From Monolithic to Microservice Architecture: The Case of Extensible and Domain Specific IDEs

Romain Belafia – Pierre Jeanjean – Olivier Barais – Benoit Combemale – Gurvan Le Guernic

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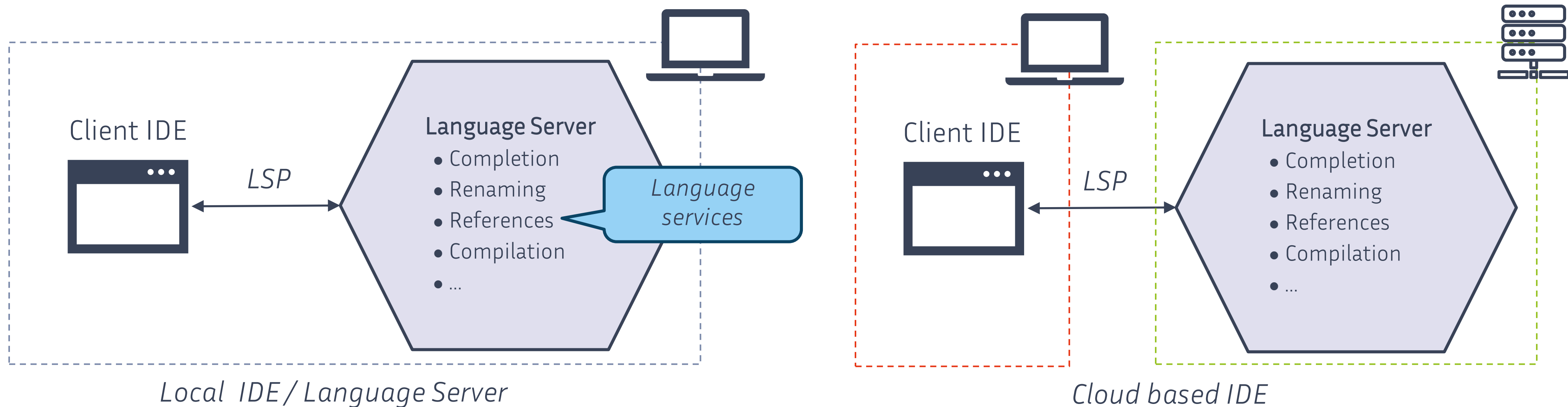
Integrated Development Environment (IDE): provides **Language Services**
- Auto-completion
- Refactoring
- Compilation
- …

Language Server Protocol (LSP)
- Allowed the separation between language-agnostic client IDE and a language server
- Allowed the migration toward cloud architectures



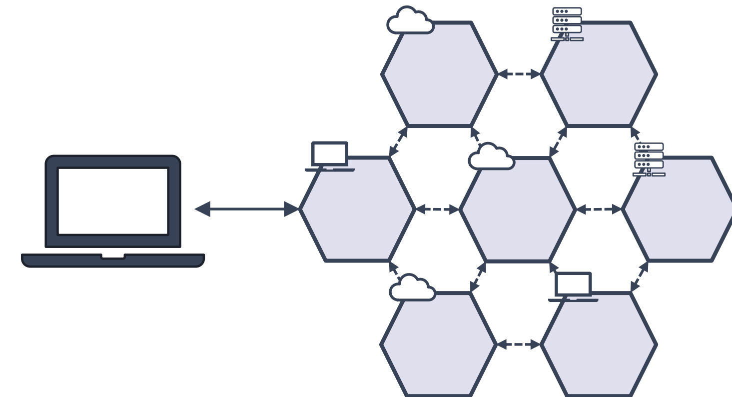
Language server built as **Monolithic Application**

1. **Lack of modularity:** monolithic architectures are not able to manage modular structures
2. **Heterogeneity of language services:** language services have various needs in response time and resources **[Modular and Distributed IDE, Coulon et al., SLE 2020]**

Auto-completion
- **Light**: little demanding in resource
- **Accessed often**: needs a short response time
  - ➢ Deployed **locally**

Compilation
- **Heavy**: very demanding in resources
- **Occasional access**: response time less impacting
  - ➢ Deployed in a **distant server**

Explored software architecture: **Microservices**
➢ Divide an application in **light** and **independent** modules focused on **one functionality**



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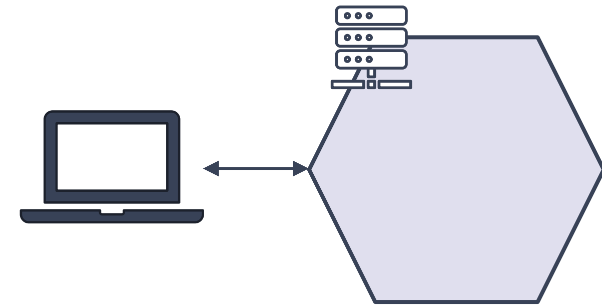
Microservices have significant benefits, e.g.:

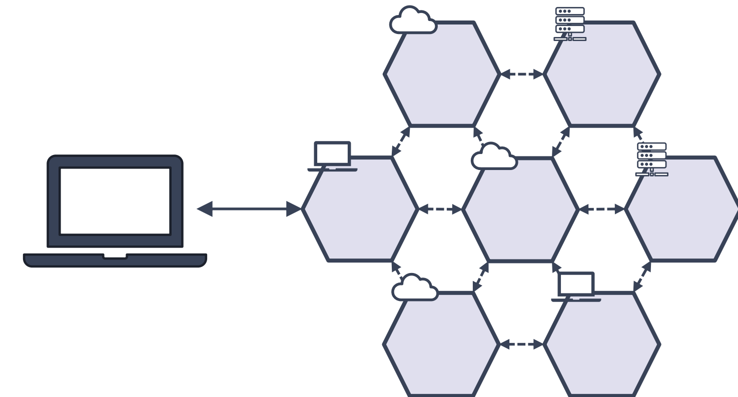
- Better **deployment flexibility**
- Have **independent development life-cycle**

Benefits in a **DevOps** context, e.g.:

- **Separation of concerns**
- **Better scalability**
- **Shorter deployment times**



Monolithic architecture



Microservice architecture

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Microservicization of legacy monolithic applications is **highly dependent of specific properties** of the application of interest

- No "universal" guide to migrate a monolithic application toward microservices
- Generalization for applications sharing specific properties

Cloud-based IDEs specificities

1. **Heterogeneity of language services**: language services have various needs in resources and response time
2. **Heterogeneity of development**: services are developed by various stakeholders
3. **Manipulation of rich and complex data structures**: programs are manipulated as rich and complex data structures (e.g., AST) which needs to be exchanged between microservices

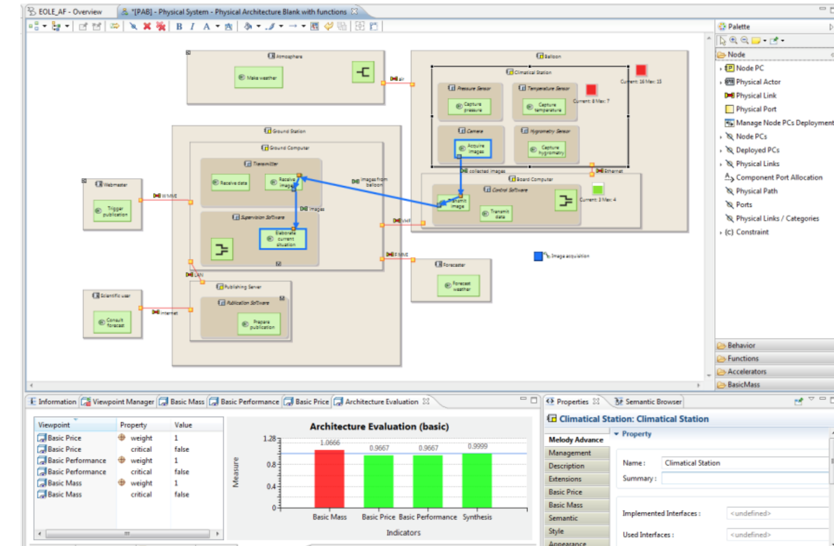
Experimental approach

- Study Cloud-based IDEs' microservicization process to provide **insights** for future applications' microservicization
- **Empirical approach**: based on the study of a case study and the difficulties encountered to draw lessons learned

Contribution: Set of lessons learned based on our experiment of a Cloud-based IDE microservicization

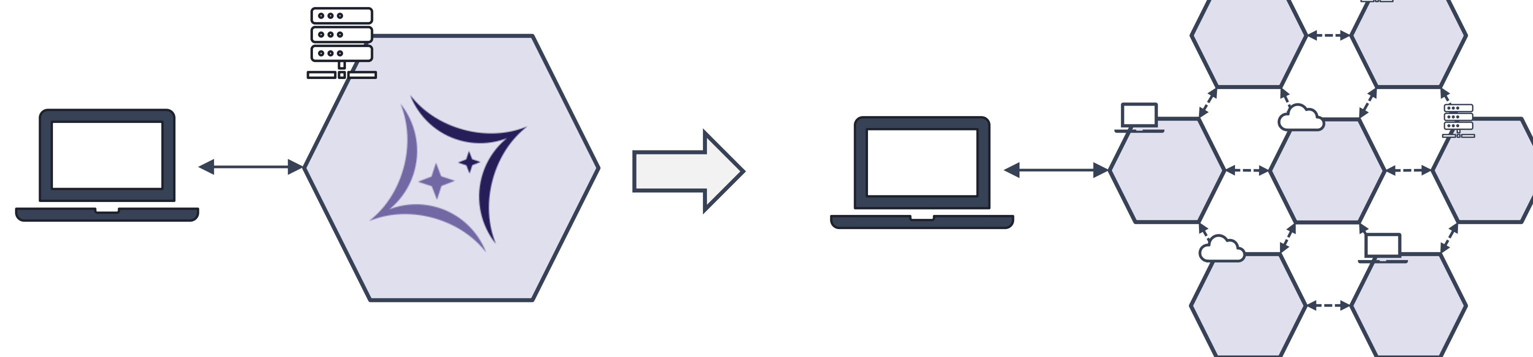
Sirius Web

- Open-source framework
- Developed by **Obeo**
- Allows the conception of **Graphical Modeling Workbenches**



Eclipse Capella by Thales

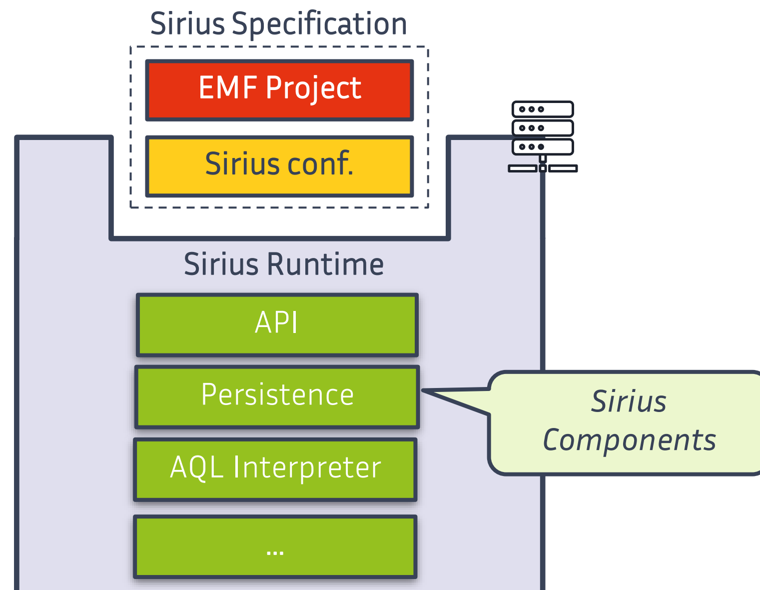
Goal: Study Sirius Web migration toward microservices



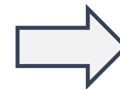
A Sirius Application relies on 2 main elements :

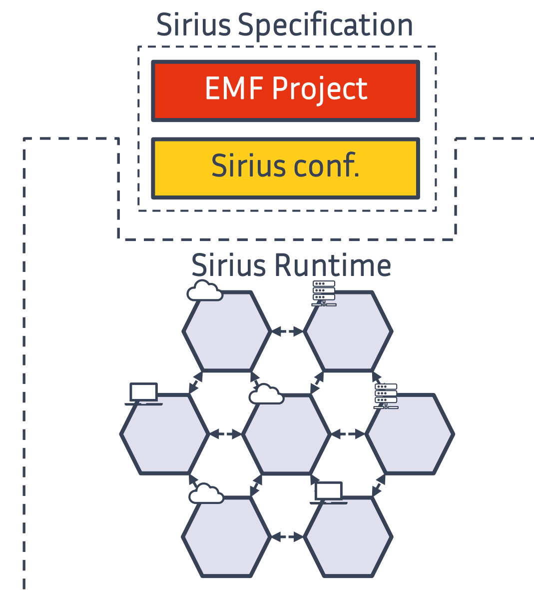
1. **Sirius Specification**
   - **EMF Project**: Provides the API to manipulate models
   - **Sirius Configuration**: Specifies the graphical representation of the manipulated models

2. **Sirius Runtime**
   - **Set of Sirius Components**: Maven modules specifying the functionalities, the API and the structure of a Sirius Web application



Original monolithic architecture



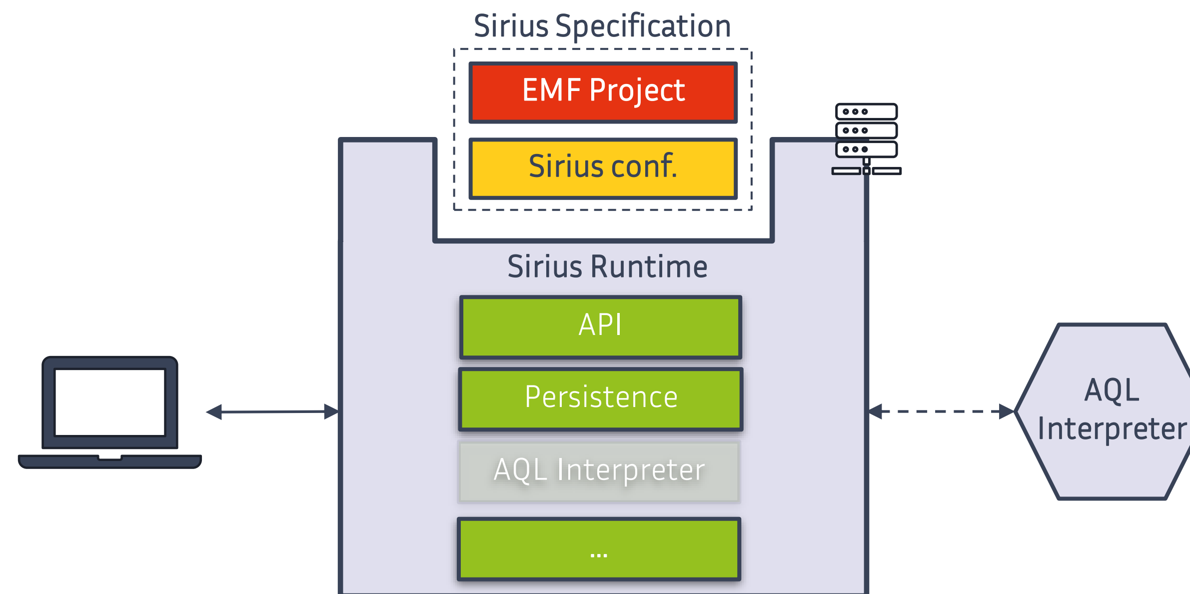


Microservice architecture

- **Acceleo Query Language:** DSL to perform queries over an EMF meta-model
- **AQL Interpreter:** evaluates AQL expressions

```
<conditionnalStyles predicateExpression="aql:self.tension>0">
    <style color="yellow" />
</conditionnalStyles>
```

Use of AQL to specify a conditional style in an .odesign file



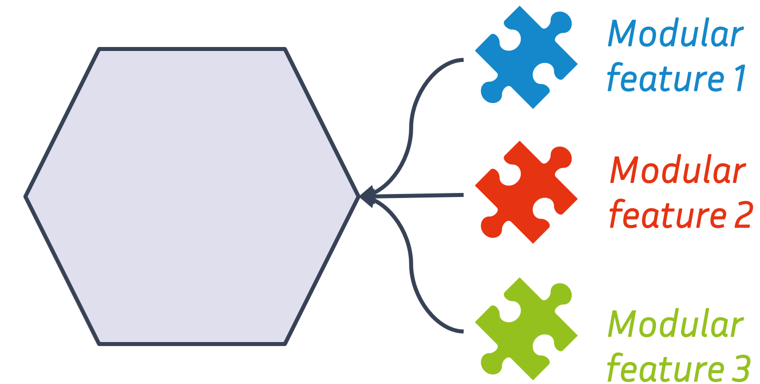
AQL Interpreter decoupled as a microservice

Lesson learned 1: open-world challenge

Modular application: incrementally add features to an application

Challenges for microservicization:

- Make new modular features available to several microservices



Modular functionalities

Lesson 1: Modularity leads practitioners to adapt the organization and the granularity of microservices to make modular functionalities available to different microservices.

Opportunities: Best architecture for modular structures in cloud application

Lesson learned 2: serialization of rich and complex data structures

Serialization: conversion process of java objects to byte stream to transfer data among services

Complex data structures, such as AST, must be serialized and transferred among language services

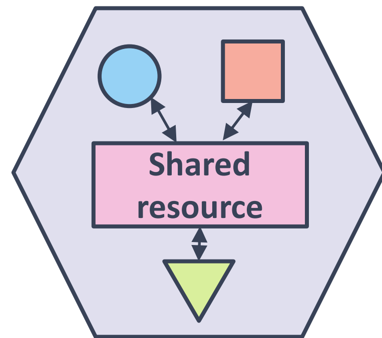
- ➢ No implementation for automatic serializations

Lesson 2: **Serialization** of data to transfer can be an arduous process when **rich and complex structures** are manipulated. The serialization should be planned upstream in the development process, especially to audit existing solution or schedule the development of adapted tools.

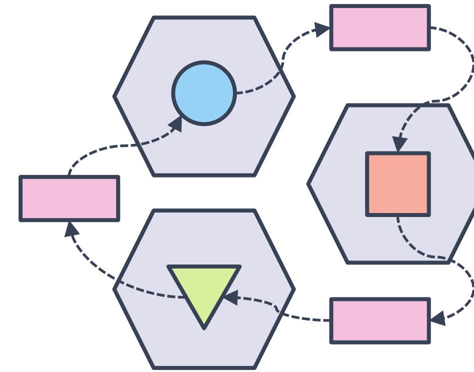
Opportunities: Static analysis tools to extract the data to exchange

Lesson learned 3: manipulation of shared resources

Various functionalities can access to **shared resources** (e.g., EPackages) initialized once



Resource shared by three functionalities of a monolithic application

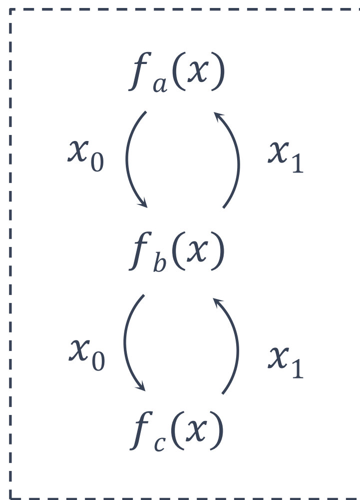


Resource shared by three functionalities of a microservice application

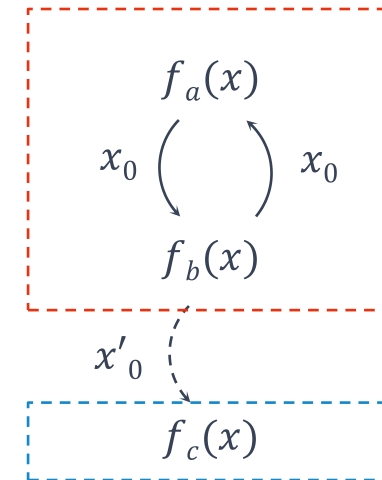
Lesson 3: Shared resources raise challenges for the microservicization process. One must be aware of their impacts on the microservice granularity and the deployment organization.

Opportunities: Find the right balance between statefulness and statelessness

Lesson learned 4: rupture of pass-by-reference chains



Pass-by-reference chain in a monolithic application



Pass-by-reference chain in a microservice application

Lesson 4: Pass-by-reference chains should be considered when migrating an application toward microservices. The microservicization process can affect and even break the original behavior of the application.

Opportunities: Annotation framework to explicit the side effects when using pass-by-references

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Conclusion

- Migration of a Cloud-based IDE toward microservices
- Case study: **Sirius Web**
- **4 lessons learned** from **AQL Interpreter** decoupling:
  - ✓ Open-world challenge
  - ✓ Serialization of rich and complex data structures
  - ✓ Manipulation of shared resources
  - ✓ Rupture of pass-by-reference chains

Perspectives

- Study of other Sirius components / Cloud-based IDE microservicization
- Development of tools to assist migration toward microservices
  - ✓ Static analysis tool to analyze and adapt the granularity of the application
  - ✓ Framework to annotate the expected behavior of pass-by-references
  - ✓ …