Dottorato di Ricerca in Informatica

Teamwork Collaboration around CAE Models in an Industrial Context

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Introduction

- World-wide enterprises
- Global and high competitive market
- Enterprises have
  - Multiple teams spread over multiple locations
- Challenges
  - Communications
  - Coordination
  - Sharing of resources (documents, know-how, etc.)

Virtual Teams

- Geographically dispersed teams
  - Sometimes over different time zones
- Driven by a common purpose
- Enabled by communication technologies
  - Internet, CSCW, etc.

Enterprise collaboration modes

Communication

- E-mail
- Chat
- Videoconferencing
- VOIP

Functional

- Collaborative editing
- Collaborative drawing
  - Virtual Whiteboards
- Screen sharing

Workflow-based

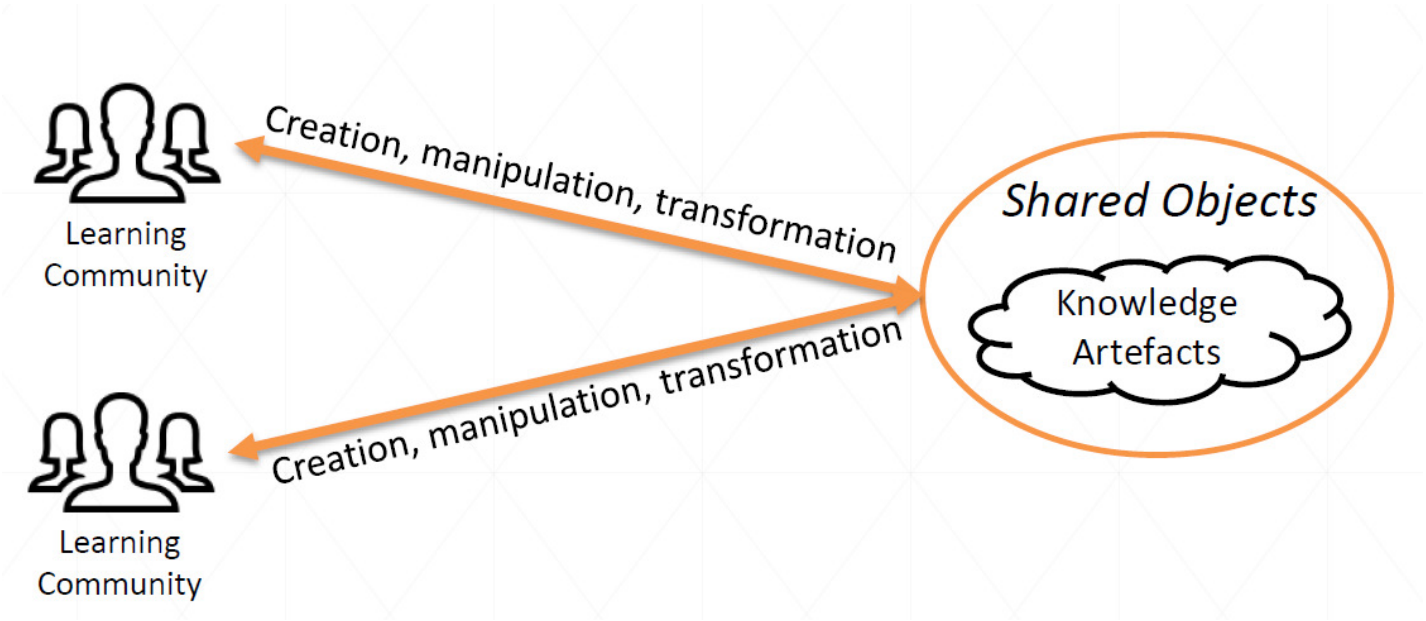
- Document Management
- Product Lifecycle Management
- Product Development Management

Social

- Enterprise Social Network
- Corporate Blog
- Social hiring

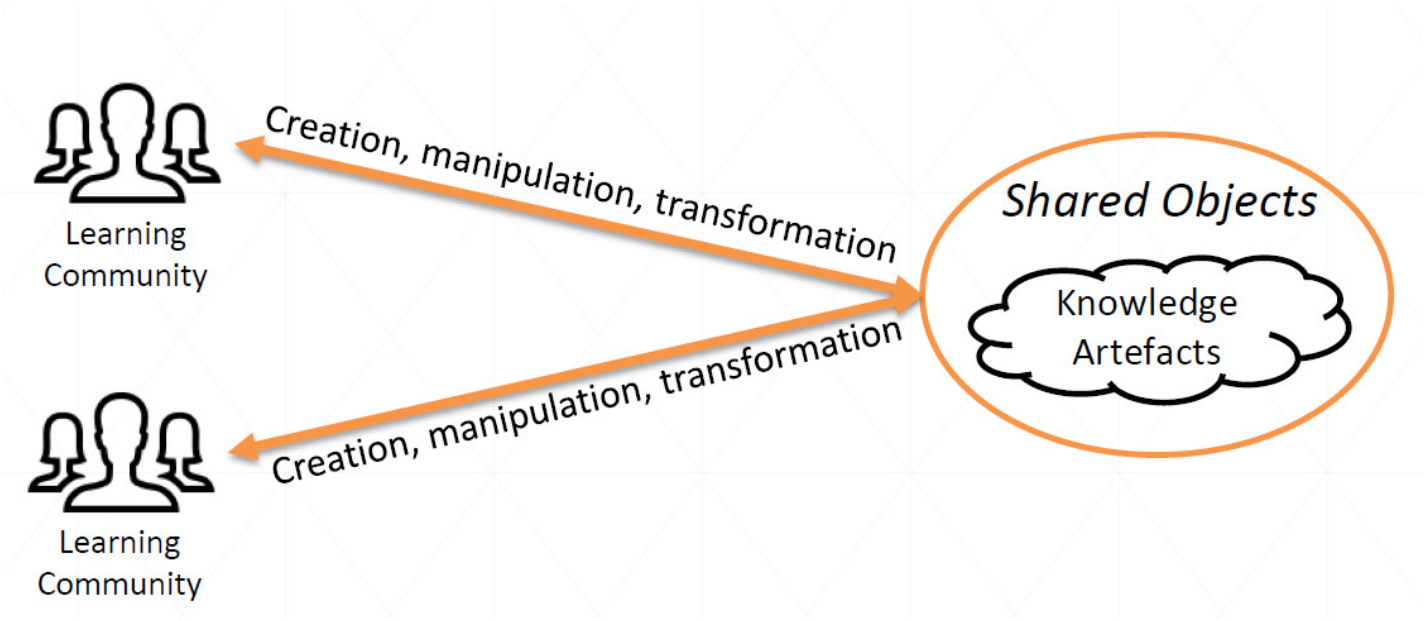
Trialogic learning model

- Learners collaborate around shared objects
  - To solve problems, originate new thoughts, and advance communal knowledge



Main contribution
Trialogic learning model in the industry

- Simulation analysts collaborate around simulation data
  - To solve problems, originate new thoughts, adding value to the Project



Trialogic learning model in the industry

- Agile and flexible
- Do not change the existing practices
- Integrated with
  - Existing best practices that raise «spontaneously» in small-medium teams
  - Existing workflow
  - Software systems
- Efficient

Goals

- Collection, identification and analysis of the key collaborative requirements of dispersed teams within a real industrial use case (FCA use case);
- Design of an integrated, extensible and modular software architecture;
- Design, implementation and testing of a real working prototype called Floasys with its collaborative and engineering functionalities;
- Design, implement and test a generic tool called ExploraTool to visually explore large datasets in hierarchical way;
- Extension to different disciplines (like Structure, Thermal, Fatigue) and different contexts (like Aeronautic, Rail and Naval sectors);
- Final verification of CSCW research requirements in the developed prototype.

Agile Methodology in the industry

- Work closely with the team of professionals
  - Direct observations
  - Stakeholders interviews
  - Informal meetings
  - A survey[1] to involve final users in the decision making process
- It is important to involve the end-users since the beginning!
- Use of interactive mockups
  - Hard-coding the data

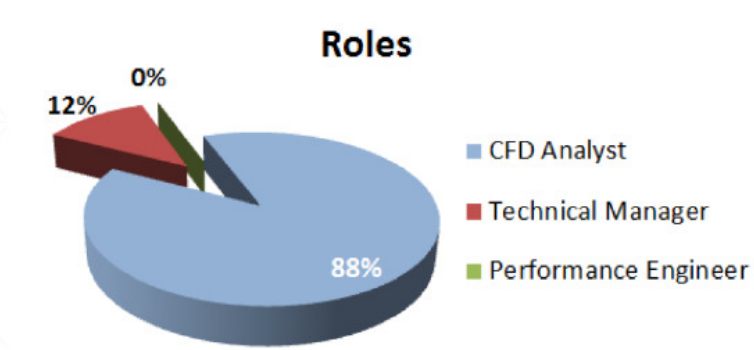
[1] Gargiulo, Pirozzi, Malandrino and Scarano, **Simulation Data Sharing to foster Teamwork Collaboration**, Journal on Scalable Computing: Practice and Experience, 2014

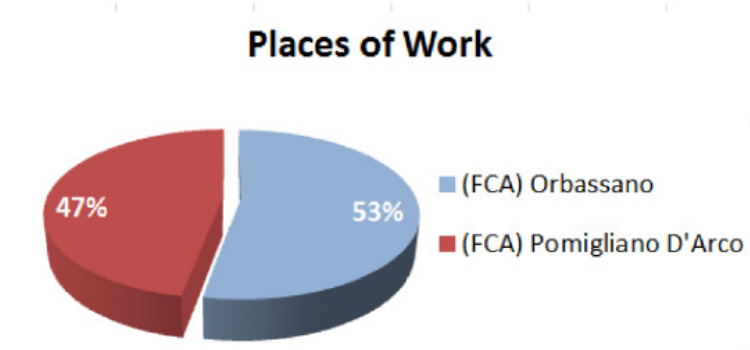
Key requirements

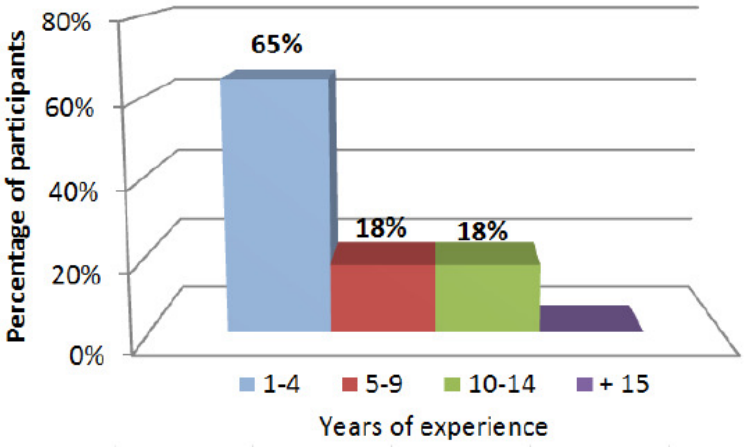
- Collaboration around simulation data
  - Simulation data centralisation
  - Tagging and adding of metadata over simulation data
  - Search facility
  - Data versioning
  - Sharing of simulations
- Simulation Repository Visualisation and Exploration
- Other engineering requirements
  - Simulation Explorer, Simulation Monitoring, Automatic Document generation, Simulation Comparison, Parametric Study, Wizards for less experienced users.

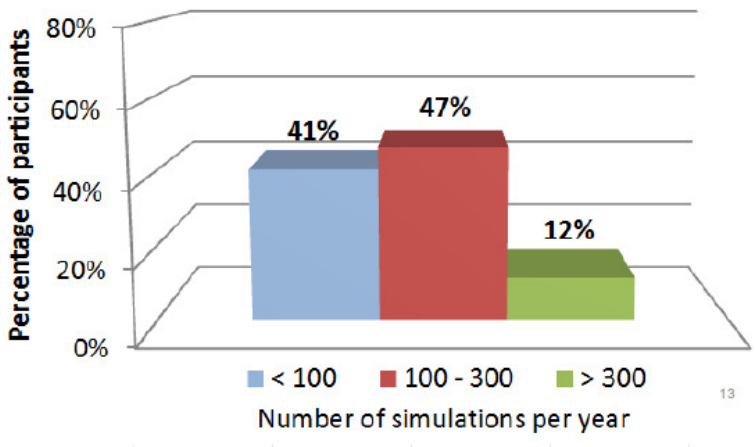
Survey partecipants

- 17 Participants within Fiat (Turin and Naples)
  - It includes workers in outsourcing









Survey: collaboration among teams

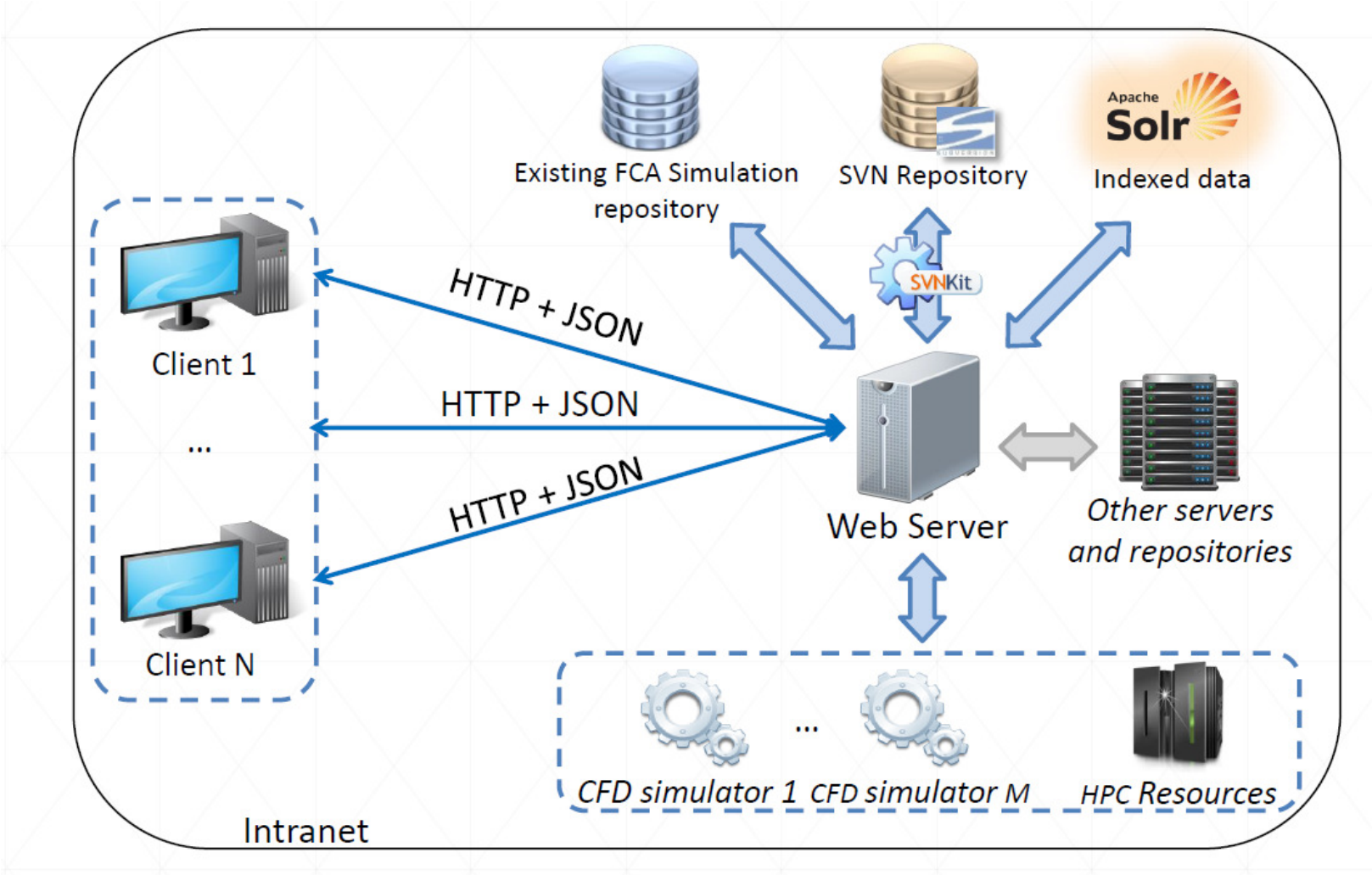
- More then half of analysts collaborate with engineers that are in other locations
- Analysts share:
  - Power Point slides and documents
    - using mainly the e-mail and chat
  - Geometric CAD files
    - using FTP, shared folder and internal catalogue
- Analysts do not share simulation models:
  - The market research «Getting Product Design Right the First Time with CFD» by Aberdeen Group defines actions to improve company competitiveness
    - Simulation data centralisation and model reuse!

Most used techniques to find a simulation

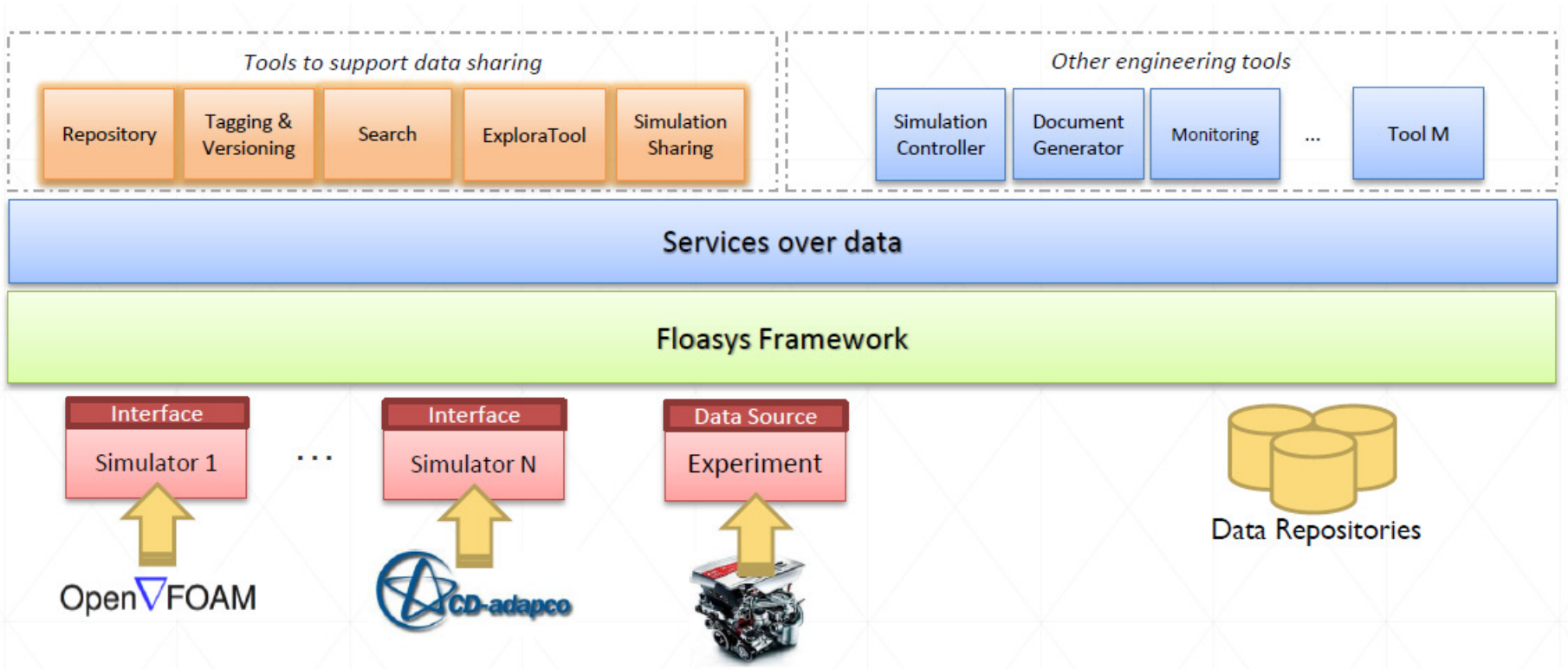
- Analysts can not use the classical search tool
- In order to find a simulation an analyst
  1. tries the free directory navigation
  2. checks the simulation file name
  3. tries to remember where the file could be stored
  4. asks to a co-worker

- Collaborative and engineering platform
- Intranet Web-based
- Extracts data and stores them in open format
  - It has a common representation for simulation data
- Extensible and modular architecture
  - Plug-in based
  - Integrates multiple engineering simulators
  - Avoids the Vendor Lock-in
- Open Source, EPL Licence

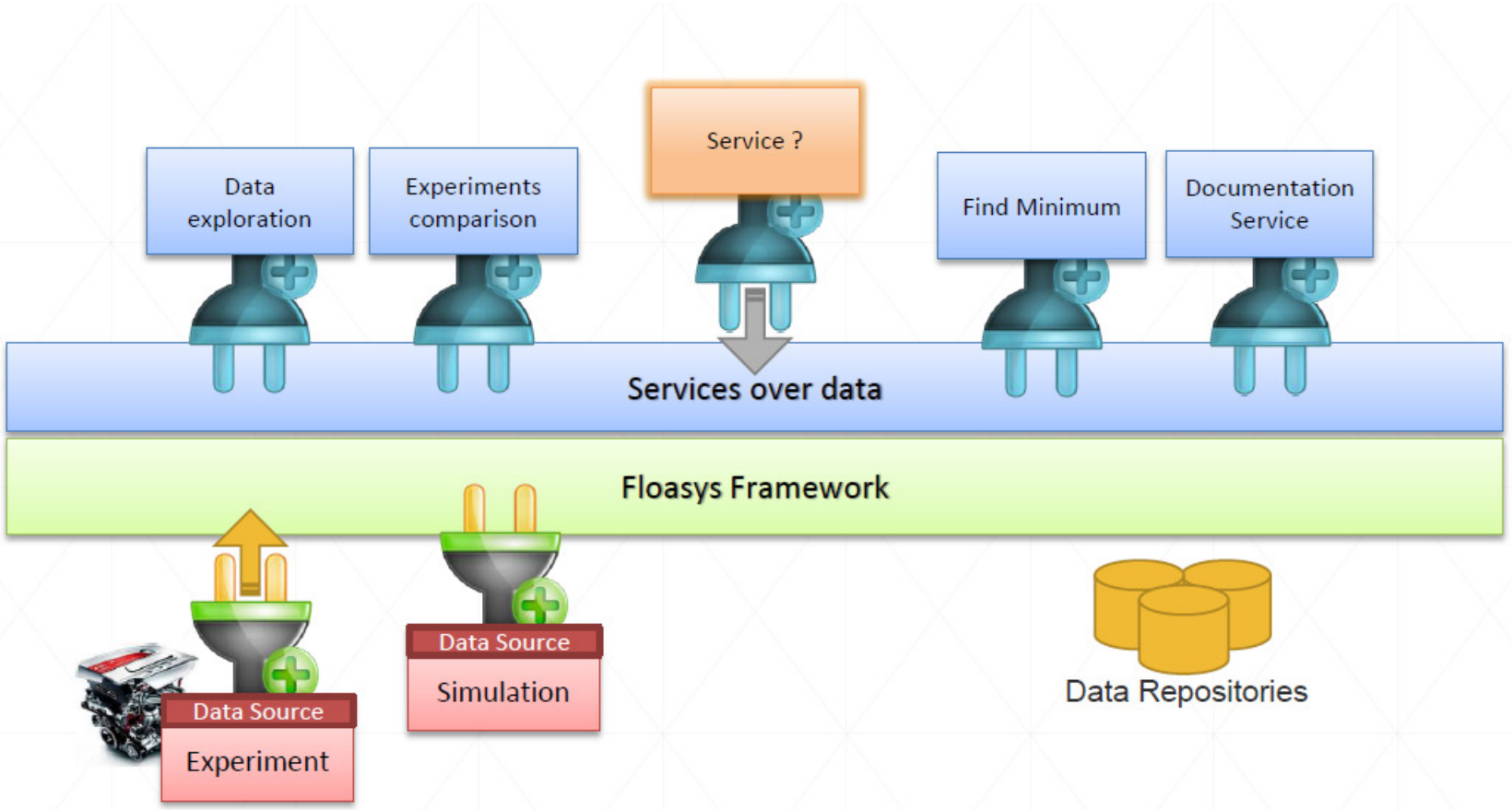
Floasys Architecture Overview



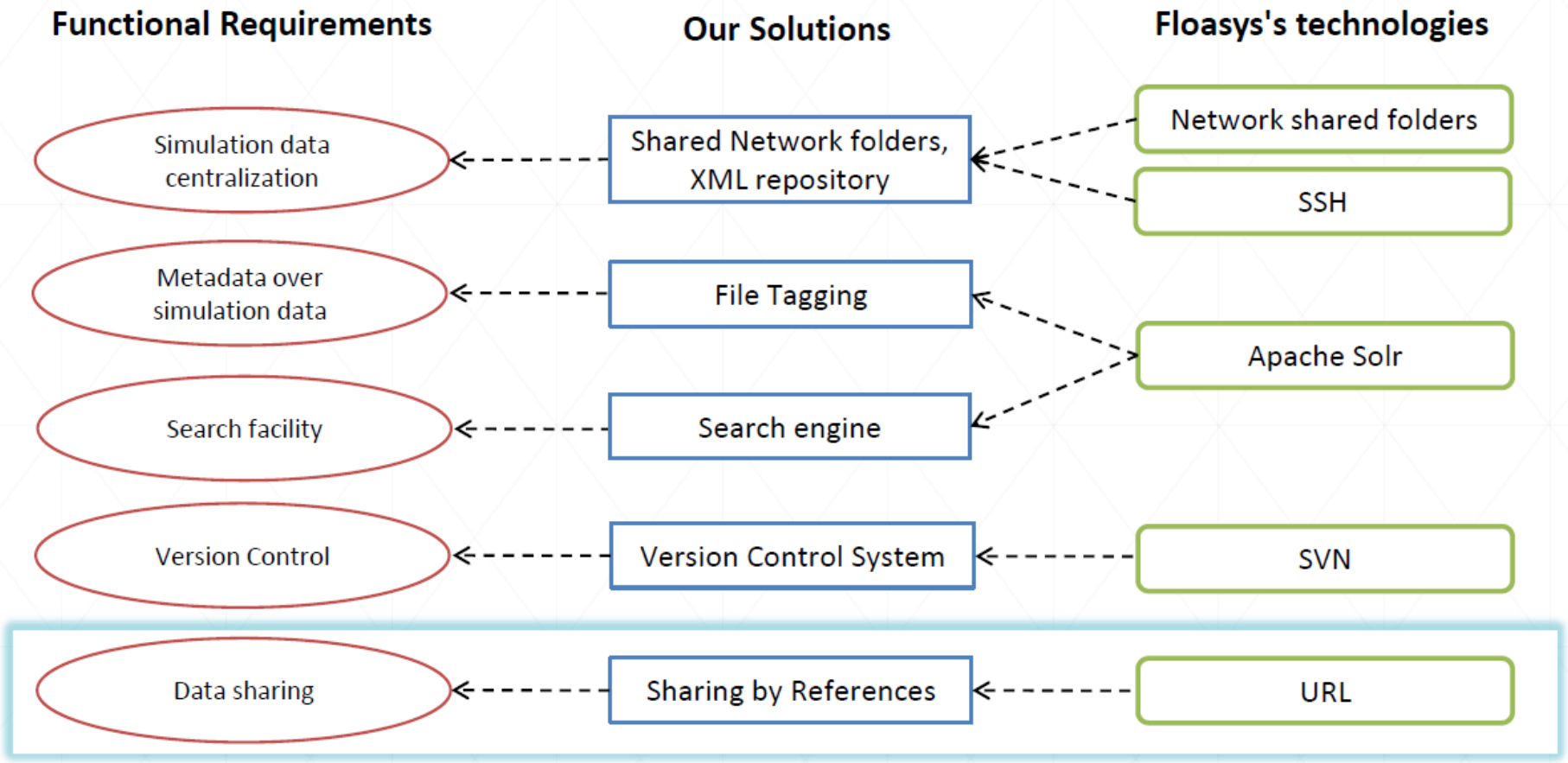
Server-Side Architecture Overview



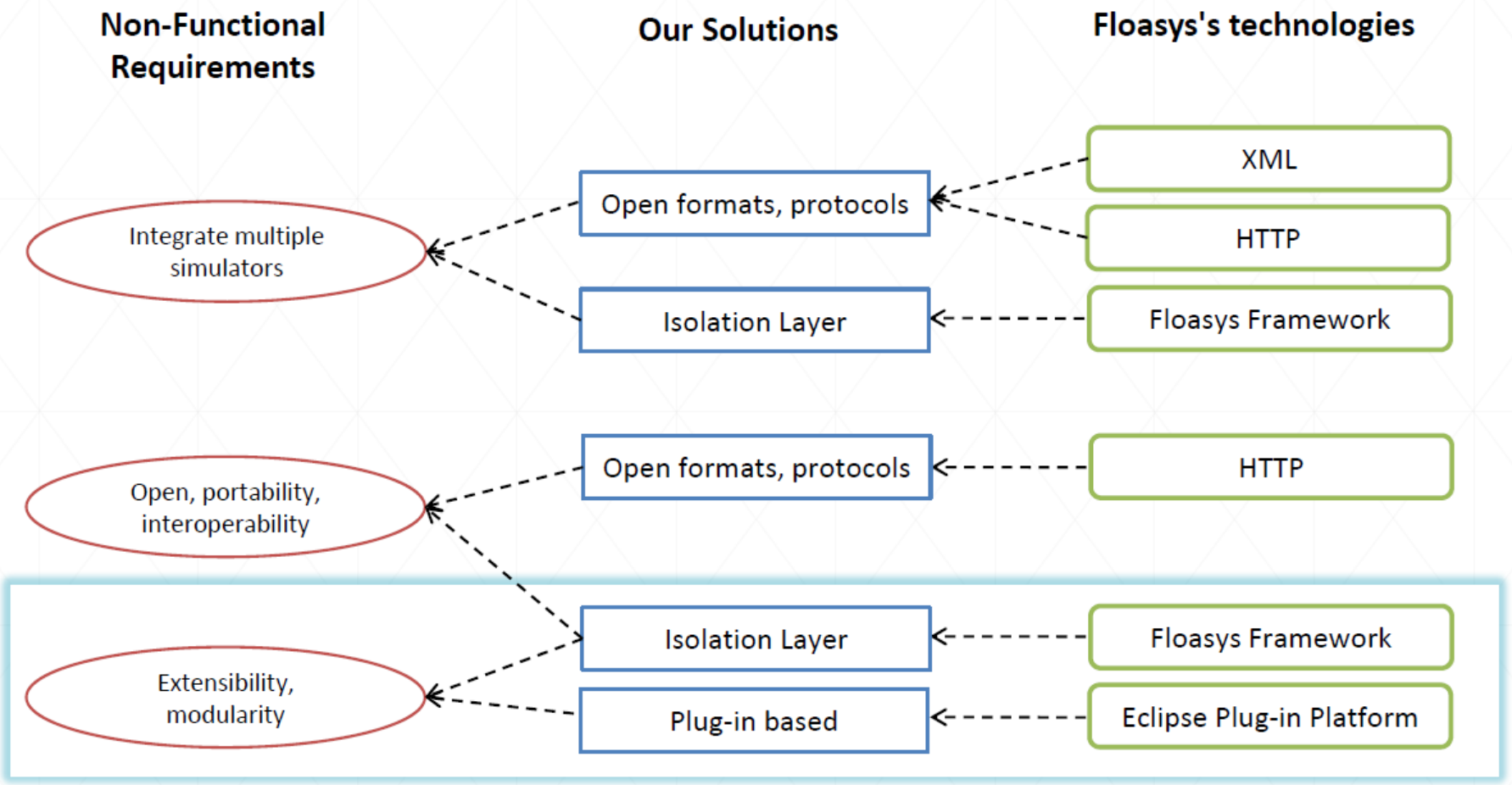
Module-based architecture



Functional Requirements

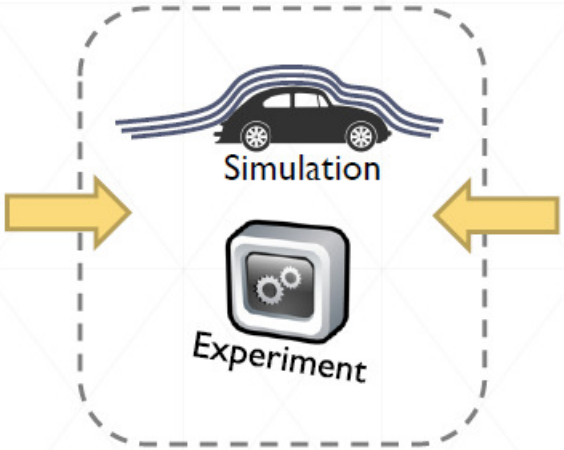


Non-Functional Requirements



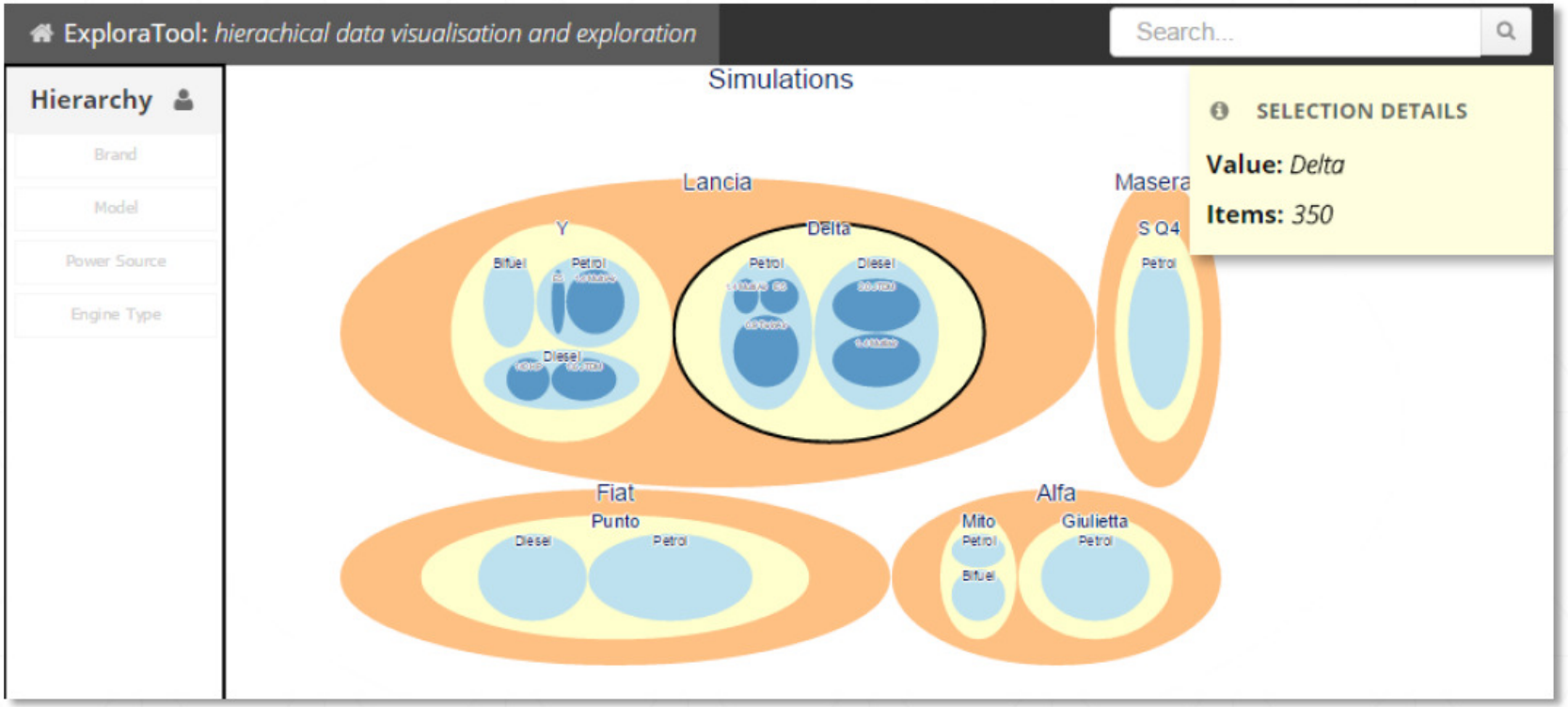
ExploraTool
Simulation Repository Exploration

Simulation/Experiment data:
- Case setup
- Sensors data
- Numerical data
- Contour-plots
- Pictures
- Videos
- …

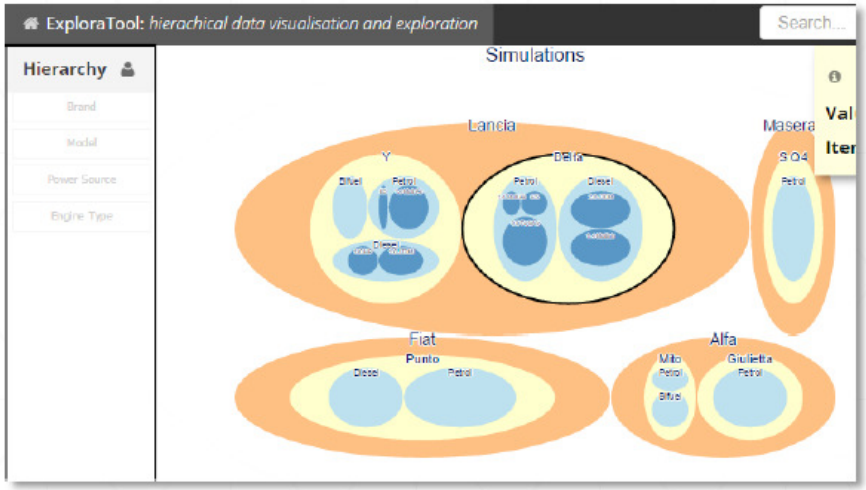


Free Tags:
- Engine
- Brand
- Project name
- Fuel supply
- Type of simulation
- Type of experiment
- Description
- …

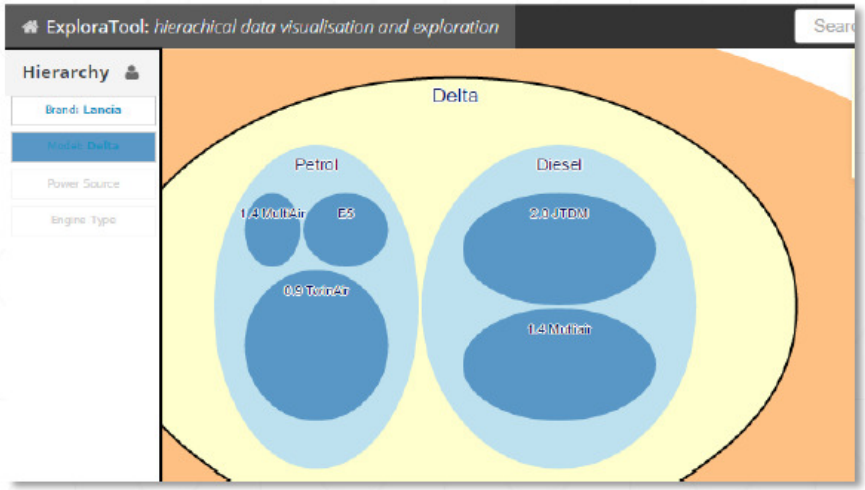
ExploraTool



ExploraTool: drill-down and roll-up



Initial overview of the repository with all simulations grouped by brand, vehicle model, power source and engine type.



The user can drill-down by directly clicking on an ellipse. ExploraTool smoothly enlarges the selected group rendering a transition.

Floasys Extensions – Multi-disciplinary applications

A complex industrial project involves several departments that have to optimize the performances to achieve the prefixed target.

Each department has its rules and best practices to reach this goal.

In this complex scenario a Collaborative Platform like Floasys comes in handy.

Floasys is not limited to the Computational Fluid Dynamics field.

Floasys Multi-Disciplinary extension includes:

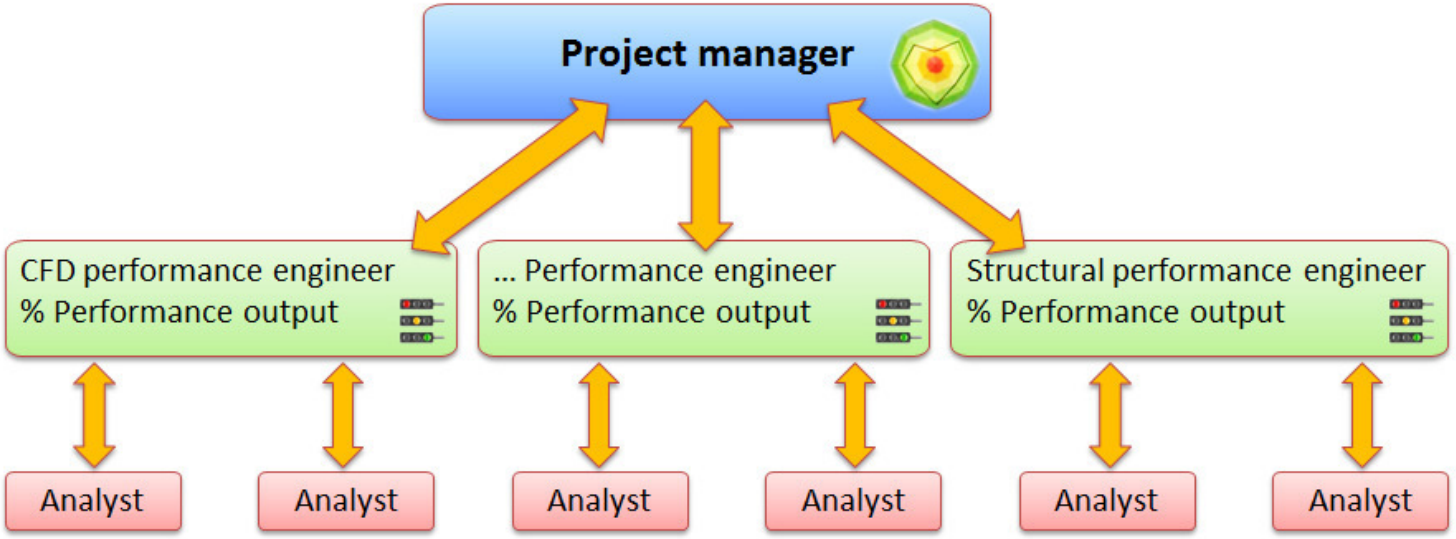
- Structural Analysis
- Thermal Analysis
- Multibody Analysis
- Fatigue Analysis
- Multiphysics Analysis

Floasys Extensions – Multi-disciplinary applications

Different roles in the company have different needs

In every engineering department we have at least these roles:

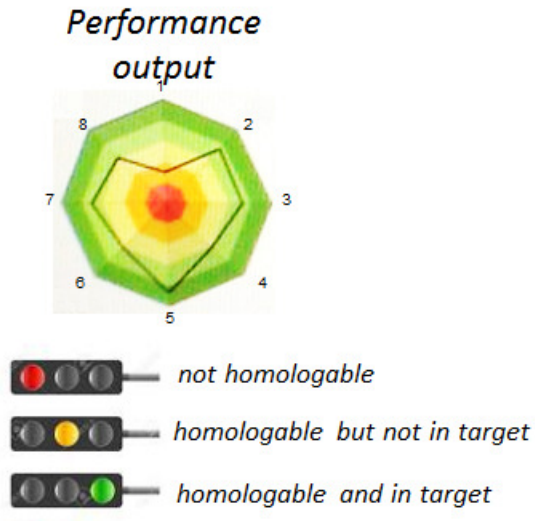
- CAE Analyst -> *does the CAE Analysis*
- Performance Engineering -> *is responsible for a specific Project Performance*
- Project Manager -> *is responsible for the whole Project*



Hierarchy in the performance target achieving

Floasys Extensions – Multi-disciplinary applications

To constantly monitor project performances the Project Manager makes use of a Radar chart as depicted in Figure.

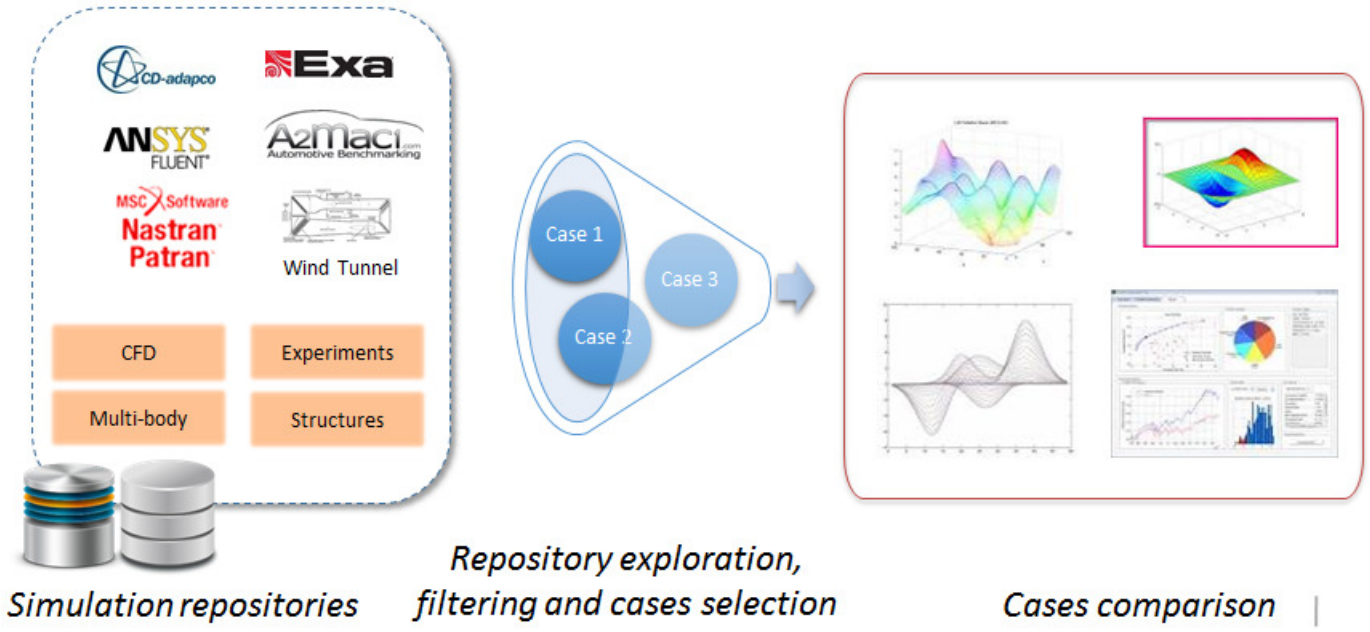


	Target	Actual	
1) Tail planes	0,01% -1%	-1,05%	
2) Engines	0,01% -1%	+0,80%	
3) Fuselage	0,01% -1%	+0,50%	
4) Wing	0,01% -1%	0%	
5) Weight	0,01% -1%	+1,05%	
6) Endurance	0,01% -1%	0%	
7) Systems	0,01% -1%	+0,25%	
8) Costs	0,01% -1%	0%	

This tool gives a fast overview of the status of the project and helps companies to recognize critical issues and put on the track of recovery actions

Floasys Extensions – Multi-disciplinary applications

Floasys guarantees collaborative needs, around the various simulation environments, through all the services previously described.

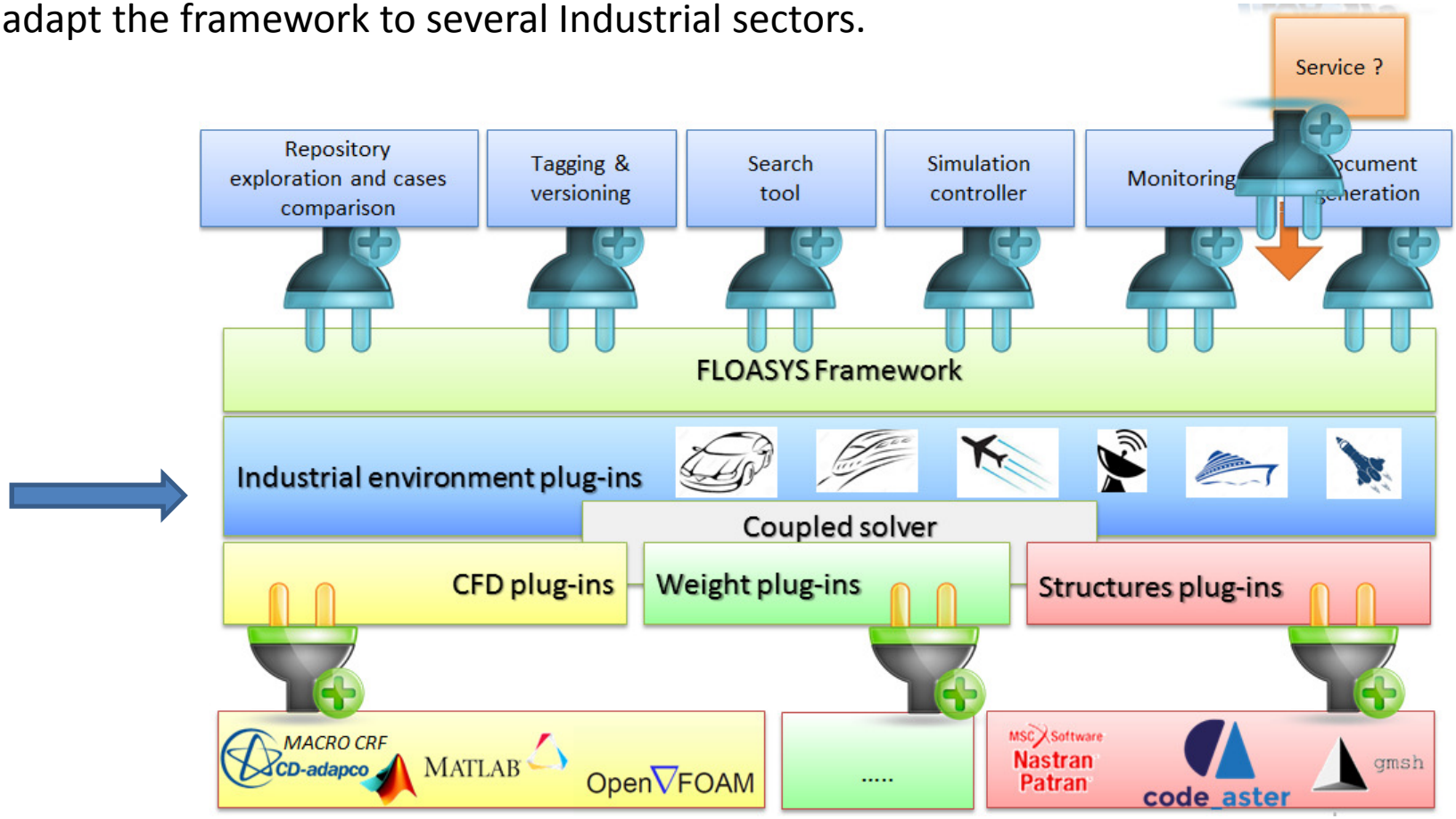


Typical Use Case involving several CAE Environments

Intersectorial Extension through Industrial Environment plug-ins

Each Industrial sector (rail, naval, automotive, aeronautical, etc.) has its own regulations, configurations and data sets.

The extensibility features of Floasys through plug-ins architecture gives opportunity to adapt the framework to several Industrial sectors.



Conclusions

Enterprises are world-wide and compete on a global market.

Internet technologies can support the communication, coordination and the sharing of resources among workers.

Starting with the main objectives that a CSCW system is intended to achieve:

- I have played a direct field experience (FCA Use Case)
- I have found that these elements emerge as customer needs
- I have implemented them in the platform prototype developed

Addressed each requirements with an integrated, extensible, and modular architecture.

Provided custom services over data:

- Metadata over data such as tags
- Search simulations, retrive data, aggregate and analyse them through charts
- Share data and results among industrial practitioners
- Automatic document generation based on templates

Extensions to multi-disciplinary applications (several CAE Environment) and to several Industrial Context (rail, naval, automotive, etc.) through plug-ins architecture.

Publications

1. Gargiulo, Claudio; Pirozzi, Donato; Scarano, Vittorio. ***An Architecture for CFD Workflow Management.*** In Proceedings of the 11th IEEE International Conference on Industrial Informatics (INDIN), Bochum, Germany, July 29-31, 2013, pp. 352-357.

2. Gargiulo, Claudio; Pirozzi, Donato; Scarano, Vittorio; and Valentino, Giuseppe. ***A platform to collaborate around CFD simulations.*** In Proceedings of the 23rd IEEE International Conference on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), Parma, Italy, June 23-25, 2014, pp. 205-210.

3. Gargiulo, Claudio; Malandrino, Delfina; Pirozzi, Donato; Scarano, Vittorio. ***Simulation Data Sharing to foster Teamwork Collaboration.*** Journal on Scalable Computing: Practice and Experience, Scientific International Journal for Parallel and Distributed Computing 2014.

4. Fish, Andrew; Gargiulo, Claudio; Pirozzi, Donato; Scarano, Vittorio. ***Simulation Repository Visualisation and Exploration.*** In Proceedings of the 13th IEEE International Conference on Industrial Informatics (INDIN), Cambridge, UK, 22-24 July, 2015.

5. Fish, Andrew; Gargiulo, Claudio; Malandrino, Delfina; Pirozzi, Donato; Scarano, Vittorio. ***Visual Exploration System in an Industrial Context.*** Journal IEEE Transactions on Industrial Informatics 12 (2), 567-575, April, 2016.


An architecture for CFD Workflow Management


A platform to collaborate around CFD simulations

thank you