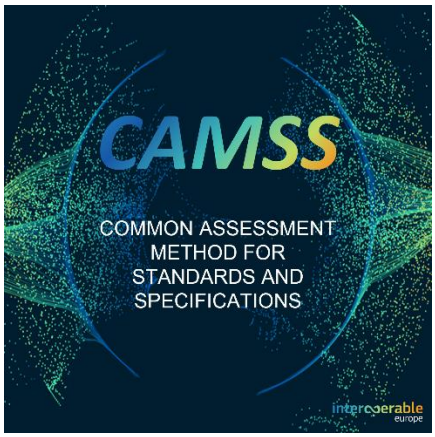

ASSESSMENT SUMMARY v1.0.0

GraphQL[1]

GraphQL Foundation[2]

[1] GraphQL specification: https://spec.graphql.org/October2021/#sec-Overview

[2] GraphQL Foundation: https://graphql.org/foundation/

Change Control

Modification	Details
Version 1.0.0	
Initial version	

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1. INTRODUCTION

The present document is a summary of the assessment of **GraphQL** carried out by CAMSS using the CAMSS Assessment EIF scenario[3]. The purpose of this scenario is to assess the compliance of a standard or specification with the European Interoperability Framework (EIF)[4].

2. ASSESSMENT SUMMARY

GraphQL is an open-source query and data manipulation language for APIs. The specification also works as an API endpoint, providing flexibility to any user interested in defining data schemas and querying data from one or multiple systems or servers. GraphQL offers an intuitive and flexible syntax and service for describing data requirements and interactions. The specification allows clients to define the structure of the data required, and the same structure of the data is returned from the server. This prevents excessively large amounts of data from being returned, but can impede web caching of query results.

GraphQL was developed internally by Facebook (now Meta[5]) in 2012 before being publicly released in 2015. On 7 November 2018, the GraphQL project was moved from Facebook to the newly established GraphQL Foundation, hosted by the non-profit Linux Foundation[6]. Up-to-date, GraphQL is present in relevant initiatives at the EU level, such as SmartM2M[7], which are using more and more the specification for developing services.

2.1. EIF Interoperability Principles

Interoperability principles are fundamental behavioural aspects that drive interoperability actions. They are relevant to the process of establishing interoperable European public services. They describe the context in which European public services are designed and implemented.

***The specification does not support the principles setting context for EU actions on interoperability*:**

- **Subsidiarity and proportionality**
  No Member State includes the GraphQL in their national catalogue with Their National Interoperability Framework (NIF) in alignment with the three categories 1. Conceptual model for integrated public services provision, 2. interoperability layers, and 3. interoperability principles.

The specification fully supports the principles setting context for EU actions on interoperability:

- **Openness**

[3] CAMSS Assessment EIF Scenario 5.1.0: EUSurvey - Survey (europa.eu)

[4] ISA[2] programme: https://ec.europa.eu/isa2/eif_en

[5] Meta: https://about.meta.com/

[6] Linux foundation: https://www.linuxfoundation.org/

[7] SmartM2M: https://www.etsi.org/deliver/etsi_tr/103700_103799/103715/01.01.01_60/tr_103715v010101p.pdf

Although GraphQL is not suitable to publish open data, the specification provides the mutation functionality and an open source extensions that allow for GraphQL to query linked open data (GraphQL-LD), which enhances the specification's capability to operate on open data.

Meta did in first place develop the specification in order to be able to process and query the huge amount of data the Facebook platform was gathering. GraphQL was open sourced in 2015, and became a neutrally governed project managed by the Linux Foundation in 2019. Currently, GraphQL is developed and maintained by the GraphQL Working Group[8], who plans and impements changes in the specification. Furthermore, there is a community of developers and GraphQL implementers that are active contributors to its development, that publish transparent and documented reports and tests.

Since its first release, GraphQL has been an innovative solution for the creation of centralised databases. There are many organisations using GraphQL, and there are some of them creating tools to facilitate its implementations, being it an important market uptake indicator. It is also publicly accessible for free at the GraphQL organisation webpage.

- **Transparency**

  The centralised databases that GraphQL is able to generate have the potential to actively promote the visibility and comprehensibility of administrative procedures by improving the processes through which the maintenance of consistent data governance is facilitated, and ensures that end consumers leverage the data available in a given organisation. It is also a good enabler for the exposure of interfaces, insofar it does not mandate a particular programming language or storage system for application services that implement it. Nonetheless, there is a lack of provisions for the management and protection of personal data.

- **Reusability**

  GraphQL is a generic and flexible engine that defines a schema syntax, query syntax, and a query execution reference for centralised databases. It is therefore domain-agnostic and is designed to be used and implemented in any domain.

- **Technological neutrality and data portability**

  GraphQL is used as an API query language, since it provides the means to query multiple databases through a unified interface which is indeed friendly to product development and useful for tool-building. It also does not mandate a particular programming language or storage system for application services that implement it. Instead, application services take their capabilities and map them to a uniform language, type system and philosophy that GraphQL encodes.

[8] GraphQL Working Group: https://github.com/graphql/graphql-wg

***The specification partially supports the principles related to generic user needs and expectations*:**

- **User-centricity**
  The user dimension of GraphQL is complex in terms of data query services compared to traditional data application (or data query services) such as REST[9] or OData[10]. Although there is no reference of any European use case explicitly stating that GraphQL allows relevant information and data to be reused nor any reference to the implementation of the OOP, GraphQL has been used in the SmartM2M and European Student Card[11] initiatives as an enabler to facilitate mapping capabilities and interworking among different applications and servers. The specification aggregates data from multiple UI components in order to not repeat code or queries to get the desired data. Furthermore, GraphQL includes reusable units called fragments which let you construct sets of fields, and then include them in queries where you need to.

- **Inclusion and accessibility**
  The purpose of GraphQL is not related to e-accessibility. Therefore, this criterion is not applicable to this specification.

- **Security and privacy**
  GraphQL and safety and privacy concerns depend on the service in which the specification is used. Nonetheless, although GraphQL might miss some security features compared to SOAP[12], which is its lightweight protocol counterpart for exchanging structured information in other domains such as the financial one[13], the specification explicitly details the use of HTTP protocol, ensuring the security of its methods. GraphQL also provides some guidelines to how to make the specification more secure. It ensures the secure exchange of data as it realizes queries towards the API and it gets back secure information to be processed.

- **Multilingualism**
  The specification only refers to programming languages, does not make any comment about natural languages distinction, only English.

The specification supports the foundation principles for cooperation among public administrations:

[9] REST: https://restfulapi.net/

[10] OData: https://docs.oasis-open.org/odata/odata-temporal-ext/v4.0/cs01/odata-temporal-ext-v4.0-cs01.html

[11] European Student Card: https://erasmus-plus.ec.europa.eu/european-student-card-initiative/help-support/technical

[12] SOAP: https://www.w3.org/TR/soap/

[13] GraphQL and privacy concerns: https://www.altexsoft.com/blog/soap-vs-rest-vs-graphql-vs-rpc/, https://graphql.org/faq/#does-graphql-use-http

- **Administrative Simplification**
  GraphQL can simplify the delivery of European public services. A clear example of its applicability is the SmartM2M initiative and the TestBed[14] adaptation service to validate GraphQL queries against GraphQL schemas. With the aim of expanding its use, TestBed offers support for projects using GraphQL by launching a new GraphQL validator, which is totally based on the GraphQL reference implementation and expects as input the query to validate as well as the target schema.

- **Preservation of information**
  The GraphQL specification preserves the information as long as the user mantain the API where the information is maintained. If it gets deleted so will the data in it. GraphQL clients can use HTTP caching to easily avoid refetching resources, and for identifying when two resources are the same.

- **Assessment of effectiveness and efficiency**
  There are several studies assessing GraphQL effectiveness and efficiency; for example, in IEEExplore there is a paper evaluating GraphQL on microservices[15].

2.2. EIF Interoperability Layers

The interoperability model which is applicable to all digital public services includes:
- Four layers of interoperability: legal, organisational, semantic and technical;
- A cross-cutting component of the four layers, 'integrated public service governance';
- A background layer, 'interoperability governance'.

The Specification supports the implementation of digital public services complying with the EIF interoperability model:

- **Interoperability governance**
  GraphQL is already associated with EIRA[16] ABBs in the European Library Of Specifications (ELIS)[17]. More specifically, GraphQL will define the interoperability aspects of the Virtual DataSet ABB of the EIRA Semantic View, as well as the Data Exchange Service, Data Exchange Component, Data Management Service, Data Management Component, 'Data Extraction, Transformation, and Loading Service', 'Data Extraction, Transformation, and Loading Component', Knowledge Discovery Component Service, Knowledge Discovery Component of the EIRA Technical View.

[14] TestBed & GraphQL reference: https://joinup.ec.europa.eu/collection/interoperability-test-bed-repository/solution/interoperability-test-bed/news/new-graphql-validation-service

[15] Roksela, P., Konieczny, M., & Zielinski, S. (2020, July). Evaluating execution strategies of GraphQL queries. In 2020 43rd International Conference on Telecommunications and Signal Processing (TSP) (pp. 640-644). IEEE. https://ieeexplore.ieee.org/abstract/document/9163501

[16] EIRA: https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/solution/eira/release/v500

[17] ELIS: https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/elis/elis-dashboard

- **Legal Interoperability**
  GraphQL is not a European Standard. The specification was originally created by Facebook. In 2015 it became open and it is now supported by its own community in GraphQL Foundation.

- **Organisational interoperability**
  The specification actively promotes and supports comprehensibility of data models, easing the modelling of business processes. With GraphQL, the business domain can be modelled as a graph by defining a schema; within the schema, it defines different types of nodes and how they connect/relate to one another.

- **Semantic Interoperability**
  The GraphQL specification community is public and is available on the GraphQL Working Group (GitHub), as well as in other platforms such as Discrod[18]. Everyone can join and contribute, encouraging the creation of national and international communities and contributors.

[18] GraphQL Discord: https://discord.com/invite/xud7bH9

3. ASSESSMENT RESULTS

This section presents an overview of the results of the CAMSS assessments for **GraphQL**. The CAMSS "Strength" indicator measures the reliability of the assessment by calculating the number of answered (applicable) criteria. On the other hand, the number of favourable answers and the number of unfavourable ones is used to calculate the "Automated Score" per category and an "Overall Score".

Category	Automated Score	Assessment Strength	Compliance Level
Principle setting the context for EU actions on interoperability	20/100 (20%)	100%	Ad-hoc
Core interoperability principles	1580/1700 (93%)	100%	Seamless
Principles related to generic user needs and expectations	820/1200 (68%)	67%	Sustainable
Foundation principles for cooperation among public administrations	440/500 (88%)	100%	Seamless
Interoperability layers*	660/1000 (66%)	100%	Sustainable
Overall Score	3120/4100 (76%)[19]	91%	

**The technical interoperability layer is covered by the criteria corresponding to the core interoperability principle ''Openness''.*

With an 91% of assessment strength, this assessment can be considered representative of the specification compliance with the EIF principles and recommendations.

The Overall Automated Score of 76% (3120/4100) demonstrates that the specification supports the European Interoperability Framework in the domains where it applies.

[19] See the "results interpretation" section of the CAMSS Assessment EIF Scenario Quick User Guide:

https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/camss-assessment-eif-scenario/results-visualisation-and-interpretation