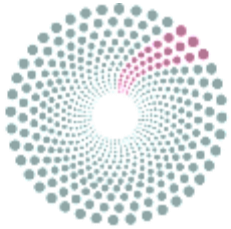


BIG DATA EUROPE

Introduction: Project, Architecture, Components, and Interfaces

Ivan Ermilov
University of Leipzig/InfAI
iermilov@informatik.uni-leipzig.de

09 October 2017

ICTCS, Amman, Jordan

Talk outline

- The BigDataEurope action
- The Big Data Integrator platform
  - Technical Architecture
  - Components & Interfaces
- Pilots across all seven H2020 challenges

BigDataEurope Action & Platform

Big Data Europe (CSA: 2015-17)

- **Show** societal value of Big Data
  - Across all societal challenges addressed by Horizon 2020
- **Lower** barrier for using big data technologies
  - Effort and resources to convert tools and workflows
  - Skills and expertise
- **Help** establish data value chains
  - Across languages, organizations, and domains

BigDataEurope: Summary

- Horizon2020 project
- 17 partners
- 7 pilots in various domains
- > 30 Big Data components
- > 250 stars on github

Consortium

Fraunhofer IAIS

InfAI Institut für Angewandte Informatik

TenForce The Pragmatic Company

universitätbonn

NCSR DEMOKRITOS

W3C

National and Kapodistrian University of Athens

VU University Amsterdam

Semantic Web Company linking data to knowledge

SatCen

The Open PHACTS Foundation

cessda

Food and Agriculture Organization of the United Nations

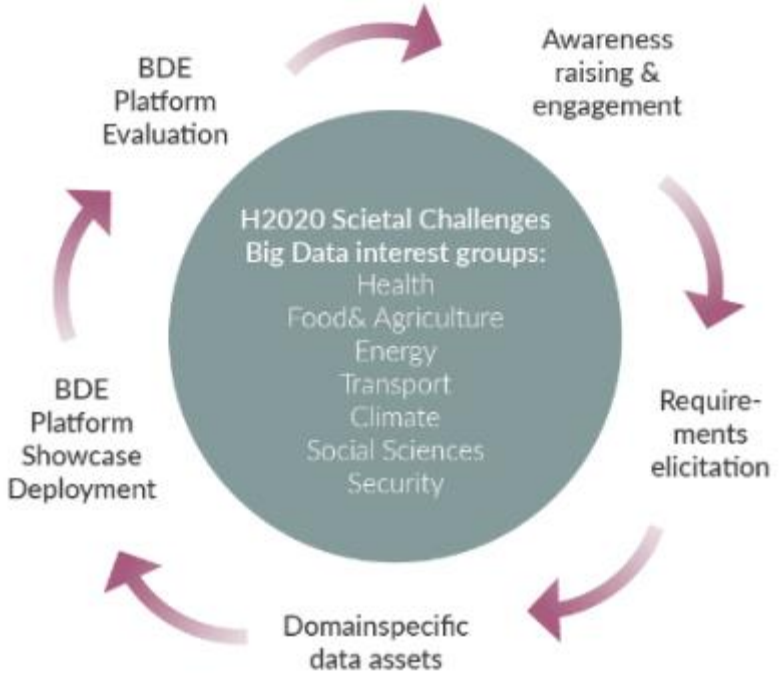
ACRO-KNOW

ERTICO

KAПE CRES

- Semantic Web and Linked Data expertise
- SW/LD technologies

Stakeholder Engagement



Stakeholder engagement workshops:

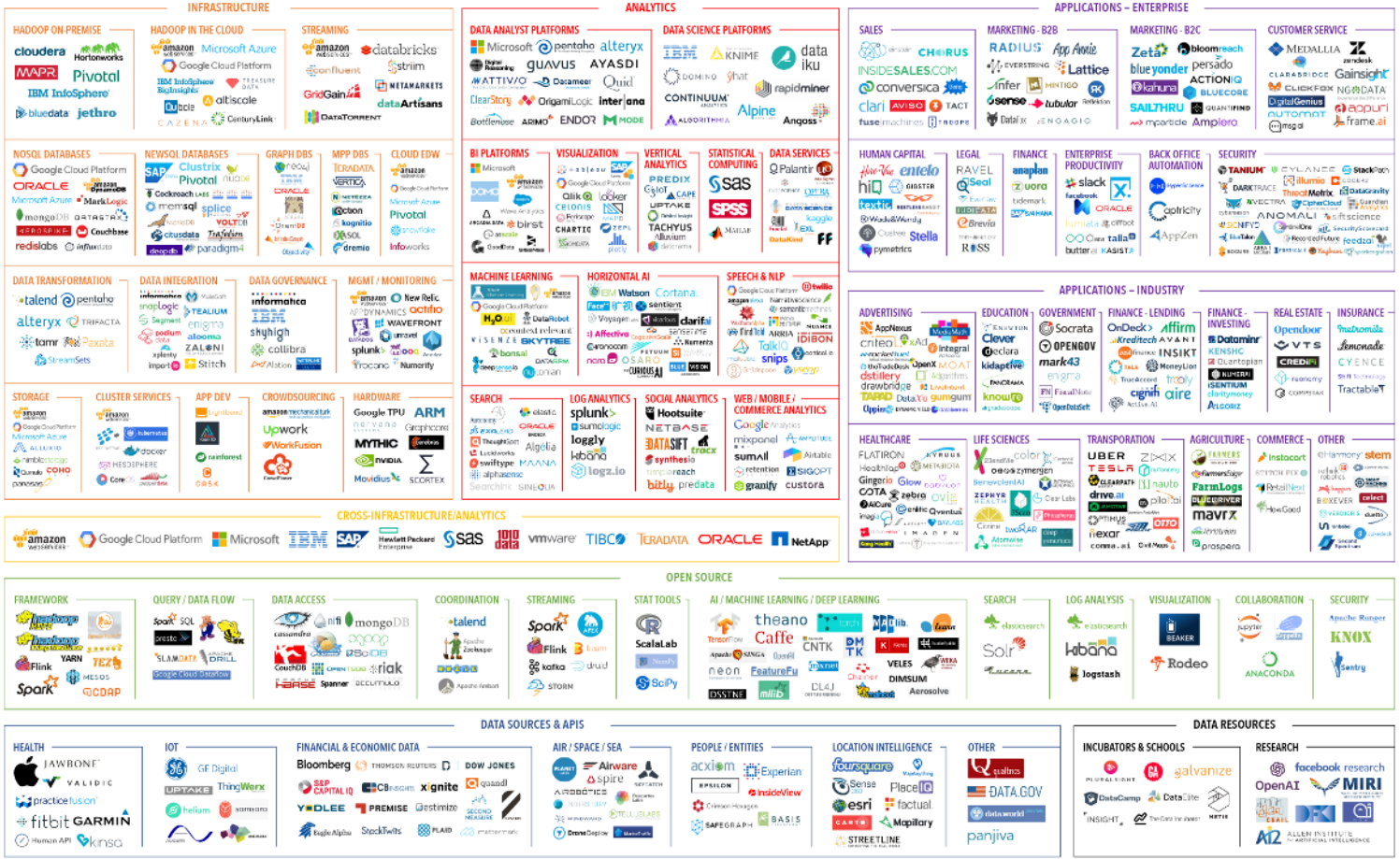
- Present the action and its showcase deployments
- Raise awareness about BDE results and what they mean for stakeholders
- Collect requirements to drive further development

Big Data Integrator

Platform Goals

- Open source
- Simple to get started with Big Data
- Support a variety of use cases
- Embrace emerging Big Data technologies
- Simple integration with custom components

BIG DATA LANDSCAPE 2017



Last updated 4/5/2017

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mattturck.com/bigdata2017

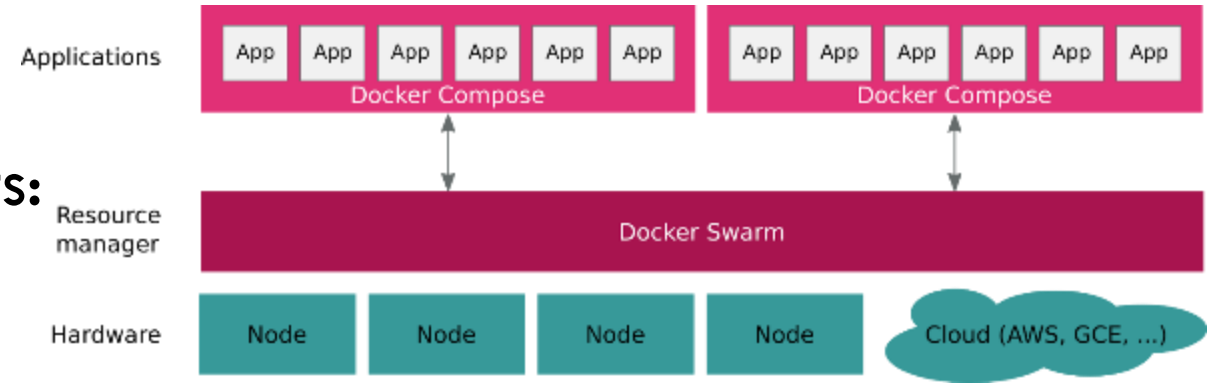
FIRSTMARK
EARLY STAGE VENTURE CAPITAL

Architecture

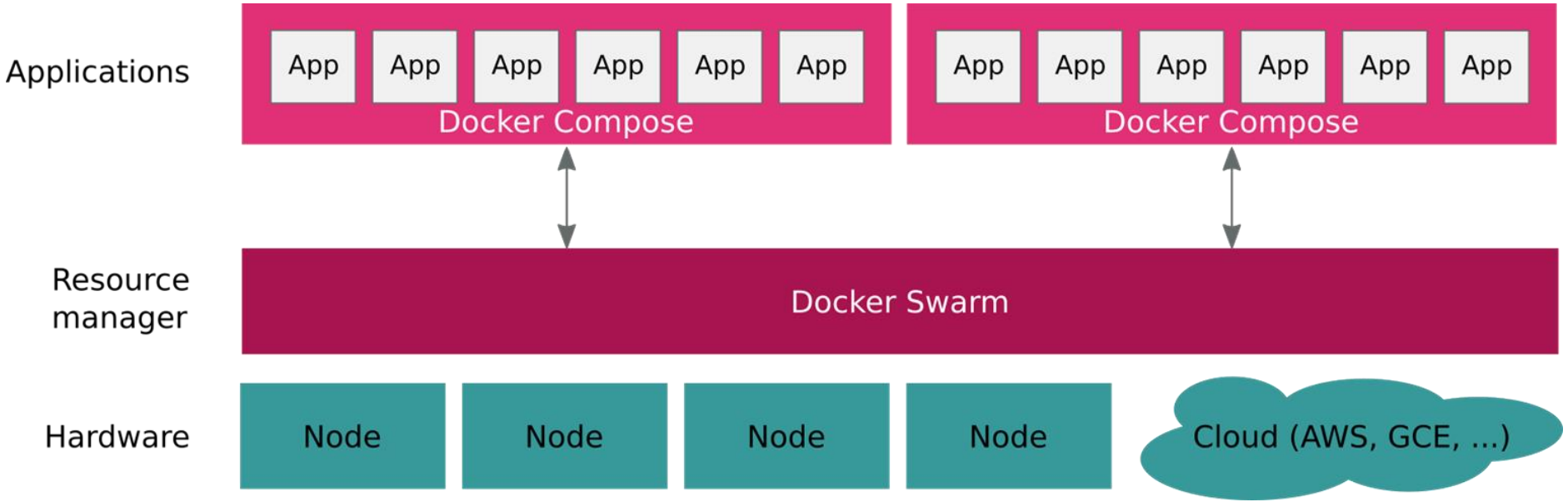
- Big Data Integrator (BDI):
  - The prototype developed by BDE
- Main points of the architecture
  - Dockerization
  - Support layer, including integrated UI
  - Semantification layer

Docker containers

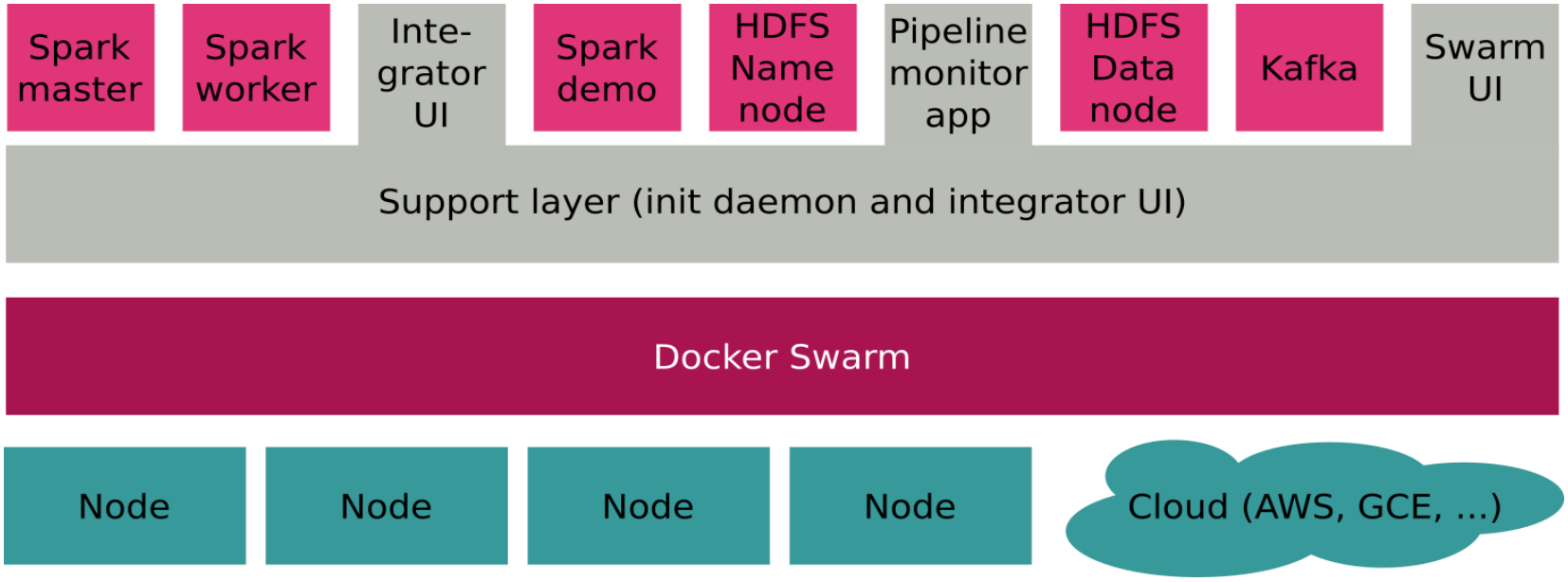
- Docker offers lightweight virtualization
  - Docker containers can be shared to be provisioned on different Linux variations and versions
- Identical base sys not required
- All BDI components: Docker containers



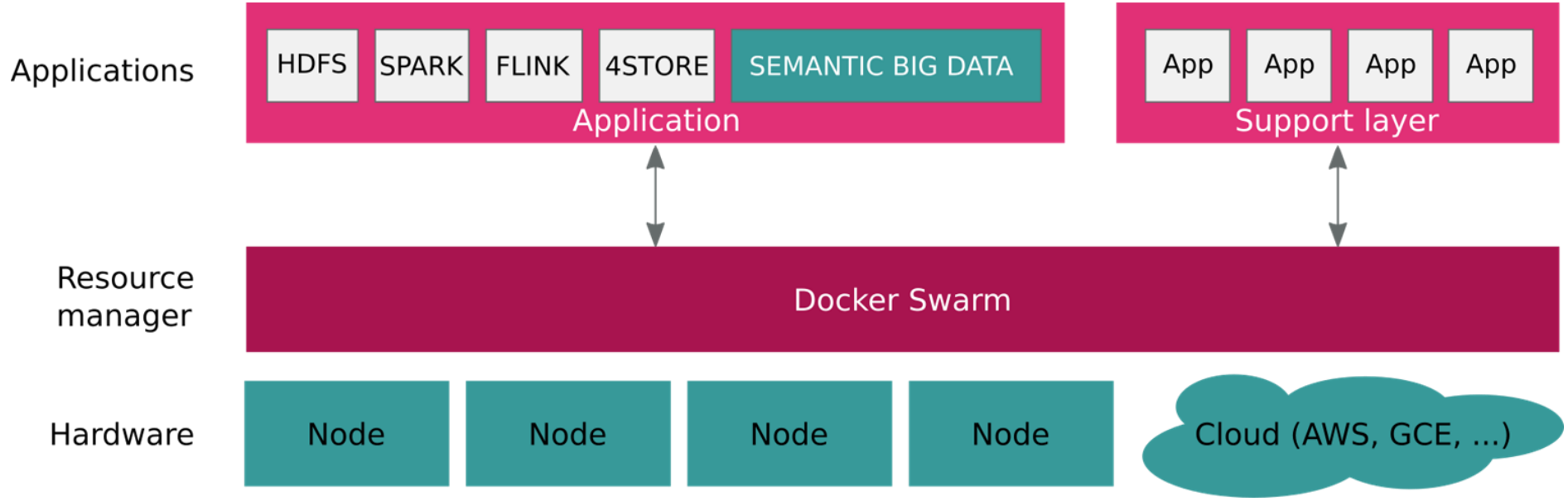
Platform Architecture



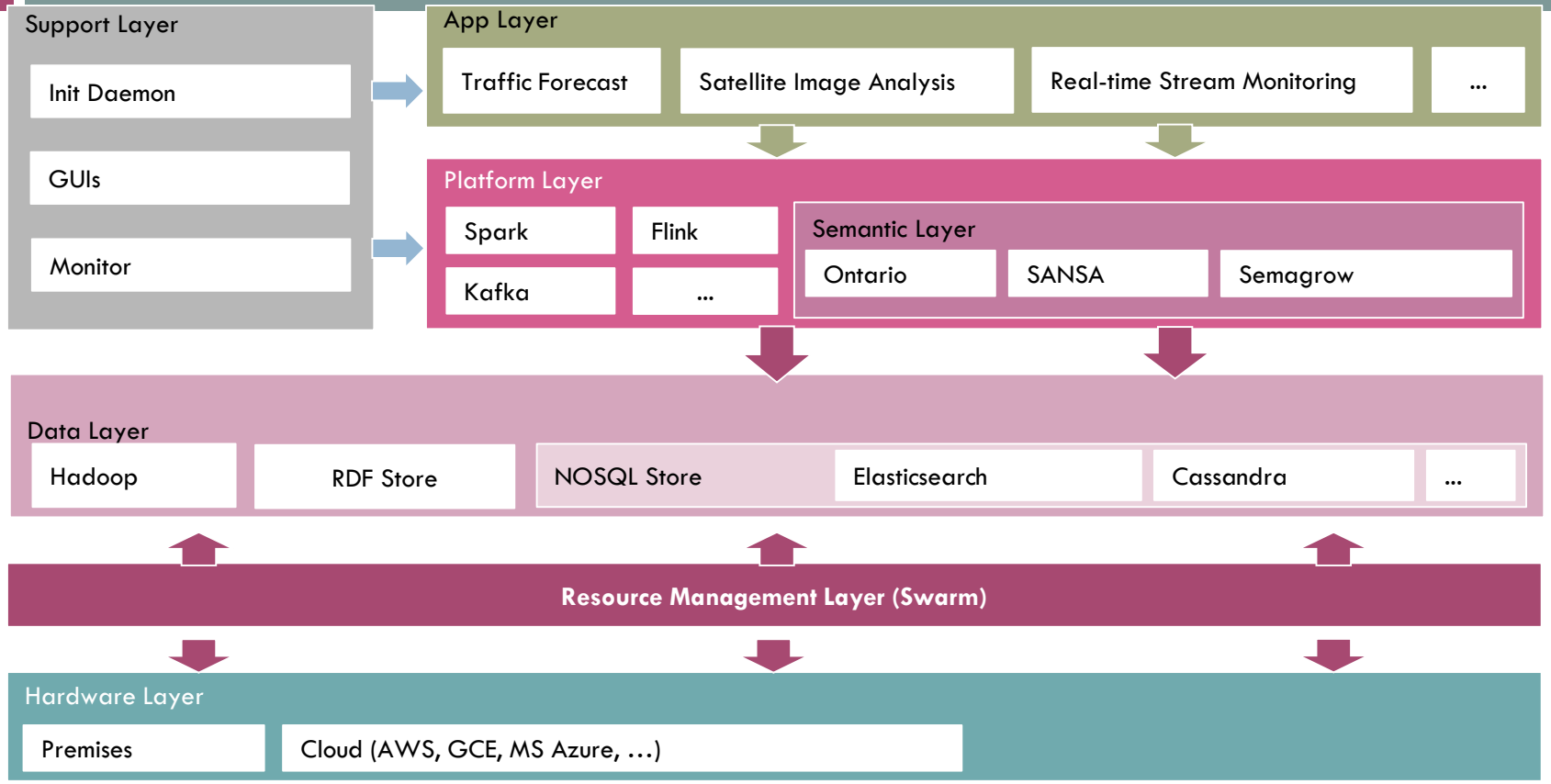
Platform Architecture



Platform Architecture

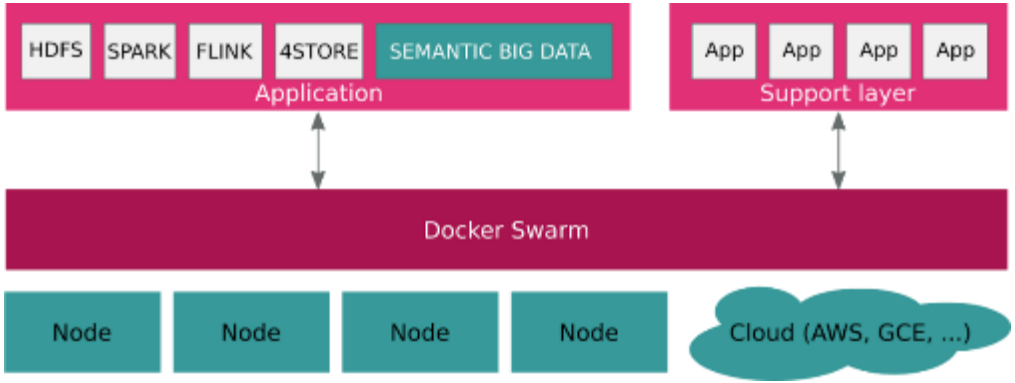


Platform Architecture



BDI components

- Processing and storage components
  - Re-used existing Docker containers where available
  - Dockerized by BDE where not
  - Ensured all can be provisioned through Docker Swarm
- Components by BDE:
  - Support Layer
  - Semantic Layer



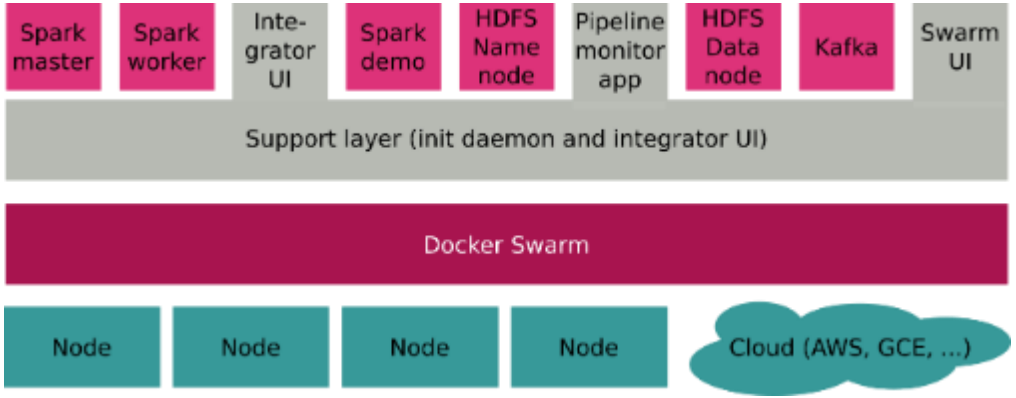
BDE Docker Containers

Supported Frameworks

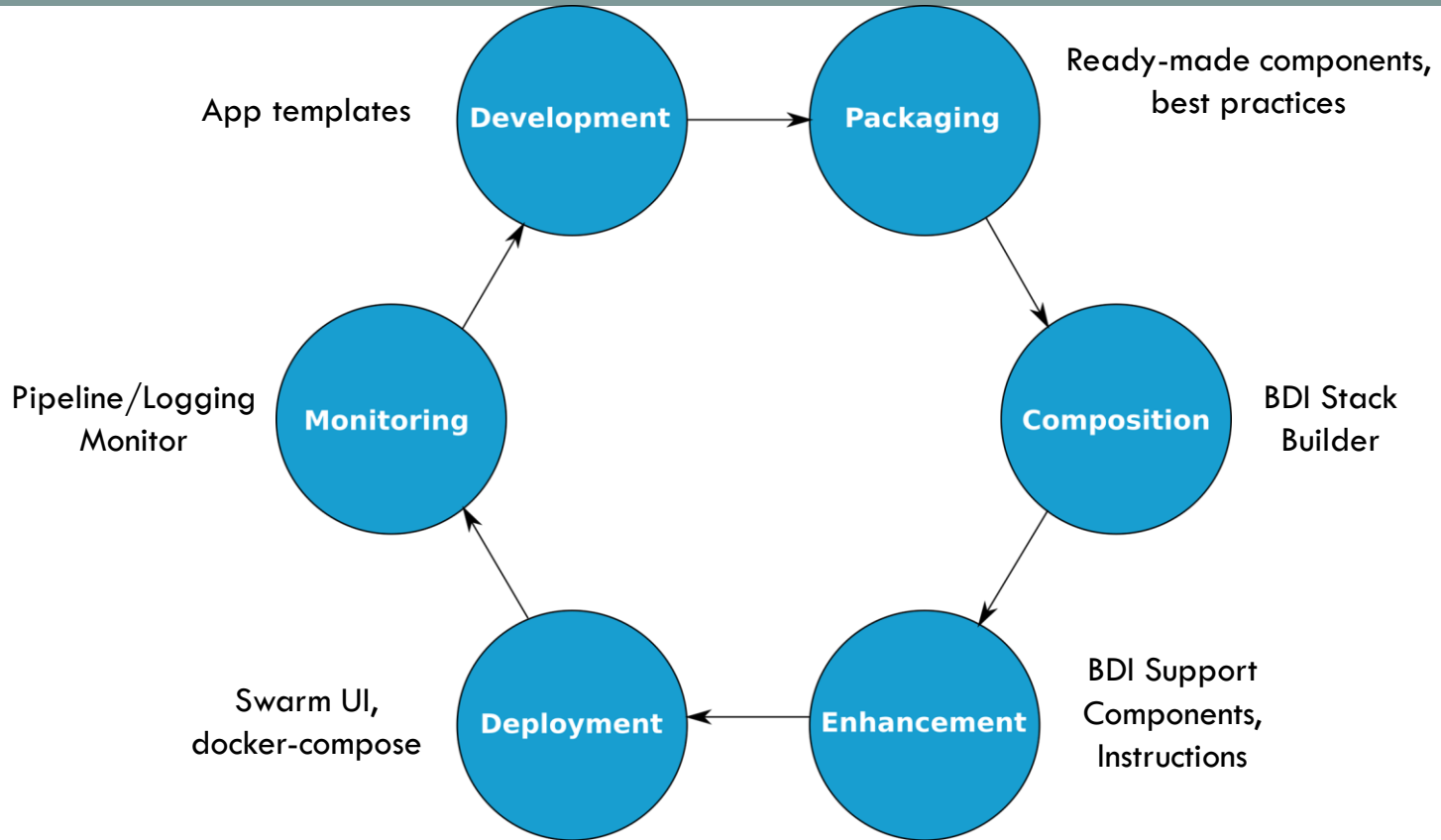
Search/indexing	**Data processing**
Apache Solr	Apache Spark
Data acquisition	Apache Flink
Apache Flume	**Semantic Components**
Message passing	Strabon
Apache Kafka	Sextant
Data storage	GeoTriples
Hue	Silk
Apache Cassandra	SEMAGROW
ScyllaDB	LIMES
Apache Hive	4Store
Postgis	OpenLink Virtuoso

Support Layer

- BDE defines uniform UI stylesheets
  - Web UIs from BDE dockers (including for third party components) follow these BDE stylesheets
- BDE-developed tools:
  - Starting containers and dependencies
  - Monitoring execution



BDI Stack Lifecycle

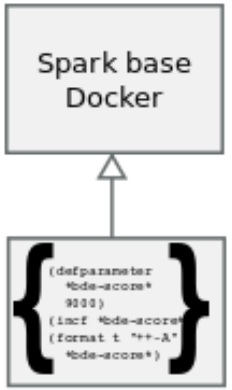


BDI Stack Development

- High level picture
  - docker-compose.yml describes pipeline topology
- BDE provided components
  - extend template image with your code
- New components
  - build a Docker image for your component
  - this is your own little Virtual Machine for your component
- Sharing
  - publish topology as git repository
  - publish new components on docker hub

Development

- Base Docker images
  - Serve as a template for a (Big Data) technology
  - Easily extendable custom algorithm/data
- Published components
  - Image repositories on GitHub
  - Automated builds on DockerHub
  - Documentation on BDE Wiki



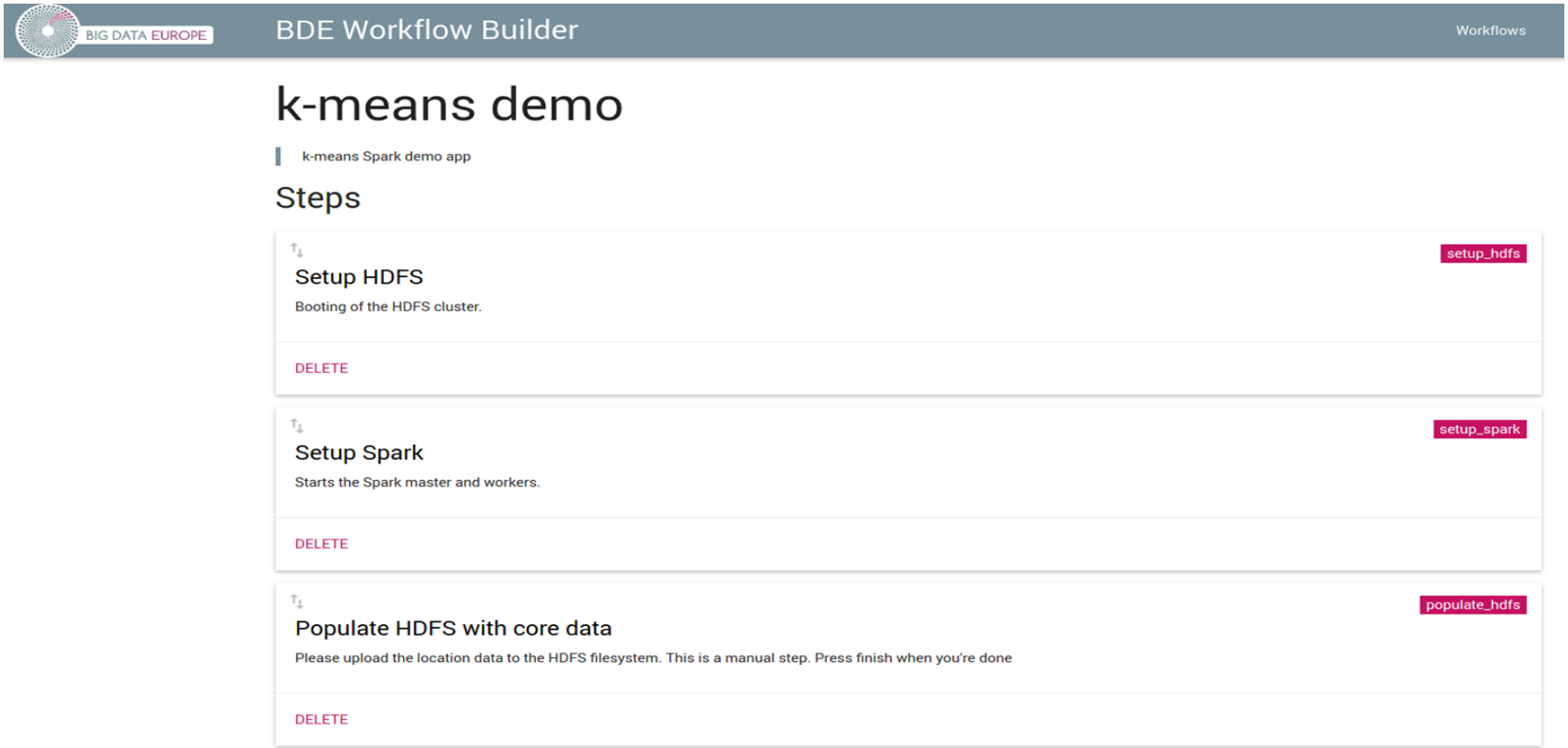
Enhancing the Component

- Orchestrator required for initialization process (init_daemon)
  - Components may depend on each other
  - Components may require manual intervention
- User Interface Integration
  - Standard Interfaces from components
  - Combine and align the interfaces

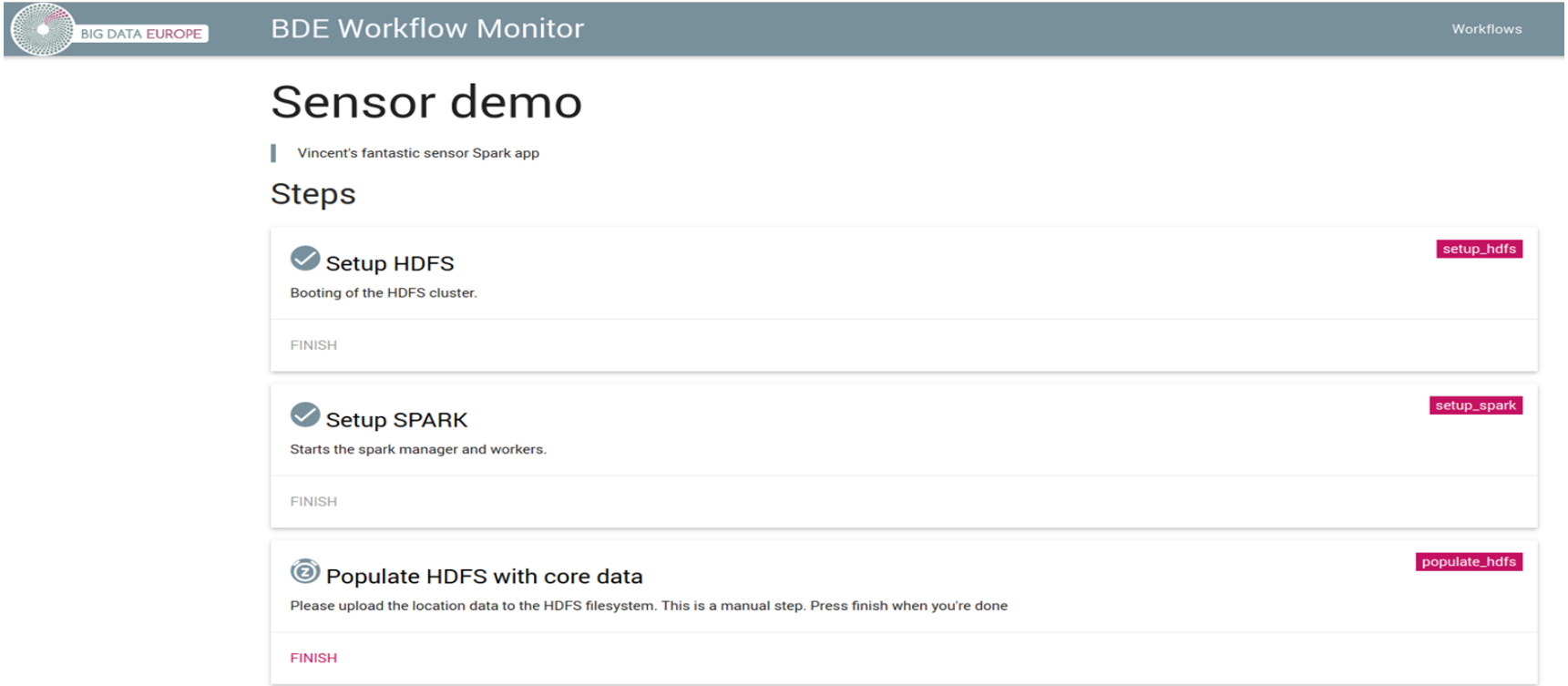
User Interfaces

- Target: Facilitate use of the platform
  - User Interface Adaption
- Available interfaces
  - Workflow UIs
    - Workflow Builder
    - Workflow Monitor
  - Swarm UI
  - Integrator UI

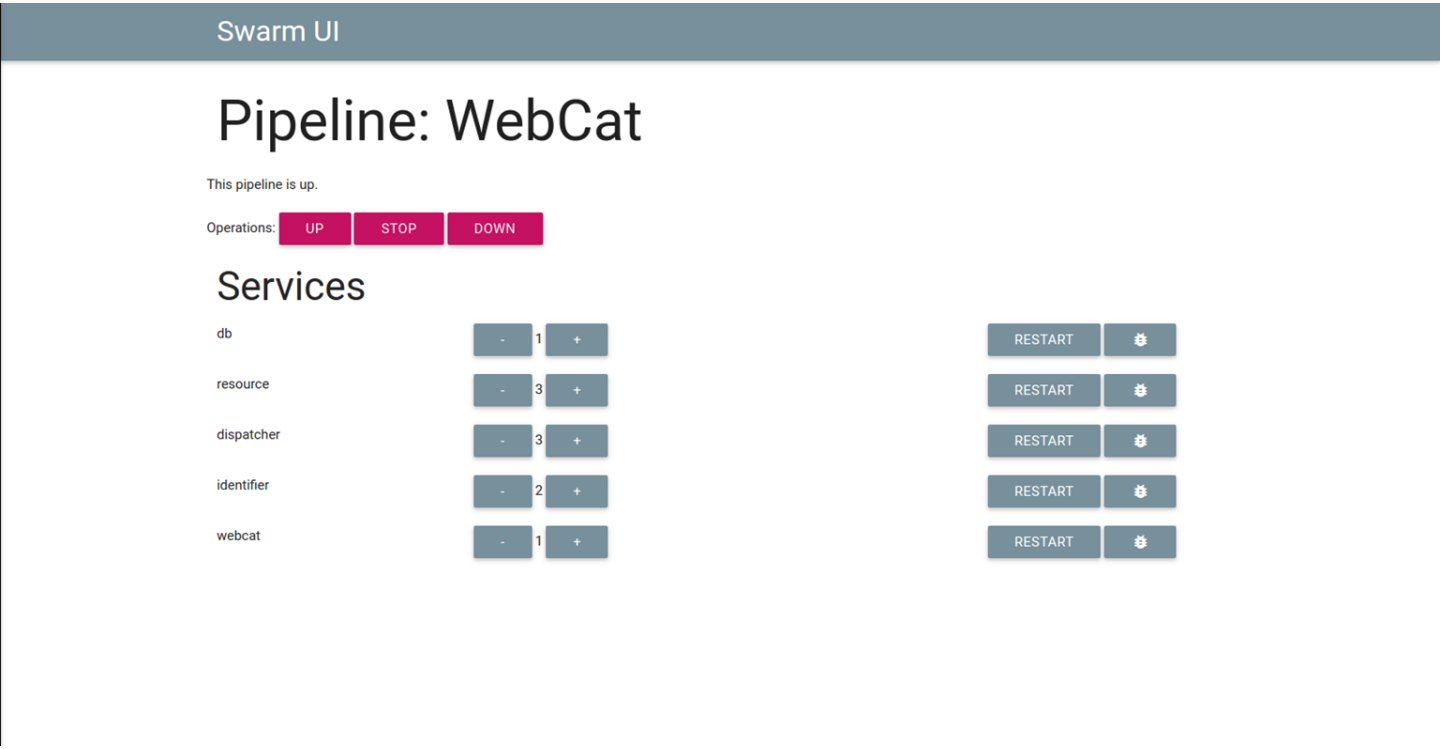
BDE Workflow Builder



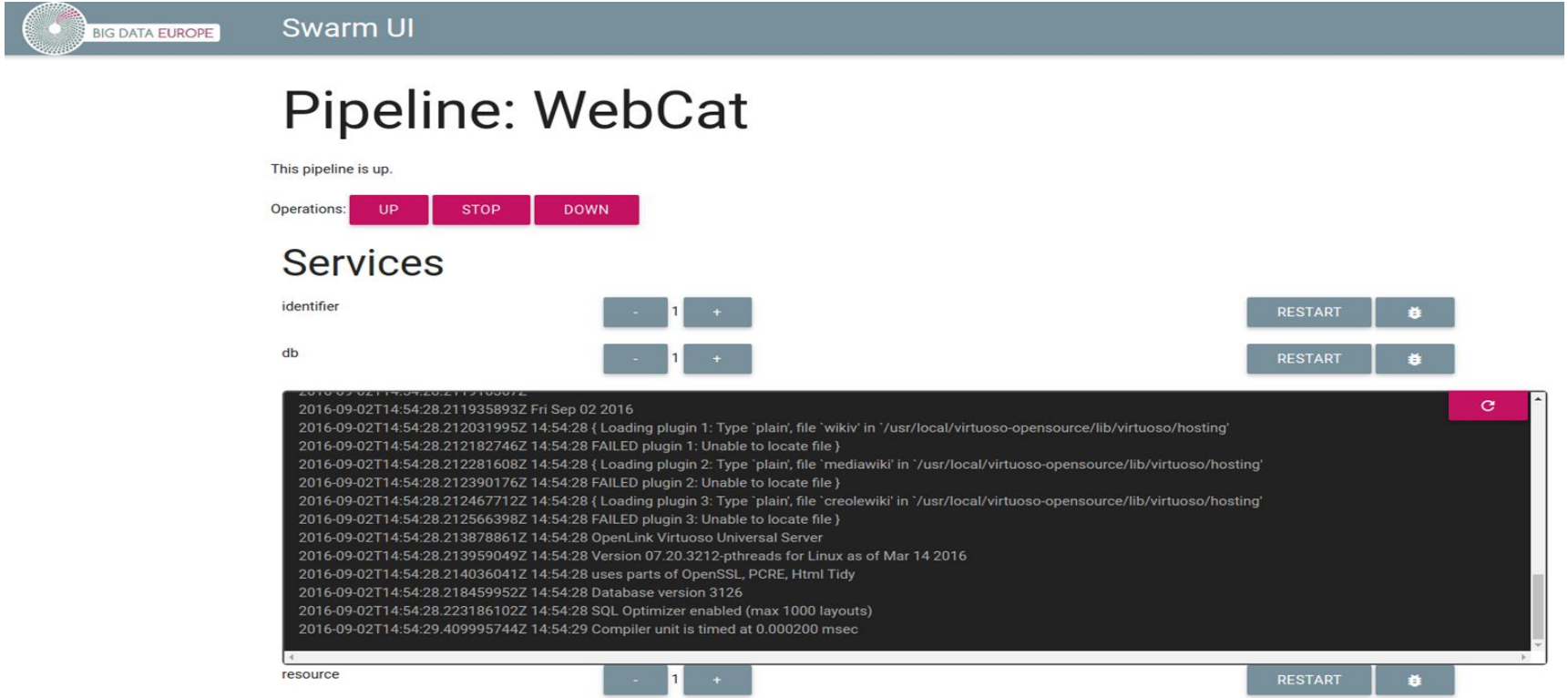
BDE Workflow Monitor



Swarm UI


Swarm UI
Pipeline: WebCat
This pipeline is up.
Operations:
UP
STOP
DOWN
Services
db
- 1 +
RESTART
resource
- 3 +
RESTART
dispatcher
- 3 +
RESTART
identifier
- 2 +
RESTART
webcat
- 1 +
RESTART

Swarm UI


BIG DATA EUROPE
Swarm UI
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1
+
RESTART
db
-
1
+
RESTART
2016-09-02T14:54:28.211935893Z Fri Sep 02 2016
2016-09-02T14:54:28.212031995Z 14:54:28 { Loading plugin 1: Type `plain', file `wikiv' in `/usr/local/virtuoso-opensource/lib/virtuoso/hosting'
2016-09-02T14:54:28.212182746Z 14:54:28 FAILED plugin 1: Unable to locate file }
2016-09-02T14:54:28.212281608Z 14:54:28 { Loading plugin 2: Type `plain', file `mediawiki' in `/usr/local/virtuoso-opensource/lib/virtuoso/hosting'
2016-09-02T14:54:28.212390176Z 14:54:28 FAILED plugin 2: Unable to locate file }
2016-09-02T14:54:28.212467712Z 14:54:28 { Loading plugin 3: Type `plain', file `creolewiki' in `/usr/local/virtuoso-opensource/lib/virtuoso/hosting'
2016-09-02T14:54:28.212566398Z 14:54:28 FAILED plugin 3: Unable to locate file }
2016-09-02T14:54:28.213878861Z 14:54:28 OpenLink Virtuoso Universal Server
2016-09-02T14:54:28.213959049Z 14:54:28 Version 07.20.3212-pthreads for Linux as of Mar 14 2016
2016-09-02T14:54:28.214036041Z 14:54:28 uses parts of OpenSSL, PCRE, Html Tidy
2016-09-02T14:54:28.218459952Z 14:54:28 Database version 3126
2016-09-02T14:54:28.223186102Z 14:54:28 SQL Optimizer enabled (max 1000 layouts)
2016-09-02T14:54:29.409995744Z 14:54:29 Compiler unit is timed at 0.000200 msec
resource
-
1
+
RESTART

Integrator UI

BIG DATA EUROPE

Dashboard

Monitor | Visualization | Spark Master | Spark Worker | HDFS Namenode | Hue | Virtuoso

Spark 1.6.2 Spark Master at spark://spark-master:7077

URL: spark://spark-master:7077
REST URL: spark://spark-master:6066 *(cluster mode)*
Alive Workers: 1
Cores in use: 3 Total, 0 Used
Memory in use: 28.4 GB Total, 0.0 B Used
Applications: 0 Running, 0 Completed
Drivers: 0 Running, 0 Completed
Status: ALIVE

Workers

Worker Id	Address	State	Cores	Memory
worker-20160901163503-172.18.0.13-33120	172.18.0.13:33120	ALIVE	3 (0 Used)	28.4 GB (0.0 B Used)

Running Applications

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

Completed Applications

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

Deploying a Big Data Stack

- Stack
  - collection of communicating components
  - to solve a specific problem
- Described in Docker Compose
  - Component configuration
  - Application topology

Platform installation

- Manual installation guide
- Using Docker Machine
  - On local machine (VirtualBox)
  - In cloud (AWS, DigitalOcean, Azure)
  - Bare metal
- Screencasts

Actors

- Cluster Setup
- Developer
- Packaging
- Stack Composition / Integration
- Deployment
- Monitoring

BDE vs Hadoop distributions

	Hortonworks	Cloudera	MapR	Bigtop	BDE
File System	HDFS	HDFS	NFS	HDFS	**HDFS**
Installation	Native	Native	Native	Native	**lightweight virtualization**
Plug & play components (no rigid schema)	no	no	no	no	**yes**
High Availability	Single failure recovery (yarn)	Single failure recovery (yarn)	Self healing, mult. failure rec.	Single failure recovery (yarn)	**Multiple Failure recovery**
Cost	Commercial	Commercial	Commercial	Free	**Free**
Scaling	Freemium	Freemium	Freemium	Free	**Free**
Addition of custom components	Not easy	No	No	No	**Yes**
Integration testing	yes	yes	yes	yes	--
Operating systems	Linux	Linux	Linux	Linux	**All**
Management tool	Ambari	Cloudera manager	MapR Control system	-	**Docker swarm UI+ Custom**

BDE vs Hadoop distributions

- BDE is not built on top of existing distributions
- Consortium does not provide commercial support
- Targets
  - Communities
  - Research institutions
- Bridges scientists and open data
- Multi Tier research efforts towards Smart Data

Beyond the state of the art ...

Smart Big Data

Increase the value of Big Data
by adding meaning to it!

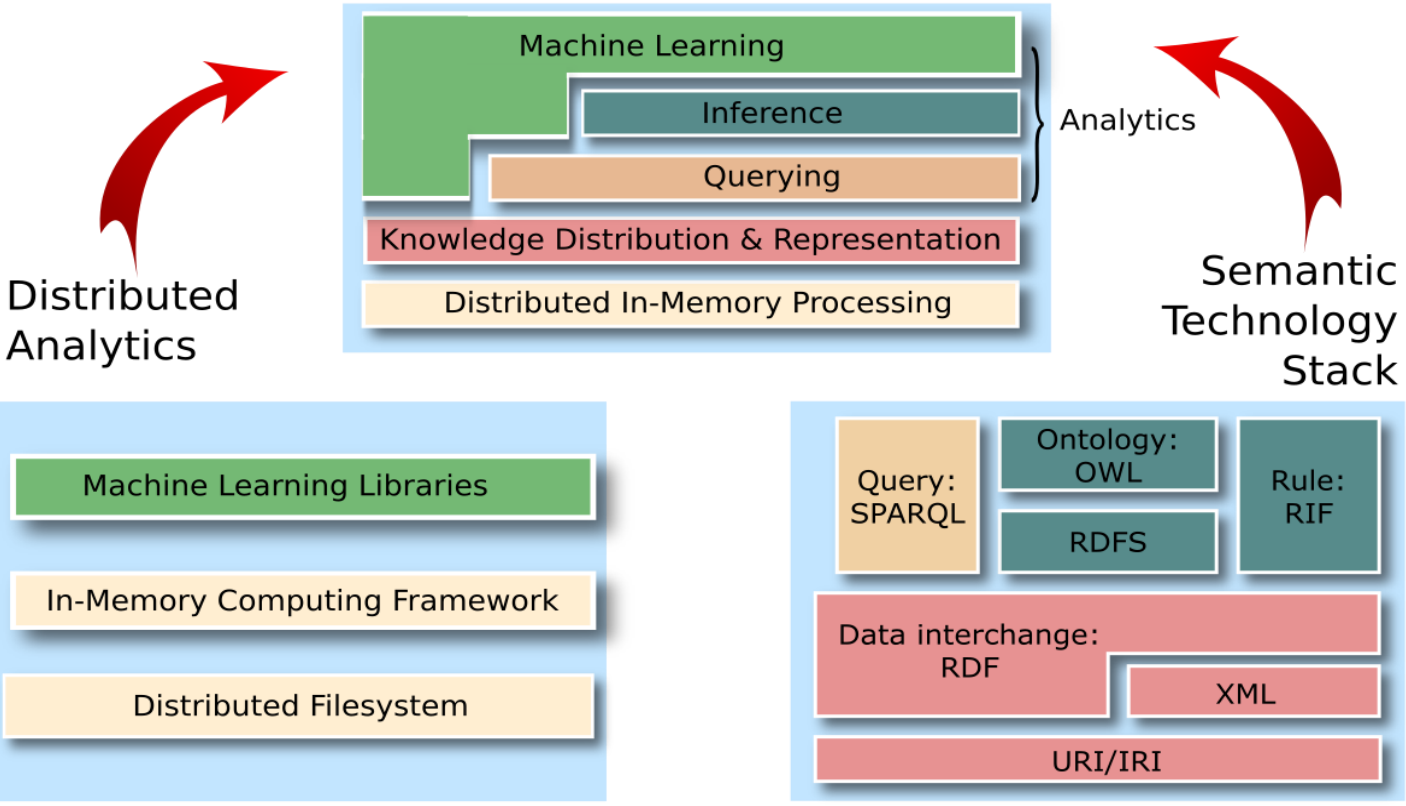
Semantic layer tools

- *Swagger*
- *Semantic Analytics Stack (SANSA)*
- *Semagrow*
- *Ontario*
- *LIMES*
- *FOX*

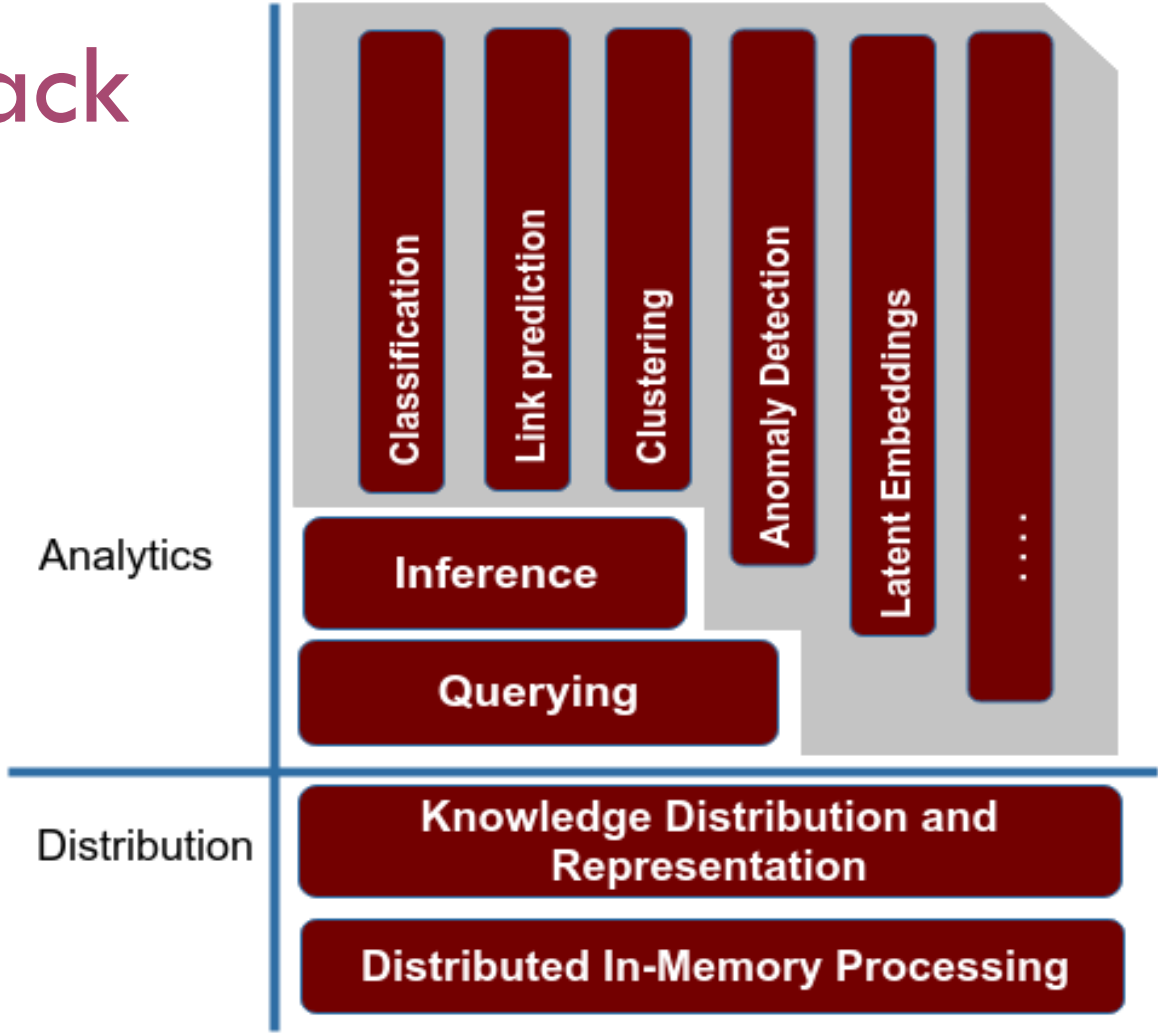
Semantic Data Lake (Ontario)

- Data Swamp
  - Repository of data in its raw format
  - Structured, semi-structured, unstructured
  - Schema-less
- Data Lake
  - Add a Semantic layer on top of the source datasets
  - The data is semantically lifted using existing ontology terms

Scalable Semantic Analytics Stack (SANSA)



SANSA Stack

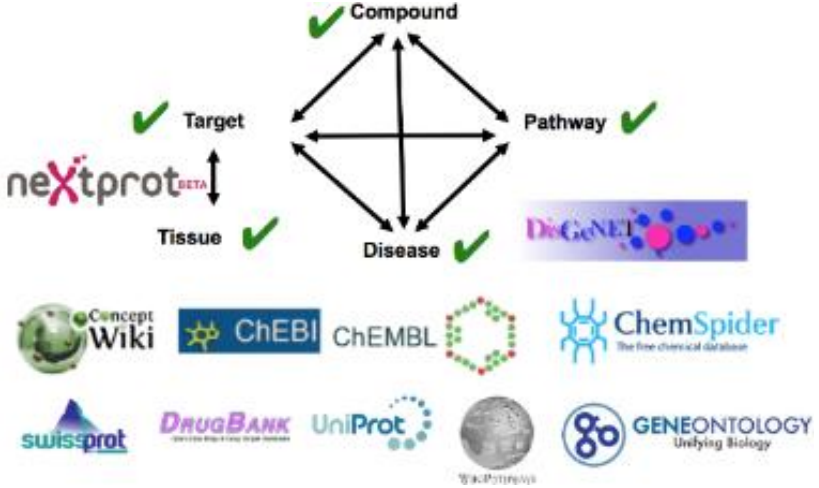

Classification
Link prediction
Clustering
Anomaly Detection
Latent Embeddings
....
Analytics
Inference
Querying
Distribution
Knowledge Distribution and Representation
Distributed In-Memory Processing

BigDataEurope Pilots

SC1: Pharmacology research

Life Sciences & Health

- Query a large number of datasets, some large
- Existing elaborate ingestion and homogenization by the OpenPHACTS Foundation
- Extensive toolset developed by OPF and others



SC1 Pilot: Points Demonstrated

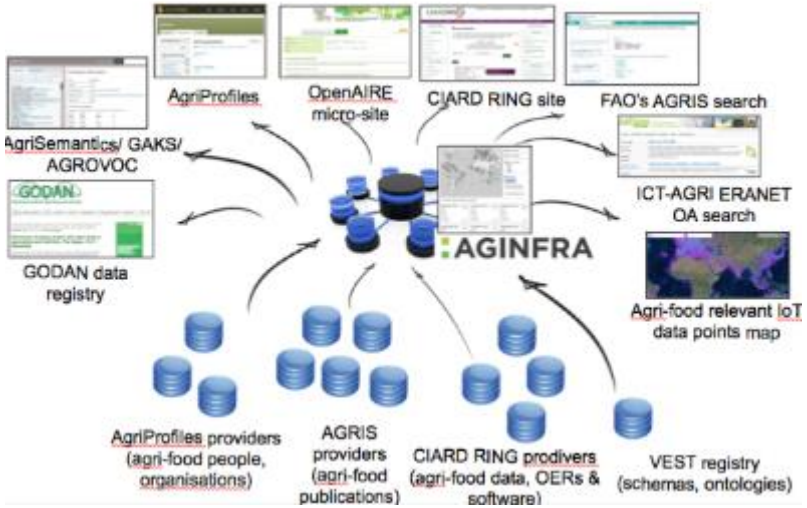
Life Sciences & Health

- Existing distributed, scalable solution
  - Based on Virtuoso
  - Proprietary distributed triple store
- Porting to BDI gives flexibility
  - Using Virtuoso or open source alternatives (in BDE, 4store) without development effort for the superstructure and tools around it

SC2: Viticulture resources

Food and Agriculture

- AgInfra is a major infrastructure for agriculture researchers, serving cross-linked bibliography, data, and processing services
- Pilot automates ingestion and thematic classification of publication full texts

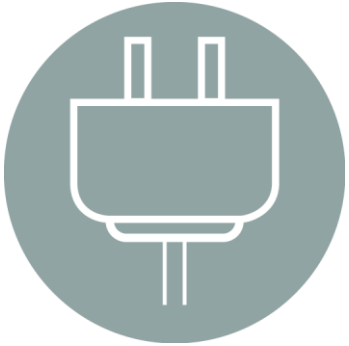


SC2 Pilot: Points Demonstrated

Food and Agriculture

- AgInfra: Existing infrastructure for data, metadata, and related services
- BDI is deployed as an external infrastructure for processing text (viticulture publications)
  - Allows storing and processing text at a larger scale than AgInfra can currently manage
  - The bibliographic metadata is added to AgInfra

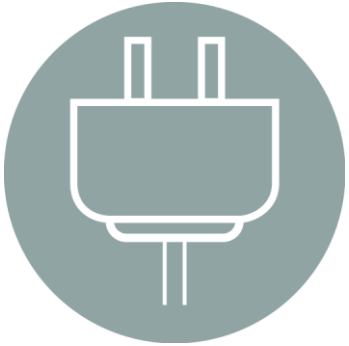
SC3: Predictive maintenance



Energy

- Wind turbine monitoring applies computational models to sensor data streams
- Models are weekly re-parameterized using week's data from multiple turbines

SC3 Pilot: Points Demonstrated



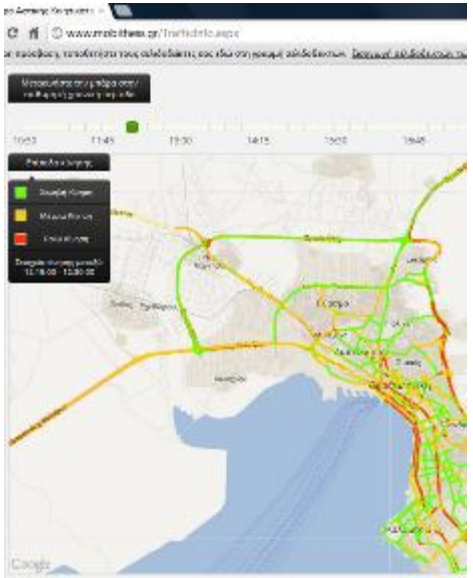
Energy

- Existing in-house non-scalable solution for model parameterization
  - Reliable Fortran software for data analysis
  - Efficient, but not scalable to data volume
- Developing a BDI orchestrator
  - Re-uses existing software unmodified
  - Makes it easy to apply in parallel to many datasets and manage the outputs

SC4: Traffic conditions estimation

Transport

- Estimation of real-time traffic conditions in Thessaloniki
- Combines:
  - Traffic modelling from historical data
  - Current measurements from a taxi fleet of 1200 vehicles



SC4 Pilot: Points Demonstrated

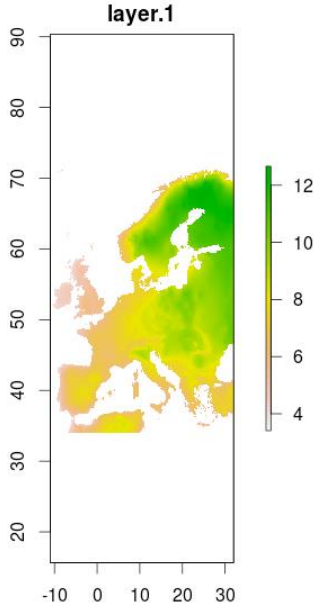
Transport

- New Flink implementations of map matching and traffic prediction algorithms
- BDI provides access to varied data sources
  - PostGIS database with city map
  - ElasticSearch database of historical data
  - Kafka stream of real-time data

SC5: Climate modelling

Climate

- Preparing modelling experiments
  - Slicing, transforming, combining datasets into new datasets
  - Submission to and retrieval from modelling infrastructure
- Discovering and re-using previously computed derivatives
  - Lineage annotation: datasets and model parameters used to compute derivative datasets
  - Finding appropriate past runs avoids repeating weeks-long modelling runs



SC5 Pilot: Points Demonstrated

Climate

- Existing infrastructure and stable, reliable software for parallel computation of models
- BDI is deployed as an external infrastructure for preparing and managing datasets
- BDI offers:
  - Hive for managing data in a way that can be retrieved and manipulated, rather than file blocks
  - Cassandra stores structured and textual metadata for searching headers and lineage

SC6: Municipality budgets

Social Sciences

- Ingestion of budget and budget execution data
- Multiple municipalities in varied formats and data models
- Homogenized data made available for analysis and comparison

SC6 Pilot: Points Demonstrated

Social Sciences

- Existing analytics and visualization tools
  - Use SPARQL queries to retrieve only the relevant slices of the overall data
- BDI is deployed as an ingestion and storage infrastructure for external tools
  - Ingests and homogenizes a constant flow of JSON, CSV, XML, and other formats following various data models
  - Exposes data as SPARQL endpoint serving homogenized data, stored in 4store, a scalable, distributed RDF store

SC7: Change detection & verification

Secure Societies

- Events are extracted from text published by news agencies and on social networking sites
- Events are geo-located and relevant changes are detected by comparing current and previous satellite images

SC7 Pilot: Points Demonstrated

Secure Societies

- Re-implementation of change detection algorithms for Spark
- Parallel orchestrator for text analytics
  - Re-uses existing software
  - Scales to many input streams
- BDI provides:
  - Cassandra for text content and metadata
  - Strabon GIS store for detected change location
  - Homogeneous access to both for analysis and visualization

Closing Remarks

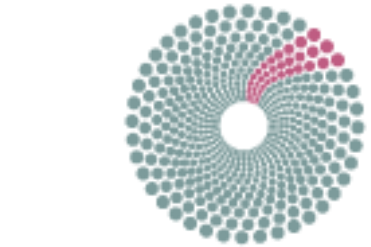
BDI use cases demonstrated

- *Flexibility to existing workflows*
  - Drug discovery platform ported to new data storage infrastructure
- *Scaling out*
  - Sensor data analysis software trivially distributed to multiple streams
  - Image analysis and traffic pattern algorithms in Spark and Flink
- *Preprocessing and ingestion*
  - Distributed data architectures pre-process and maintain big data
  - Not needed simultaneously or reduced to small data

Semantic Web and Big Data

- *Adding triple stores to the Apache ecosystem*
  - Scalability for Semantic Web technologies
  - Semantics stores for the Apache ecosystem
- *Advocating RDF technologies for describing processing and data services*
  - The Semantic Data Lake vision builds an RDF layer over Swagger/OAI
- *Advocating RDF and SPARQL as the lingua franca for Big Data retrieval*
  - Semagrow federations of heterogeneous internal and external data stores

Thank you for your attention! Questions?



- BigDataEurope action Web site:
  https://www.big-data-europe.eu
- Big Data Integrator:
  https://github.com/big-data-europe
- Semagrow:
  http://semagrow.github.io
- SANSA:
  http://sansa-stack.net