

ANTENNAE – DES-HE-ER02

Initial Data Management Plan (DMP)

Deliverable ID:	D1.3
Project acronym:	ANTENNAE
Grant :	101167288
Call :	HORIZON-SESAR-2023-DES-ER-02
Topic :	HORIZON-SESAR-2023-DES-ER2-WA2-1
Consortium coordinator :	COLLINS AEROSPACE IRELAND, LIMITED
Edition date:	31 October 2025
Edition:	02.00
Status :	Official
Classification:	PU

Abstract

This document establishes a Data Management Plan (DMP) for the ANTENNAE project. The project will follow as much as possible the 'FAIR' approach, which is findable, accessible, interoperable, and reusable. These principles precede implementation choices and do not necessarily suggest any specific technology, standard, or solution. The document provides information on (i) what data will be collected, processed and/or generated; (ii) the handling of research data during & after the end of the project; (iii) which methodology & standards will be applied; (iv) whether data will be shared/made open access and; (v) how data will be curated & preserved (including after the end of the project). This is the second (intermediary) release of the DMP.

As we continue forward through the remaining months of the ANTENNAE project and research testing and validation results are generated, the research team aims to define and apply a method to track future citation and usage of datasets resulting from research activities. At the submission of this intermediate version of the

DMP, the potential tools, systems, and methods for facilitating the tracking of dataset usage are still being considered. The approach selected for tracking dataset usage will be described in the final version of the DMP.

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TID	05/05/2025
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Rejected by²

Organisation name	Date

Document history

Edition	Date	Status	Company author	Justification
00.01	28/02/2025	Final	COLLINS	Initial DMP - DRAFT
01.00	28/02/2025	Final	COLLINS	Initial DMP - FINAL
01.02	05/05/2025	Final	COLLINS	Minor Edits per JU Assessment
02:00	31/10/2025	Final	COLLINS	The document is finalised to Edition 02.00

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ANTENNAE

DATA DRIVEN COST EFFECTIVE 5G INTEGRATED CNS AS A SERVICE

ANTENNAE



This document is part of a project that has received funding from the SESAR 3 Joint Undertaking under grant agreement No 101167288 under European Union's Horizon Europe research and innovation programme.



² Representatives of the beneficiaries involved in the project

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List of Acronyms

Name	Acronym
Relevant Document (PMP) Acronyms	
Data Management Plan	DMP
Digital Object Identifier	DOI
General Data Protection Regulation	GDPR
Global Field Power	GFP
General Project Acronyms	
3GPP	3rd Generation Partnership Project
5G	5 th Generation of Cellular Networks
6G	6 th Generation of Cellular Networks
AB	Advisory Board
AG	Advisory Group
AGL	Above Ground Level
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
A-SUR	Aircraft-based Alternate Surveillance
CA	Consortium Agreement
CDE	Communication, Dissemination and Exploitation
CIS	Common Information Service
CISP	Common Information Service Providers
CNS	Communications, Navigation, and Surveillance
ConOps	Concept of Operations
DMP	Data Management Plan
EASA	European Union Aviation Safety Agency
EC	European Commission
EDA	European Defence Agency
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
eMBB	Enhanced Mobile Broadband

ERA	European Research Area
ETA	Emerging Technology Aircraft
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
eVTOL	A type of aircraft that uses all-electric and hybrid-electric powered vertical take-off and landing
IAM	Innovative Air Mobility
ICAO	International Civil Aviation Organization
IPR	Intellectual Property Rights
ISO	International Organisation for Standardisation
JCS	Joint Communication & Sensing
JU	Joint Undertaking (in reference to SESAR JU)
KPI	Key Performance Index
OEM	Original Equipment Manufacturer
PMP	Project Management Plan
R&D	Research & Development
RPAS	Remotely Piloted Aircraft Systems
RTCA	Radio Technical Commission for Aeronautics
SJU	SESAR Joint Undertaking
SME	Small or Medium Enterprise
UAM	Urban Air Mobility
UAS	Unmanned Aircraft Systems
URLLC	Ultra Reliable Low Latency Communications
USSP	U-space Service Provider
UTM	Unmanned Aircraft System Traffic Management
VCA	VTOL capable aircraft
VLL	Very Low level (airspace)
VTOL	Vertical Take-off and landing

Table 1: list of acronyms

1 Data summary

1.1 Project overview

Emerging U-Space and UAM concepts envisage a new generation of small, highly manoeuvrable, and highly automated aircraft operating at low altitude, alongside existing helicopter, and general aviation users. Coordination & deconfliction of large numbers of such aircraft operating in primarily urban environments requires new Communications, Navigation, and Surveillance (CNS) infrastructure to ensure safety of passengers, the public, and other stakeholders while supporting complex low-altitude operations. Leveraging the scalable waveforms of 5G New Radio (NR), modern IP-based software-defined networking, and distributed computing capabilities, ANTENNAE (dAta driveN cost-Effective 5G iNtegrated CommuNication, Navigation, and Surveillance (CNS)-as-A-ServicE) proposes a flexible and resilient integrated CNS-as-a-Service model supporting both low-altitude piloted and U-Space operations, and builds upon the mature and growing family of 3GPP 5G standards including system architecture, deployment models, and commercial implementations.

ANTENNAE will apply advanced modelling to validate the applicability of 3GPP standards to deliver low-altitude CNS functions, including the full range of aeronautical data services (through 5G eMBB & URLLC), navigation (through 5G-based A-PNT), and surveillance (through emerging A-SUR and joint communication & sensing (JCS) concepts). ANTENNAE will examine the architectural benefits of established 5G deployment models for providing distributed data services, network resilience, and scalability. ANTENNAE will also look to the future of the 3GPP standards by examining technologies under development in the 3GPP working groups for beyond 5G ("6G") services.

Finally, ANTENNAE will conduct a rigorous quantitative techno-economic analysis informed by these engineering models to assess the financial feasibility of deploying a scalable integrated CNS-as-a-Service through a 5G access network, with comparison to alternative technological approaches.

1.2 Re-use of existing data

ANTENNAE will contribute to the scope of the HORIZON-SESAR-2023-DES-ER2-WA2-1 topic, and specifically the sub-topic "Use of dedicated 5G network for complex low altitude operations". To address this, ANTENNAE will validate the applicability of the 3GPP global telecommunications standards to deliver low- altitude CNS functions, including the full range of aeronautical data services, navigation, and surveillance functions. ANTENNAE will examine the architectural benefits of established 5G deployment models for providing distributed data services, network resilience, and scalability. ANTENNAE will also look to the future of the 3GPP standards by examining technologies under development in the 3GPP working groups for beyond 5G ("6G") services.

The ANTENNAE project has the following General Objective (GO):

General Objective	Description
GO.1	To develop and demonstrate through dedicated 5G network system level simulations a cost- effective setup of integrated communications, navigation and surveillance services enabled by emerging 3GPP standards and technologies for 5G and Beyond 5G networks for IAM operations in low-altitude airspace.

Figure 1 - General Objective (GO)

A **single** SESAR Solution (ANTENNAE-01) will cover the scope of the HORIZON-SESAR-2023-DES-ER2-WA2-1 topic and ANTENNAE’s General Objective (GO.1) and ANTENNAE-01 will be evaluated at TRL2, including technical and economic (**techno-economic**) feasibility:

ANTENNAE-01 – “Cost-Effective 5G Integrated CNS-as-a-Service” – is an Integrated CNS (I-CNS) architecture for low altitude¹ aircraft² operations across all phases of flight based on the application of current and emerging 3GPP global telecommunications standards to provide performance-based communications, navigation, and surveillance (CNS) functions, though the use of both dedicated and shared network resources.

To achieve GO.1, the following Specific Objectives (SO) have been defined:

Specific Objective	Description	Work Package (WP)	Success Criteria [Associated task & deliverable]
SO.1	The concept of operation and requirements for an integrated CNS as a service for low altitude operations, including aircraft with pilot on board, remotely piloted, and fully autonomous aircraft.	WP2	<ul style="list-style-type: none"> Aggregated concept of operations and requirements for CaaS for low-altitude operations [T2.1 CONOPS] Definition of operational services & environment to be supported by Solution 1 [T2.2 OSED]
SO.2	Verified compliance of 3GPP 5G communication standards, KPIs, and available spectrum to satisfy CaaS requirements.	WP2	<ul style="list-style-type: none"> Identification of key 3GPP KPIs critical to achieving CaaS performance [T2.3 FRD] Construction of compliance matrix of 3GPP standards against CaaS requirements [T2.3 FRD] Identification of suitable EU radio spectrum for deployment of Solution 1 [T2.3 FRD]

SO.3	Low altitude-specific network configuration & management policies to deliver cost-effective CNS-as-a-service in low altitude operations, across all stakeholders.	WP2	<ul style="list-style-type: none"> • Definition of Solution 1 overall network configuration and architecture, and associated management policies [T2.2 OSED] • Definition of critical validation scenarios for Solution 1 [T2.4 ERP] • Validated and documented network management and user mobility algorithms for terrestrial networks [T2.5 ERR]
SO.4	Hybrid network architectures comprising terrestrial & non-terrestrial network segments for increased availability & resilience.	WP2	<ul style="list-style-type: none"> • Validated and documented network management and user mobility algorithms for hybrid networks [T2.5 ERR] <ul style="list-style-type: none"> • Evaluation of resilience features within Solution 1 configuration [T2.5 ERR]
SO.5	RAN optimization solutions for antenna power and antenna beamforming configurations, and spatial-domain interference mitigation to achieve coexistence.	WP2	<ul style="list-style-type: none"> • Validated and documented RAN optimization algorithms [T2.5 ERR]
SO.6	A-PNT and A-SUR system performance validated, and positioning & integrity algorithms specified for low-altitude operations.	WP2	<ul style="list-style-type: none"> • Characterization of achievable A-PNT and A-SUR system performance within Solution 1 configuration [T2.5 ERR]

SO.7	Validation of identified KPIs for a 3GPP 5G-aligned network for CNS-as-a-Service for low altitude operations.	WP2	<ul style="list-style-type: none"> Validated and documented performance for Solution 1 configuration [T2.5 ERR]
SO.8	A technic-economic comparative analysis for the regional deployment of CNS using shared or dedicated 5G networks to achieve performance, coverage, and network planning requirements for low altitude operations.	WP2	<ul style="list-style-type: none"> Determination of the cost and benefits of deploying Solution 1 over a representative geographical region [T2.6 ECO-EVAL] Comparison of Solution 1 techno-economic analysis against alternative CNS technologies (LDACS) [T2.6 ECO-EVAL] Critical review of the impact of long-term 3GPP technology roadmaps on delivery of emerging I-CNS functions [T2.6 ECO-EVAL]

Figure 2 - Specific Objectives

Below is a preliminary list of the data that will be re-used within the ANTENNAE project. As the project progresses, more information will be included, and the DMP will be updated accordingly.

Source	Data	WP	Format
Standard modelling and simulation methodologies; Other SESAR projects; Technical literature review	State of the art for modelling and simulation. Results of other SESAR projects	WP2	DOC/DOCX/PDF
ETHER project (EU Horizon Europe Programme, Grant Agreement number 101096526); SATERA project (EU SESAR, Grant agreement ID: 101164313)	Simulation environment and simulation logs regarding the modelling of Terrestrial & Non-Terrestrial Hybrid Networks sourced from the ETHER and SATERA projects.	WP2	Database

Table 2: Re-used data within ANTENNAE

1.3 Data collected/generated within the project

As part of WP2, data will be generated via the application of advanced modelling and simulation to validate the applicability of 3GPP standards to deliver low-altitude CNS functions, including the full range of aeronautical data services (through 5G eMBB & URLLC), navigation (through 5G-based A-PNT), and surveillance (through emerging A-SUR and joint communication & sensing (JCS) concepts).

As we continue forward through the remaining months of the ANTENNAE project and research testing and validation results are generated, the research team aims to define and apply a method to track future citation and usage of datasets resulting from research activities. At the submission of this intermediate version of the DMP, the potential tools, systems, and methods for facilitating the tracking of dataset usage are still being considered. The approach selected for tracking dataset usage will be described in the final version of the DMP.

Additionally, qualitative and quantitative data will be collected/generated through workshops, interviews, small real-time simulations, and human-in-the-loop simulations.

Types of data	For ANTENNAE
<p>Data means any digital representation of acts, facts or information and any compilation of such acts, facts or information, including sound, visual or audio-visual recording (reg. EU 2022/868, Article 2(1)).</p>	<p>Any digital representation collected and/or generated throughout the project (e.g., data from simulations, questionnaires, surveys, data augmented (data enriched with other data), and/or data from meetings, interviews, or other human interactions data).</p>
<p>Personal data means any information relating to an identified or identifiable natural person (data subject); an identifiable natural person can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person (reg. EU 2016/679 (General Data Protection Regulation (GDPR)), Article 4(1))</p>	<p>The ANTENNAE consortium will only collect contact information such as name, company, email, and/or phone number, for individuals within the consortium, serving on the ANTENNAE Advisory Board, or who may participate (participants) in dissemination activities and events such as workshops, meetings, interviews, or other human interactions.</p> <p>Within the project’s research activities, the ANTENNAE consortium will <u>not</u> collect any personal data, control any personal data (it will not be a data controller pursuant to GDPR regulation), process any personal data (it will not be a data processor pursuant to GDPR regulation), or create or retain any personal data.</p>

<p>Non-personal data means data other than personal data (reg. EU 2018/1807, Article 2(1); reg. EU 2022/868, Article 2(4))</p>	<p>The research activities within the project will involve collecting and analysing context data to evaluate research (modelling and simulation) results.</p>
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Table 3: Types of data to be collected/generated

The following table provides a preliminary list of the data expected to be collected within the project.

Raw data	Outcome	Type	Format	WP(s)
In relation to WP2 activities, data generated via the application of advanced modelling and simulation to validate the applicability of 3GPP standards to deliver low-altitude CNS functions, including the full range of aeronautical data services (through 5G eMBB & URLLC), navigation (through 5G-based A-PNT), and surveillance (through emerging A-SUR and joint communication & sensing (JCS) concepts).	Modelling and simulation results (data)	Collected	DAT / MAT / EDF / MP3 / LOG / CSV / XLS / XLSX	WP2
Photos and recordings generated or acquired regarding evaluating and validating research results, data collected from workshops, focus groups, or other interactions with humans outside the consortium.	Photos, plots, or videos generated from research activities; Query (survey/questionnaire) results from dissemination activities	Collected/Generated	PNG; JPG; MP4; MPEG-4; AVI; MOV; MP3	WP2, WP3
Name, company, licences / operational experience, email, phone number, participant ID/pseudonym	Personal Data from dissemination activity participants	Collected	DOC/DOCX /XLS/XLSX/ CSV	WP3
System logs data (modelling and simulation tool/application log files and/or database files).	System (Tool/Application) log files and modelling/simulation results data files and any metadata used to enrich modelling/simulation results data	Collected	DAT / LOG / CSV / XLS / XLSX/MP4	WP2

Table 4: Expected data to be collected/generated within the project

2 FAIR data

The research results deriving from the ANTENNAE WP2 activities will be made publicly available in accordance with the FAIR (Findable Accessible Interoperable Re-usable) principles and open data requirements.

2.1 Making data findable, including provisions for metadata

ANTENNAE data collection will be publicly accessible through trusted repositories. The assignment and management of persistent identifiers (PIDs) to the data will be assessed in the project's first year, starting with evaluating available PID services.

All ANTENNAE open results will be identifiable and locatable using a persistent Uniform Resource Locator (URL). If possible, open ANTENNAE results will be assigned a Digital Object Identifier (DOI) to make content easily and uniquely citable.

Open ANTENNAE results that are deposited in institutional repositories, repositories of scientific publishers or other data and research repositories will be at least indefinable by a persistent URI. If the institution is a DOI registrant with an agreement with a DOI registration agency, a DOI will also be assigned.

Whether scientific publications will be assigned a unique identifier like DOI, Publisher Item Identifier (PII), International Standard Serial Number (ISSN), etc., will depend on the open access chosen by the editors and thus also on the respective scientific publisher and the selected research repository.

2.2 Making data accessible

2.2.1 Repository

The open ANTENNAE results will be deposited into a secure repository which will be defined within the intermediate version of this DMP. Additionally, all project deliverables containing or referencing research results will be deposited in the STELLAR Deliverables register as well as within the EU Horizon Portal register.

2.2.2 Data

Open Science is the initiative to make scientific research activity and data obtained during this activity available to any member of an inquiring society, from professionals and industry to citizens. This approach significantly improves the effectiveness and productivity of research by preventing duplication and increasing reproducibility, thus contributing to research integrity and excellence.

The ANTENNAE consortium expects that following open science principles will help support the efficient dissemination of research results and/or outcomes. First, publication in open-access journals or features will result in a higher citation rate and more efficient dissemination. Second, research papers will be freely available to the public and industry stakeholders. Thirdly, publications available in an open access regime will enable better science dissemination to attract the interest of the public

and industry stakeholders. ANTENNAE will follow an approach (the principles above) to maximise the open access policy and ensure that research outcomes are freely and reasonably accessible.

All the publications will also be uploaded to either a general repository or a discipline-specific repository trusted in each research field. The upload will take place at the latest on the publication date. Special attention will be paid to the copyright conditions set by the journals to ensure that the articles are published under CC-BY or similar licence to allow commercial use of the outputs. Furthermore, the partners are committed to making the research data as open as possible while taking confidentiality and IP protection into account.

Scientific publications and deliverables marked as Public in the project Grant Agreement will also be available on the project website and SJU official page.

In some cases, non-public research data could be archived at the repository using a restricted access option. The category of data that won't be made openly available:

- Personal data: Datasets referring to the personal data of research participants are not open by default as their publication poses privacy and ethical issues.
- Raw modelling/simulation or data: Only aggregated data results will be public.
- Data from dissemination activities such as workshops or surveys: Only aggregated or summarised data will be public.

2.2.3 Metadata

Metadata will be retrievable by their identifier using a standardised communication protocol.

The open results deposited in the repository will be available at least 5 years after the project's conclusion or pursuant to the ANTENNAE Grant Agreement (GA) requirements for research results availability timeframes.

2.3 Making data interoperable

All data sets will be described using standard descriptive metadata to ensure metadata interoperability for indexing and discoverability. All relevant documentation explaining data collection procedures and analysis will be made available along with the data to guarantee the intelligibility, reproducibility, and validation of the project findings.

2.4 Increase data reuse

Making data FAIR requires an investment of money and researchers' time. For ANTENNAE, the cost of data preservation after the project ends is expected to be zero because the foreseen repositories do not apply fees for archiving and data curation. A cloud storage solution will be adopted to share data among partners during the project. The project budget will cover the cost of activating and maintaining it for the project's duration. The budget also covers the expenses related to setting up the project website. All the data will be password-protected. If mobile devices are used to store data files (e.g.,



backup files), they will be kept in a safe place accessible only to the researchers involved. All partners are asked to keep locally updated copies of all their files: all the research materials stored in computers will be subject to regular backup to safeguard them from accidental loss. Information regarding personal data collection, storage, etc., is available in the Ethics section on the portal.



3 Other research outputs

The ANTENNAE research results (output) will be made available in:

- Official project deliverables
- Publication of scientific articles
- Publication of news articles, press releases, or posts on social media
- Participation in / presentations at conferences, workshops or similar events

The policy for official deliverables is laid down in the ANTENNAE GA and the available Horizon Europe Guidance Material.

The management of scientific articles, news, press releases, social media posts, or presence at a conference/workshop or similar events has been defined in project deliverable D3.1-Initial Communication, Dissemination and Exploitation Plan (CDE) and will be updated in the subsequent CDE submissions.

4 Allocation of resources

Data management will be the responsibility of the coordinating partner, Collins.

All partners cover the costs and efforts to make data FAIR within the budget allocated to the project. No expenses are foreseen for storing open results in the project's repository. Additional details will be provided in future DMP versions.

The coordinating partner, Collins, has been allocated resources for long-term preservation.

The ANTENNAE website is hosted by the project's partner leading WP3 CDE tasks (VTT). The information will be retained and accessible for the website's lifetime.

To consider all ethical and legal aspects related to data management, the chief legal officer of each partner generating data during the project will assume the role of data controller, as stated in Article 24 of the GDPR. Each partner managing (i.e., generating and/or processing) data will nominate a Local Data Manager to oversee interactions with the Data Controller.

The following table provides the list of Data Managers. The Data Managers below will identify and support the respective Data Controllers within their work package. That information will be included in a more mature version of the document.

ANTENNAE WP	Partner and Data Manager(s)
WP1 – Project Management	Charles Cleary (Collins)
WP2 – Modelling/Simulation and Techno-economic evaluation	Davi Brilhante (Collins), Giovanni Geraci
WP3 – Communication, Dissemination, and Exploitation	Vadim Kramar (VTT)

Table 5: Partners' Data Managers

5 Data security

Data storage in ANTENNAE depends on its type, whether public or confidential. Confidential data is stored in a certified SharePoint repository with the highest security standard. It will be preserved for five years after the project ends.

To disseminate public information, a web page was created where the deliverables are uploaded as they are available so the interested audience can follow the project's evolution. Social network profiles, such as LinkedIn, were also created, where news is shared.

Due to the amount of information and its relevance, several security measures are taken to avoid loss. Data will be backed up regularly (including incremental and regular full backups). Access to these physical copies will be controlled and restricted. Where possible and practical, information will be encrypted to protect it from cyberattacks.

All the partners will ensure the appropriate technical and organisational implementation of measures to implement the following data security concepts, as shown in the table below.

Security	Definition
Data pseudonymisation	Processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject without the use of additional information, provided that such additional information is kept separately and is subject to technical and organisational measures to ensure that the personal data are not attributed to an identified or identifiable natural person (reg. EU 2016/679, Article 4(5)).
Data anonymisation	Processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject (reg. EU 2016/679, Article 4(5), <i>ex converso</i>).

Security processing	<p>Considering the state of the art, the costs of implementation and the nature, scope, context and purposes of processing, as well as the risk of varying likelihood and severity for the rights and freedoms of natural persons, the controller and the processor shall implement appropriate technical and organisational measures to ensure a level of security appropriate to the risk, including among other things as appropriate:</p> <ul style="list-style-type: none"> (a) the pseudonymisation and encryption of personal data. (b) the ability to ensure the ongoing confidentiality, integrity, availability and resilience of processing systems and services. (c) the ability to restore the availability and access to personal data promptly in the event of a physical or technical incident. (d) a process for regularly testing, assessing and evaluating the effectiveness of technical and organisational measures to ensure the security of the processing (reg. EU 2016/679, Article 32(1)).
Secure processing environment	<p>The physical or virtual environment and organisational means to ensure compliance with Union law, such as Regulation EU 2016/679, in particular about data subjects’ rights, intellectual property rights, and commercial and statistical confidentiality, integrity and accessibility, as well as with applicable national law, and to allow the entity providing the secure processing environment to determine and supervise all data processing actions, including the display, storage, download and export of data and the calculation of derivative data through computational algorithms (reg. 2022/868, Article 2(20)).</p>

Table 6: Data security concepts to be considered by data controllers in the project

6 Ethics

The Consortium is fully aware of the proposed research's ethical implications. It respects the ethical rules and standards of HORIZON EUROPE and those reflected in the European Union's Charter of Fundamental Rights.

Personal Data. Ethical, social and data protection considerations are crucial. The ANTENNAE consortium will ensure the proper handling of any personal data, the appropriate handling of ethical issues, and the adherence to national, European, and international law, regulations, and directives and, more specifically, the following:

- Regulation (EU) 2016/679 (General Data Protection Regulation)
- The Universal Declaration of Human Rights and the Convention 108 for the Protection of Individuals Regarding Automatic Processing of Personal Data.
- Directive on Privacy and Electronic Communications (2002/58/EC) and the upcoming Privacy Regulation, aiming to repeal it to reinforce trust and security in the Digital Single Market and ensure alignment with GDPR's new rules.
- Directive 96/9/EC of the European Parliament and the Council of 11 March 1996 on the legal protection of databases.

7 Other issues

No other issues were identified.