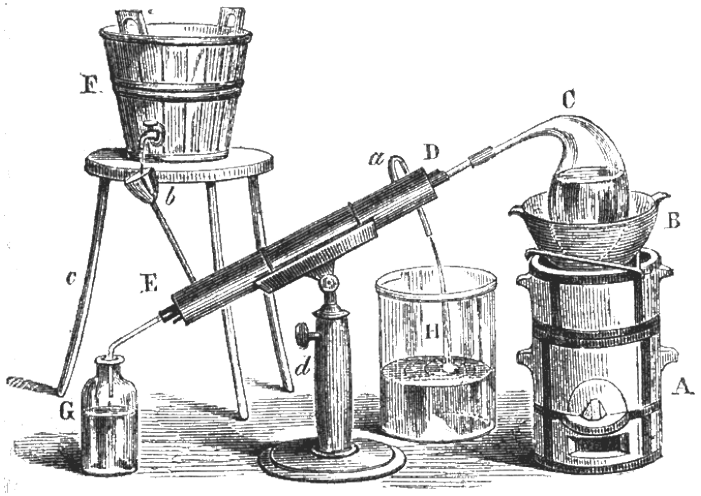
Odense, 26/10/2017

A linguistic approach to microservices

Claudio Guidi, italianaSoftware



Distilling the core concepts of microservices into a programming language

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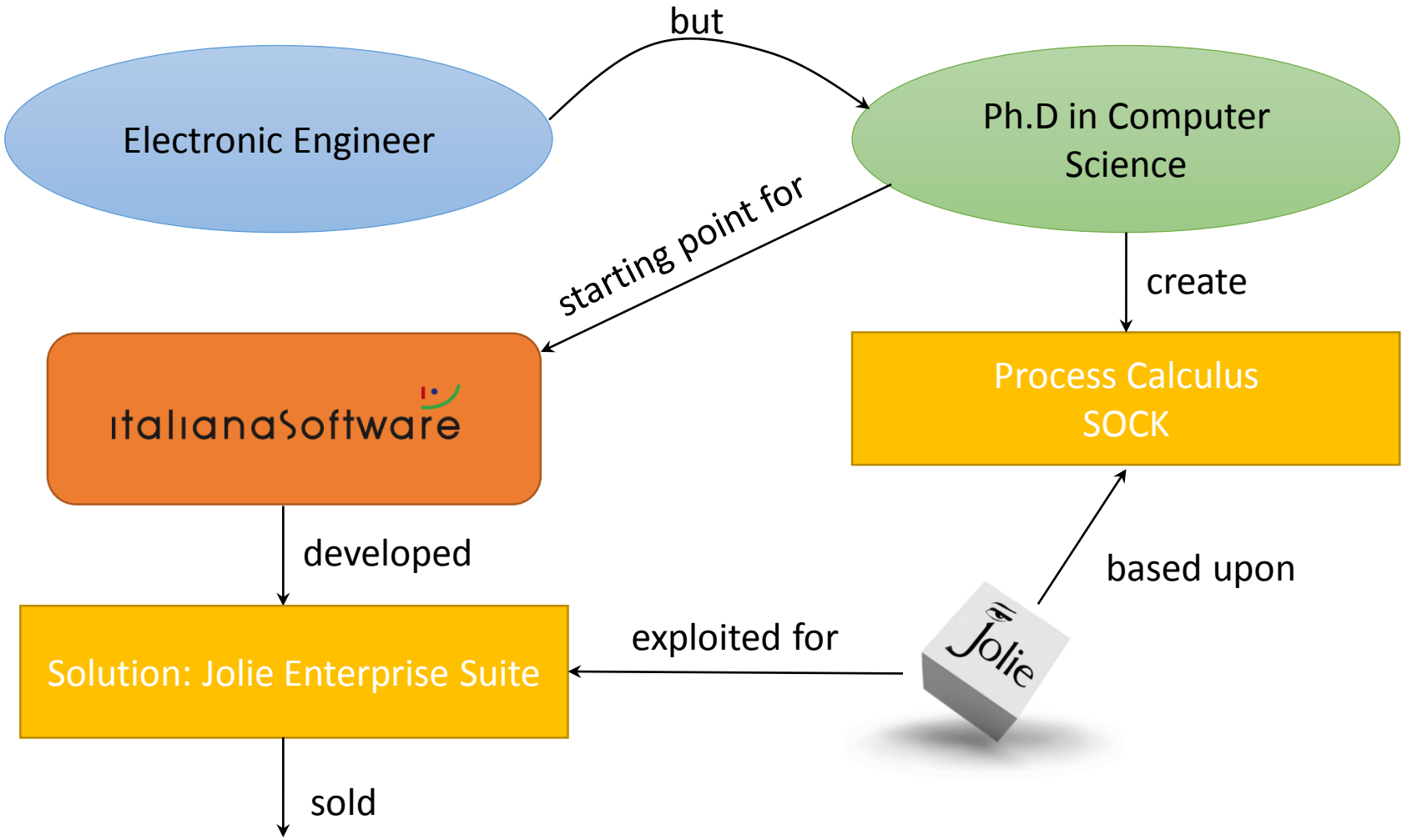
About me



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About italianaSoftware

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Is part of

gruppoimola

imola sensiblelogic

Microservices centered
Product and technology centered
Target customers: manufacturing area

Consultancy centered
Finance area (banks and assurance)
Strong experience in SOA

Based in Imola

A linguistic approach to microservices

Interesting… but why?

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The nature of computational resources is going to change

A machine

The computational resource so far

Naturally not distributed.

Processes focused on **computation.**

Functions, procedures and objects**.**

A cloud of machines

The reference computational resource in the next years

Naturally distributed.

Processes focused on **communication**.

Services, microservices**,** nanoservices, **…**

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Containers are going to replace the idea of machine we know so far

Containerization
(cloud independence)

Virtualization
(hardware independence)

Real Computational Resource

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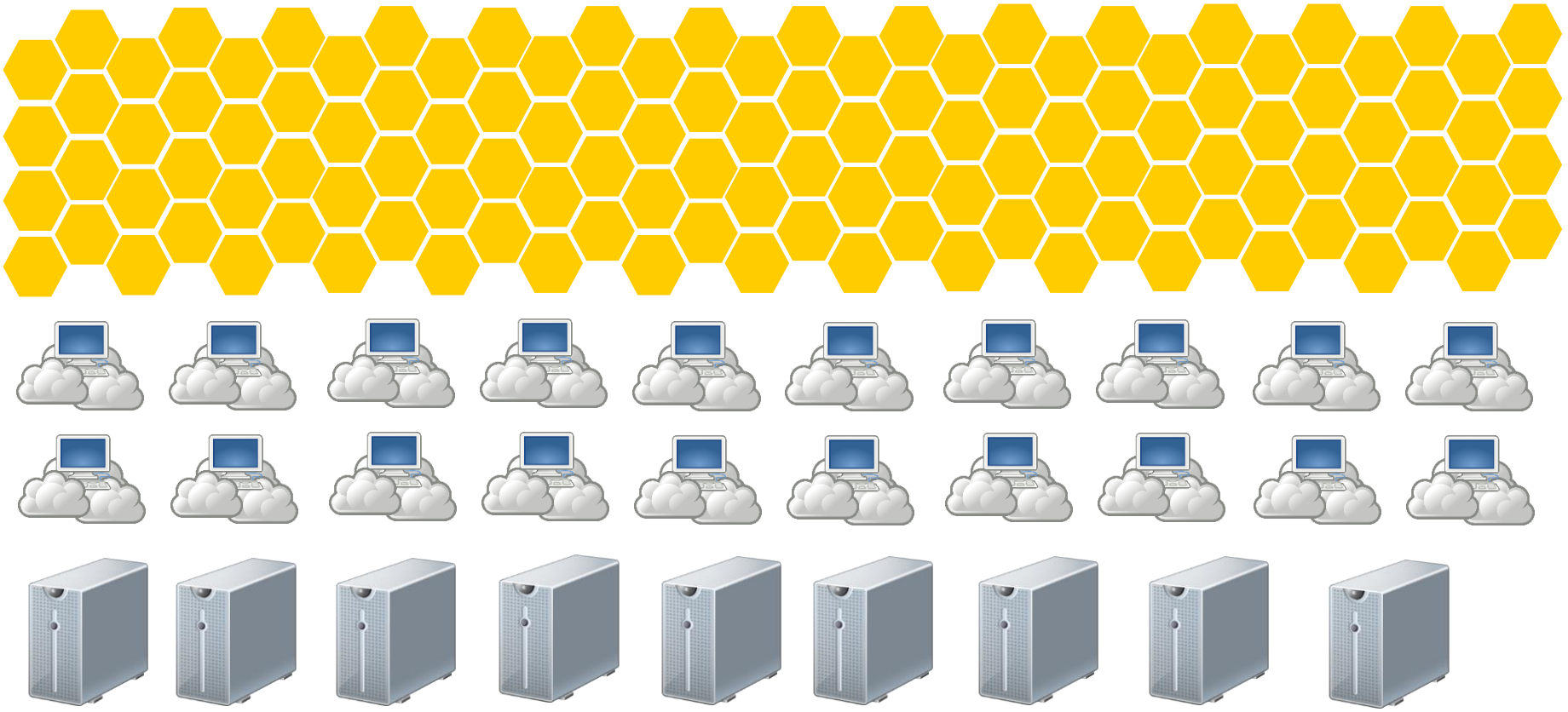
Layers of abstraction



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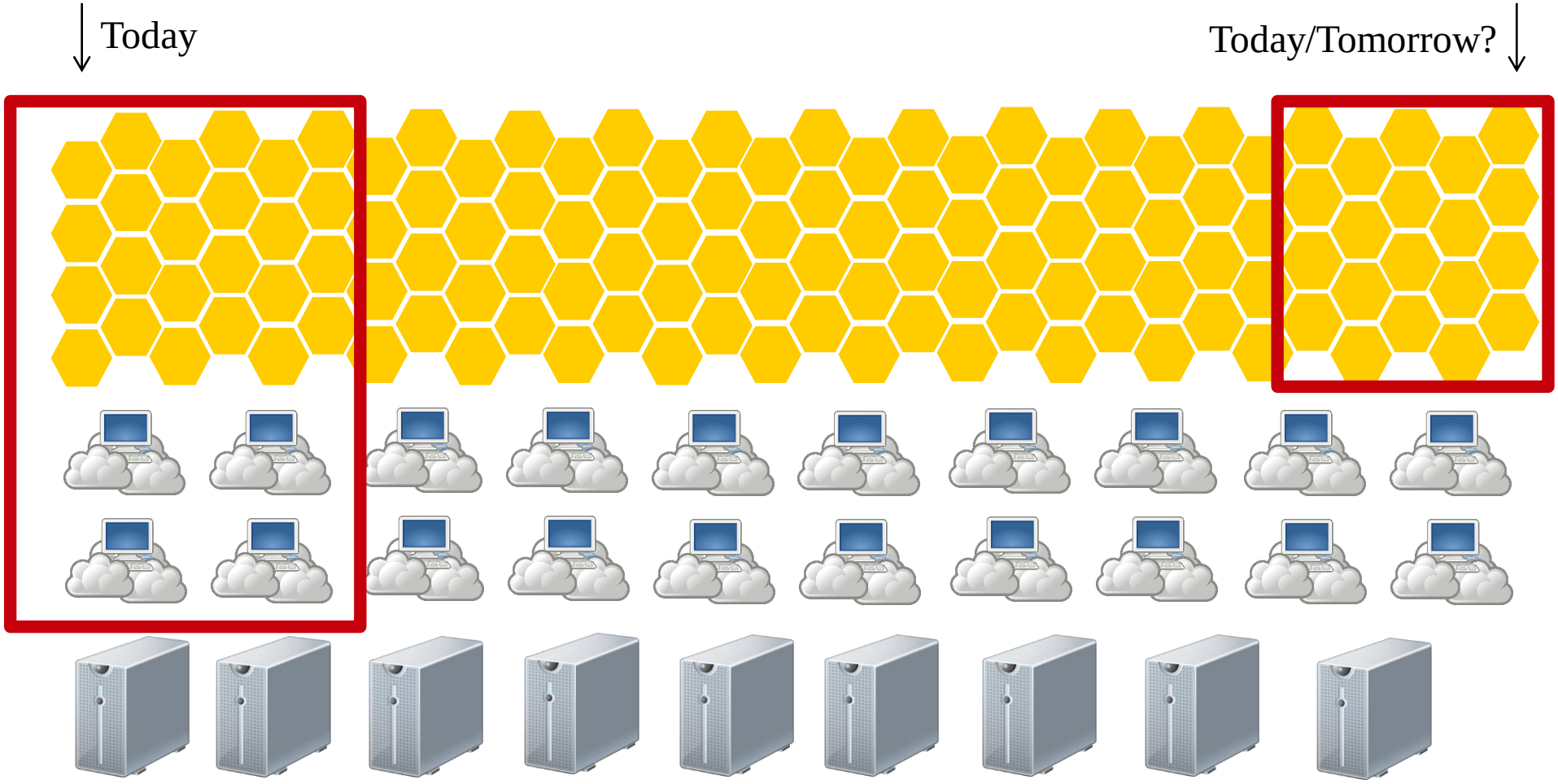
How long are we seeing behind the surface?



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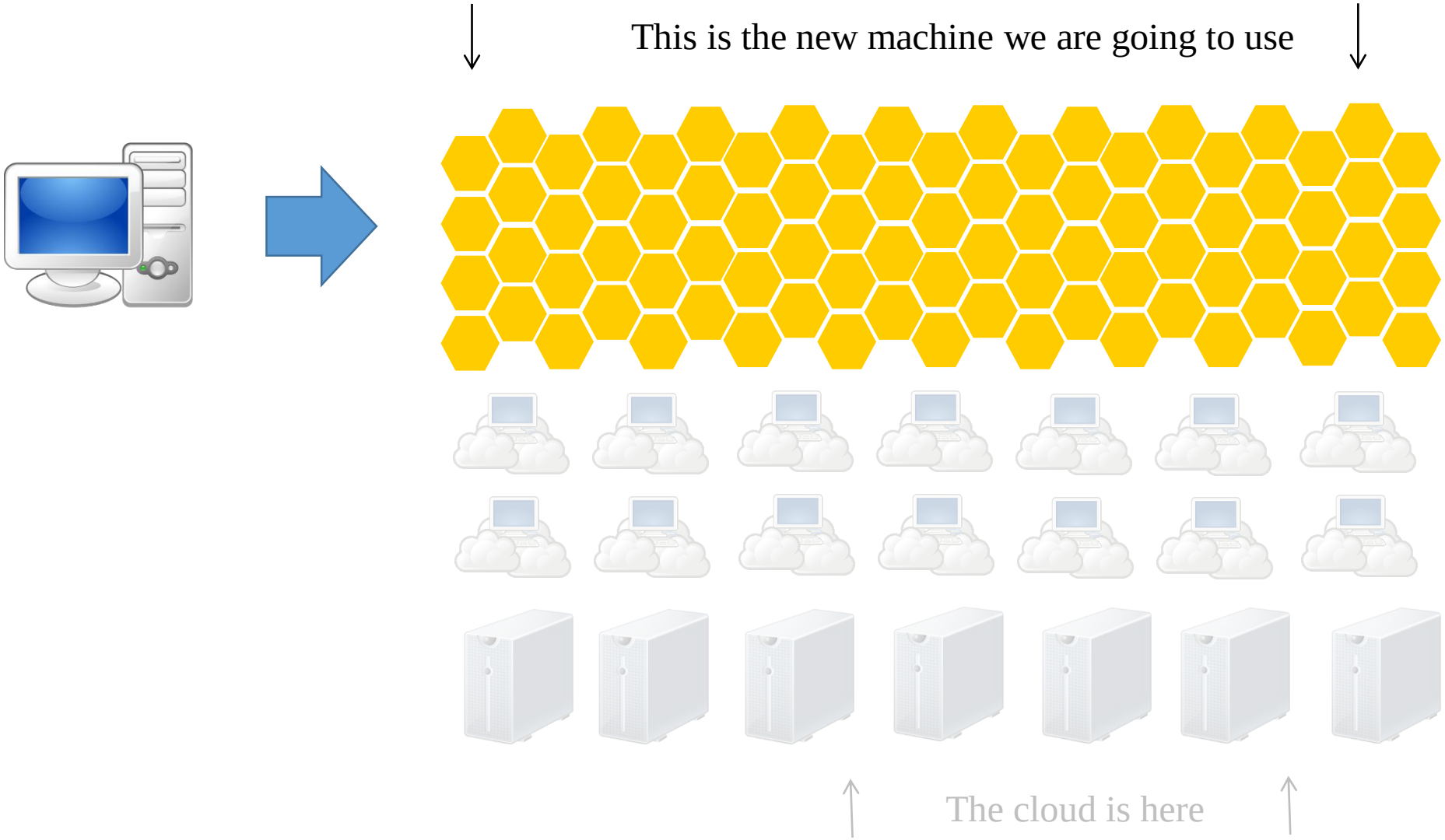
The new machine



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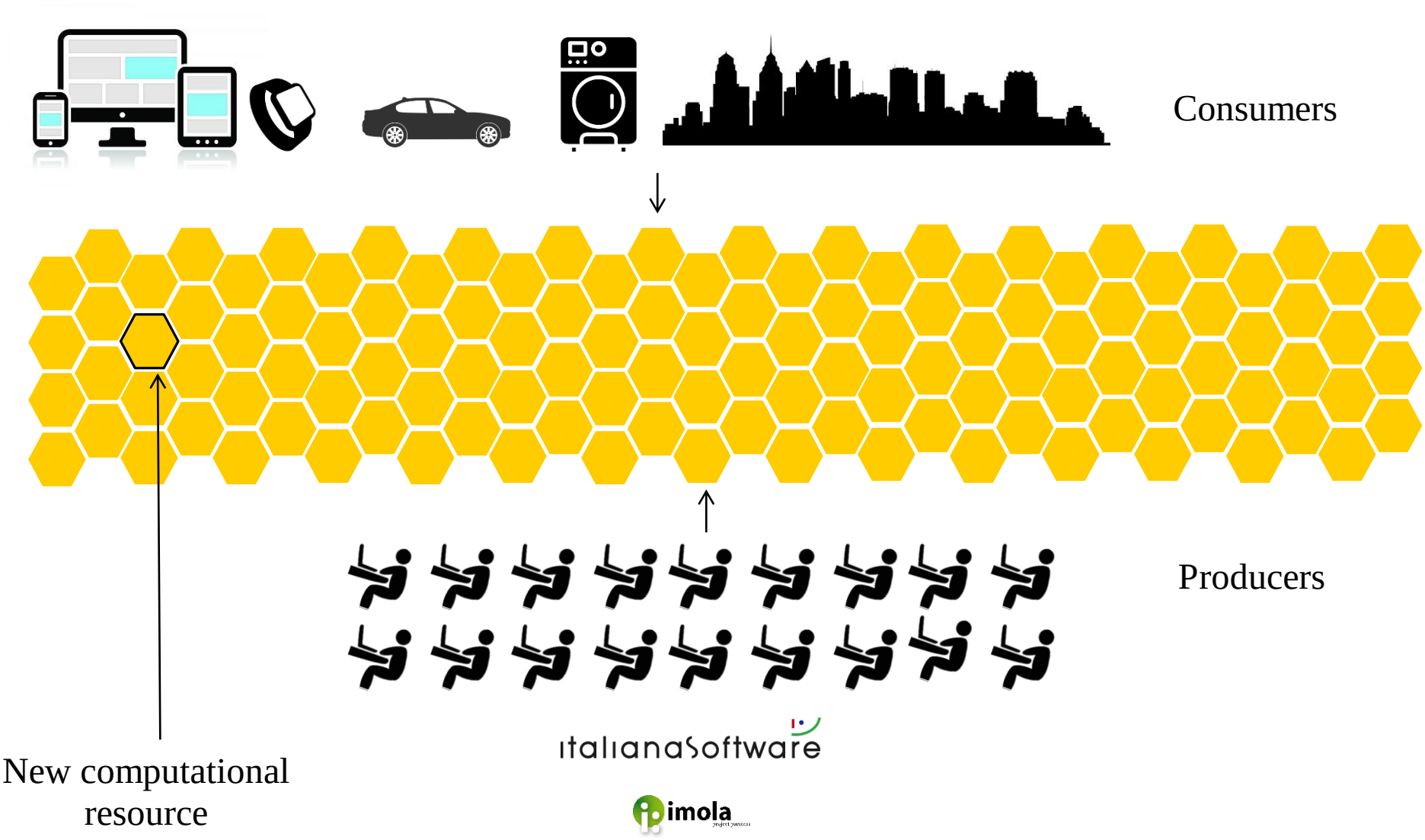
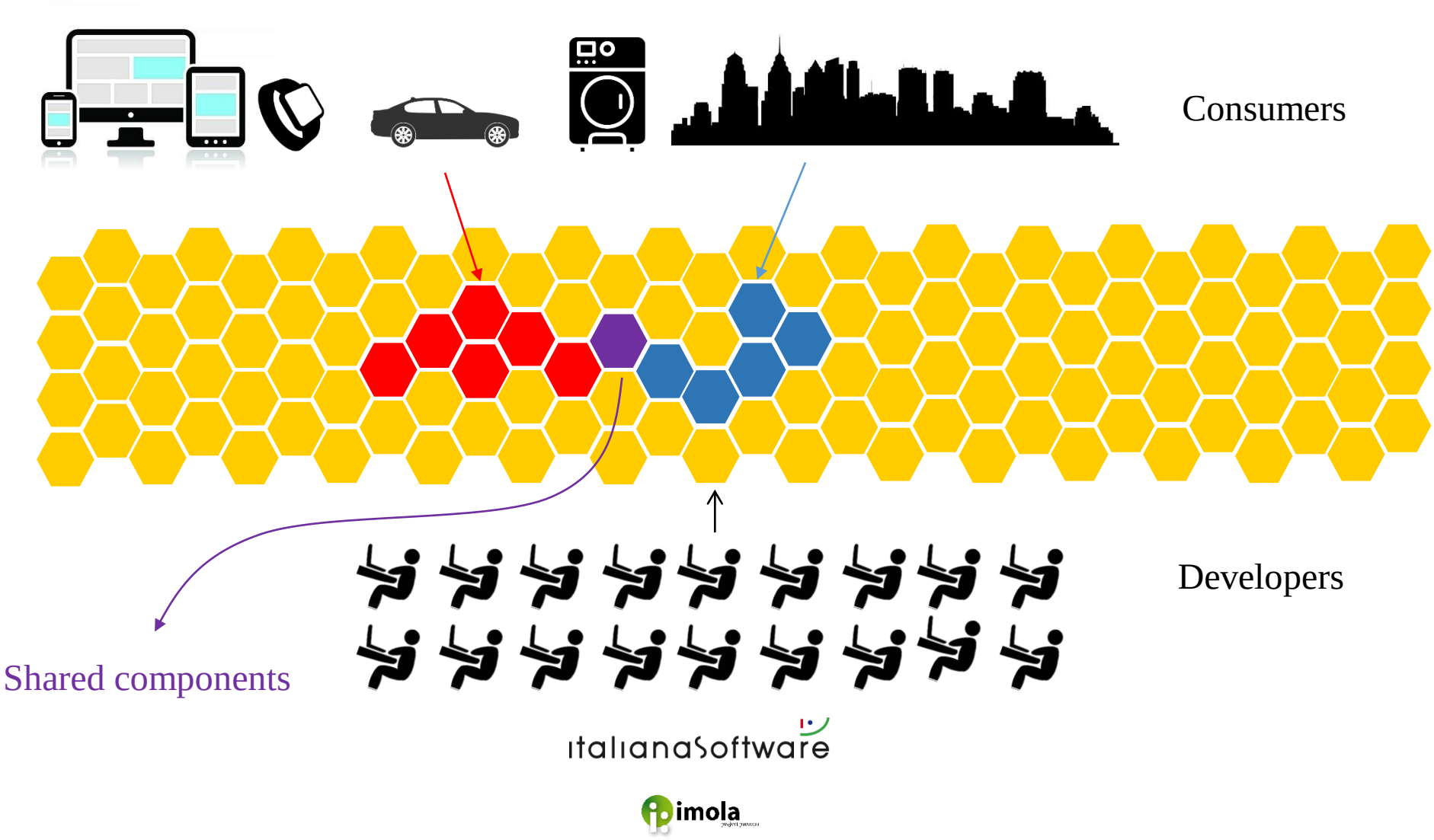
What does it imply?

Which are the short terms and the long terms consequences of such a scenario?



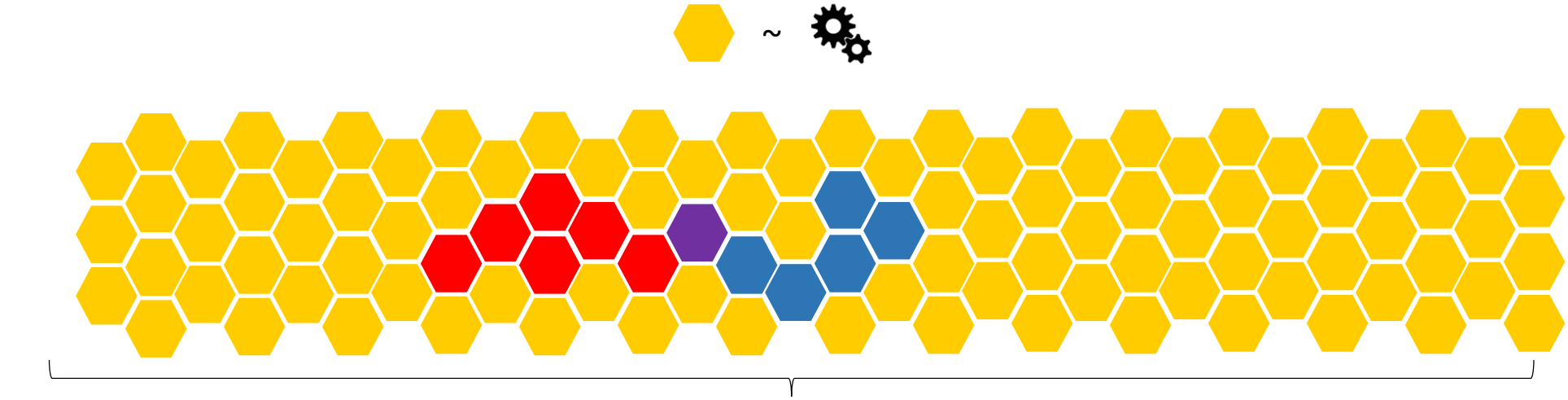
The applications

The applications will be obtained as a composition of existing components



Computational resource
~
Software functionality

Ideally, the concept of computational resource will be more and more interchangeable with the concept of software component.



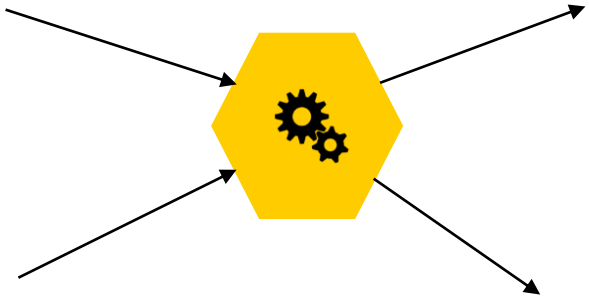
≠

In the classical idea where a computational resource is a computer machine, the software is concretely installed into the machine and it is strongly tight to the technical features of the machine

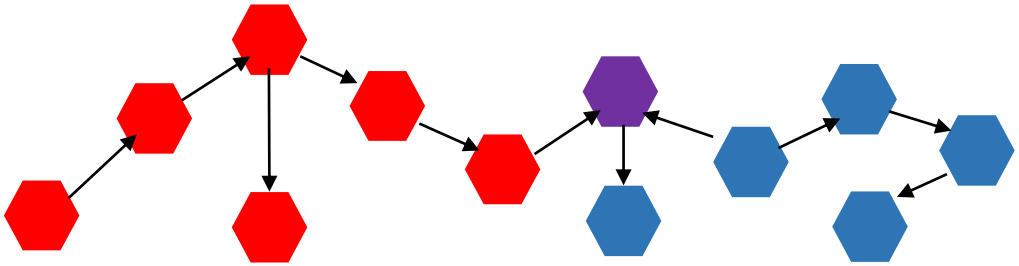
In the new machine the metrics of the system will be managed by the cloud platform provider as a all which will optimize the loads, by relocating resources or replicating them. The software functionlities will be actually decoupled from the available technical resources.

Communication is more important than computation

Communication and coordination will be more important than computation



The management of the connections and the dependencies among the components is the key point!



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Containers today

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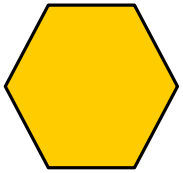
Core concepts of a container



System Level

- Lighter than Virtual Machines
- Requires a software layer installed in the hosting machine, ex: Docker

Application Level

- Instantiated starting from an image
- Usually requires connections with other containers
- Remotely controlled status: start/stop/pause/destroy/…

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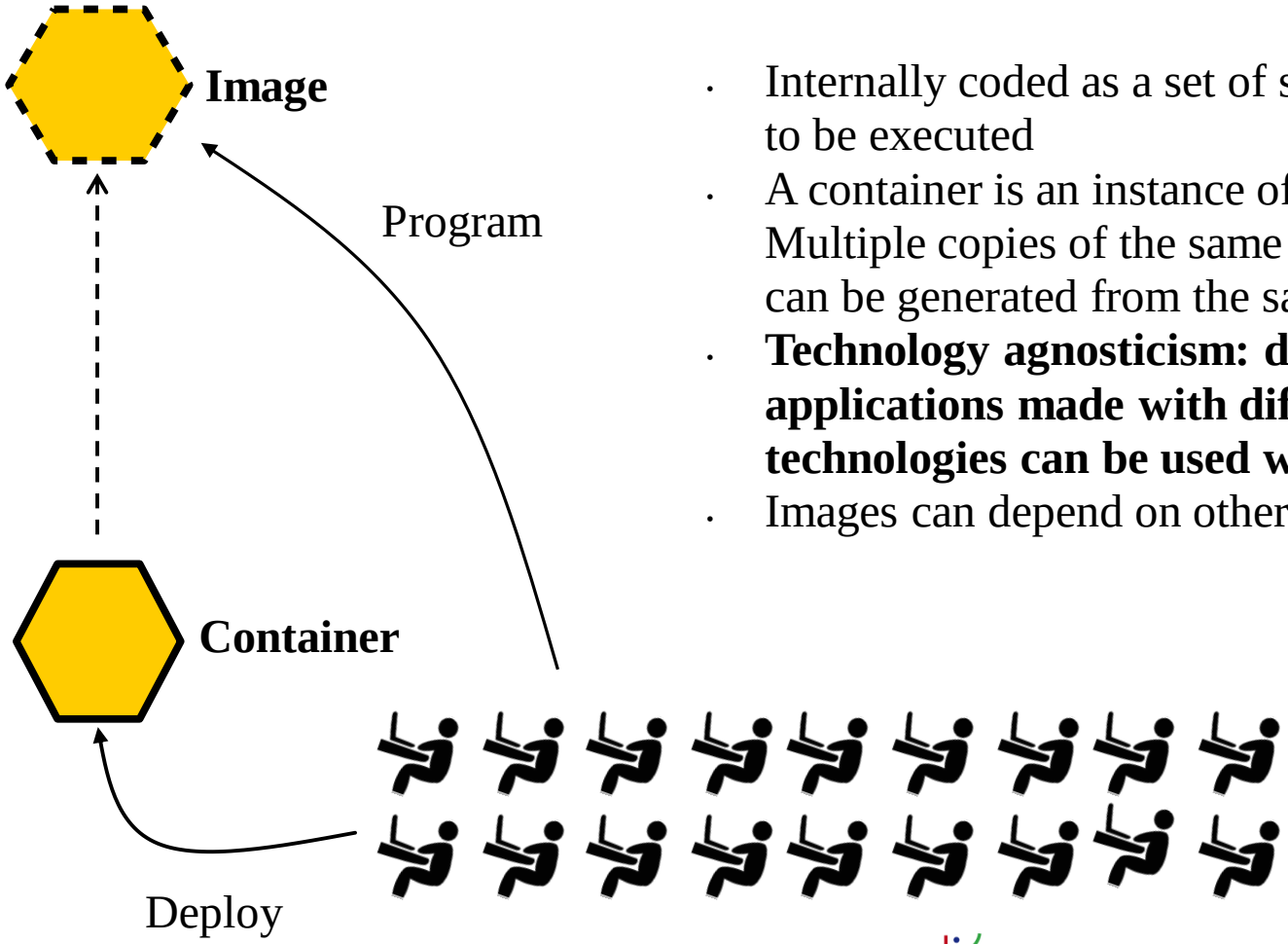
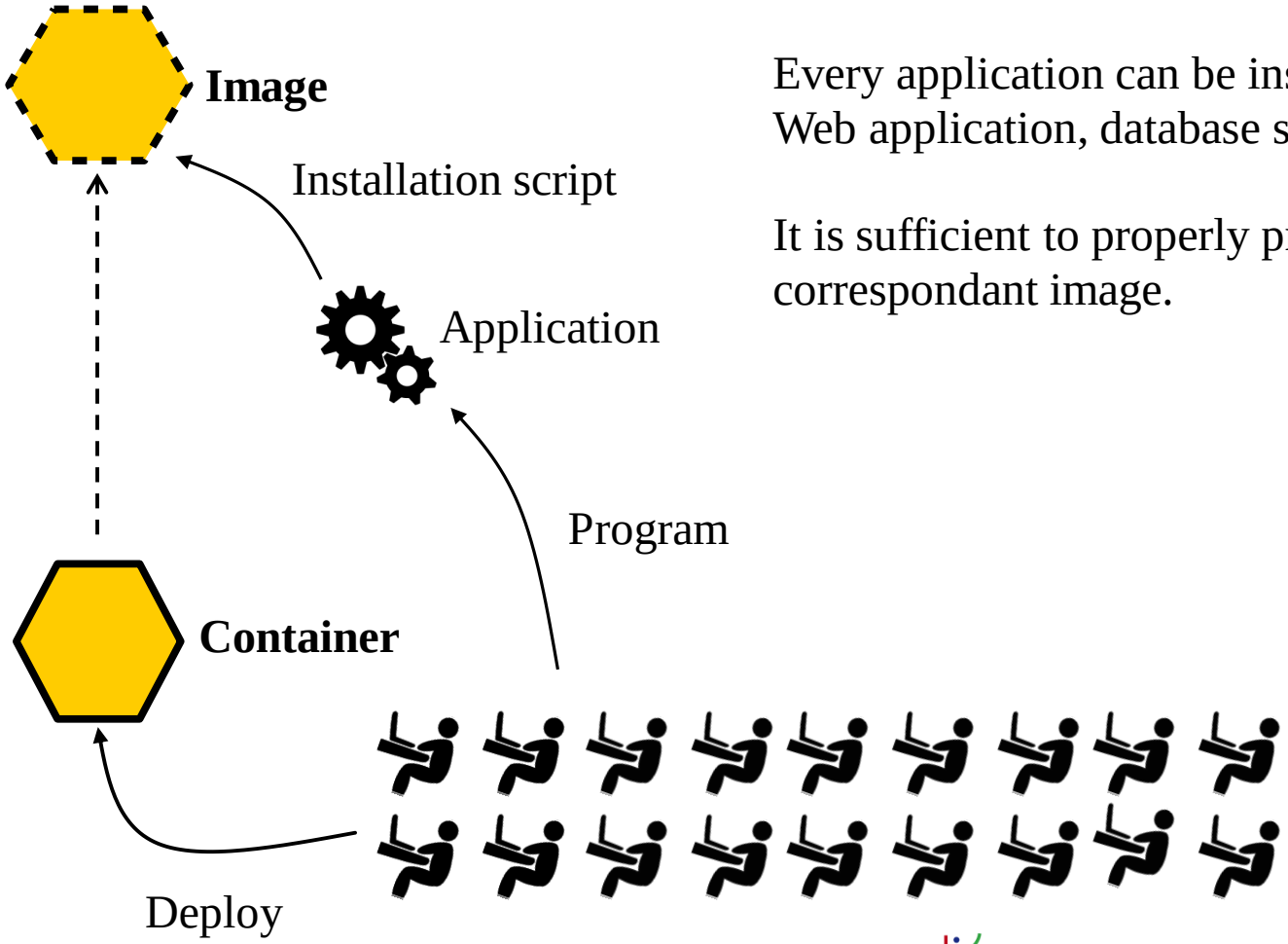
Images



- Internally coded as a set of script to be executed
- A container is an instance of an image. Multiple copies of the same container can be generated from the same image.
- **Technology agnosticism: different applications made with different technologies can be used within a container**
- Images can depend on other images

Inside a container



Every application can be installed within a container.
Web application, database servers, load balancers, etc.

It is sufficient to properly prepare the correspondant image.

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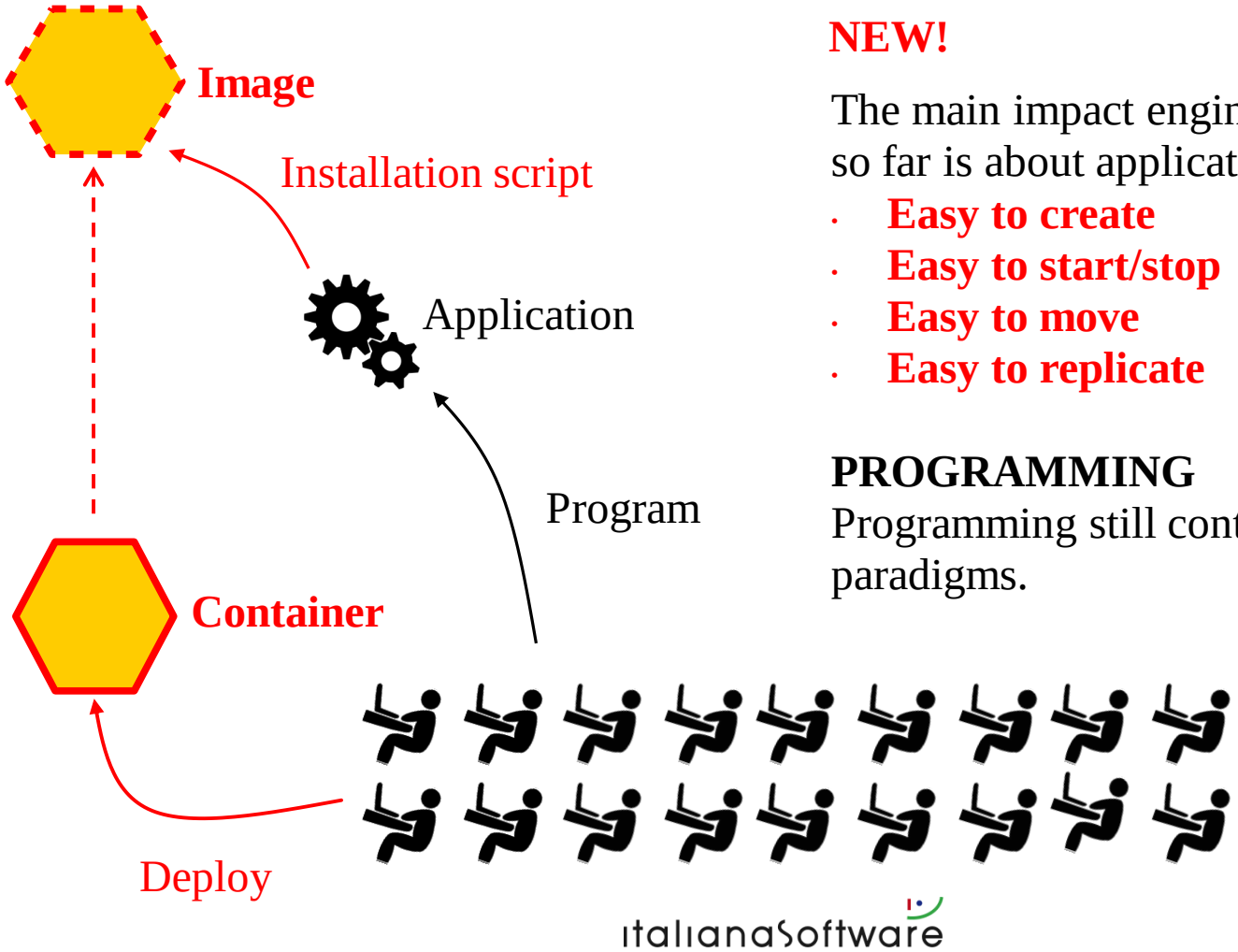
Deploying



NEW!

The main impact engineers are facing so far is about application deployment.

- **Easy to create**
- **Easy to start/stop**
- **Easy to move**
- **Easy to replicate**

PROGRAMMING

Programming still continue to exploit traditional paradigms.

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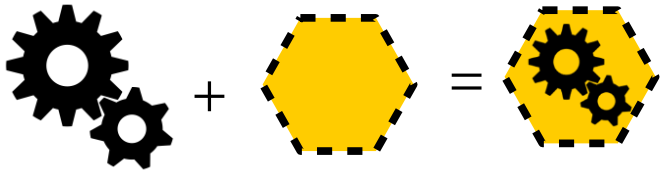
What's programming?

Remember: communication and **coordination** are the main features to deal with

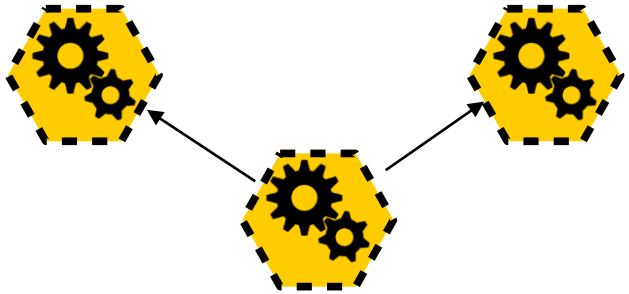
Depending on the technologies there are different languages, different tools, different methods



Two aspects:

1. **Single component** programming
    1. Communication endpoints
    2. Communication protocols
    3. Communication primitives
    4. Activity flow
    5. Fault handling

2. **Architecture** programming.
    1. Component composition
    2. Message routing
    3. Protocol transformation
    4. Asynchronous vs synchronous communication

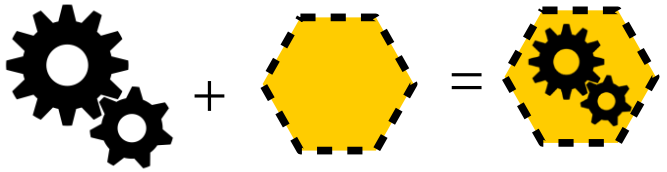


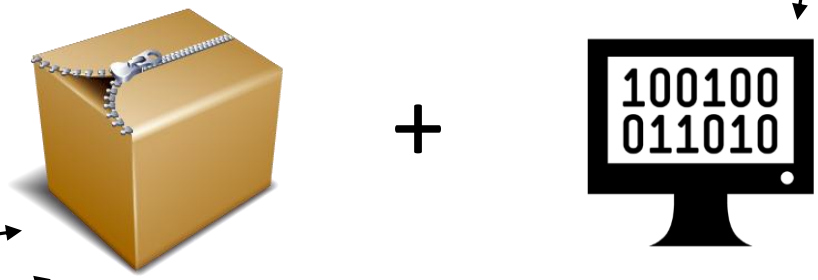
Single component programming

Access endpoints for providing functionalities
- Communication protocols
- Interfaces of the functionalities

Other components dependencies
- Communication protocols
- Interfaces of the functionalities

Business logics
- Actual coding of the provided functionalities



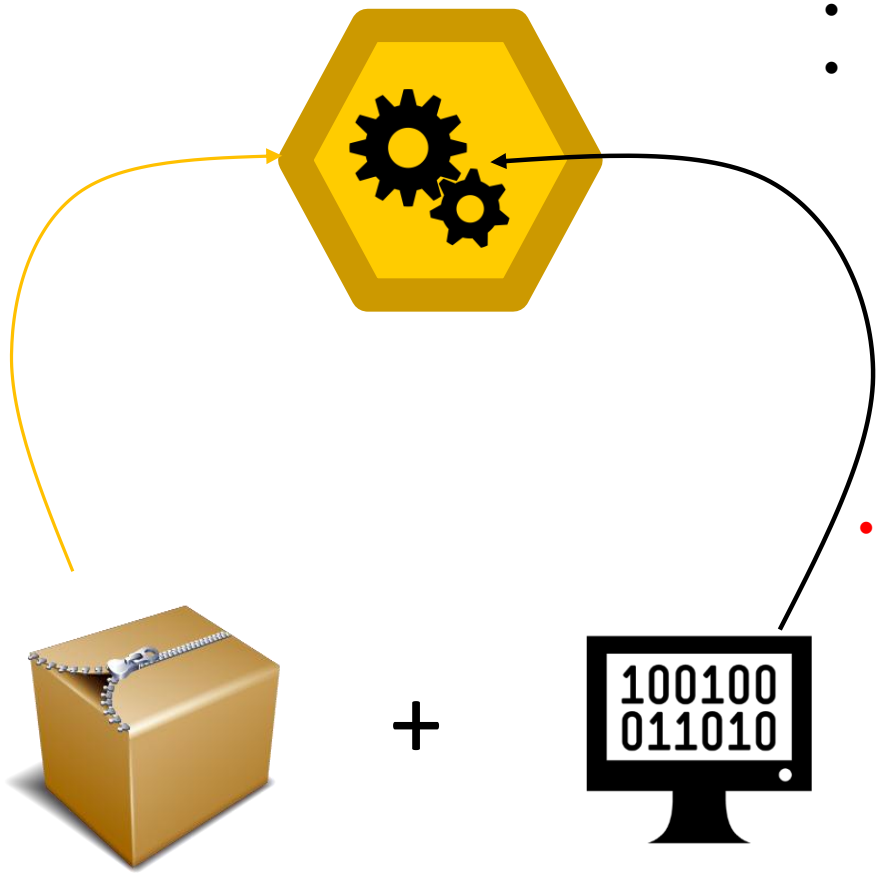


Libraries and Frameworks + Programming Languages

Frameworks and languages

Communication and coordinationfeatures are usually demanded to the usage of frameworks and libraries

- Several tools and frameworks
- They change very often.
- They require upgrades which could have impacts on the code.
- Specific skills required by the developers
- No actual standards for defining interfaces
- Usually structurally designed for specific protocols (ex: http)



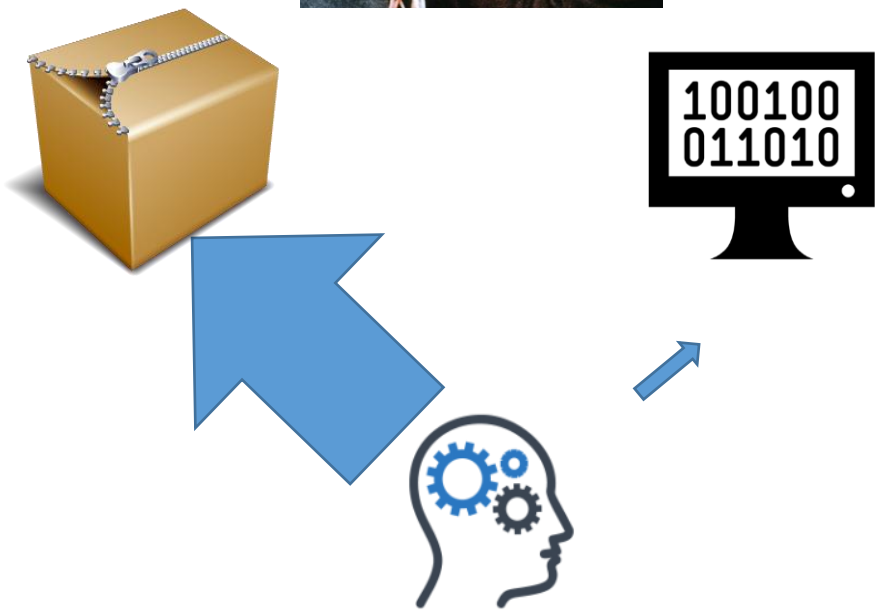
Libraries and Frameworks + Programming Languages

- The syntax is quite stable
- Once trained, a developer has all the important knowledge to be productive

- **Unfortunately**, the code related to the communication activities **is strictly bound** to the chosen framework and libraries.

Programming languages are irrelevant

The knowledge required to manage frameworks and libraries **eats up** the knowledge required to manage the programming language **which become quite irrelevant**



Knowledge is money

- More than one
- They change often
- High dinamicity

- Syntax usually stable in the long terms. Backward compatibility usually guaranteed

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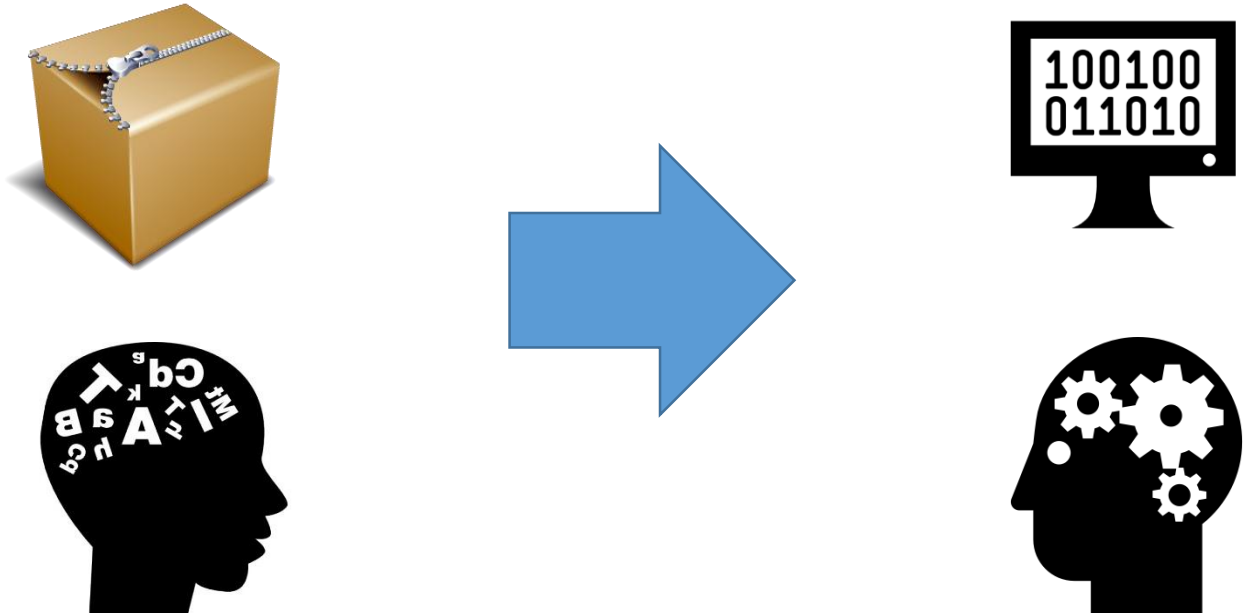
How to reduce the knowledge?

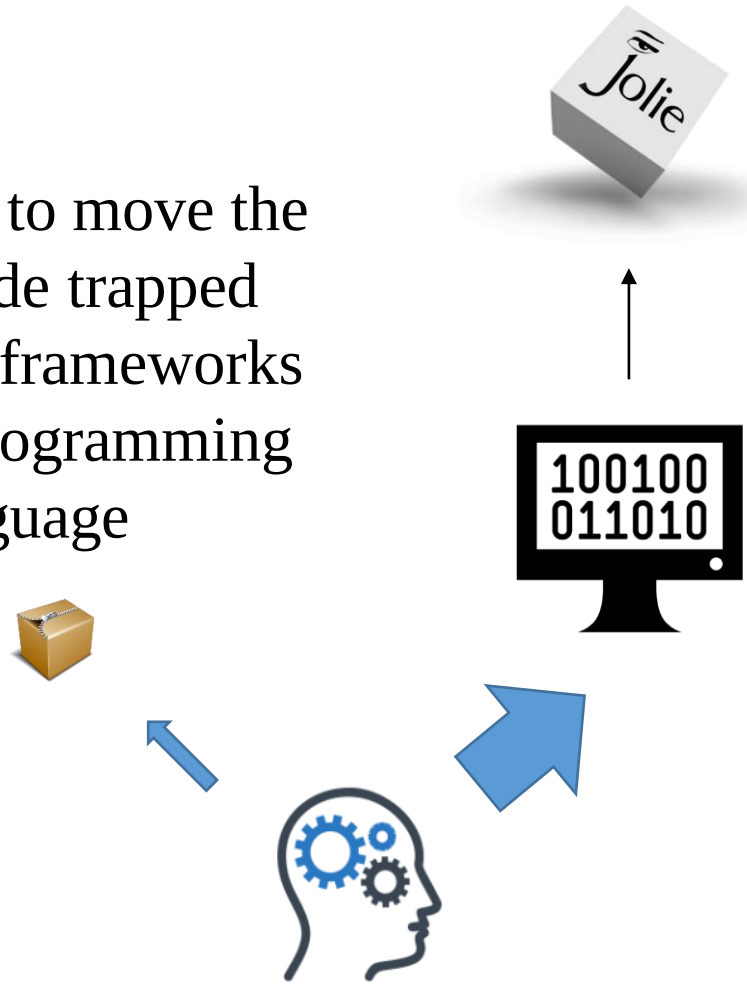
Reducing the required knowleldge by moving the programming concepts hidden in the frameworks into a stable syntax of a programming language



A new programming language

Our choice is to introduce a new programming language.
Jolie represents our solution.

Our aim is to move the knowlegde trapped within the frameworks into the programming language



Jolie

http://www.jolie-lang.org

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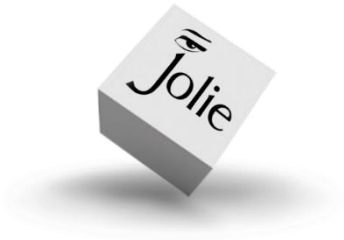
Once upon a time...

SOA standard specifications analysis (WSDL, SOAP, WS-BPEL,…)

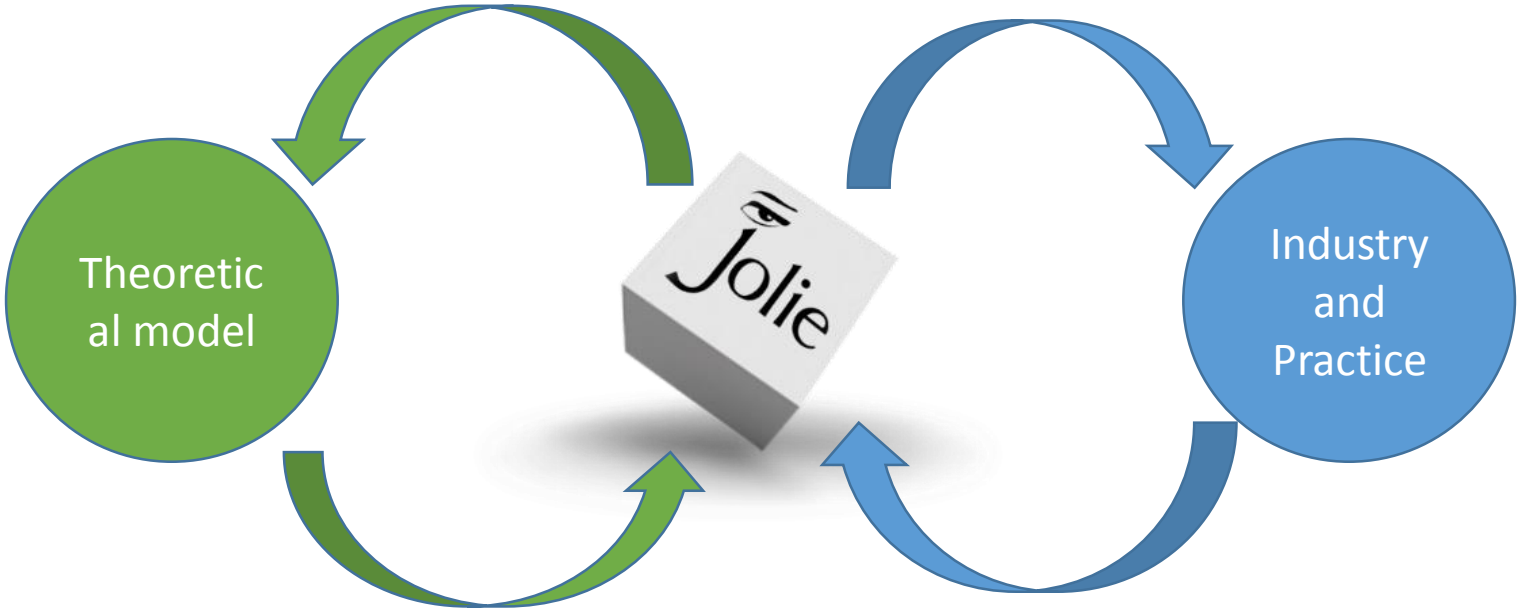
Development of a Milner's CCS based process calculus (SOCK).
Definition of operational semantics

Development of a language based (Jolie) and of its interpreter engine

Exploitation in industry and real life



Action model



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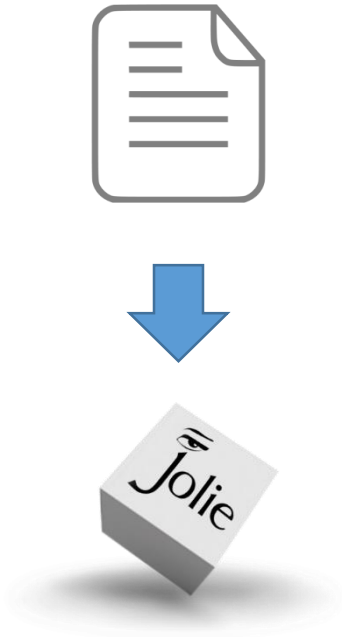
Jolie is interpreted

A jolie service is described by a script
which is interpreted at runtime by the jolie engine.

No compilation required.

The engine is developed in Java

We call **microservice** the running instance of a service



Services

The main idea behind Jolie is that

A service is a single unit of programmable software.

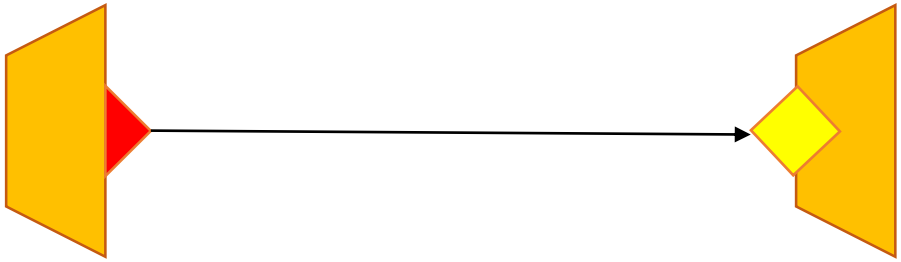
It is not obtained as a customization or a specialization of an existing server, but it is the only possible programmable entity.

We usually exploit a trapezoid for representing a service.

The linguistic constructs for communication

outputPort OPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

inputPort IPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

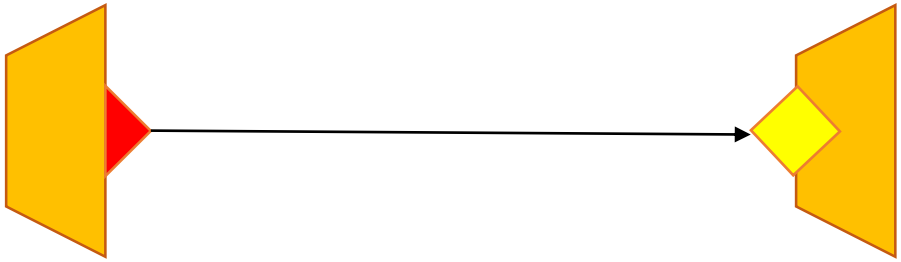


Listener endpoints and sender endpoints are a specific construct in the language. They are called ports: **inputPorts** and **outputPorts**.

Where

outputPort OPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

inputPort IPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

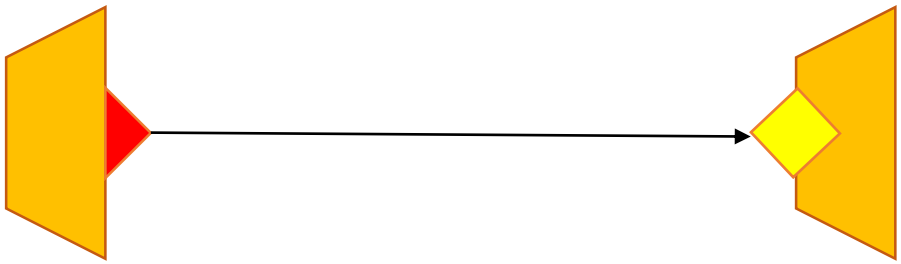


The location represents the place, in the space of the Internet, where the service can be reached.

How

```
outputPort OPName {
Location: ‘‘socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}
```

```
inputPort IPName {
Location: ‘‘socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}
```

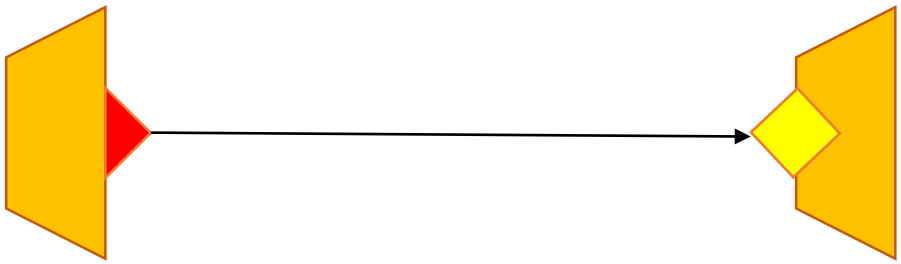


The protocol specifies the application protocol to be used. Sodep is a protocol released with Jolie but also http, http/json, http/soap and https.

What

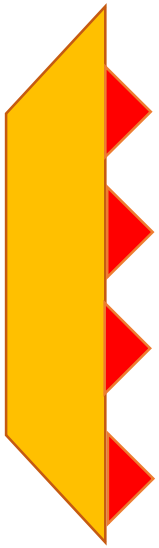
outputPort OPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

inputPort IPName {
Location: ‘’socket://230.230.230.230:8000’’
Protocol: sodep
Interfaces: MyInterface
}

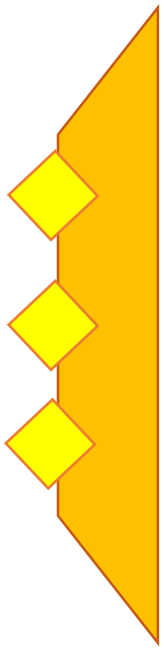


The interface expresses all the available operations provided by a service.

More than one port are possible



A service can invoke different services on different ports.

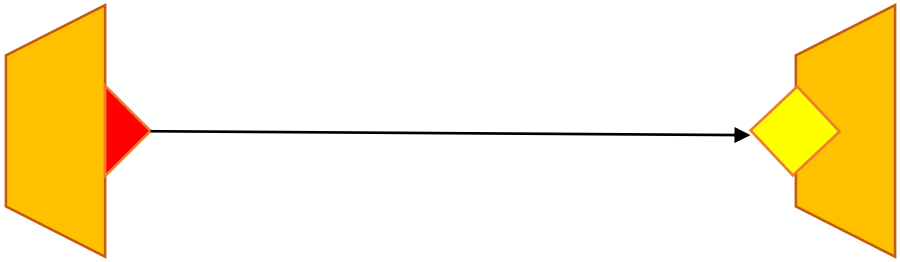


A service can provide its functionalities on more than one port. Different protocols and locations are possible for a service.

The interface definition is part of the language

```
outputPort OPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}
```

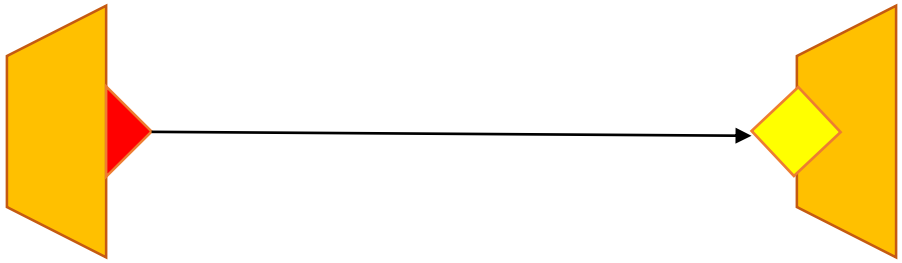
```
inputPort IPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}
```



```
type TestRRequest: void {
        .field: string
}

Interface MyInterface {
RequestResponse:
                testRR( TestRequest )( string )
OneWay:
                testOW( TestRequest )
}
```

Communication primitives

OneWay: asynchronous

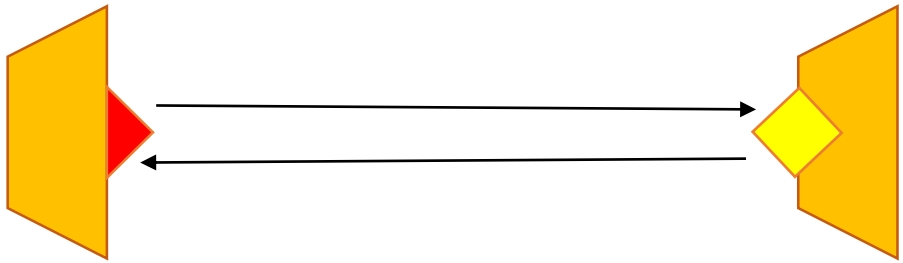


```
outputPort OPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    request.field = ''hello world!''
    testOW@OPName( request );
    …other activities…
}
```

```
inputPort IPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    testOW( request );
    …other activities…
}
```

Communication primitives

RequestResponse: synchronous



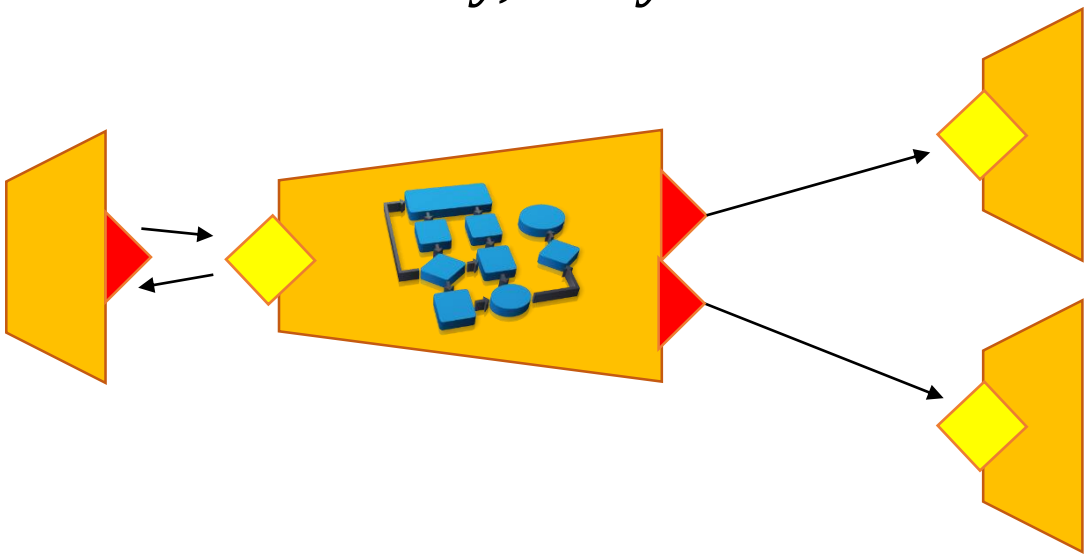
```
outputPort OPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    request.field = ''hello world!''
    testRR@OPName( request )( response );
    …other activities…
}
```

```
inputPort IPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    testRR( request )( response ) {
    …other activities…
    }
}
```

The behaviour

The behaviour of a service is represented by a **workflow**.

Potentially, every service is an orchestrator.



inputPort OPName2 {
Location: "socket://230.230.230.230:8001"
Protocol: sodep
Interfaces: MyInterface2
}

inputPort OPName3 {
Location: "socket://230.230.230.230:8002"
Protocol: sodep
Interfaces: MyInterface3
}

Parallel, sequence, external choice

```
main {
    testRR( request )( response ) {
            ....
            test2RR@OpName2( ... )( ... )
            |
             test3RR@OpName3( ... )( ... )
    }
}
```

A behaviour structured as a workflow permits to focus on the message flows instead of computation

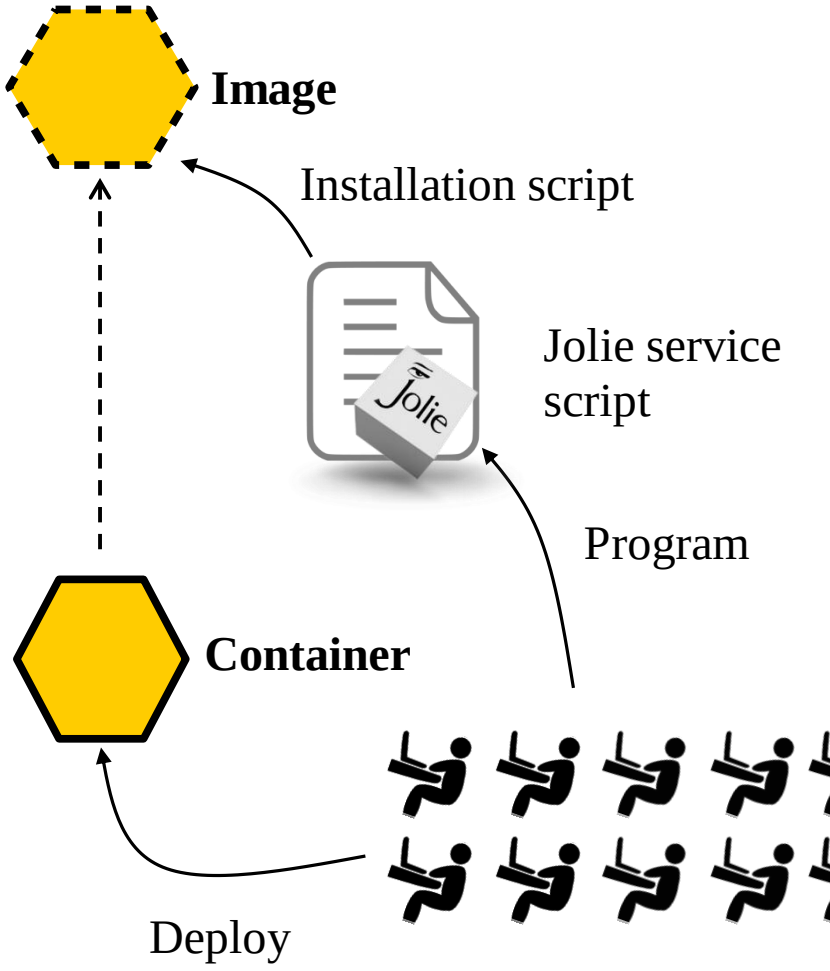
Other

- **Tree format for data and messages**
- **Standard computation constructs**
  - if then
  - for
  - while
- **Other constructs**
  - spawn
  - foreach
  - provide until
  - linkIn and linkOut
- **Fault handling**
  - Termination handlers
  - Compensation handlers
  - Dynamic installation handlers
- **Sessions**
  - Session correlation (correlation sets)
  - Global data and session data
  - Critical sections programming (synchronize)
- **Execution modalities**
  - Single
  - Sequential
  - Concurrent

Important distilled single component programming concepts

Programming Constructs	Benefits
Ports	They permit to define in a standard way endpoints: protocols and available operations are just parameters.
Interface	It permits to formally define the interface of the service without exploiting external tools.
Communication primitives	They permit to define message communication actions (send and receive) independently from protocols and formats.
Workflow behaviour	It permits to define the activities of a service by focusing on the message flow instead of computation. Sessions are instantiated automatically.
…	

If you remember...



PROGRAMMING WITH JOLIE
No specific packaging is required or libraries.
Just prepare the container with the Jolie Engine.

The code is readable.

The syntax is stable.

Less knowledge required.

Common concepts and constructs immediately shared by all the team members.
Everybody can read and understand what a service is doing wothout any additional knowledge.

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Programming architectures

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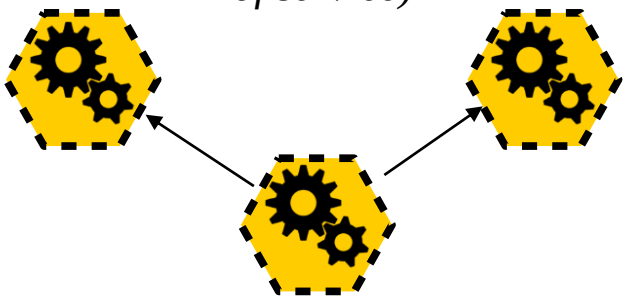
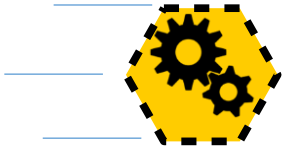
Where is the architecture?

Containers

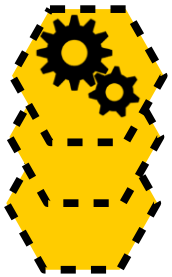
Creating connections
(they must still available at the level of service)



Moving



Scaling



Services

?

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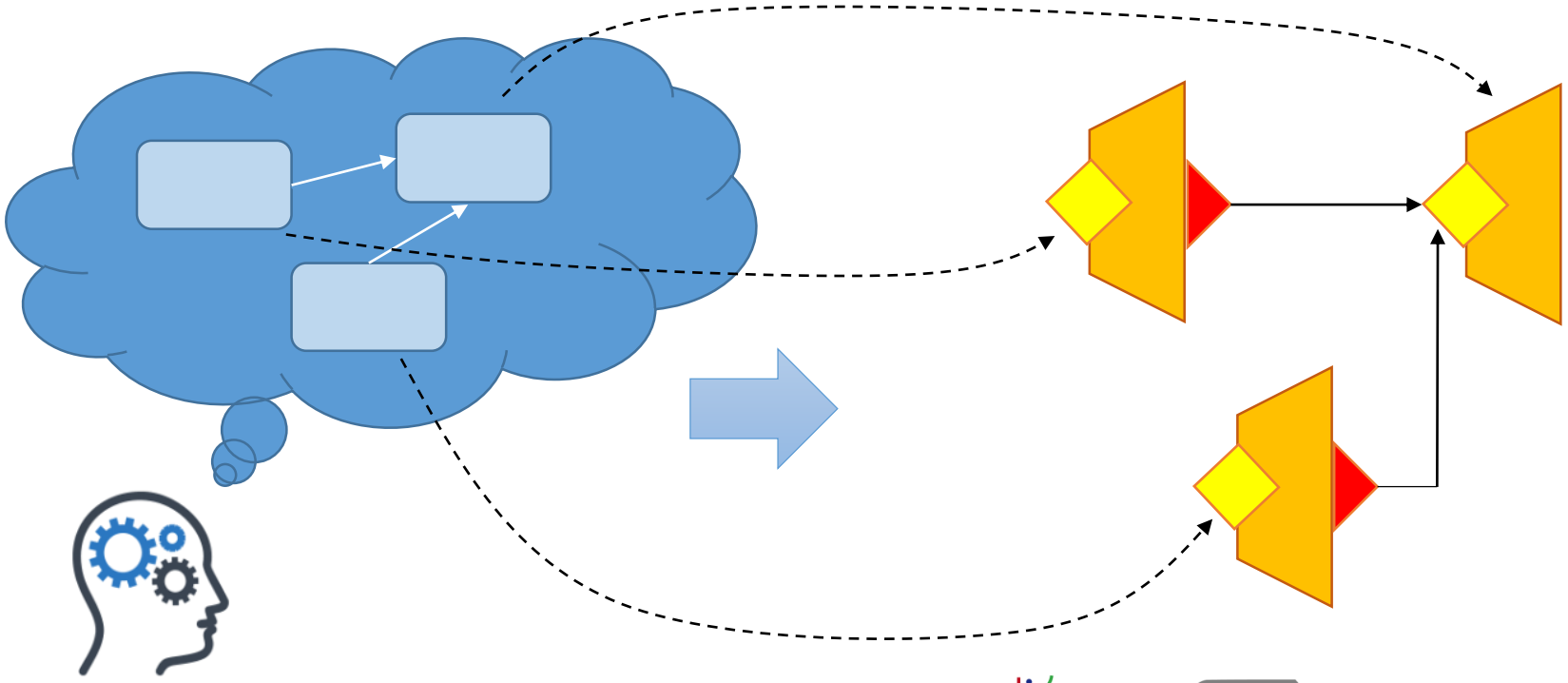
Programming services means programming architectures

Since the single programmable unit is a service, it does not matter the conceptual designing model you choose for designing your system or your application because ***the result will always be an architecture of services!***



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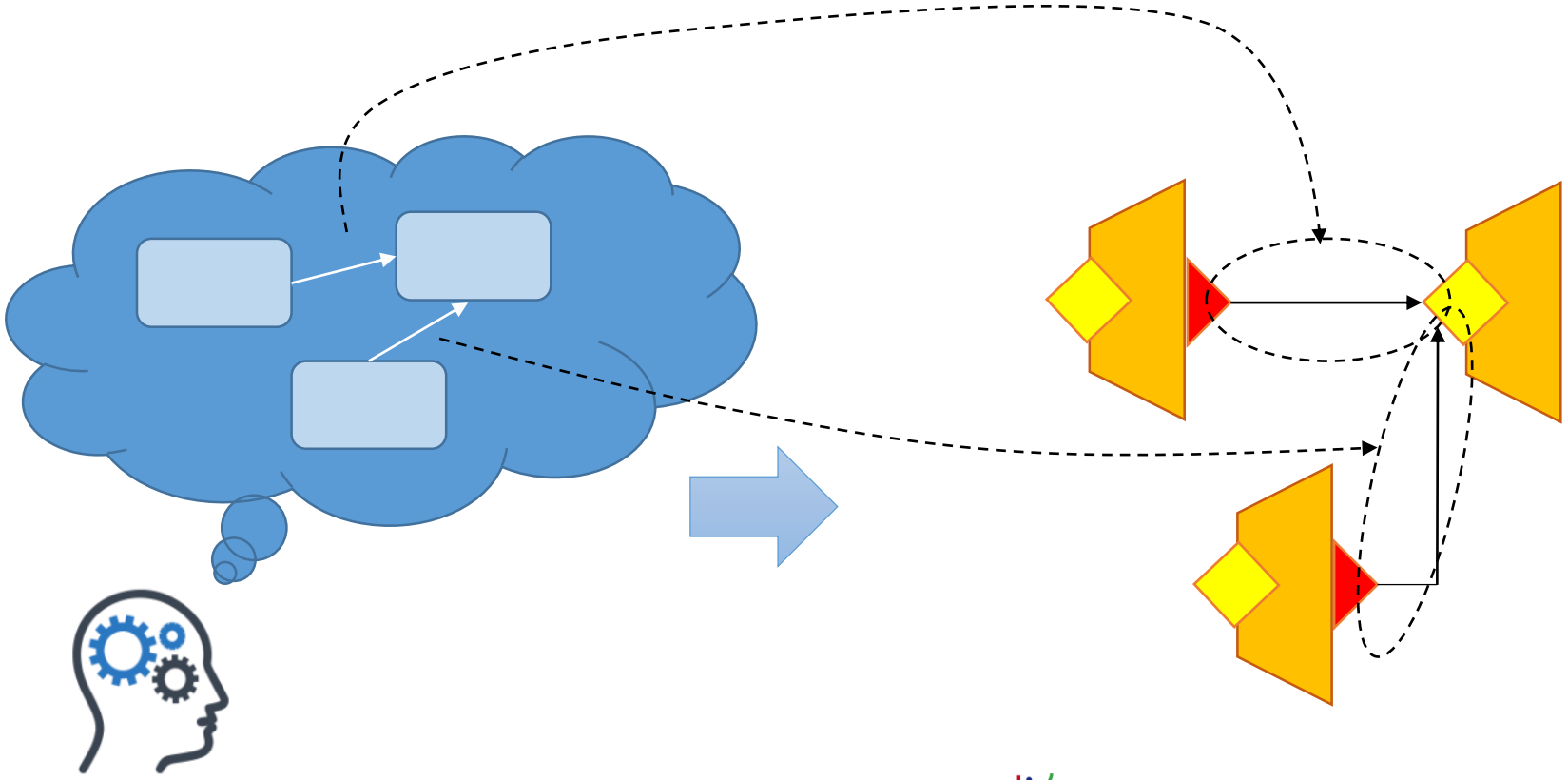
Each modelled service has an immediate and direct representation into code

Prommaning services means programming architectures

The relation among entities are directly modelled as service dependencies



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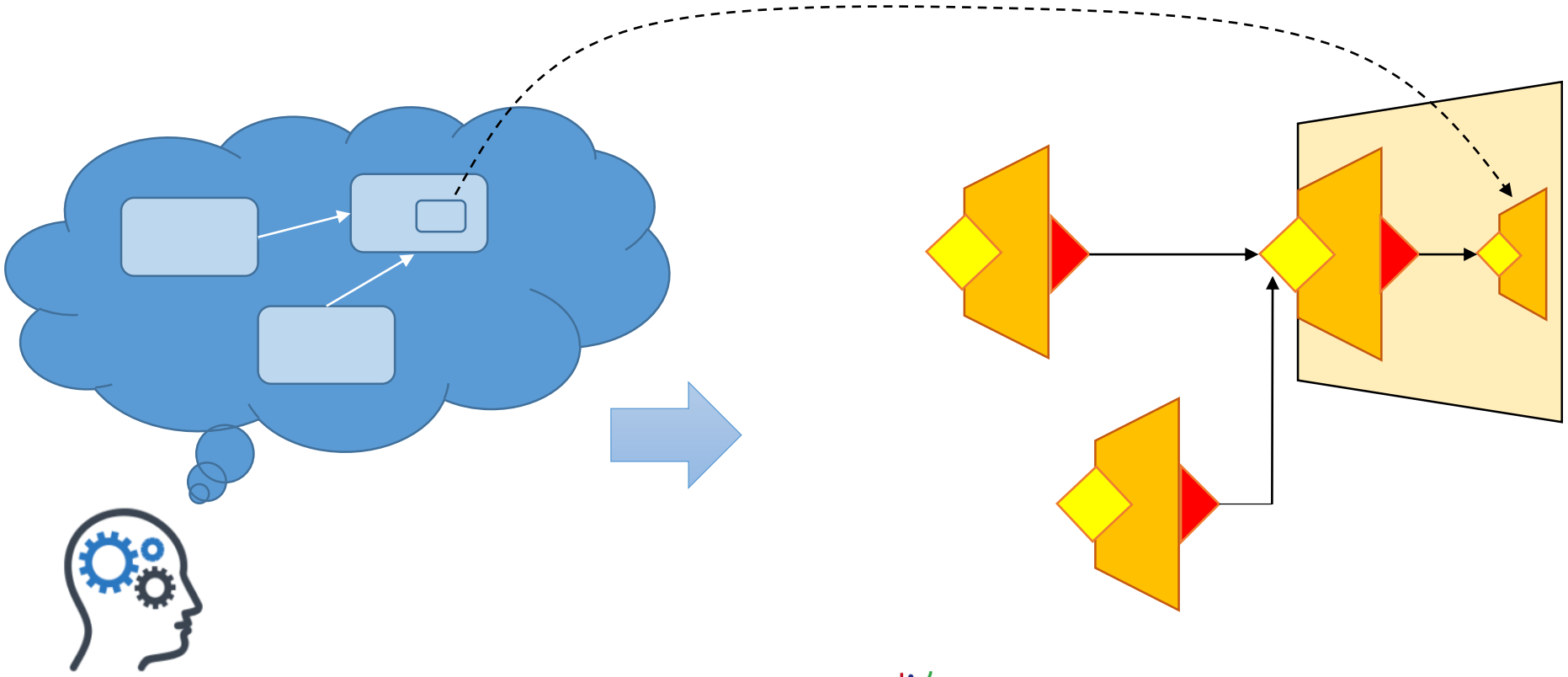
Service size is not a problem

You can easily fragment your entities in sub-entities
by keeping the mapping with services because services can be ***EMBEDDED***



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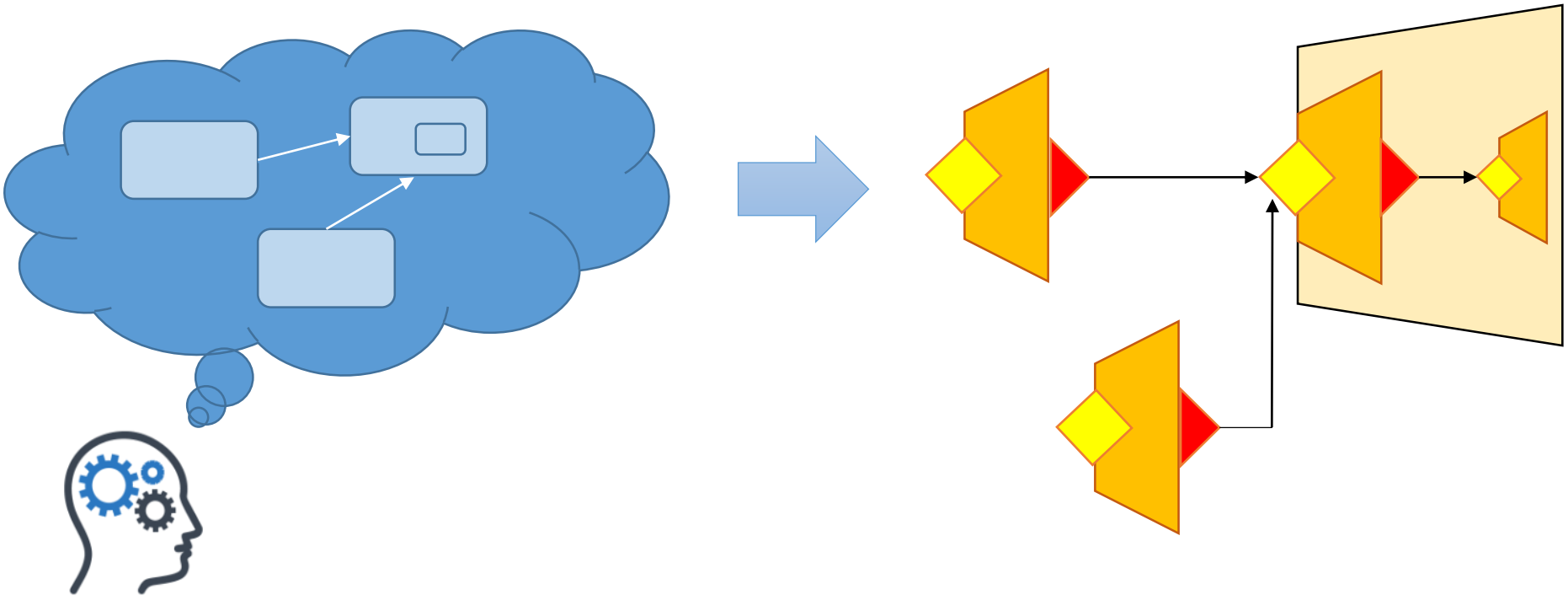
Everything you think is an architecture!

Do you remember? We said we want to reduce the knowledge!



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Jolie

embedded {
...
}

Programming architectures with Jolie

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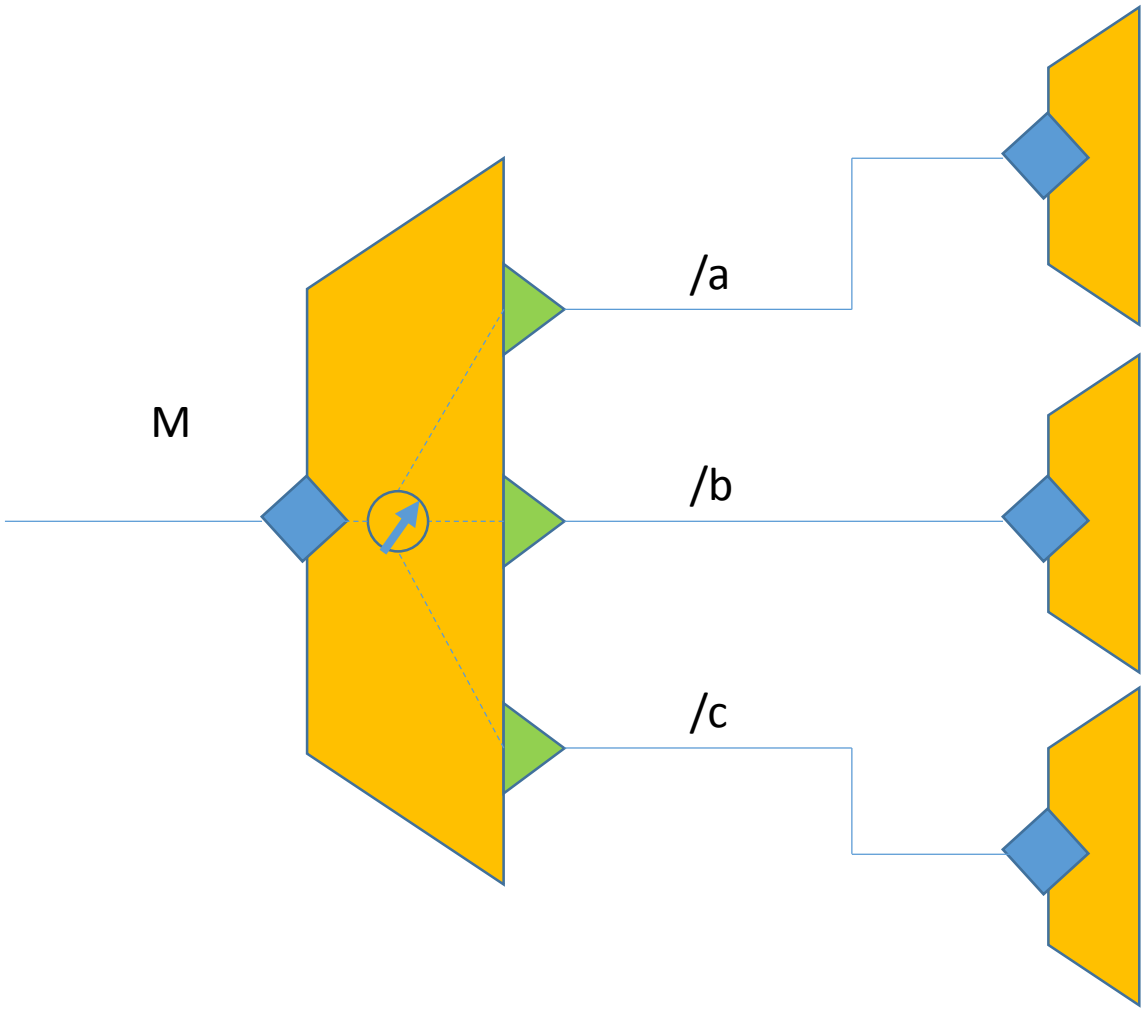
Redirection



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Redirection, the code

```
outputPort SubService {
    Location: "socket://localhost:8001/"
    Protocol: soap
}

outputPort SumService {
    Location: "socket://localhost:8002/"
    Protocol: soap
}

inputPort M {
    Location: "socket://localhost:8000/"
    Protocol: sodep
    Redirects: a => A,
               b => B
}
```

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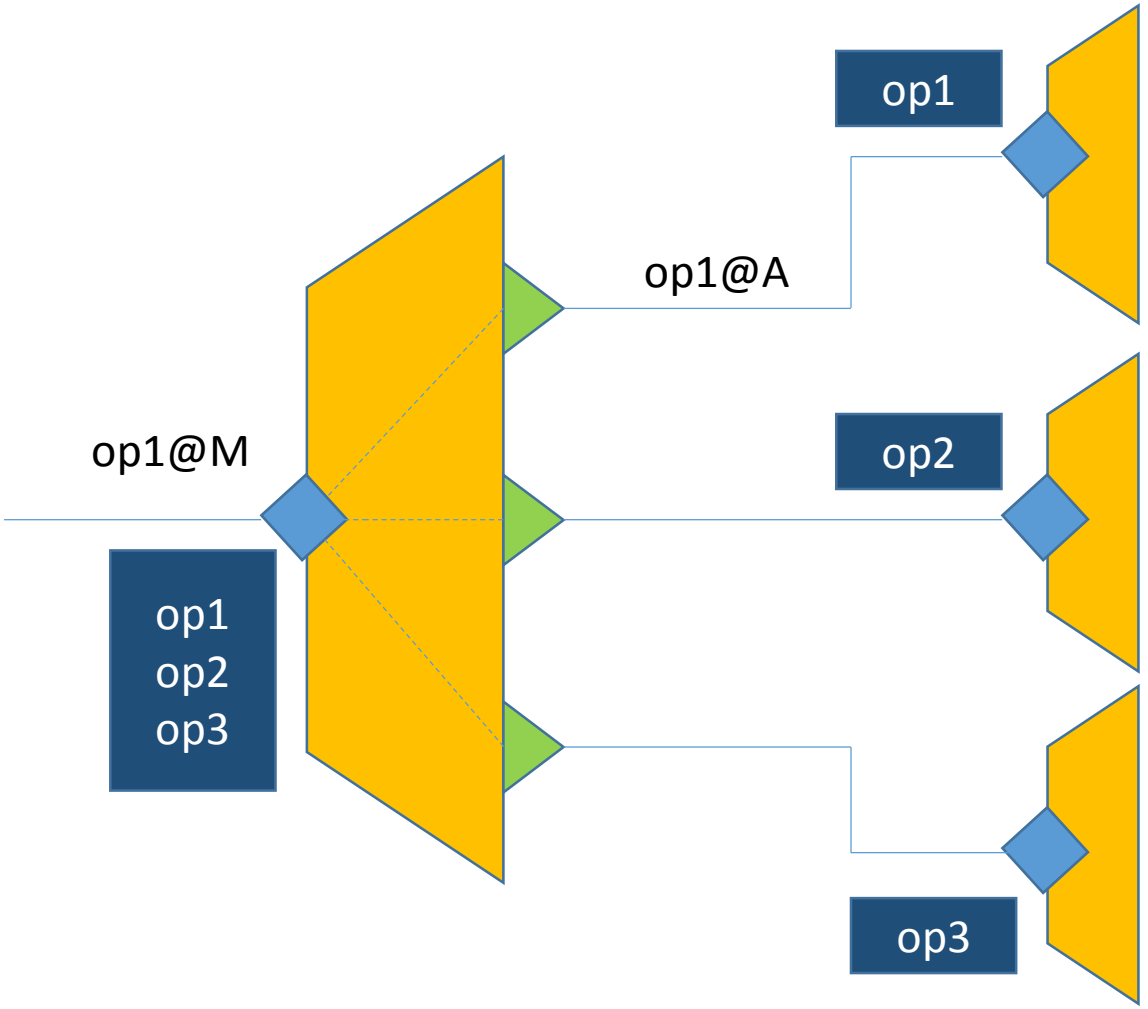
Aggregation



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Aggregation, the code

```
outputPort A {
    Location: "socket://localhost:8001/"
    Protocol: soap
}

outputPort B {
    Location: "socket://localhost:8002/"
    Protocol: soap
}

inputPort M {
    Location: "socket://localhost:8000/"
    Protocol: sodep
    Aggregates: A, B
}
```

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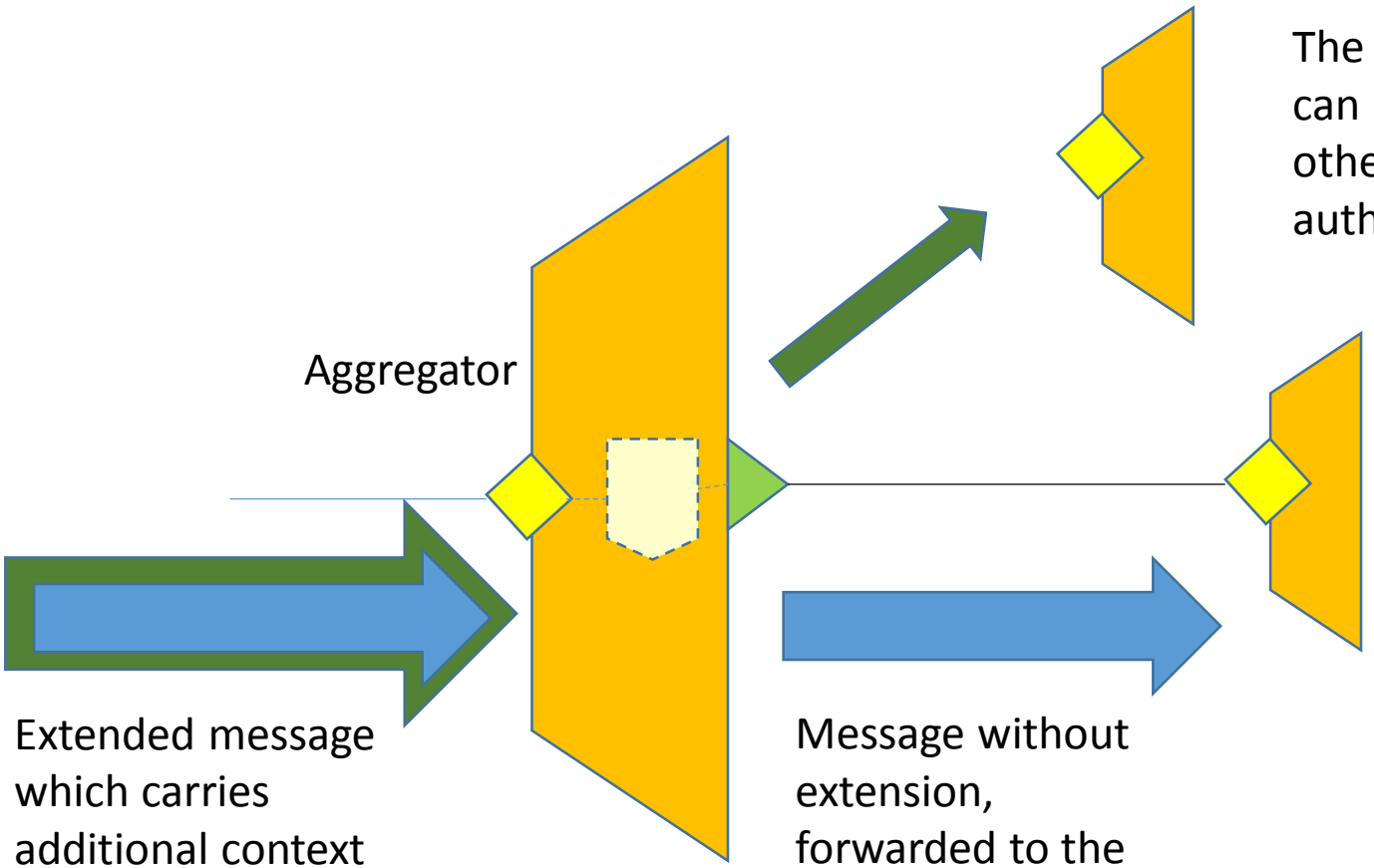
Couriers



The extended information can be used for invoking other services (ex: authentication services)

Aggregated service

Extended message which carries additional context infos (ex: security tokens)

Message without extension, forwarded to the target service

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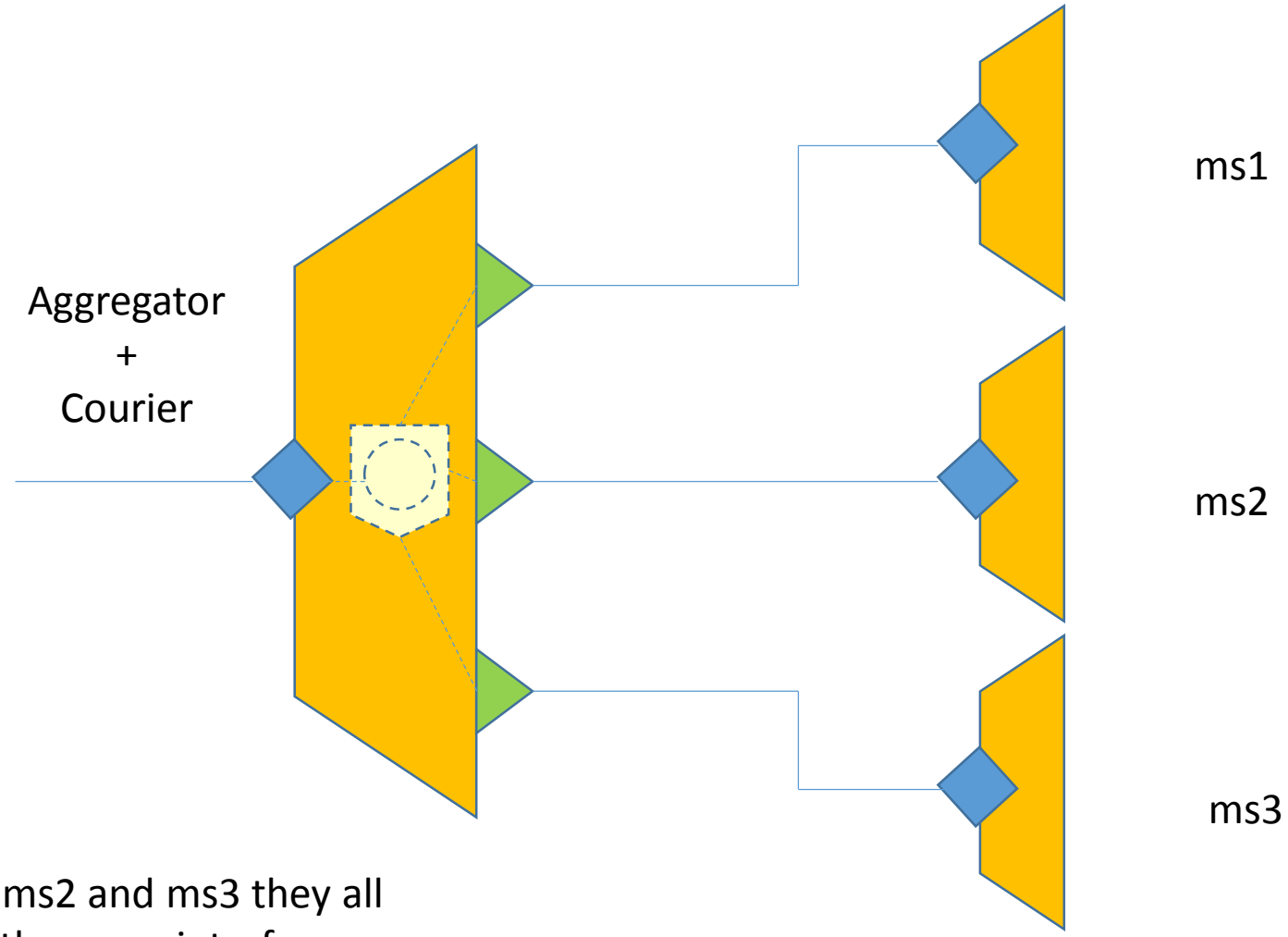
Collection



Ms1, ms2 and ms3 they all have the same interface. Forwarding is decided by using the extended information of the message.

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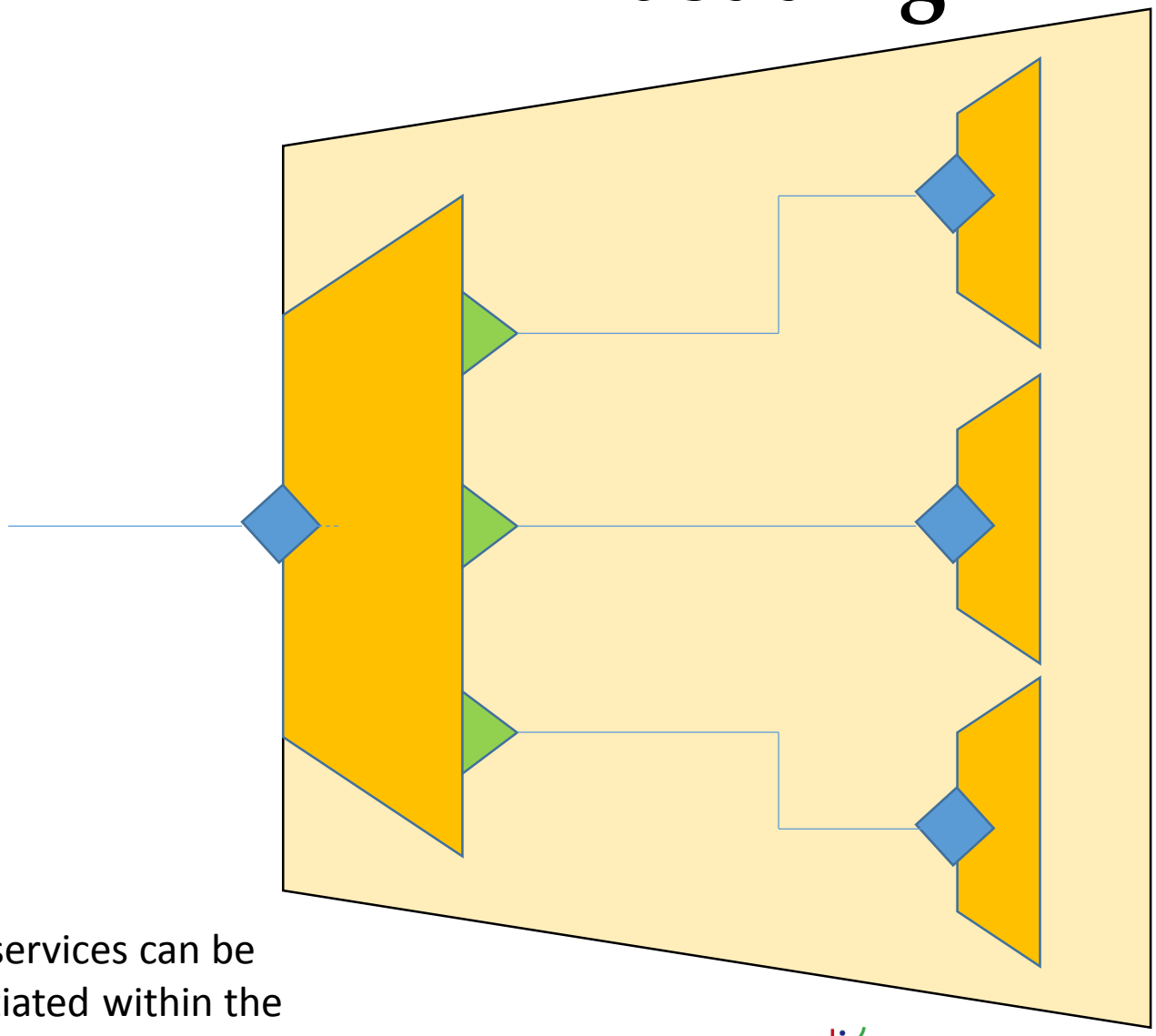
Embedding



More services can be instantiated within the same microservice

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Jolie & Docker

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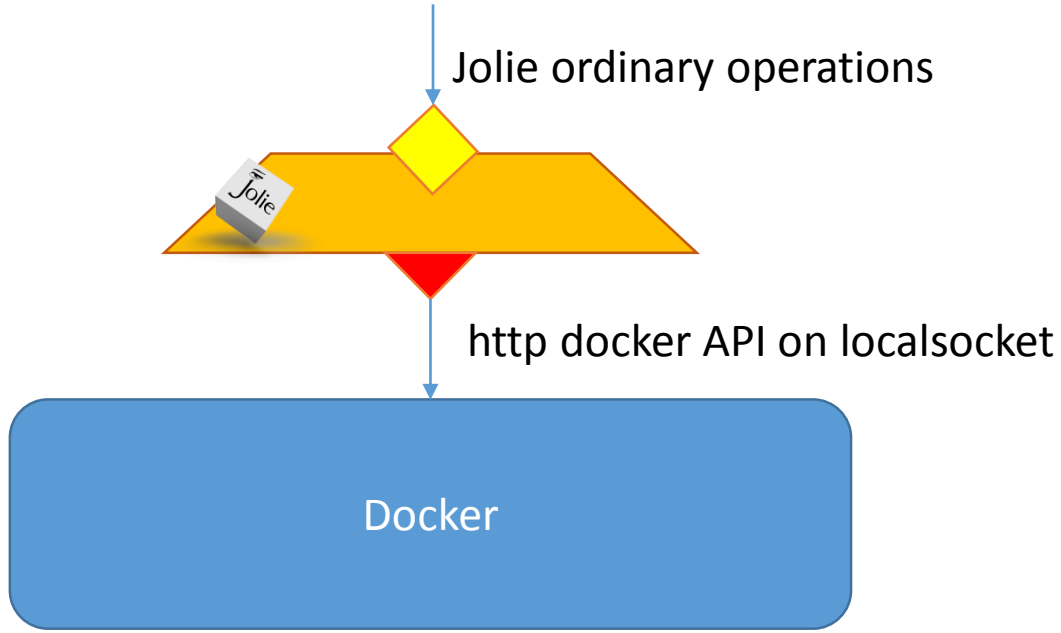
Jocker

docker pull jolielang/jocker



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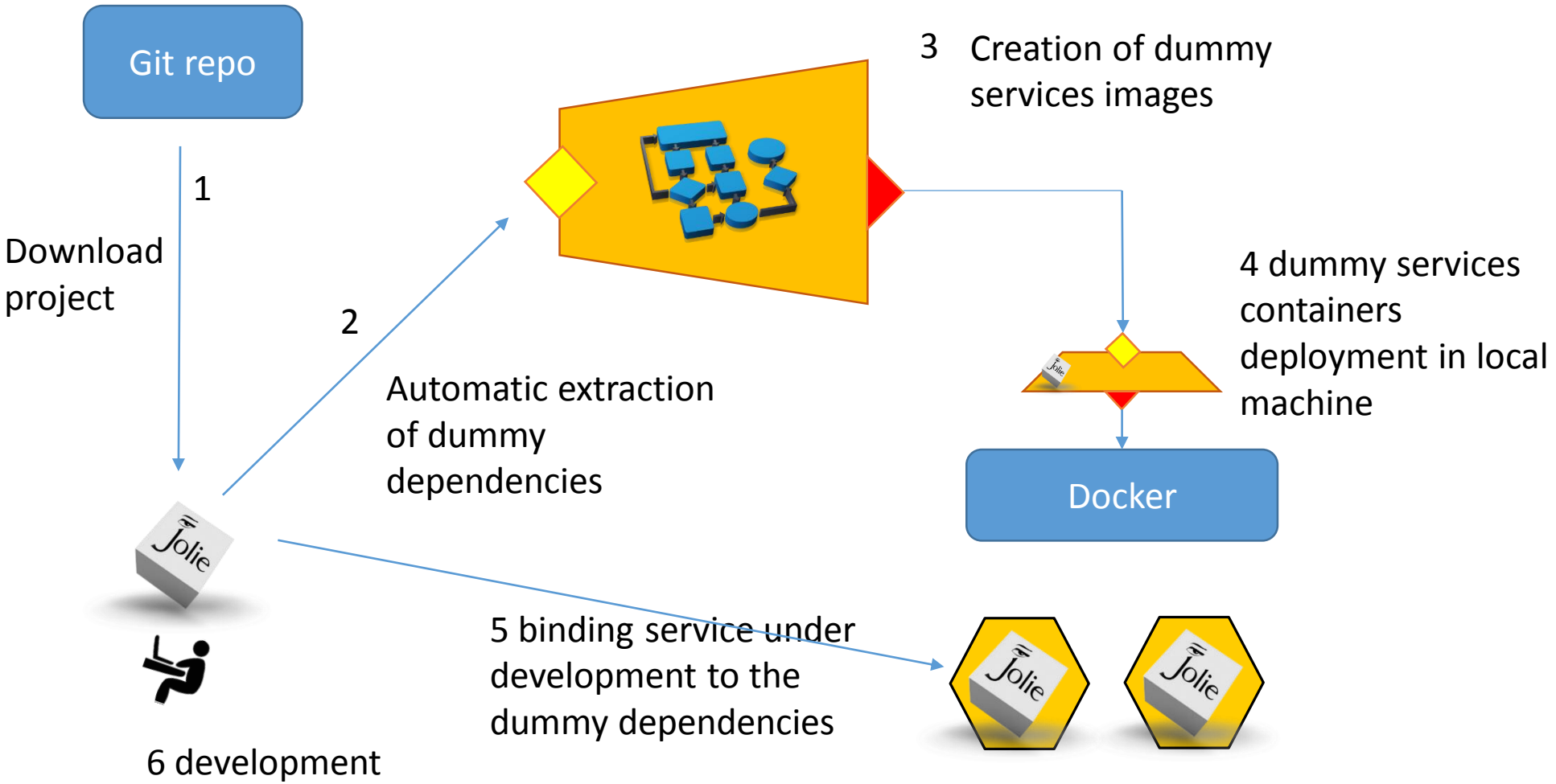
Developing

(experimental)



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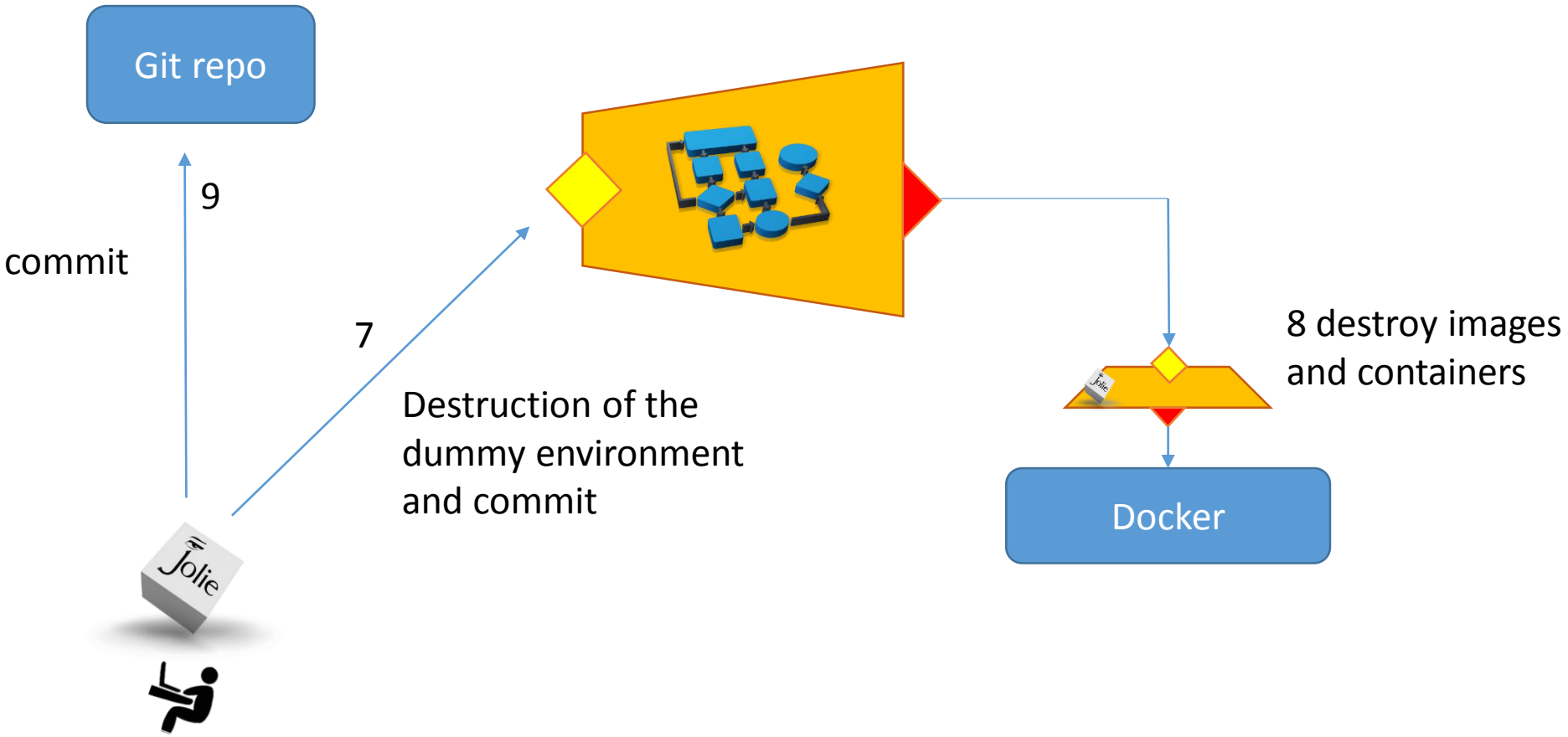
Developing

(experimental)



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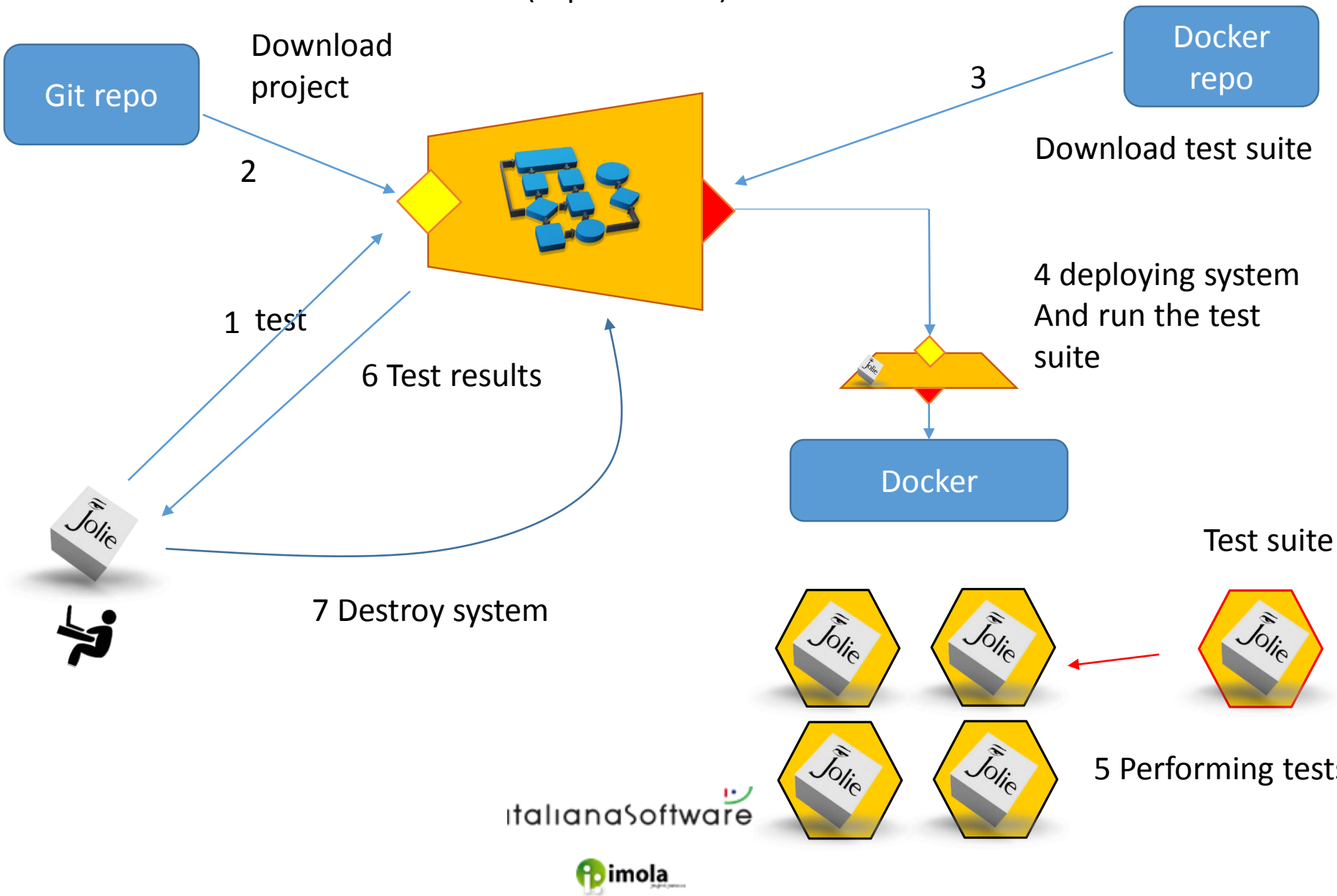
Testing

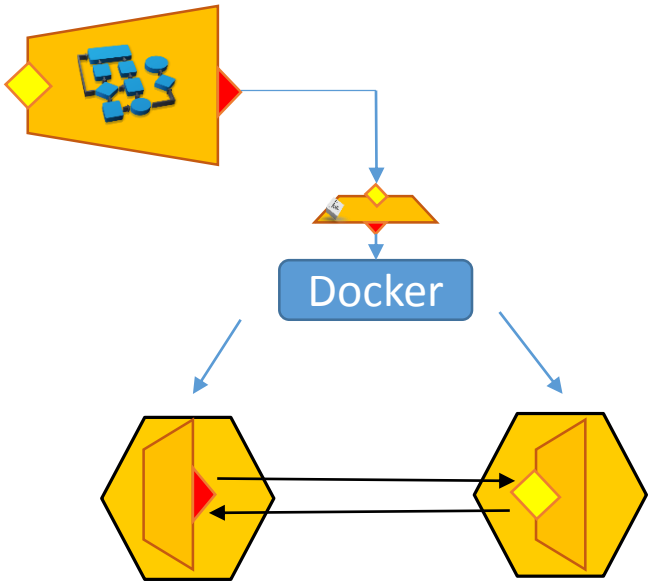
(experimental)



Dynamic Architectures

(Experimental)

From synchronous…

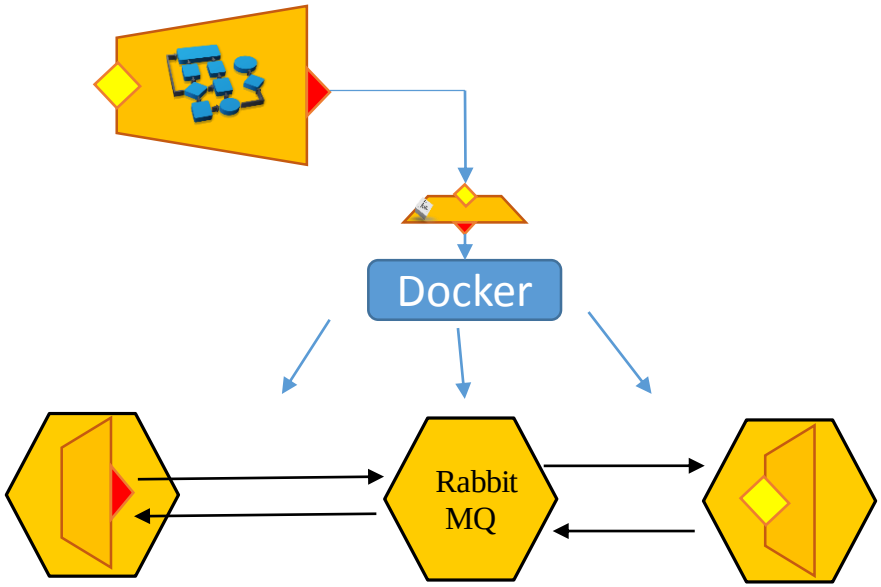



```
outputPort OPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    request.field = ''hello world!''
    testRR@OPName( request )( response );
    …other activities…
}
```

```
inputPort IPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
        testRR( request )( response ) {
        …other activities…
        }
}
```

Dynamic Architectures

(Experimental)
…to asynchronous




```
outputPort OPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
    request.field = ''hello world!''
    testRR@OPName( request )( response );
    …other activities…
}
```

Keeping the code synchronous!!!!

```
inputPort IPName {
Location: ''socket://230.230.230.230:8000''
Protocol: sodep
Interfaces: MyInterface
}

main {
        testRR( request )( response ) {
        …other activities…
        }
}
```

Integration with other technologies

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Just a brief list of possibilities

- ***Java***
  - There is a native possibility to integrate Java code into a Jolie service (JavaServices)
  - It is possible to run a Jolie service within an hosting application server (Ex: JBoss)
  - It is possible to send sodep messages to Jolie from a third party Java application
- ***Javascript***
  - As for Java, it is possible to embed javascript code into a Jolie service
- **Text Editors**
  - Plugins for **Atom** and **Sublime Text**
- ***HTTP and HTTPs***
  - *HTTP and HTTPs are supported protocols*
- ***SOAP Web Services***
  - SOAP is a supported protocol
  - jolie2wsdl and wsdl2jolie are tools which permit to convert Jolie interface into WSDL documents and viceversa
- **JSON**
  - JSON format is supported as format for the http Protocol
- ***Web***
  - **Leonardo** is a web server written in Jolie.
- ***REST***
  - Thanks to the usage JSON messages can be exploited just parameterizing a port
  - If necessary, it is possible to implement a standard REST services by exploiting **Jester**, a REST router for jolie services
- ***Databases***
  - SQL databases can be easily connected to a Jolie service using JDBC libraries.
  - MongoDB connector (by Balint Maschio)

Jolie in industry

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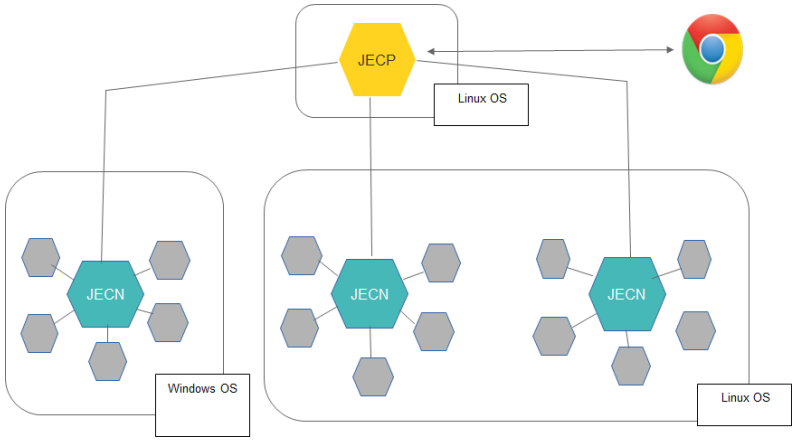
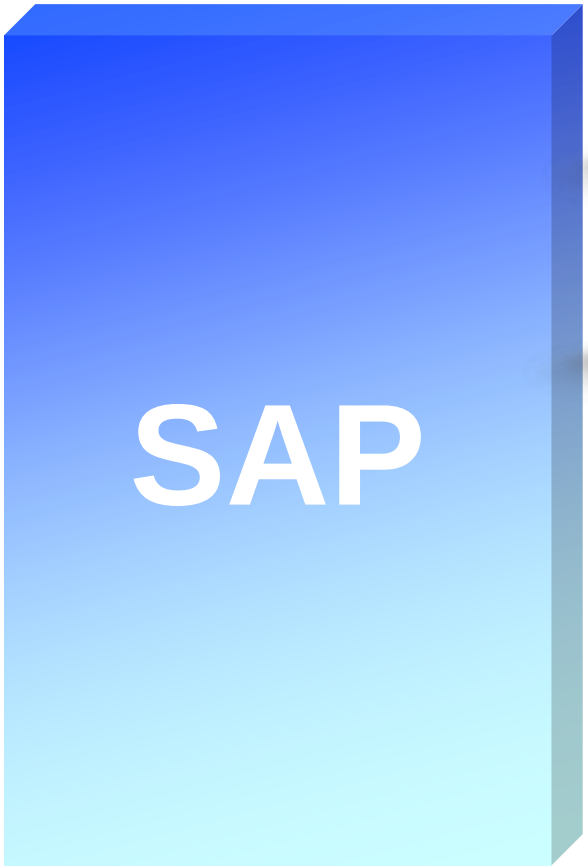
Jolie Enterprise

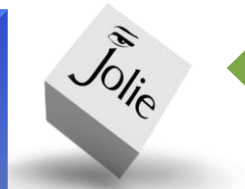


- Central control panel
  - Deployment
  - Start/stop
- Logging and monitor
  - All the Jolie service can be monitored and logged

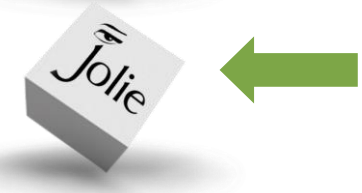
- Used as a digital platform for system integration and business process development

JSAP

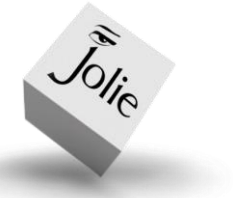




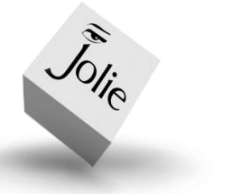
RFC client: it permits to call SAP RFC



IDOC client: it permits to send IDOC to SAP

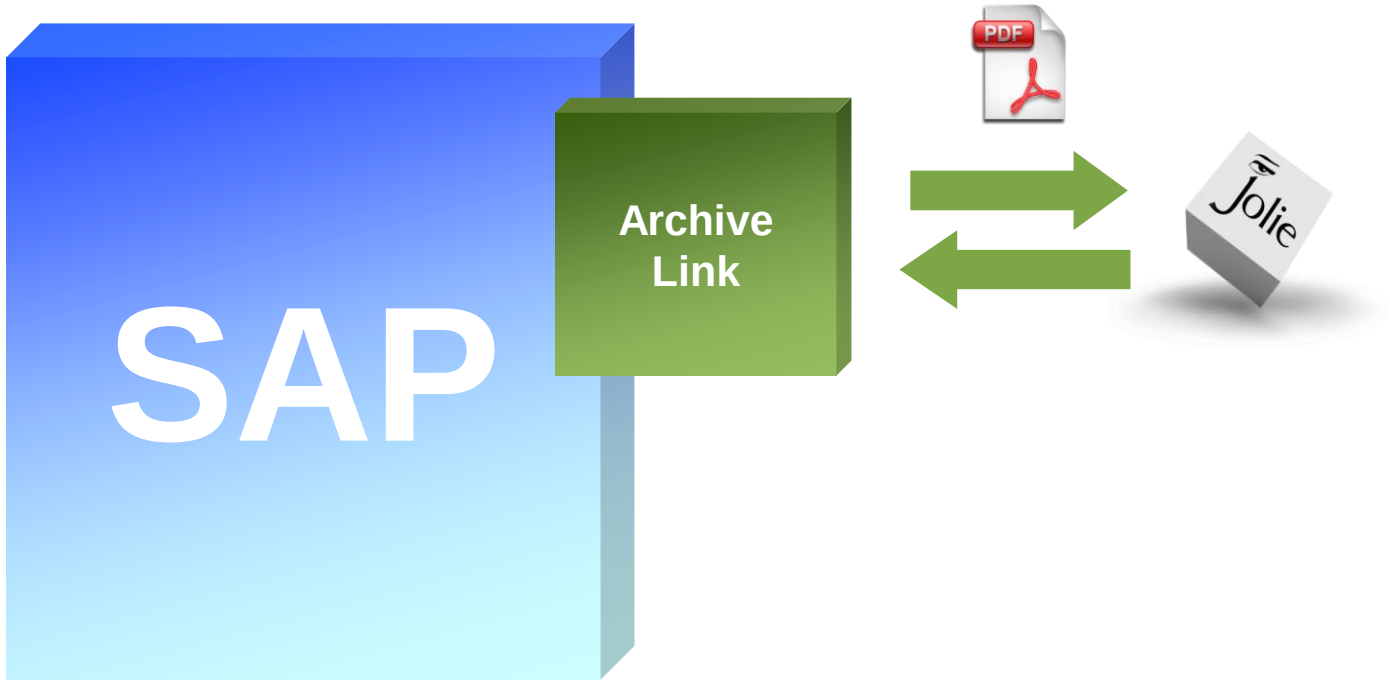


IDOC server:
It permits to receive IDOC documents from SAP



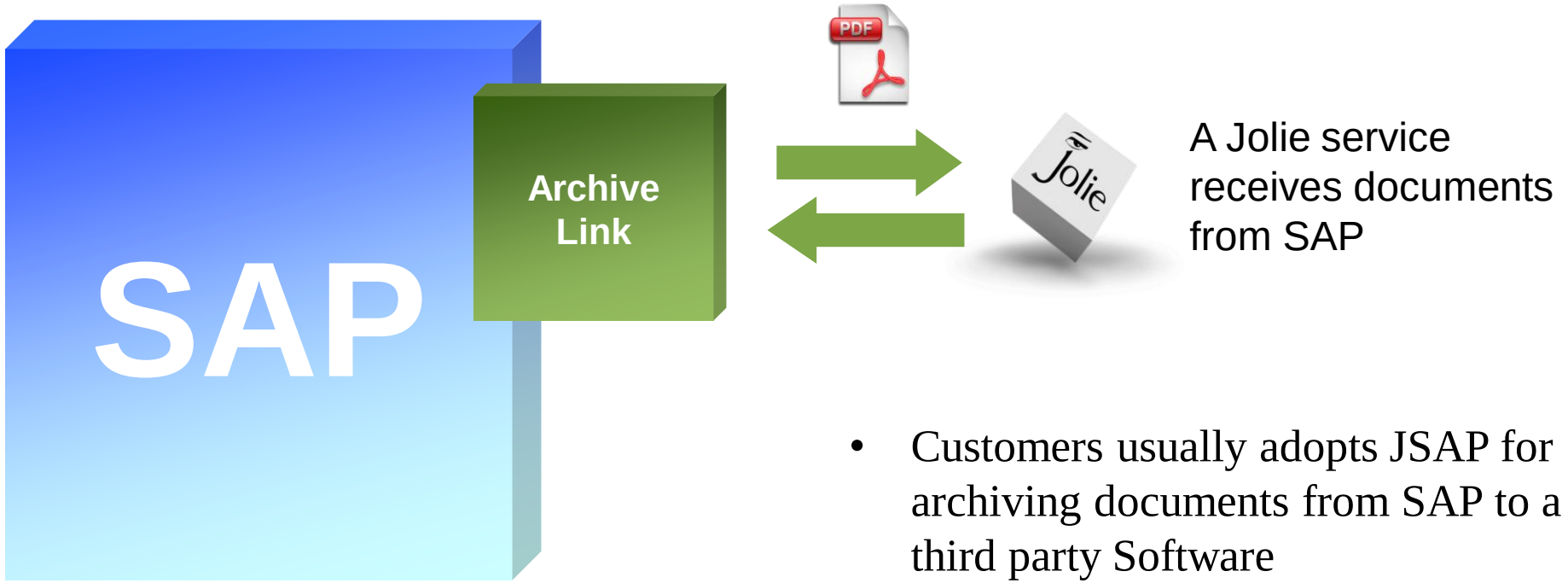
RFC server:
It permits to receive RFC calls from SAP

JSAP



A Jolie service receives documents from SAP

JSAP



A Jolie service receives documents from SAP

- Customers usually adopts JSAP for archiving documents from SAP to a third party Software

Conclusion

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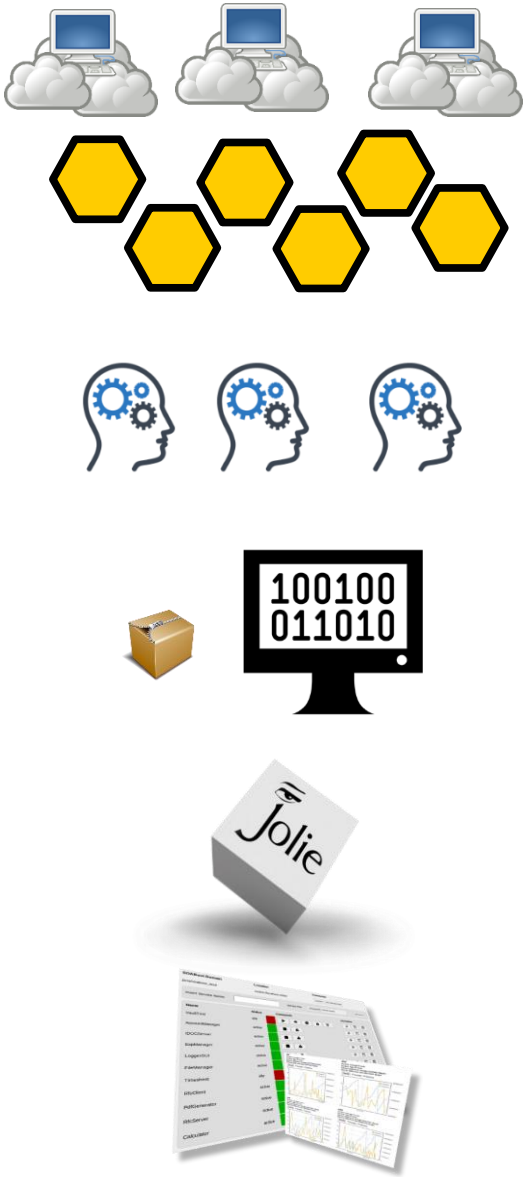
Summarizing...

- A new computational resources paradigm has been introduced by cloud computing
- Software distribution is the natural paradigm for approaching such a kind of systems
- The high level of complexity of distributed systems require to reduce the required knowledge for managing them
- A new generation of languages which crystalize the basic microservice programming principles could help in reducing the required knowledge
- Jolie is a good candidate for representing this new generation of languages
- Jolie is already used as a technology in the industry with successfull results



Thank you

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