Scalable Policy-awarE Linked Data arChitecture for prIvacy, trAnsparency and compLiance (SPECIAL)

Sabrina Kirrane, WU

Workshop on creating a common European data space in the transport sector

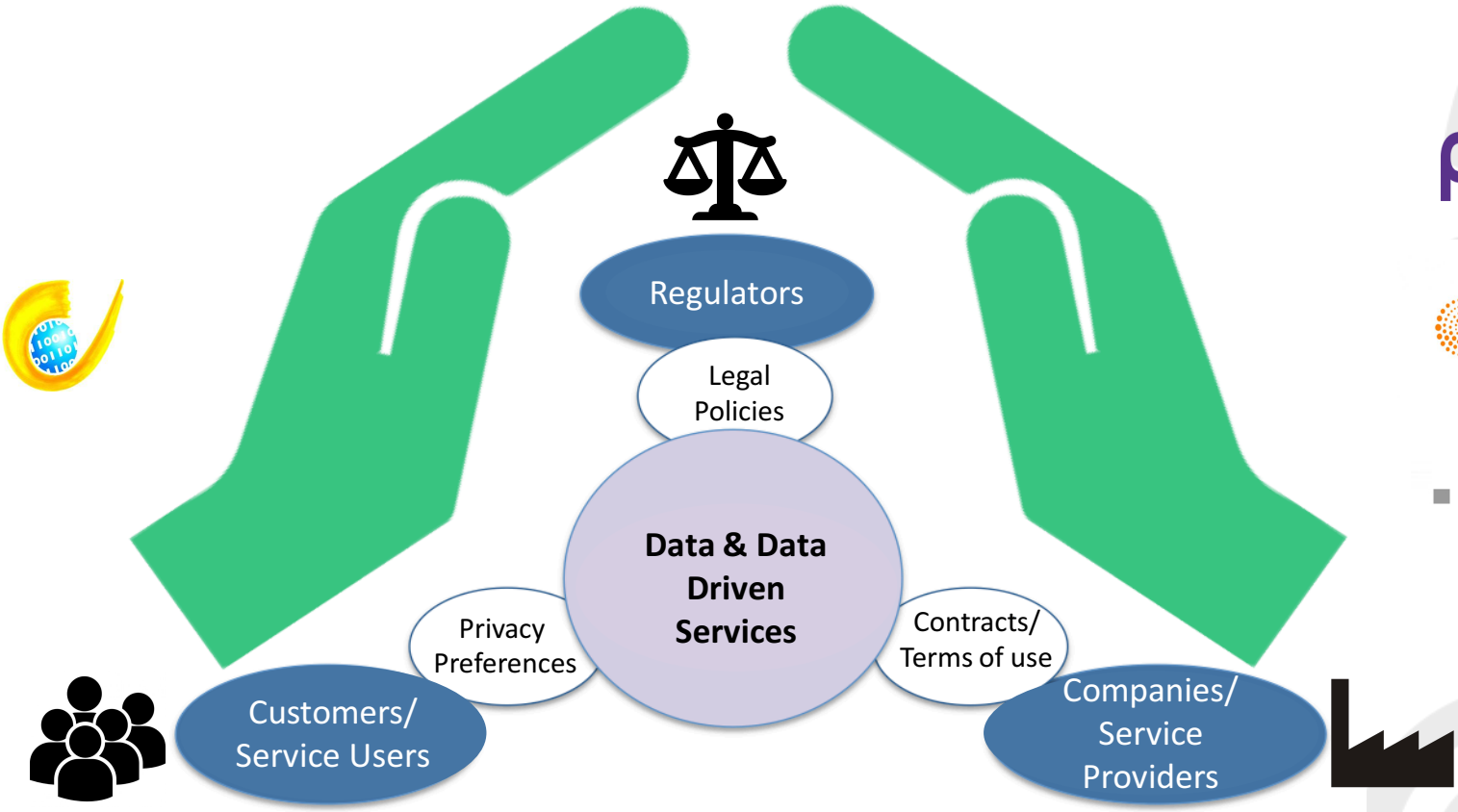
20th of September 2019

SPECIAL

European Commission

Horizon 2020
European Union funding
for Research & Innovation

SPECIAL Aims



Cyber-Physical Social Systems (CPSSs)
CitySpin Use Cases

Smart city infrastructures such as transportation and energy networks are evolving into so-called Cyber-Physical Social Systems (CPSSs) that collect and leverage citizens' data in order to adapt services to citizens' needs

- Scenario 1: A personalized mobility planning
- Scenario 2: Event partnership
- Scenario 3: A fully-fledged privacy dashboard
- Scenario 4: Decision support for WStW planners

User Consent Modeling for Ensuring Transparency and Compliance in Smart Cities, Javier D. Fern´andez, Marta Sabou, Sabrina Kirran,Elmar Kiesling, Fajar J. Ekaputra, Amr Azzam, Rigo Wenning, Personal and Ubiquitous Computing Journal (to appear)

The SPECIAL Usage policy language
Syntax and expressivity

The SPECIAL Usage Policy Language
version 0.1

SPECIAL

Unofficial Draft 06 April 2018

Editor:
Javier D. Fernández (Vienna University of Economics and Business)

Authors:
Piero Bonatti (Università di Napoli Federico II)
Sabrina Kirrane (Vienna University of Economics and
Iliana Mineva Petrova (Università di Napoli Federico I
Luigi Sauro (Università di Napoli Federico II)
Eva Schlehahn (Unabhängies Landeszentrum für Dat

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Abstract

This document specifies usage policy language of SPECIA
both the data subjects' consent and the data usage policie
by a computer, so as to automatically verify that the usage

The ontology defined in this document is publicly available

Vocabulary …/langs/usage-policy#

Bert Bos Last Updated: 17 April 2018

(You can download this ontology as an OWL file.)

The following is the formulation in functional syntax of the Usage Policy Language Ontology with identifier

> http://www.specialprivacy.eu/langs/usage-policy#

The documentation can be found in Policy Language V1 (deliverable D2.1).

```
# NAMESPACE DEFINITIONS

Prefix(spl:=<http://www.specialprivacy.eu/langs/usage-policy#>)
Prefix(owl:=<http://www.w3.org/2002/07/owl#>)
Prefix(rdf:=<http://www.w3.org/1999/02/22-rdf-syntax-ns#>)
Prefix(xml:=<http://www.w3.org/XML/1998/namespace>)
Prefix(xsd:=<http://www.w3.org/2001/XMLSchema#>)
Prefix(rdfs:=<http://www.w3.org/2000/01/rdf-schema#>)

# ONTOLOGY IRI AND ITS VERSION

Ontology( <http://www.specialprivacy.eu/langs/usage-policy-ontology>
<http://www.specialprivacy.eu/langs/usage-policy-ontology/1.0>
```

- Detailed in *D2.1 Policy Language V1 & D2.5 Policy Language V2*
- Available for download via the SPECIAL website: https://www.specialprivacy.eu/publications/public-deliverables
- An unofficial *draft specification* has been published online https://www.specialprivacy.eu/platform/ontologies-and-vocabularies

Fast Compliance Checking in an OWL2 Fragment. Piero A. Bonatti. Proceedings of the 27th International Joint Conference on Artificial Intelligence (IJCAI 2018)

SPECIAL ODRL Regulatory Compliance Profile
Syntax and expressivity

ODRL Regulatory Compliance Profile
version 0.1

Unofficial Draft 29 May 2019

Editor:
Sabrina Kirrane (Vienna University of Economics and Business)

Authors:
Sabrina Kirrane (Vienna University of Economics and Business)
Marina De Vos (University of Bath)
Julian Padget (University of Bath)

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Abstract

The Open Digital Rights Language (ODRL) is a policy expression language that provides a flexible and interoperable information model, vocabulary, and encoding mechanisms for representing statements about the usage of content and services.

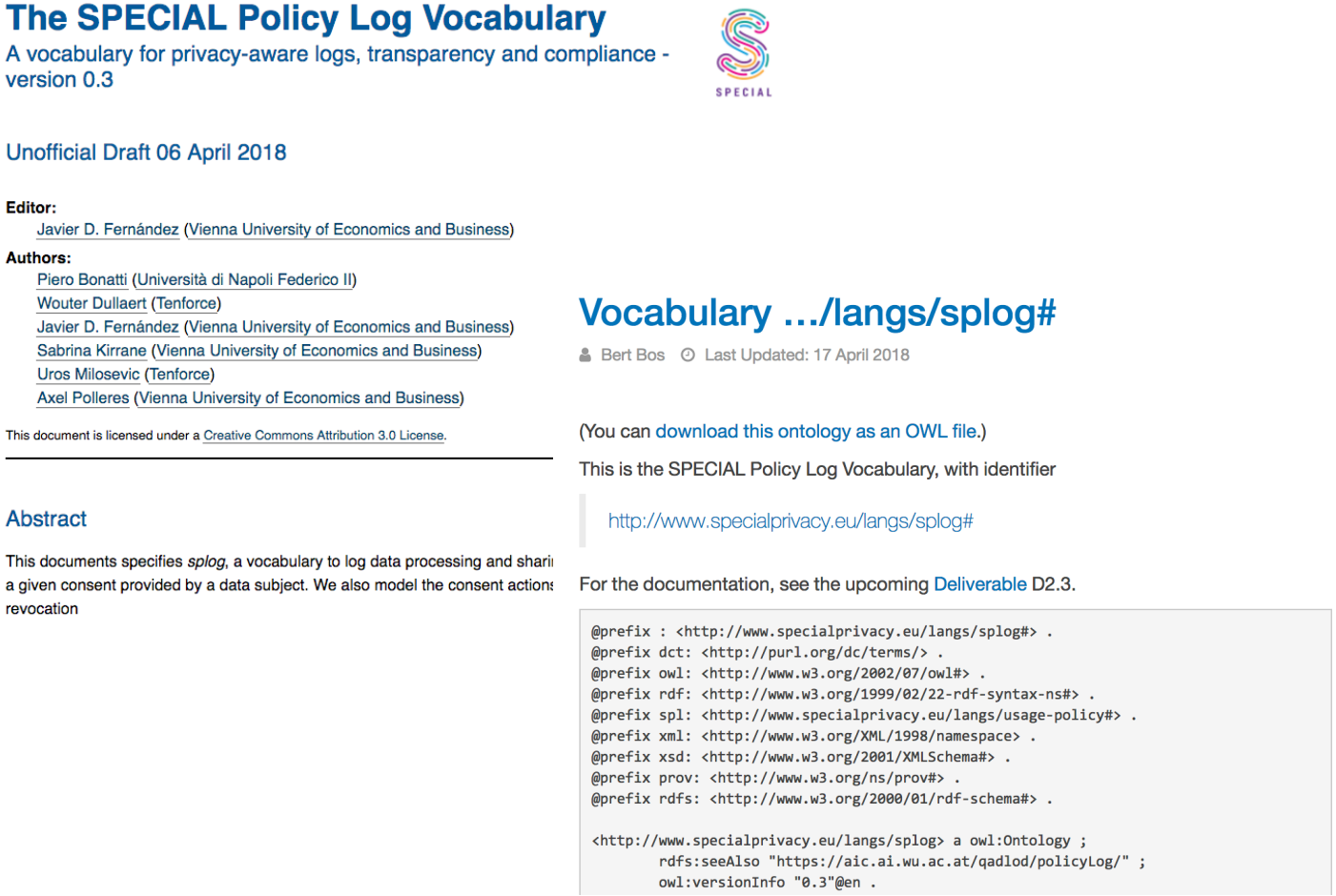
This document constitutes an ODRL profile that adapts the ODRL Core Model and Vocabulary with concepts and terms to support regulatory compliance checking of business policies.

In essence, ODRL Regulatory Compliance Profile policies are used to represent regulatory permissions, prohibitions, obligations, and dispensations, which may be limited by constraints (e.g., temporal, spatial).

- Preliminary Analysis Detailed in *D2.2 Formal Representation of the legislation V1 & D2.6 Formal Representation of the legislation V2*
- Available for download via the SPECIAL website: https://www.specialprivacy.eu/publications/public-deliverables
- An unofficial *draft specification* has been published online https://www.specialprivacy.eu/platform/ontologies-and-vocabularies

ODRL policy modelling and compliance checking, Marina De Vos, Sabrina Kirrane, Julian Padget and Ken Satoh, Proceedings of the 3rd International Joint Conference on Rules and Reasoning (RuleML+RR 2019)

The SPECIAL Policy Log Vocabulary
Syntax and expressivity



The SPECIAL Policy Log Vocabulary

A vocabulary for privacy-aware logs, transparency and compliance - version 0.3

SPECIAL

Unofficial Draft 06 April 2018

Editor:
Javier D. Fernández (Vienna University of Economics and Business)

Authors:
Piero Bonatti (Università di Napoli Federico II)
Wouter Dullaert (Tenforce)
Javier D. Fernández (Vienna University of Economics and Business)
Sabrina Kirrane (Vienna University of Economics and Business)
Uros Milosevic (Tenforce)
Axel Polleres (Vienna University of Economics and Business)

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Abstract

This documents specifies *splog*, a vocabulary to log data processing and sharii
a given consent provided by a data subject. We also model the consent actions
revocation

Vocabulary …/langs/splog#

Bert Bos Last Updated: 17 April 2018

(You can download this ontology as an OWL file.)

This is the SPECIAL Policy Log Vocabulary, with identifier

> http://www.specialprivacy.eu/langs/splog#

For the documentation, see the upcoming Deliverable D2.3.

```
@prefix : <http://www.specialprivacy.eu/langs/splog#> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix spl: <http://www.specialprivacy.eu/langs/usage-policy#> .
@prefix xml: <http://www.w3.org/XML/1998/namespace> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix prov: <http://www.w3.org/ns/prov#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

<http://www.specialprivacy.eu/langs/splog> a owl:Ontology ;
        rdfs:seeAlso "https://aic.ai.wu.ac.at/qadlod/policyLog/" ;
        owl:versionInfo "0.3"@en .
```

- Detailed in *D2.3 Transparency Framework V1* delivered in M14
- Available for download via the SPECIAL website https://www.specialprivacy.eu/langs/splog
- An unofficial *draft specification* has been published online https://www.specialprivacy.eu/platform/ontologies-and-vocabularies

A Scalable Consent, Transparency and Compliance Architecture, Sabrina Kirrane, Javier D. Fernández, Wouter Dullaert, Uros Milosevic, Axel Polleres, Piero Bonatti, Rigo Wenning, Olha Drozd and Philip Raschke , Proceedings of the Posters and Demos Track of the Extended Semantic Web Conference (ESWC 2018)

Transparency and compliance checking
Subsumption Algorithm

- The development of a compliance checking algorithm for the SPECIAL policy language devised in T2.1
- A company's policy can be checked for compliance with data subjects' consent and with part of the GDPR by means of subsumption queries
- We provide a complete and tractable structural subsumption algorithm for compliance checking
- Detailed in *D2.4 & D2.8 Transparency and Compliance Algorithms*

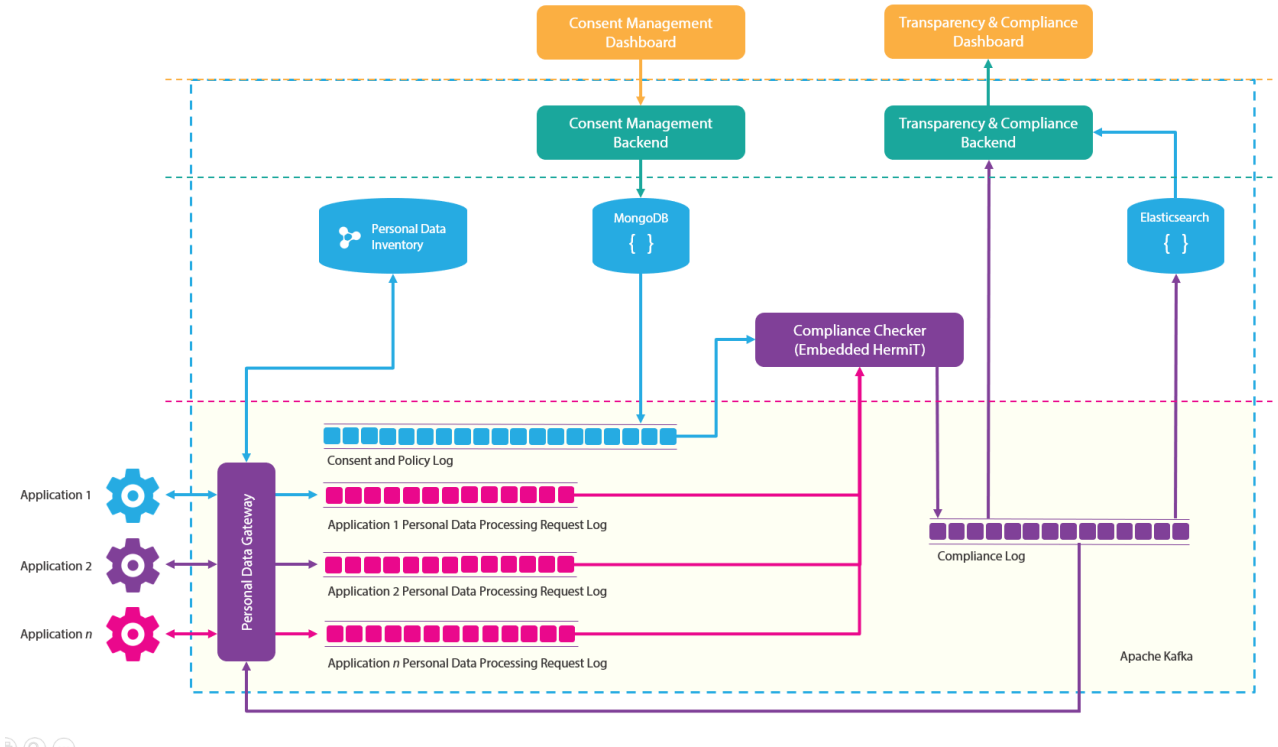
Algorithm 1: $\mathsf{STS}(\mathcal{K}, C \sqsubseteq D)$

Input: $\mathcal{K}$ and an elementary $C \sqsubseteq D$ where C is normalized
Output: `true` if $\mathcal{K} \models C \sqsubseteq D$, `false` otherwise
Note: Below, by $C = C' \sqcap C''$ we mean that either $C = C'$ or C' is a conjunct of C (possibly not the first one)

1 **begin**
2 **if** $C = \bot$ **then return** `true`
3 **if** $D = A$, $C = A' \sqcap C'$ *and* $A' \sqsubseteq^* A$ **then return** `true`
4 **if** $D = [l, u](f)$ *and* $C = [l', u'](f) \sqcap C'$ *and* $l \leq l'$ *and* $u' \leq u$ **then return** `true`
5 **if** $D = \exists R.D'$, $C = (\exists R.C') \sqcap C''$ *and* $\mathsf{STS}(\mathcal{K}, C' \sqsubseteq D')$ **then return** `true`
6 **if** $D = D' \sqcap D''$, $\mathsf{STS}(\mathcal{K}, C \sqsubseteq D')$, *and* $\mathsf{STS}(\mathcal{K}, C \sqsubseteq D'')$ **then return** `true`
7 **else return** `false`
8 **end**

*Piero A. Bonatti. Fast Compliance Checking in an OWL2 Fragment. Proceedings of the 27th International Joint Conference on Artificial Intelligence (**IJCAI 2018**)*

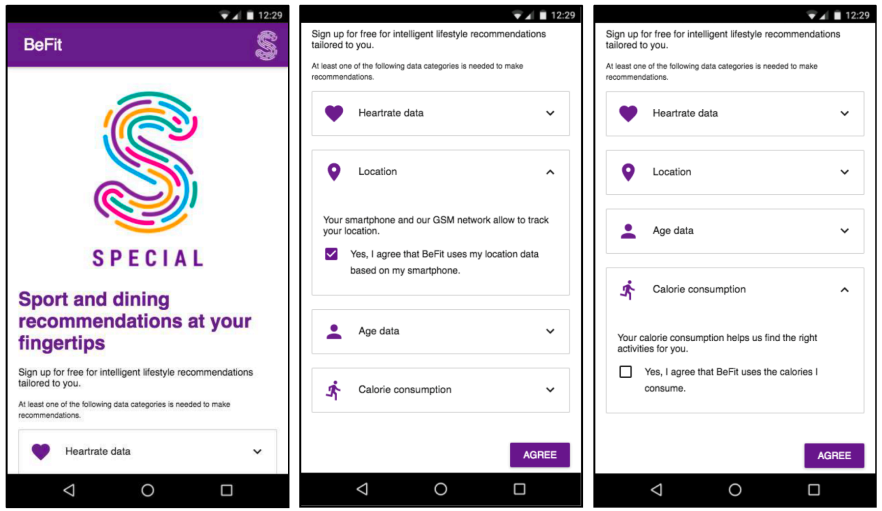
Transparency and compliance checking
Stream processing platform

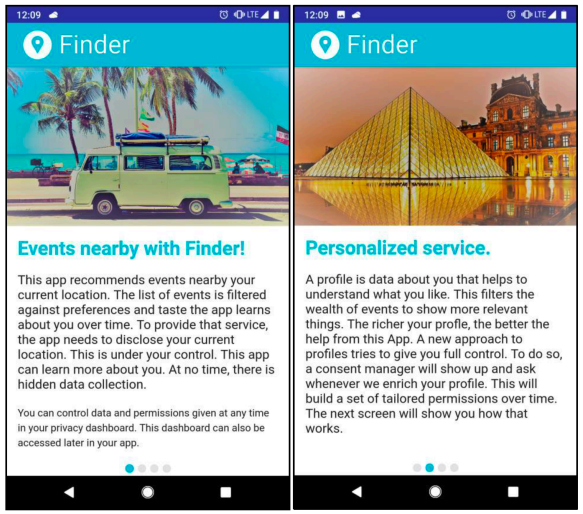


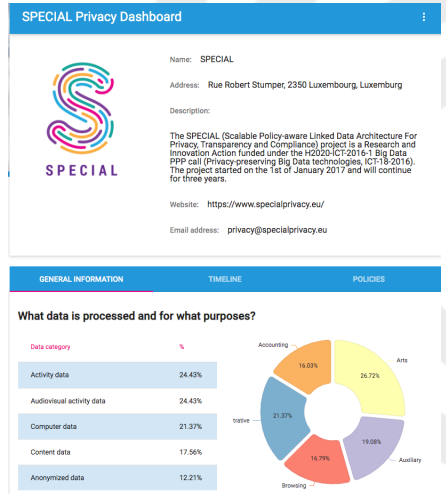
- Data processing and sharing event logs are stored in the **Kafka** distributed streaming platform, which in turn relies on Zookeeper for configuration, naming, synchronization, and providing group services.
- We assume that consent updates are infrequent and as such usage policies and the respective vocabularies are represented in a **Virtuoso triple store**.
- The compliance checker, which includes an embedded
- A **HermiT reasoner** uses the consent saved in Virtuoso together with the application logs provided by Kafka to check that data processing and sharing complies with the relevant usage control policies.
- As logs can be serialized using JSON-LD, it is possible to benefit from the faceting browsing capabilities of **Elasticsearch** and the out of the box visualization capabilities provided by **Kibana**.

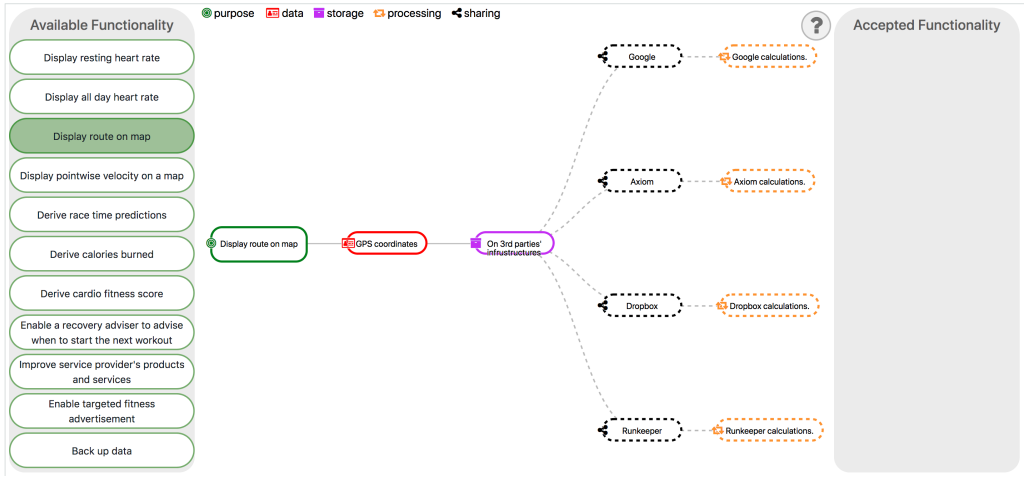
A Scalable Consent, Transparency and Compliance Architecture, Sabrina Kirrane, Javier D. Fernández, Wouter Dullaert, Uros Milosevic, Axel Polleres, Piero Bonatti, Rigo Wenning, Olha Drozd and Philip Raschke , Proceedings of the Posters and Demos Track of the Extended Semantic Web Conference (ESWC 2018)

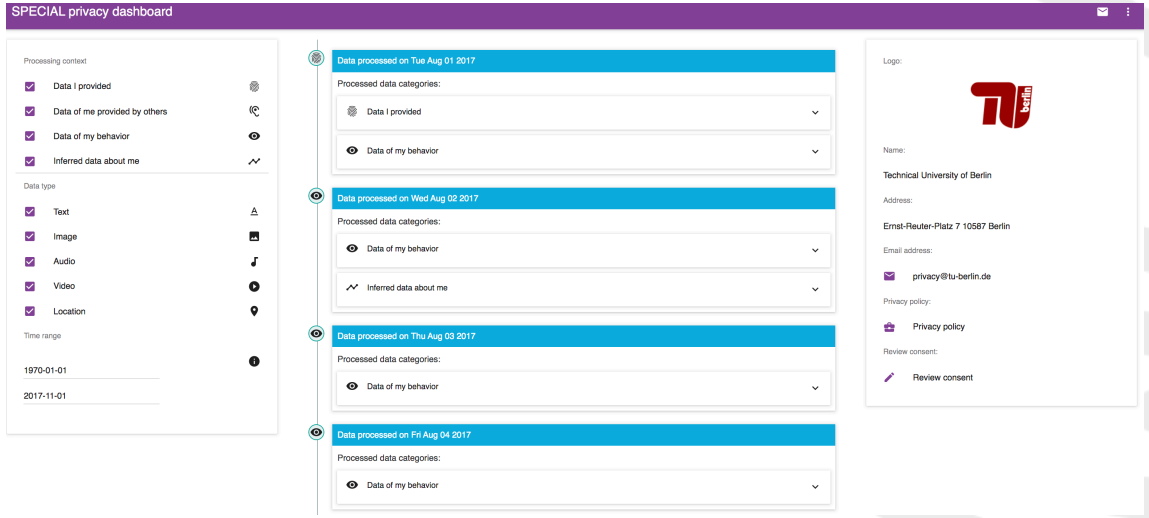
The SPECIAL Mobile Consent UI







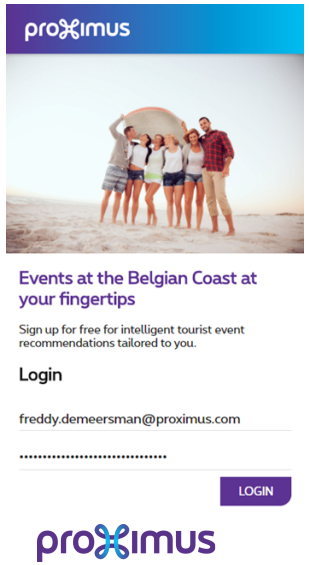


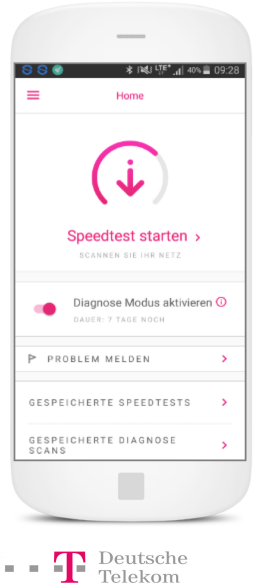


Towards Common Data Spaces
Challenges & Opportunities

- Standardisation of vocabularies (data, processing, purpose, storage, sharing) is difficult
- There are cognitive limitations in terms of understanding consent and transparency
- GDPR Compliance is only the tip of the iceberg, from a usage control perspective we also need to consider other regulations, licenses, social norms, cultural differences
- From a data spaces perspective, we need to embrace distributed and decentralised systems, which complicates things further
- Ensuring such systems are well behaved is a crucial to success (i.e., all usage constraints are adhered to and the system as a whole works as expected)

Any Questions?





The SPECIAL Usage Policy Language
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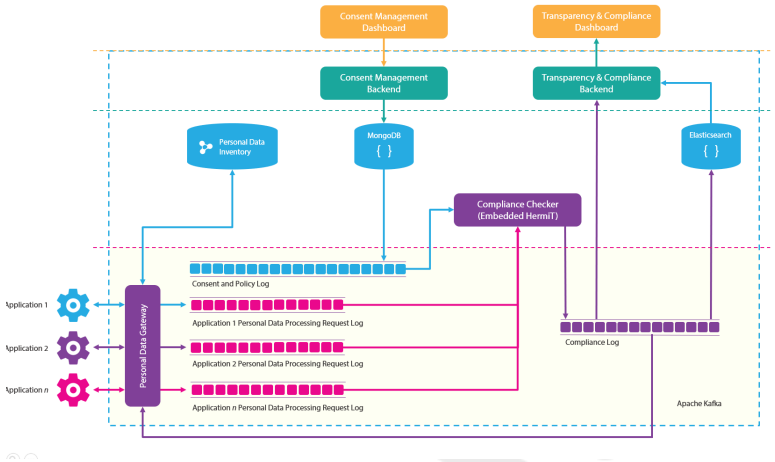
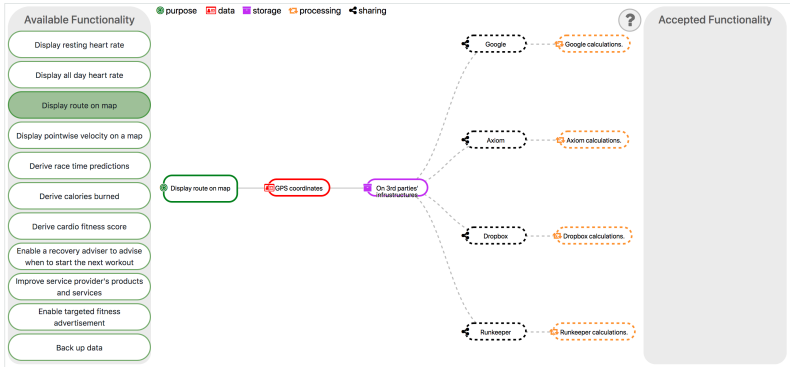
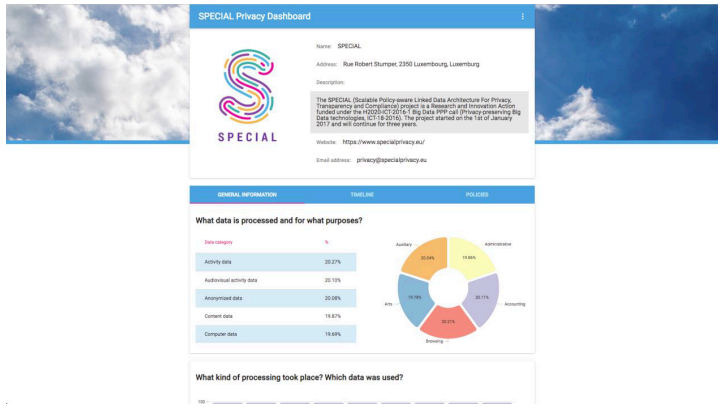
Abstract

This document specifies usage policy language of SPECIAL. The usage policy language is meant to express both the data subjects' consent and the data usage policies of data controllers in formal terms, understandable by a computer, so as to automatically verify that the usage of personal data complies with data subjects' consent.

The ontology defined in this document is publicly available at http://www.specialprivacy.eu/langs/usage-policy.







Contact Details

Technical/Scientific contact

Sabrina Kirrane

Vienna University of Economics and Business

sabrina.kirrane@wu.ac.at

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