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Converters – why are they necessary?

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Abstract	The DC4EU project is creating converters that convert known data models into the European Learning Model (ELM). In addition to a technical description of the use of each converter, this document is intended to provide a higher-level overview.
Keywords	Converter ELMO OpenBages Microcredentials

Document Revision History

Version	Date	Description of change	List of contributor(s)
V0.1	30.08.2024	Initial version	Helmut Nehrenheim, Guido Bacharach
V0.2	23.10.2024	9-Points guide included	Helmut Nehrenheim, based on discussion in the group
V0.3	31-10-2024	Added microcredential text	Pär Hansson
V0.4	21.02.2025	Example of usage	Helmut Nehrenheim

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Nature of the deliverable:	**R**	
Dissemination Level		
PU	Public, fully open, e.g. web	X
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CO	Confidential to DC4EU project and Commission Services	

** R: Document, report (excluding the periodic and final reports)*

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc.

Content

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1. INTRODUCTION

There are currently different data models in Europe that describe digital certificates in the European education domain. There are also different ways in which pupils or students receive their certificates. The aim of DC4EU is to transport these certificates digitally to the newly created EU Digital Identity Wallet (EUDIW) and store them as an electronic attestation of attributed (EAA). Under the control of the holder of the EUDIW (pupils or students) these EAA can be used in subsequent processes.

To avoid the EUDIW having to support the different data models, the data format European Learning Model (ELM) [1] in the current version 3.2, will be used. It is therefore necessary to develop and provide appropriate converters that convert the source data formats - the currently known formats are ELMO/EMREX, OpenBadges and MicroCredentials - into ELM, until the issuing entities are able to get in touch directly with the EUDIW.

Furthermore, it seems necessary to consider the individual national data models and implement a converter to ELM for them as well.

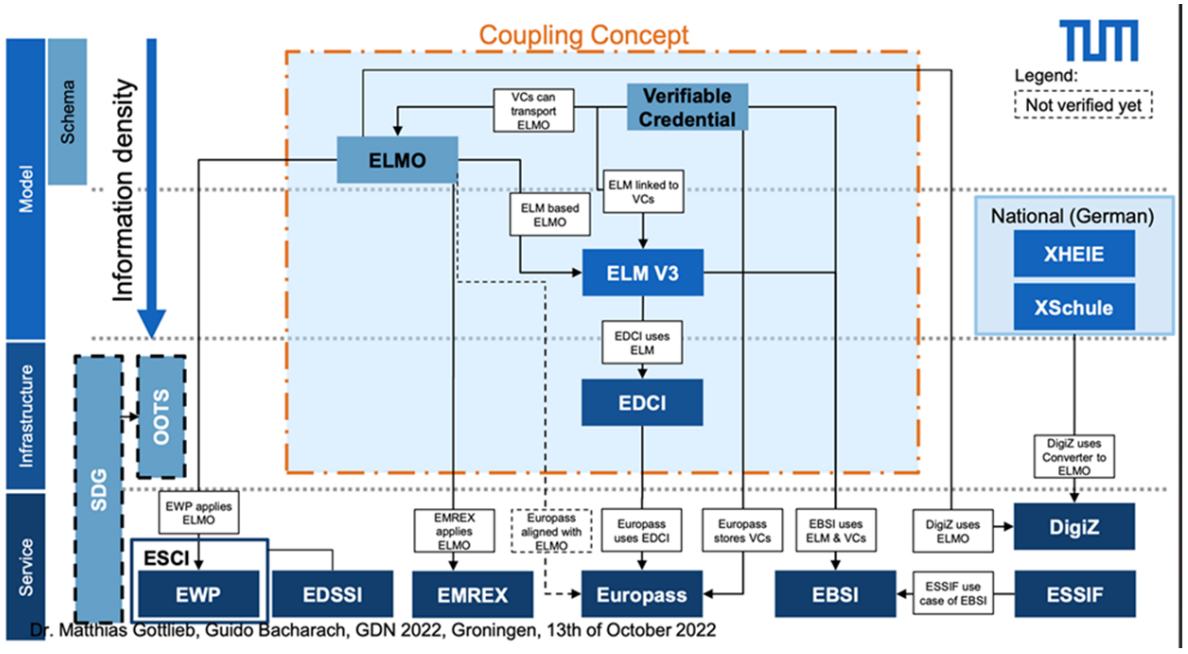

FIGURE 1 - INTEROPMATRIX

[1] https://europass.europa.eu/de/news/launch-european-learning-model

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The converters should also support use cases with which ELM data is converted into other formats (ELMO/EMREX, Open Badges, Microcredential, national formats). In this way, extensive interoperability between different formats and infrastructures can be guaranteed.

This document describes at a high level the converters in the education domain that are developed in DC4EU. Detailed information regarding the usage of the converters (API) are provided online via OpenAPI.

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2. BACKGROUND

A certificate in the education domain (and of course in others as well) can be divided into two main logical parts:

- Non educational part (type, signature, seal, …)
- educational part (credentialSubject)

The converters mainly focus on the credentialSubject part and the semantic of the content.

The issuing of a EAA to the EUDIW including signing and sealing must be considered separately, as it has to be done by a legal entity or an entity on behalf of a legal entity. Therefore, the converters provide an Application Programming Interface (API) to be included in process-chains.

The responsible task-leaders consider it useful to develop the three converters to be offered by the DC4EU project in the same way at certain points (technically and semantically) and thus provide users with similar functionality and, where possible, similar interfaces.

COMMON FOUNDATIONS:

- The development of converters and architectural solutions will be aligned with established trust frameworks and governance models.
- The development of converters and architectural solutions will take into account integration with the EUDIW.
- The development of converters and architectural solutions will also take into account the implementation of Verifiable Credentials (VCs) and Decentralized Identifiers (DIDs).

Although this document is not intended to go into too much technical detail, the most important topics of VC and DID are described in the next chapter. After that each converter describes some details necessary to understand the goal of their development.

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3. GUIDE FOR THE ADOPTION AND USE OF CONVERTERS

Within the DC4EU project, converters will be developed to ensure seamless interoperability between different educational credential formats (e.g. such as OpenBadges, ELM, ELMO and Microcredential). To ensure their success, the community must not only focus on developing the code but also on a holistic strategy to guarantee widespread adoption and efficacy.

This chapter outlines the actions and elements necessary for ensuring that converters developed by DC4EU are both useful and widely adopted by educational institutions and other stakeholders. The focus is to provide practical steps that enable a smooth transition and long-term engagement. Adopting these actions will ensure that the converters developed within DC4EU are not only technically sound but also practical and widely used across the educational sector in Europe. By focusing on documentation, real-life examples, training, compliance, and ongoing support, the DC4EU community can ensure long-term success in advancing digital credentials and interoperability across Europe.

1. Collaborative Development
   - Involve stakeholders from the start: Establish working groups composed of educational institutions, technical teams, and regulatory bodies to provide iterative feedback throughout the development process.
   - Benefit: Ensures that converters meet real-world needs and can be smoothly integrated into existing workflows.
   - Action: feedback from DC4EU WP5 Task 2 and the piloting-agents are very welcome.
2. Document Data Models
   - Develop comprehensive documentation: Clearly define both source (e.g., OpenBadges, ELMO, Microcredentials) and target data models (e.g., ELM), mapping fields and attributes for accurate conversion.
   - Benefit: Helps developers and implementers understand how the conversion process works, ensuring data accuracy and compatibility.
   - Action: Provide semantic mapping guides that clarify how credentials, certificates, and metadata are transformed. The mapping will be done, for example, by providing an Excel file.
3. Provide Use Cases and Case Studies
   - Create illustrative examples: Develop case studies based on pilot implementations at different types of institutions (e.g., higher education, vocational schools).
   - Benefit: Demonstrates practical application, helping other institutions envision how they could use the converters.
   - Action: Ensure that the examples cover both simple and complex scenarios of integration. feedback from DC4EU WP5 Task 2 and the piloting-agents are very welcome. Converter-Family will not provide real UC/CS.

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4. Piloting and Validation
   - Run pilot programmes: Conduct pilots in diverse institutional environments, ensuring converters perform in various real-world contexts (legacy systems, new digital infrastructure).
   - Benefit: Identifies potential issues early and builds confidence in the solution.
   - Action: Document the results of the pilots and share lessons learned with the broader DC4EU community. we will support DC4EU WP5 Task 2 and the piloting-agents.
5. Training and Capacity Building
   - Offer training workshops: Organise workshops for IT teams and institutional staff to familiarise them with the tools, data models, and integration methods.
   - Benefit: Ensures the technical teams understand how to implement and maintain the converters.
   - Action: Create detailed documentation and hands-on guides for various skill levels.
6. Interoperability Testing
   - Implement rigorous testing frameworks: Set up testing environments where converters are evaluated for compatibility across systems and countries.
   - Benefit: Ensures data integrity and smooth credential exchange, which is essential for widespread adoption.
   - Action: Provide pretests that institutions can run to verify that their systems work with the converters. This includes only module-tests but not the whole workflow.
7. Legal and Compliance Frameworks
   - Ensure compliance with EU regulations: Converters must comply with eIDAS, GDPR, and other relevant standards, including verifiable credentials and digital signatures.
   - Benefit: Builds trust with institutions concerned about legal requirements and data protection.
   - Action: Publish legal guidelines and ensure converters have built-in support for compliance measures. The certificates to be converted contain personal data. The development of the converters takes into account that no personal data needs to be stored permanently. Personal data will only be transferred between the calling entity and the converter and vice versa. If temporary conversion data is created during the conversion, it will be deleted when it is no longer needed. The documentation for the converter operators explicitly points this out, especially if the operators are responsible for deleting the temporary files created by the converters themselves.
8. Community and Support Structures
   - Establish community forums: Create spaces where institutions and developers can exchange knowledge, share experiences, and troubleshoot issues collectively.
   - Benefit: Encourages peer learning and continuous improvement of the tools.
   - Action: Develop an online platform for documentation, updates, and community discussions. A funding-structure that will enable us to continue our efforts beyond DC4EU is needed.

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9. Regular Updates and Maintenance
   - Maintain converters post-launch: Ensure there are regular updates to adapt to evolving standards and technological changes (e.g., new versions of ELM, OpenBadges, etc.).
   - Benefit: Keeps the converters functional and relevant as the digital landscape evolves.
   - Action: Provide a roadmap for future updates and a support team to address immediate issues. A funding-structure that will enable us to continue our efforts beyond DC4EU is needed.

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5. VERIFIABLE CREDENTIALS AND DECENTRALIZED IDENTIFIERS

Verifiable Credentials (VCs) and Decentralized Identifiers (DIDs) are fundamental technologies underpinning the new paradigm of digital identity and credentials. These technologies, developed by the World Wide Web Consortium (W3C), provide the foundation for secure, verifiable, and privacy-preserving digital interactions.

KEY COMPONENTS OF VCS

- Metadata: Information about the credential itself, such as the issuer and expiration date.
- Claims: Statements about the subject (e.g., name, qualification, or achievement).
- Proofs: Cryptographic proof of the credential's authenticity and integrity.

VC DATA MODEL

The VC Data Model, as defined by W3C, consists of:

- Context: Provides semantic clarity for the credential.
- Identifier: A unique identifier for the credential.
- Type: Describes the nature of the credential.
- Issuer: Identifies the entity that issued the credential.
- Issuance date: The date the credential was issued.
- Credential subject: Contains the claims about the subject.
- Proof: Cryptographic proof of the credential's integrity.

BENEFITS OF VCS IN EDUCATION

- Enhanced security and trust in digital credentials.
- Improved interoperability between different educational systems.
- Support for lifelong learning through easily verifiable and shareable achievements.
- Reduced administrative burden in credential verification processes.

DECENTRALIZED IDENTIFIERS (DIDS)

- Definition and purpose

  Decentralized Identifiers are a new type of identifier that enables verifiable, decentralized digital identity. DIDs are designed to be independent of centralized registries, identity providers, or certificate authorities.

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BENEFITS OF DIDS IN EDUCATION

- Enhanced privacy and control over personal data for students and professionals.
- Improved security in identity verification processes.
- Support for seamless cross-border recognition of identities and credentials.
- Reduced reliance on centralized identity providers.

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6. ELMO

As described above the ELMO2ELM converter will semantically convert a source-data model into a target-data model. The prerequisite is that both data models must be convertible following a defined set of rules.

We define “semantical conversion” as the conversion of semantical elements from one data structure (ELMO or ELM) into the other. The converter will have as input and as output only plain-text in the target format.

We will provide a conversion between ELMO XML and ELM-JSON-LD-Format (in both directions) and will be prepared to other requests. A conversion to/from ELM 3 (JSON-LD) to ELM XML is not in scope.

As already described, not in the scope are conversion of:

- VC ID elements like DIDs,
- Proofs,
- Context elements

Identification of the subject of the original certificate will be assured externally.

We will provide at least a documentation for each schema containing the required fields (minimum set) to avoid errors and a description of the return-codes and messages (What is the problem? What should the user do? …). The schema-owners are expected to provide a full documentation.

State of the art/status quo

- **ELMO**
  - The current version of ELMO is the version 1.7. A Preview of a version 2.0 exists. ELMO 1.7 is semantically 100% equivalent to ELM Version 3. As far as we understand this also works for ELMO version 2.0.
- **ELM**
  - The current version of ELM is the version 3.2.
- **ELM & EDCI**
  - ELM is the data model supported by EDCI.
  - EDC 2.3/2.4 supports ELM 3.2.
- **ELM & EBSI**
  - EBSI supports ELM V3.2.

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In a first version the converter will support a conversion

ELMO to ELM

- A table to map the elements of ELMO 1.7 to ELM Version 3 exists. Therefore, in first step it is planned to convert ELMO files in the version 1.7 to ELM files in the version 3.2.
- Optionally it can be checked whether ELMO version 2.0 is also compliant to ELM version 3.

ELM to ELMO

- Since ELM is more powerful in its quantity we have to define a subset of ELM that defines an ELMO schema. Means a schema containing that fields that exists in ELM and ELMO and therefore can be converted. It must be made clear that a conversion ELM to ELMO is only possible within that subset/schema. Presumably this means there could be data loss, unless we bundle the source payload in the target (ELM as attachment of ELMO). This will be kept as optional requirement.

Additional conversions are planned as nice to have (not in the scope of the project mandatorily), e.g.

XBildung (German-Standard) to ELM

- Until now in Xbildung there are only XML-standards for some kinds of university certificates and two primary/secondary school certificates (change of school and upper secondary school certificate) existing.
- It is not clear how far Xbildung and ELM are compliant. It is very likely that both standards will be subsets of each other.

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7. OPENBADGES

An open badge is a digital record of achievement—a verifiable credential that describes specific skills demonstrated by an individual and often includes actual evidence used to evaluate the individual's achievement. Open Badges are a special type of digital badge based on adherence to the 1EdTech Open Badges technical standard, which contains not only a visual image but a set of rich metadata embedded directly inside the image file itself. A broader ecosystem of technology services has emerged based on the Open Badges standard, allowing learners to move their badges into and out of various platforms over time. The Open Badges standard supports the learner's ability to take control of their credential by saving it and sharing it with whom the learner chooses.

The current public version of the standard, Open Badges 2.0 (OBv2), and its companion OBv2.1, offer robust and reliable functionality to users in the education and employment marketplace with skills metadata, verifiable authenticity and quality, and learner control of their personal achievement records. OBv2.1 BadgeConnect is an open API standard that supports learning mobility by allowing learners to move their credentials to systems of their choice. BadgeConnect is an essential element of interoperability.

The latest version of the standard, Open Badges 3.0 (OBv3), offers the benefits of OBv2, and includes enhanced features, such as layers of cryptographic proof that can provide security and privacy, alignment with the W3C Verifiable Credential Data standard, aligned with the Comprehensive Learning Record 2.0 standard, and supports a native API to allow for learning mobility.

Since both OBv3 and Digital European Credentials adhere to the broader Verifiable Credentials specification, it could prove advantageous to combine efforts. Adding an ELM/EDC object would allow for easy mapping and a more generic serialization and deserialization method.

Ideally the solution is based on existing tools, SDKs, and (ontology) languages to reduce the amount of rework and potentially foster open source adaptation. As a starting point the following projects have been identified:

- Project Cambria
- Grafana's Thema
- The Data Ecosystem Mapping (DESM) tool from T3 Innovation Network
- and the Web Ontology Language (OWL) as well as its ecosystem of SDKs and solutions.

The scope of this converter-project is to develop an SDK to translate between OBv3 credentials and ELM credentials bi-directionally.

- The SDK provided MUST fit within the current SURF EduBadges platform and MUST be able to incorporate into the solution currently being built with the DC4EU consortium.

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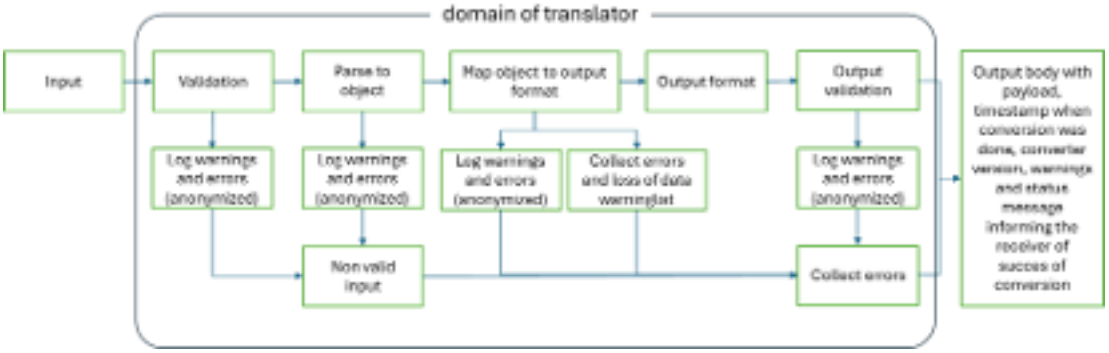
- The architectural decisions and usage of existing tools, solutions and SDKs MUST be both documented and presented to SURF.
- The solution SHOULD take into account future maintainability and extensibility for additional credential data models

The SDK MUST enable the following user stories:

- A user of the SDK can translate an OBv3 credential to an ELM credential bi-directionally through a Command Line Interface (CLI).
- As a result of the translation, the user of the SDK will be able to receive feedback on which mappings are incomplete (lacuna), have other types of errors based on the error flow in figure 1. This feedback is configurable and MUST support multi-language support for the languages used in the DC4EU consortium.
- The user of the SDK can create, update and maintain mappings in order to resolve the lacuna of a translation automatically.
- The SDK SHOULD enable the following user stories:
- A developer is able to extend the SDK with an additional credential data model by providing the sufficient mapping files

The SDK must be developed as Open Source and made available to the general public.



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8. MICROCREDENTIALS

EU countries implemented free border polices therefore a lot of students are seeking higher education from other EU countries, professionals are migrating for better opportunities and even online learning models (opportunities) are becoming popular to enhance skills. Therefore, there is a need for portable, validated, secure, and verifiable digital credentials. At the EU level, they realized that individuals have the right to acquire, update and improve the knowledge, skills and competences they need to meet the requirements of the evolving labour market and society. On the other hand, EU is also building infrastructure for providers to enhance the quality, transparency, and flexibility of their learning offer to empower individuals to enhance their personalized learning and career pathways. EBSI, EDCI are few of them.

The EU has published a Council Recommendation2 on a European approach to micro-credentials which includes a short list of required and optional standard elements to describe micro-credentials. Hence, as of this writing, there is not yet an officially adopted standard. Europass has published documentation on ELM to micro credential mapping, which this converter has aligned with3.

Micro-credentials also feature in the European Pillar of Social Rights Action Plan4 and the Commission Communication on achieving the European Education Area by 20255.

This converter will, using the GovPart software framework, enable semantically converting a source-data model into a target-data model, using JSON-LD-Format (in both directions). As this framework supports ELM and ELMO, conversion to/from these formats are supported.

As already described, not in the scope are conversion of:

- VC ID elements like DIDs,

[2] https://education.ec.europa.eu/education-levels/higher-education/micro-credentials

[3] https://europass.europa.eu/system/files/2024-05/MC-Mapping.pdf

[4] https://op.europa.eu/webpub/empl/european-pillar-of-social-rights/en/

[5] https://education.ec.europa.eu/document/achieving-the-european-education-area-by-2025-communication?

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- Proofs,
- Context elements

Identification of the subject of the original certificate will be assured externally.

We will provide at least a documentation for mapping at least the required fields to the ELM data model.

STATE OF THE ART/STATUS QUO

- **ELM**

  The current version of ELM is the version 3.2.

- **EU GUIDELINES FOR MICROCREDENTIALS**

  On 16 June 2022, the Council of the European Union (EU) adopted a Recommendation on a European approach to micro-credentials for lifelong learning and employability. The Recommendation seeks to support the development, implementation and recognition of micro-credentials across institutions, businesses, sectors and borders.

- **EUROPASS MICROCREDENTIAL DEFINITION**

  Europass team presented a mapping document to map the ELM-attribute to the EU-guidelines. This foundation for the extension of the RISE defined Microcredential.

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9. EXAMPLES OF USAGE

We have created a demo website (https://converters.dc4eu.eu) that allows you to upload files in the different certificate formats and to download the corresponding converted result. **Please note that no production data may be used here, as this is only an example application.** The converters offer a web service interface that is basically the same for all three converters and is used internally by the website mentioned above. The parameters are in JSON-Format. The following examples are intended only to provide a rough overview and are not meant to be a detailed description (the “content”-field contains the base64-encoded file to be converted; the content is presented in a reduced form for reasons of readability). The result is also a base64-encoded representation of the converted file.

a. ELMO2ELM

```
curl -L 'http://localhost:8080/rest/request' -H 'Content-Type:
application/json' -d '{
    "From": {"Name": "elmo", "Version": "1.7"},
    "To": {"Name": "elm", "Version": "3.2"},
    "Parameters": {"PreferredLanguages": ["en", "sv"]},
    "Content":
      "eyAgIkBjb250ZXh0IjogWwogICAgImh0dHBzOi8vd3d3LnczLm9
      ……
      wZSI6ICJDb25jZXB0U2NoZW1lIgogICAgICB9CiAgICB9CiAg"}'
```

b. OpenBadges

```
curl -L 'http://localhost:8080/rest/request' -H 'Content-Type:
application/json' -d '{
    "From": {"Name": "OB", "Version": "3.0"},
    "To": {"Name": "elm", "Version": "3.2"},
    "Parameters": {"PreferredLanguages": ["en", "sv"]},
    "Content":
      "eyAgIkBjb250ZXh0IjogWwogICAgImh0dHBzOi8vd3d3LnczLm9
      ……
      wZSI6ICJDb25jZXB0U2NoZW1lIgogICAgICB9CiAgICB9CiAg"}'
```

c. Microcredentials

```
curl -L 'http://localhost:8080/rest/request' -H 'Content-Type:
application/json' -d '{
    "From": {"Name": "mc", "Version": "1.0"},
    "To": {"Name": "elm", "Version": "3.2"},
    "Parameters": {"PreferredLanguages": ["en", "sv"]},
    "Content":
      "eyAgIkBjb250ZXh0IjogWwogICAgImh0dHBzOi8vd3d3LnczLm9
      ……
      wZSI6ICJDb25jZXB0U2NoZW1lIgogICAgICB9CiAgICB9CiAg"}'
```

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