RDF Mapping Language (RML)

A Generic Language for Integrated RDF Mappings of Heterogeneous Data

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http://semweb.mmlab.be/rml

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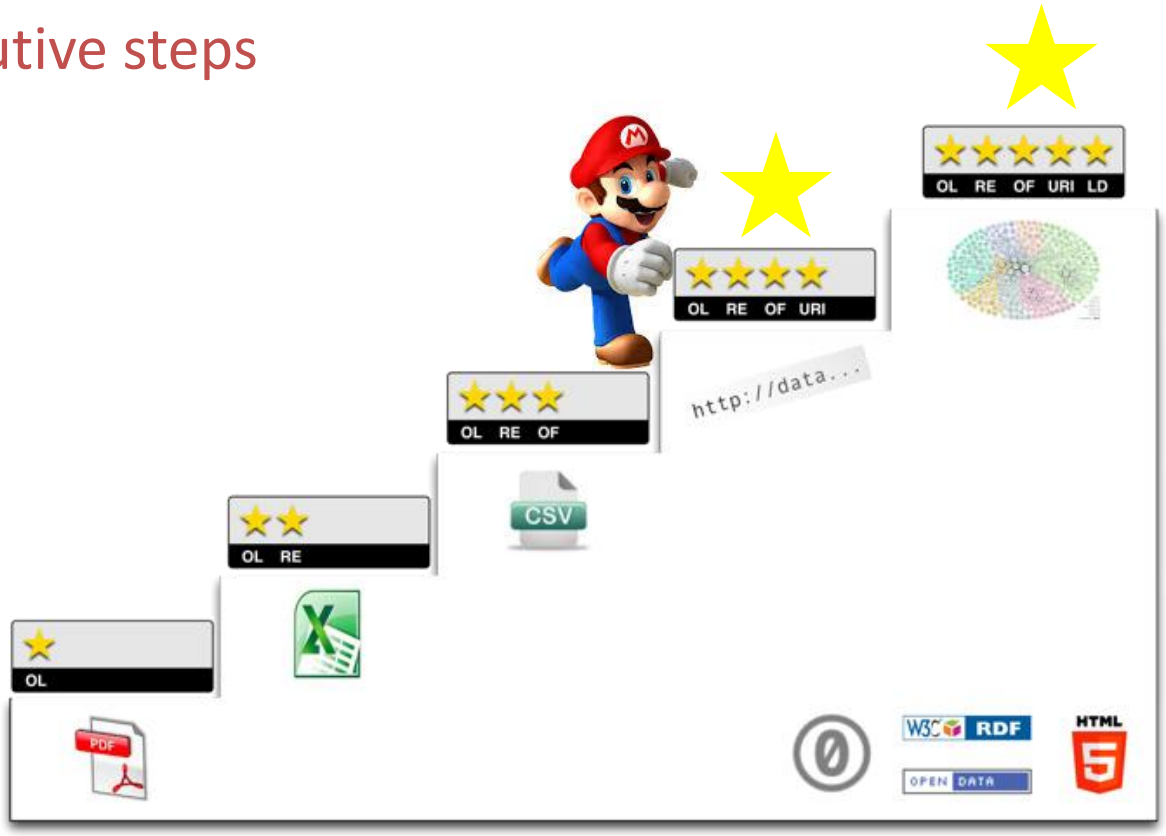
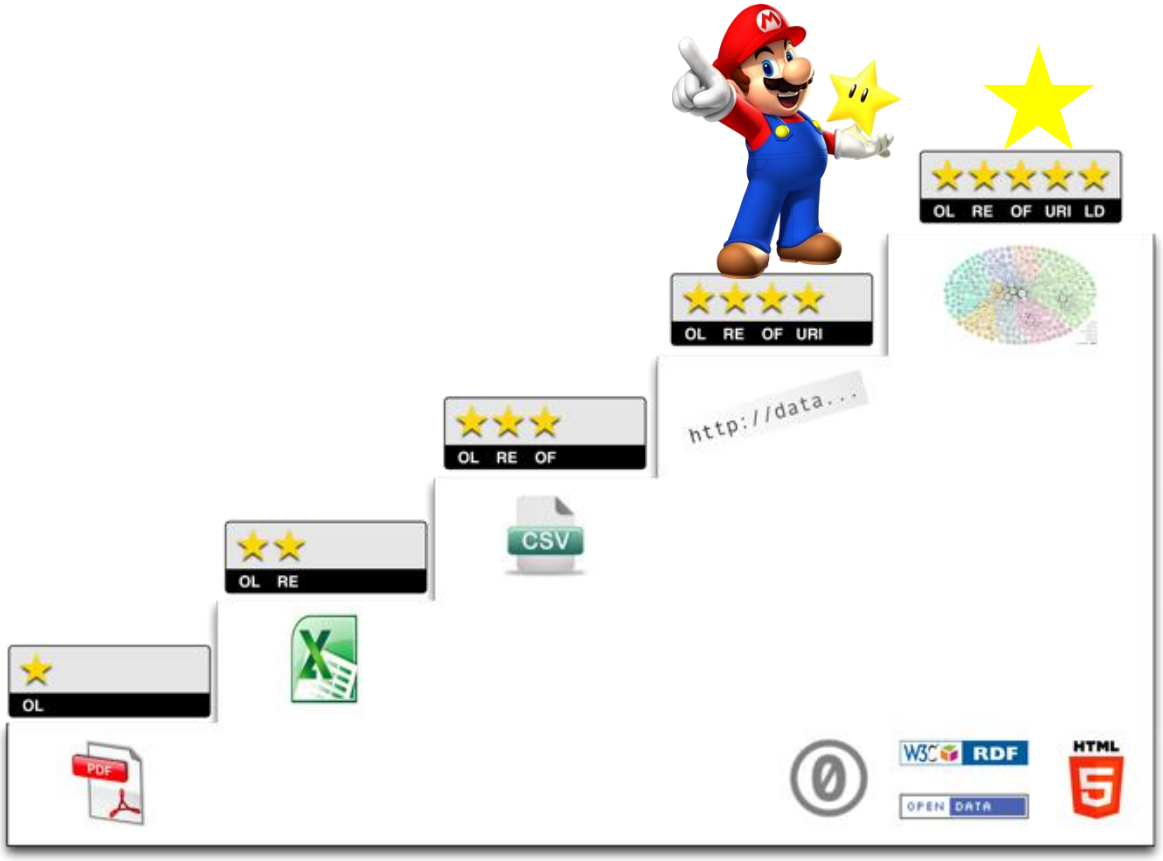
The five stars of the Linked Open Data scheme are approached as a set of consecutive steps



… and are applied to a single input source every time



Limitations of current solutions

The semantic representation of each mapped resource is

Independently defined

disregarding its possible prior definitions
and its links to other resources

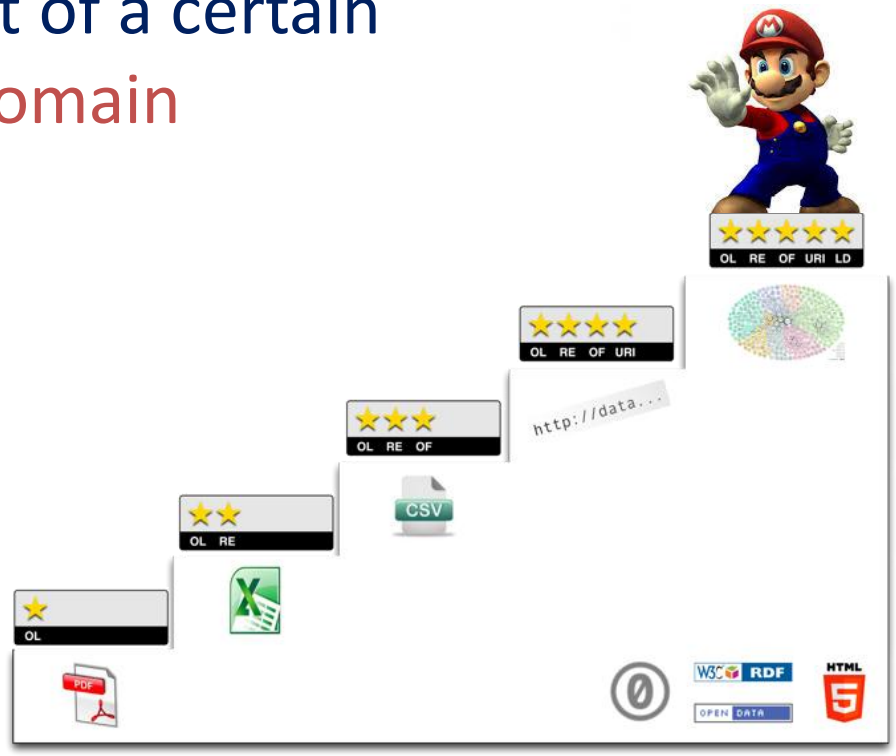
Manual aligned

to its prior appearances (if possible)
by reconstructing the same URIs

Not linked to other resources

links are defined after the data are mapped and published

Need for a well-considered policy regarding mapping and primary interlinking of data in the context of a certain knowledge domain

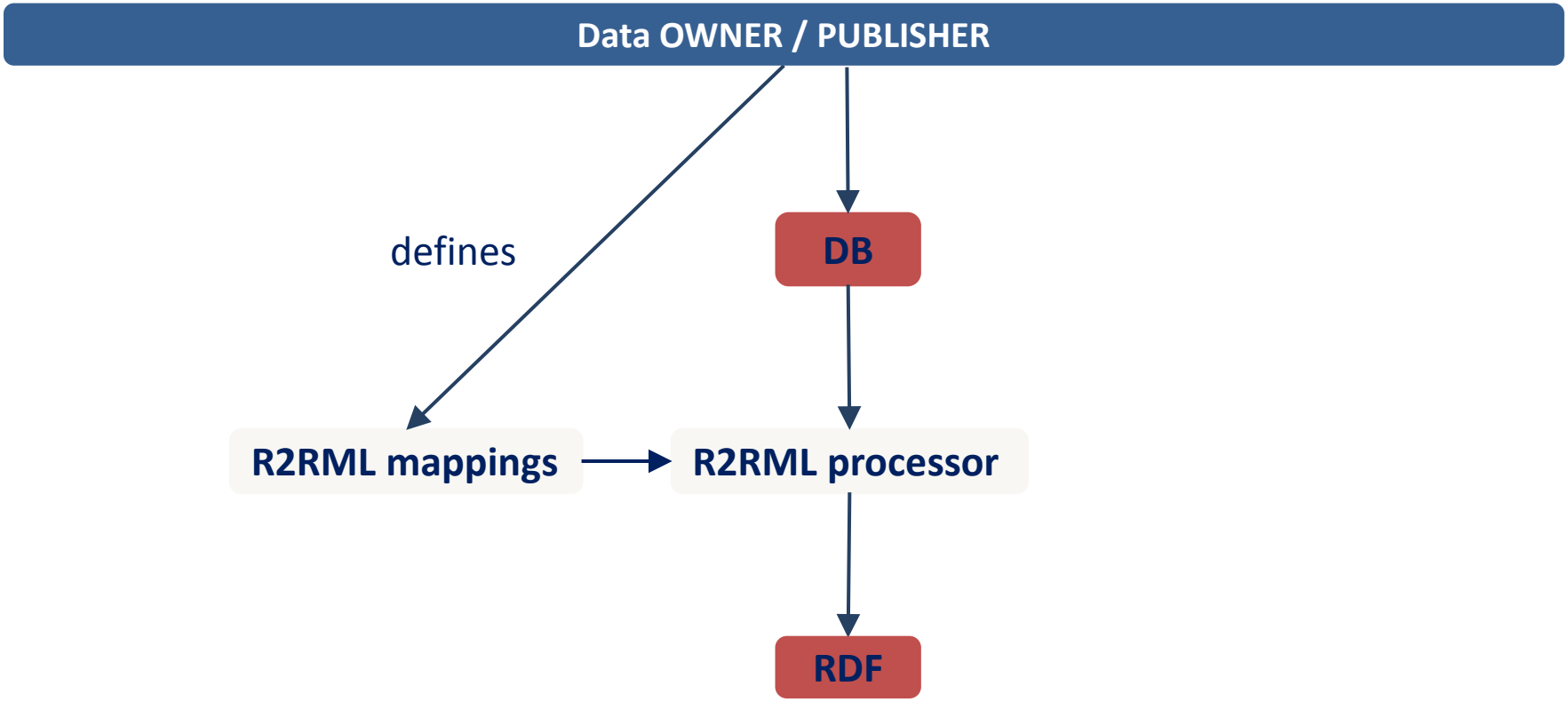


No mapping formalization

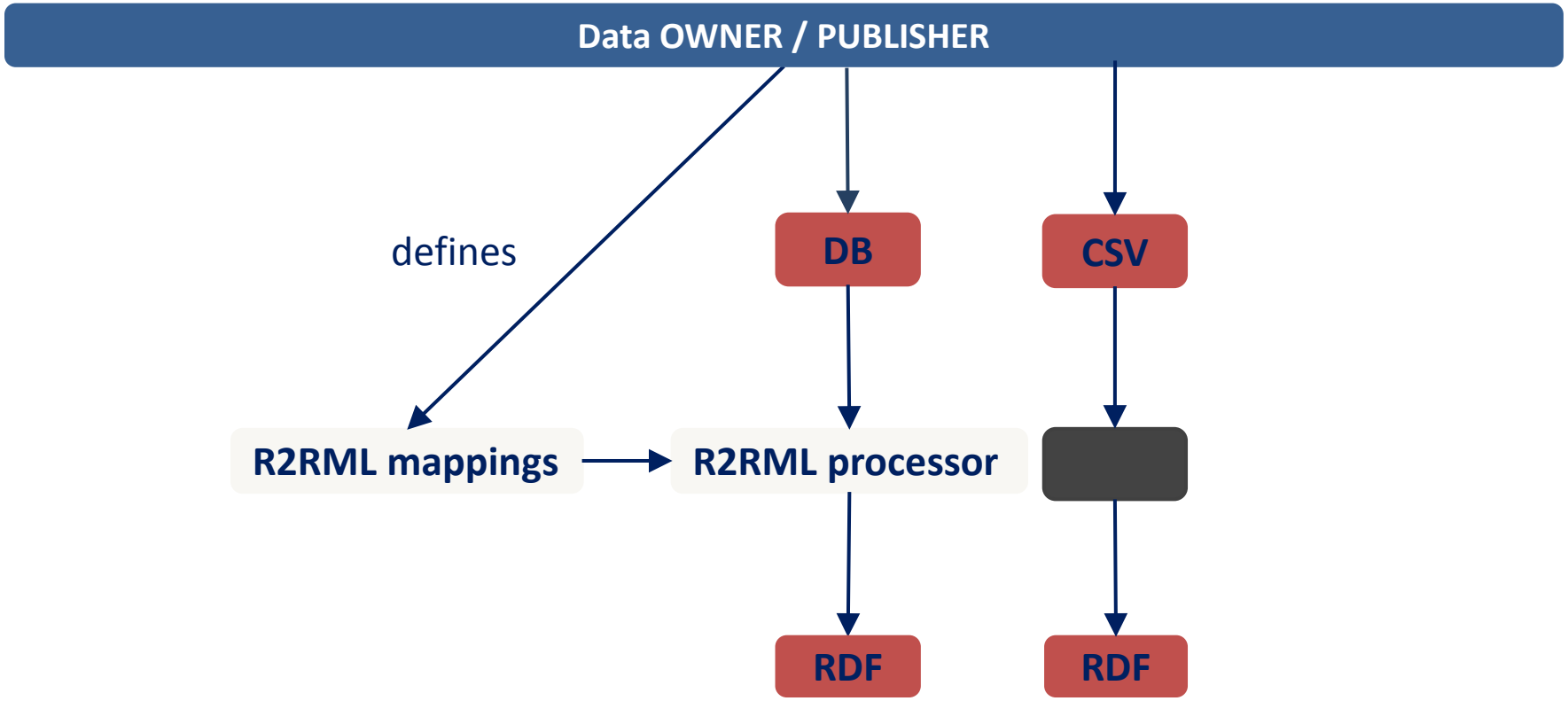
exists that defines how to map heterogeneous sources into RDF

using integrated and interoperable mappings.

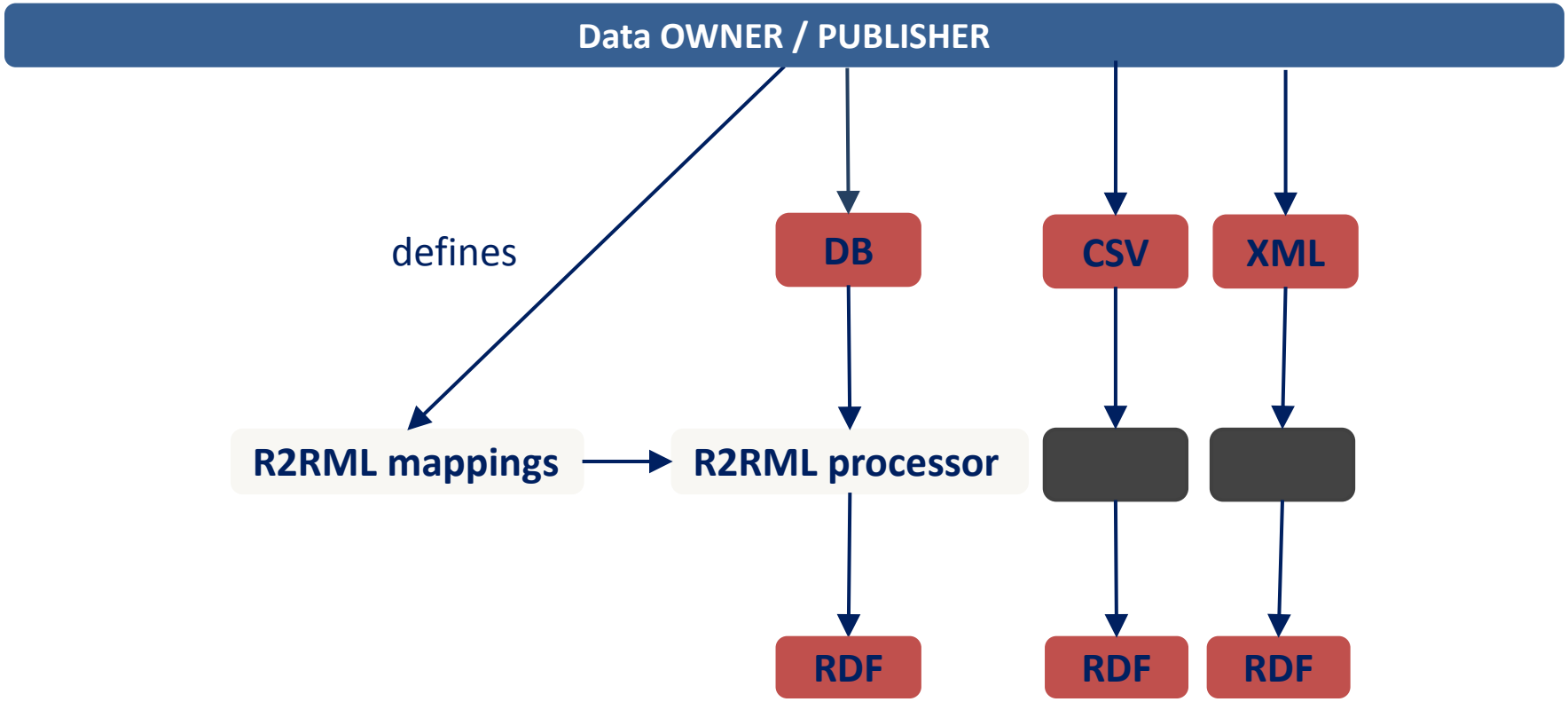
Relational Database to RDF (R2RML W3C)



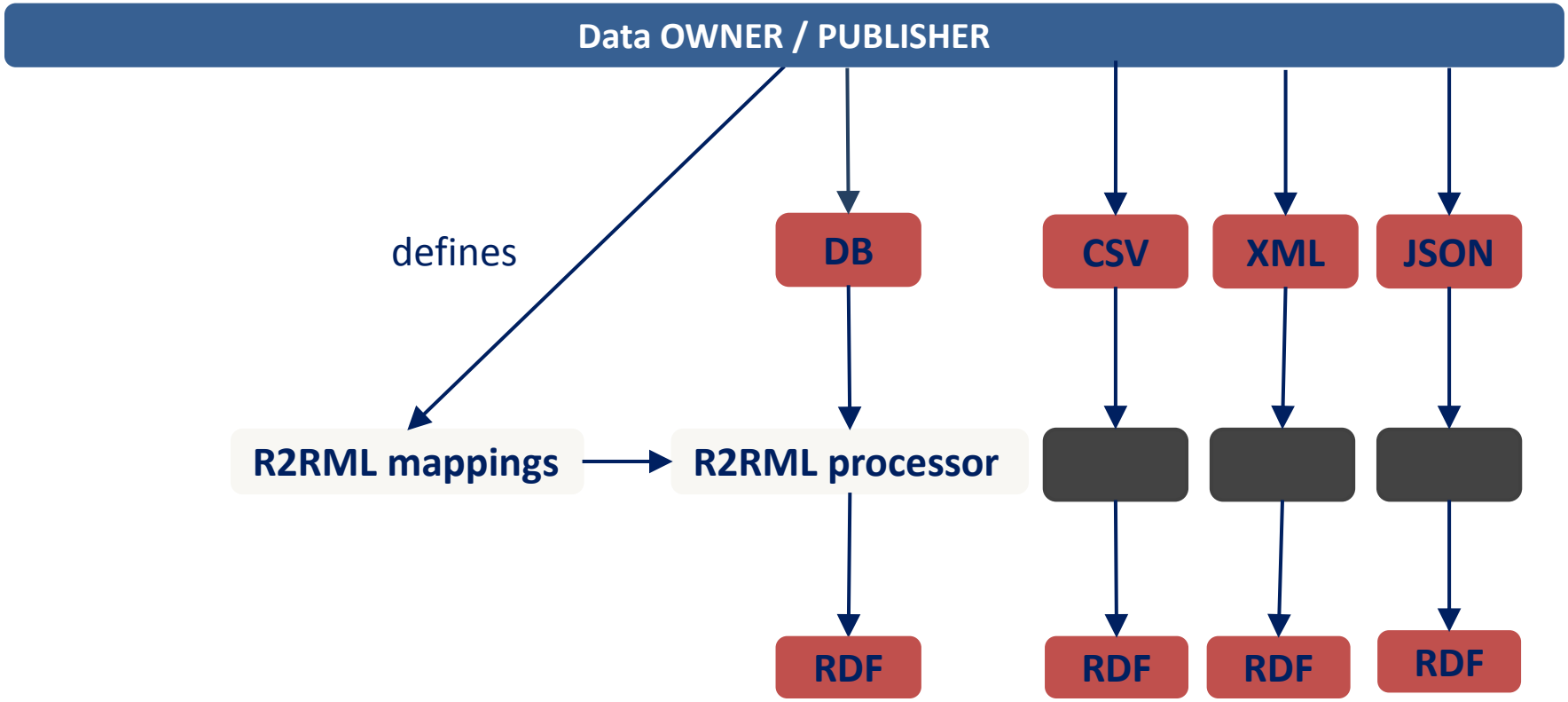
Mapping heterogeneous resources to RDF



Mapping heterogeneous resources to RDF



Current limitation:
mapping data on a per-source & per-format basis



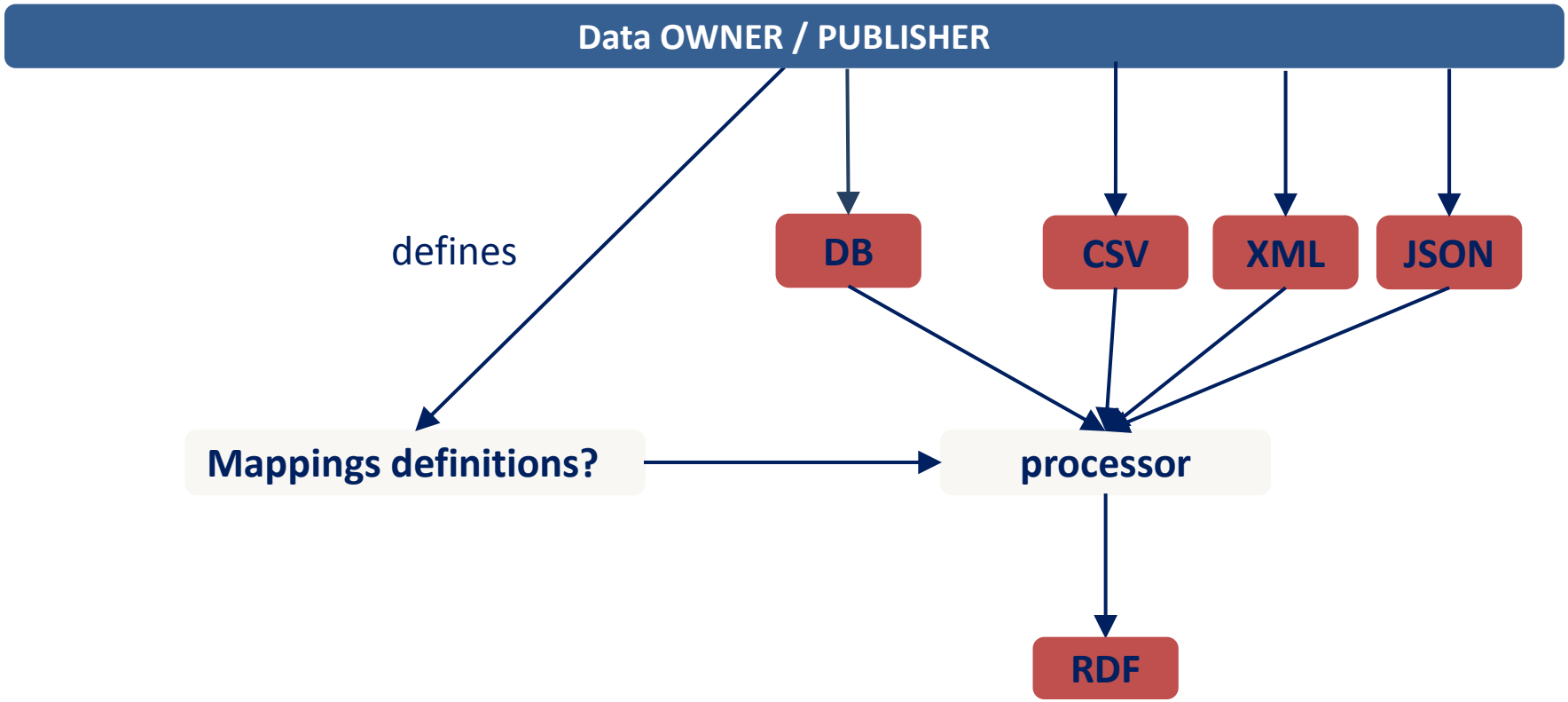
Further limitation:
lack of uniform and interoperable solutions

The mappings are tied to the implementations
not interoperable across different implementations

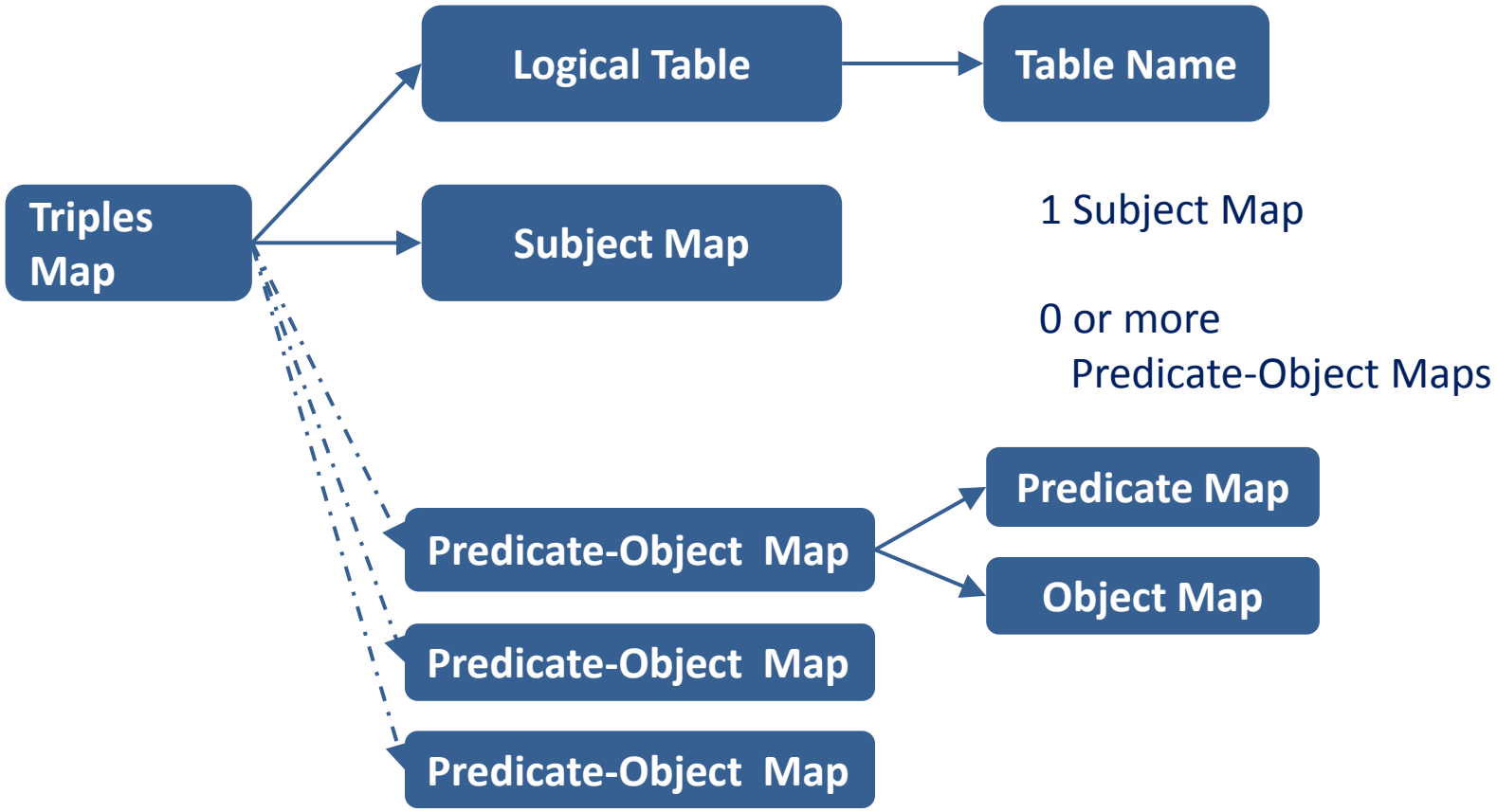
No uniform way to describe mappings of
heterogeneous resources that
describe complementarily the same domain

Mapping definitions are not reused
for data in the same or different formats

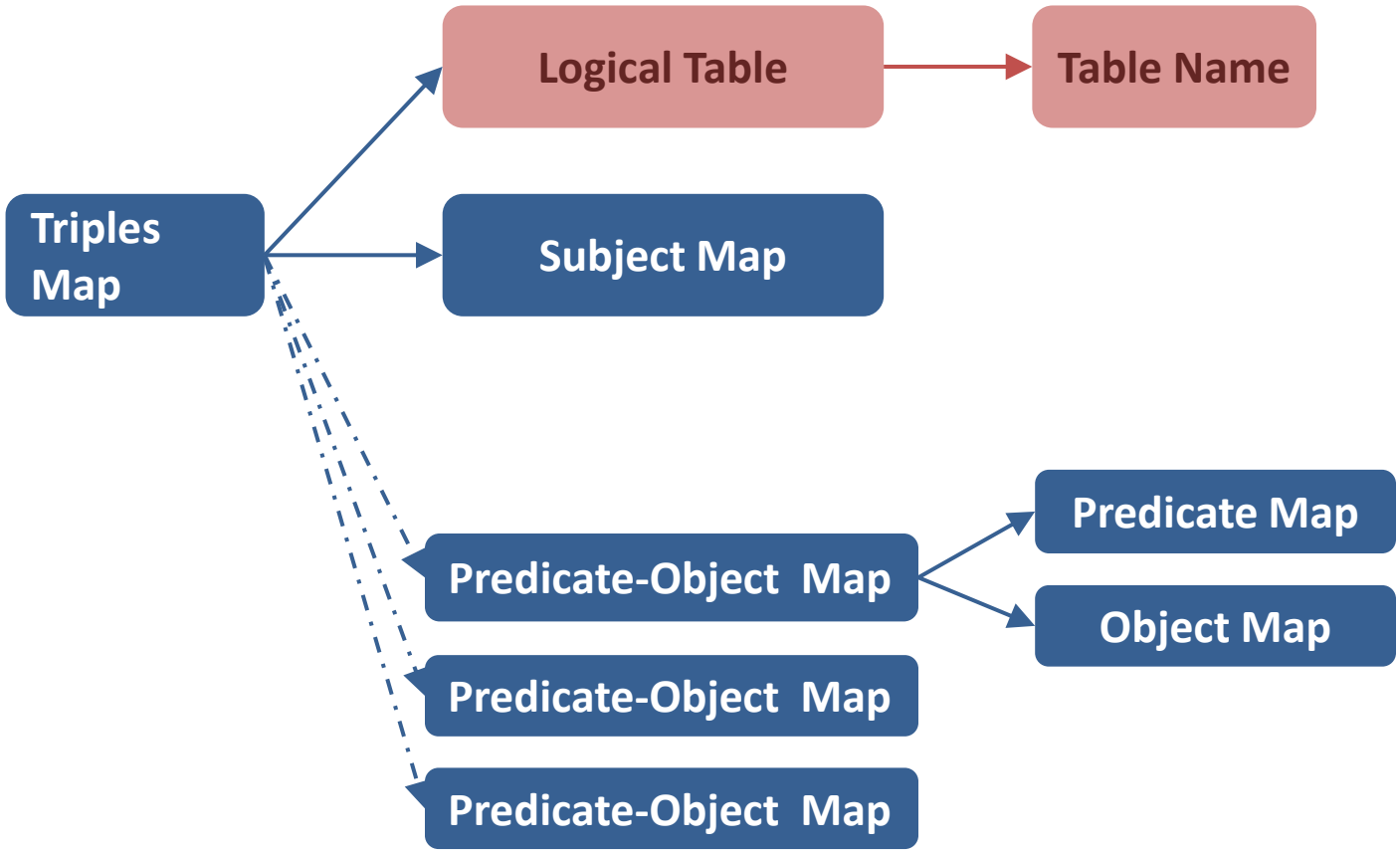
Uniform way for integrated mapping of heterogeneous sources



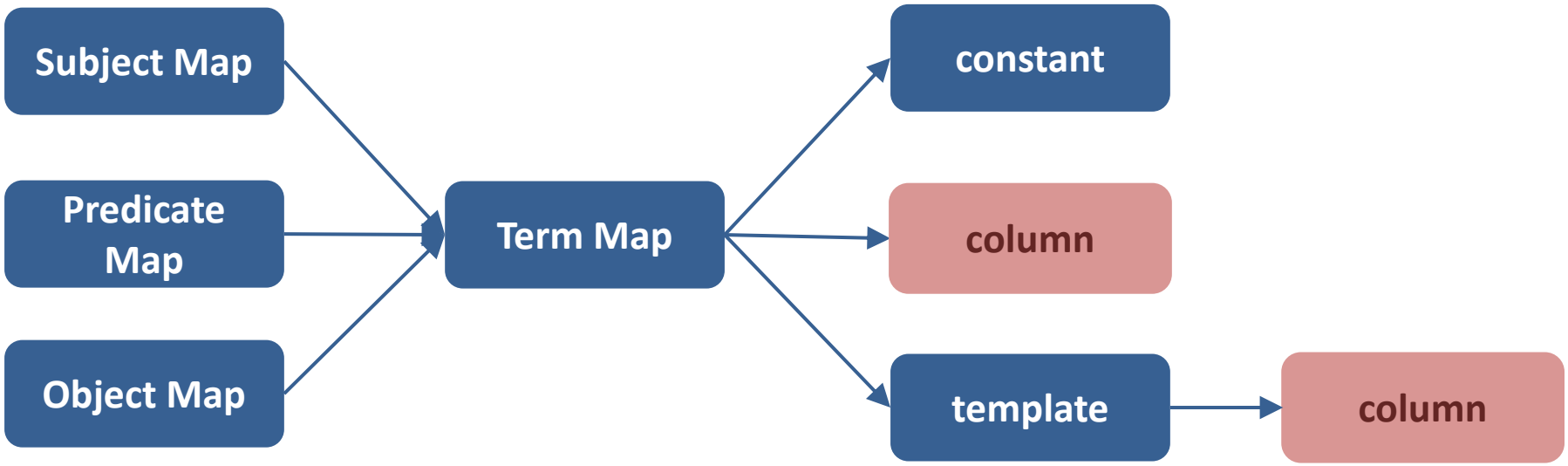
R2RML mapping definition



R2RML mapping definition



From R2RML to a generic mapping language



RDF Term :
- a URI,
- a literal,
- a blank node

R2RML Mapping

Suitcase	Name
567	Samsonite DeLux 45

ex:567 a schema:Product;
rdfs:label “Samsonite DeLux 45”.

```
<#ProductMapping>
  rr:logicalTable [
    rr:tableName “Suitcase" ];

  rr:subjectMap [
    rr:template "http://ex.com/{Suitcase}";
    rr:class ex:Person ];

  rr:predicateObjectMap [
    rr:predicate rdfs:label;
    rr:objectMap “Name” ].
```

from R2RML to a generic mapping language

R2RML	Generic mapping language
Logical Table	Logical Source (CSV, XML, JSON)
Table Name	Source name / URI
Column	???
per row iteration	???

References to values of heterogeneous resources

```
<PendingOrders>...
   <Order  id="398">
      <Product>
         <Id>AE5982</Id>
         <Name>Samsonite DeLux 45</Name>
      </Product>
   </Order>...
<PendingOrders>
```

XPath for XML

Reference:

"Order@Id"

Iterator:

"/PendingOrders /Order"

```
{ … ,
"ProductInStock" :
 { "ID": "567",
   "Name": "Samsonite DeLux 45",
   "type": "suitcase",
 },  …
}
```

JSONPath for JSON

Reference:

"$. ProductInStock.ID"

Iterator:

"$.ProductInStock"

from R2RML to a generic mapping language

R2RML	~~R2~~RML
Logical Table	Logical Source (CSV, XML, JSON)
Table Name	Source name / URI
Column	Reference (defined Reference Formulation)
per row iteration	defined Iterator

Mapping XML files

```
<PendingOrders>…
  <Order  id="398">
    <Product>
      <Id>AE5982</Id>
      <Name>Samsonite DeLux 45</Name>
    </Product>
  </Order> …
</PendingOrders>
```

ex:AE5982 a schema:Product ;
rdfs:label “Samsonite DeLux 45”.

```
<#OrdersMapping>
  rml:logicalSource [
    rml:source “orders.xml";
    rml:referenceFormulation ql:XPath;
    rml:iterator “/PendingOrders/Order/Product” ];

  rr:subjectMap [
    rr:template http://ex.com/{Id};
    rr:class schema:Product ];

  rr:predicateObjectMap [
      rr:predicate rdfs:label ;
      rr:object “Product/Name” ] .
```

Mapping JSON files

```
{ … ,
“ProductInStock” :
 { “ID”: "567",
   “Name”: “Samsonite DeLux 45”,
   “type”: “suitcase”
 },  …
}
```

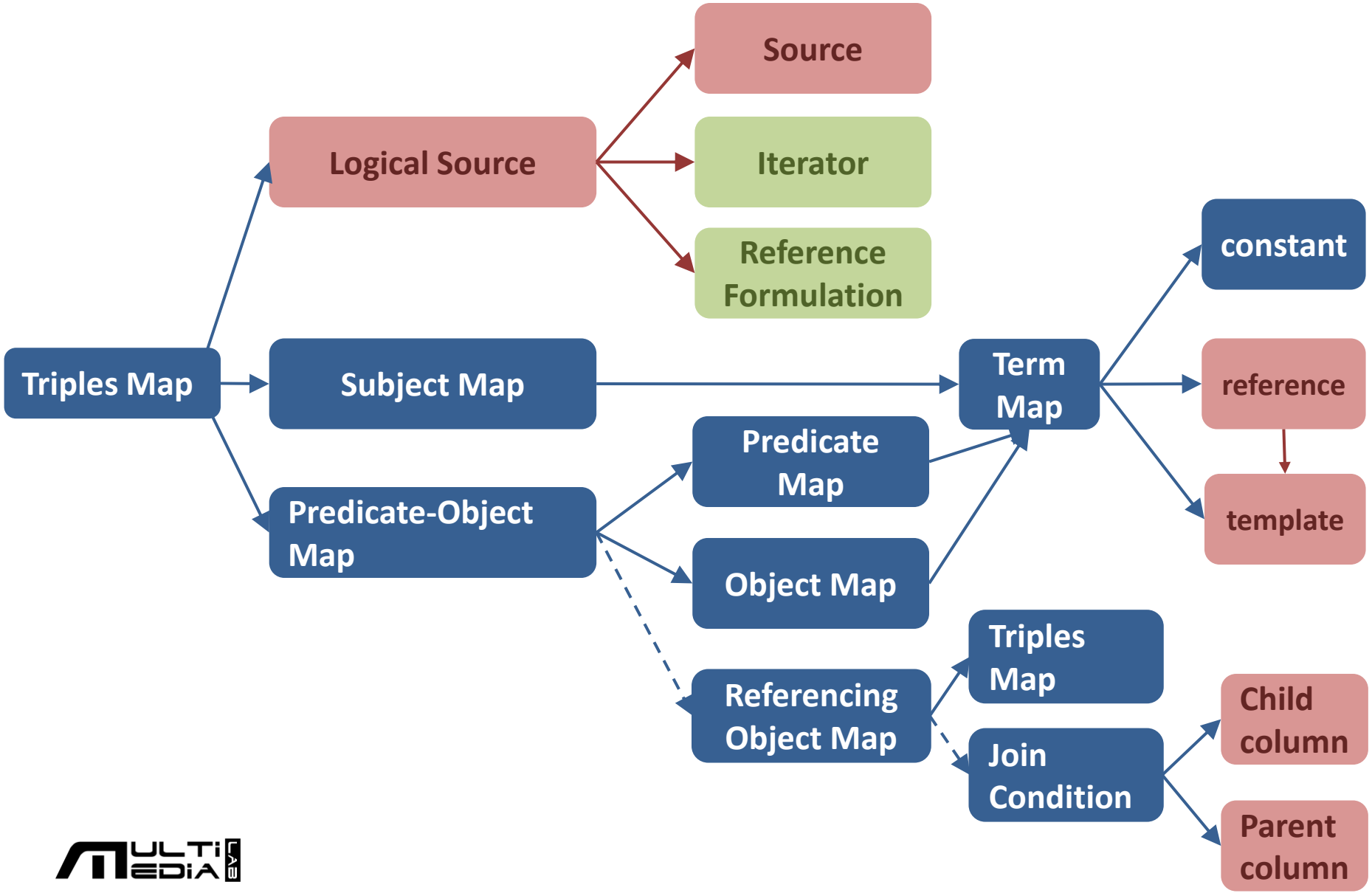
```
ex:567 a schema:Product ;
        rdfs:label “Samsonite DeLux 45” .
```

```
<#ProductInStockMapping>
    rml:logicalSource [
      rml:source “stock.json";
      rml:referenceFormulation ql:JSONPath;
      rml:iterator “$.ProductInStock” ];

    rr:subjectMap [
      rr:template http://ex.com/{ID};
      rr:class schema:Product ];

    rr:predicateObjectMap [
       rr:predicate rdfs:label ;
       rr:object “Name” ] .
```

RDF Mapping Language (RML)



Robust cross-references

```
{ ... "Performance" :
  { "Perf_ID": "567",
    "Location": {
      "lat": "51.043611" ,
      "long": "3.717222"}
   },
... }
```

```
<#PerformancesMapping>
  rr:subjectMap [
     rr:template “http://ex.com/{Perf_ID}”];

 rr:predicateObjectMap [
   rr:predicate ex:location;
   rr:objectMap [
     rr:parentTriplesMap <#LocationMapping> ] ].
```

```
<Events> ...
  <Exhibition id="398">
    <Location>
      <lat>51.043611</lat>
      <long>3.717222</long>
    </Location>
  </Exhibition> ...
</Events>
```

```
<#EventsMapping>
  rr:subjectMap [
    rr:template "http://ex.com/{@id}" ];

rr:predicateObjectMap [
    rr:predicate ex:location;
    rr:objectMap [
      rr:parentTriplesMap <#LocationMapping> ] ];
```

Robust cross-references

```
{ ... "Performance" :
  { "Perf_ID": "567",
    "Location": {
      "lat": "51.043611" ,
      "long": "3.717222“ } } ,
... }
```

```
<Events> ...
  <Exhibition id="398">
    <Location>
      <lat>51.076891</lat>
      <long>3.717222</long>
    </Location>
  </Exhibition> ... ...
</Events>
```

```
<#LocationMapping>
  rr:subjectMap [
    rr:template "http://ex.com/{lat},{long}"];

  rr:predicateObjectMap [
    rr:predicate ex:long;
    rr:objectMap [ rml:reference "long" ] ];

  rr:predicateObjectMap [
    rr:predicate ex:lat;
    rr:objectMap [ rml:reference "lat" ] ] .
```

```
ex:567 ex:location ex:51.043611, 3.717222
ex:398 ex:location ex:51.076891, 3.717222

ex:51.043611, 3.717222
    ex:lat ex:3.717222
    ex:long ex:51.043611.
```

Primary Interlinking

```
{ ... "Performance" :
  { "Perf_ID": "567",
    "Venue": {
      "Name": "STAM",
      "Venue_ID": "78" },
    "Location": {
      "long": "3.717222",
      "lat": "51.043611" } } , ... }
```

```
<#PerformancesMapping>
 rr:subjectMap [
   rr:template “http://ex.com/{Perf_ID}”];

   rr:predicateObjectMap [
     rr:predicate ex:venue;
     rr:objectMap [
       rr:parentTriplesMap <#VenueMapping> ] ].


<#VenueMapping>
  rml:logicalSource [
    rml:source "http://ex.com/performances.json";
    rml:referenceFormulation ql:JSONPath;
    rml:iterator "$.Performance.Venue.[*]" ];

rr:subjectMap [
      rr:template "http://ex.com/{Venue_ID}";
      rr:class ex:Venue ].
.
```

Primary Interlinking

```
{ ... "Performance" :
  { "Perf_ID": "567",
    "Venue": {
    "Name": "STAM",
    "Venue_ID": "78" },
... }
```

```
<Events> ...
  <Exhibition id="398">
    <Venue>STAM</Venue>
  </Exhibition> ... ...
</Events>
```

```
<#EventsMapping>
  rr:subjectMap [
    rr:template "http://ex.com/{@id}" ];

  rr:predicateObjectMap [
    rr:predicate ex:venue;
    rr:objectMap [
      rr:parentTriplesMap <#VenueMapping>;
        rr:joinCondition [
          rr:child "$.Performance.Venue.Name";
          rr:parent "/Events/Exhibition/Venue" ] ] ] .
```

```
ex:567 ex:venue ex:78.
ex:398 ex:venue ex:78.
```

Robust cross-references and primary interlinking

Avoid redefining and replicating URI patterns

Uniquely define the URI patterns that
generates a resource and refer to its definition

Modifications to the patterns or data values
are propagated to every other reference of the resource

Links between resources in different inputs
are defined already on mapping level

New mappings are automatically aligning

Extensibility and Scalability

Address the mappings definition in a generic way
scale over the input data extracts.

Distinct and not interdependent
references to the data extracts and the mappings

Proof: CSS3 selectors to map HTML documents
enrich the aforementioned data with data from amazon.com and ebay

Conclusions: Addressed Limitation

Limitations:

Mapping of data on a per-source and per-format basis

Mapping definitions are tied to the implementation

Lack of Mapping definitions' reuse

RDF Mapping Language (RML):

Uniform and interoperable mapping definitions

Robust cross-references and interlinking

Scalable mapping language

RDF Mapping Language (RML)

generic language for mapping
heterogeneous resources into RDF
in an integrate and interoperable fashion

RML: http://semweb.mmlab.be/rml
RML Processor: https://github.com/mmlab/RMLProcessor

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