Web Technologies and Privacy Policies for the Smart Grid

Sebastian Speiser†, Andreas Wagner†, Oliver Raabe‡ and Andreas Harth† | Energieinformatik 2013
Agenda

1. Introduction
2. ICT Architecture and Data Model
3. Use-Case I
4. Policies for a Privacy-aware Smart Grid
5. Use-Case II
6. Evaluation
7. Conclusion
Introduction
(Some) Key ICT Requirements

Requirements, see [2, 3]

R1 Lightweight data access.
R2 Open and flexible data model.
R3 Distinction between syntactic and semantic data content.
R4 Users decide what data in which granularity to expose to whom.
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- **R3** Distinction between syntactic and semantic data content.
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Contributions

- **R1-R3**: Semantic Web communication architecture (Section 2).
- **R4**: Policy model (Section 4).
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- **R4**: Policy model (Section 4).
Communication Architecture
Overview: A Semantic Web-based Communication Architecture I

Data access layers

- URIs for identification of participants.
- TCP/IP stack with HTTP as transfer protocol.
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Overview of a Semantic Web-based Communication Architecture II

Data representation layers

- RDF(S) (if necessary extended with OWL features) for machine-interpretable data encoding.
- Linked Data principles for data access:
  - Use (HTTP) URIs for identification of entities.
  - When someone looks up a URI, provide useful (RDF) data.
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Use-Case I
Use-Case I (iZEUS) – Smart Grid/Traffic Service Platform – Data Management I
Use-Case I (iZEUS) – Smart Grid/Traffic Service Platform – Data Management III

Future work

Service Requests

Get additional data

Linked Data Endpoint

Smart Traffic Navigator

RDF Data

Get additional data

Smart Meter Analyzer

WWW

Data logging

GET additional data

RDF data logging

TCP/IP/HTTP

Service Platform

sm:apt

sm:meter

car:uamp760e3

RDF

RDF

RDF

RDF

Get additional data

Future work

Smart home at KIT

sm:apt

RDF

RDF

TCP/IP/HTTP

RDF

RDF

Get additional data

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Use-Case I (iZEUS) – Smart Grid/Traffic Service Platform – Data Management IV

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Linked Data Endpoint

Service Requests

RDF Data

car:uamp760e1
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TCP/IP/HTTP

Service Platform

RDF Data

Get additional data

Gridpedia as data model

RDF Data

WWW

Get additional data

Smart Traffic Navigator

Smart Meter Analyzer

Privacy Policies

Evaluation

Conclusion

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Communication Architecture

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Use-Case II

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Privacy Policies
Policy Model

Intuition

- Policies model user intent, thus, they help to preserve data privacy.
- A Policy is bound to its associated data.
- Policies are taken into account whenever data is accessed.
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Policy Model II

```
Policy
   validFrom
   validTo

Date

Usage
   purpose
   perspective
   recipient

Purpose

Perspective

Agent Description
```

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Policy-aware Data Access

Access procedure

i) Requestor performs a HTTP lookup on a URI (e.g., ex:uamp760e).

ii) Web server returns an *authorisation required* response.

iii) Requestor sends a request, i.e., a specification of identity and purpose.

iv) Device matches the request with an applicable policy (either a law-based or a user policy) → if request and policy match, requested data and (signed) policy is sent.
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Use-Case II
Use-Case II (iZEUS) – Smart Grid/Traffic Service Platform – Data Privacy I

Diensteverzeichnis

Verbrauchsrechnung und individualisierte Fahrprofile [10]


eMobil Nutzung [11]

Wie haben Sie Ihr Elektrofahrzeug bisher genutzt? Anhand der Fahrtaufzeichnungen mit dem Tablet bekommen Sie eine Übersicht darüber. Sie erfahren wie viele Kilometer sie täglich gefahren sind, wo sie parkten, weshalb sie unterwegs waren und wie viel Emissionen sie durch das Elektrofahrzeug eingespart haben.

Welcome, KIT Institut DSN (DSN@kit)

Speiser et al. – Web Technologies and Privacy Policies for the Smart Grid
Use-Case II (iZEUS) – Smart Grid/Traffic Service Platform – Data Privacy II

Welcome, KIT Institut DSN (DSN@KIT)

Diensteverzeichnis

Verbrauchsrechnung und individualisierte Fahrprofile

Beschreibung


Dienst-URL:

http://gridpedia.org/id/RouteData

Aktueller Status: Dienst ist aktiviert. Deaktivieren...

Erstelle: KIT Institut ETI
Version: 1.0
Plattform:
Evaluation
Our previous works aimed at evaluation of privacy policies via German privacy laws [1, 4].

This work evaluates the practical feasibility of privacy policies stored (matched) on lower-power devices.
Scope of Evaluation

- Our previous works aimed at evaluation of privacy policies via German privacy laws [1, 4].
- This works evaluates the practical feasibility of privacy policies stored (matched) on lower-power devices.
We implemented a policy matcher based on Rasqal\(^1\).

Two hardware platforms:

- 2.4 GHz Core2Duo laptop with 4 GB RAM.
- SheevaPlug device with an 1.2 GHz ARM processor and 512 MB RAM.

We created of varying sizes policies, i.e., we varied # allowed usages between 1 and 75.

For each size, 10 policies with random allowed usages were matched against every request.\(^2\)

\(^1\)http://librdf.org/rasqal/

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Evaluation Results

The graph illustrates the evaluation results for different policy sizes in seconds. The x-axis represents the policy size, and the y-axis shows the matching time in seconds. There are four lines on the graph, each representing different scenarios:

- **Allowed Core2Duo**
- **Denied Core2Duo**
- **Allowed ARM**
- **Denied ARM**

Each scenario shows a trend where the matching time increases with the policy size.
Conclusion
By means of real-world use-cases we showed that ...

- ... Semantic Web technologies are applicable and highly useful ...
- ... Linked Data allows for efficient data access ...
- ... policies give effective means for technical privacy enforcement ...

... in a Smart Grid setting.

We evaluated our policy approach in terms of technical feasibility w.r.t. lower-power devices.
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Slides will be available at http://slideshare.net/
Paper will be available at http://aifb.kit.edu/
Acknowledgements: iZEUS Project

This work was supported by the German Federal Ministry of Economics and Technology (E-Energy iZEUS, Grant 01 ME12013). The authors are responsible for the content of the presentation.
References
References I


Andreas Wagner, Sebastian Speiser, Oliver Raabe, and Andreas Harth.
Linked Data for a Privacy-aware Smart Grid.
Backup Slides
Use-Case I (iZEUS) – Collaborative
Smart Grid Ontology – Gripedia I

Welcome to Gridpedia, featuring a RDF\(\text{ontology}\) for the Smart Grid!

Gridpedia is different from other ontologies, as it allows users to collaboratively define concepts (in a structured and unstructured manner). That is, users may model concepts, i.e., unstructured text (e.g., a definition), but also via structured information (e.g., relations of a particular concept to other concepts). The contents of Gridpedia are exported (as a stable knowledge base dump) via RDF/XML format and thus can be used in any other tool or context. Gridpedia features already a lot of content:

There are currently 251 classes, 66 properties, and 64 instances defined. You should contribute, too!

News

- 6 Nov 2013 (CET): Updates throughout the ontology
- 5 July 2012 (CET): Published GridPedia dump v2
- 23 June 2012 (CET): Updated Help/Introduction
- 12 May 2012 (CET): Extended Help/Section
- 31 January 2012 (CET): Gridpedia.org goes live...

Dataset and Online Access

The contents of the Gridpedia wiki are frequently exported as stable RDF/XML\(\text{dump}\):

- 23.59. 5 July 2012 (CET): V0.2 as stable RDF dump\(\text{v2}\)
Use-Case I (iZEUS) – Collaborative Smart Grid Ontology – Gripedia III

Edit Class: Actor

Class Name

Class Name: Actor

Please give this class a meaningful name.

Class Hierarchy

SubClassOf:

If this class is a subclass of another class, then please specify it here.

Definitions and Descriptions

Description:

Actors have the capability to make decisions and exchange information with other actors through interfaces. Actors may be devices, computer systems, or software programs and/or the organizations that own them. An actor may also comprise other actors.


Description:

Ein Agent ist eine (natürliche oder juristische) Person, welche eine Transaktion auf dem Markt im Auftrag seines Kunden oder seines Arbeitgebers ausführt. Es kann erforderlich sein, dass für gewisse Transaktionen ein Personenbezugs-Handelsgesetz gilt.

Quelle: NRReiMoeb http://neriomobild.forschung.kit.edu/.

Description:


Quelle: NRReiMoeb http://neriomobild.forschung.kit.edu/.

Add text

Here you can add several free-form texts. They can be used for definitions as well as descriptive texts.

SameAs Definitions
Linked Data for the Smart Grid – Example

Legend

<table>
<thead>
<tr>
<th>Communication Flow</th>
<th>Actor</th>
<th>Domain</th>
<th>Network</th>
</tr>
</thead>
</table>

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Mary’s Linked Data

// lookup on ex:coolWash; data resides at washing machine
ex:coolWash
    rdf:type sg:Appliance;
    sg:manufacturer <http://coolWash.com/company>;
    sg:owner ex:mary;
    sg:washingData washer:program40;
    sg:consumption sm:data20100310.
Mary’s Linked Data II

// lookup on sm: data20100310; data resides at smart meter
sm: data20100310
    rdf: type sg: Consumption;
    rdf: value "1.04"^^sg:kWh;
    ical: dtstart "2010-03-10T00:00:00";
    ical: dtend "2010-03-10T01:00:00".
Matching procedure

The matching procedure is implemented as a rule, checking whether . . .

i) requestor is subsumed by the recipient description and

ii) the requested purpose is subsumed by the allowed purpose (both w.r.t. the applicable policy)

Assumption: the same purpose and recipient definition is employed $\rightarrow$ subclass-of or same-as check is sufficient for realising the subsume operation.
An example policy for Mary’s UltraAmp 760e I

```xml
wtrsh: eCarPol rdf:type sg:Policy;
    ical: dtstart "2010-01-01T00:00:00"^^xs:dateTime;
    ical: dtend "2010-12-31T23:59:59"^^xs:dateTime;
    sg: allows #ultraAmpUse.

#ultraAmpUse rdf:type sg:Usage;
    sg: purpose gov:Purpose#service;
    sg: recipient <http://ultraAmp.com/company>;
    sg: perspective #ultraAmpPerspective.
```
An example policy for Mary’s Mary’s UltraAmp 760e II

```
#ultraAmpPerspective rdf:type sg:Perspective;
    sg:definition "PREFIX ... CONSTRUCT { ?s ?p ?o }
WHERE { ?s rdf:type sg:Appliance .
FILTER (?p != sg:consumption) }").
```