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Towards Formal Semantics for ODRL Policies:

Defining Expressive Access Policies for Linked Data using the ODRL Ontology

Simon Steyskal & **Axel Polleres**
WU Wien, Austria

Twitter: @AxelPolleres

web: http://www.polleres.net

Agenda

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1. Motivation
2. Introducing ODRL
3. Example Policies
4. Reasoning over ODRL Policies

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Open Data on the Web is great... But not all data is, or ever will be open.

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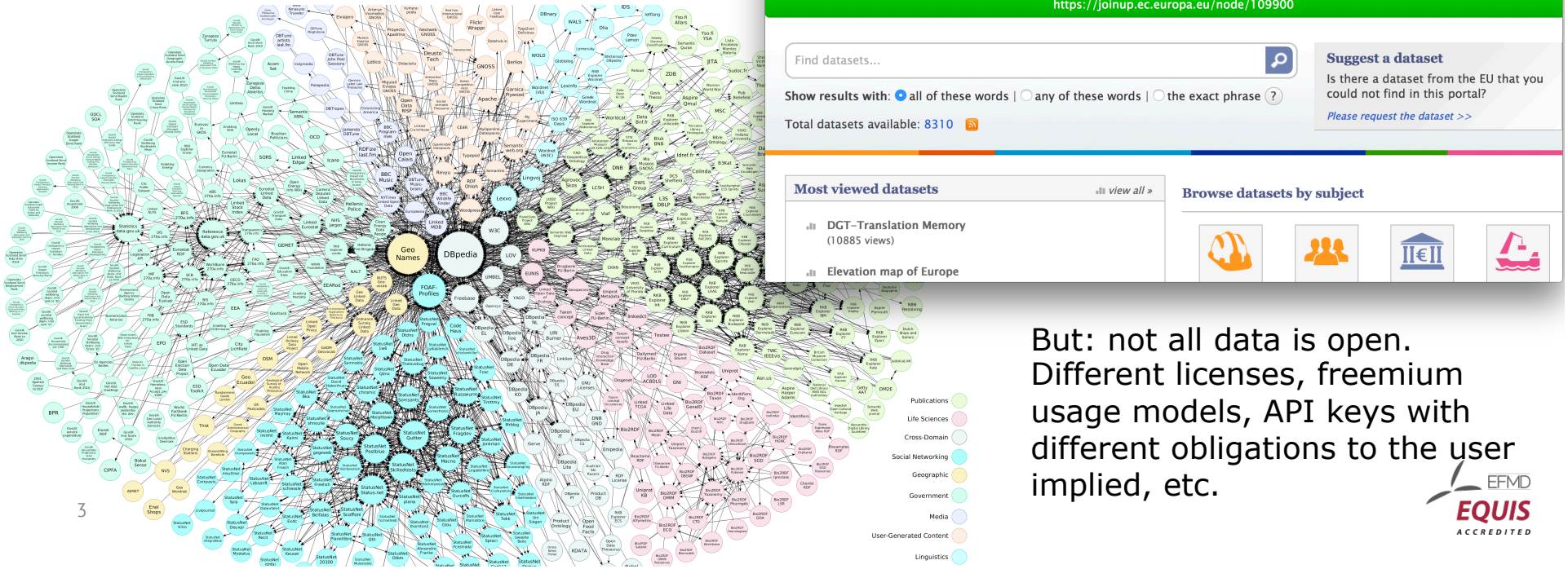
A lot of activity in terms of standardization (in W3C) focused on

- Formats (RDF)
- Publishing best practices (Linked Data)



But: not all data is open. Different licenses, freemium usage models, API keys with different obligations to the user implied, etc.

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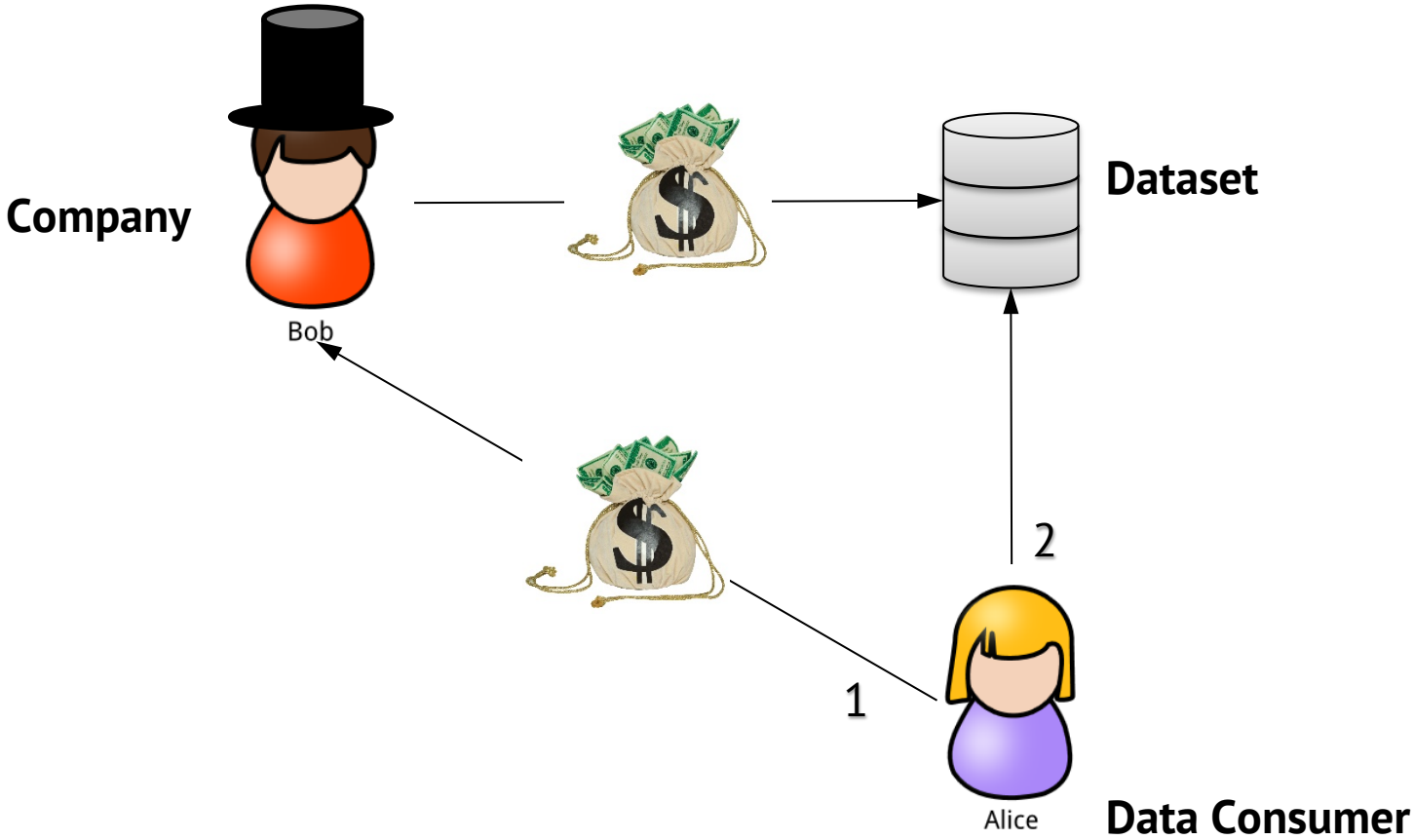
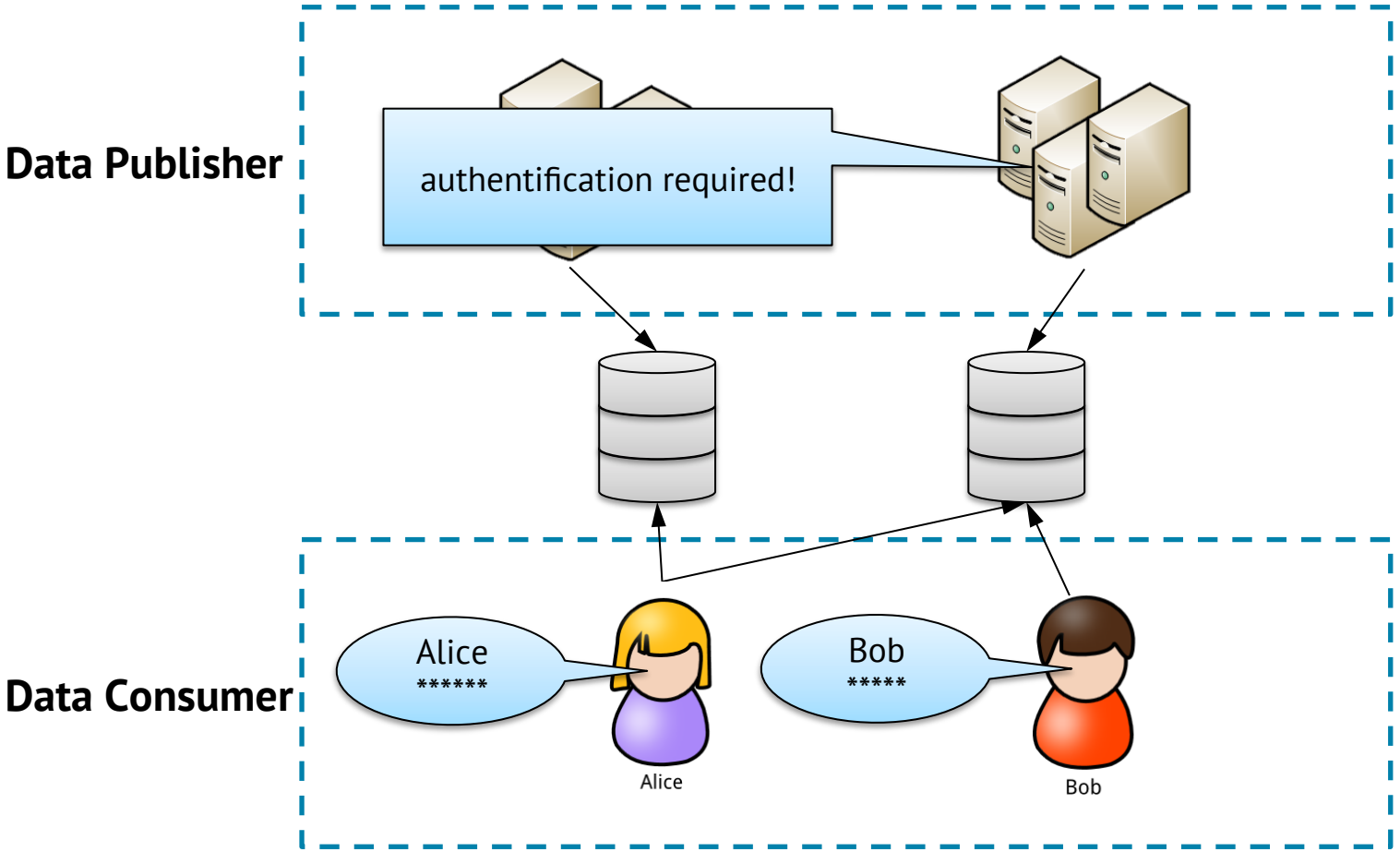
Motivation

hypothesis: companies won‘t offer you data for free



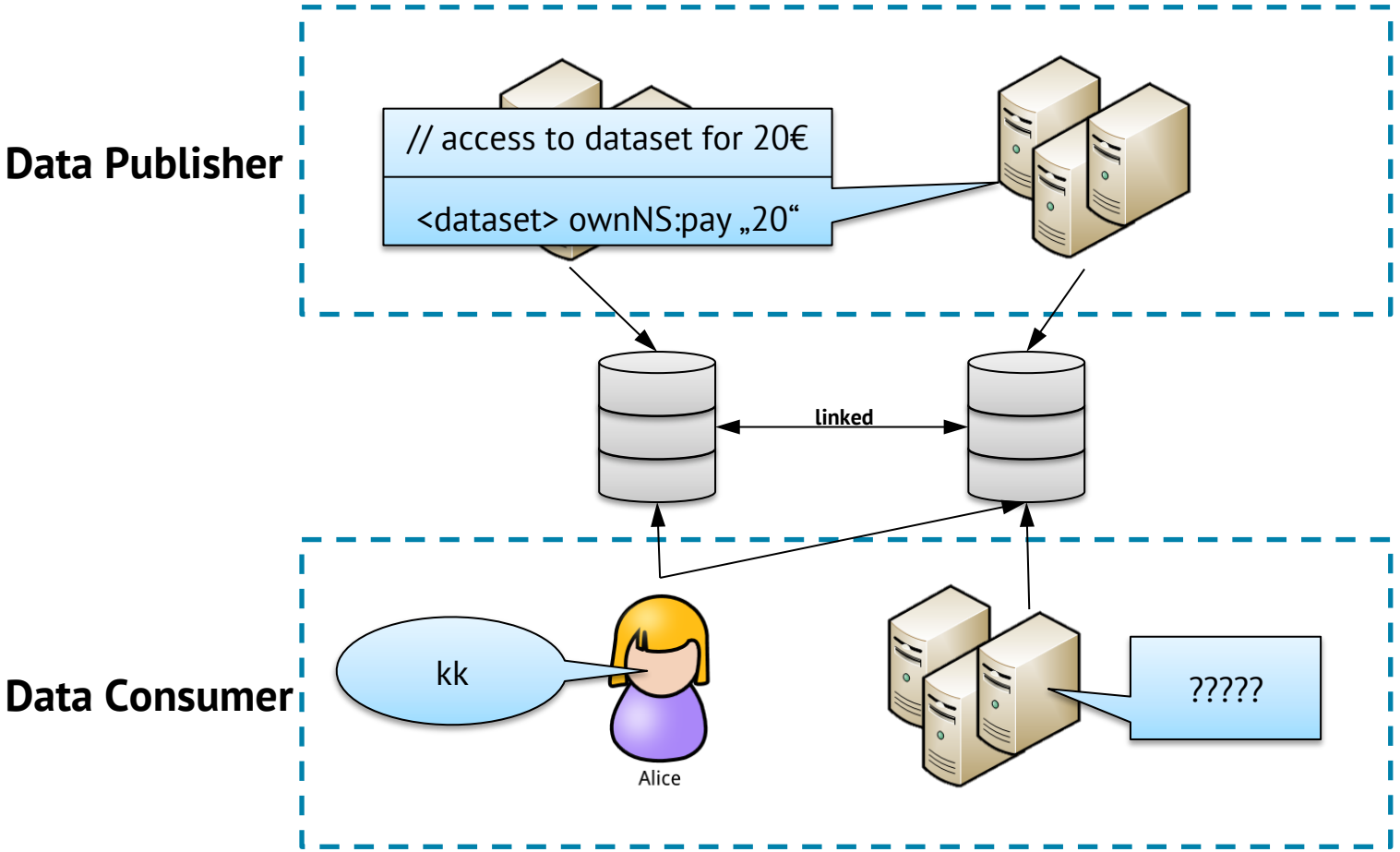
Motivation

from simple access conditions and machine-human interaction...

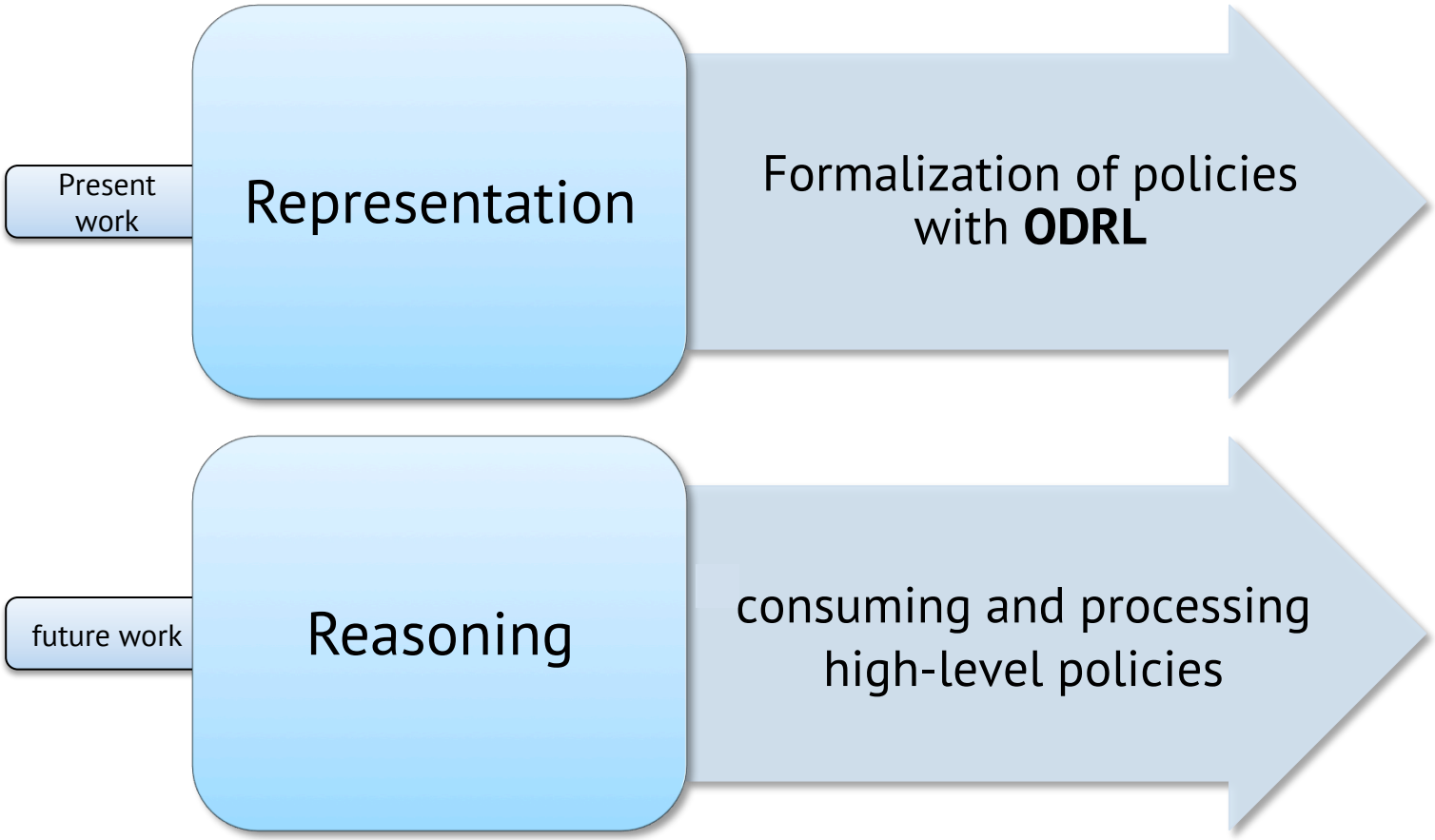


Motivation

... to high-level policies and machine-machine interaction!



Goal:
Representation & Reasoning



Representation:

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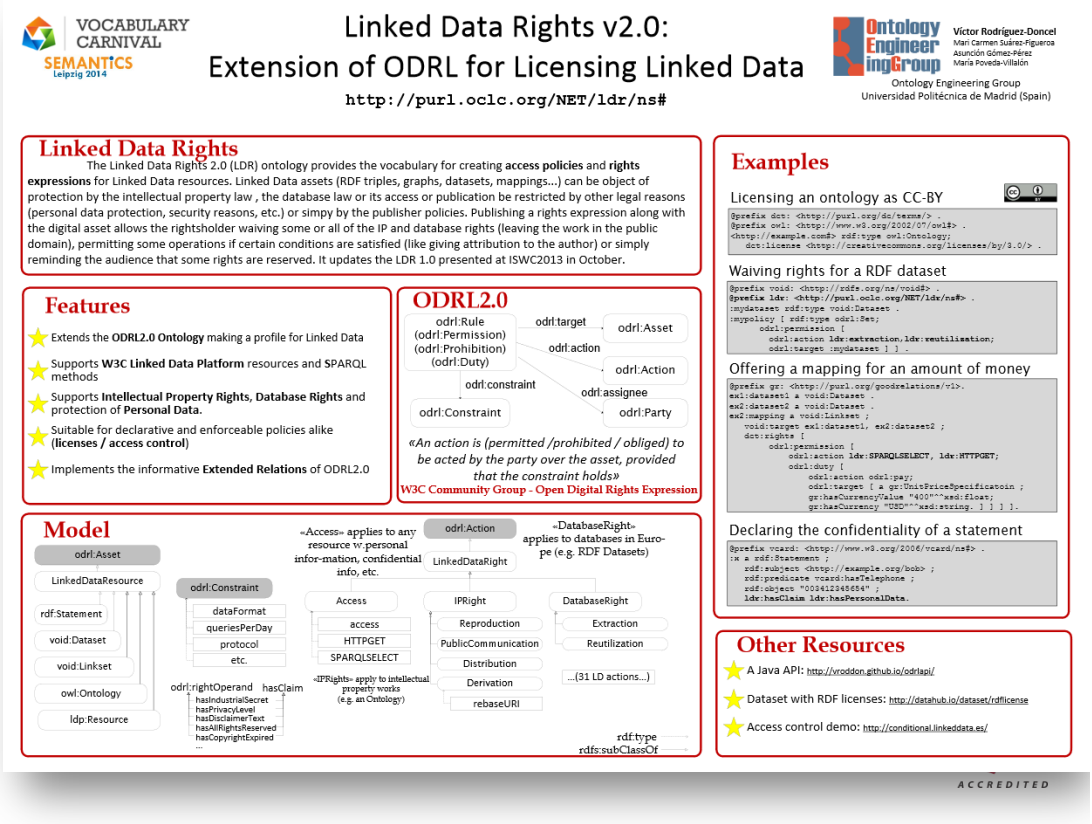
ODRL

Obvious candidate …

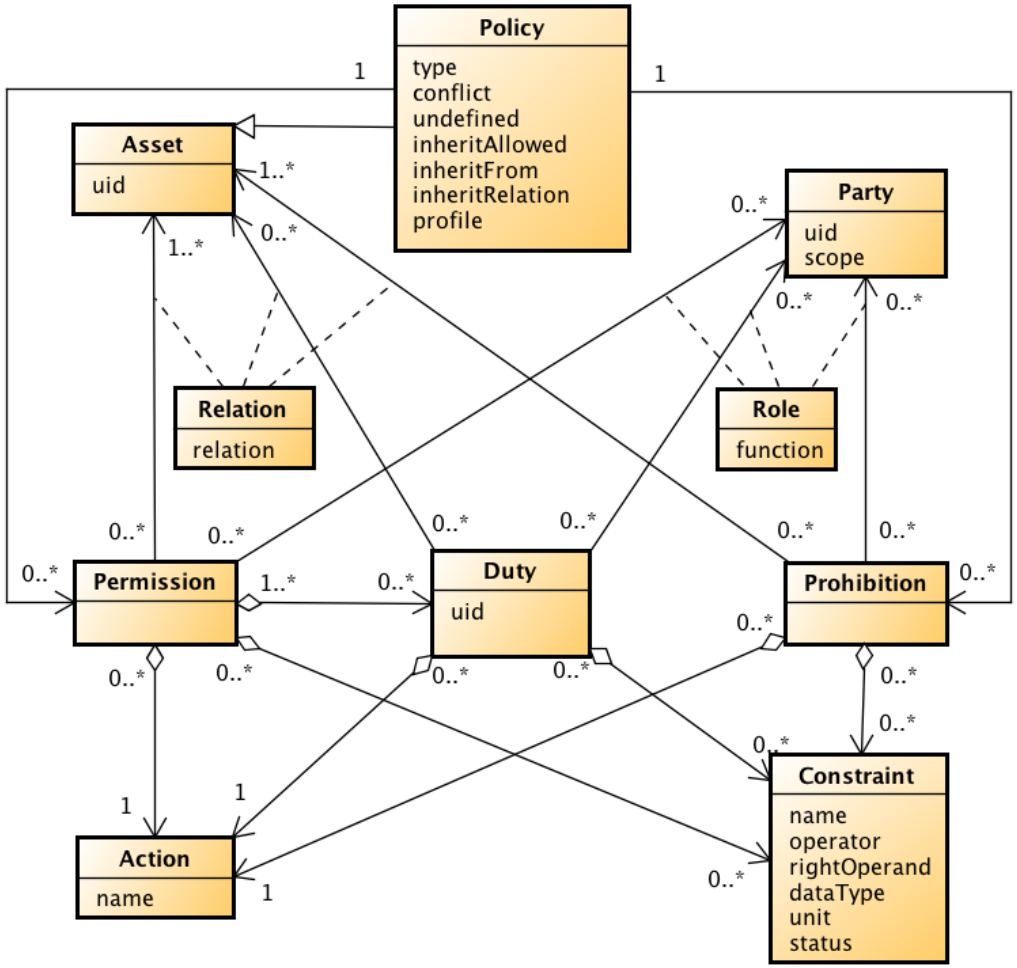
- *Originally an XML representation of policies concerning digital rights management*
- *RDF representation & ontology (ORDL 2.1 Ontology) → final draft just published by W3C community group.*

Linked Data Rights v2.0

Rodríguez-Doncel et al.



ODRL Core Model 2.0



http://www.w3.org/community/odrl/two/model/

ODRL Concepts 1/5
Policy

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Policy

A **Policy** is the central entity that forms ODRL policy expressions. It can refer to **Permissions** and **Prohibitions** which hold for that **Policy** and be further distinguished into several subtypes such as:

Offer

A **Policy** which proposes terms of usage from an **Assigner** to possible **Assignees**.

Alice allows anyone who pays her 20€ to read her dataset.

Agreement

A **Policy** which contains all terms of usage between both an **Assigner** and an **Assignee** about an **Asset.**

Alice allows Bob to read her dataset if he pays her 20€.

ODRL Concepts 1/5
Policy

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Request

A **Policy** which proposes terms of usage from an **Assignee** to an **Assigner** (owner of the **Asset**).

Bob wants to pay Alice 20€ if she allows him to read her dataset.

Set

A **Policy** which defines **Prohibitions**, **Permissions** and/or **Duties** for a certain **Asset**.

Dataset XY is licensed under CC-BY. (i.e. duty to attribute asset owner)

Ticket

A **Policy** which proposes terms of usage to any holder of a valid **Ticket.**

Dataset XY is accessible till May 2015 to any holder of a valid ticket.

Privacy

A **Policy** which defines terms of usage over personal information.

Alice grants Bob to distribute her personal data but only for the purpose of contacting Alice. Furthermore he has to delete the asset after 30 days.

ODRL Concepts 2/5
Asset and Party

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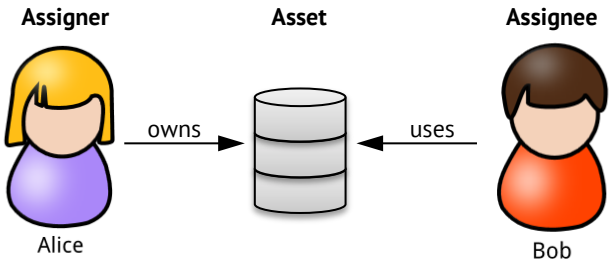
Asset

An **Asset** is the entity whose terms of usage are restricted by its surrounding policy expression. In the domain of *Linked Data* an **Asset** usually represents a dataset or parts of a dataset (triples) .

Party

A **Party** can be distinguished into **Assigners** (the parties who propose the policy statements) and **Assignees** (the ones who receive the policy statements).



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ODRL Concepts 3/5
Permission, Prohibition, and Duty

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Permission

A **Permission** specifies **Actions** which are allowed to be executed on a certain **Asset**.

Alice allows Bob to read her dataset.

Prohibition

Prohibitions are used to forbid specific **Actions** on an **Asset** and cannot refer to **Duties**.

Alice prohibits Bob to distribute her dataset.

Duty

Duties define **Actions** that have to be perfomed so that sorrounding **Permissions** or **Policies** become valid.

Alice allows Bob to read her dataset if he pays her 20€.

Permission **Duty**

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ODRL Concepts 4/5
Action

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Action

Actions are operations on **Assets** that a potential **Assignee** is allowed (if related to a **Permission**), is prohibited (if related to a **Prohibition**) or has (if related to a **Duty**) to perform. In a Linked Data scenario actions could be:

aggregate – can be used to express the action of querying different datasets and aggregate the retrieved data.

read – the act of obtaining data from the asset (e.g. via SPARQL query).

copy - the action of copying data is fundamental when defining copyright restrictions and necessary for certain license definitions.

write - can be used to represent SPARQL INSERT queries, since it specifies the action of writing to an asset.

<custom> - although there are many prepoposed **Actions** that can be used out of the box, new actions which might fit the intended semantics more precisely can easily be added to the ontology.

ODRL Concepts 5/5
Constraint

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Constraint

Constraints offer the possibility to restrict and limit the scope of **Permissions**, **Prohibitions** and **Duties**, using a simple mathematical structure with two operands and one operator:

The number of query requests must be less or equal than 100.

operand — operator — operand

Additionally a specific **Purpose** of the constrained **Action** can be defined:

Reading from a dataset using ASK queries shall be restricted to 100 executions.

action — purpose — constraint

Access Policy Examples 1/7

Restricting access to specific parties and assets

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Listing 1

```
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy1 a odrl:Agreement ;
         odrl:permission [
             a odrl:Permission;
             odrl:action odrl:read;
             odrl:target :dataset1, :dataset2;
             odrl:assigner :owner;
             odrl:assignee :alice
         ].
```


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Access Policy Examples 2/7

Limiting number of allowed requests

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Listing 2

```
@prefix spin: <http://spinrdf.org/sp/> .
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy2 a odrl:Agreement ;
         odrl:permission [
             a odrl:Permission;
             odrl:assigner :owner;
             odrl:assignee :alice;
             odrl:action odrl:read;
             odrl:target :dataset1;
             odrl:constraint [
                  a odrl:Constraint;
                  odrl:purpose spin:Ask;
                  odrl:operator odrl:lteq;
                  odrl:count "100"^^xsd:integer;
                  odrl:status "42"^^xsd:integer].].
```


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Access Policy Examples 3/7

Permit access only in specific time frames

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Listing 3

```
@prefix spin: <http://spinrdf.org/sp/> .
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy3 a odrl:Agreement ;
         odrl:permission [
             a odrl:Permission;
             odrl:assigner :owner;
             odrl:assignee :alice;
             odrl:action odrl:read;
             odrl:target :dataset1;
             odrl:constraint [
                  a odrl:Constraint;
                  odrl:purpose spin:Ask;
                  odrl:operator odrl:lteq;
                  odrl:dateTime "2016-12-31"^^xsd:date
             ] .
```


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Access Policy Examples 4/7
Representing license information (CC-BY-NC-SA)

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Listing 4

```
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy4 a odrl:Set;
         odrl:permission [
                  a odrl:Permission;
                  odrl:action odrl:reproduce,
                              odrl:distribute,
                              odrl:derive;
                  odrl:duty odrl:attribution,
                            odrl:attachPolicy,
                            odrl:shareAlike
         ] .
         odrl:prohibiton odrl:commercialize .
```

Villata et al. (ESWC 2014)

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Access Policy Examples 5/7

Defining rights for derived data

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Listing 5

```
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy5 a odrl:Set;
         odrl:permission [
             a odrl:Permission;
             odrl:action odrl:distribute;
             odrl:target :dataset;
             odrl:duty [
                a odrl:Duty;
                odrl:action odrl:nextPolicy;
                odrl:target :newPolicy ] .

:newPolicy a odrl:Set;
         odrl:permission [
             a odrl:Permission;
             odrl:action odrl:display;
             odrl:target :dataset] .
```


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Access Policy Examples 6/7

Introducing payment duties

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Listing 6

```
@prefix gr: <http://purl.org/goodrel/v1#> .
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy6 a odrl:Set;
         odrl:permission [
             a odrl:Permission;
             odrl:action odrl:read;
             odrl:target :dataset;
             odrl:duty [
               a odrl:Duty ;
               odrl:action odrl:pay ;
               odrl:constraint [
                  a odrl:Constraint ;
                  odrl:payAmount 50.00 ;
                  odrl:operator odrl:eq ;
                  odrl:unit <http://cvx.iptc.org/iso4217a:EUR>
               ] .
             ] .
```

odrl:unit & odrl:dataType with ODRL 2.1

Access Policy Examples 7/7
Combining prohibitions and permissions

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```
@prefix gr: <http://purl.org/goodrel/v1#> .
@prefix odrl: <http://w3.org/ns/odrl/2/> .
@prefix gn: <http://www.geonames.org/ontology#">.
@prefix : <http://www.example.com/> .

:policy7 a odrl:Set;
    odrl:permission [
       a odrl:Permission;
       odrl:action odrl:read;
       odrl:target :dataset;
       odrl:duty [
          a odrl:Duty;
          odrl:action odrl:pay;
           odrl:constraint [
             a odrl:Constraint ;
             odrl:payAmount 50.00 ;
             odrl:operator odrl:eq ;
             odrl:unit
                 <http://cvx.iptc.org/iso4217a:EUR>
           ] .
```

Listing 7

```
odrl:prohibtion [
   a odrl:Prohibition;
   odrl:action odrl:distribute;
   odrl:target :dataset;
   odrl:constraint [
      a odrl:Constraint;
      odrl:operator odrl:eq;
      odrl:spatial [
          a gn:Feature.
          gn:countryCode “AT”
      ] .
   ] .
] .
```

Reasoning Tasks:

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- As a first step, we look into implications between actions, permissions and duties associated with them which are ***not yet formally captured in ODRL***

- Next steps:
  - Consistency/Combinability of policies (for licences expressed in ODRL: **done** ;-) see last talk)
  - Alignment necessary in case policies refer to different RDF vocabularies?
  - E.g. Semantics of constraints needs more than plain OWL reasoning.
  - negotiation, etc. (not necessarily in scope of ODRL?)

Just a starting point...

- Formalizing ODRL 2.1:
- Conceptual model:

	ODRL Policy Components	
Policy	$\mathcal{P}$	$::= \mathcal{P}_{id} = [\langle(\mathcal{PRR}_{id}\|\mathcal{PER}_{id})^{+}\rangle, \mathcal{ALG}]$
ProhibitionRule	$\mathcal{PRR}$	$::= \mathcal{PRR}_{id} = [\mathcal{RM}, \mathcal{A}, \mathcal{CONS}]$
PermissionRule	$\mathcal{PER}$	$::= \mathcal{PER}_{id} = [\mathcal{RM}, \mathcal{A}, \langle\mathcal{DUR}^{*}_{id}\rangle, \mathcal{CONS}]$
DutyRule	$\mathcal{DUR}$	$::= \mathcal{DUR}_{id} = [\mathcal{RM}, \mathcal{A}, \mathcal{CONS}]$
ConstraintSet	$\mathcal{CONS}$	$::= \mathcal{CONS}_{id} = \langle\mathcal{CON}^{*}_{id}\rangle$
Constraint	$\mathcal{CON}$	$::= \mathcal{CON}_{id} = f^{bool}(status(a), operator(o), bound(a))$
RuleMatch	$\mathcal{RM}$	$::= \mathcal{RM}_{id} = \langle\mathcal{M}^{+}\rangle$
Match	$\mathcal{M}$	$::= \mathcal{M}_{id} = \phi(a)$
Action	$\mathcal{A}$	$::= \mathcal{A}_{id} = action(a)$
	$\phi(a)$	$::= party(a) \mid asset(a)$
	a	$::= value$
	o	$::=$ `eq` | `neq` | `lt` | `lteq` | `gt` | `gteq`
ConflictRes.Strat.	$\mathcal{ALG}$	$::=$ `perm` | `prohibit`| `invalid`
	Query & Proof	
QueryRequest	$\mathcal{Q}$	$::= \langle party(a)?, action(a), asset(a)\rangle$
DutyTarget	$\mathcal{DT}$	$::= \mathcal{DT}_{id} = \langle party(a)?, action(a), asset(a)?\rangle$
DutyProof	$\mathcal{DPF}$	$::= \mathcal{DPF}_{id} = [\mathcal{DT}, \mathcal{CON}_{id}, status(a)]$
Proof	$\mathcal{PF}$	$::= \mathcal{PF}_{id} = [\mathcal{CON}_{id}, status(a)]$
ProofSet	$\mathcal{PFS}$	$::= \langle(\mathcal{DPF}_{id}\|\mathcal{PF}_{id})^{*}\rangle$

Table 1. Abstract Syntax of ODRL

Just a starting point…

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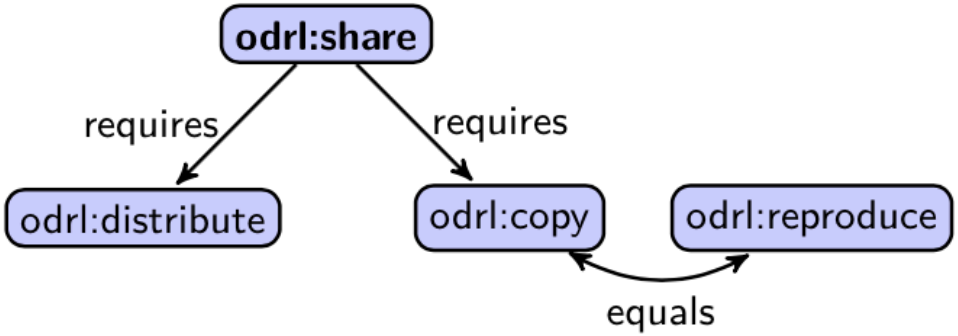
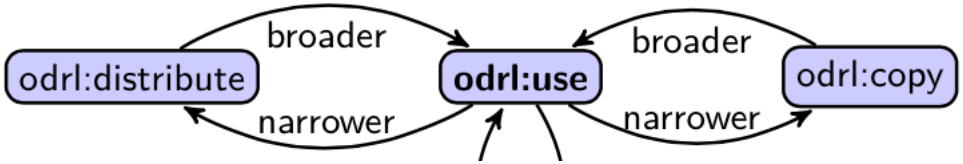
- **Implicit Dependencies among ODRL Actions**

odrl:share: *The act of the non-commercial* ***reproduction*** *and* ***distribution*** *of the asset to third-parties.*



- **Other dependencies expressed using SKOS (in the ODRL ontology):**



- Our current work:
  - 1) express these dependencies in terms of rules
  - 2) express ***conflict resolution strategies*** in rules

- `perm`: the `Permissions` will always takes precedence
- `prohibit`: the `Prohibitions` will always takes precedence
- `invalid`: the policy is not valid

Remarks:

- Some Duties/Prohibitions may be enforceable, others not. E.g.
  - "***Limiting number of allowed requests***" can be enforced by the server (block user)...
  - But how about controling ***distribution of items to which are readable only***?

    → read implies the ***ability*** "can copy/distribute,

  - → may make sense to distinguish between "enforcable" and non-enforcable" policies, between ability and enforcability?

  - Cf. existing work on policiy negotiation?

Summary: Representing &Reasoning about Linked Data policies with ODRL

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(1) only a starting point

- **Many more things to do: reasoning, enforcement of fulfillment, …**

(2) popular & emerging research topic

- **Rodríguez, Villata, Rotolo, Governatori…**

Other topics related to Normative MAS,I'd love to discuss, except enabling Data Markets (but no time ☹) … :

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- Policies and regulations in safety-critical engineering projects (national project SHAPE)
- Belief revision and SPARQL Update with RDFS/OWL entailment (national project SEE)
- How to enable Semantic Search in legal texts / laws? (project with the Federal Chancellery of Austria: RISearch)
- Details: http://www.polleres.net/

… Hopefully time to discuss these offline with you! ☺

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