Semantics in the wild: a digital assistant for Flemish citizens

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ABSTRACT[1]

Public service fragmentation across more than 800 digital channels of government administrations in the region of Flanders (Belgium), causes administrative burden and frustrations, as citizens expect a coherent service. Given the autonomy of the various entities, the fragmentation of information and budget constraints, it is not feasible to rewire the entire e-gov ecosystem to a single portal. Therefore, the Flemish Government is building a smart digital assistant, which supports citizens on the governmental portals, by integrating status information of various transactions. This paper outlines our ongoing research on a method for raising semantic interoperability between different information systems and actors. In this approach, semantic agreements are maintained and implemented end-to-end using the design principles of Linked Data. The lessons learned can speed-up the process in other countries that face the complexity of integrating e-government portals.

CCS CONCEPTS

• **General and reference~Computing standards, RFCs and guidelines** • *Applied computing~E-government*

KEYWORDS

Public Administration; Interoperability; e-Government; Linked Data, RDF; Vocabulary

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1 INTRODUCTION

Citizens expect an integrated customer experience from their government as they became accustomed to by electronic commerce services in the private sector [11]. Integrating public services from a citizen's point of view - even when these services are provided by different departments or authorities – is researched intensely and is often referred to as a 'one-stop government' [24, 21, 13, 22]. However, one-stop shop governments that integrate different services are scarce [19] and mostly stuck in vague visions [1]. The ambition of the Flemish Regional Government in Belgium is to digitize all interactions from public authorities to citizens and businesses by 2020 [23]. Belgium is a federal country with three communities, three regions, and four language areas. Public services in Flanders are fragmented across federal administrations, over 500 portals of regional administrations [10] and 308 municipalities, the latter having at least one portal. The portals have several authentication methods, specific citizen profiles and a different 'feel' (layout and portal-flow). This entails that citizens have to follow-up and coordinate the public services on different portals which cause frustrations. Moreover, administrations often request information the government already has, which is in conflict with the 'once-only' principle [2] . Because of the autonomy of Flemish municipalities, the autonomy of the regional public sector agencies [17] and budget constraints, it is not feasible to rewire the entire ecosystem to a single portal. Therefore, via the program 'Flanders Radically Digital'[3], the Flemish Information Agency is building a smart digital assistant, which will support citizens on the governmental portals of the regional and local administrations. The Smart Digital Assistant gives citizens an integrated customer experience, by providing a single-sign-on, a single profile with preferences and an overview of all interactions with the government, regardless of the portals citizens have used. On top of this, citizens have an insight into the information that the government is using in public services, which increases transparency. By integrating a smart component at the top of the government portals in Flanders, citizens have a recognizable entry point. The component, which behaves similarly to a widget, provides citizens access to their personal information, all open transactions and notifications regarding public services (see section 2). When consulting the status of a service, the citizen is provided with a link to a more specialized back-office application of the administration which handles the specific public service. In order to integrate the information systems of the different administrations with the digital assistant, they need to be interoperable.

Interoperability is the ability of organizations to share information and knowledge, through the business processes they support, by means of the exchange of data between their ICT systems [8]. According to the European Interoperability Framework [6] multiple interoperability levels need to be addressed; namely on the legal, organizational, semantic and technical level. Because these levels assume a hierarchy in terms of maturity [12], the primary focus of this paper is on the technical and semantic level.

This article researches how we can raise interoperability in an operational context, by supporting business analysts and developers in their complex design decisions to maintain semantic agreements. We focus on how information models can be aligned with existing standards and how to detect and resolve discrepancies. We outline a method for designing standardized programmable Web interfaces, which maintain the semantic agreements. As such, we address the following question: *'How to develop a scalable technique for raising and maintaining semantic and technical interoperability, within an operational public sector context?'*.

First we will provide an overview of the main concepts and outline the importance of interoperability. Next, section 2 will describe the digital assistant in-depth, followed by a description of the critical success factors, challenges encountered and how they were addressed. In section 3, we will discuss the method for raising and maintaining semantic and technical interoperability. After a short discussion in section 4, this paper ends with conclusions and future work.

2 BACKGROUND

2.1 Strategy

Belgium is a federal state with three communities, three regions, and four language areas. The Federal State, the Communities and the Regions are at the top level and equal from a legal viewpoint[4]. Flanders is the northern federated state of Belgium [5] and an umbrella term for the Flemish Region and the Flemish Community. At bottom level are the municipalities, which are closest to the citizen. The different governmental levels are responsible for different policy domains, which causes fragmentation of the public services.

Figure 1: The front-end design of the Digital Assistant, including the citizen's preferences, access to personal information, active public services and notifications [15].

[2] https://joinup.ec.europa.eu/community/once-only-principle/home
[3] https://overheid.vlaanderen.be/informatie-vlaanderen/radicaal-digitaal
[4] https://www.belgium.be/en/about_belgium/government/federale_staat/
[5] https://www.vlaanderen.be/en/discover-flanders

The Digital Assistant aims to facilitate a one-stop government in Flanders by creating an integrated user experience. Due to the autonomy of the various entities, the fragmentation of information and budget constraints, the Flemish government did not opt to develop a single entry point which integrates all services in a central portal (single window) but opted for the concept of a virtual window by integrating a smart assistant in the header of each portal, as illustrated in Figure 1. These efforts are a first step in a strategy towards proactive public services where citizens do not have to take any action to receive a government service, often referred to as a no-stop-shop [18]. Qualitative research with citizens in Flanders in 2016, conducted in the context of the Digital Assistant, identified three main user requirements; (1) an overview of all interactions with the government, by means of status information and notifications, (2) an insight into the information the government maintains and the ability to reuse this information and (3) personalized support. A non-functional requirement was the request to create a more uniform layout on all government portals.

2.2 Building blocks

These findings led to the development and integration of following generic building blocks:

3.1.1 Single Sign-On (SSO): this building-block allows the citizen to authenticate once and be logged in to all government portals without further manual interaction [16]. The required authentication method depends on whether the citizen is using services that process privacy-sensitive information, the latter requiring substantial authentication. The European security standard[6] (eIDAS) defines a substantial degree of confidence in the claimed or asserted identity of a person to substantially decrease the risk of misuse or alteration of the identity[7].

3.1.2 Citizen profile: the citizen can manage preferences, including how he/she wants government administrations to interact regarding specific public services.

3.1.3 My Data: citizens can consult personal information that governments use in public services (once-only principle) and maintain in their authoritative information sources. This allows citizens to retrieve and consult information about their properties such as houses and land, learning certificates, and family situation

3.1.4 Feedback loop: when citizens discover mistakes in the information they can give feedback, which is automatically dispatched to the responsible party.

3.1.5 Status information: the dashboard allows the user to consult the status of all interactions with the government. This overview contains also deep links to a more specialized back-office application of the administration which handles the specific public services.

3.1.6 Notifications: if the status of public service changes or a government administration wants to interact with a citizen, the notifications are sent via the preferred channel.

3.1.7 Contextual support: this building block brings the user in contact with the responsible government administration, including online help, chat with the helpdesk or support via telephone.

3 Method

3.1 Critical success factors and challenges

In order to integrate the information systems of the different administrations with the building blocks of the digital assistant, they need to be interoperable.

The primary focus of this paper is to raise interoperability on the technical and semantic level. The Flemish Government has an interoperability program called Open Standards for Linked Organizations (OSLO) [2]. OSLO brings together expertise from the public and private sector and delivers context-neutral vocabularies, in line with international information standards [3]. The specifications are published at data.vlaanderen.be[8]. Until today, the OSLO-vocabularies were mainly applied to publish authoritative data sources, such as the base registry for addresses in Flanders. Since the semantics of the vocabulary terms are defined, the services implementing these vocabularies are self-describing. This supports exploration of information by automated agents and human users, which helps the latter by introducing a consistent lexicon across government administrations. In the case of the Digital Assistant, the integration services have to support use-cases for the interaction with end-users on various platforms and integration with the back-office systems of the different government bodies. The services exchange both authoritative data and other information which merely supports the use-cases and has no formal semantic agreements or schema. The requirements for the services are: (a) to make the authoritative data self-describing and (b) to focus on ease-of-use in order to speed-up the adoption. by public administrations that focus on citizen-centric public services.

3.2 Towards machine-readable information

The data specification process in Flanders follows a transparent process.

The semantic agreements are traceable and aligned to match the different stakeholders: policy makers, domain experts, analysts and developers (see Figure 2).

3.2.1 Domain specialists: the semantic agreements are reached in open thematic working groups which consist of domain experts, both from the public and private sector. This approach is inspired by best practices of the European Commission [9]. The information-modelling follows a transparent process: all records of decisions[9], discussions[10] an models are publicly accessible, the latter is documented using the Unified Modelling Language™[11] (UML) [3] (see Figure 2: conceptual data model).

[6] https://www.eid.as/home/
[7] http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014R0910
[8] http://data.vlaanderen.be/ns/
[9] https://informatievlaanderen.github.io/OSLO/
[10] https://github.com/Informatievlaanderen/OSLO/issues
[11] http://www.omg.org/spec/UML/

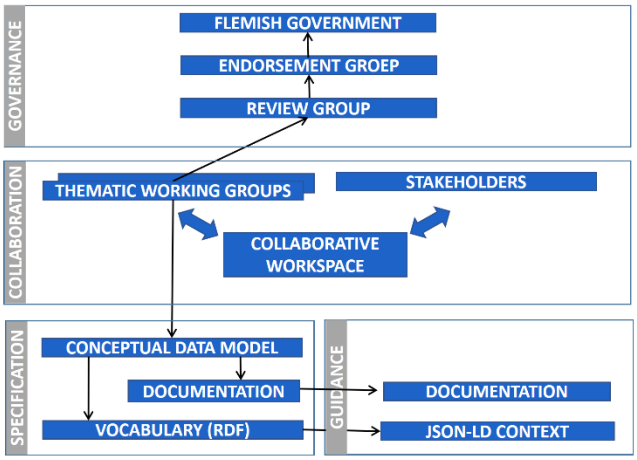

Figure 2: An overview of how the semantic agreements are preserved and documented to match the different stakeholders.

3.2.2 Analysts: because of its extensibility and for being a standard for data interchange on the web, the Flemish Information Agency has chosen the Resource Description Framework[12] (RDF) as a data model and the principles of Linked Data for exchanging data. The UML information-model is mapped on properties of existing (international) vocabularies and transformed [13] to a RDF-vocabulary (see Figure 2: vocabulary), which is the core of the formal data specification. This specification is then transformed into a formal specification, which adds additional constraints including mandatory properties and constraints on relations.

3.3.3. Policy makers: After a public review and a review by the OSLO-review group, the formal specification is ratified by the endorsement group (see Figure 2: endorsement group). The endorsement group is empowered by a decree[14] and referred to as 'steering committee of Flemish Information and ICT-policy'. This means that these ratified formal specifications require mandatory implementation.

3.3.4 Developers: the Flemish Information Agency is building upon the principles of Linked Data, to allow data to be exposed and shared across different applications. Linked Data refers to a set of best practices for publishing and connecting structured data on the Web using international standards of the World Wide Web Consortium" [25]. In line with the design principles[15] as asserted by Tim Berners-Lee in 2006, all the information objects are given a universally unique identifier which can be looked up via the web; for example http://data.vlaanderen.be/id/adres/2179183 for an address. When a person or machine navigates to this identifier (URI) on the web, standardized information is provided, using RDF as a data model. In addition, links to other useful datasets and resources are included. This strategy is already used for publishing authoritative data sources in Flanders, including addresses[16] and organizations[17]. Although RDF is a simple data model, a lot of developers are overwhelmed by the (perceived) complexity [14]. Therefore we have applied a developer friendly approach by using JSON-LD, which is based on linked data but also complies with the requirements of the digital assistant, namely to make the authoritative data self-describing and to focus on ease-of-use in order to speed-up the adoption. JSON-LD is used by hundreds of millions of applications; most often without the knowledge of the application users [14]. Another advantage is that this method allows combining self-describing data linked to an RDF-schema with other information which has no formal semantic agreements. The information that is under the governance of OSLO is linked to the vocabularies using a JSON-LD context[18], which allows embedding the semantic agreements in JSON services. The identifiers of the governed information objects are dereferenceable and allow integrators to discover more about the authoritative reference data. The context file (see Figure 2: JSON-LD context), which bridges the semantics of the interface to the vocabulary is maintained and published by the authority. In section 3.4 we will discuss the implementation of JSON-LD.

3.2 Unpacking the harmonization process

This section describes how the information models of the Digital Assistant are aligned with existing OSLO vocabularies and how they are inspired by the best practices of the Interoperability program of the European Commission [7] and the World Wide Web Consortium[19].

3.2.1 Development of the conceptual data model. A first step in the development of semantic agreements is the use-case modelling, which describes a specific usage of a system by one or more actors [5]. A second step is the design of a conceptual data model in UML, which is the most abstract form of a data model. It consists of UML Classes and their definitions, which represent things that exist in the real world (e.g. a person), and their associations and properties (e.g. a relation to family members).

3.2.2 Mapping of the information model to existing vocabularies. The goal of this step is to identify whether there already are existing qualitative vocabularies, in order to raise interoperability. In addition, the reuse of existing analyses lowers the development costs.

3.2.3 Detection of possible discrepancies. The goal of this step is to document the semantic design decisions and to prepare the design of the data model. Table 1, which is based on a method[20] of the interoperability program of the European Commission, illustrates how one of the information models of the Digital Assistant is mapped to the OSLO vocabularies. The properties and associations are compared using the relations defined in the Simple Knowledge Organization System vocabulary [21] (SKOS). These relations are defined as (a) *closeMatch* indicates that the concepts can be used interchangeably across a wide range of

[12] https://www.w3.org/2001/sw/wiki/RDF
[13] https://github.com/Informatievlaanderen/OSLO-EA-to-RDF
[14] http://docs.vlaamsparlement.be/pfile?id=1213278
[15] https://www.w3.org/DesignIssues/LinkedData.html
[16] http://data.vlaanderen.be/id/adres/2179183
[17] http://data.vlaanderen.be/id/organisatie/OVO002949
[18] https://www.w3.org/TR/json-ld-syntax/#the-context
[19] https://www.w3.org
[20] http://mapping.semic.eu/
[21] https://www.w3.org/2009/08/skos-reference/skos.html

applications, (b) *relatedMatch* is used to link two concepts that are sufficiently similar that they can be used interchangeably in particular applications, (c, d) *broadMatch* and *narrowMatch* are used to state a hierarchical mapping link between two concepts and finally (d) *relatedMatch* is used to state an associative mapping link between two concepts.

Table 1: A subset of the vocabulary mapping, based on a method of the European interoperability program (ISA) (terms are translated [22] to English).

Digital Assistant "family relations."		*SKOS Relation*	*OSLO² Person vocabulary*	
Class	**Property**		**Class**	**Property**
Person	*name*	*Exact match*	*fullName*	*Person*
Person	*registry*	*Related match*	*citizenship*	*Person*
Person	*family members*	*Broad match*	*Has-Relation-With*	*Person*
Person	*Reference person*	*Narrow match*	*Family head*	*Person*
Person	*Administr a-tor*	*No match*		

3.2.4 Resolving the discrepancies. If a property does not have a corresponding term in an existing vocabulary, we need to assign a new globally unique name. A good starting point for finding existing terms are the Linked Open Vocabularies[23]. It is important to evaluate whether the definition of the term matches the correct context. To ensure these names are unambiguous they are identified by Unique Resource Identifiers (URIs), generalized versions of a URLs used to locate web pages via a browser. By using HTTP URIs, they provide a link to a description online. If the one cannot find an existing term, one needs to define a new one; this process is often referred to as minting URIs [25].

3.2.5 Development of the formal data specification

The vocabulary terms in the UML model are now mapped to the RDF vocabulary terms, as defined in section 3.2.2 and 3.2.3. The UML model along with the mappings are then automatically transformed[24] into an RDF model [4]. In addition, documentation for developers and business-analysts is automatically generated from the RDF-schema and enriched with contextual information.

3.3 Implementation

To comply both with the ease-of-use requirement and to make the authoritative data self-describing, we have based our approach on JSON-LD. JSON (JavaScript Object Notation) is a popular lightweight data-interchange format[25]. The disadvantage of JSON is that the services can only be documented in the human readable documentation, unlike Extensible Markup Language[26] (XML) based services that can be annotated with machine-readable descriptions by using the XML schema language[27]. JSON-LD allows to make JSON documents self-descriptive and allows developers to work with Linked Data without the high entry barrier [14]. Being fully compliant with the classic JSON, the Flemish Information Agency has decided to create a blend: the objects that are under the governance of OSLO are JSON-LD enabled, whereas the other information, which merely supports the use-cases, is in plain JSON integrated within the same document.

```
{
"@context": {
   "Organisatie":"http://www.w3.org/ns/org#Organization",
   "voorkeursNaam ": "http://www.w3.org/2004/02/skos/core#prefLabel",
   "alternatieveNaam ":"http://www.w3.org/2004/02/skos/core#altLabel"
 },
 "@id": "http://data.vlaanderen.be/id/organisatie/OVO002949",
 "@type": "Organisatie",
 "voorkeursNaam": "Informatie Vlaanderen",
 "alternatieveNaam": "AIV"
}
```

Figure 3: Code snippet of a JSON-LD object, which describes an organisation in the citizens portal.

When people communicate, the relation between linguistic expressions and what they express takes into account the context in which expressions are used and interpreted: "the context of the conversation" [20]. A context in JSON-LD affords information systems to communicate more efficiently by using shortcut terms, which can be compared as referring to the first name of a mutual friend, to communicate more quickly without losing accuracy[28]. The code snipped in Figure 3 describes the *organisation* "Informatie Vlaanderen" in the citizens portal. As outlined in section 3.2.4, dereferenceable URIs allow machines to browse the web of data, as humans browse the web of documents. The object *organisation* has a unique URI[29], which is governed by the Flemish Government[30]. The term *voorkeursNaam*, which is Dutch for *preferable name*, is associated[31] with the Object *organisation* which is the Dutch for an organization by using the JSON-LD context. The context maps the shortcut term *voorkeursNaam* to the URI '…/skos/core#prefLabel'[32], which provides a definition in line with international information standards. In the example in Fig. 3, the context is embedded in the JSON-document. In the services of the Digital Assistant, the context is pointing to an external document[33] and generated automatically from the formal specification, for reasons of maintainability.

[22] http://bit.ly/dig_assist_mapping_oslo
[23] http://lov.okfn.org/dataset/lov/
[24] https://github.com/Informatievlaanderen/OSLO-EA-to-RDF
[25] http://www.json.org/
[26] https://www.w3.org/XML/
[27] https://www.w3.org/XML/Schema
[28] https://json-ld.org/spec/latest/json-ld/#the-context
[29] http://data.vlaanderen.be/id/organisatie/OVO002949
[30] https://overheid.vlaanderen.be/OSLO-URI-standaard
[31] https://json-ld.org/spec/latest/json-ld/#dfn-expanded-term-definition
[32] http://www.w3.org/2004/02/skos/core#prefLabel
[33] http://data.vlaanderen.be/context/organisatie.jsonld

5 CONCLUSIONS AND FUTURE WORK

The aim to provide access to public services via a single entry point is researched intensely, but governments still struggle to realize a one-stop government. The Smart Digital Assistant gives the citizen an unified customer experience without the need for rewiring all existing portals to a single channel. Although this approach is based on lean integration, interoperability is crucial. In this paper, we proposed a method to raise interoperability on the technical and semantic level based on the architectural principles of Linked Data.

The method includes an implementation framework that describes how to make authoritative data self-describing. The semantic agreements are traceable and aligned to match the different stakeholders: policy makers, domain experts, analysts and developers. We showed that the Resource Description Framework (RDF) can facilitate the semantic agreements and that JSON-LD allows developers to work with Linked Data without a high entry barrier. Our framework can be used by countries that face the complexity of integrating e-government portals. Simultaneously, our work can benefit e-government integration projects as it provides an end-to-end governance, as well as practical insights on the design of lightweight services. New avenues for research are to add machine-readable validating rules to the formal data specification. The set of conditions will be formalized using the Shapes Constraint Language [34] (SHACL), which will allow creating automated compliance tests. We will research if the set of conditions can be generated semi-automatically.

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