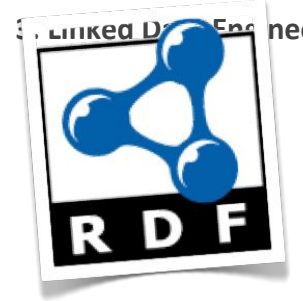
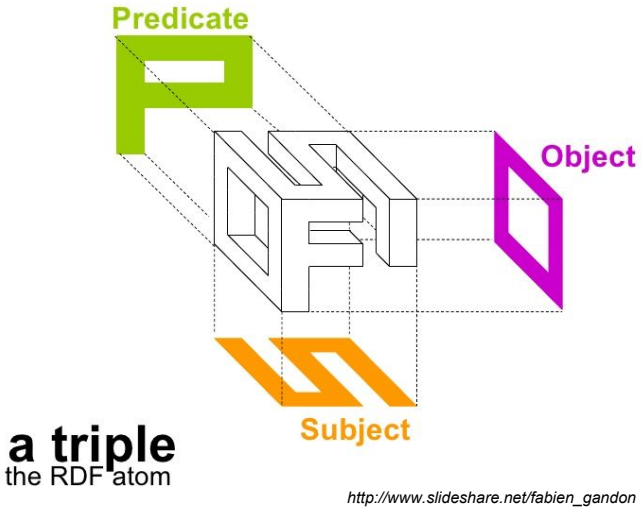
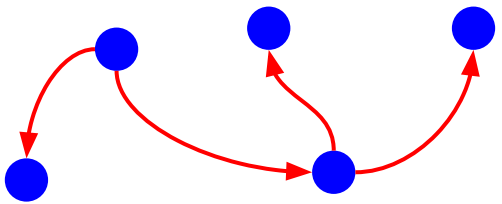
Resource Description Framework



RDF is a **Triple Model**
i.e. every piece of knowledge is broken down into
(**subject** , **predicate** , **object**)



RDF is a **Graph Model**
i.e. every piece of knowledge is interpreted as
(**vertex** , **edge** , **vertex**)



Resource Description Framework

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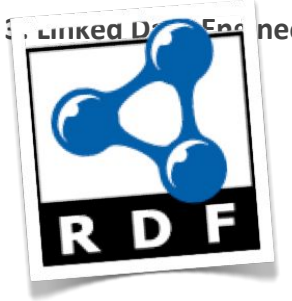
… … …

Subject **Property** **Object**

RDF Triples



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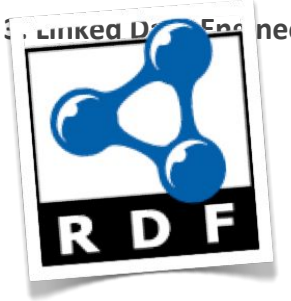
Individuals (Entities)



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Classes

Resource Description Framework

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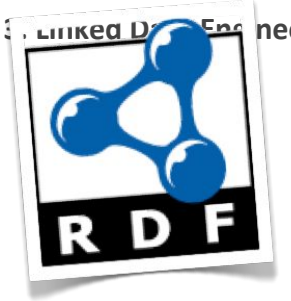
Literals



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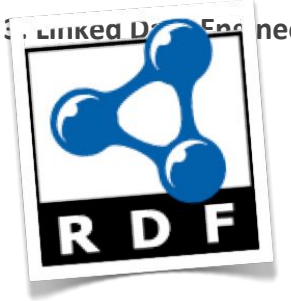
Properties



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… … …

Vocabularies / Ontologies

Resource Description Framework

- **Knowledge in RDF** is expressed as a **list of statements**
- all RDF statements follow the same simple schema, i.e. the **RDF Triple**

Subject	Property	Object / Value	
URI	**URI**	**URI / Literal**	RDF Building Blocks

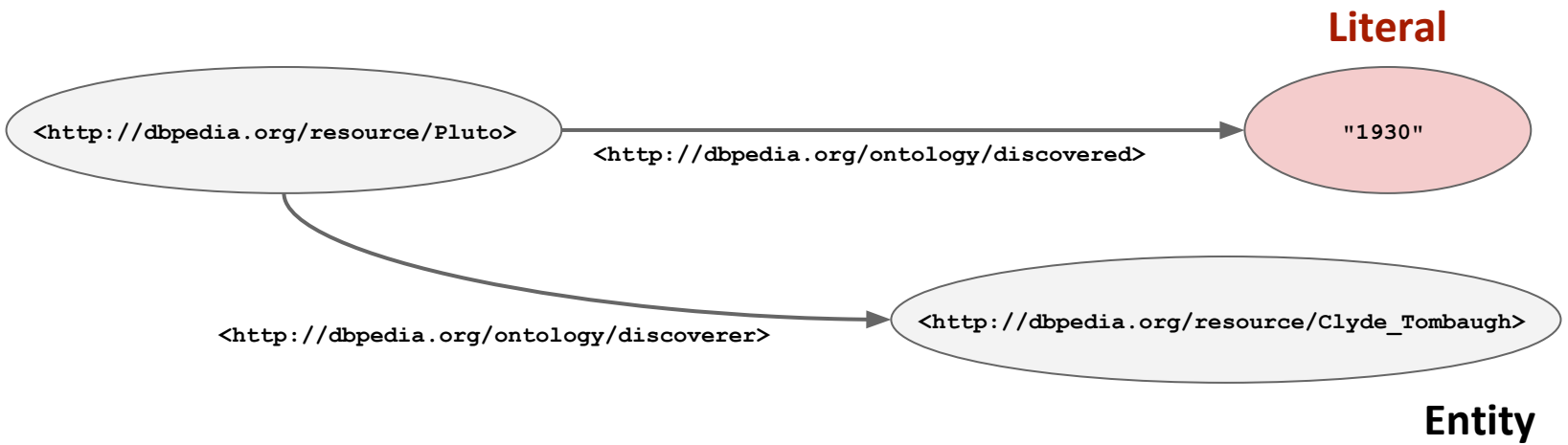
N-Triples Serialization

```
<http://dbpedia.org/resource/Pluto>    <http://dbpedia.org/ontology/discovered>    "1930" .
```

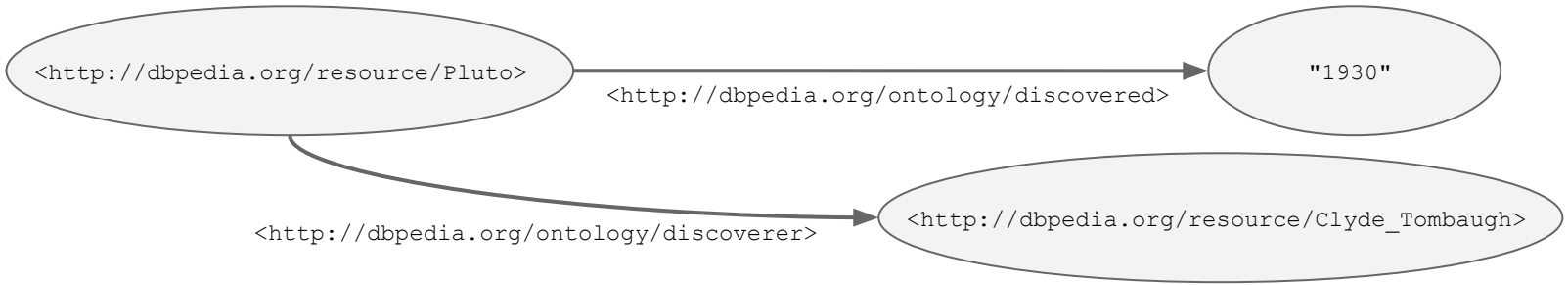
graph representation

Resource Description Framework

- **URIs and Literals**
  - **URIs** reference resources uniquely
  - **Literals** describe data values that don't have a separate existence



RDF Serializations



- **Turtle (Terse RDF Triple Language) Notation**
  - extension of N-Triples

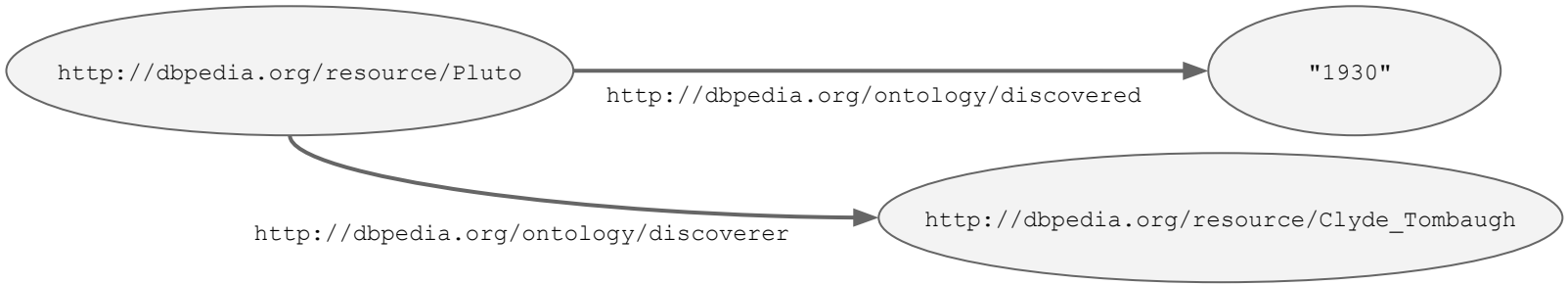
```
@prefix dbo: <http://dbpedia.org/ontology/> .
@base  <http://dbpedia.org/resource/> .

<Pluto> dbo:discovered "1930" .

<Pluto> dbo:discoverer <Clyde_Tombaugh> .
```

RDF/Turtle allows shortcuts and abbreviations for readability

RDF/Turtle



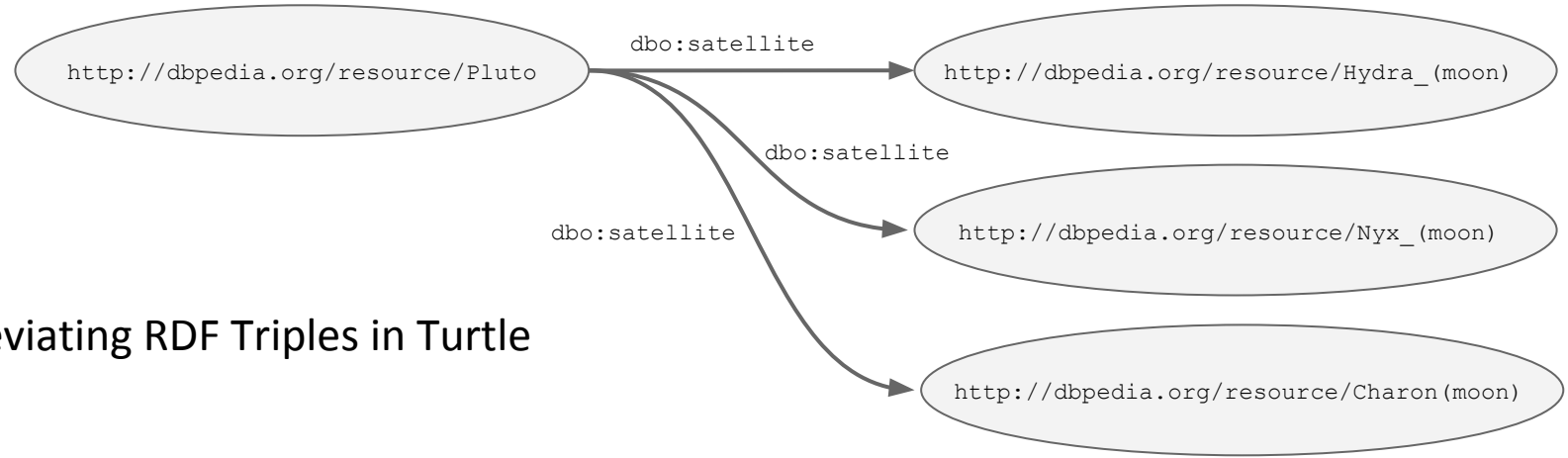
- Abbreviating RDF Triples in Turtle

```
@prefix dbo: <http://dbpedia.org/ontology/> .
@base  <http://dbpedia.org/resource/> .

<Pluto> dbo:discovered "1930" ;
        dbo:discoverer <Clyde_Tombaugh> .
```

semicolon indicates that subsequent triples have the same subject **(predicate list)**

RDF/Turtle



- Abbreviating RDF Triples in Turtle

```
@prefix dbo: <http://dbpedia.org/ontology/> .
@base  <http://dbpedia.org/resource/> .

<Pluto> dbo:satellite <Hydra_(moon)> ,
                      <Nyx_(moon)> ,
                      <Charon_(moon)> .
```

comma indicates that subsequent triples have same subject and property **(object list)**

RDF Schema

- **RDF Schema**, officially called "**RDF Vocabulary Description Language**"

- RDF Schema allows:
  - Definition of **classes** via `rdfs:Class`
  - Class instantiation in RDF via `rdf:type`
  - Example:

```
:Planet rdf:type rdfs:Class .
:Earth  rdf:type :Planet .
```

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix :     <http://example.org/Space#> .
```

RDF Schema

- Definition of **properties** via `rdf:Property`
- Definition of **property restrictions on domain and range** via `rdfs:domain` and `rdfs:range`
- Example

```
:CelestialBody rdf:type     rdfs:Class .
:satelliteOf   rdf:type     rdf:Property .
:satelliteOf   rdfs:domain  :CelestialBody .
:satelliteOf   rdfs:range   :CelestialBody .
```

RDF Schema

- Some more properties:
  - **rdfs:seeAlso**
    defines a relation of a resource to another, which explains it
  - **rdfs:isDefinedBy**
    subproperty of `rdfs:seeAlso`, defines the relation of a resource to its definition
  - **rdfs:comment**
    comment, usually as text
  - **rdfs:label**
    „readable“ name of a resource (contrary to ID)

04 - Linked Data Engineering

Open HPI - Course: Semantic Web Technologies - Lecture 6: Applications in the Web of Data

How to Get Data From the Web?

- There is a number of different (proprietary) **Web APIs**, data exchange formats, and **Mashups** on top of that

Mashup

Web API 1

Web API 2

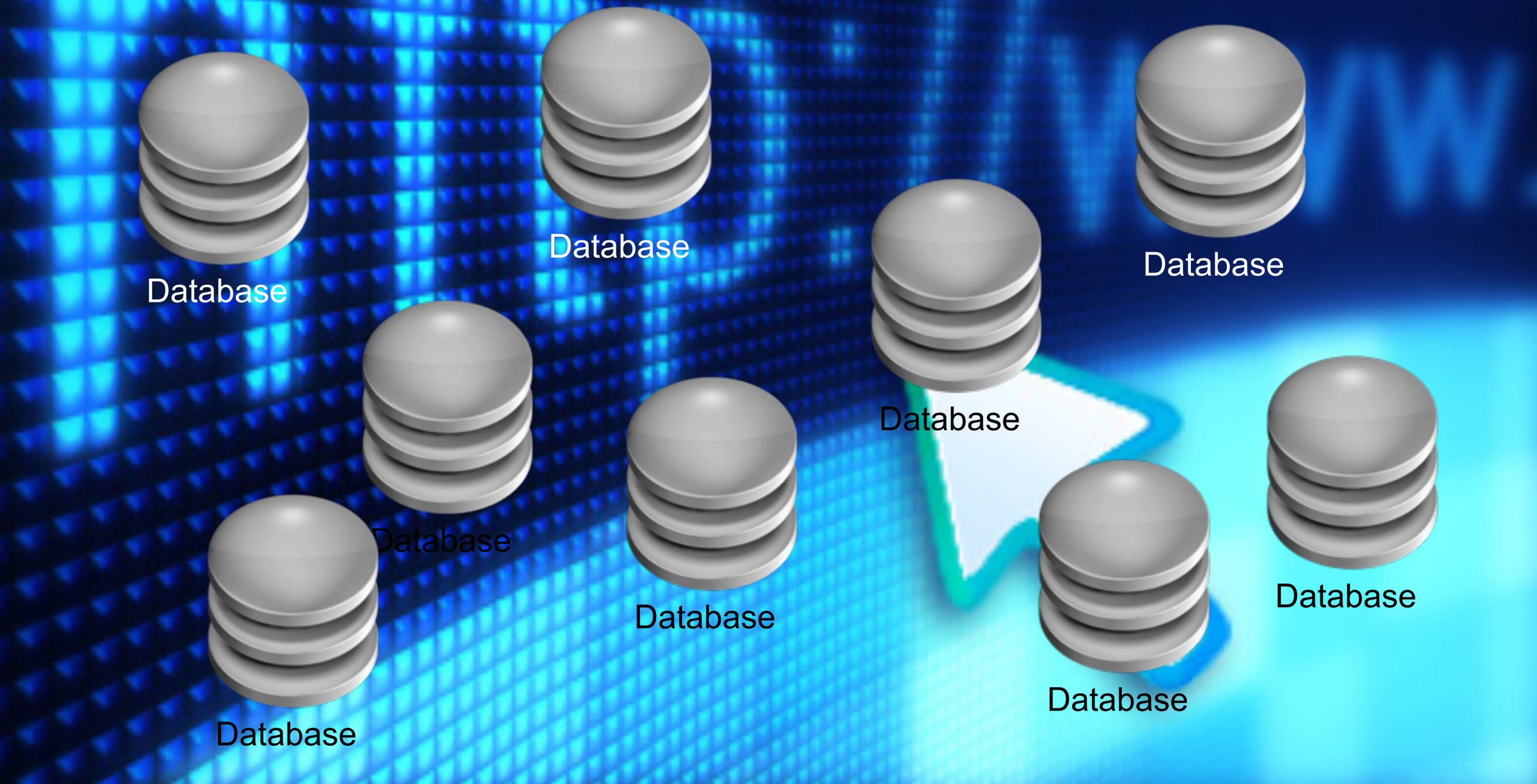
Web API 3

Web API 4

Database 1 Database 2 Database 3 Database 4

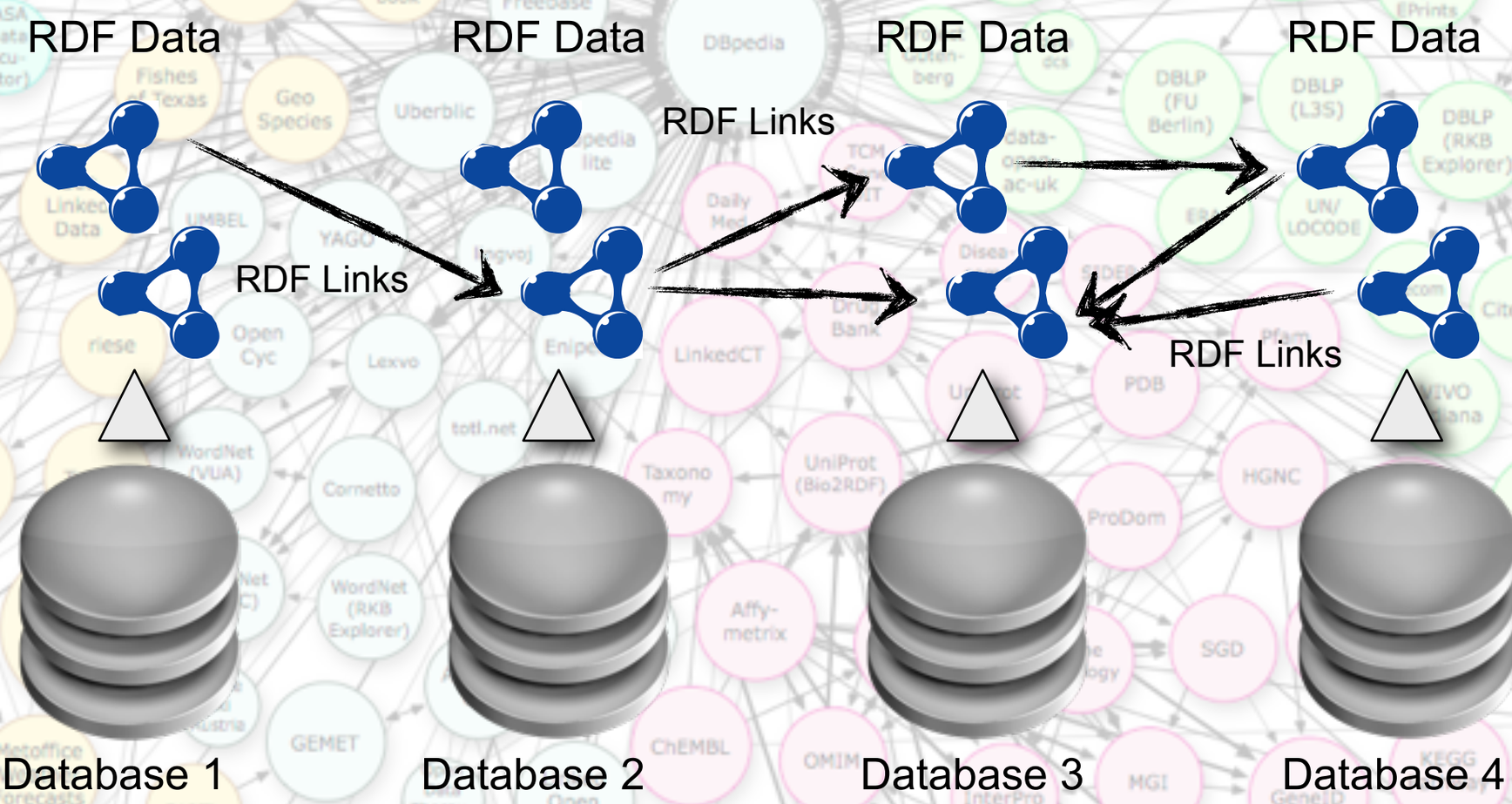
In the Web today...

- Data is locked up in small data islands
- Other applications usually cannot access this data...



How to Get Rid of Closed Data Islands on the Web?

- Apply semantic technologies:
  - to publish structured data on the web
  - to draw connections from one data source to data from other data sources



Linked Data Principles

(1) Use **URIs** as names for things.

(2) Use **HTTP URIs**, so that people can **look up** those names.

(3) When someone looks up a URI, provide **useful information**, using the **standards** (RDF, SPARQL)

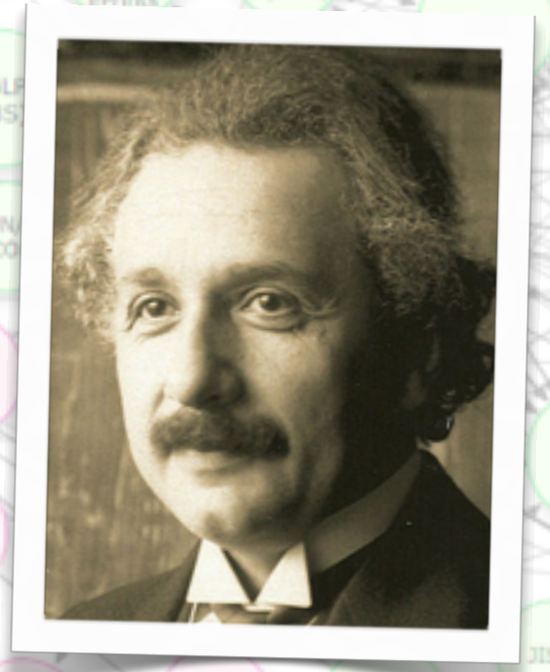
(4) Include **links to other URIs**, so that they can discover more things.

Linked Data Principles

(1) Use **URIs** as names for things.

- URIs do not only identify documents but also arbitrary objects of the real world as well as abstract concepts

http://yovisto.blogspot.com/



http://dbpedia.org/resource/Albert_Einstein

http://musicbrainz.org/artist/b10bbbfc-cf9e-42e0-be17-e2c3e1d2600d

Linked Data Principles

(2) Use **HTTP URIs**, so that people can **look up** those names.

- HTTP URIs (URLs) as globally unique names enable dereferencing of assiciated information in the Web
- via http Content Negotiation
- 303 URIs
  http Response Code `303 ‚See Other‘` (redirect)
- Hash URIs
  `http://example.com/Harald#me`

Linked Data for Humans and Computers

- URI should deliver information as well as for humans as for computers, i.e.

(Thing)

http://dbpedia.org/resource/Ernest_Hemingway

Accept:
application/rdf+xml

http://dbpedia.org/data/
Ernest_Hemingway.rdf

(RDF data)

Accept: text/html

http://dbpedia.org/page/
Ernest_Hemingway

(HTML page)

Linked Data Principles

(3) When someone looks up a URI, provide **useful information**, using the **standards** (RDF, SPARQL)

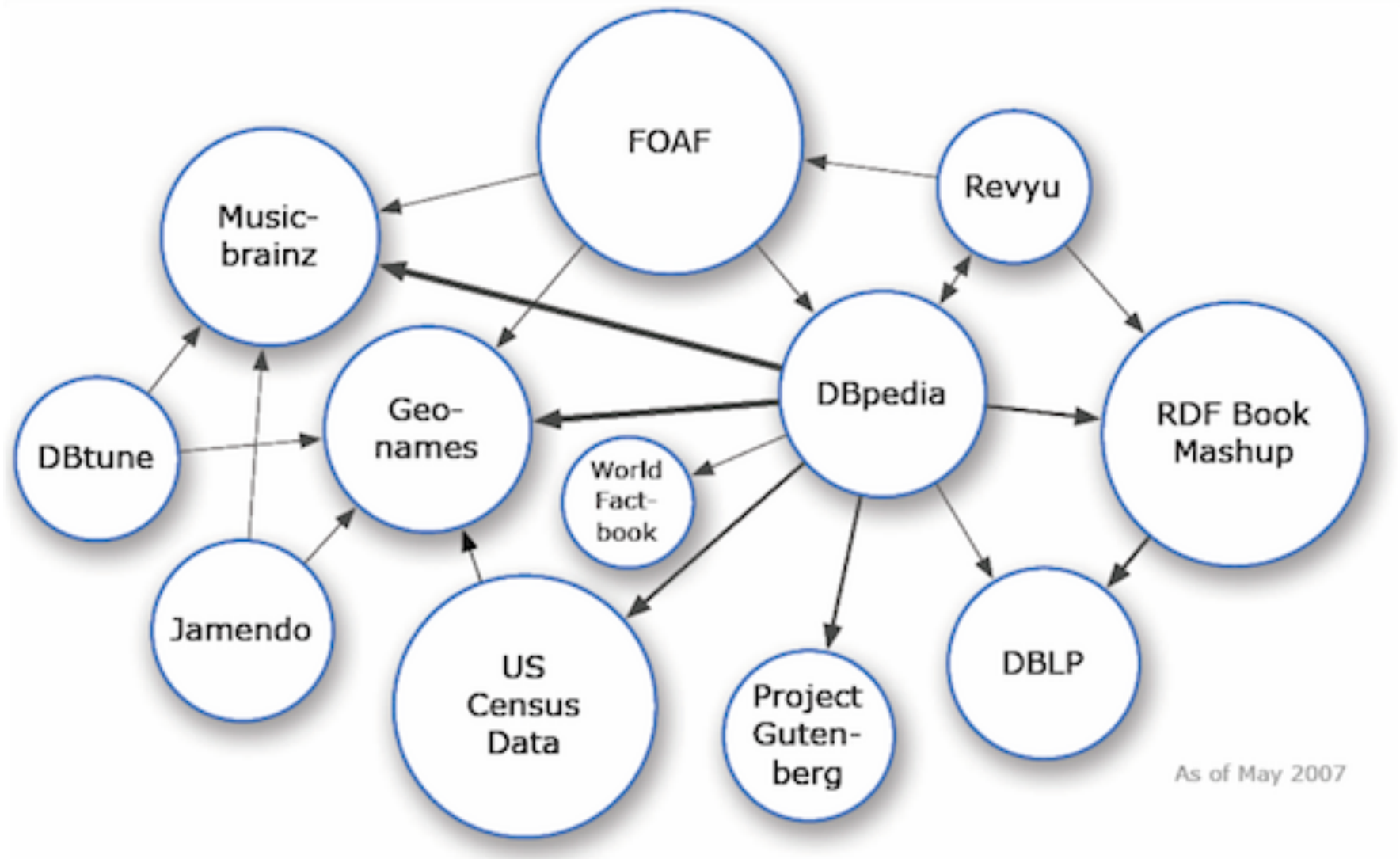
- RDF as universal data model for publishing structured data on the Web
- Make all URIs in the RDF graph **dereferencable**
- Avoid RDF constructs that cause problems in Linked Data context
  - RDF Reification
  - RDF Collections und Containers
  - unnamed Blank Nodes

Linked Data Principles

(4) Include **links to other URIs**, so that they can discover more things.

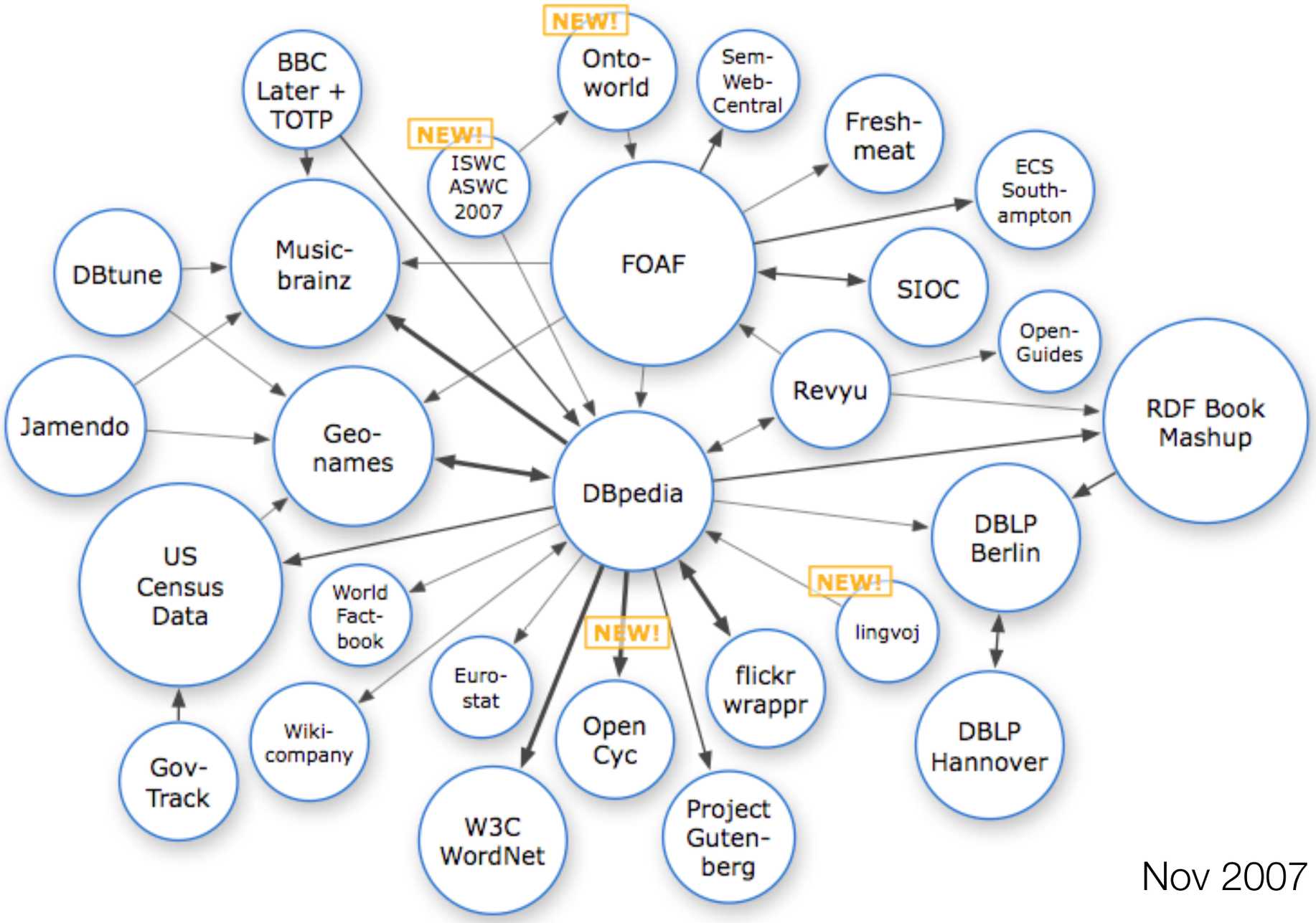
- Link RDF references among data between different data sources, to find information related by content
- **Relationship Links**
  Links to external LOD Entitites related with the original entity
- **Identity Links**
  Links to external LOD Entities referring to the same object or concept
- **Vocabulary Links**
  Links to definitions of the original entity

Development of the ‚Web of Data‘



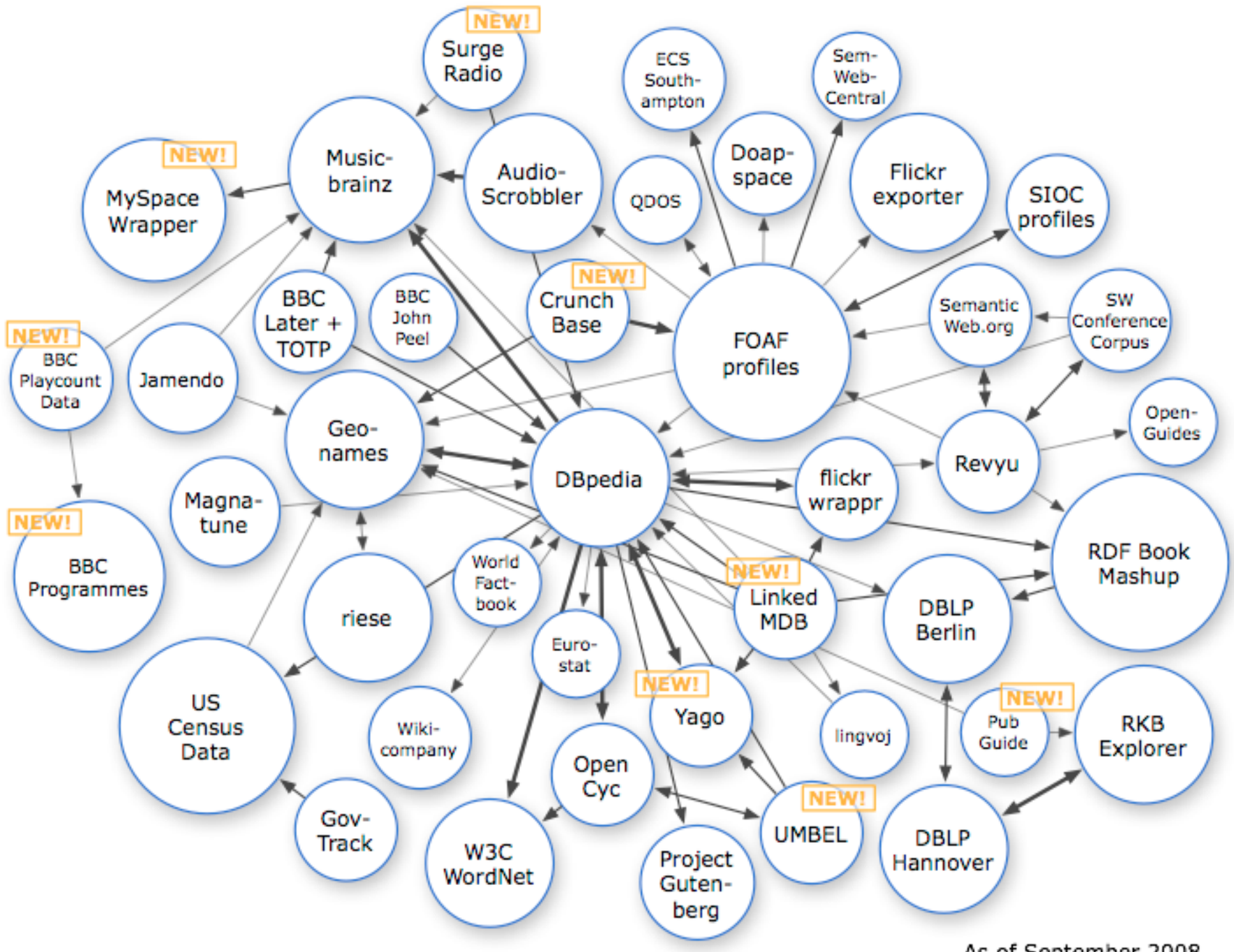
May 2007

Development of the ‚Web of Data‘



Nov 2007

Development of the ‚Web of Data‘



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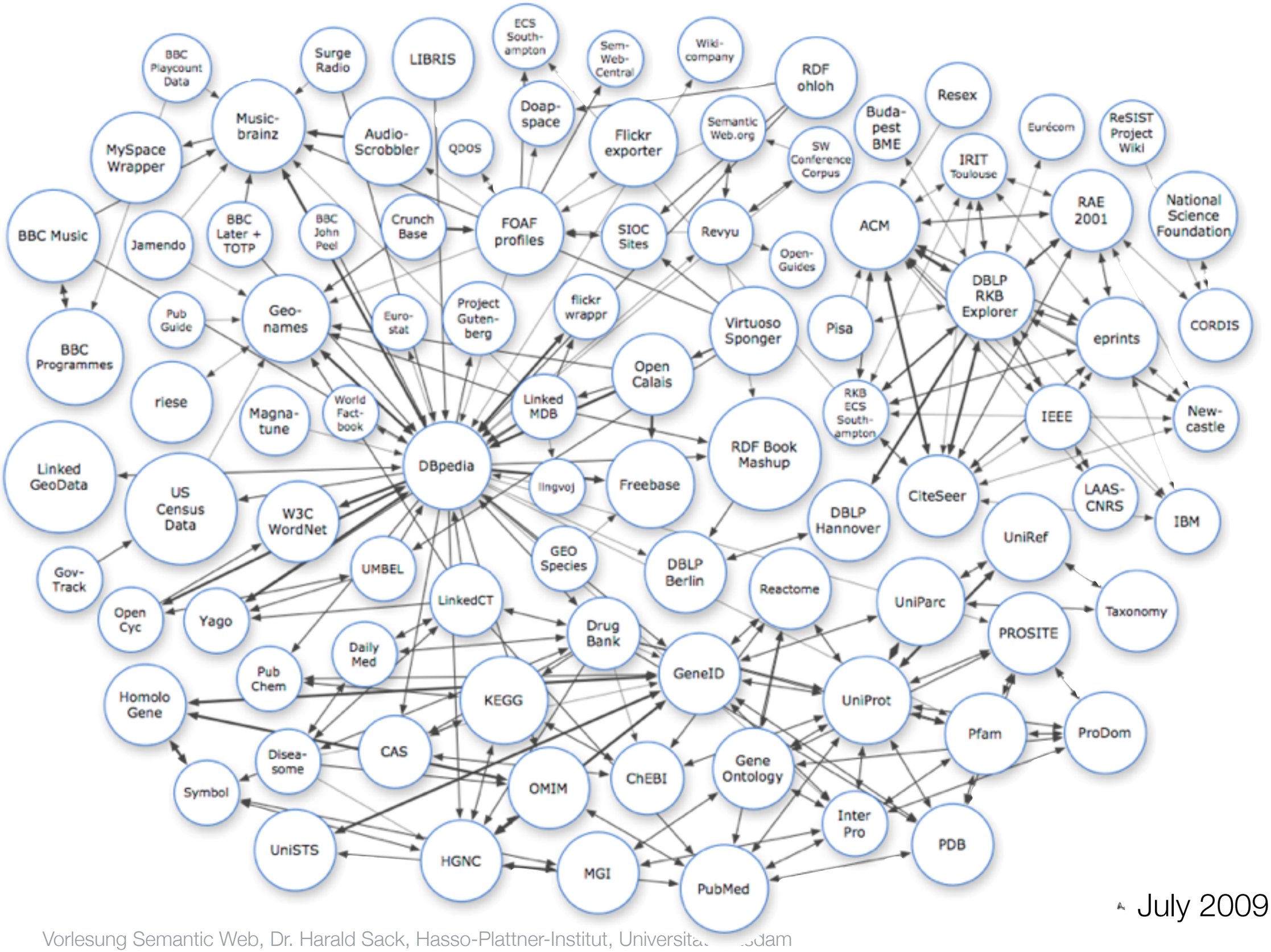
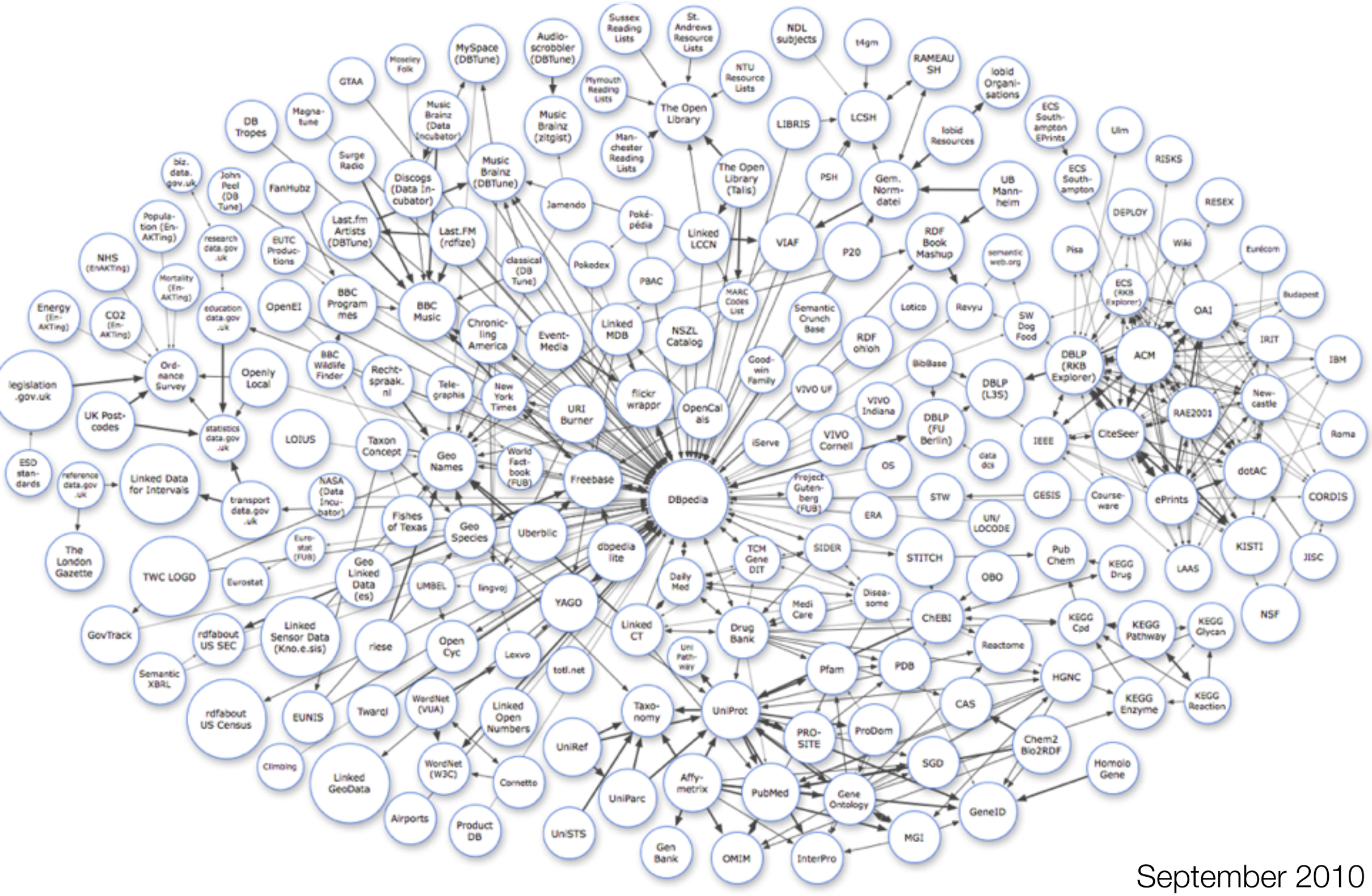


July 2009

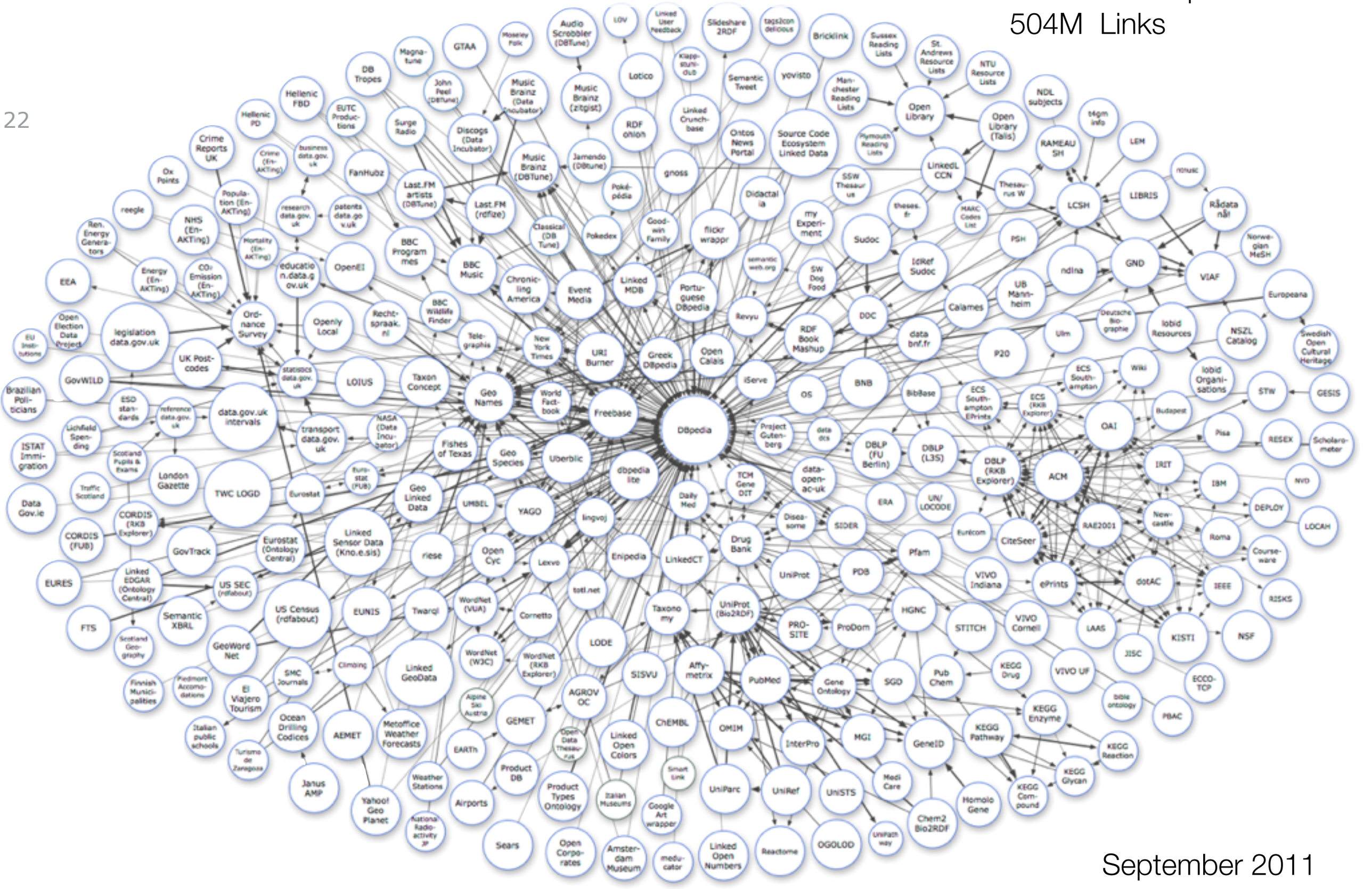
Development of the ‚Web of Data‘



September 2010

Development of the ‚Web of Data‘

300 Datasets
31B RDF Triples
504M Links



September 2011

Linked Open Data

- Public Linked Data resources in the Web, licensed as „Creative Common CC-BY“
- Tim Berners-Lee‘s 5-Star Criteria for Linked Open Data

★ Available on the web (whatever format) but with an **open licence**, to be Open Data

★★ Available as **machine-readable structured data** (e.g. excel instead of image scan of a table)

★★★ as (2) plus **non-proprietary format** (e.g. CSV instead of excel)

★★★★ All the above plus: use **open standards from W3C** (RDF and SPARQL) to identify things, so that people can point at your stuff

★★★★★ All the above, plus: **link your data to other people’s data** to provide context