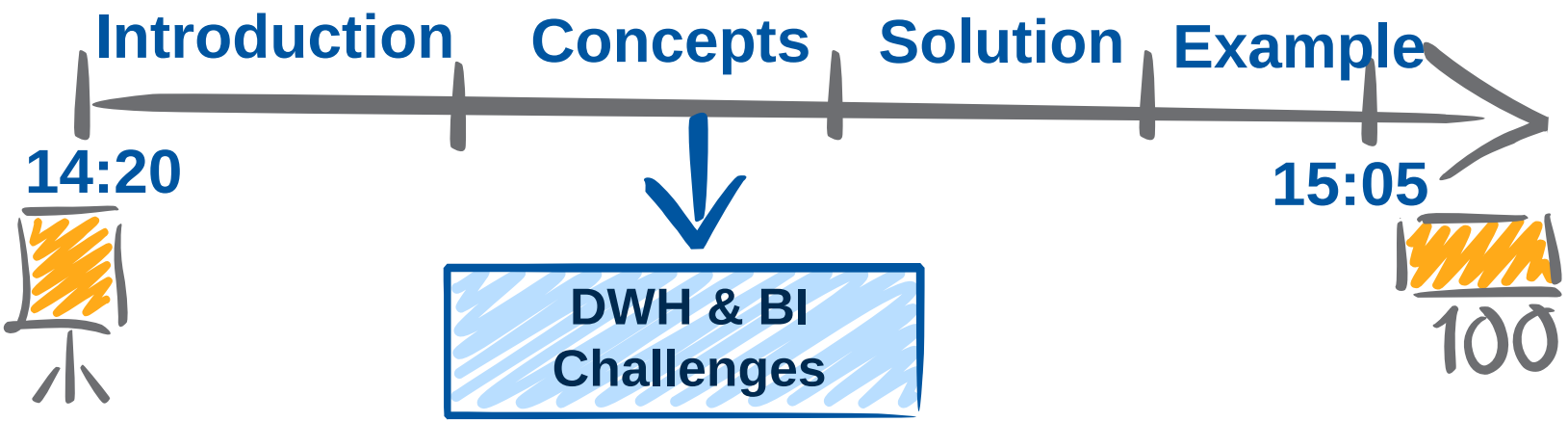
CERN

An Open Data architecture for building a key performance indicator system powered in real time with BAM

David Diaz Diaz CERN GS-AIS

Agenda

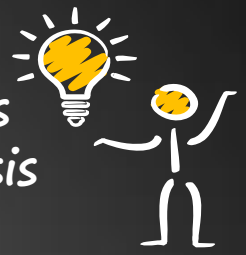
1. Introduction
2. Analyse challenges of BI and DWH
3. Proposed solution
4. Case study



- Success
- Competitive advantage

How?

The power of analysis and predictive analysis



What?

Data
- Present
- Past

Analyze

Forecast

Inform
- Present
- Future

Compare

KPI

- 90% of deliveries received on time
- 99% of payments on time

Tools

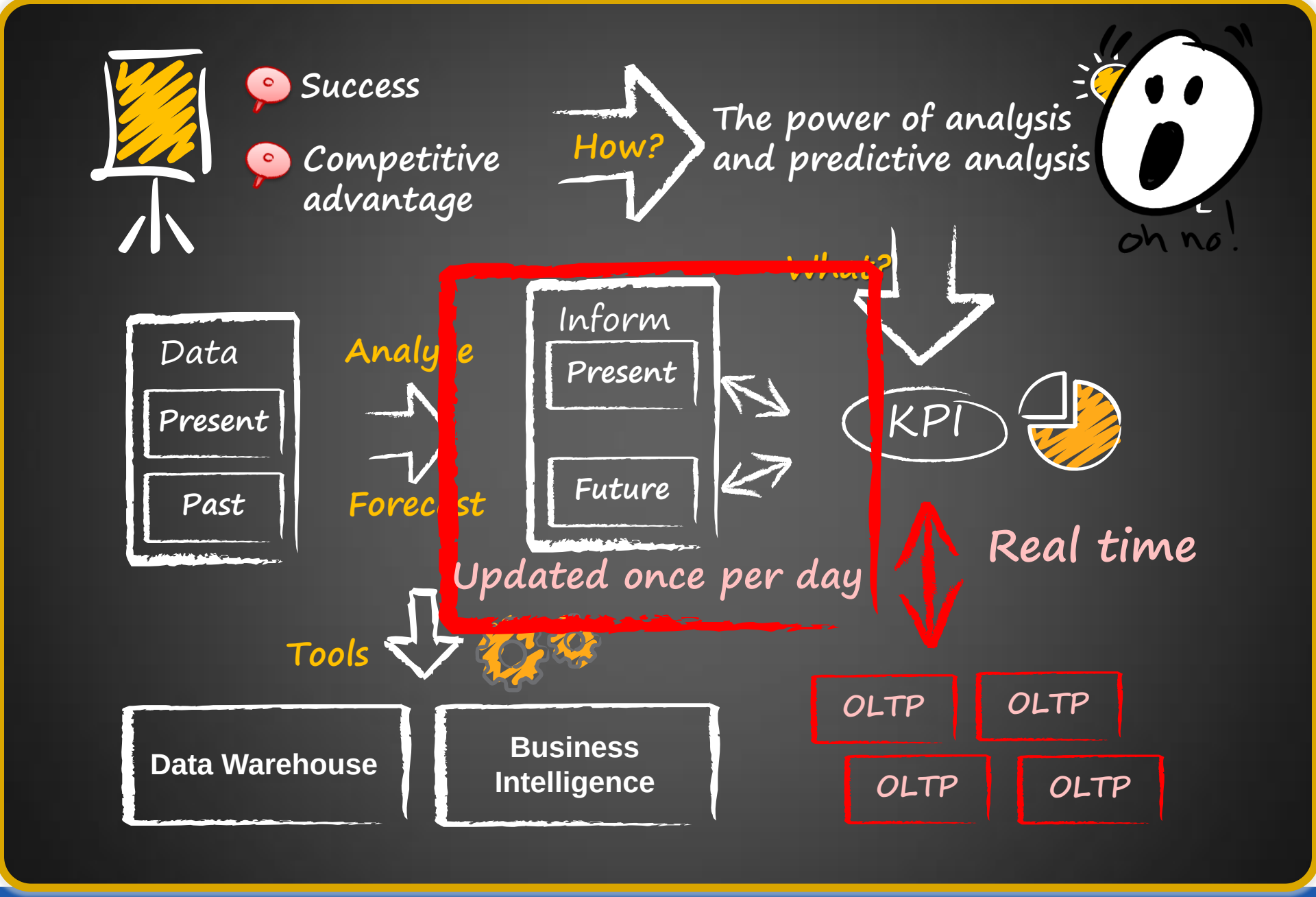
Data Warehouse

Business Intelligence

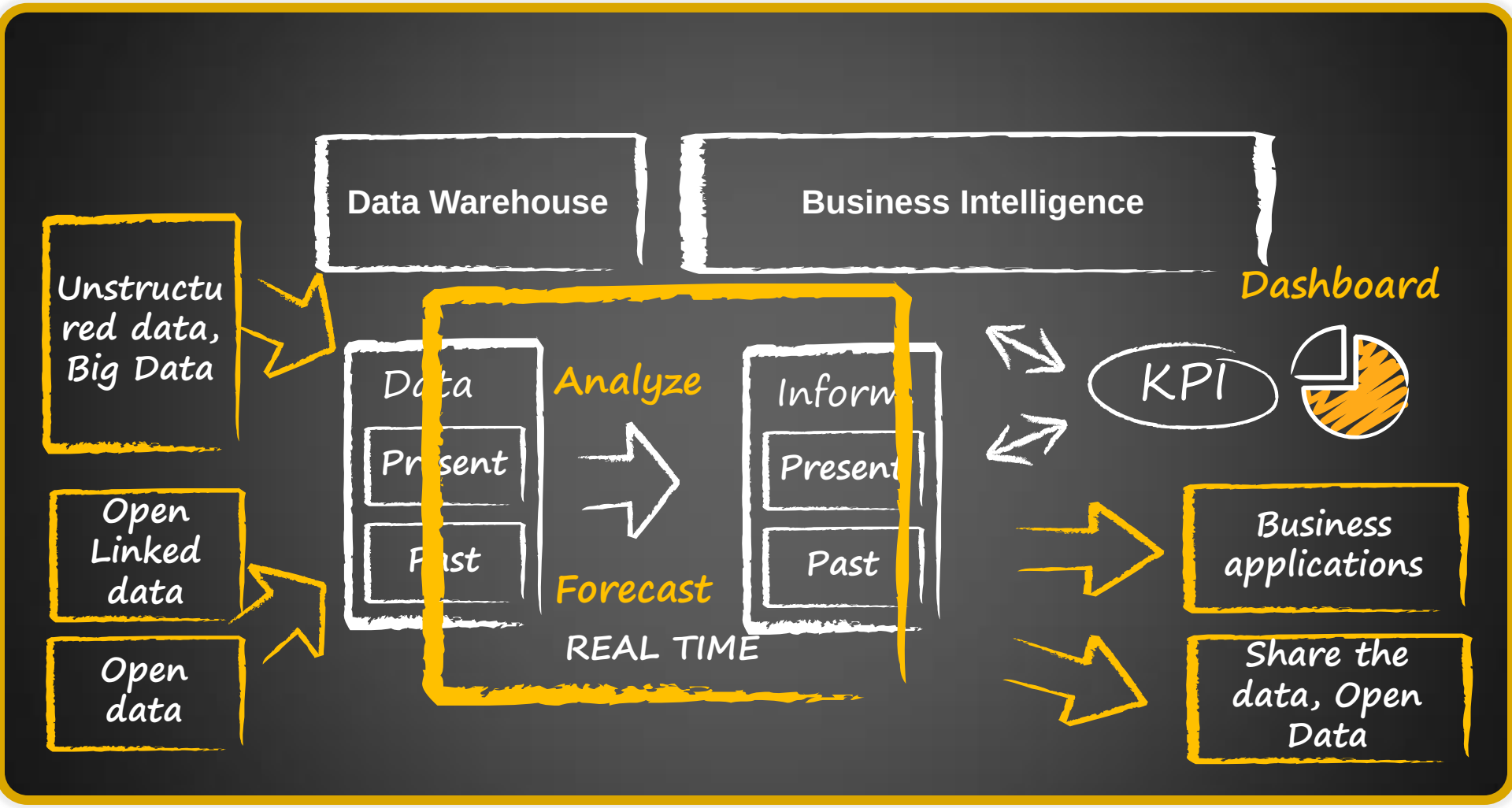
Introduction

BI & DWH

Challenges and common issues


Success
Competitive advantage
How?
The power of analysis and predictive analysis
oh no!
What?
Data
Present
Past
Analyze
Forecast
Inform
Present
Future
KPI
Updated once per day
Real time
Tools
Data Warehouse
Business Intelligence
OLTP
OLTP
OLTP
OLTP

What can we improve?



Challenges of BI & DWH

- Real time BI and real time DWH
  - Enables business users to get instant or up-to-the-minute information
  - Real time decisions
- Huge amount of unstructured data
  - Big data
- Open data
- Share data
  - Among different business applications
  - Everywhere – Open Data

Challenges of Data

The four V's of Data

Paul Miller, 2012

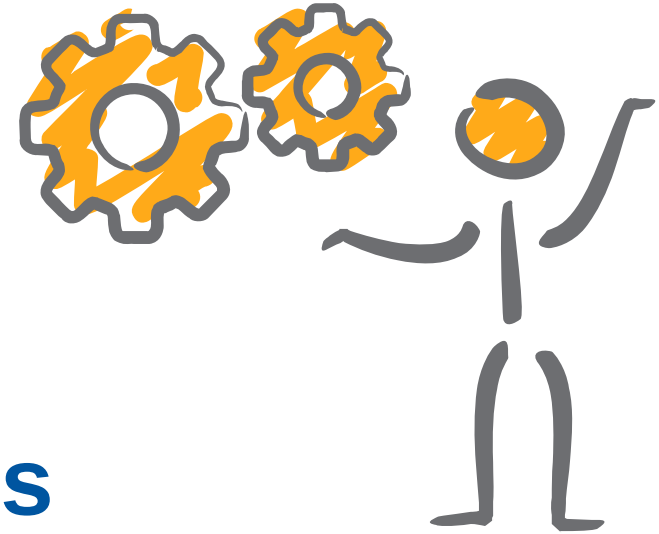
http://daa.ec.europa.e

Value, Semantic

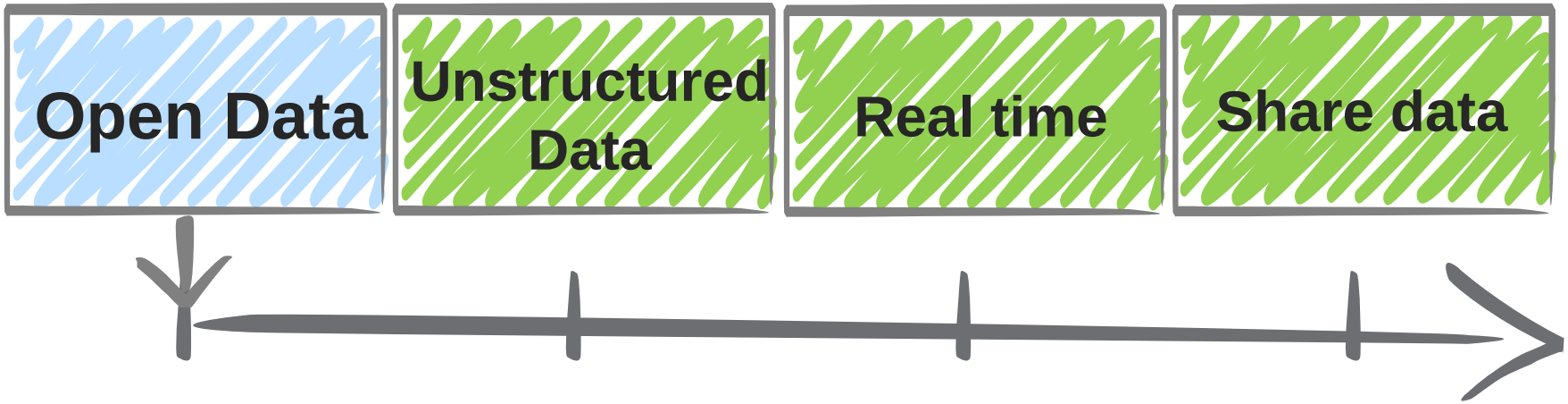
Variety, look for a stantard

Velocity, Real time o ASAP

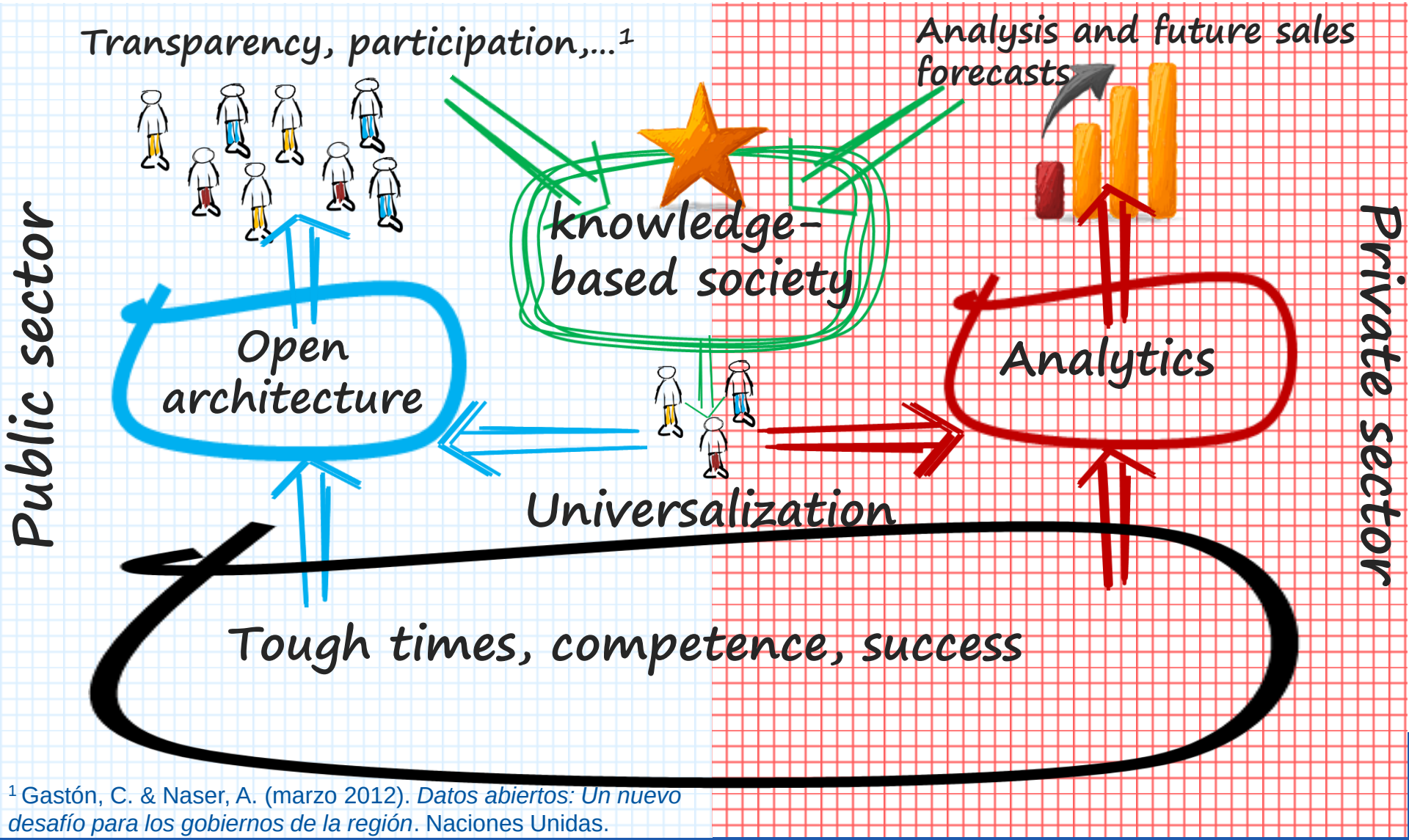
Volume, Big Data



BI & DWH Challenges



Open Data



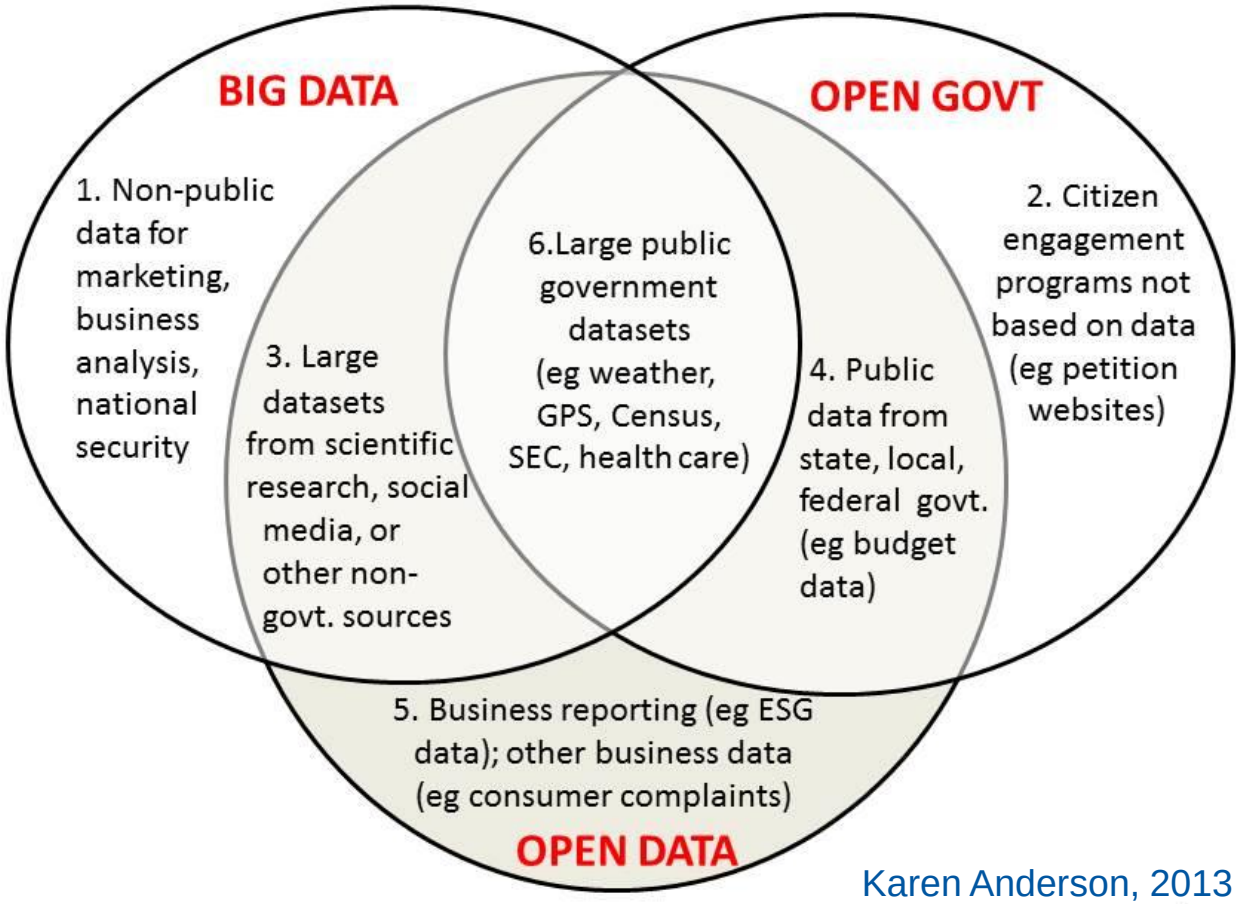
[1] Gastón, C. & Naser, A. (marzo 2012). *Datos abiertos: Un nuevo desafío para los gobiernos de la región*. Naciones Unidas.

Open Data

Big Data makes organizations smarter, but Open Data makes them richer

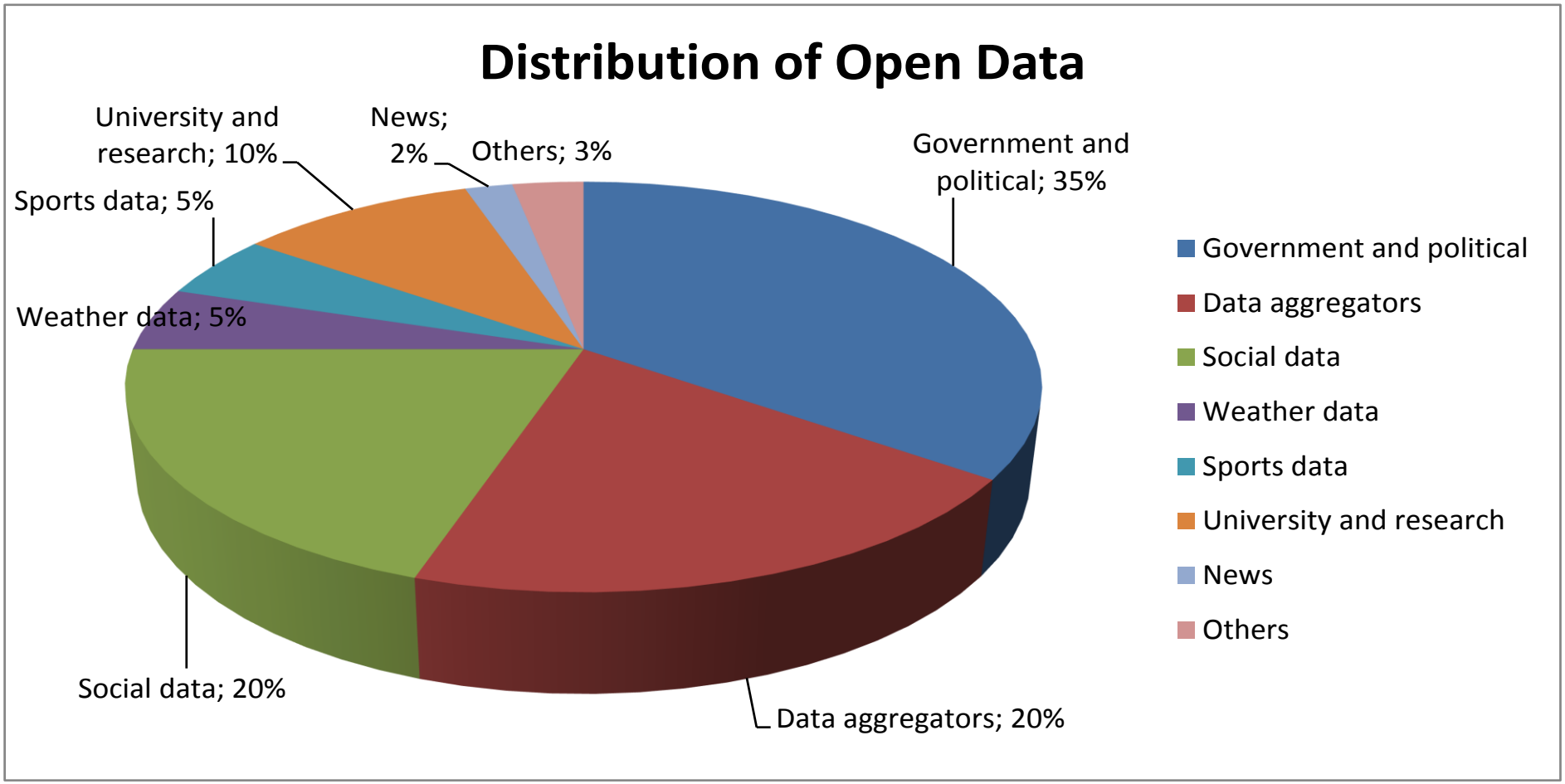
Gartner, 2013

Open Data



Karen Anderson, 2013
http://ontopoftheboxeval.wordpress.com

Open Data


Distribution of Open Data
University and research; 10%
News; 2%
Others; 3%
Government and political; 35%
Sports data; 5%
Weather data; 5%
Social data; 20%
Data aggregators; 20%
Government and political
Data aggregators
Social data
Weather data
Sports data
University and research
News
Others

Characteristics of Open Data

Open
- Data freely available

Accessible
- Data easy to use and re-use

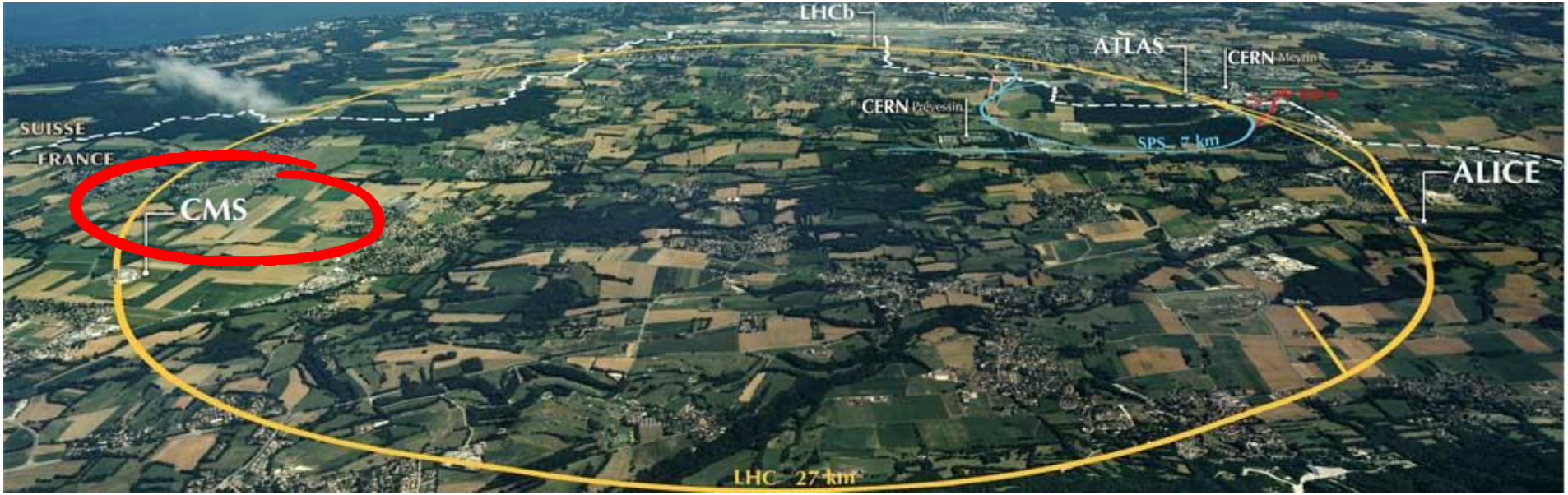
Searchable
- Data easy to find

Benefits

- Transparency
- Participation, allow external contribution
  - E.g.: GoldCorp, Google translator
- Innovation
- Improve or new private products and services
- New knowledge from combined data sources and patterns

Open data at CERN - CMS

- LHC- CMS detector has collected more than 64 petabytes of analyzable proton-proton data so far

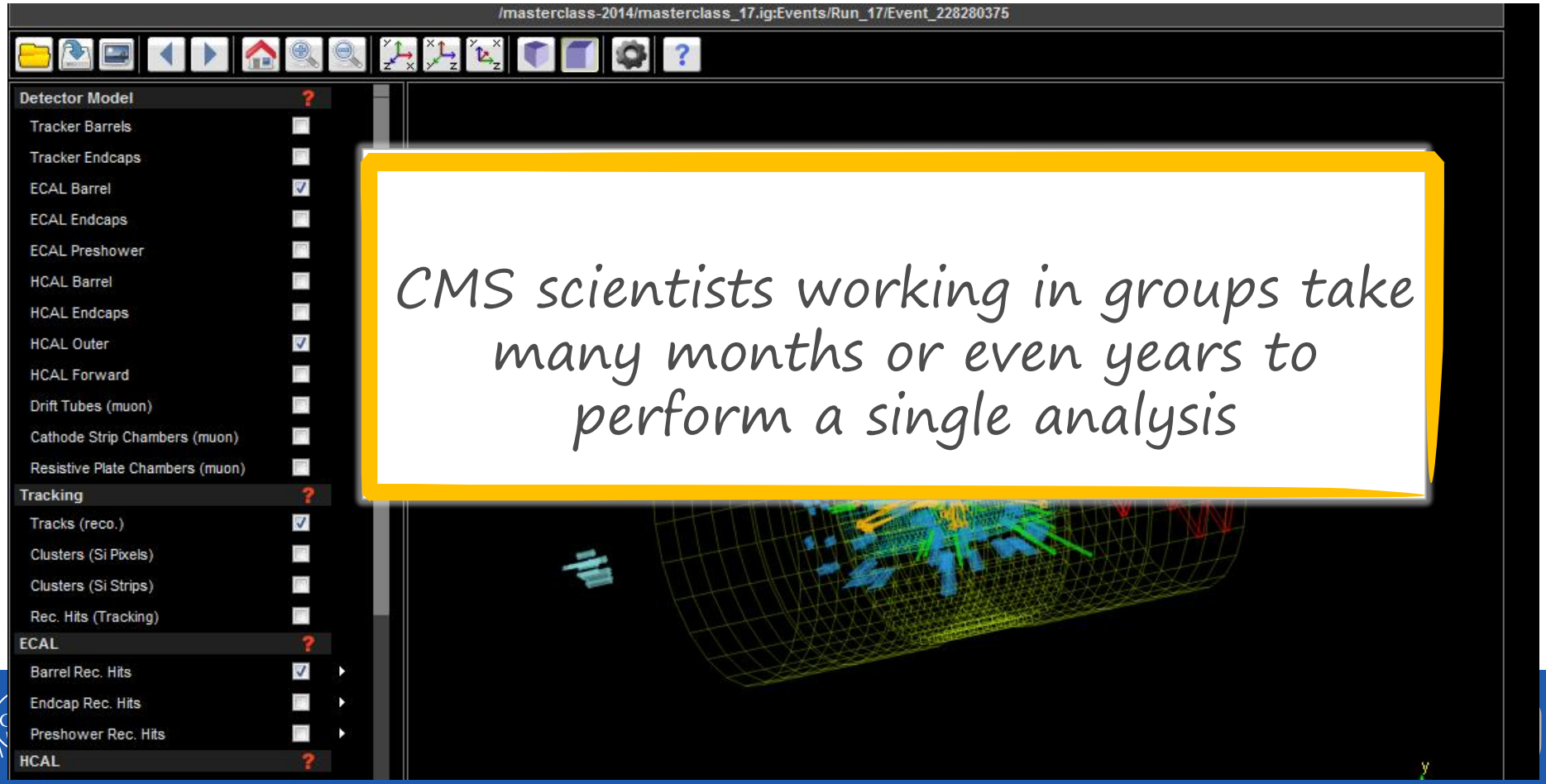


Open data at CERN - CMS

- Over 200.000 events are provided containing electrons, muons, top quarks and more
- Data available in several formats
- Different levels
  1. All data in CMS publications
  2. Small examples for education programmes
  3. Scientists data

Open data at CERN - CMS

- http://cms.web.cern.ch/content/cms-public-data-samples



CMS scientists working in groups take many months or even years to perform a single analysis

Open data in the world

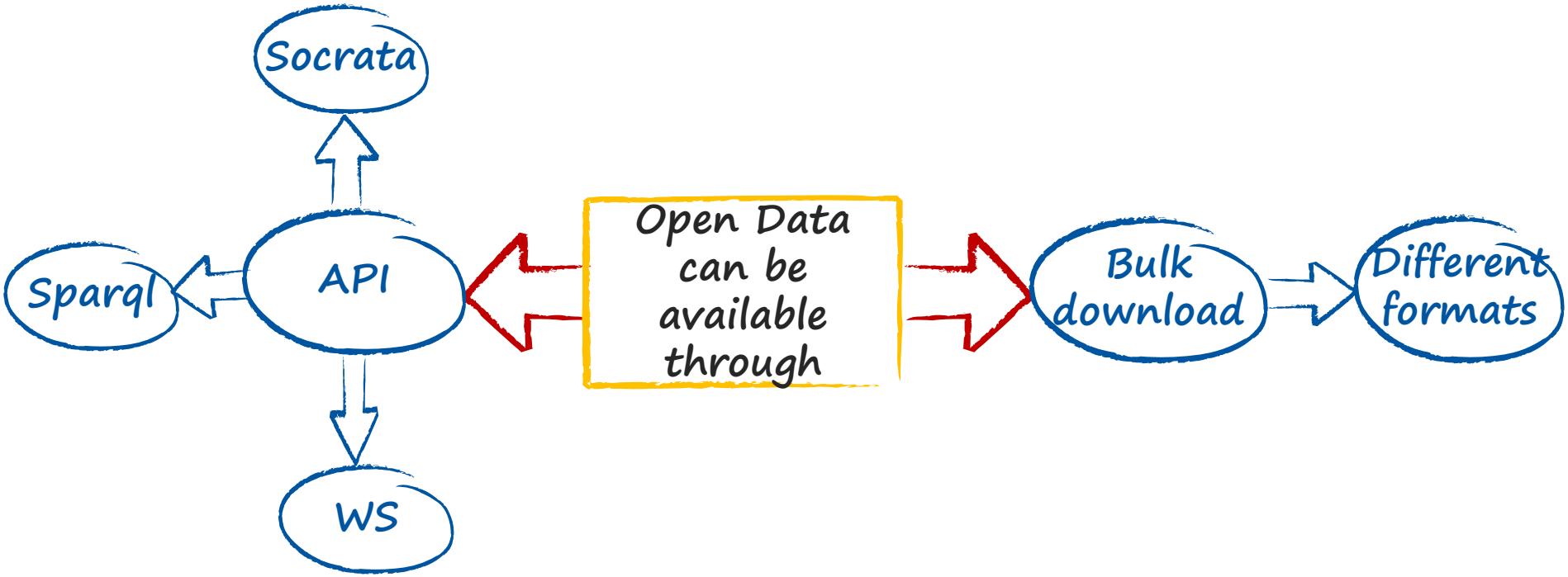
- Fast growing

2013, www.data.gov

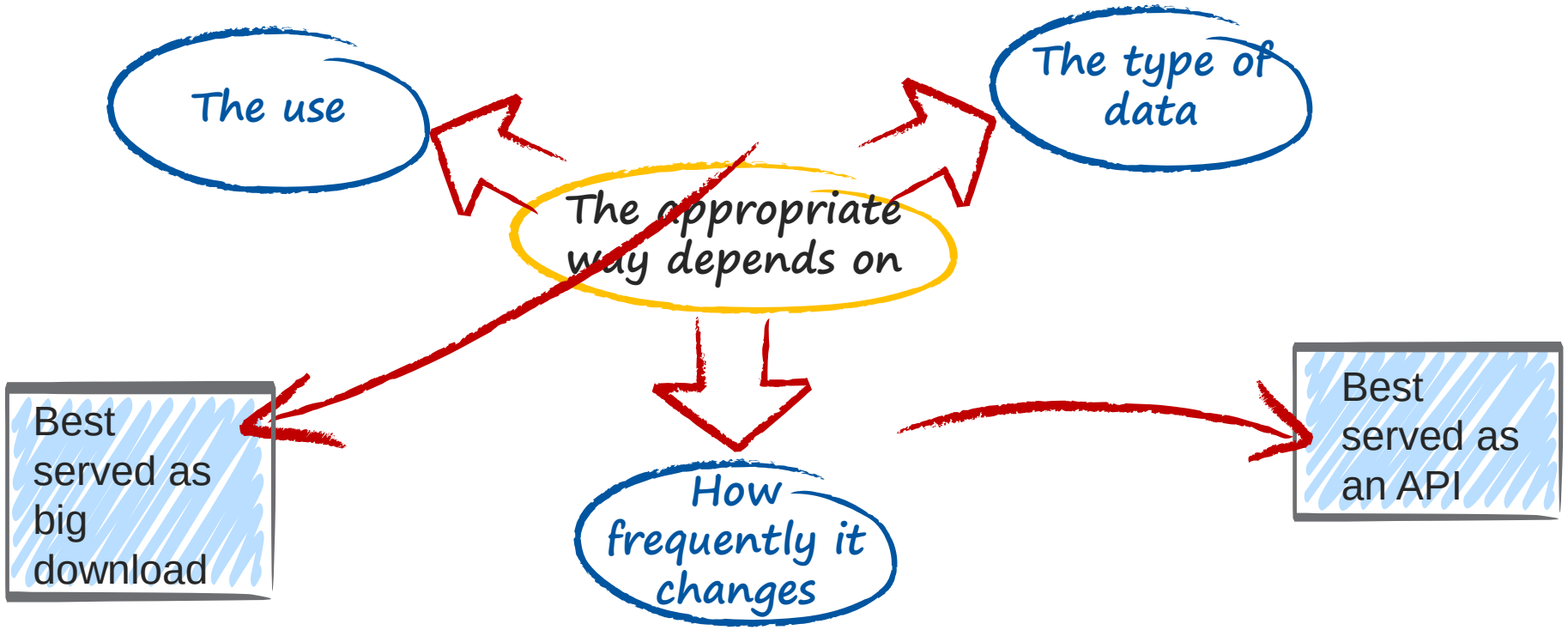
Open data in the world

- European Union Open Data Portal, Eurostat
  - Total datasets available: 6.581
  - http://open-data.europa.eu/en/data/
- Open Data UK
  - Total datesets available: 13.993
  - http://data.gov.uk/
- Open Data US
  - Total datasets available: 90.925
  - https://www.data.gov/

How to consume the data?

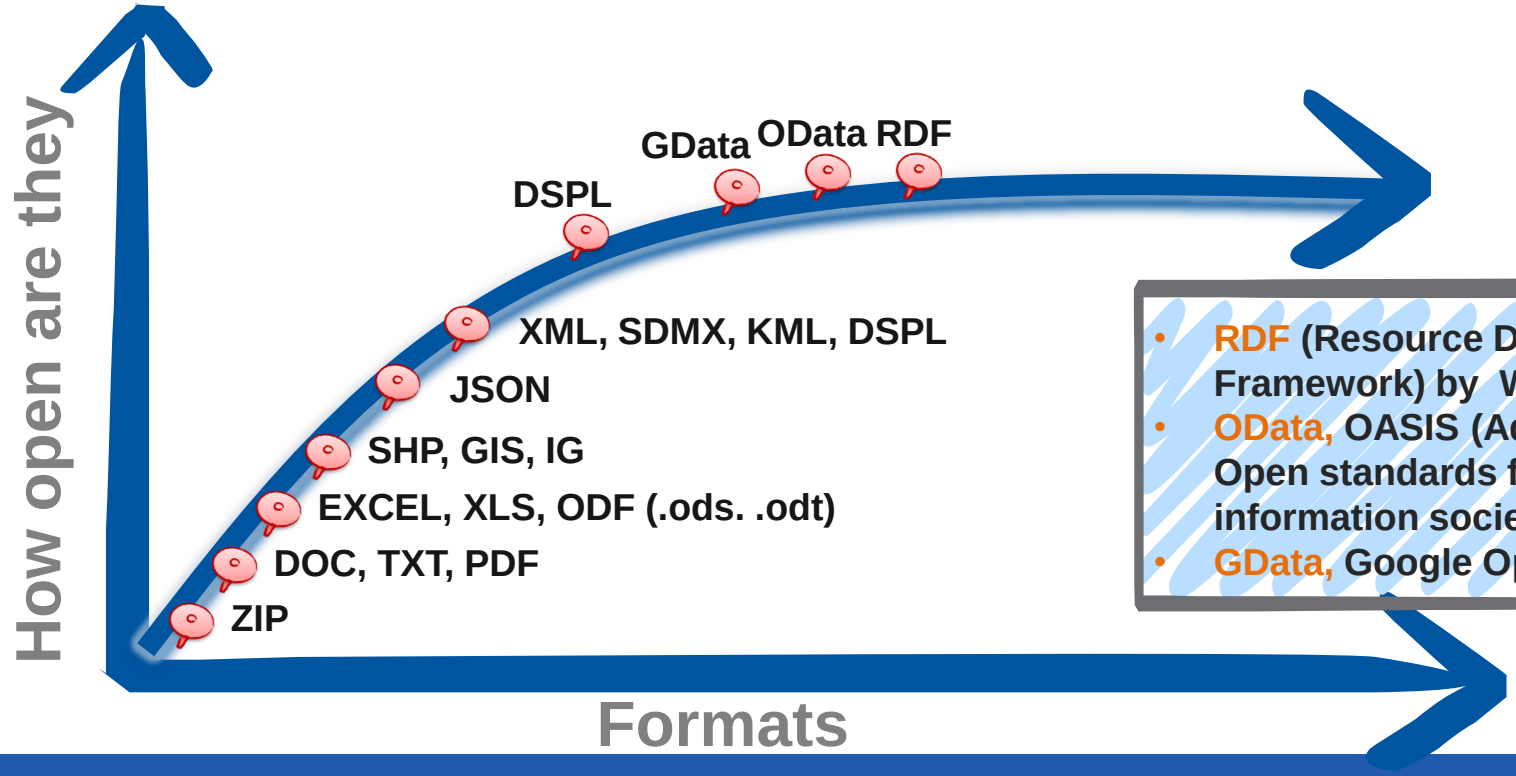


How to consume the data?



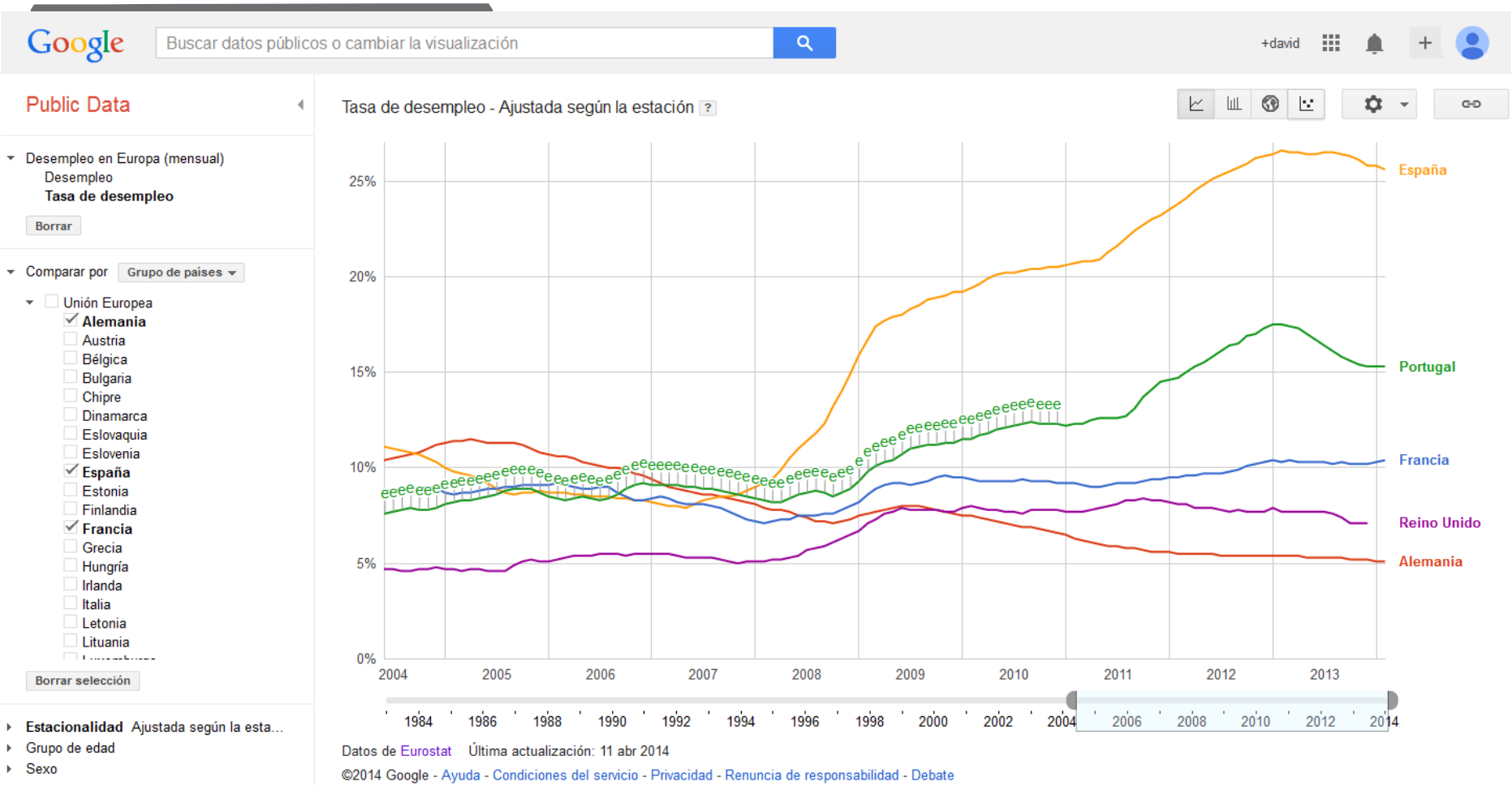
Challenges of open data

- Define specifications and standards
- Right now = Heterogeneity



- RDF (Resource Description Framework) by W3C
- OData, OASIS (Advancing Open standards for the information society)
- GData, Google Open Data

DSPL Dataset Publishing Language



The Power of Open Data (Exhibit)

Open Data Asturias

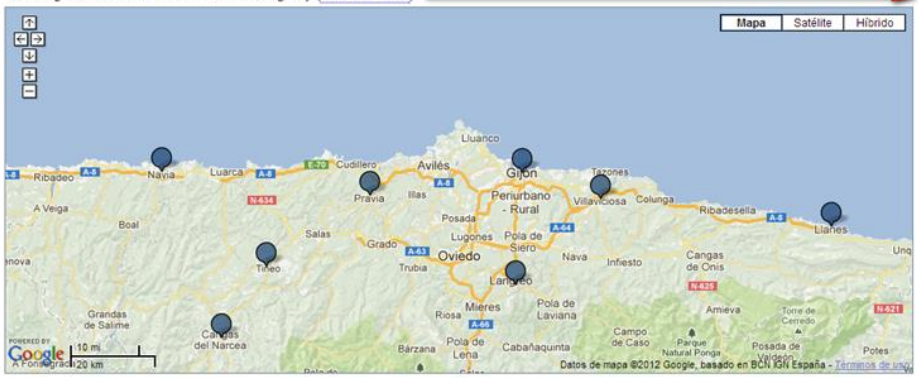
Edificios del Gobierno de Asturias

Tipo de Organismo

- 304 Administración
- 527 Educación
- 14 **Hacienda**
- 29 Justicia
- 189 Sanidad

Filter
ex:role="exhibit-facet"

14 OrganismoHacienda filtered from 1063 originally (Reset All Filters)



Map
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ex:viewClass="Map"

Hacienda

14 OrganismoHacienda filtered from 1063 originally (Reset All Filters)

Grid
ex:role="view"
ex:viewClass="Tabular"

Edificio	Calle	C.P.	Localidad
OFICINA DE RECAUDACION TRIBUTOS DE AVILES	CALLE JULIA DE LA RIVA 4		AVILES
OFICINA DE RECAUDACION TRIBUTOS DE C.DEL NARCEA	CALLE CARMEN CONDE S/N		CANGAS DEL NARCEA
OFICINA DE RECAUDACION TRIBUTOS DE CANG. DE ONIS	JARDINES DEL AYUNTAMIENTO		CANGUES D'ONÍS
OFICINA DE RECAUDACION TRIBUTOS DE GIJON	CALLE ANSELMO CIFUENTES 13	33205	GIJON
OFICINA DE RECAUDACION TRIBUTOS DE GRADO	TRAVESIA AYUNTAMIENTO S/N		GRAU
OFICINA DE RECAUDACION TRIBUTOS DE LANGREO	CALLE DORADO 15		LANGREO
OFICINA DE RECAUDACION TRIBUTOS DE LAVIANA	CALLE ARMANDO P. VALDES S/N		POLA LLAVIANA, LA
OFICINA DE RECAUDACION TRIBUTOS DE LLANES	CALLE NEMESIO SOBRINO S/N		LLANES
OFICINA DE RECAUDACION TRIBUTOS DE NAVIA	CALLE LAS ARMAS 10		NAVIA
OFICINA DE RECAUDACION TRIBUTOS DE PRAVIA	CALLE SAN ANTONIO 28		PRAVIA
OFICINA DE RECAUDACION TRIBUTOS DE SIERO	CALLE FLORENCIO RODRIGUEZ 39		POLA SIERO, LA
OFICINA DE RECAUDACION TRIBUTOS DE TINEO	PLAZA ALONSO MARTINEZ 2		TINEO
OFICINA DE RECAUDACION TRIBUTOS DE VEGADEO	CALLE LA MILAGROSA 16		VEIGA, A
OFICINA DE RECAUDACION TRIBUTOS DE VILLAVICIOSA	CALLE RAMON DEL VALLE 5		VILLAVICIOSA

Conjunto de Datos

Catálogo

En la siguien
y se puede c

Consulta má

Recursos
Inversion
Archivo fo
Estadístic
Oferta Fo
Organigra
Edificios y

RDF/N3	TURTLE
✔	✔
✔	✔
✔	✔
✔	✔
✔	✔
✔	✔
✔	✔

A1 | Name

	A	B	C	D	E
1	Name	Type	Building	Zip Code	Hours
2	Main Library	Main		70112	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Fri. & Sat.
3	New Orleans	LA 70112			
4	(29.95416549312152	-90.07523776084666)"			
5	Children's Resource Center	Children		70115	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Sat.
6	New Orleans	LA 70115			
7	(29.920960863812635	-90.10133539961669)"			
8	Alvar Branch	Branch		70117	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Sat.
9	New Orleans	LA 70117			
10	(29.96377048820458	-90.03696441258404)"			
11	Central City Branch	Branch	Building C, Room 235	70113	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Sat.
12	New Orleans	LA 70113			
13	(29.941384190756278	-90.08683740411858)"			
14	Lakeview Branch	Branch		70124	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Sat.
15	New Orleans	LA 70124			
16	(30.004711520415174	-90.10253526943542)"			
17	Milton H. Memorial Latter Branch	Branch		70115	9 am - 8 pm, Mon. & Wed.; 9 am - 6 pm, Tues. &Thurs.; 10 am - 5 pm, Sat.;
18	New Orleans	LA 70115			
19	(29.92696620365509	-90.10995602763454)"			
20	Martin Luther King Branch	Branch		70117	9 am - 5 pm, Mon. - Fri.
21	New Orleans	LA 70117			
22	(29.96633682003188	-90.0140551648767)"			
23	Mid-City Branch	Branch	American Can Building	70119	10 am - 6 pm, Mon. - Thurs.; 10 am - 5 pm, Sat.
24	New Orleans	LA 70119			
25	(29.977130308023277	-90.0925239431577)"			

Hoja1 | New_Orleans_Public_Libraries

Linked Open data

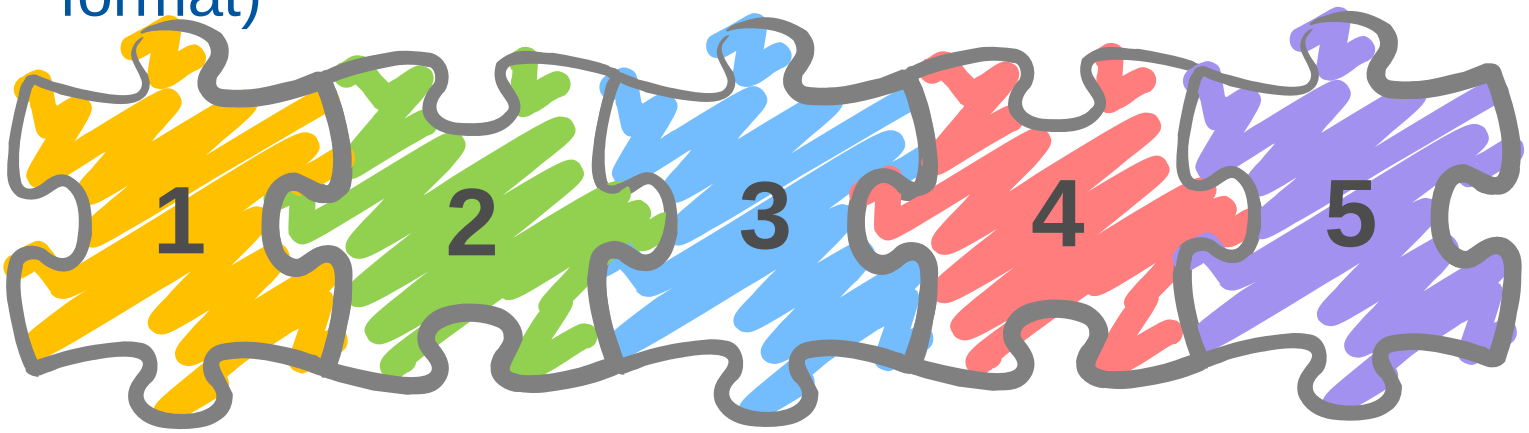
- Is an evolution of the Open Data term
- Publish and make relations between the data
  - DBPedia: Wikipedia
  - PubMed: Medical data
  - MusicBrainz: Open music encyclopedia
  - WordNet: Lexical database of English
  - Geonames: Geographical database

The five stars of Open Data

Data available on the Web (whatever format)

Non-propetary format (eg: csv)

Link your data to other people's data



Available as structured data (excel)

Use URLs to identify things

The five stars of data by Tim Berners-Lee
http://5stardata.info/

Resource Description Framework (RDF)

- RDF is a language for:
  - Representing information about resources in the world wide web
  - Representing metadata about Web resources (eg. city, person) such as the title and author of a Web page
- In RDF, resources are described in terms of these triples, (subject, property, object)
- RDF Schema (RDFS) extending vocabulary

```
:Person rdfs:subClassOf :Animal
```

- RDF is computer readable and understandable

RDF, SPARQL

http://dbpedia.org/sparql

dbpedia.org/sparql

name	pop	dpop
"Andalusia"@en	"8424102"^^<http://www.w3.org/2001/XMLSchema#int>	"2011"^^<http://www.w3.org/2001/XMLSchema#int>
"Catalonia"@en	"7535251"^^<http://www.w3.org/2001/XMLSchema#int>	"2011"^^<http://www.w3.org/2001/XMLSchema#int>
"Community of Madrid"@en	"6445499"^^<http://www.w3.org/2001/XMLSchema#int>	"2010"^^<http://www.w3.org/2001/XMLSchema#int>
"Valencian Community"@en	"5111706"^^<http://www.w3.org/2001/XMLSchema#int>	"2009"^^<http://www.w3.org/2001/XMLSchema#int>
"Galicia"@en	"2796089"^^<http://www.w3.org/2001/XMLSchema#int>	"2009"^^<http://www.w3.org/2001/XMLSchema#int>
"Castilla and León"@en	"2510849"^^<http://www.w3.org/2001/XMLSchema#int>	"2005"^^<http://www.w3.org/2001/XMLSchema#int>
"Basque Country"@en	"2155546"^^<http://www.w3.org/2001/XMLSchema#int>	"2008"^^<http://www.w3.org/2001/XMLSchema#int>
"Autonomous Community of the Basque Country"@en	"2155546"^^<http://www.w3.org/2001/XMLSchema#int>	"2008"^^<http://www.w3.org/2001/XMLSchema#int>
"Canary Islands"@en	"2117519"^^<http://www.w3.org/2001/XMLSchema#int>	"2011"^^<http://www.w3.org/2001/XMLSchema#int>
"Castile–La Mancha"@en	"2095855"^^<http://www.w3.org/2001/XMLSchema#int>	"2010"^^<http://www.w3.org/2001/XMLSchema#int>
"Region of Murcia"@en	"1424063"^^<http://www.w3.org/2001/XMLSchema#int>	"2008"^^<http://www.w3.org/2001/XMLSchema#int>
"Aragon"@en	"1277471"^^<http://www.w3.org/2001/XMLSchema#int>	"2006"^^<http://www.w3.org/2001/XMLSchema#int>
"Balearic Islands"@en	"1106049"^^<http://www.w3.org/2001/XMLSchema#int>	"2010"^^<http://www.w3.org/2001/XMLSchema#int>
"Extremadura"@en	"1097744"^^<http://www.w3.org/2001/XMLSchema#int>	"2009"^^<http://www.w3.org/2001/XMLSchema#int>
"Principality of Asturias"@en	"1076896"^^<http://www.w3.org/2001/XMLSchema#int>	"2006"^^<http://www.w3.org/2001/XMLSchema#int>
"Navarre"@en	"620337"^^<http://www.w3.org/2001/XMLSchema#int>	"2007"^^<http://www.w3.org/2001/XMLSchema#int>
"Chartered Community of Navarre"@en	"620337"^^<http://www.w3.org/2001/XMLSchema#int>	"2007"^^<http://www.w3.org/2001/XMLSchema#int>
"Cantabria"@en	"591886"^^<http://www.w3.org/2001/XMLSchema#int>	"2009"^^<http://www.w3.org/2001/XMLSchema#int>
"La Rioja"@en	"308968"^^<http://www.w3.org/2001/XMLSchema#int>	"2007"^^<http://www.w3.org/2001/XMLSchema#int>
"Province of Zamora"@en	"200678"^^<http://www.w3.org/2001/XMLSchema#int>	"2007"^^<http://www.w3.org/2001/XMLSchema#int>

Execution timeout: 0 milliseconds *(values less than 1000 are ignored)*

The five stars of Open Data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  xmlns:dct="http://purl.org/dc/terms/" xmlns:ovt="http://purl.org/ctic/infraestructuras/organizacion#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:foaf="http://xmlns.com/foaf/0.1/"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
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      <dct:identifier>2</dct:identifier>
      <ovt:dependeDe rdf:resource="http://dadesobertes.caib.es/data/uniadm/1"/>
      <geo:location rdf:resource="http://dbpedia.org/resource/Illes_Balears"/>
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      <foaf:depiction rdf:resource="http://www.caib.es/root/archivo.do?id=153646" type="V"/>
      <foaf:depiction rdf:resource="http://www.caib.es/root/archivo.do?id=127319" type="S"/>
      <foaf:depiction rdf:resource="http://www.caib.es/root/archivo.do?id=127318" type="T"/>
      <foaf:homepage rdf:resource="http://presidencia.caib.es"/>
      <foaf:phone rdf:resource="971 17 65 65"/>
      <foaf:phone rdf:resource="971 17 65 87" type="fax"/>
    - <foaf:Person>
      - <rdf:Description>
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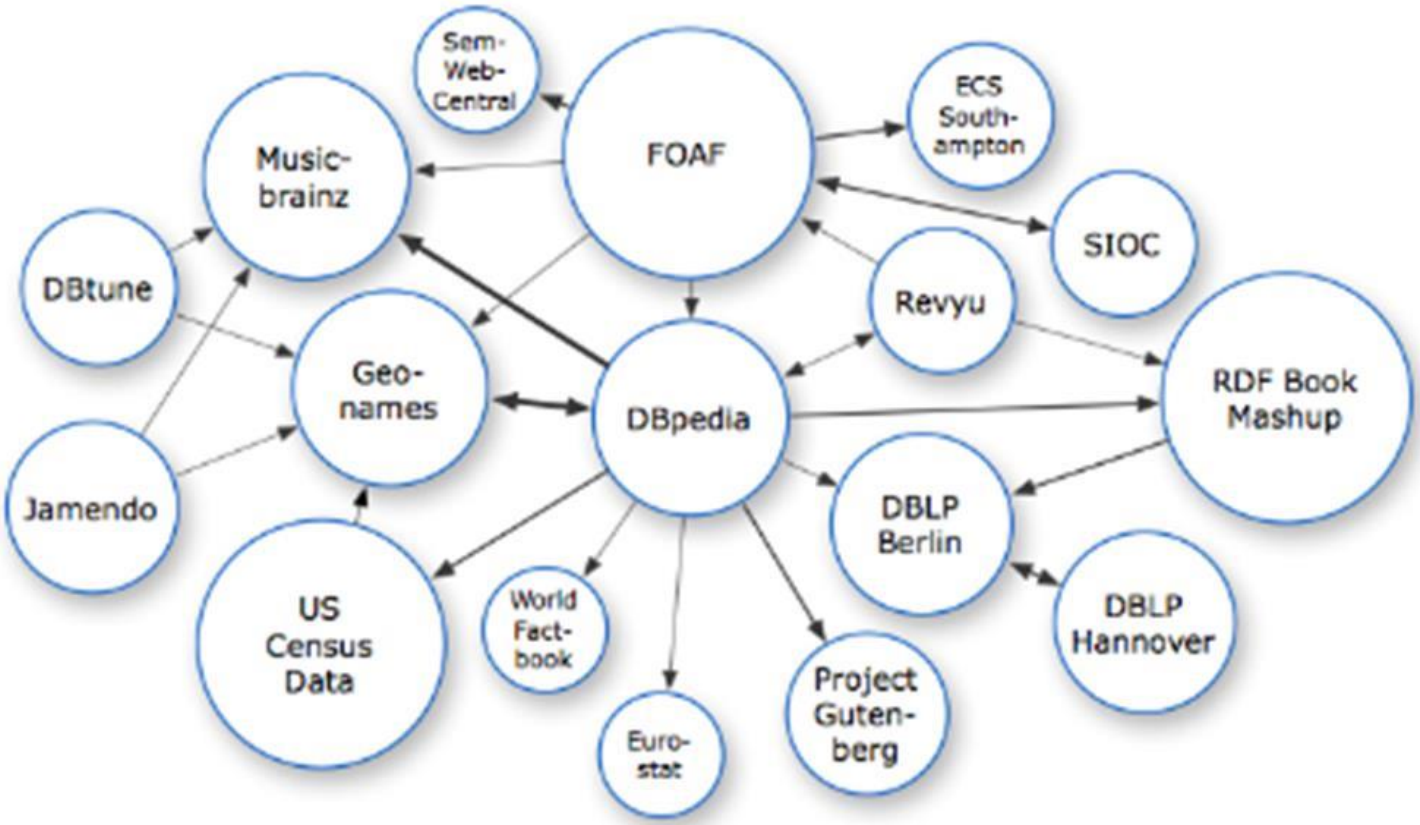
          <foaf:name>José Ramón Bauzá Díaz </foaf:name>
          <foaf:Group>President</foaf:Group>
          <foaf:thumbnail>http://www.caib.es/root/archivo.do?id=873565</foaf:thumbnail>
          <foaf:img>http://www.caib.es/root/archivo.do?id=874587</foaf:img>
        </rdf:Description>
      </foaf:Person>
      <dct:title xml:lang="ca">Presidència</dct:title>
      <dct:description xml:lang="ca">&lt;p&gt;Benvinguts a la p&amp;agrave;gina web de la Presid&amp;egrave;ncia del Govern de les Illes
        Balears a on podreu trobar informacions del vostre inter&amp;egrave;s. Podeu accedir-hi directament des d'aquesta
        adre&amp;ccedil;a: http://presidencia.caib.es&lt;/p&gt;</dct:description>
      <dct:title xml:lang="de">Presidéncia</dct:title>
      <dct:description xml:lang="de">&lt;p&gt;Herzlich Willkommen auf unserer Website. Hier finden Sie Informationen von allgemeinem
```

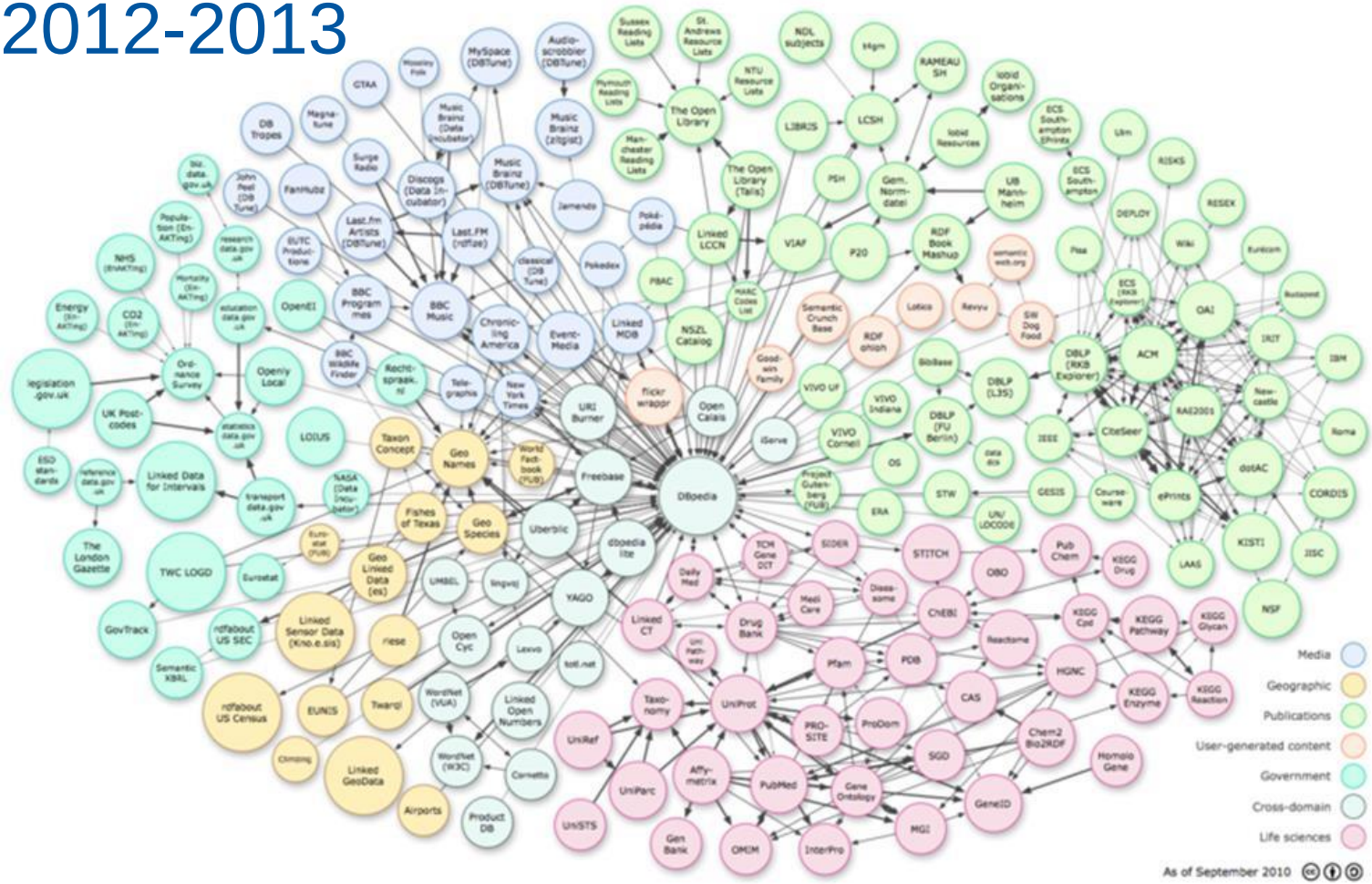
Linked Open data

- 2007 - 2010



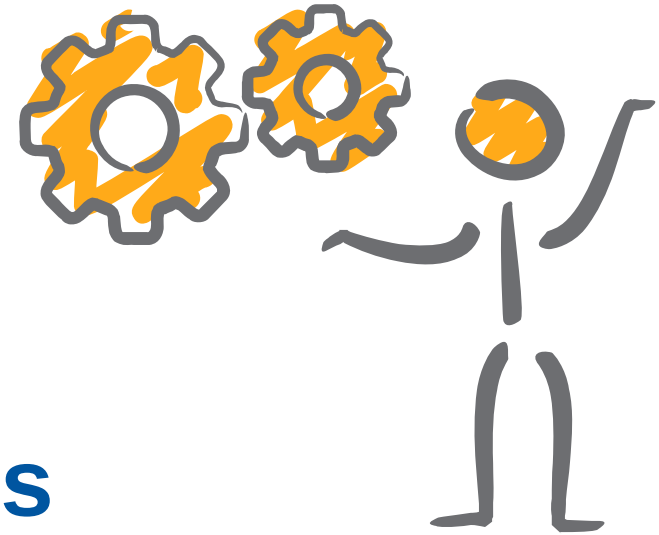
Linked Open data

- 2012-2013

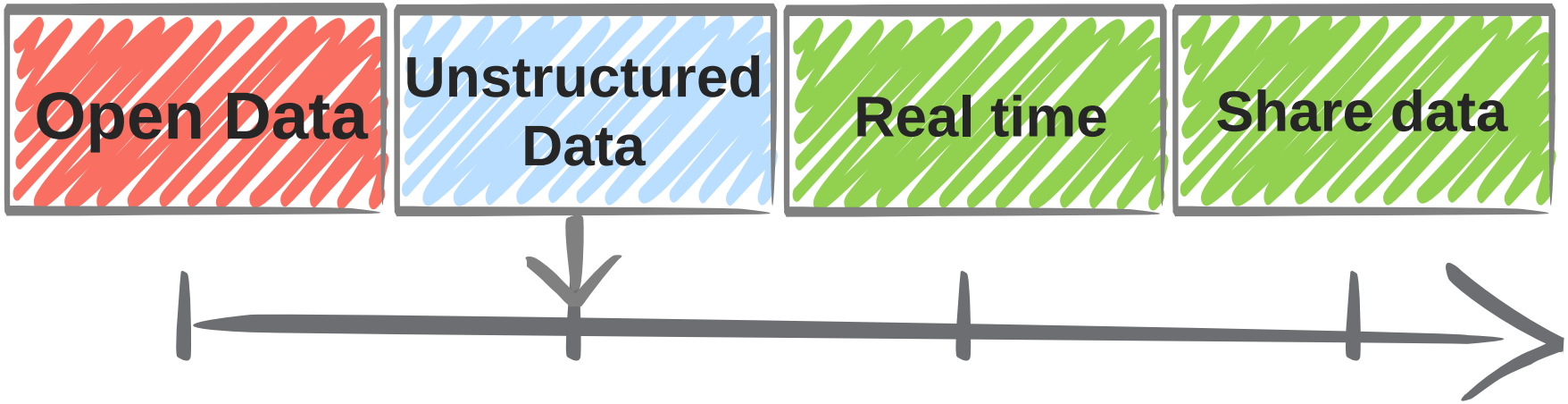


Linked Open data

- CERN Bibliographic Data
  - http://datahub.io/dataset/cern-library-bibliographic-data
  - MARC 21 Format for Bibliographic Data



BI & DWH Challenges



Unstructured data

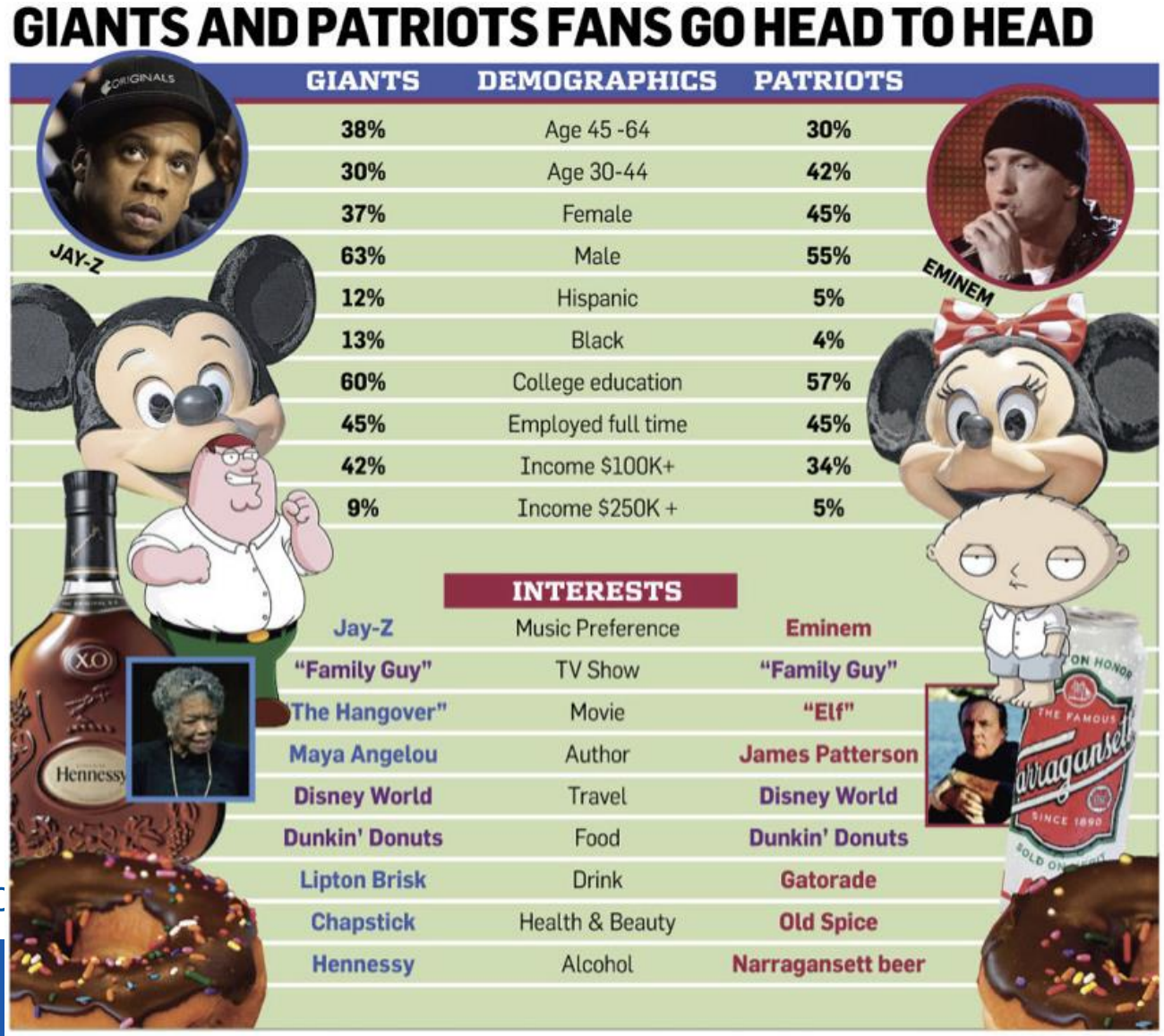
- Data exchange which is not stored in databases or indexed in DMS
- 80% - 90% of the data is unstructured
- 90% of Big data is unstructured

Extract Collective Wisdom Locked in Unstructured Data

Unstructured data

- Brands and organizations on Facebook receive 34,722 Likes every minute of the day
- 100 terabytes of data uploaded daily to Facebook
- One in every nine people on Earth is on Facebook
- Facebook is the world's 3rd largest country (2 times USA)
- Data production will be 44 times greater in 2020 than it was in 2009
- YouTube users upload 48 hours of new video every minute of the day

Example



GIANTS	DEMOGRAPHICS	PATRIOTS
38%	Age 45 -64	30%
30%	Age 30-44	42%
37%	Female	45%
63%	Male	55%
12%	Hispanic	5%
13%	Black	4%
60%	College education	57%
45%	Employed full time	45%
42%	Income $100K+	34%
9%	Income $250K +	5%

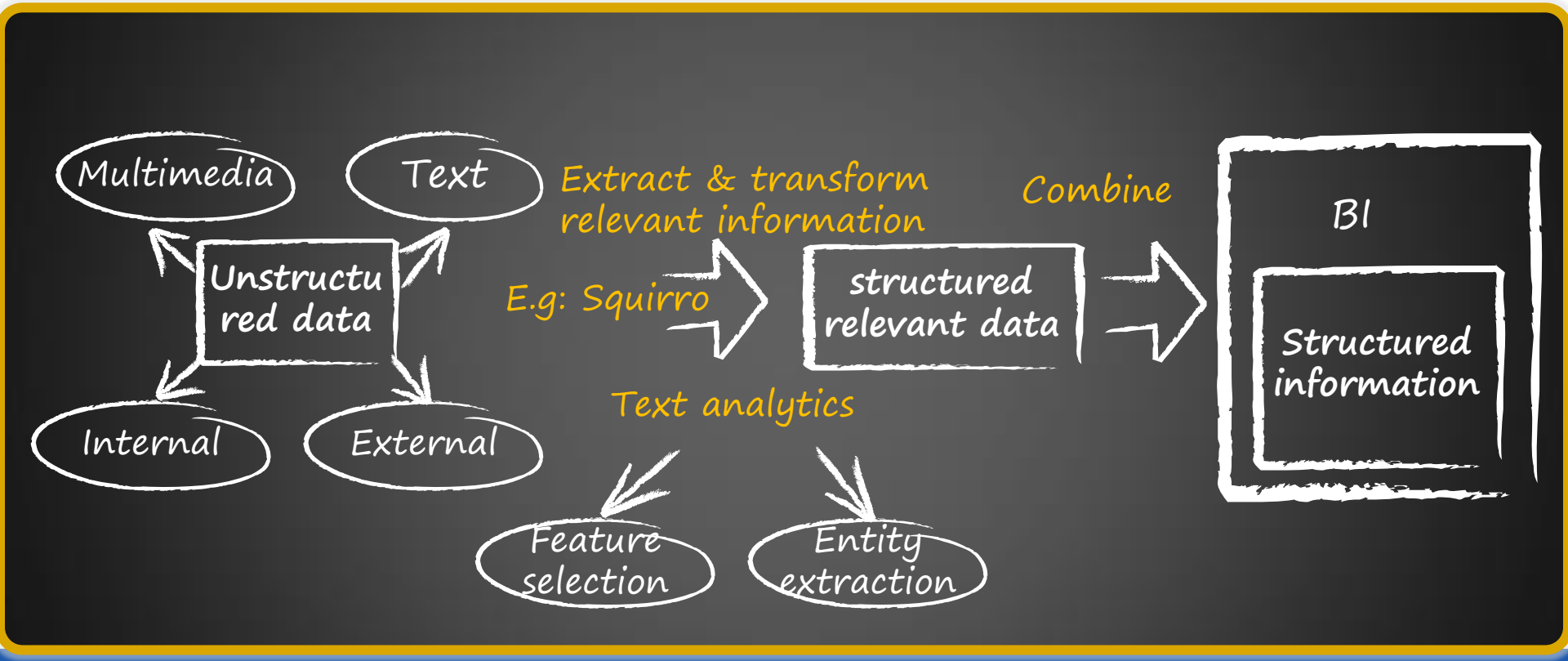
INTERESTS		
Jay-Z	Music Preference	Eminem
"Family Guy"	TV Show	"Family Guy"
"The Hangover"	Movie	"Elf"
Maya Angelou	Author	James Patterson
Disney World	Travel	Disney World
Dunkin' Donuts	Food	Dunkin' Donuts
Lipton Brisk	Drink	Gatorade
Chapstick	Health & Beauty	Old Spice
Hennessy	Alcohol	Narragansett beer

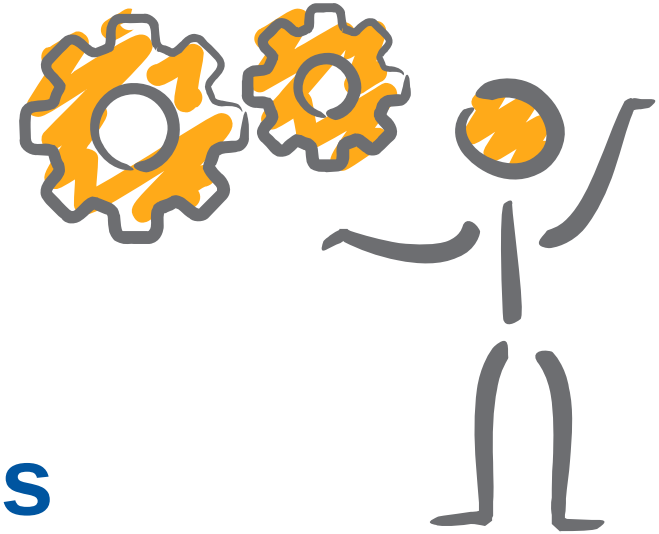
Source: Scarborough Sports Marketing; Wisdom.com based upon Facebook fans' interests

http://blog.wisdc

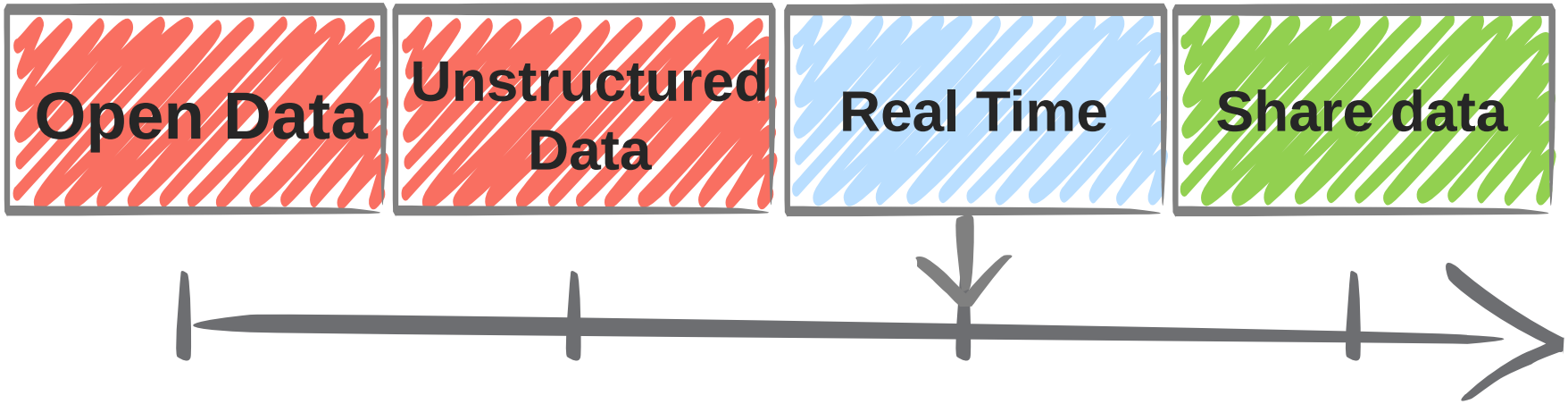
Unstructured data

- Improve the quality of existing BI
- Is the key enabler for new types of insights





BI & DWH Challenges



Benefits real time DWH / BI

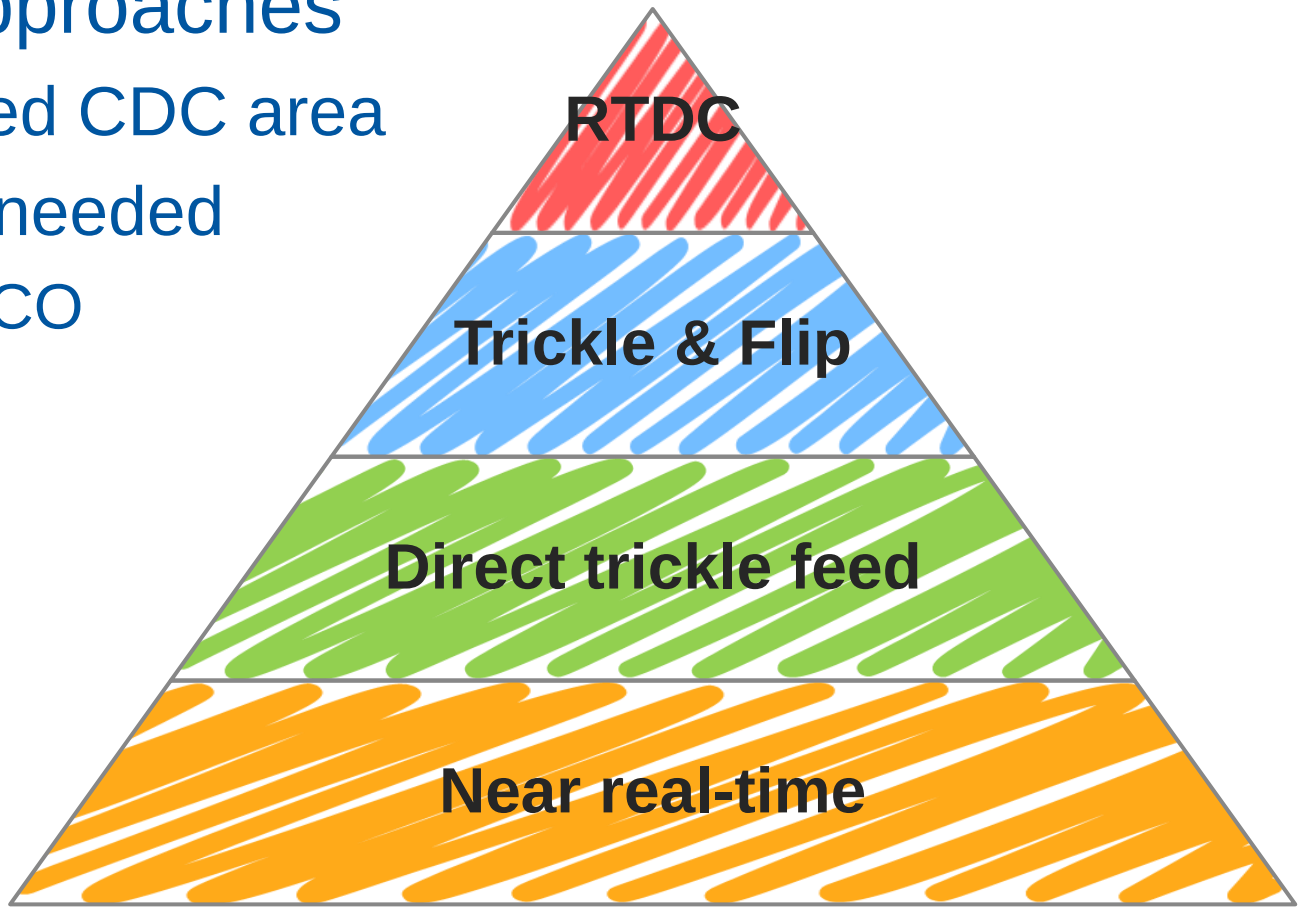
- Active decision support
- Alerting
- Up-to-the moment reporting
- Avoid users to access two different systems:
  - DWH for historical picture of what happened in the past
  - Many OLTP systems for what is happening now
- Can be built on top of existing data warehouse

Real time DWH

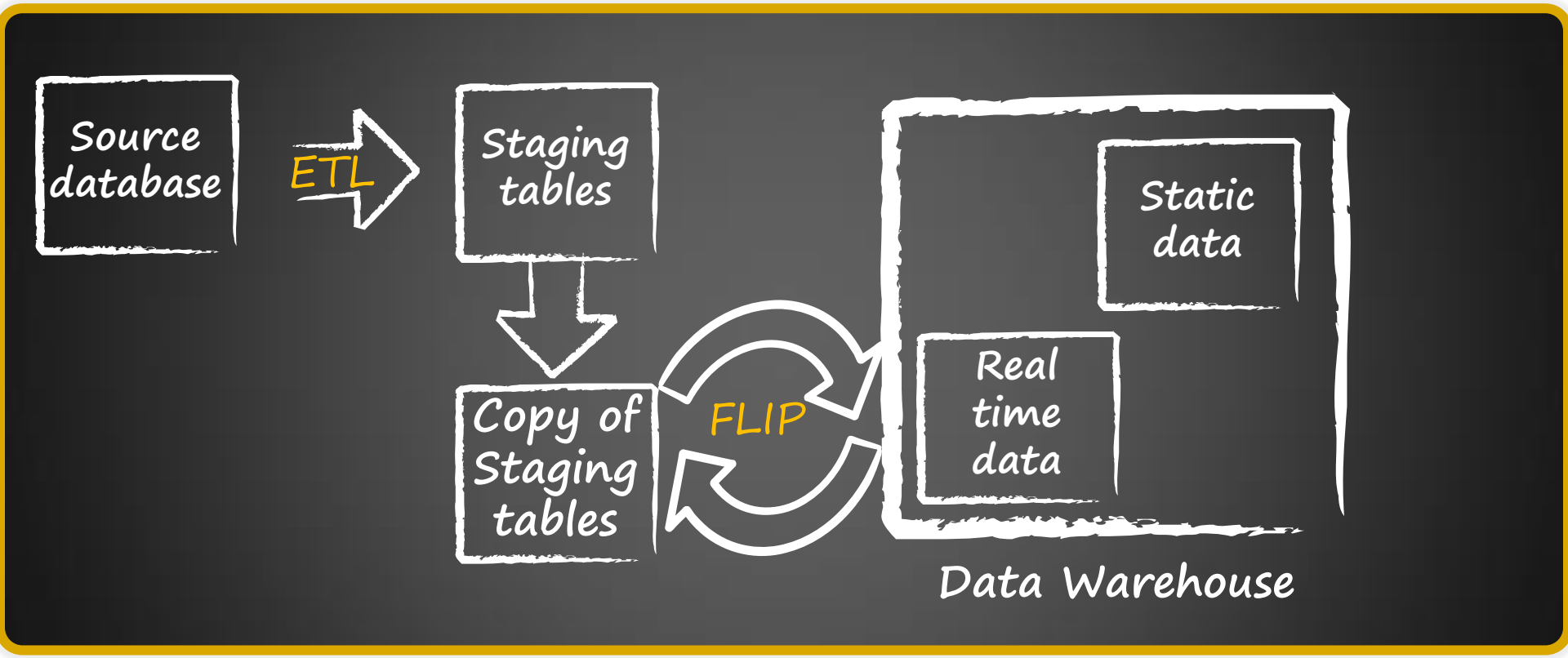
- Near real-time DWH
  - Fact
  - Dimension
- May have performance problems
- ETL should work in real-time
- Several approaches

Real time DWH

- Several approaches
  - They Need CDC area
  - Magic is needed
    - E.g: TIBCO



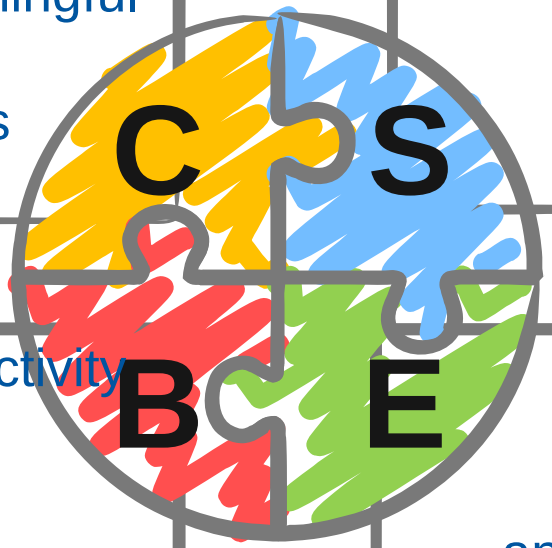
Real time DWH



Enablers real time DWH / BI

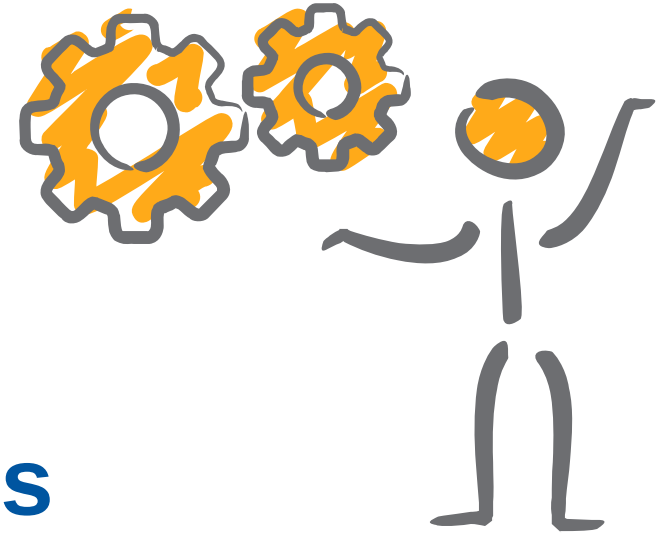
- CPE, Complex event processing
  - Identify meaningful event
  - Group events

- SOA, Service-oriented architecture
  - Services combined to provide the complete functionality

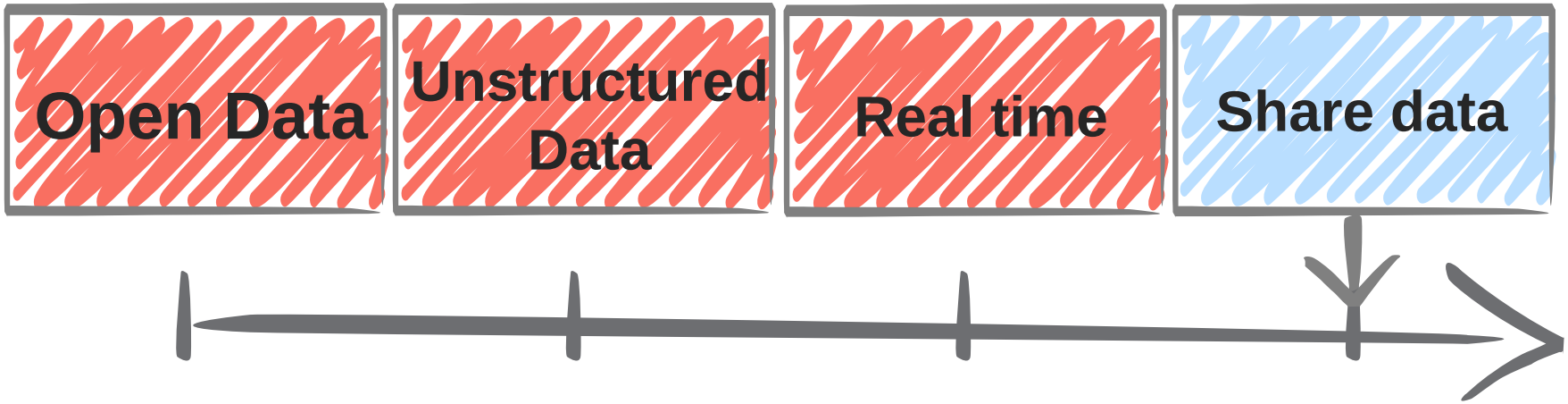


- BAM, Business Activity monitoring
- Used for:
  - Key Performance Indicators (KPIs)
  - Service-Level Agreements (SLAs)

- EAI (enterprise application integration)
- Exchange information among applications



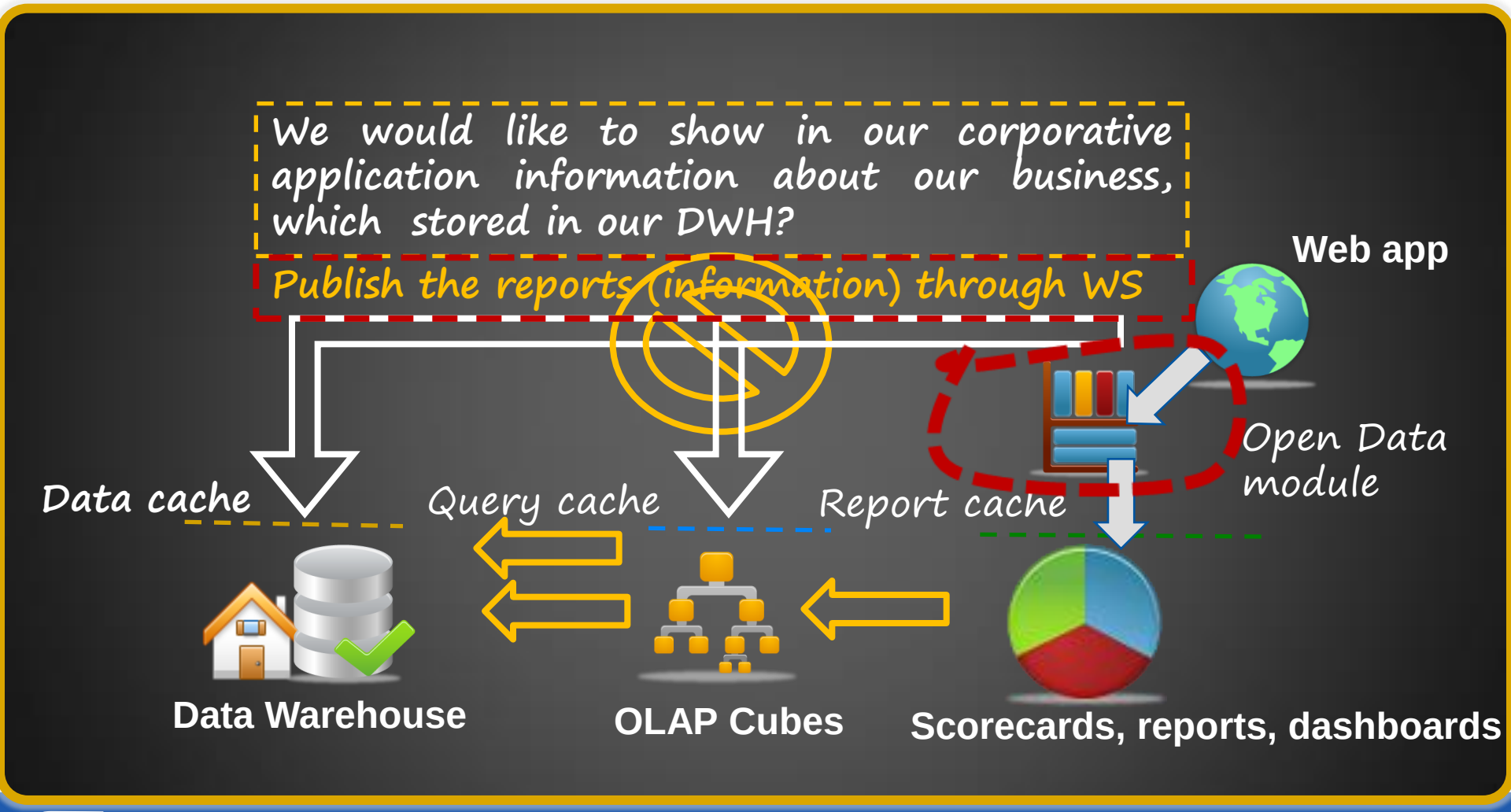
BI & DWH Challenges



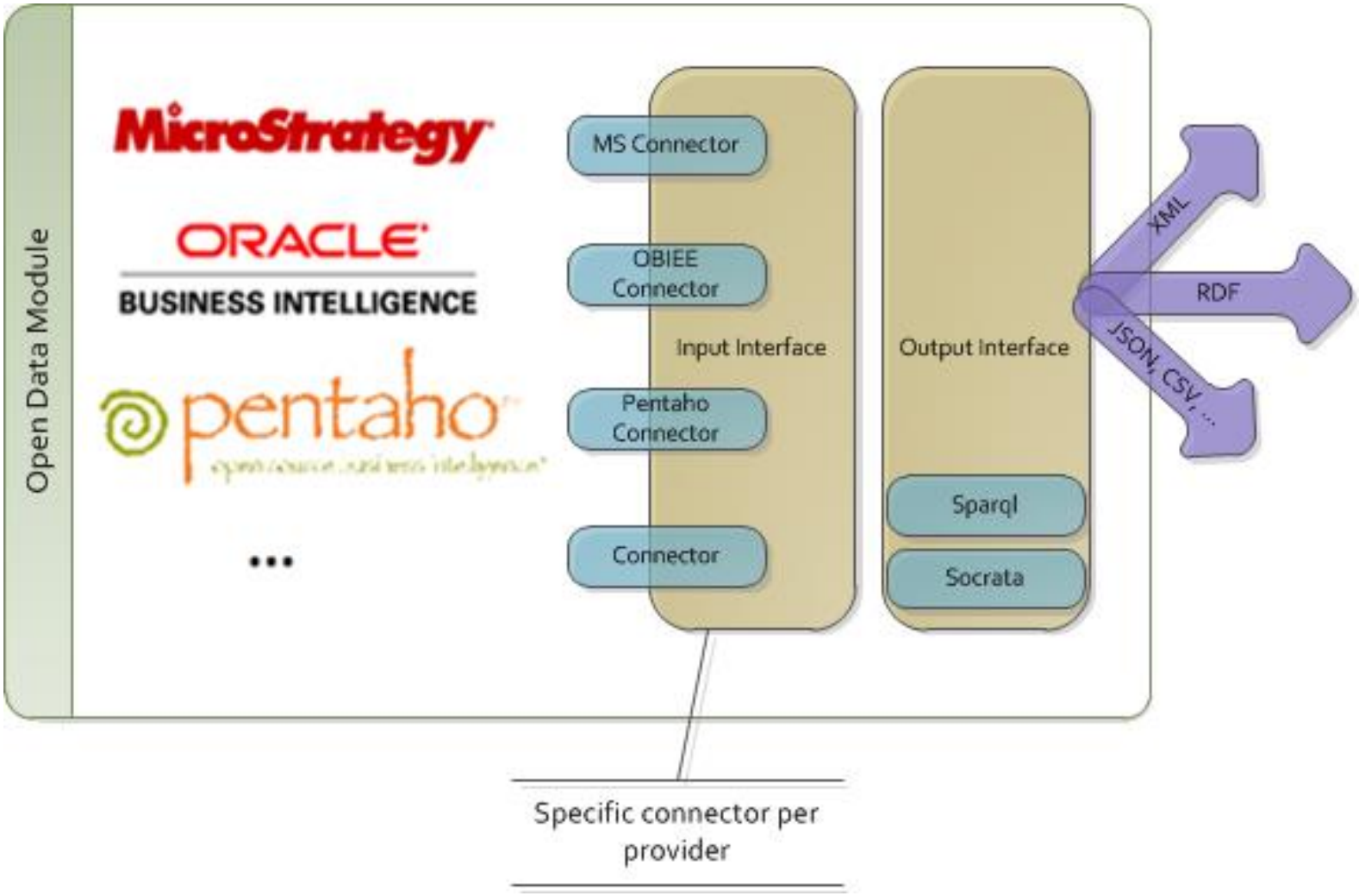
Benefits

- Share data among operational applications
- No complex queries
  - The queries are already pre-cooked
  - Hidden by BI reports
- Data consistency
  - Only one truth
  - Users will trust the informaion
- Performance
  - Data is cached

Share data


We would like to show in our corporative application information about our business, which stored in our DWH?
Publish the reports (information) through WS
Web app
Open Data module
Data cache
Query cache
Report cache
Data Warehouse
OLAP Cubes
Scorecards, reports, dashboards

Share data connector

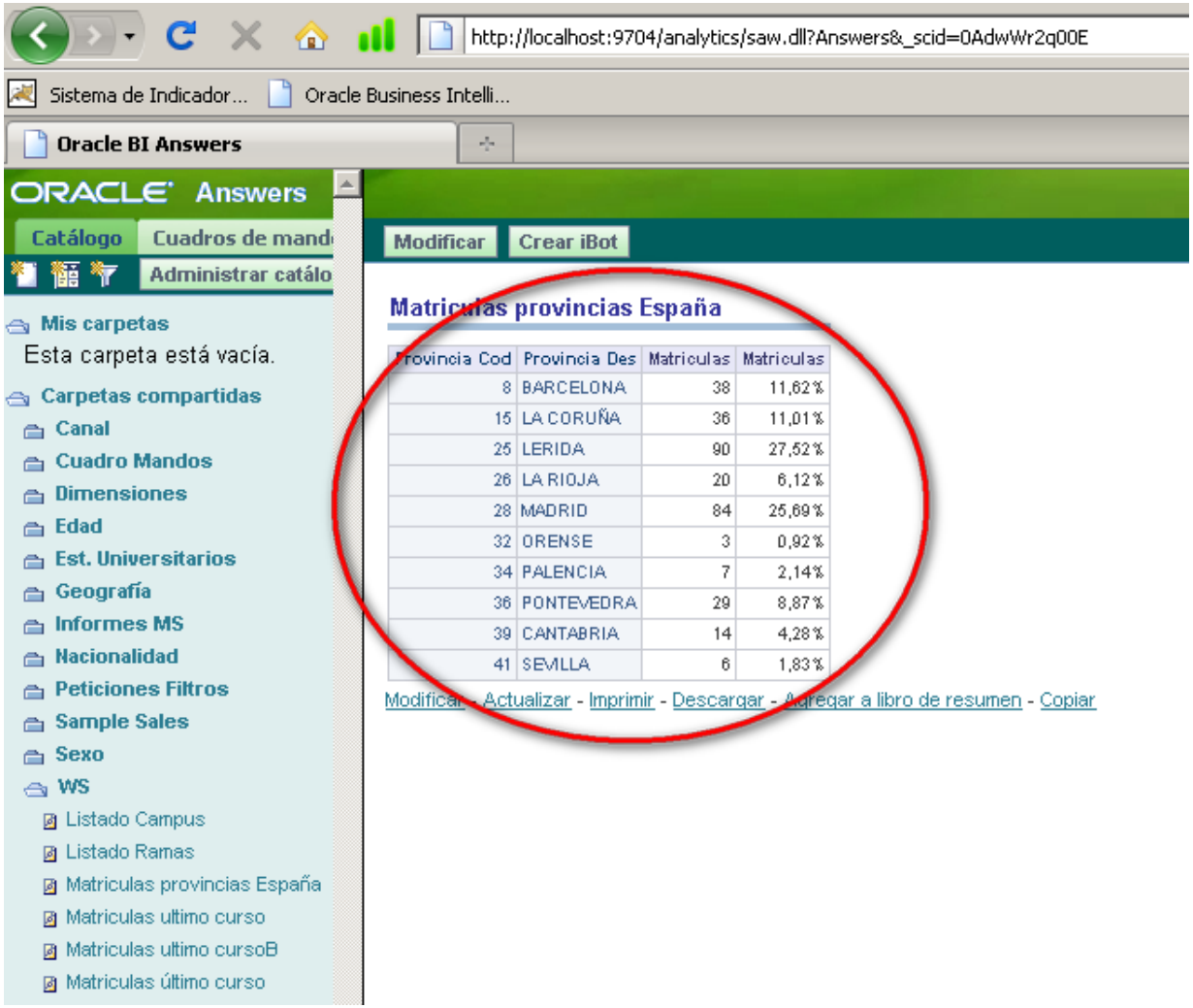


Share data connector

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!--XML Schema para la transferencia de información en el bus de servicios-->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="report">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="head" minOccurs="1" maxOccurs="1"/>
        <xs:element ref="rowset"  minOccurs="1" maxOccurs="1"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="row">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="col" minOccurs="1" maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="rowset">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="row" minOccurs="0"  maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="head">
    <xs:complexType>
```

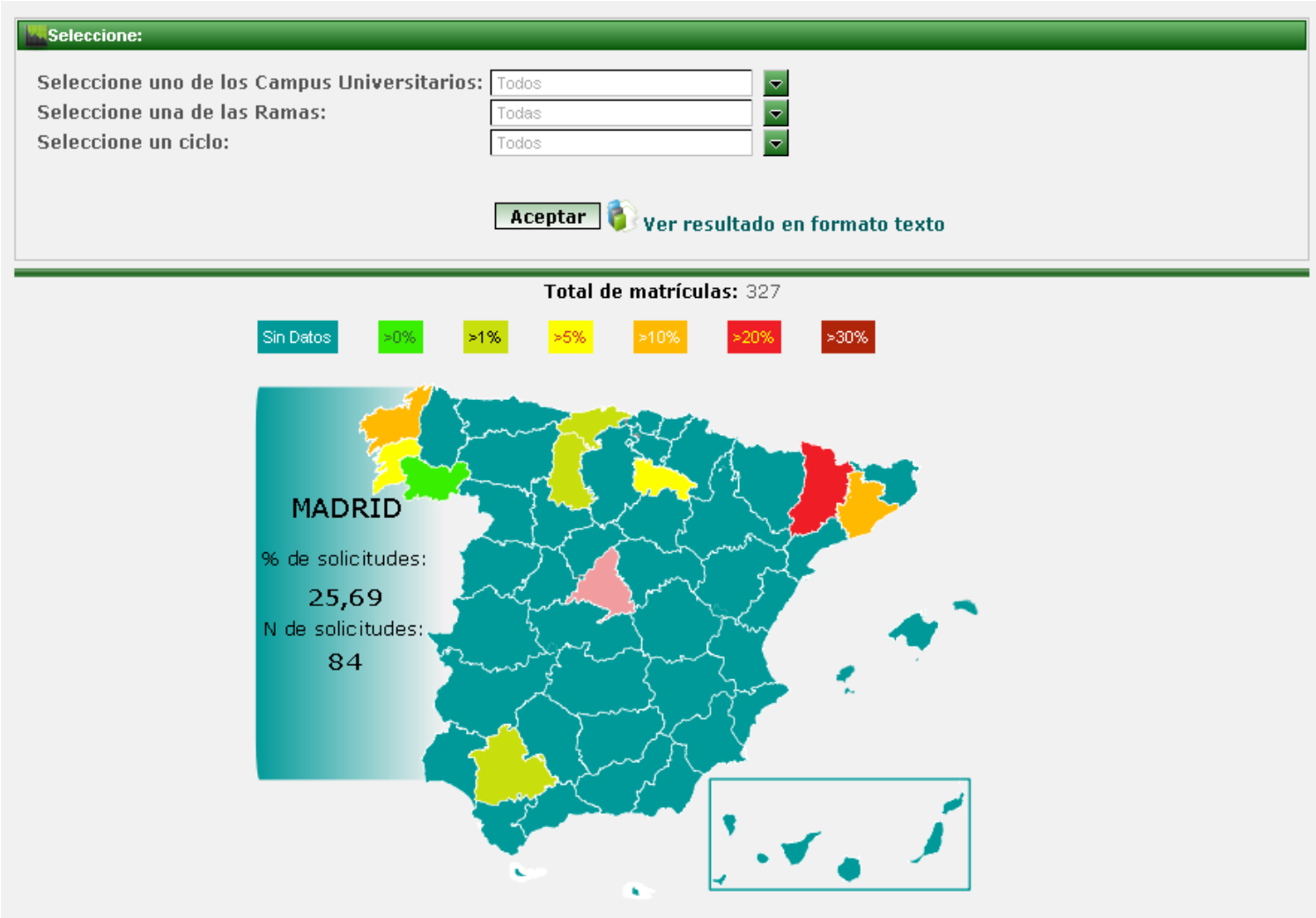
```xml
<?xml version="1.0" encoding="UTF-8"?>
<report xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:noNamespaceSchemaLocation="informationTransfer.xsd">
  <head>
    <col>Id. Provincia</col>
    <col>Provincia</col>
    <col>Porcentaje matriculas</col>
    <col>Matriculas</col>
  </head>
  <rowset>
    <row>
      <col>15</col>
      <col>LA CORUNA</col>
      <col>8.0</col>
      <col>19.047619047619</col>
    </row>
    <row>
      <col>36</col>
      <col>PONTEVEDRA</col>
      <col>7.0</col>
      <col>16.6666666666667</col>
    </row>
  </rowset>
</report>
```

Share data connector

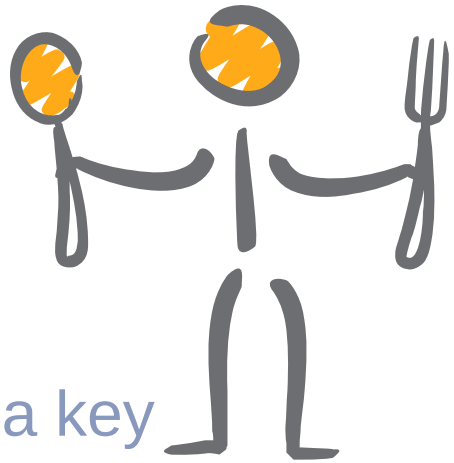


Provincia Cod	Provincia Des	Matriculas	Matriculas
8	BARCELONA	38	11,62%
15	LA CORUÑA	36	11,01%
25	LERIDA	90	27,52%
26	LA RIOJA	20	6,12%
28	MADRID	84	25,69%
32	ORENSE	3	0,92%
34	PALENCIA	7	2,14%
36	PONTEVEDRA	29	8,87%
39	CANTABRIA	14	4,28%
41	SEVILLA	6	1,83%

Share data connector



Proposed solution



An Open Data architecture for building a key performance indicator system powered in real time with BAM

Problem

- Building a key performance indicator system to display Open Data powered in real time with BAM

Solution

- Combine the advantages of BAM, SOA, Business Intelligence and data procesing to build a CME

Data

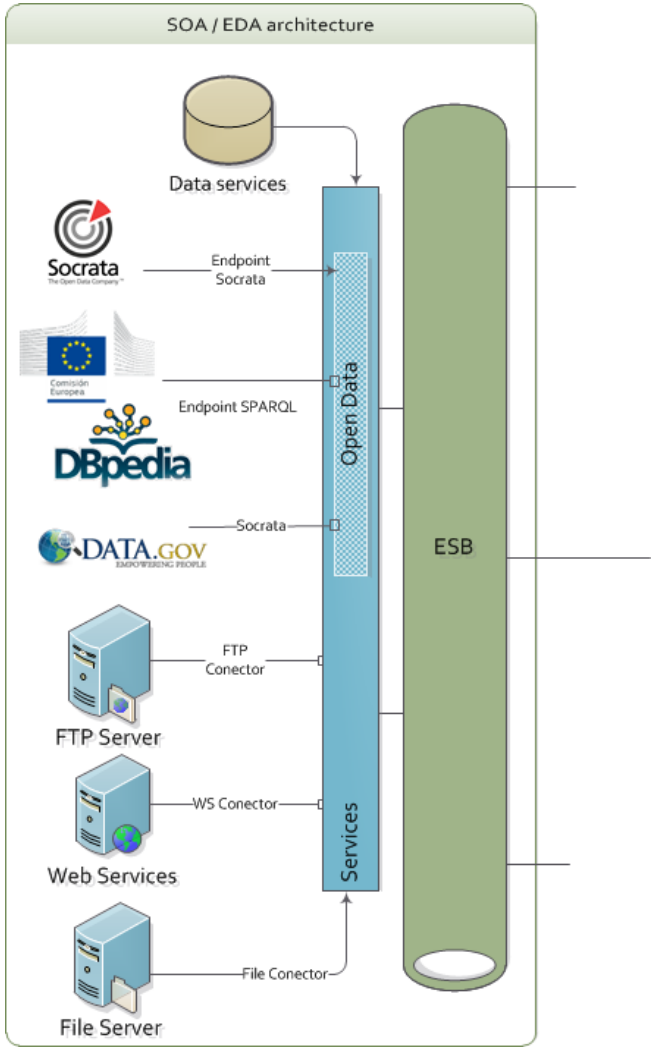
- SOA rol **V**ariety
  - Communication among apps
  - Open Data
- BAM rol **V**elocity
  - Real time monitoring
  - CEP

Information

- DWH rol, DM **V**alue
  - Enhance data
  - Improve the data giving it a meaning
- BI rol, **V**olume
  - Optimization
  - Knowledge

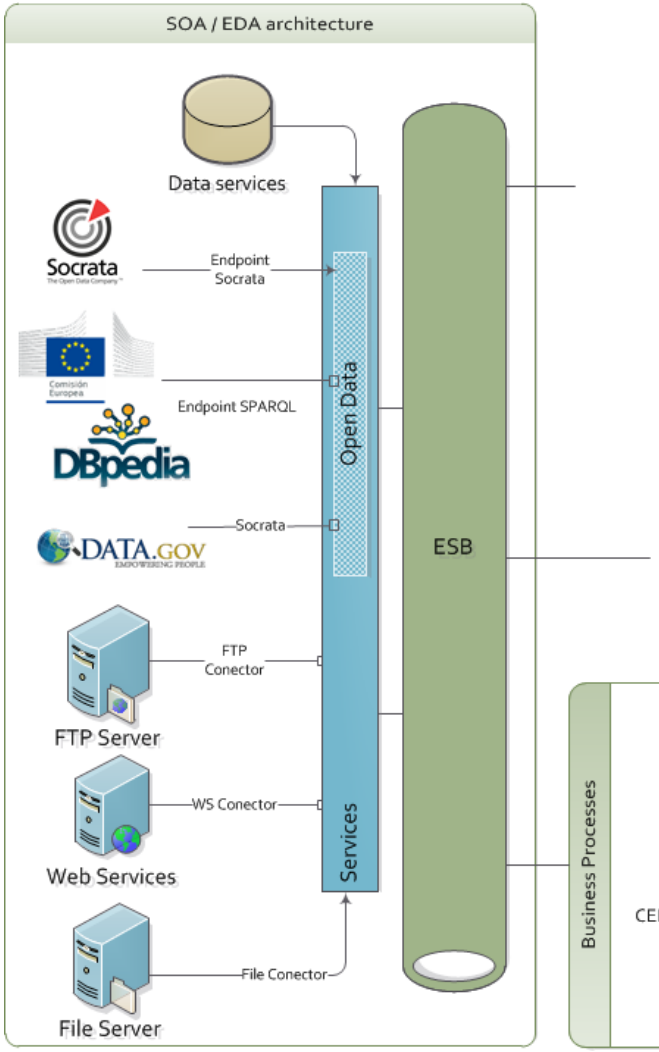
Knowledge

Solution

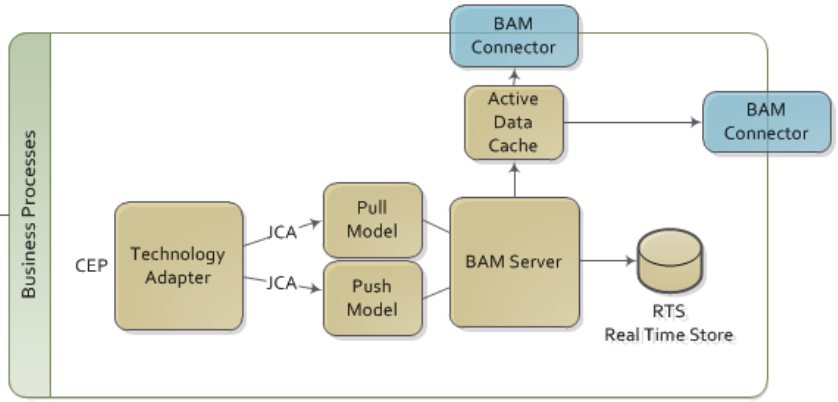


- Service bus, SOA/EDA
  - Real time
  - Orchestation
  - Heterogeneity
- Open Data connectors
  - Sparql
  - Socrata
  - Others

Solution

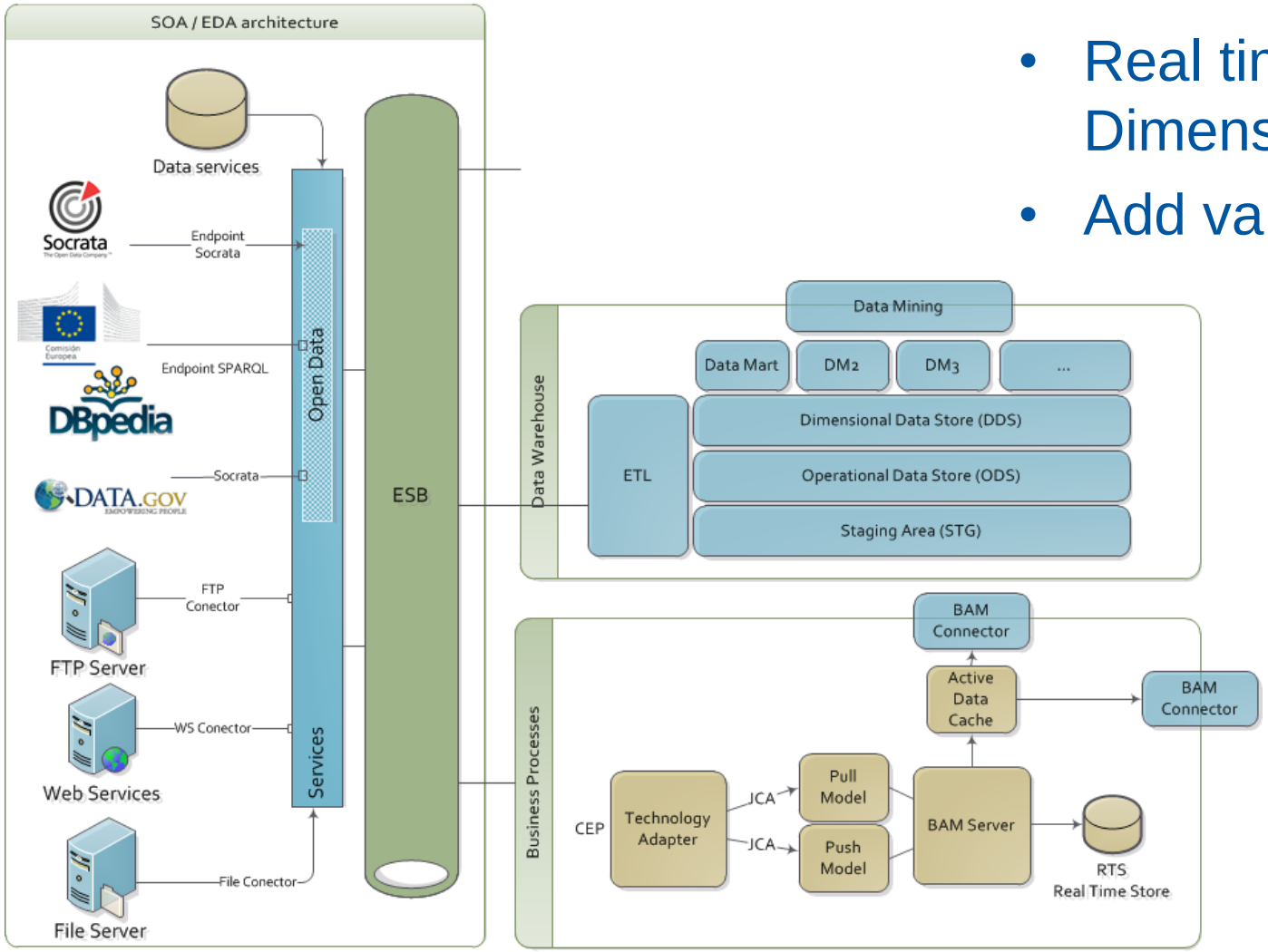


- BAM (Business Activity Monitoring)
  - Real time monitoring
  - CEP

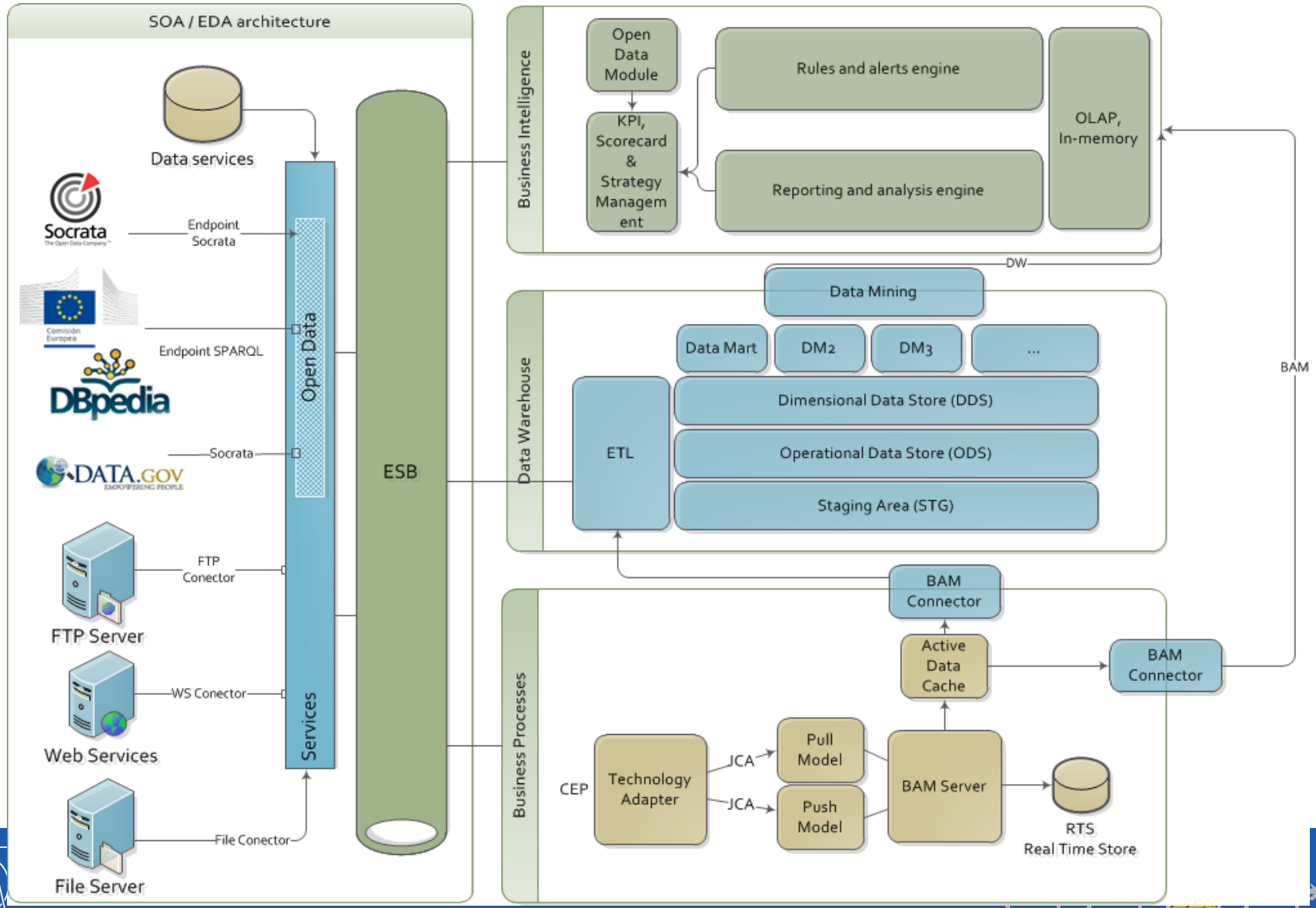


Proposal solution

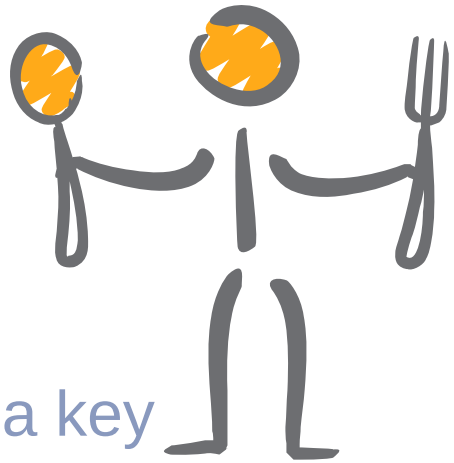
- DWH
  - Real time - Dimensional
  - Add value to the data



Solution


SOA / EDA architecture
Data services
Socrata
Endpoint Socrata
Endpoint SPARQL
DBpedia
Socrata
DATA.GOV
FTP Conector
FTP Server
WS Conector
Web Services
File Conector
File Server
Open Data
Services
ESB
Business Intelligence
Open Data Module
KPI, Scorecard & Strategy Management
Rules and alerts engine
Reporting and analysis engine
OLAP, In-memory
DW
Data Warehouse
Data Mining
Data Mart
DM2
DM3
...
ETL
Dimensional Data Store (DDS)
Operational Data Store (ODS)
Staging Area (STG)
BAM
BAM Connector
Active Data Cache
BAM Connector
Business Processes
CEP
Technology Adapter
JCA
JCA
Pull Model
Push Model
BAM Server
RTS
Real Time Store

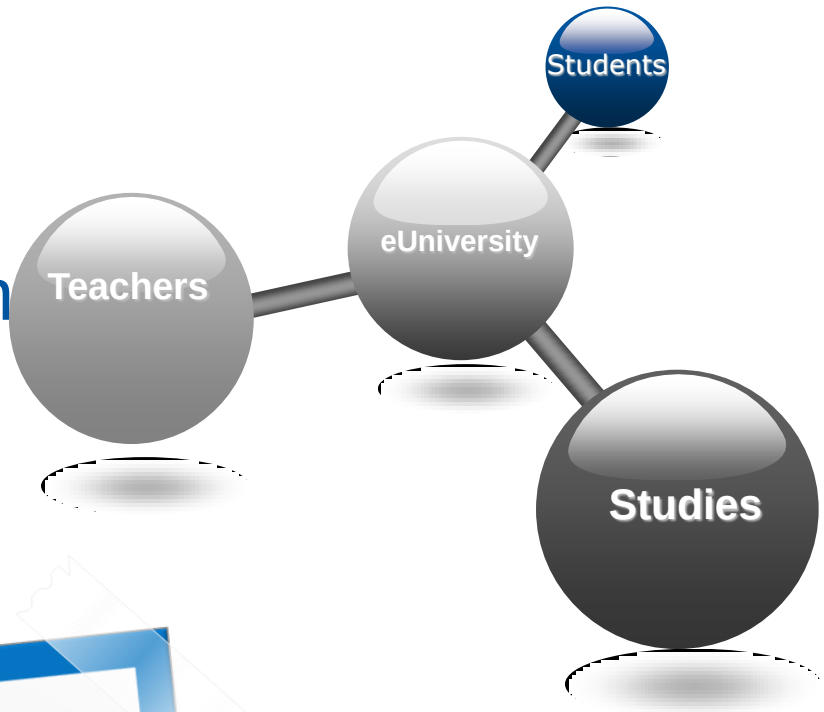
Case study



An Open Data architecture for building a key performance indicator system powered in real time with BAM for an University

Case study

- Key performance indicator system for a university, which allows to measure in real time the relationship between the students, teachers and university studies



Enrollments
+
Open Data

Solution

- Dimensional database model
  - Data Warehouse
  - Data proccess (ETL)

Data Warehouse

- Business Intelligence platform
  - Provide the most relevant indicators

BI

- Interactive Dashboards
  - Present and visualize information using charts, pivot tables and reports

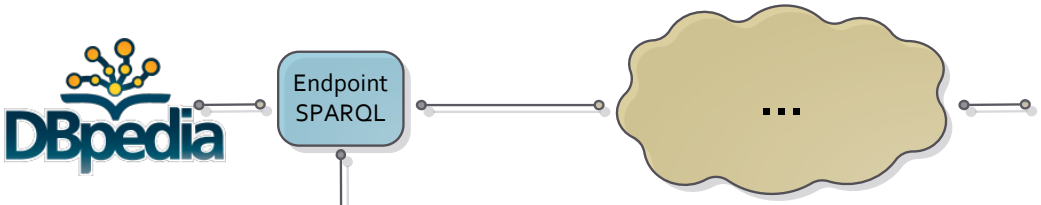
KPI, Dashboards

- Open data - Web services
  - Share the information between systems and everywhere

Open data

Populate dimensions

- Conector Open Data



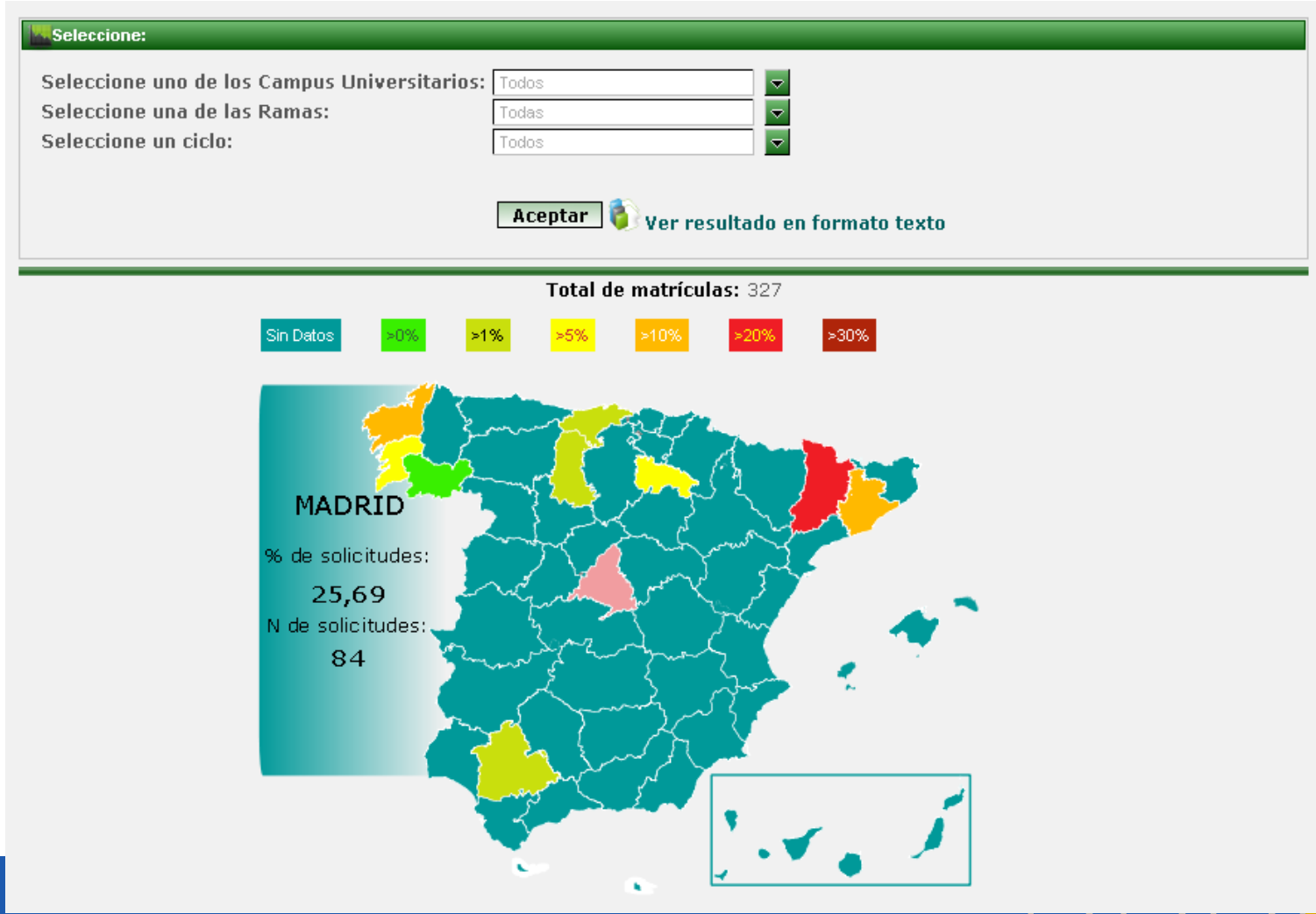
DIM_GEOGRAPHICAl	
PK	**CITY_COD**
	TOTAL_COD TOTAL_DES COUNTRY_COD COUNTRY_DES PROVINCE_COD PROVINCE_DES CITY_COD CITY_DES CITY_POB

```
PREFIX o: <http://dbpedia.org/ontology/>
PREFIX p: <http://dbpedia.org/property/>
PREFIX r: <http://dbpedia.org/resource/>
PREFIX g: <http://www.w3.org/2003/01/geo/wgs84_pos#>

PREFIX foaf: <http://xmlns.com/foaf/0.1/>
 SELECT ?name, ?pop, ?dpop, ?lat, ?long
 WHERE {
 ?x o:type r:Autonomous_communities_of_Spain;
 foaf:name            ?name ;
 p:populationTotal    ?pop ;
 p:populationAsOf     ?dpop ;
 g:lat                ?lat;
 g:long               ?long.
}
```

Share data

- Open data module



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Questions?