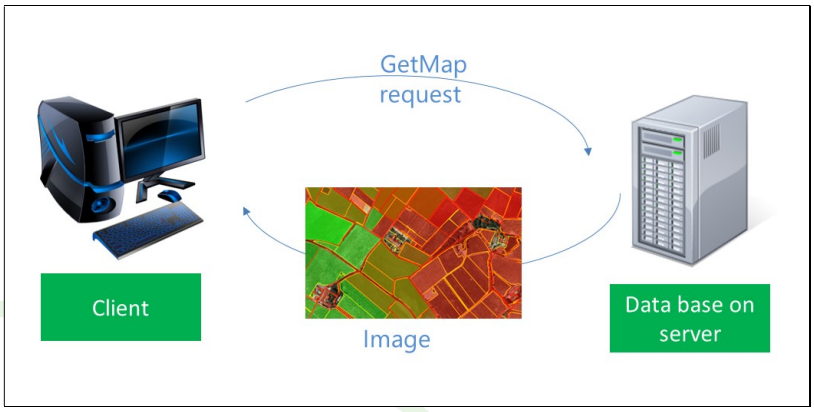

Figure 16 - Principle of WMS

OGC API Maps will be the new generation standard and should replace WMS.

- **WMTS (Web Map Tile Service)**

The WMTS Implementation Standard provides a standard-based solution to serve digital maps using pre-defined image tiles. The service advertises the tiles it has available through a standardized declaration in the *ServiceMetadata* document common to all OGC web services. This declaration defines the tiles available in each layer (*i.e.* each type of content), in each graphical representation style, in each format, in each coordinate reference system, at each scale, and over each geographic fragment of the total covered area. The *ServiceMetadata* document also declares the communication protocols and encodings through which clients can interact with the server. Clients can interpret the *ServiceMetadata* document to request specific tiles.

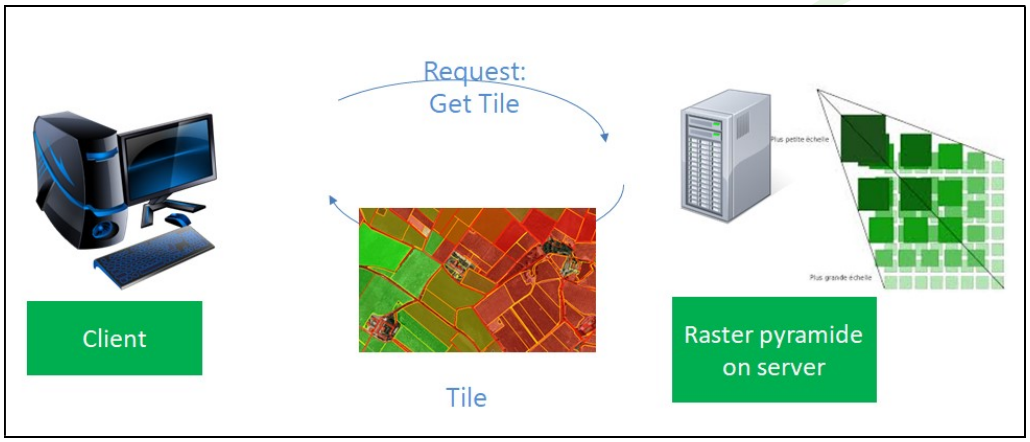

Figure 17 - Principle of WMTS

The WMTS standard complements the existing Web Map Service (WMS) standard.

- The images (digital maps) are computed in advance and stored
- Advantage: it makes the time response shorter ; it is well adapted for resources that are widely requested ; Drawback: the computation and storage of the pyramids of precomputed images takes time (server side) and storage place ; as a consequence, it is less flexible and generally, there is limited choice of styles and projections (CRS).

In case of update, it is possible to pre-compute again only the tiles that have changed; this enables to offer relatively good update frequence but WMTS remains less adapted than WMS for view services on databases with frequent evolutions.

OGC API Tiles will be the new generation standard and should replace WMTS.

- **Table Joining Service (TJS)**

The Table Joining Service (TJS) is an OGC standard that defines how to join attribute data to its associated geographic framework, or framework data. TJS gives possibility to construct maps on-the-fly by joining geographic data with tabular data using a common identifier.

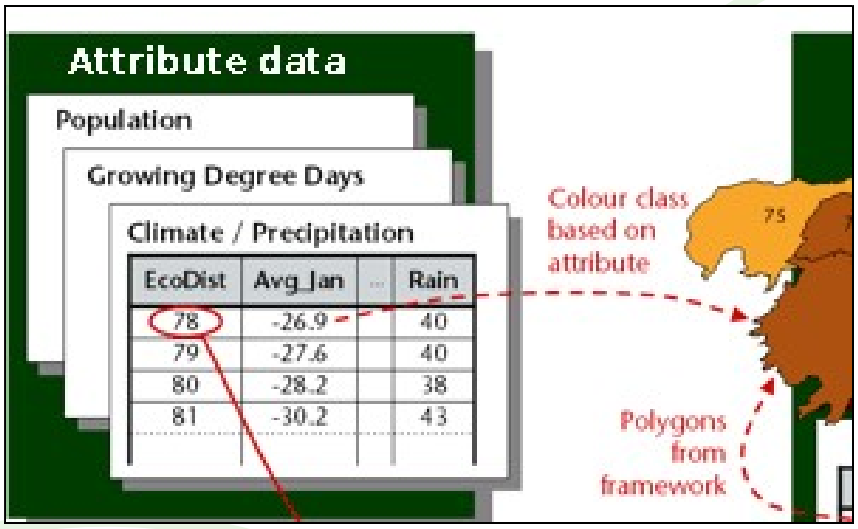

Figure 18 - Principle of Table Joining Service

Attribute data refers to data that can be mapped, but is not directly attached to and bundled with geographic coordinates. Attribute data uses an identifier, found in a framework key field, to indicate the geographic feature to which it applies.

Framework data refers to data that describes the positioning on the surface of the earth of a set of geographic features such as countries. Framework data must include a framework key field, an identifier that allows attribute data to be attached to an individual geographic feature.

TJS offers a simple web-based method of finding, accessing, and using attribute data from multiple sources dynamically, in order to populate databases, perform analyses, and/or make maps. It is widely used by the statistical offices for displaying the multiple variables they are collecting : TJS is economic for the statistical office that doesn't have to predefine a huge number of maps while offering a user-friendly access to the richness of statistical data.

7.2.2 Access and download services

- **Web Feature Service (WFS)**

WFS defines a standard for exchanging vector data over the Internet. With a compliant WFS, clients can query both the data structure and the source data. Advanced WFS operations also support feature locking and edit operations.

The WFS standard defines the framework for providing access to, and supporting transactions on, discrete geographic features in a manner that is independent of the underlying data source. Through a combination of discovery, query, locking, and transaction operations, users have access to the source spatial and attribute data in a manner that allows them to interrogate, style, edit (create, update, and delete), and download individual features. The transactional capabilities of WFS also support the development and deployment of collaborative mapping applications.

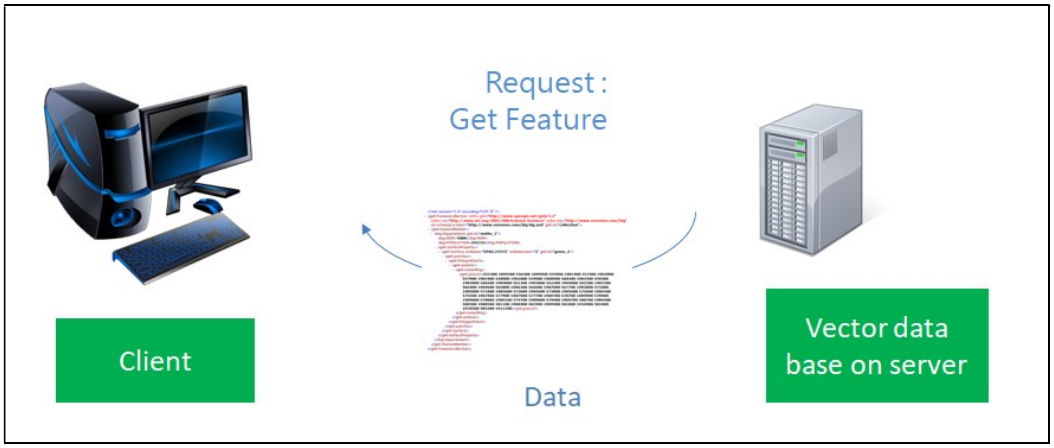

Figure 19 - Principle of WFS

WFS provides direct access to database content and enables users to get data as fresh as possible; it is well adapted to databases that are continuously updated. WFS drawback is that it is not adapted to the exchange of big volumes of data.

OGC API Features will be the new generation standard and should replace WFS.

- **Web Coverage Service (WCS)**

The WCS supports requests for coverage data (rasters). One can think of WCS as the equivalent of WFS, but for raster data instead of vector data. It lets you get at the raw coverage information, not just the image.

WCS provides a standard interface for how to request the raster source of a geospatial image. While a WMS can return an image it is generally only useful as an image. The results of a WCS can be used for complex modeling and analysis, as it often contains more information. It also allows more complex querying - clients can extract just the portion of the coverage that they need.

OGC API Coverages will be the new generation standard and should replace WCS.

- **ATOM FEED**

ATOM feeds are a useful way to share frequently updated content. Users can subscribe to a feed and automatically have access to the most up-to-date data. INSPIRE data download requirements can be met using ATOM feeds and a number of organizations are doing so.

In practice ATOM is an XML file indicating the feed and sub-feeds, i.e., it is a kind of repertory of predefined data sets enabling to serve them easily and offering a simple interface.

ATOM feed is well adapted to predefined packages.

7.3 INSPIRE rules

More detailed information is available on: https://inspire.ec.europa.eu/document-tags/network-services

- **View services**

For serving the dynamic maps computed on-the-fly, INSPIRE recommends WMS 1.3.1 that is ISO 19 128 standard. In addition, the service should offer at least geographic coordinates for the map CRS, it should provide the map images in PNG or GIF formats; data should be as much as possible organized according to the INSPIRE layers and the INSPIRE data specifications of the related theme provide default style.

For serving the static maps computed in advanced and stored on the server, INSPIRE recommends WMTS 1.0.0 (OGC standard). In addition, the service should offer at least geographic coordinates for the map CRS, it should provide the map images in PNG or GIF formats.

These static maps are generally provided at several scales, forming a pyramid of images. To enforce interoperability and to allow possible combination, the standard allows only a limited set of well-kown scales, all based on the use of WGS 84 and geographic coordinates.

- **Access or download services**

Regarding vector data, INSPIRE is recommending ATOM-Feed (Geo-RSSS) for the download of predefined datasets. For direct access, INSPIRE is recommending WFS 2.0 (ISO 19142) and Filter Encoding (ISO 19143) for the request language. OGC API feature has recently be added to the INSPIRE recommended access services.

Regarding coverage data, INSPIRE is recommending ATOM-feed for download and WCS2.0 for direct access.

7.4 Current practices

Technologies for data exchange		
Paying Agency	**Relevant technologies for fast exchange of big amount of data between IACS's or IACS and other Information Systems**	**Relevant techniques of technologies for fast exchange of small amount of data between IACS's or IACS and other Information Systems**
PA2	RESTfull API-s exchanging (Geo)JSON	RESTfull API-s exchanging (Geo)JSON
PA9	Real Time Exchange	
PA3	Db links	Web services
PA4	Not an opinion	Soap, and rest web services, xml and Jason
PA11	ORACLE Dumps, Geopackage	OGC API-Features
PA10	It depends	It depends
PA12	Web download services via ATOM	Linked open data LOD, Web services for alphanumerical and vector data and WMS and WMTS services for raster
PA13	Solution would be based on custom or existing formats such as Geopackage	Web services, standards for geospatial data exchange
PA8	Web Services	JSON and RESTful endpoints

Table 3 - Technologies for data exchange

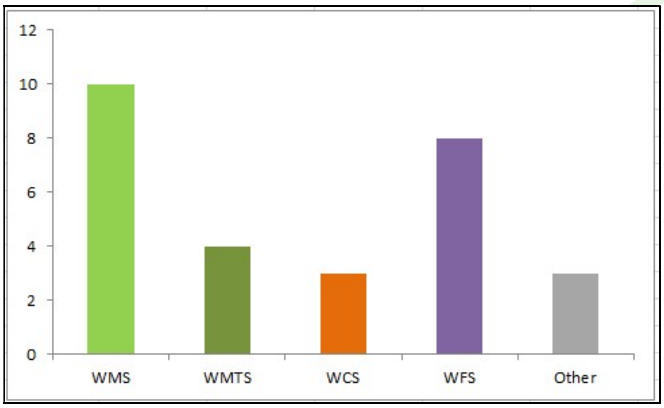

Figure 20 - Use of web services by Paying Agencies

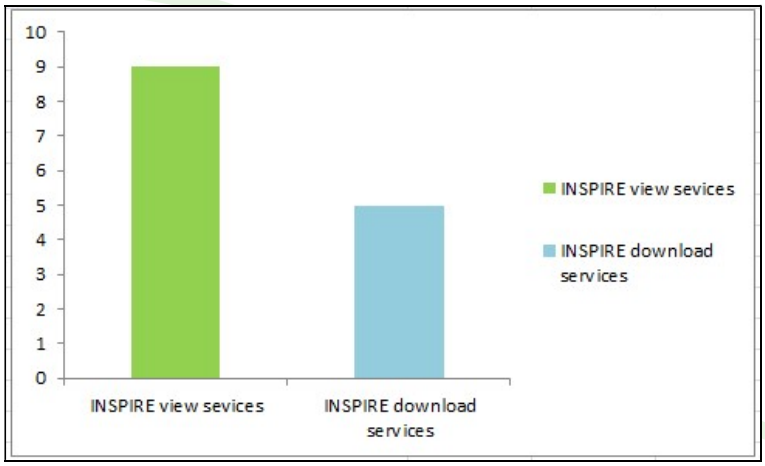

Figure 21 - Implementation of INSPIRE services by Paying Agencies

7.5 Recommendations

- **Respect INSPIRE obligations for web services**

Paying Agencies should of course respect the INSPIRE rules regarding network services for the IACS data that is under INSPIRE scope. For simplicity reasons, it is adivised to use as much as possible the same technologies for whole IACS data.

- **Adapt the services to the context and objectives**

Regarding view services, it may be worth to offer both WMS (rich functionalities but limited number of simultaneous requests) that targets more advanced users and WMTS (big number of possible simultaneous requests but poor functionalities) that is targeting a wider audience. Table Joining

Service may become an option in future if, due to new CAP regulation, Paying Agencies decide to collect and publish significantly more data on same geometry (e.g. on agricultural parcels).

Regarding download services, ATOM-feed may be a good option at least for short-term: due to the yearly cycle of IACS data, predefined datasets may be computed only a few times per year (at least once) and the ATOM-feed will enable download of significant volume of data, which may be necessary as IACS is large scale data. Download of predefined packages may be also a good enough solution for historic data (IACS data from previous campaigns).

On longer term, due to the new CAP regulation, IACS data might or even should be maintained in a more continuous way and WFS might then become of more interest.

- **Keep aware of what is going on**

Technology is an evolving sector; OGC is preparing a new generation of API services that might be recommended by INSPIRE in future. Paying Agencies are encouraged to keep aware on the evolutions in the technical recommendations about INSPIRE services (e.g. by regular contacts with their national representative in the INSPIRE MIG)

8 Security

8.1 Data security concerns

When were asked their opinion about the main incentives for an attacker with regards to IACS information system and data, Paying Agencies have expressed their main fears:

- Main risk is on sensible data (mainly personal data but also statistic and strategic data); for instance, personal data can be used for financial gain
- Frauds and illegal declaration are mentioned several times
- More generic political motivations: disrupt society, crash food safety systems, disrupt farm operations.

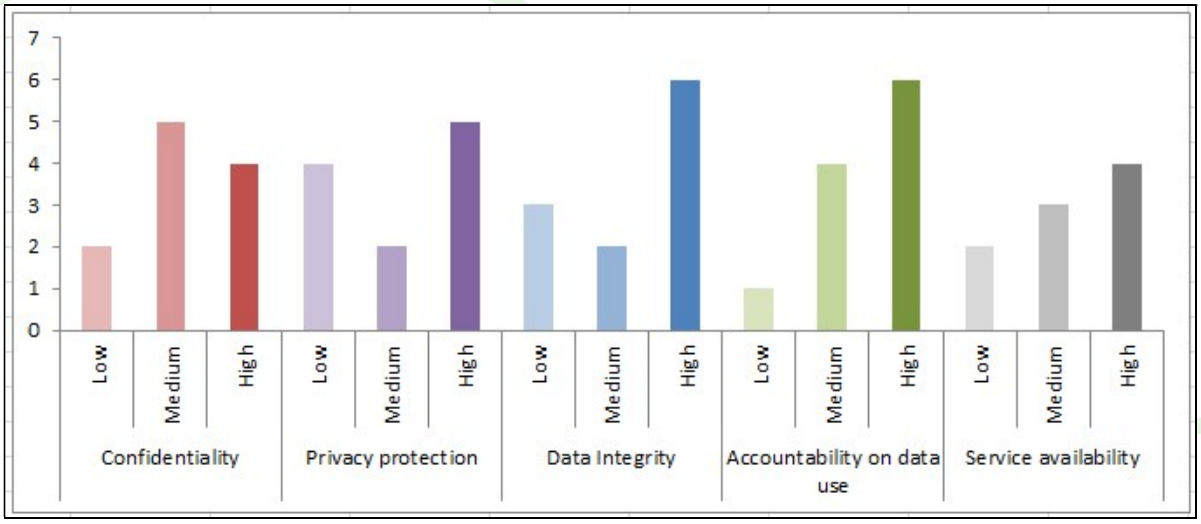

Figure 22 - Main concerns of Paying Agencies regarding data exchange security

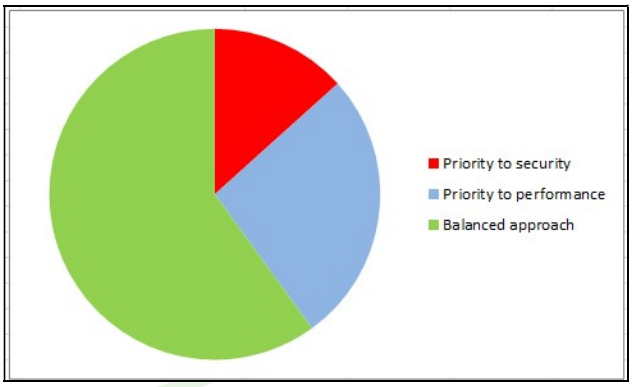

Figure 23 - Preference of Paying Agencies regarding data exchange security or performance

8.2 Data security considerations

8.2.1 Secuity in the IACS process

Data security has to be ensured at all steps of IACS data management, from the data capture to the data publication.

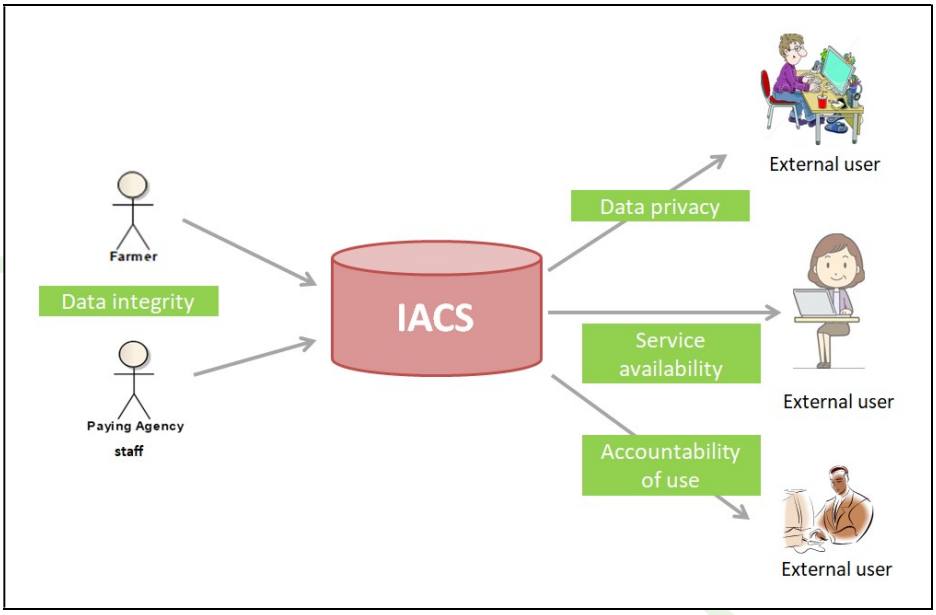

Figure 24 - Main security concerns in IACS data flows

There are risks on security at each step of the processes:

- Data capture: it should be ensured that only relevant persons having “writing rights” can create, modify or delate IACS data; main risk is about data reliability and integrity
- Data storing and management: the IACS system has to be protected (at least) from technical breakdowns and from hacking tentatives
- Data publication: the process should ensure both the security of the data producer (only the data the producer intends to publish is made available) and the secutity of users (they should rely on the network services when they need them to perform their activities).

8.2.2 Data capture and management

The two first steps are covered by the fact that in most cases Paying Agencies are following the ISO 27001 requirement and have the related certification.

Therefore, this deliverable focus mainly on the last step : data publication.

8.3.3 Data publication

According to the INSPIRE obligations regarding Quality of Service, security is the quality aspect of the Web service of providing confidentiality and non-repudiation by authenticating the parties involved, encrypting messages, and providing access control.

Security can be assessed through a set of different characteristics:

- Authentication: Process of verifying a user's identity through the use of a shared secret (such as a password), a physical token (such as a key), or a biometric measure (such as a fingerprint).Users (or other services) who can access service and data should be authenticated whenever applicable
- Authorisation: Users (or other services) should be authorised so that they only can access the protected services whenever applicable
- Confidentiality: Data should be treated properly so that only authorised users (or other services) can access or modify the data whenever applicable
- Accountability: The supplier can be hold accountable for their services; systematically tracks and records the operations and activities undertaken by individuals or accounts while they're active in a system or working environment (accounting
- Traceability and Auditability: It should be possible to trace the history of a service when a request was serviced.
- Data encryption: Data should be encrypted whenever required
- Non-Repudiation: A user cannot deny requesting a service or data after the fact.

The user journey toward a protected service is often summarized by the AAA acronym: Authentication, Authorization and Access

8.3 Use of eID for authentication of users

The EU has mandated that if a Member State offers an online public service to citizens/businesses for which access is granted based on an electronic identification scheme, then they must also recognise the notified eIDs of other Member States [73]. The details of the regulation can be found in [2].

With the implementation of eID, for example, a farmer or an SME based in “country A” could submit an Aid Declaration in “country B”, using the identification data of the country in which it is based.

The implementation of eID also enables a farmer to use the same identification for all his/her administrative procedures within a Member State, including the aid declaration on IACS. More

generally, eID implementation contributes to reduce the administrative burden on all citizens, including the agriculture stakeholders.

8.3.1 Electronic identification (e Ids)

eID are technical specifications to implement an identification scheme. The idea behind the regulation, is that an eID issued in one Member State will be valid (and usable) in another member state.

An entity that wants to use a service offered in one member state, can use its eID even if that is issued by another member state. The service provider is responsible for contacting its' local eIDAS Node, which in turn is responsible for contacting the eIDAS Node of the entity's country to eventually give back the authorisation results. An eIDAS Node implements the service responsible for the connection and interchange of identity information between member states.

This exchange is depicted in Figure 26.

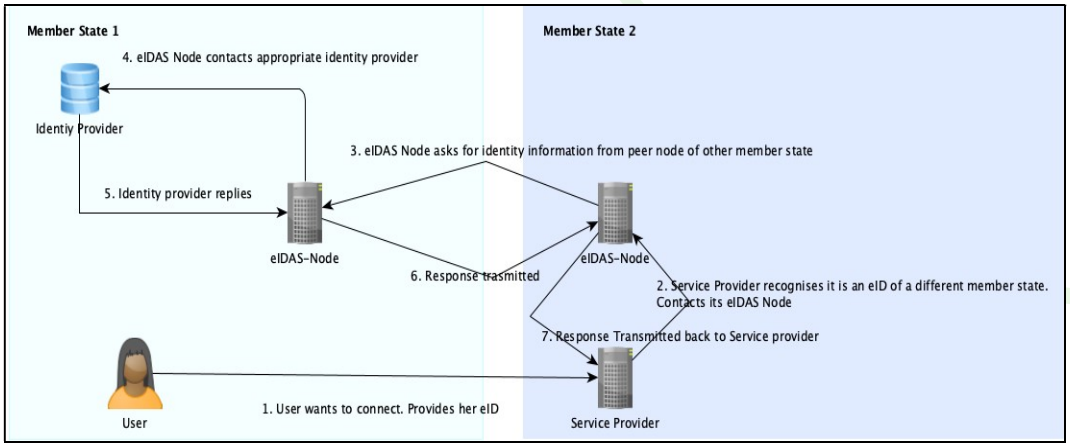

Figure 25 - eID authentication flow

Each member state has a unique eIDAS Node. Each eIDAS-Node has different pre-requisites for letting service and identity providers connecting to it.

An identity provider is responsible for authorising a particular user and providing information about its identity. An identity provider that wants to be able to participate in an eIDAS exchange will have to be approved beforehand, a process which is called notification. Notification ensures that the eID schemes connected to the eIDAS Network satisfy the conditions of quality and security set out by the eIDAS Regulation. As a general rule, all eID schemes connected to the eIDAS Network must be notified, though in some specific cases, service providers may make use of non-notified eID schemes.

The implementation of a national identity scheme provider is outside the scope of the project. Similarly, as mentioned before, neither the implementation of an eIDAS Node is within the scope of the project. However, it is important for the services provided by the common platform and the member's IACS to be able to connect and use the services of an eIDAS Node, should the need arise.

Since each member' eIDAS Node may have different connection requirements, in the following only a generic set of guidelines will be described. Specifics will need to be discussed with the eIADS Node single point of contact for each country where the service will be employed. For a list of contacts per country, see [73].

8.3.2 Minimal set of attributes identifying an entity

eID defines a minimum dataset that can identify a person. Services developed should assume that this is the only information available to uniquely identify a person. The description of these attributes can be found in eID Documentation https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Find+your+Single+Point+of+Contact . However, in order to present important points these attributes are presented below as well.

e-IDAS Minimal Dataset for Natural Persons	
A uniqueness identifier	The identifier does not necessarily reveal a correspondence with the subject's actual identifier (e.g. fiscal number).
Current family name	A sequence of string elements
Current first name(s)	A sequence of string elements
Date of birth	A date using the following format: YYYY+"-"+MM+"-"+DD

Table 4 - e-IDAS Minimal Dataset for Natural Persons

Minimal Dataset for Legal Persons	
A uniqueness identifier	The identifier does not necessarily reveal a correspondence with the subject's actual identifier (e.g. fiscal number).
Legal Name	A sequence of string elements

Table 5 - e-IDAS Minimal Dataset for Legal Persons

8.4 Recommendations

- **Take care of security for the development of NIVA tools**

The guidelines of ISO 27001 should be followed, for instance:

- Communication should be only over HTTPS channels. In general all communication between components should be encrypted
- User information should be kept separately from the rest of the data. User passwords must be encrypted.
- Audits should be kept for any access to databases and appropriate logs should be generated and kept for reference
- All components should be tested with an appropriate security check tool (SQL injection, Cross-Site Scripting etc) and conduct penetration testing. There is a multitude of tools that can be used (Wapiti, Vega, etc). Security test results should be reviewed and appropriate action should be taken.

NOTE: This recommendation is a reminder of the chapter about code security in the NIVA Deliverable Common Guidelines for software development.

Procedures suggested by the OWASP Foundation (https://www.owasp.org) should also be adopted (see for example the 10 most common errors for web development [73], or the procedures for checking mobile applications [73]).

- **Define which data exchange services should be protected**

Data privacy or confidentiality, accountability of data use are mainly data sharing issues. There are various regulations at European and national levels, some encouraging data sharing, some requiring data protection, such as GDPR.

Paying Agencies have to define first which IACS data should be available and for which kind of use or users. These rights to access and use should be formalised in licences. More detailed recommendations will be available in the NIVA deliverable about legal interoperability.

In practice, service protection is more often required for acces and download services.

- **Apply the AAA process for service protection**

In first step, Authentication aims to identify the potential service user.

In second step, the user requests access to one or several data exchange services and the system should check if this given user is allowed to access the requested resources (if the user complies with the licence conditions and if he/she has accepted the licence) : this is the Authorization process.

In last step, user should be given Access to data.

- **Use CEF tools for authentication**

Whatever means of autentication and authorisation is chosen for the services developed by the NIVA project, it will be necessary to do so in a manner that is compatible with the EU regulation [73].

The NIVA project components that are dealing with user authentication should:

- Support for eID (uniqueness identifier). In other words NIVA components should allow users to identify themselves using an eID.
- Assume that only the minimal dataset mentioned previously in tables 4 and 5 will be available
- Use mainstream protocols for authentication, i.e. OpenId-Connect or SAML, for these are the most likely to be supported by an eIDAS-Node of a Member State

These recommendations are also relevant for the Paying Agencies whose Member State has adopted the eID system.

The use of eSignature may also be quite useful in the authentication process. The NIVA Use Case 3 (Farm Registry) has investigated potential use and implementation of CEF e-Signature and eID services in the infrastructure of the NIVA project. More details about this investigation may be founfd in Annex 2.

- **Use of eSignature for documents**

It is proposed to Payment Authorities to use the CEF Building Block eSignature in order to enable farmers and farming companies to submit the required signed documents for trans-border Aid Declarations.

The PA may use some software and tools available for eSignature implementation.

Trusted List Browser Tool to browse the European trusted lists. One can search by type of trust service and country, by name of the trust service or search a trust service that issued the signing certificate contained in a file.

TL-Manager Tool that enables the management of Member States' Trusted Lists.

Monitoring the quality of Trusted Lists: Notification tool Tool that will help improve the notification system about trust services received from Member States. The information will be structured, centralised via an easy-accessible location and in a user-friendly way.

eSig validation tests Tool to test an eSignature implementation (software providers, TSP, conformity assessment bodies, supervisory bodies, ...). "Fake" LOTLs, TLs, certificates and signed documents are generated automatically, and refreshed on a regular basis. Service meant to facilitate the improvement of the Trusted Lists through webinars, trainings, development of internal KPIs, etc.

Notification Tool that will help improve the notification system about trust services received from Member States. The information will be structured, centralised via an easy-accessible location and in a user-friendly way.

- **Ensure service availability**

Service availability is measured through the following 3 criteria : the response time to a user request, the number of simultaneous requests and the availability of the service itself.

INSPIRE provides requirements regarding the above criteriafor view and download services. These requirements should of course be followed but they are really minimum criteria that may be not ambitious enough to ensure satisfying data exchanges through web services.

Paying Agencies should more generally proportionate their delivery infrastructure to the number of current (or even potential) visits to their services and to the user expectations.

8.5. References

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Annex 1: Questionnaire and results analysis

Table 1. Questionnaire

Code	TOPIC / QUESTION
	LPIS
1	Which ortho image format(s) is/are used in your LPIS? How are they stored? Is a local or a cloud solution used for storage?
2	What is the pixel size of your ortho images? Please specify if it varies.
3	Please provide the dimensions of an ortho imagery (tile) in Km or pixels e.g. 3kmX4km or 3000 pixels X 4000 pixels
4	How much storage space is required for the sum of all your images? What would be the answer assuming maximum detail in all areas? Please comment if there are other considerations that affect storage space.
5	Which technology is used for the storage of vector data, i.e. reference parcels, ineligible features, EFA, others? Please specify the method and vendor. If it is a custom solution please briefly describe. Which information is stored how?
6	Do you use a dedicated layer containing Agro – Environmental info? If yes, what type (e.g. linear) and format do you use?
7	How are the alphanumerical data in your LPIS combined with the above vector data? Are they stored/cashed locally in the LPIS and if yes, what's the storage format?
8	Is it possible to perform queries, in a structured language, in order to view/download specific data from your LPIS?
	AID DECLARATION
10	Do you provide a GSAA? If so, what percentage of your total Aid Declarations is covered by it (assume last year's applications)?
11	Assuming you provide a GSAA, do you require the farmer to attach documents to it (e.g. contracts)? If so, what file formats are allowed (e.g. pdf)?
12	In case of non-100% coverage by a GSAA, what is the format/method that an application is submitted besides the GSAA? Are the applications still digitally stored and what is a commonly used file format for the application or parts of it (e.g. pdf)?
13	Is your GSAA fully integrated or it does it involve/require the use of more than one system?
14	Which technology is used for the storage of Aid Declaration vector data, e.g. agricultural parcels? Please specify the method and vendor. If it is a custom solution, please briefly describe.
15	Assuming a hierarchy of objects in an Aid Declaration of: "Application-Parcel-Crop", please mark(X) the objects that are spatially depicted in your LPIS. For example: "Application -Parcel(X)-Crop" means that

	only the parcels of the application are visibly represented in space.
16	What information is included in your Aid declaration agricultural parcel, other than the area and crop(s) declared by the farmer?
17	What personal information is included in your Aid declaration (e.g. tax number, name, etc.)?
AUDITS / CONTROL DATA (current status)	
18	What kind of audit / control data, do you include in your LPIS (e.g. OTSC, Remote Sensing, etc.)?
19	In the case of OTSC, what derived data do you include in your LPIS (parcel measurement polygon, measurement area and center, other)?
20	In the case of Remote Sensing, what derived data do you include in your LPIS?
21	How are the OTSC/Remote Sensing data stored in your LPIS?
22	Does your organization utilize digitized mechanisms (web application, mobile applications) for integrating audit/control data? E.g. A mobile application that integrates feedback from an OTSC.
23	In the case of Remote Sensing, please provide a brief description of the procedure that incorporates the Remote Sensing results into your LPIS.
24	What kind of geospatial cross checks do you perform, using your LPIS? • Parcel to parcel • Parcel to ineligible features • Other
25	What are the results of the geospatial cross checks?
26	Have you already used, or tested, Monitoring as a control method? Please specify one of two, or nothing.
27	If so, what kind of data / result is produced? How are they stored/ used in your LPIS?
INTEROPERABILITY	
28	Does your organization supports web services for sharing LPIS related data? - View services yes □ no □ - Download services yes no □ - Other services yes □ no □
29	Does your organization supports web services for sharing Geo Spatial Aid Application (GSAA) related data?
30	Which standards are you using for your DataExchange? - WMS yes no □ - WMTS yes □ no □ - WCS yes □ no □ - WFS yes x no □ - Other yes □ no □
31	Are you aware of the OGC organisation? Yes/No
32	Are you aware of the OGC API standards? Yes/No

33	If yes does your organization currently uses these standards for modelling geospatial data. Please provide an approximation to what extend your organisation's data are covered by the standard.
34	Are you aware of the OGC Certification and Compliance Testing (https://www.opengeospatial.org/compliance)? Yes/No
35	If yes do you consider this process as useful?
36	Has your organization implemented INSPIRE conformant services?
37	Do the implemented web services provide information about all aspects of the aid declaration? If not, explain which aspects are excluded
38	Do you utilize web services that can modify the contents of an application through means other than through your main GSAA application?
39	Are you aware of the following data modeling approaches? CSV: yes □ no□ XML: yes □ no□ RDF: yes □ no □ RDFS: yes □ no□ OWL: yes □ no □ JSON: yes □ no□ JSON-LD: yes □ no □
40	What type of Database technologies/Information Management Systems is your organization currently utilizing (e.g. Relational DB, NoSQL DB, Graph DB, Spatial DB, other)? In case you are using a combination of technologies please specify which technology is supporting the respective information elements.
41	In your opinion, what would be the relevant techniques/technologies or even complete mechanisms that could be used for fast exchange of small amounts of data between IACS's or IACS and other Information Systems (e.g. FMIS, farm machinery, agro-environmental monitoring services).
42	In your opinion, what would be the relevant techniques/technologies or even complete mechanisms that could be used for exchange of big data between IACS's or IACS and other Information Systems.
43	Would you be in favor of a common framework for data exchange from/to IACS's? yes □ no □ Explain why :
44	Do you consider that cross-IACS data sharing mechanisms may impose security and privacy threads? At what level? Low □ Medium □ High □ Severe □ More comments:
45	To your opinion what the main incentives for an attacker with regards to IACS information system and data?
46	Please indicate the importance of the following threats with regards to IACS data manipulation:

	Confidentiality of exchanged information: low □ medium□ high□ Integrity of exchanged information: low □ medium□ high□ Availability of data exchange service: low □ medium□ high□ Privacy protection: low □ medium□ high□ Accountability on data utilization: low □ medium□ high□ Others: …… Implementing strict security protection mechanisms may considerably increase the overall complexity of an information management system. What of the following statements reflects your opinion for an interoperable IACS system: a) Performance of the IACS should not be significantly affected by complicated security mechanisms □ b) Security is more important than performance and ease of use for an interoperable IACS □ c) A balanced approach combining security and performance is necessary to be implemented. □ PLEASE COMMENT:
47	Would you be in favor of a framework for a cross-border common user authentication scheme? yes □ no □ Explain why :
48	Do you have any ideas about this potential framework for a cross-border common user authentication scheme? yes □ no □ If yes, please, propose your ideas
OTHER IACS-RELATED SUB-SYSTEMS	
49	Is the system accessible via public/private Web Services? yes □ no □
50	Is the interface (data exchange format) documented? yes □ no □ Please provide details
51	Is data available only under Access control? (eg. Is there requirement for Identification/Authentication in order to obtain access to data resource?) yes □ no □ Please provide details
52	Is the system accessible via public/private Web Services? yes □ no □
53	Is the interface (data exchange format) documented? yes □ no □ Please provide details
54	Is data available only under Access control? (eg. Is there requirement for Identification/Authentication in order to obtain access to data resource?)

	yes □ no □ Please provide details
55	Is the system accessible via public/private Web Services? yes □ no □ Livestock I&R System
56	Is the interface (data exchange format) documented? yes □ no □ Please provide details Livestock I&R System
57	Is data available only under Access control? (eg. Is there requirement for Identification/Authentication in order to obtain access to data resource?) yes □ no □ Please provide details Livestock I&R System

Table 2.Answers of 6 PA's

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
1	Format: Ecw, Externalprovider	.Ecwformat, localfileserver	.sid cached to WMS, stored locally	10 cm winter image and a 25 cm summer image. The summer image is also open data and stored in PDOK portal	geotiff, locallystored	MrSid-format; localserver
2	20-30 cm depending on the year	10, 20, 25 cm	25x25cm	10 cm winter image and a 25 cm summer image.	0,5 m pixel	20cm; No variety
3	1x1 km tiles	5x5km tiles	10x10 km	4x4 km	6x6km	2x2 km
4	External provider, no information	1993-2019, 6 TB	Eachyear 150 GB	1,2 TB (1 TB for 10 cm image and 200 GB for 25 cm image	X	X
5	Oraclespatial	All the vector data is stored in Oracle Locator (that is DB for custom built desktop GIS), but some of the data is also replicated into Postgres PostGIS (that is the DB for webmaps used in different e-services, incl GSAA).	From LPIS custodians LPIS layers are provided via webservice (gml format). In PA all LPIS layers are stored in Oracle Spatial DB and GIS layers (WMS) are published via Geoserver	OracleSpatial	solution, oracle database with lines that form polygons	SQL-Database and ArcGIS-Database
6	Yes, polygons	Yes. Polygons, vector data in Oracle and Postgres DB-s	yes, polygon, shape, WMS	the provinces in NL are responsible for a AE layer where the different AE goal areas are depicted. We also have a reference layer with LE features for the claimed areas. We are studying the possibility of a national land-	No	X

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
				wide covering register of all LE features.		
7	Yes, Oracle spatial	Alphanumeric data is stored in the same DB-s as spatial/vector data.	Each web GIS layer are published as WMS and labeled form attribute table (block ID)	What alphanumeric data are you talking about? Different layers are present. The bare LPIS but also a permanent grassland layer. Permanent crops also.	yes, as an oracle database	SQL-Database and ArcGIS-Database
8	Yes, but only internally	Yes	Yes	It is possible to perform queries with SQL within a Database Management Tool and it is also possible to perform queries within ESRI ArcGis Desktop (ArcCatalog/ArcMap)	Yes	Yes, SQL
10	Yes, 100%	Yes, 100% since 2018.	Yes, 100%	Yes, 100%	Yes, 93,6% electronically and 4,6% by paper	100%
11	No	no attached files are needed	No	No	In some rare cases yes, in pdf format	Pdf
12	X	Not applicable	NA	X	By paper, applications are digitally stored in pdf format	X
13	Fullyintegrated	GSAA is fully integrated to LPIS/IACS.	GSAA is the independent system and all data after confirmation is transferred via DB links to PA	Fullyintegrated	Fullyintegrated	Fullyintegrated
14	Oracle spatial	GSAA is a custom made webmap with Postgres PostGIS database in the backend. After the application is submitted, the data (incl vector) is	all aid declaration data vector data are transferred to PA via using DB link in JSON format and stored at PA in Oracle Spatial DB	ESRI and Oracle	stored as polygons in oracle database	ESRI-Shapefile

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
		sent to IACS (i.e vector data is converted into Oracle SDO_GEOMETRY) and all the checks are performed there.				
15	Application -Parcel(X)-Crop	Application -Parcel(X)-Crop.	Application -Parcel(X)-Crop(X)	Application -cropParcel (X) (parcel and crop are the same) This question is a bit vague.	Application (partly X) – Parcel (X) – Crop (X)	X
16	Many application data is also available on the fields e.g. whether the field is organic	Land use, overlapping with EFA-s.	information as attribute about second pillar measures (e.g. organic farming, LFA, Natura 2000), information about land parcel management right (e. g. own, rent, lease of state land)	Area, crop, the user, the title of use (owner, lease etc)	Catch crop, land use type, eligibility, ground water area	EFA, 2. Pillar
17	Unique identifier from the "The Central Business Register" and where this is not needed we use the "Civil Registration System"	Name, e-mail, phone number, personal or company ID number of applicant (and if needed represantative's name).	Name, surname, address, phone number, email, IBAN number	It is possible to perform queries with SQL within a Database Management Tool and it is also possible to perform queries within ESRI ArcGis Desktop (ArcCatalog/ArcMap)	name, address, personal ID/ tax number, contact information (phone, email)	Adress, Name, Dates, Tax-Number, Bank-Information
18	OTSC, monitoring (to some extent)	OTSC, Remote Sensing, geo-tagged photos (made by inspectors).	OTSC, RS, LPS QA	When a parcel is changed, the parcel will receive a new version. A reason is also added with the following reasons: - Counselor - Objection and appeal - Physical check NVWA - Physical check SAT - GPS measurement from farmer himself - Further field inspection other than from check selection adjustment but no reason, based on LUFO: LPIS update and adjustments based on GO or comments of	OTSC data GPS measures and field visits are a part of the LPIS update	OTSC, RemoteSensing

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
				farmers		
19	Ineligible areas	Parcel measurement polygon, measurement area, geo-tagged photos (made by inspectors).	Parcel measurement polygon	deviations in field boundaries that appear from the field checks and measurements are assessed and can lead to adjustments to the LPIS: geometries, crops (land cover layer within LPIS), whether or not agricultural land (no agricultural land will be excluded from LPIS)	the measurements are converted to a correction and sent to the LPIS as an update trigger	Parcel measurement polygon
20	X	Satellite images that are used to delineate and measure areas in CwRS areas, delineated/measured areas, mowing detection data (mowing statuses and dates that are calculated (using Sentinel 1 and 2 images) by a dedicated system).	LPIS custodians update RP boundaries using VHR imagery	deviations in field boundaries that appear from the field checks and measurements are assessed and can lead to adjustments to the LPIS: geometries, crops (land cover layer within LPIS), whether or not agricultural land (no agricultural land, then from LPIS)	No remote sensing	Parcel measurement polygon
21	Polygons + images (oracle)	Satellite images and geo-tagged photos are stored in fileserver, all other data is stored in Oracle database.	from PA all OTSC measurements are transferred via webservice to LPIS custodians, all data are stored in Oracle spatial db	See question 18. The parcel register also records the OTSC layer per year = all parcels that have been measured for OTSC, SAT + field checks)	actual OTSC data is stored in IACS, corrections to LPIS are stored in LPIS	As control-layer
22	Yes. We have an app for our inspectors to do measurements. These data are available for the applicants for the next year	No apps are used yet. All the data gathered on the spot will be imported into IACS/LPIS.	no each OTSC measurement are integrated manually one by one	No	OTSC app is used	No

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
23	X	ARIB uses satellite images provided by JRC for CwRS. In RS areas (up to 11) all the parcels are delineated and the areas are linked and compared to the data of applications.	PA is responsible for Remote Sensing, but results are not integrated into LPIS. VHR are used for LPIS boundary and land cover updates by LPIS custodians	brief description of RS result that goes to database: the measured geometries are placed in the OTSC layer. The results of measurements / checks per parcel go to ROC. He processes that in CTE. The result goes to the parcel register. Where CTE shows that there is a deviation, the parcel register assesses whether the reference plot must be adjusted. They use the data from the enforcement layer for this. The changes can be taken from this.	X	Reference up date orders
24	Parcel to parcel X Parcel to ineligible features X Other • Specify: Anything outside the RP's	Parceltoparcel x	Parcel to parcel x• Parcel to ineligible features •x Other x• Specify: Parcel to sensitive permanent grassland layer, grassland parcel to permanent grassland layer, parcel to erosion layer, parcel to LFA layers, parcel to NATURA layers etc	no self interseecting polygons. No multipolygons (two polygons with the same IDO) Ineligible features outside of LPIS.	sum of agricultural parcels to reference parcel	X
25	Very few overlaps as most overlaps are handled by the applicants themselves	Overlapping (Y/N) or overlapping area (ha).	notification for user	X	? results are areas "outside" reference parcels. these are changes that has been made to LPIS after submitting GSAA. Paymentsarecutaccordingto LPIS parcel	X

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
26	Used for 2019	For mowing detection ARIB has built a dedicated system that monitores the grasslands throughout the season.	pilot for grassland mowing detection, land cover change detection, abandoned land detection	we test in pilot monitoring the minimum agricultural activity. We have implemented a change detection in LPIS as from 2019	No	No
27	Traffic light. Stored in oracle	Mowing detection system calculates for each grassland mowing dates and statuses using as input data parcel geometries and the timeseries of Sentinel 1 and 2 images.	results as shape files stored locally	results have not been published	X	X
28	View services yes X, Download services yes X	View services yes x no □ Download services yes x no □ Other services yes □ no x	Other services yes x□ no □ Specify (for other services) ……all LPIS data are shared via national geoportal as view and download services	View services yes v□ no □ Download services yes v no □ Other services yes □v no □	View services yes X no □ Download services yes □ no X Other services yes □ no X	View services yes x□ no □ Download services yes x□ no □
29	View services yes X, Download services yes X	View services yes x no □ Download services yes x no □ Other services yes □ no x	Other services yes □x no □ Specify (for other services) … GSAA data are shared via national geoportal as view and download services	View services yes x no □ Download services yes x no □	View services yes □ no X Download services yes □ no X Other services yes □ no X	View services yes x□ no □ Download services yes x□ no □
30	WMS yes X, WFS yes X	WMS yes x no □ WMTS yes □ no x WCS yes x no □ WFS yes x no □ Other yes □ no x	Which standards are you using for your DataExchange? WMS yes □x no □ WMTS yes □x no □ WCS yes □ no □ WFS yes □x no □ Other yes □ no □ Specify (for other services) ……WMS basic	WMS yes x no □ WMTS yes □ no □ WCS yes □ no □ WFS yes x no □ Other yes □ no □	WMS yes □ no X WMTS yes □ no X WCS yes □ no X WFS yes □ no X	WMS yes x□ no □ WMTS yes □ no □ WCS yes □ no □ WFS yes x□ no □ Other yes □ no □
31	No	Yes	Yes	Yes	Yes	Yes
32	No	Yes	No	Yes	Yes	Yes

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
33	No	Geospatial data created by ARIB is OGC compliant.	X	RVO is using UML for modelling, with use of Enterprise Architecture software, by which the datamodel can be translated into ESRI Arc INFO services.	all datasets produced by PA is distributed through standard API (WFS/WMS)	X
34	No	Yes	No	Yes	Yes	No
35	X	Yes	X	be aware but not practiced.	notevaluated	X
36	No, No, No	View services yes x no □ Download services yes x no □ Other services yes □ no x	Other services yes □x no □ Specify (for other services): ……INSPIRE conformant services are implemented by national geoportal custodians	View services yes □ x no □ Download services yes □x no □ Other services yes □x no □ Specify (for other services): …using PDOK for inspire publications. And use dedicated web services for exchanging data with the farmers and agro service partners. (cooperatives etc)	View services yesX no □ Download services yes □ no X	View services yes □ no x□ Download services yes □ no x□
37	No	As the web services are open data services, there is no personal data of the applicants.	from GSAA validated parcel boundary and crop type	Yes	Yes	No
38	No	No	Yes	Yes	No	No
39	CSV: yes X, XML: yes X, JSON: yes X	CSV: yes x no□ XML: yes x no□ RDF: yes □ no x RDFS: yes □ nox OWL: yes □ no x JSON: yes x no□ JSON-LD: yes □ no x	CSV: yes □x no□ XML: yes □x no□ RDF: yes □ no □x RDFS: yes □ no□x OWL: yes □ no □ JSON: yes □x no□ JSON-LD: yes □ no □x	CSV: yes □x no□ XML: yes □x no□ RDF: yes □ no □x RDFS: yes □ no□ x OWL: yes □ no □x JSON: yes □ x no□ JSON-LD: yes □x no □	X	CSV: yes x□ no□ XML: yes x□ no□
40	Oraclespatial	Oracle DB, PostgreSQL DB	Relation DB and Spatial DB	relational DB, spatial DB, SQL DB	X	X
41	X	RESTful API-s exchanging (Geo)JSON	webservices	soap, and rest webservices, xml and Jason	X	X

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
42	X	RESTful API-s exchanging (Geo)JSON	dblinks	noopinion in these	X	X
43	No, Only if we can use it for training data for algorithms etc	Yes	yes □x no □ Explain why : ……it would be great to have technology based on open source decisions	yes □x no □ Explain why : saves a lot of design and development , provides a powerfull demand to the agro industry partners. Makes the private sector to comply to a single EU approach to exchange data inagri food. Both machines, FMIS and supply chain data, and to the governmetns. . Forces the industry to harmonise their communication standards as ISObus, agrixml, etc	yes X no □ Explain why : standardisation is good. this might also be a push forward to adopt new technology	X
44	Medium (x), We are not worried about data regarding eligibility e.g. reference parcels etc., but there are concerns regarding the geospatial aid application data	Low	High □x	High □ x Severe □x More comments: …for security severe risk, for privacy …high risks.	Low	ISO27001
45	Manipulation of data to server their own purpose	Personal data of applicants can be misused.	Political motivations: examples include destroying, disrupting, or taking control of targets.	there are many, disrupt society, crash food safety systems, disrupt farm operations . high risk in the data exchange systems, as many systems gets connected and rely on each other.	X	X

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
46	Confidentiality of exchanged information: low □ medium X high□ Integrity of exchanged information: low □ medium□ high X Availability of data exchange service: low □ medium□ high□ No opinion Privacy protection: low □ medium X high□ Accountability on data utilization: low □ medium□ high X b) Security is more important than performance and ease of use for an interoperable IACS X	Confidentiality of exchanged information: low x medium□ high□ Integrity of exchanged information: low x medium□ high□ Availability of data exchange service: low □ medium□ highx Privacy protection: low x medium□ high□ Accountability on data utilization: low □ mediumx high□, c) A balanced approach combining security and performance is necessary to be implemented. x	Confidentiality of exchanged information: low □ medium□ high□x Integrity of exchanged information: low □ medium□x high□ Availability of data exchange service: low □ medium□ high□x Privacy protection: low □ medium□ high□x Accountability on data utilization: low □ medium□x high c) A balanced approach combining security and performance is necessary to be implemented. □x	Confidentiality of exchanged information: low □ medium□ x high□ Integrity of exchanged information: low □ medium□ high□x Availability of data exchange service: low □ medium□ high□x Privacy protection: low □ medium□ x high□ Accountability on data utilization: low □ medium□ high□x c) A balanced approach combining security and performance is necessary to be implemented. □x PLEASE COMMENT: …a balanced system, but high level of secururity	a) Performance of the IACS should not be significantly affected by complicated security mechanisms X	Confidentiality of exchanged information: low □ medium□ high x □ Integrity of exchanged information: low □ medium□ high x□ Availability of data exchange service: low □ medium□ high□ Privacy protection: low □ medium□ high x□ Accountability on data utilization: low □ medium□ high x□ a) Performance of the IACS should not be significantly affected by complicated security mechanisms x□
47	no X Explain why : There is a possibility that this will be costly to implement, or does not fit with the current system that we have	no x , ARIB currently provides services only to farmers that have the local ID card for authentication.	yes □x , in the future it will be mandatory	yes □ **no** □ **x** Explain why : …cross border is already to be implemtned by other EU regulations. Nospecialrequirements for IACS	yes □ **no X** Explain why : …this might be reinventing the wheel as for example banks already operate worldwide	**yes x**□ no □ Explain why : In use in Germany
48	No	No	No	No	No	No

Q/A	PA1	PA2	PA3	PA4	PA5	PA6
49	We do not have this information	No	Yes	X	Yes	No
50	We do not have this information	No	Yes	X	Yes	X
51	We do not have this information	No	Yes	X	Yes	Yes
52	No	No	No	X	Yes	X
53	We do not have this information	No	LT don't use payment entitlements system	X	Yes	X
54	Yes	No	No	X	Yes	X
55	?	Yes	Yes	X	Yes	X
56	?	Yes	Yes, Data exchange format is documented in legal agreement	X	Yes	X
57	?	Yes	Yes, All users must perform Identification/Authentication in obtain access to data resourse	X	Yes	X

~~Table 3~~.Answers of the other 7PA's

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
1	CLOUD	Georeferenced PNG and JPG, stored locally in an Oracle database. The imagery is tiled and pyramided in 6 levels. There is a mosaic of the latest coverage of each tile for entire area as capturing cloud free data in a single year has been problematic.	Aerial orthophotos. They are stored in uploading and located in local solution.	They are in PNG, but we have a service (WMS), so they are physically stored at our National land survey.	Format is .ecw, stored in Files on local Server	LPIS Orthoimages are stored in Tiled Tiff format, grouping the images in a standard format (tiff). A tiff file contains a range of levels, with one image per level. These images represent the same area of land; the difference between them is that each image is twice the size in pixels (resolution) as the previous one. Each image is cut into 256x256 pixel tiles (JPEG) that correspond to the tiles of the net. The answer to the request of a tile is to locate the tiff that contains it and extract it.	JP2 format, locally stored
2	25x25cm	It varies, 0.25, 0.30m aerial and 0.5m satellite, archive ortho data (pre-2009) is 1 metre.	20x20cm, resolution 1:5000	0,5 m/pixel, going down to 0,4 and 0,16 starting this year	actual Images are 20cm Pixels, former ortho images were 25cm Pixels	0,15 m, 0,25 m and 0,50 m	50cm x 50cm
3	X	2Km x 2Km, with sub tiles for the pyramid levels,	Medium resolution of the images is 18.000 pixels x	5x5km for 0,4/0,5 and 2,5x2,5km for 0,16m	580km x 300km for Austria	The minimum size of a tile is 256x256 pixel	3x4 km

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
		giving a total of 341 records for each tile.	17.000 pixels.				
4	X	About 500Gb for a single national coverage for the highest resolution but archive imagery is still deployed which dates back to 1995	All the imagery stored in the SDI require a disk space of about 42Tb.	they are physically stored at our National land survey. I havenoidea	4 TB for RGB images since 2003, and around 3 TB for CIR	LPIS Orthoimages storage requires 5 Tb. They are available with máximum level of detail, for SRID 3857, 4326 and 326XX	Different tile sets (and their corresponding geotiffs) are maintained for specific year-spans. The total sum is approx. 3TB
5	POSTGRESQL (open software). For all data	The data is stored in Oracle 2D SDO_GEOM (type 2003) objects. The system is moving from line based to polygon based in a major re-engineering project. EFA (hedgerows) will continue to be line segments	Reference parcels, ineligible features, EFA layer, polygons land cover refreshed every 3 years, pasture layer, nature 2000 and ELP layers are stored in Oracle DB 11G Spatial.	Right now, Oracle and ArcSDE, in 2 years Postgres and PostGIS	ORACLE Spatial (SDO_GEOMETRY-Type)	Vector data related to reference parcels, landscape elements, EFA etc is stored in a Microsoft SQL Server database with proprietary format DinaNET, and distributed in PostgreSQL PostGIS databases.	All vector layers are stored in Oracle 11.2 EE spatially enabled tables
6	Yes, polygon.	Yes, polygon data on Natura layers and pre-calculated layers of overlap with LPIS parcels	Marks are only in alphanumeric mode.	Yes, for pastures, polygons.	ORACLE Spatial	Agro – Environmental info is contained in vector layers such as RED NATURA, Zones of protection of groundwater against pollution caused from agricultural sources, Soil erosion or Less-favored areas.	Yes, polygons

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
7	CLOUD (SDG)	The data is addressable in separate schema	Farmer dossier contains alphanumeric data integrated/intersected with LPIS vector data. Stored in localserver.	They are stored as attributes in every layer	The alphanumeric data are stored on the same server and ORACLE DB as the LPIS vector data, and hence can be freely combined with ORACLE Spatial queries	Alphanumerical data is obtained by intersection of vector layers with the Reference parcel layer and distributed in sqlite format. It is not stored in the LPIS.	All alphanumeric data directly related to geometries are stored as attributes of said geometries (i.e. one record/row of a spatial table has one (or more) geometry field(s) and a varying number of numeric or character fields, pertaining to the specific geometry.
8	Yes	Yes	Yes	Yes, if you have the right priviligies	ORACLE SQL/PLSQL	Yes, there are web services that provide data from the LPIS, such as http://sigpacdataserver.magrama.es/sigpac/utilidades/AtributosRecinto.asmx	Yes
10	Yes, 100%	Yes, 100%	Yes, 100%	Yes, 100%	Yes, 100%	Yes, 100%	Yes, 100%
11	NO. ONLY ANNUAL DECLARATION.	Not required but additional info docs may be uploaded in PDF format – max 3MB	Yes, in pdf format (contract lands title rights).	No requirement, but possible. PDF	Farmers can or must, depending on the usecase append files in standardadized formats like JPG, PDF, etc.	Yes. PDF, DOC, JPG, PNG	Yes, in pdf format (contract lands title rights for example).
12	X	N/A 100% applications	NA 100% GSAA coverage.	X	n.a.	Thisquestiondoesn'tapply	NA
13	NOT FULLY INTEGRATED	Fullyintegratedwith mapping	GSAA fullintegrated.	Our GSAA are integrated with our IACS and our LPIS.	All Tools/UIs are available over one central portal. All software	GSAA is fully integrated.	Fully integrated

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
					components are fully interlinked.		
14	X	X	Oracle DB 11G Spatial.	Postgis and polygons, open source	ORACLE for alphanumeric data and ORACLE Spatial for vector data	Oracle DB, Postgis DB	They are stored in Oracle 11.2 EE spatially enabled tables.
15	APPLICATION (x)PARCEL (X) CROP (X)	Application - Parcel(X)-Crop	Crop plan cultivation at agricultural parcel.	Application - Parcel(X)-Crop	Yes the AMA has a hierarchy in its data: (1)Feldstücke, (2)Schläge, and the reference parcels (0)	Application -Parcel – Crop. Up to now, in our LPIS there is no information about applications, just reference layers. It is foreseen to publish a GSAA in 2020 with this information Application –Parcel(x) –Crop(x)	Application -Parcel(X)-Crop
16	VARIETY, PROPERTY, SYSTEM OF IRRIGATION, AND AGRICULTURE ACTIVITY	Exclusions, EFA's, historic imagery and dates of imagery	Agriculture parcel and agriculture activities (also for Pillar II).	A lot. We have 9 different aid scheems in pillar 1 and 2, they all goes through our GSAA.	This must be worked out in detail. What can be given out here?	Crop cycle, type of seed, common pasture mark, agricultural activity, tenure regime/ land tenure regime, valid for organic farming, agroforestry, Area/ Reference Parcel identification with forage harvesting, number of nut trees: almond, hazel, walnut, carob tree, pistachio tree, chestnut, DP schemes/ RD measures claimed, second crop with type of seed, qualify as EFA	title of use (owner, lease etc), irrigation or not, second pillar measures information,

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
17	NAME, ID NUMBER, ADRESS AND ANOTHER FOR STADISTIC INFORMATION	Herd Number, Name, Address, Telephone No., Eircode	Farm details including tax unique code	Organisation number, bank account, name, address…	Same as question 16	Name, surname, ID, address: residence and notification, e-mail, telephone number, mobile number, bank account, spouse information	Name, surname, address, phone number, email, IBAN number, personal ID/ tax number
18	OTSC, RS, Monitoring.	Both the OTSC and Remote Sensing. There is an annual LPIS update project and the annual LPIS QA.	OTSC by RS at 100%.	Internal audit and OTSC	We were unable to answer questions on this topic because it is not known or it is not clear what should be stated officially.	OTSC, Remote Sensing and Checks by Monitoring results are used to update the LPIS. There is a traceability of the origin of these updates	OTSC, RS, LPIS QA
19	MEASUREMENT AREA POLYGON, AND USE	Measurements, CropFound	Parcel measurements polygons and land cover.	We show some parcels and chosen information. The total results are in their own system	>>	Data derived from OTSC stored in LPIS is parcel measurement polygon, changes in land cover, and field visit date.	Parcel measurements polygons and land cover.
20	MEASUREMENT AREA POLYGON, AND USE	Measurements, CropFound	Land use at parcel level.	X	>>	Data derived from RS stored in LPIS is parcel measurement polygon and land cover. The date in case of RapidFieldVisit.	No remote sensing
21	ANUALLY UPDATE	Q20 – Q21 – For Remote Sensing inspections, based on a review of a range of satellite imagery the LPIS is updated to identify relevant features, both eligible and	RS data can overlap LPIS; results by OTSC are integrated in LPIS after each campaign.	Polygons and attributes	>>	OTSC and Remote Sensing data are stored in LPIS reference parcel, Nut Trees layer and Landscape Features layer	Results geodata base fully integrated in the LPIS in separate layer

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
		ineligible. For classical OTSCs the outcome of the inspection process in the field leads to the updating of the LPIS for relevant features. The results of this updating leads to the calculation of the Maximum Eligible Area (MEA) which is used for payment purposes across the various area-based schemes.					
22	YES. TABLETS WITH GPS	For both the Classical OTSC (Ground inspections) and RFVs (Rapid Field Visits) for Remote Sensing inspections, a mobile inspection software package 'E-Inspect' captures relevant information, e.g. crop types, and relevant physical features, e.g. new boundary, ineligible features.	Web application.	Yes, we have a handheld device with GPS	>>	Yes, in most Paying Agencies OTSC are performed using Table PC, and the results are semi automatically fed in the LPIS	no each OTSC measurement are integrated manually one by one

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
23	COMPLETELY UPDATE WITH ANY CHANGE DETECTED	A visual assessment of a range of imagery identifies and applies required updates to the Reference Parcel in the LPIS. In addition the outcome of RFVs are applied to the LPIS, where required.	Following the JRC remote sensing technical specifications.	Not any more in this AMS-times	>>	Results are provided in a spatial database and incorporated automatically in the LPIS.	Inital RS data are processed through GIS software, then the results geodatabase is fully and automaticalyintegraded in the IACS and LPIS systems.
24	Parcel to parcel X Parcel to ineligible features •X	Parcel to ineligible features	Parcel to parcel X Parcel to ineligible features X	Parcel to parcel •X	>>	Parcel to parcel	Parcel to parcel X Parcel to ineligible features X Other • Specify: Parcel to reference parcel, parcel to OTSC results
25	X	X	Boundaries matching with orthophotos.	Ok/notok	>>	The results of the geospatial checks are spatial and alphanumerical data at reference parcel level, which are provided in database and incorporated automatically in the LPIS.	Overlapping notification for users for everything mentioned in Q24
26	YES. USED	X	YES the JRC specification of Quality Assurance.	tested crop classification using Sentinel 2, tested activity using sentinel 2 and manually looking at images	>>	We are using Monitoring as a control method since 2019.	No

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
27	COMPLETELY UPDATE WITH ANY CHANGE DETECTED	X	Indicators from Sentinel data and their traffic light generation, Stored in Oracle DB 11G Spatial and used for consultation by the farmer and in consultation/integration by the back-office operator.	crop classification – excel files, not used operationally	>>	Currently results include information of land cover type, risk of abandonment and parcels flagged to review with next orthoimage renewal. They are used in the upkeep of the LPIS, in the recinto and atributorecinto layers.	X
28	View services yes □ Download services yes □	View services **yes** □ no □ Download services yes □ **no** □**,** Specify (for other services) Data management/protection input	Viewservicesyes X	View services yes X□ no □ Download services yes X□ no □ Other services yes X□	View services yes □ no X - Download services yes X no □ - Other services yes □ no X Specify (for Other services) : asynchronous webservice for authorized companies	View services yes X no □ - Download services yes □ no □ - Other services yes X no □ Specify (for Other services) …Discovery	View and Download services - strictly for authenticated personnel
29	View services yes □ Download services yes □	View services **yes** □ no □ Download services yes □ **no** □	Viewservicesyes X	View services yes □ no X □ Download services yes X □ no □ Other services yes X □	View services yes □ no X Download services yes X no □ Other services yes □ no X Specify (for other services) … asynchronous service for authorized companies	View services yes □ X no □ Download services yes □ X	View service for authenticated users

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
30	WMS yes □ WMTS yes □	X	WMS yes X no □ - WMTS yes X no □ - WCS yes X no □ - WFS yes □ no X - Other yes X no □	WMS yes X □ no □ - WMTS yes X □ no □ - WCS yes X □ no □ - WFS yes X □,	Other yes X no □ Specify (for Other services) … ECWP (Hexagon), XML, SOAP (webservice) L33	WMS yes X no □ - WMTS yes X no □ - WCS yes □ no □ - WFS yes □ no □ - Other yes X no □ Specify (for Other services) PostgrepostGIS files	WMS, WFS
31	Yes	No	Yes	Yes	Yes	Yes	Yes
32	Yes	No	Yes	Yes	Yes	Yes	Yes
33	NEXT STEPS.	X	Actually my organization does not use these standards.	The newstuff… maybe 25%	These standards are mostly for data services. For data storing: e.g. GeoTIFF, Geopackage, etc	Standard covers web viewer services (WMS)	Both data and services are generaly compliant, but are also customized
34	No	No	Yes	No	Yes	No	Yes
35	Yes	X	Yes, in somecases.	X	Basically yes, but our organization has at the moment no components of its own to certify	X	Yes

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
36	View services yes □ Download services yes □	View servicesyes □	View servicesyes x	View services yes X □ no □ Download services yes X □ no □ Other services yes X □ Specify (for other services): Metadata	View services yes X no □ Download services yes X no □ Other services yes X no □ Specify (for other services): Discovery Services on Metadata	View services yes x no □ Download services yes □ no X Other services yes X no □ Specify (for other services)…Discovery	No
37	Historical declaration data. Parcel declaration layer individula and anonimus global layer	X	Yes	We have nothing about the application in Inspire	TBD	Yes, we provide information about all aspects of the declaration only for internal use by other components of the system	NA
38	Yes	X	Yes	No	In Terms of a machine readable service: no	No	No
39	CSV: yes □ XML: yes □ JSON: yes □	YES … bar "owl"	CSV: yes X XML: yes X RDF: yes X RDFS: yes X OWL: yes X JSON: yes X JSON-LD: yes X	CSV: yes X □ no□ XML: yes X □ no□ RDF: yes □ no X □ RDFS: yes □ no X □ OWL: yes □ no X □ JSON: yes X □ no□ JSON-LD: yes □ no X □	X	CSV: yes x no□ XML: yes x no□ RDF: yes x no □ RDFS: yes x no□ OWL: yes x no □ JSON: yes x no□ JSON-LD: yes x no □	Yes, all

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
40	X	Beside relational and spatial, we likely will support properly a NoSQL instance but nothing yet	Spatial DB, Relational DB.	Oracle and PostgreSQL	ORACLE (Spatial)	Information is stored in a Relational SQL DB with implementation of a proprietary spatial component (DinaNet). DataisexchangedusingS patial DB (PostGre/PostGis)	Oracle spatial
41	X	JSON and RESTfulendpoints	FADN, farm machinery, agro-environmental monitoring service, farm income, fiscal tax data (simplified or normal), type/s of farm productions, algorithms for a better production, land management efficiency.	Don´t know/understand/it depends	OGC API - Features	Linked open data LOD; Web services for alphanumerical and vector data and WMS and WMTS services for raster.	Web Services, Standards for geospatial data exchange
42	X	WebServices	Real timeexchanges.	Don´t know/understand/it depends	ORACLE Dumps, Geopackage	Web download services via ATOM	Solutions would be based on custom or existing formats such as Geopackage.
43	yes X no □ Explain why : : EASY USE FOR MODELS DATABASE	yes □, Yes, makes sense, so long it is a common, recognized international standard being adopted underneath	Yes, Avoiding twice requested same data to the farmers.	Yes, Standards/framework s make som thing s easier	TBD	yes □X no □ Explain why: It would simplify the exchange between different MS.	Yes, it would help with design and development, promote data reusability.
44	Low □, More comments: NO PERSONAL	X	Medium X	Low X	Severe X, Is also a legal question / data	Medium □X	Medium. Even if the data are anonymized, geospaciatial data are

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
	DATA				protection?		still a concern.
45	ILLEGAL AID DECLARATION.	X	Private and sensible data useful for frauds.	Fraud	Personal Data, because all non-personal data (Geometries of Parcels and References) are open data	Strategic and statistical information on GSAA	Disruption can be attribution to political motivations, wheareas obtaining personal data can be used for financial gain
46	Confidentiality of exchanged information: low □ **mediumX** high□ Integrity of exchanged information: low □ medium□ **highX** Availability of data exchange service: low □ medium□ **highX** Privacy protection: **low X** medium□ high□ Accountability on data utilization: low □ medium□**highX** a) Performance of the IACS should not be significantly	Confidentiality of exchanged information: low □ medium□ **high**□ Integrity of exchanged information: low □ medium□ **high**□ Availability of data exchange service: low □ **medium**□ high□ Privacy protection: low □ medium□ **high**□ Accountability on data utilization: low □ medium□ **high**□ c) A balanced approach combining security and performance is necessary to be implemented.	Confidentiality of exchanged information: low □ **mediumX** high□ Integrity of exchanged information: low □ **mediumX**high□ Availability of data exchange service: low □ **mediumX** high□ Privacy protection: low □ medium□ **highX** Accountability on data utilization: low □ **mediumX** high□ c) A balanced approach combining security and performance is necessary to be implemented. X , PLEASE COMMENT: Anyway security is	Confidentiality of exchanged information: low X □ medium□ high□ Integrity of exchanged information: low X □ medium□ high□ Availability of data exchange service: low X □ medium□ high□ Privacy protection: low X □ medium□ high□ Accountability on data utilization: low X □ medium□ high□ Others: We have personal data in another system. c) A balanced approach combining security and performance is necessary to be implemented. □ X	a) Performance of the IACS should not be significantly affected by complicated security mechanisms X YES b) Security is more important than performance and ease of use for an interoperable IACS X YES c) A balanced approach combining security and performance is necessary to be implemented. X YES	Confidentiality of exchanged information: low □ medium□ X High□ Integrity of exchanged information: low □ X medium□ High□ Availability of data exchange service: low □ X medium□ High□ Privacy protection: low □ X medium□ High□ Accountability on data utilization: low □ medium□ High□ X c) A balanced approach combining security and performance is necessary to be implemented. X	Confidentiality of exchanged information: high Integrity of exchanged information: high Availability of data exchange service: medium Privacy protection: high Accountability on data utilization: medium c) A balanced approach combining security and performance is necessary to be implemented. X

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
	affected by complicated security mechanisms □		more important than performance and ease of use for an interoperable IACS.				
47	no □ Explain why : COMPLICATED MECANISM	X	No	no X □ Explain why : ……1 paying agency, no close neighbours	TBD	No	No. because a) the local authentication schemes are already intricate enough to accommodate for different apps, roles, services and b) there are probably other solutions to specific authentication challenges c) there might be different requirements for each country
48	No	X	Yes, Common definitions needed at WU wide.	No	TBD	no □ X Not at national level	No
49	Yes	Yes	Yes	Yes	No	No	No
50	Yes	Yes	Yes	Yes	X	No	NA
51	Yes, ID USUARY	Yes	Yes	Yes	Yes, (for GSAA UI)	No	Data is only accessed through the specific application. Different roles govern the type of access each user has at each time and each user is assigned one or more roles. For the usertoaccess the application, IAA

Q/A	PA7	PA8	PA9	PA10	PA11	PA12	PA13
							ismandatory
52	Yes	No	Yes	Yes	X	Yes	No
53	Yes	No	Yes	Yes	X	Yes	NA
54	Yes, ID USUARY	No	Yes, Data available only under access control for security scope.	Yes	X	X	Data is only accessed through the specific application. Different roles govern the type of access each user has at each time and each user is assigned one or more roles. For the usertoaccess the application, IAA ismandatory
55	Yes	No	Yes	Yes	X	Yes	No
56	Yes	No	No	Yes	X	Yes	NA
57	Yes, ID USUARY	Yes	Data available only under access control for security.	Yes	X	X	Data is only accessed through the specific application. Different roles govern the type of access each user has at each time and each user is assigned one or more roles. For the user to access the application, IAA is mandatory

Table 5. Answers about Orthoimages

Member State	Format	Storage	Pixel size	Dimensions	Storage space for sum of images
PA1	Ecw	External provider	20-30 cm	1X1 Km tiles	No information
PA2	Ecw	Local fireserver	10, 20, 25 cm	5X5 Km tiles	6 TB (1993-2019)
PA3	From *sid to WMS	locally	25X25	10KmX10Km	150 GB per year
PA4	10 cm winter & 25 cm summer	Summer image: open data, stored in PDOK portal	10 cm winter & 25 cm summer	4X4	1,2 TB (1TB for 10 cm and 200 GB for 25 cm images)
PA5	Geotiff	Locally	0,5 m pixel	6X6 Km	-
PA6	Mr Sid	Local Server	20 cm	2X2 Km	-
PA7	-	Cloud	25 cm	-	-
PA8	Png, Jpg	Locally oracle DB	0,25, 0,30 (aerial) & 0,5 satellite	2X2 Km	500 GB
PA9	Aerial Orthophotos	Uploading & local solution	20 cm (1:5000)	18000 pixels X 17000pixels	42 Tb (SDI)
PA10	Png	National land survey	0,5 m/pixel, 0,4 and 0,16	5X5 Km for 0,4/0,5 & 2,5X2,5 Km for 0,16 m	-
PA11	Ecw	Local Server	20 cm pixels	580 Km X 300 Km	3 TB for CIR (4 TB for RGB since 2003)
PA12	Tiff	Local	0,15 m, 0,25 m & 0,50 m	256X256 pixel minimum	5TB
PA13	Geotiff, gwc	Cloud	25 cm X 25 cm & 50X50 before 2017	1,5 X 2 for 0,25 & 3X3 for 0,5	3TB

Table 6. answers about Alphanumeric and Vector data

Member State	Storage of vector data	Storage of alphanumeric data	Combination of vector & alphanumeric data
PA1	Oracle spatial	Oracle spatial	Oracle spatial
PA2	Oracle Locator & Postgres Post GIS	Oracle Locator & Postgres Post GIS	-
PA3	Oracle Spatial & Geoserver	WMS	Block ID
PA4	Oracle Spatial	-	-
PA5	Oracle database	Oracle database	Oracle database
PA6	SQL database & ArcGIS database	SQL database & ArcGIS database	SQL database & ArcGIS database
PA7	PostgreSQL	Cloud (SDG)	-
PA8	Oracle 2D	Separate schema	-
PA9	Oracle Spatial	Local server	Integrated/intersected
PA10	Now, Oracle & ArcSDE, in 2 years Postgres & PostGIS	Attributes	-
PA11	Oracle Spatial	Oracle Spatial	Oracle spatial queries
PA12	PostgreSQL PostGIS database	Not stored in LPIS	Sqlite format
PA13	Oracle Spatial	attributes	-

Annex 2 : Core concepts, usage and implementation of e-Signature and eID services on NIVA project infrastructure

Introduction

The purpose of this document is to consolidate de results of the preliminary investigation about the potential usage and implementation of CEF e-Signature and e-ID services in the infrastructure of the NIVA project. Without having reached any conclusion about the suitability and necessity of these services on the project, at the expenses of research and decisions from other participants and stakeholders of the project, this document includes some convenient core concepts to understand these services and a guide about how implement and exploit them in a software infrastructure.

Core Concepts

CEF e-Signature Services

This section includes a sum up of e-Signature documentation published on https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Documentation+eSignature, selecting those concepts that are crucial to understand how does e-Signature work, and could it be a applied in a real project.

What is an electronic signature?

Before starting to define what e-Signature is and how does it work, it is important to describe the concept of electronic signature.

An electronic signature is an electronic indication of a person's intent to agree to the content of a document or a set of data to which the signature relates.It is a legal concept capturing the signatory's intent to be bound by the terms of the signed document.

Figure 26 - Digital Signature process diagram (from: https://ec.europa.eu/cefdigita)

Defined by the eIDAS Regulation, three levels of electronic signatures can be found; 'simple' electronic signature, advanced electronic signature and qualified electronic signature. The requirements of each level build on the requirements of the level below it, such that a qualified electronic signature meets the most requirements and a 'simple' electronic signature the least.

'Simple' Electronic Signatures

An electronic signature is defined as "data in electronic form which is attached to or logically associated with other data in electronic form and which is used by the signatory to sign" (eIDAS Article 3) . Thus, something as simple as writing your name under an e-mail might constitute an electronic signature.

Advanced Electronic Signatures (AdES)

An advanced electronic signature (eIDAS Article 3) is an electronic signature which is additionally:

- Uniquely linked to and capable of identifying the signatory.
- Created in a way that allows the signatory to retain control.
- Linked to the document in a way that any subsequent change of the data is detectable.

The most commonly used technology able to provide these features is the use of a public-key infrastructure (PKI), which involves the use of certificates and cryptographic keys.

Qualified Electronic Signatures (QES)

A qualified electronic signature (eIDAS Article 3) is an advanced electronic signature which is additionally:

- Created by a qualified signature creation device
- Is based on a qualified certificate for electronic signatures.

Qualified certificates for electronic signatures are provided by (public and private) providers which have been granted a qualified status by a national competent authority as indicated in the national 'trusted lists' of the EU Member State.

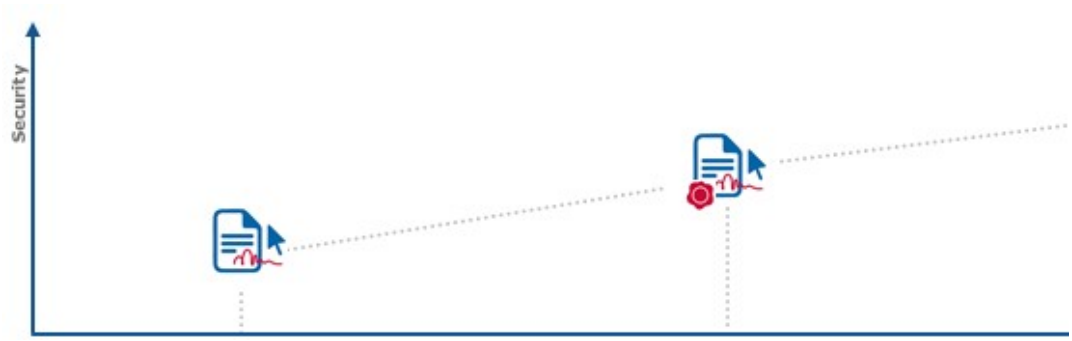

Figure 27 Electronic signature levels and their relationship with security (from: https://ec.europa.eu/cefdigita)

What is e-Signature CEF Building Block?

Once electronic signature concept has been introduced, it's time to describe how European Commission is supporting electronic signatures in Europe. The eSignature building block of the Connecting Europe Facility (CEF) it's a set of service that helps public administrations and business to accelerate the creation and verification of electronic signatures. These services include:

- The Digital Signature Services (DSS) open-source library for the creation and validation of e-signatures, that will be explained in detail on the following sections of this document.
- The Trusted List Manager.
- Technical specifications and associated standards (manteined by ETSI)

With eSignature, the European Commission aims to allow the full digitalization of business processes, eliminating the time and costs of printing, faxing, mailing, copying, scanning and filing in paper formats. Some of the use cases of the eSignature are:

- European legislative process.
- Judiciary procedural documents.
- Electronic registrations.

CEF eID Services

The CEF eID building block is a set of services (including software, documentation, training and support) provided by the European Commission and endorsed by the Member States, which helps public administrations and private Service Providers to extend the use of their online services to citizens from other European countries. This is realized through the mutual recognition of national electronic identification (eID) schemes (including smartcards, mobile and log-in), allowing citizens of one European country to use their national eIDs to securely access online services provided in other European countries.

CEF eID primarily supports the Member States in the roll-out of the eIDAS Network (the technical infrastructure which connects national eID schemes). Service Providers (public administrations and private sector organizations) may then connect their services to this network, making these services accessible across borders and allowing them to enjoy the legal recognition brought by eIDAS.

Benefits of eID

In general, eIDAS eID (supported by CEF eID) offers a means of effective and secure cross-border authentication through the mutual recognition of national eID schemes. In summary, it offers the following key benefits:

- **Interoperability**

Ensures that people and businesses can use their national eID schemes to access services in other EU countries.

- Legal interoperability: The legal validity of the authentication process when information is exchanged across borders (while respecting data protection requirements).
- Organisational interoperability: The organisational relationship between the different Member States and the necessary operational management related processes is clear.
- Semantic interoperability: Semantic elements of cross-border eID authentication are compatible, allowing the different national IT systems across Europe to exchange data with unambiguous, shared meaning.
- Technical interoperability: The technical elements of cross-border eID authentication are compatible. CEF eID facilitates this by providing a sample implementation of the eIDAS eID technical specifications.

- **Security**

Levels of Assurance (LoA) of eID schemes under eIDAS lower the risk of identity theft and misuse of personal information.

- **Trust**

Provides and ensures legal validity of transactions across borders and the same legal status as traditional paper-based processes.

How can specific actors benefit?

Cross-border EU projects delivering public services (e.g. the Online Dispute Resolution platform) will be able to provide secure and trusted access to their services for any citizen or business with an eID linked to the eIDAS Network. To do this, many EU projects will also be able to leverage the EU-Login component, meaning they will not need to implement or manage their own user access management. This represents a significant financial benefit.

eSignature standards and specifications

The European Telecommunications Standards Institute (ETSI) defines formats and levels (or profiles) of electronic signature, and the packaging of the signature on the signed document. Understanding these concepts is important to understand how the DSS works and operates with signatures.

Formats of advanced signature

The format of electronic signature inside the eSignature service are mainly related to the file format or extension that the signed document is managed in. These are:

- XML advanced electronic signature (XAdES), based on XML signatures;
- PDF advanced electronic signature (PAdES), based on PDF signatures;
- CMS advanced electronic signature (CAdES), based on Cryptographic Message Syntax (CMS);
- JWT advanced electronic signature (JAdES), based on Json Web Tokens (JWT);
- Associated Signature Container (ASiC) based on ZIP format and supporting XAdES and CAdES signature formats.

When signing/sealing a single document, the format of signature to choose typically depends on the format of the document to sign:

- XML documents are suggested to be signed/sealed using XAdES signature format (either with enveloped or enveloping packaging);
- PDF documents are suggested to be signed/sealed using PAdES signature format;
- Binary files are suggested to be signed/sealed with XAdES or CAdES signature formats (with enveloping packaging).

When signing/sealing multiple documents, it is suggested to use ASiC containers.

Baseline Levels or Profiles of electronic Signature

The ETSI defines four baseline levels to protect the validity of the signature in time, These levels are:

- **B-B level**, which is the level of a *Basic Signature* meaning that it is a signature that can be validated as long as the signing certificate is valid (not revoked or expired).
- **B-T level**, which is the level of a Signature with Time , meaning that it is a signature that proves that the signature existed at a given point in time. It is built from the previous level by adding a time stamp token on the signature as unsigned properties.
- **B-LT** level, which is the level of a Signature with Long-Term Validation Material , meaning that it is a signature that provides the long-term availability of the validation material by incorporating all the material or references to material required for validating the signature. It is built from the previous level by adding this material, that is: the complete certificate and revocation data on the signature and the time stamp(s) as unsigned properties.
- **B-LTA** level, which is the level of a Signature providing *Long Term Availability* and Integrity of Validation Material . It is built from the previous level by adding a timestamp token on the validation material as unsigned properties, thereby establishing evidence that the validation

data existed at the indicated time. This level targets the long-term availability and integrity of validation material, and if appropriate measures are put in place (e.g. periodical timestamping), a signature at this level could still be validated long after the cryptographic algorithms used for its creation are no longer considered secure enough, or more simply after the expiration of the validation data.

The appropriate level to use when creating an electronic signature depends on the intended usage of the signature:

- If the signature only needs to be validated in the short term (e.g. when signing invoices), a basic signature at the B-B level would usually be enough;
- On the other hand, if there is a need for a signature (and its eventual qualification level) to be able to be validated in the long term, a preservation process of periodical B-LTA level augmentation should be considered. Such a preservation process is however usually much heavier to put in place than the simple generation of an electronic signature and its application should be duly justified.

These levels can be applied to any of the previously described advanced signature formats.

Packaging of a signature

Regarding to how the signature is located in relation with the signed data, different packaging formats are defined.

A signature can be **enveloped** or **detached**, whether it is included as an element of the file containing the signed data or a separate signature file is created, that refers to the data upon which it bears:

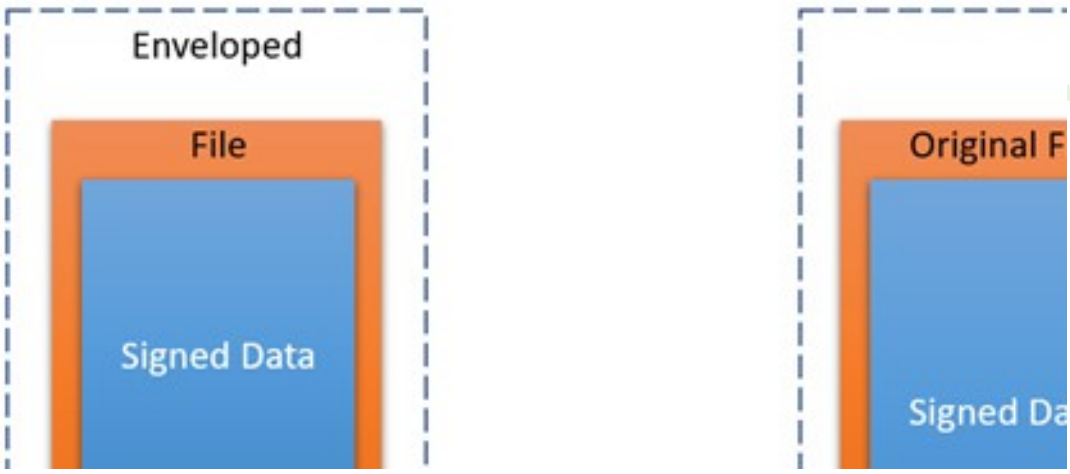

Figure 28 : enveloped or detached signature

It can also be **enveloping** when the signed data are included as a sub-element of the signature, and in special cases where the signature is detached but both the signed data and the signature data are included in another file, it is called **internally detached.** (Internally detached signatures are very rarely used).

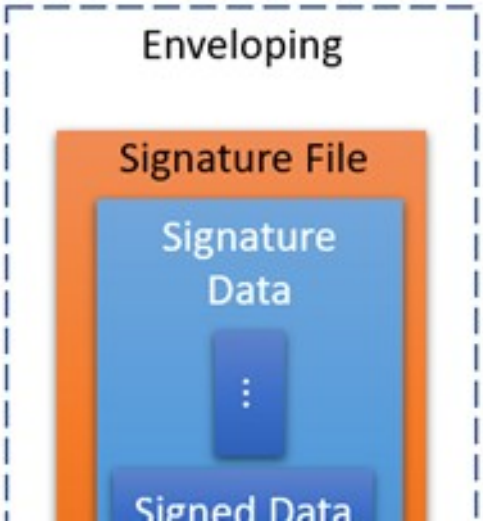

Figure 29 : enveloping or internally detached signature

Not all signature formats support these different locations and positionings of a signature and a simplified overview can be given by the following:

- Enveloped signatures can be created using XAdES or PAdES formats
- Detached signatures can be created using XAdES or CAdES formats
- Enveloping signatures can be created using XAdES or CAdES formats
- Internally detached signatures can only be created using XAdES format.

Digital Signature Services (DSS)

What is DSS?

DSS (Digital Signature Services) is an open-source software library for electronic signature creation and validation. DSS supports the creation and verification of interoperable and secure electronic signatures in line with European legislation. In particular, DSS aims to follow the eIDAS Regulation and related standards closely.

DSS can be re-used in an IT solution for electronic signatures to ensure that signatures are created and verified in line with European legislation and standards. DSS allows re-use in a variety of different ways: in an applet, in a stand-alone application or in a server application. DSS can also be used as a reference implementation for IT solutions which do not directly re-use it.

Benefits of the DSS

CEF eSignature's DSS open-source library delivers the following benefits to its users:

- Open-source software under LGPL 2.1, a non-viral open source license;
- Written in Java, guaranteeing portability on numerous platforms;
- Interoperability of the e-signatures;
- Supports both e-signatures and e-seals;
- Validation of countersignatures and multiple signatures;
- A flexible library, that can be:
    - Reused in different topologies: in an applet, as a stand-alone application, server-based, or any combination;
    - Used in its entirety or on a module-by-module basis;
- Adapted to numerous usages via configuration files or extension points;
- Alignment with the eIDAS Regulation and related standards;
- Supports EU standards on:
    - Signature formats and packaging methods;
    - Signature validation procedures;
- Validation relying on Member States' trusted lists:
    - Status of trust service providers/trust service.
    - Compensation of information.
    - Path validation.

How does eIDAS eID solution work?

The eIDAS solution allows citizens from Member States to prove and verify their identification when accessing on-line services in other Member States. It allows citizens to authenticate themselves by using their eIDs and connecting with their Identity Provider (IdP) from their country. A high level process is as follows:

1. A citizen requests an on-line service in a Member State.
2. The citizen is requested to authenticate themselves by the on-line service.

   At the authentication stage, it becomes apparent that the citizen has an eID from another Member State.
3. Authentication request is sent to the citizen's country for authentication, through the eIDAS solution, to the citizen's Identity Provider (IdP) where authentication takes place.
4. Authentication result is returned to the service provider.
5. Authentication is complete and the citizen can proceed with accessing the service.

The eIDAS Solution makes different eID national protocols interoperable with each other. The solution uses the eIDAS protocol to translate national identification data into a common format that is understood and used by Member States.

This leads to eIDs of Member States being interoperable and accepted in other Member States, opening new possibilities and opportunities to the citizens to use services across-border.

The animation below illustrates how the use of the eIDAS protocol and the implementation of eIDAS-Nodes allow for communication between independent national eID scheme architectures, supporting smooth cross-border authentication.

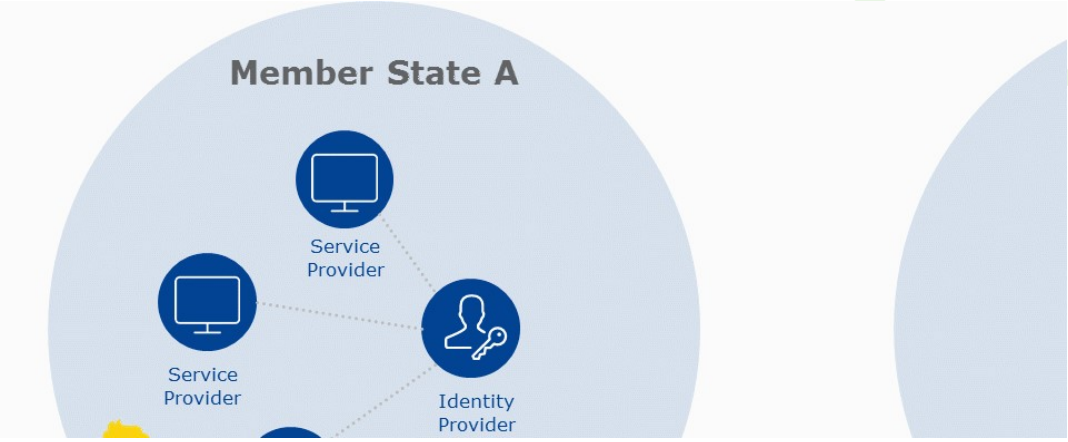

Figure 30 : cross-border identification

How does eSignature and eID integrate with NIVA Project infrastructure.

Once the core concepts of what eSignature and eID have been stablished, it's time to determine how can these two components take part on the NIVA project infrastructure.

CEF eSiganture and CEF eID services essentially combine together to generate a validated, extensively tasted, standardized and easy to implement method of authenticate the information sent or uploaded to NIVA components from either a user interface or automated piece of software.

On its own, eSignature could allow any source of document or information of any kind to authenticate and verify its identity, but in every case a certificate its needed to validate the electronic signature. Combined with eID Services, it makes these types of certificates complementation easy and accessible to every member state user or entity, for example allowing a user to upload a document and signing it from its smartphone, documents such as images or monitorization registers.

For these purposes, the main challenge is to connect the project infrastructure with the eIDAS Network through the EU-Login component. In these cases, when Sector-specific EU projects could benefit from using the eIDAS Network, it is recommended then to request assistance from the eID team, conduct a feasibility study.