Plant biology open data interoperability in the big data era

Anne-Francoise Adam-Blondon, Sophie S. Durand, Erik Kimmel, Raphaël-Gauthier R.-G. Flores, Cyril Pommier, Michael M. Alaux, Delphine Steinbach, Hadi Quesneville

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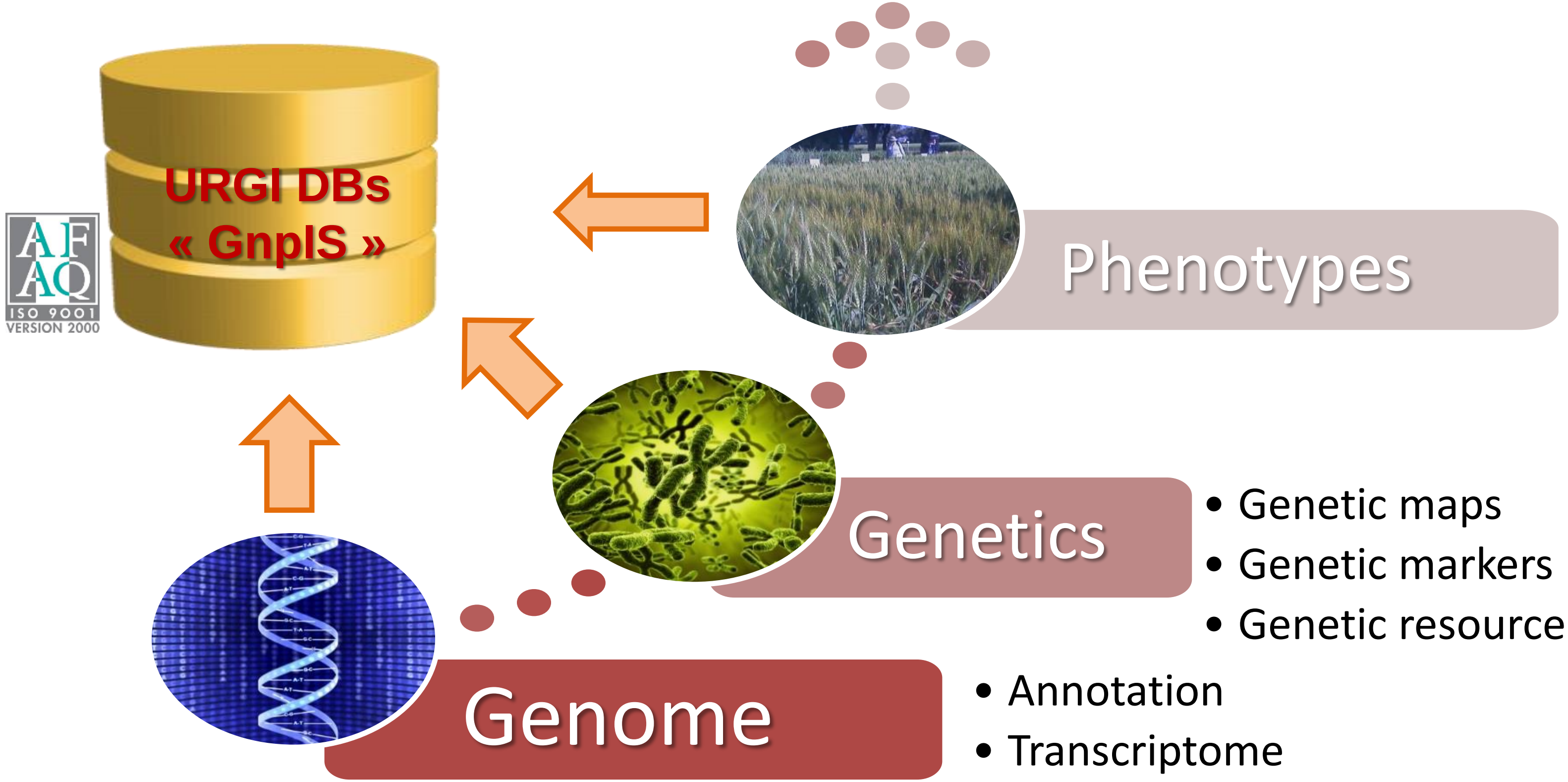
EPSO-FEBS 2014, le 27/06/14

A bioinformatic unit for crops and pathogens

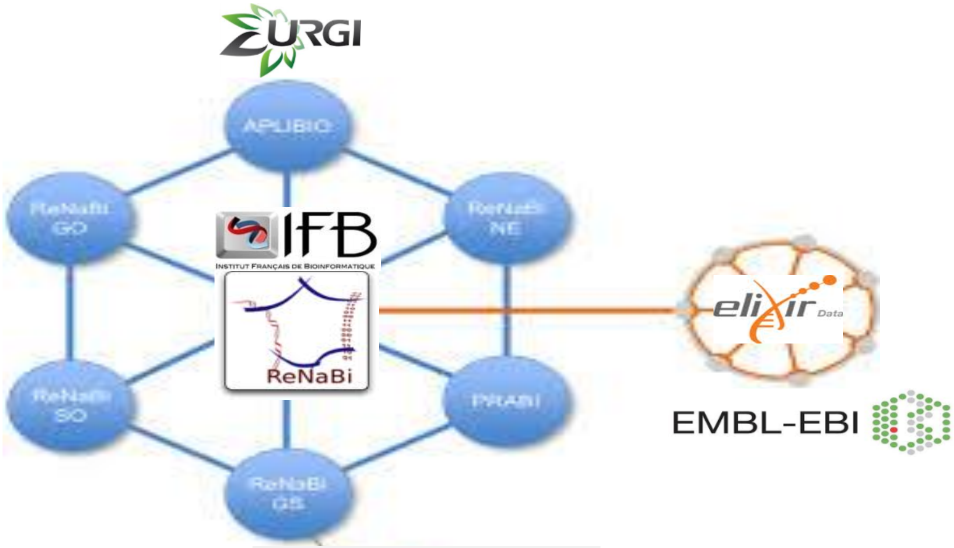


- GxE
- QTL maps
- GWAS, GS

- Genetic maps
- Genetic markers
- Genetic resources

- Annotation
- Transcriptome
- SNP / Structural variant

URGI is a node of the french network of bio-informatics facilities (IFB-ReNaBi)



Challenges

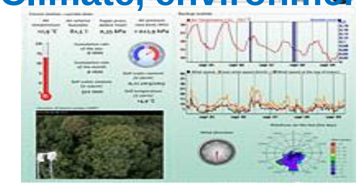
Necessity to connect data stored into different information systems

- Because the volumes are becoming too big for one information system (Ex: NGS)
- Because it is impossible to store all data in a single data model (Ex: phenotyping)
- Because data relevant for a scientific question may be stored in different databases dedicated to other purposes

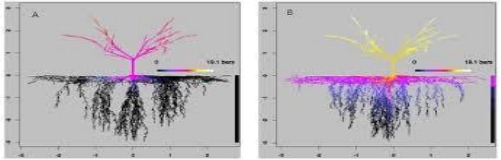
Necessity to organize and query heterogeneous data collected in different laboratories/context

Different data structures <-> different initial question
Potentially different experimental protocoles

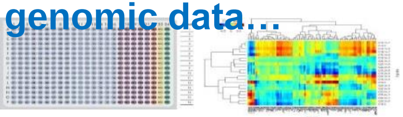
Climate, environment



Physical measurements, sensors…



Metabolites, proteins, genomic data…



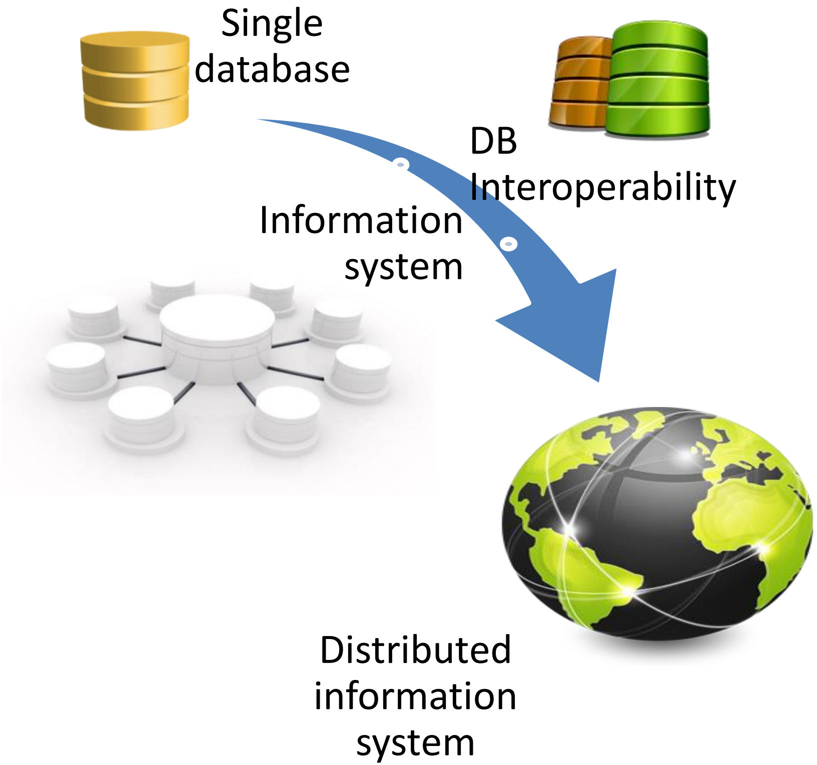
Bibliography, human sciences…

Post-harvest

→ Development of guidelines, ontologies and standards by the **community of data producers/researchers**

Consequences on information systems

Towards distributed systems



Work in progress

Towards distributed information systems

Wheat Initiative

WheatIS: the information system of the International Wheat Initiative (coord. H. Lucas): (chair: H. Quesneville)

transPLANT

Google-like query tool allowing to retrieve information in the databases of the transnational **TransPLANT** infrastructure (coord P. Kersey, EBI)

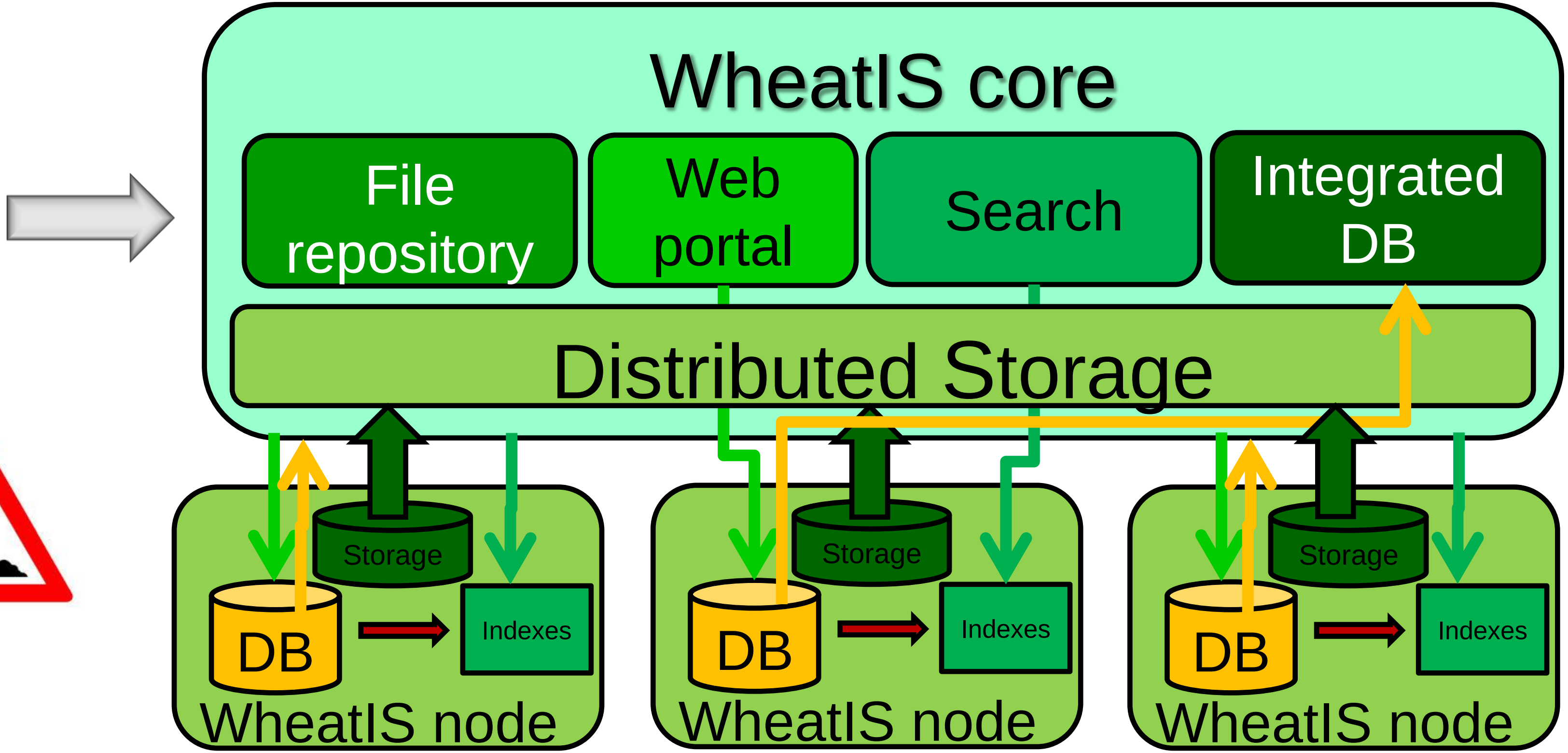
PHENOME
Réseau Français Phénomique végétale F P P N

Information system for French Plant Phenotyping Network (**Phenome**, coord F. Tardieu)

arcad

Building a portal for the french crop **germplasm collections** (ARCAD-FEDER, J-L Pham coord)

WheatIS architecture



Definition of standards

Survey of existing standards: **(1) data, (2) ontologies, (3) meta-data**

“**Cookbook**”: how to produce easily shareable, reusable and interoperable “wheat data”

Identification of **end-users** categories and **WheatIS nodes**

Challenge : adoption of the recommendations by the community

- simple ontologies
- good balance between genericity and necessary specifity
- alignment with other international initiatives
- tools to help users

Ontologies / Thesaurus

References Ontologies

PATO

- Area
- …

Plant Ontology

- Leaf
- …

Unit Ontology

- cm2
- …

Plant Ontology PO Consortium

Applied Ontologies

Crop Ontology

Wheat

Leaf Area

- Unit : cm2
- Method

Yield

- Unit : t/ha
- Method

Rust

- Scale
- Method
- Stage

Vitis

Budbreak date

Young Shoot: aperture of tip

- OIV:001
- Scale:1-3-5
- UPOV:3

Generation Challenge Programme
CULTIVATING PLANT DIVERSITY FOR THE RESOURCE POOR

Bioversity International

Thesaurus

BreedWheat

- Leaf Area
  - **BreedWheat Method**
- Yield

Breed Wheat

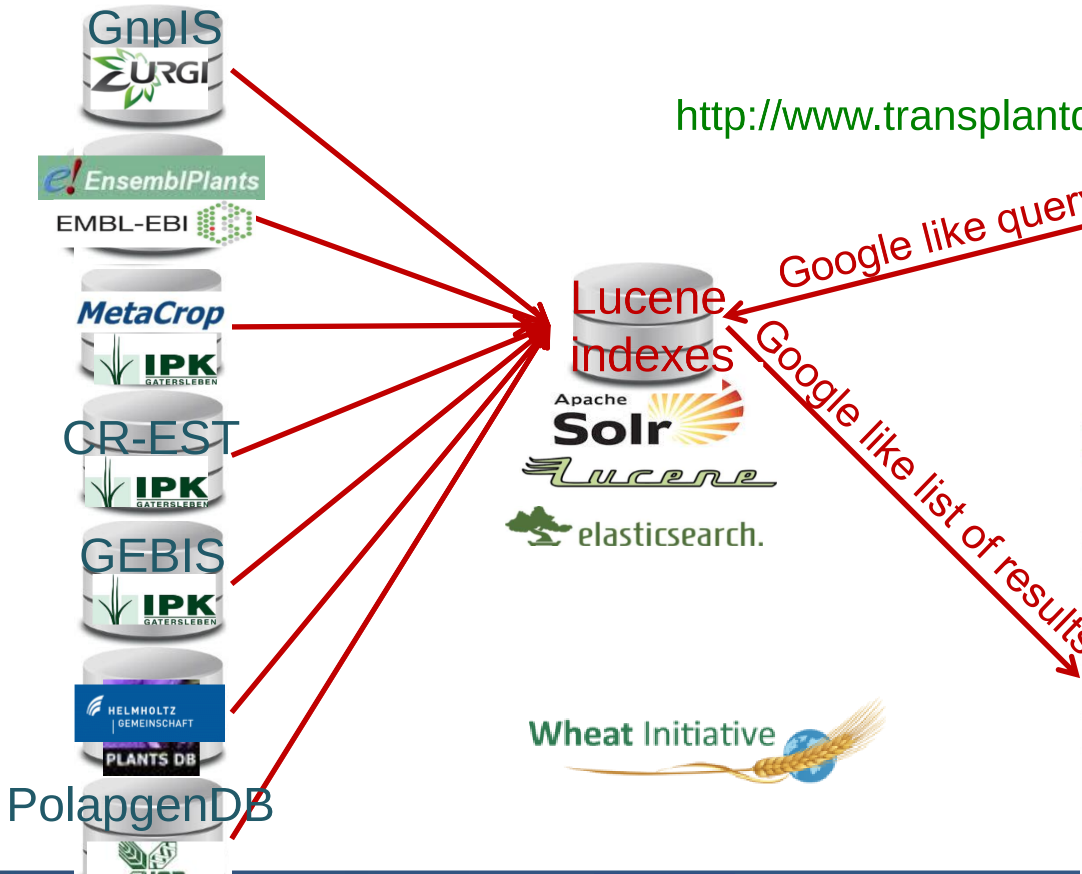
Phenome

- Leaf Area
- Budbreak date

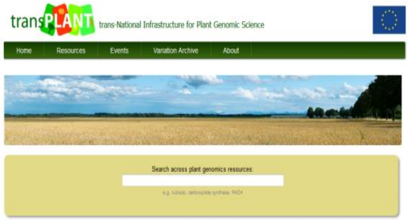
PHENOME Réseau Français Phénomique végétale F P P N

AnaEE Analysis and Experimentation on Ecosystems France

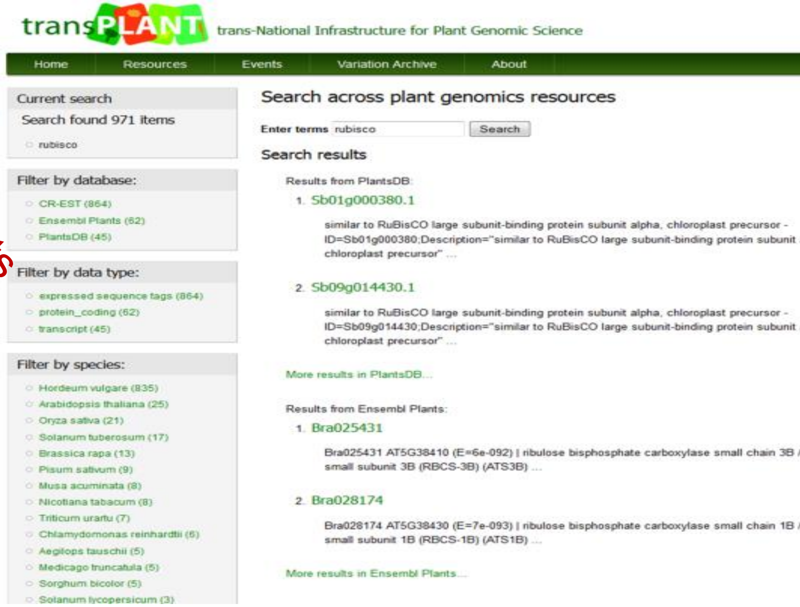
Full text queries of distributed databases



http://www.transplantdb.eu/


transPLANT trans-National Infrastructure for Plant Genomic Science
Home
Resources
Events
Variation Archive
About
Search across plant genomics resources:
e.g. rubisco, carboxylate synthase, PAD4

User web interface


transPLANT trans-National Infrastructure for Plant Genomic Science
Home
Resources
Events
Variation Archive
About
Search

Current search

Search found 971 items

- rubisco

Filter by database:

- CR-EST (864)
- Ensembl Plants (62)
- PlantsDB (45)

Filter by data type:

- expressed sequence tags (864)
- protein_coding (62)
- transcript (45)

Filter by species:

- Hordeum vulgare (835)
- Arabidopsis thaliana (25)
- Oryza sativa (21)
- Solanum tuberosum (17)
- Brassica rapa (13)
- Pisum sativum (9)
- Musa acuminata (8)
- Nicotiana tabacum (8)
- Triticum urartu (7)
- Chlamydomonas reinhardtii (6)
- Aegilops tauschii (5)
- Medicago truncatula (5)
- Sorghum bicolor (5)
- Solanum lycopersicum (3)

Search across plant genomics resources

Enter terms rubisco

Search results

Results from PlantsDB:

1. Sb01g000380.1

   similar to RuBisCO large subunit-binding protein subunit alpha, chloroplast precursor - ID=Sb01g000380;Description="similar to RuBisCO large subunit-binding protein subunit chloroplast precursor" ...

2. Sb09g014430.1

   similar to RuBisCO large subunit-binding protein subunit alpha, chloroplast precursor - ID=Sb09g014430;Description="similar to RuBisCO large subunit-binding protein subunit chloroplast precursor" ...

More results in PlantsDB...

Results from Ensembl Plants:

1. Bra025431

   Bra025431 AT5G38410 (E=6e-092) | ribulose bisphosphate carboxylase small chain 3B small subunit 3B (RBCS-3B) (ATS3B) ...

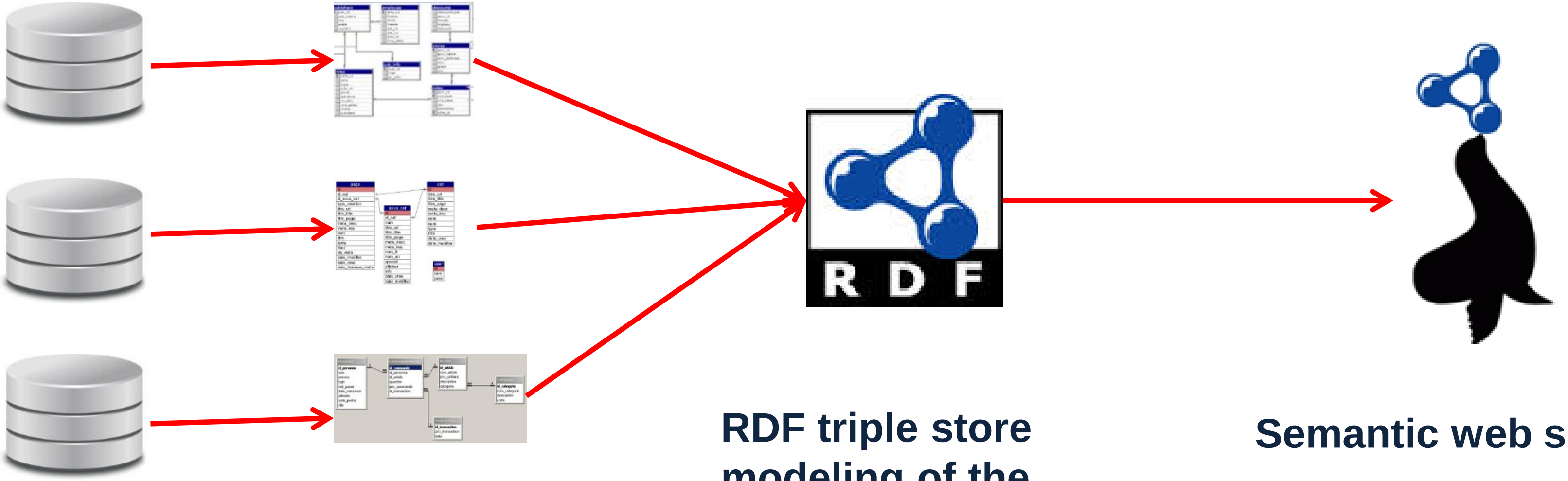
2. Bra028174

   Bra028174 AT5G38430 (E=7e-093) | ribulose bisphosphate carboxylase small chain 1B small subunit 1B (RBCS-1B) (ATS1B) ...

More results in Ensembl Plants...

Perspectives

Develop a web semantic interoperability between the plant databases of the French Elixir node



Ontology based annotation of database schemes

RDF triple store modeling of the databases schemes integrated with existing ontologies

Semantic web services

Summary

Challenge: the query of high volumes of heterogeneous and distributed data

⇒ Federation of information systems

- ❖ At the national and european level
- ❖ through noSQL technologies (SolR, ElasticSearch…)
- ❖ Web semantic layer

Aknowledgements

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AGENCE NATIONALE DE LA RECHERCHE ANR

INVESTISSEMENTS D'AVENIR

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Gerard Lazo…

RDA RESEARCH DATA ALLIANCE

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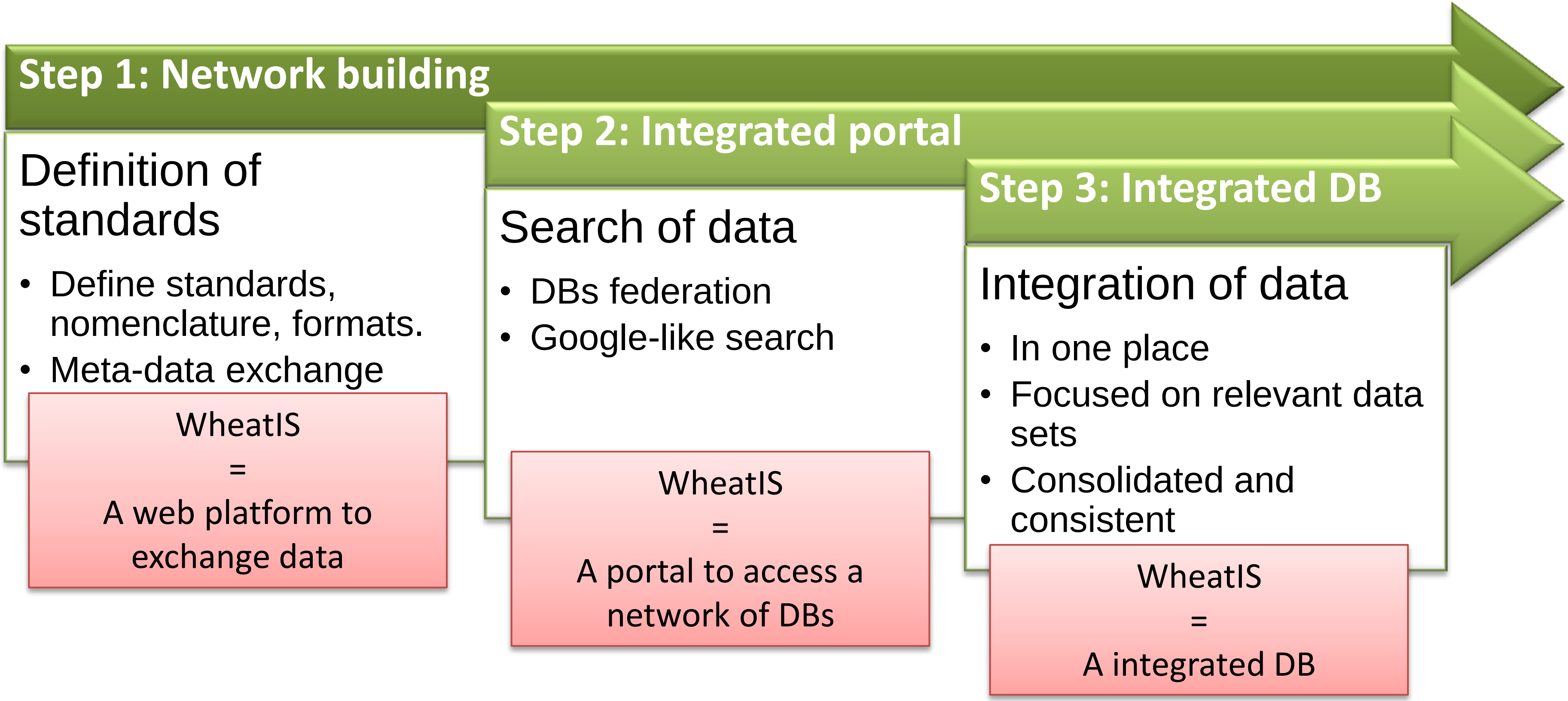
transPLANT

Paul Kersey
Dan Bolser…

WheatIS timeline



Step 1: Network building

Definition of standards

- Define standards, nomenclature, formats.
- Meta-data exchange

WheatIS
=
A web platform to exchange data

Step 2: Integrated portal

Search of data

- DBs federation
- Google-like search

WheatIS
=
A portal to access a network of DBs

Step 3: Integrated DB

Integration of data

- In one place
- Focused on relevant data sets
- Consolidated and consistent

WheatIS
=
A integrated DB