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Towards a Tool-based Approach for Microservice Antipatterns Identification

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About the presenter

RAFIK TIGHILT

I'm a MSc student in computer science at Université du Québec à Montréal, currently working on microservice-based system antipatterns.

I previously got a MSc in IT systems management. I worked on the industry for 3 years including founding my own startup before starting the current MSc program in computer science at UQAM.

My fields of interest include software engineering, web development and competitive programming.

Outline

- About microservices
- Approach
- Microservice antipatterns
- Meta-model definition
- Meta-model components
- Detection rules
- Discussion
- Threats to validity
- Conclusion

About Microservices

- Microservice architecture is more and more popular
- Adopted by industry leaders (Amazon, Netflix, Riot Games, etc...)
- Consists of independently deployable and manageable services
- Each microservice fulfils a single business capability
- Allow automated deployment
- Offer greater agility
- Reduce the complexity of handling application scalability

But...

- Microservices are highly volatile
- Microservices are very dynamic
- Microservices are continuously developed and deployed
- Like any other system, microservices face challenges with maintainability and evolution

This factors can lead to the introduction of poor solutions to recurring design and implementation problems (ie. **Antipatterns**).

How can we automatically identify antipatterns in microservice-based systems ?

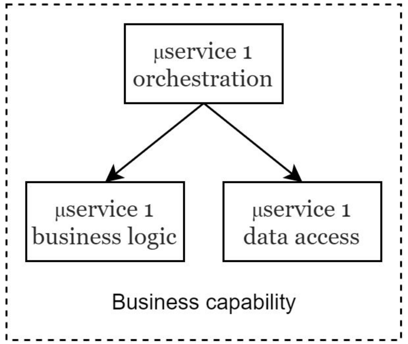
Approach

- Literature and open-source systems reviews
- 27 papers obtained describing microservices antipatterns
- 67 open-source microservice-based systems manually analyzed
- Establishment of a catalog of microservice antipatterns

- Definition of a meta-model for the automatic analysis
- Definition of detection rules for each of the antipatterns

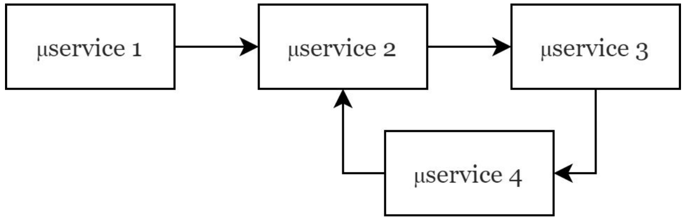
Microservice antipatterns

Wrong cuts



Microservices organized around technical layers instead of business capabilities.

Cyclic dependencies



Circularly co-dependent microservices

Microservice antipatterns

Mega Service

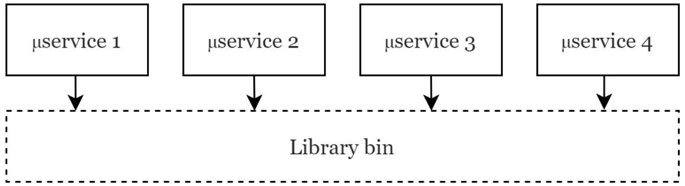
A microservice serving multiple business capabilities, not manageable by a single team.

Nano Service

Multiple microservices working together to fulfil a single business capability.

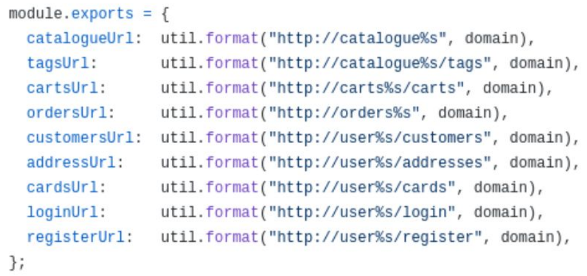
Microservice antipatterns

Shared libraries



Single libraries / files used by multiple microservices.

Hardcoded endpoints

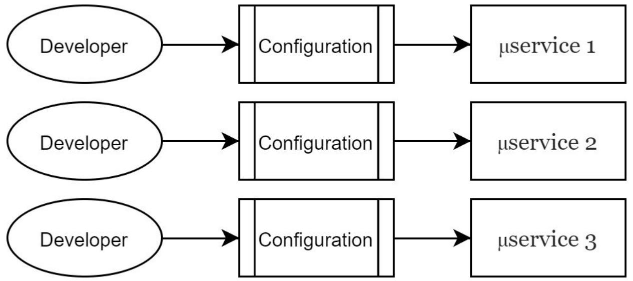


```
module.exports = {
  catalogueUrl:  util.format("http://catalogue%s", domain),
  tagsUrl:       util.format("http://catalogue%s/tags", domain),
  cartsUrl:      util.format("http://carts%s/carts", domain),
  ordersUrl:     util.format("http://orders%s", domain),
  customersUrl:  util.format("http://user%s/customers", domain),
  addressUrl:    util.format("http://user%s/addresses", domain),
  cardsUrl:      util.format("http://user%s/cards", domain),
  loginUrl:      util.format("http://user%s/login", domain),
  registerUrl:   util.format("http://user%s/register", domain),
};
```

URLs, IP addresses, hostnames and other endpoints hardcoded in the source code.

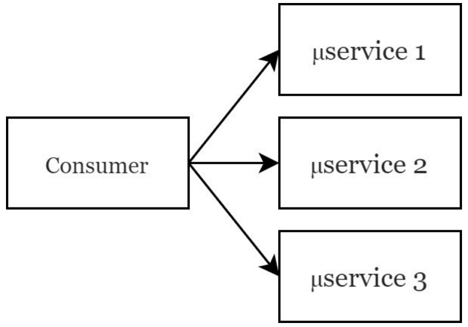
Microservice antipatterns

Manual configuration



Configuration manually pushed for each microservice.

No API Gateway



Consumer applications communicate directly with individual microservices.

Microservice antipatterns

Timeouts

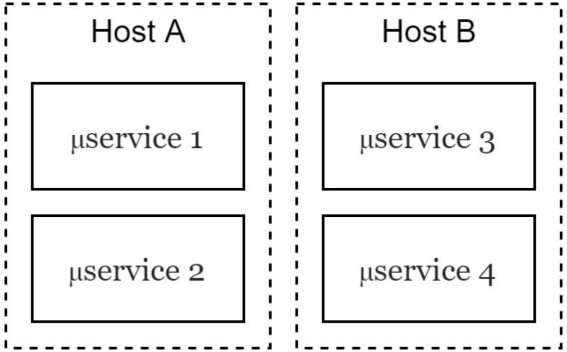
Timeout values are set and hardcoded in HTTP requests inside microservices source code.

No CI/CD

No Continuous Integration / Continuous Delivery machinery in the process of developing, testing and deploying microservices

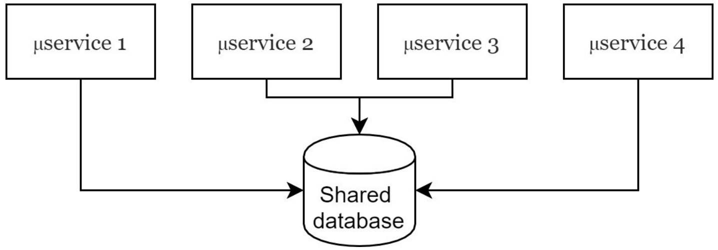
Microservice antipatterns

Multiple service instances per host



Multiple microservices are deployed on a single host.

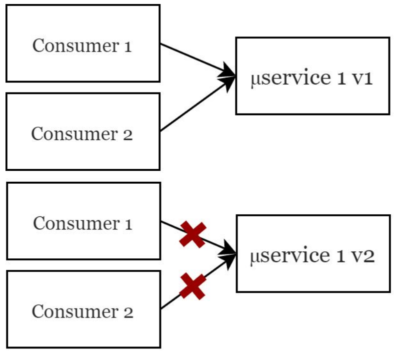
Shared persistence



Multiple microservices share a single database.

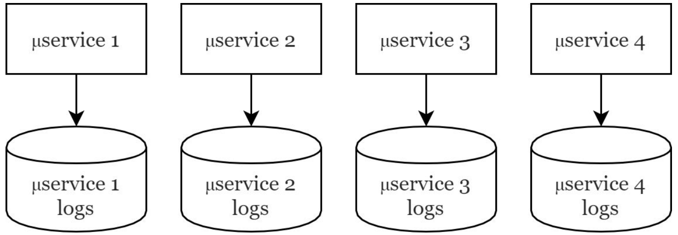
Microservice antipatterns

No API versioning



No information available about a microservice version.

Local logging



Microservices have their own logging mechanism.

Microservice antipatterns

No healthcheck

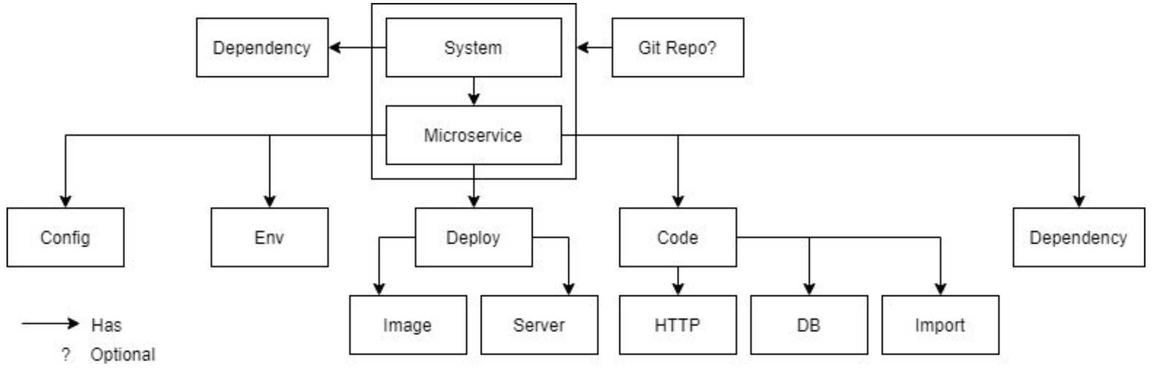
Microservices are not periodically health-checked to verify availability.

Insufficient monitoring

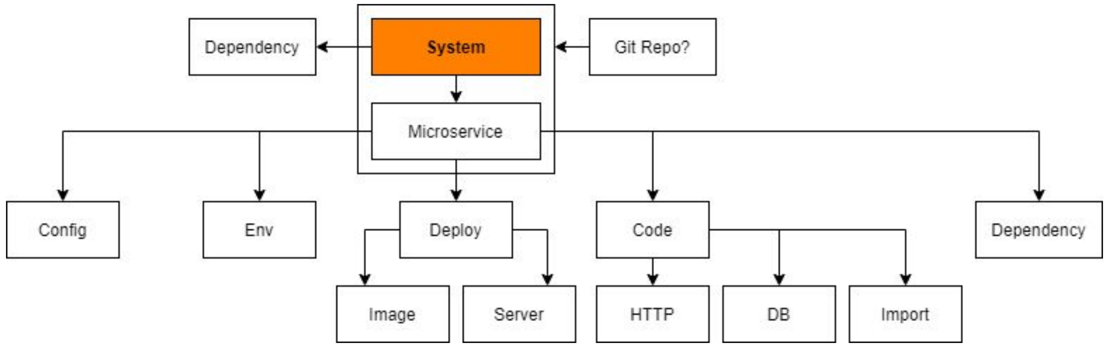
Microservices performance and failures are not tracked or monitored.

Meta-model definition

- The meta-model encapsulate the needed information to identify microservice antipatterns
- Consists of 13 components
- Each component contains some information about the system and its microservices

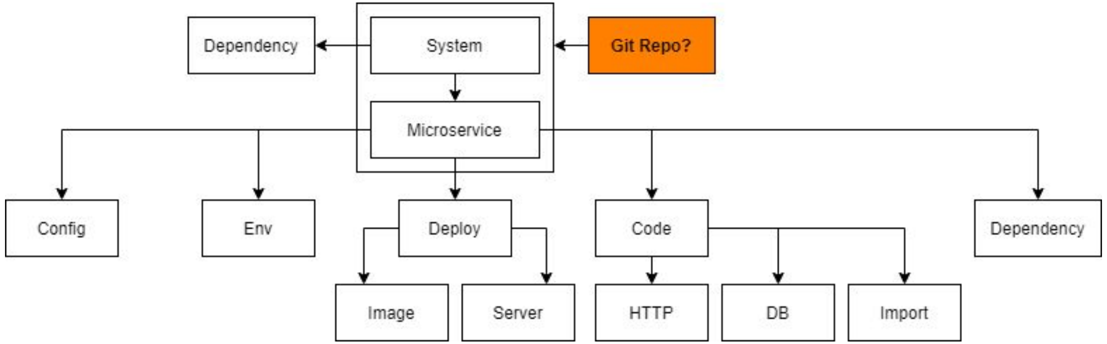


Meta-model components



System
Holds information about the system itself (Name, version, is git repository, etc...)

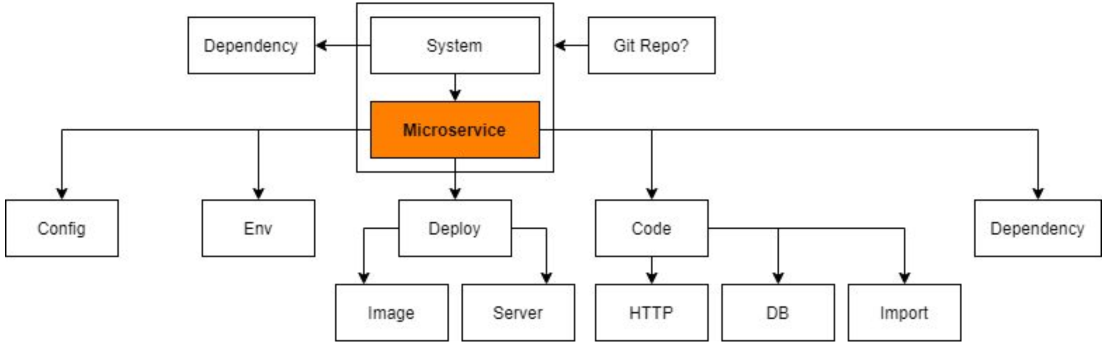
Meta-model components



Git repository

If the system is a git repository, contains information such as repository URL, number of commits, number of contributors, etc…

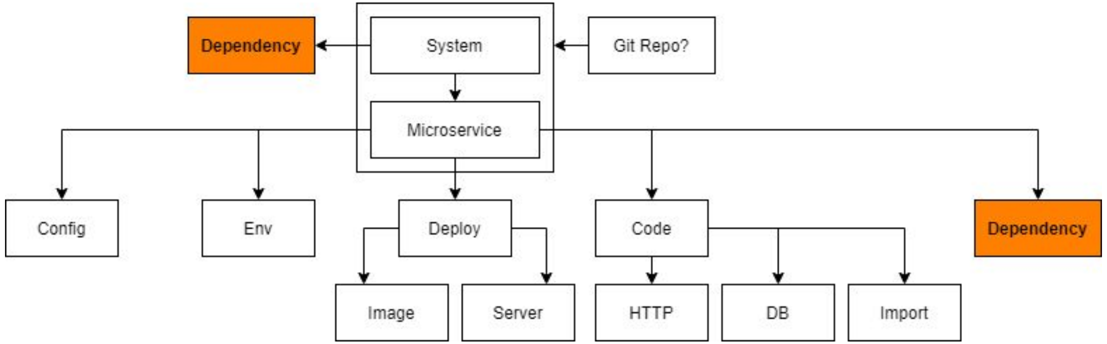
Meta-model components



Microservice

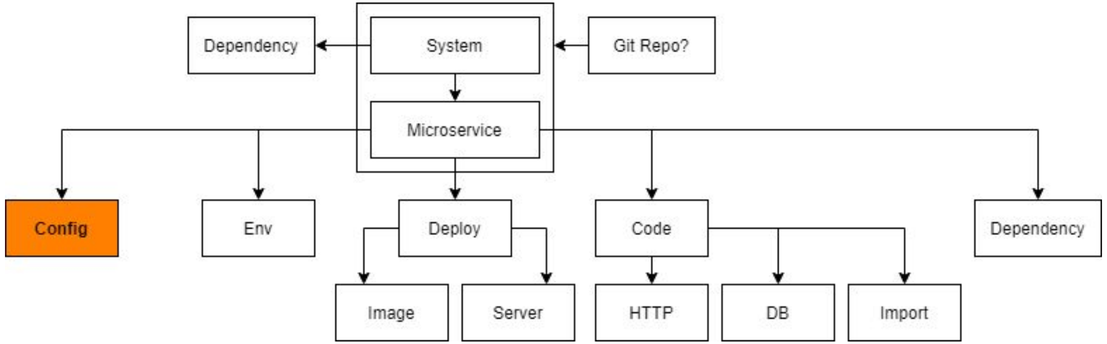
Stores information about single microservices (programming languages, LOCs, etc...)

Meta-model components



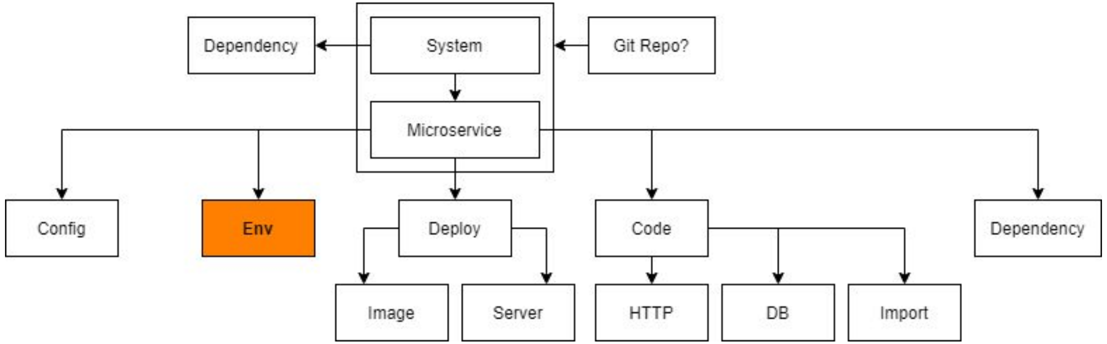
Dependency
Contains information about a single dependency (Name, type, etc...)

Meta-model components



Config
Holds information about configuration (Key value pairs, etc...)

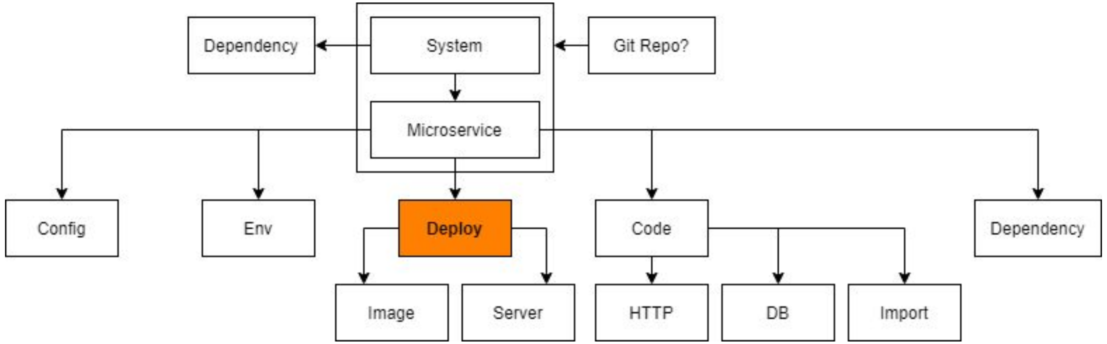
Meta-model components



Env

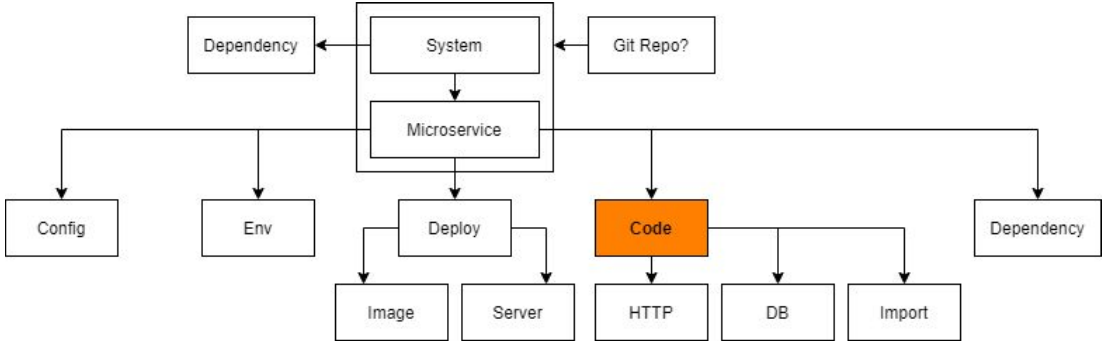
If available, represents environment variables used by the system

Meta-model components



Deploy
Contains deployment information (Docker instructions, etc...)

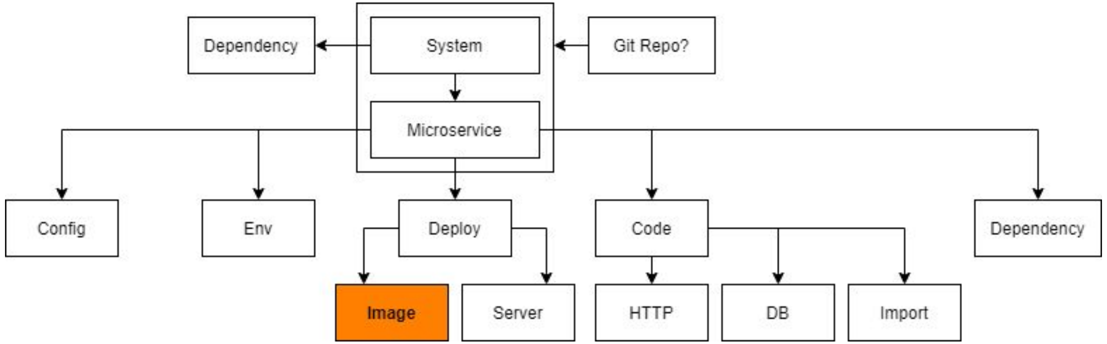
Meta-model components



Code

Stores information about a single source code file (Programming language, LOCs, etc...)

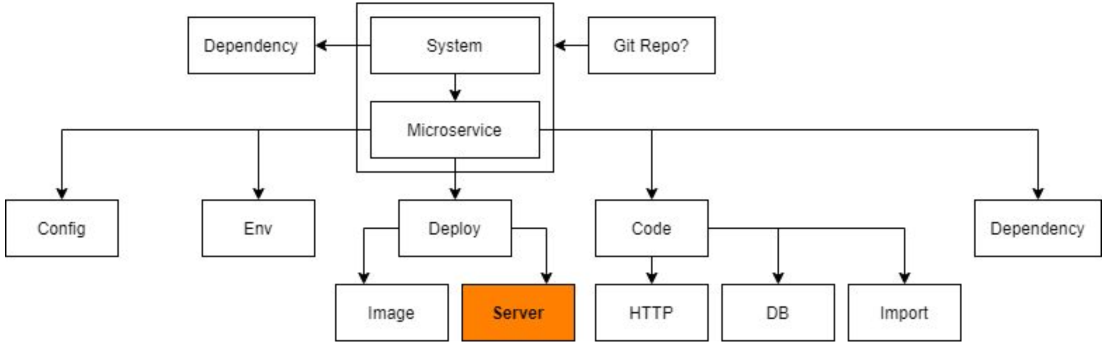
Meta-model components



Image

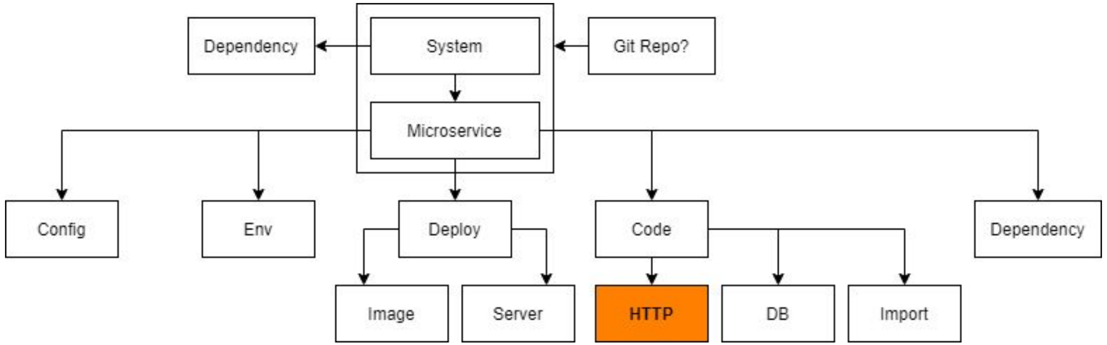
If available, this component contains information about container images of the system

Meta-model components



Server
Holds information about deployment servers of the system

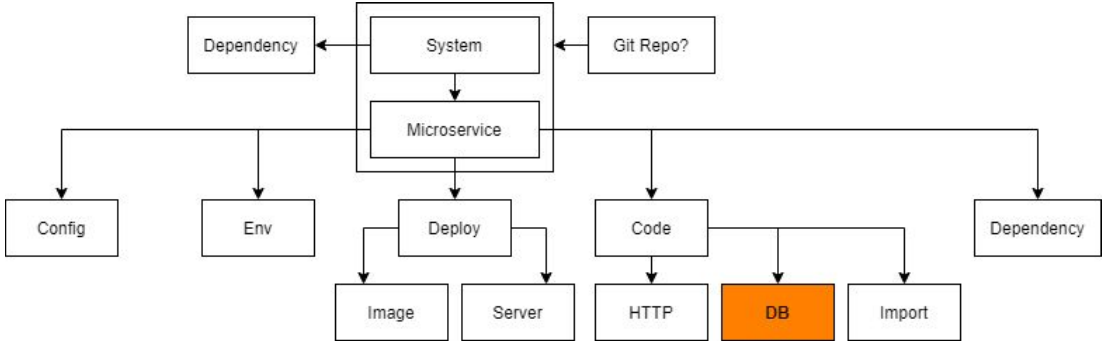
Meta-model components



HTTP

Stores information about HTTP requests (Endpoints, source file, etc...)

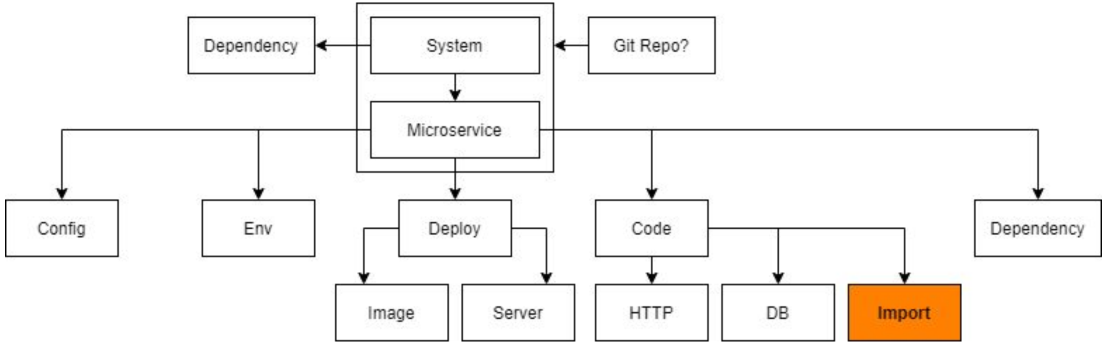
Meta-model components



Database

Stores information about database queries (query type, source file, etc...)

Meta-model components



Import

Contains information about imported classes and packages

Detection rules

For each antipattern, we established a set of detection rules to assess its presence or not in a given microservice based system.

This rules are detailed in the following slides.

Wrong cuts	One file type in source code, connects to other microservices containing only one file type
Cyclic dependencies	Microservice performing calls to each other in a circular way
Mega service	Relatively high number of lines of code, relatively high number of dependencies
Nano service	Relatively low number of lines of code, relatively low number of dependencies
Shared libraries	Binary files, source files and libraries shared between two or more microservices
Hardcoded endpoints	No service discovery libraries in the dependencies, URLs and endpoints in the source code
Manual configuration	No configuration management libraries in the dependencies, independent configuration files
No API gateway	No API gateway libraries in the dependencies

Timeouts	No circuit breaker libraries in the dependencies, hardcoded timeout values in the source code
No CI / CD	No CI / CD libraries in the dependencies, no CI / CD information in the repository if available
Multiple service instances per host	Shared deployment scripts between two or more microservices
Shared persistence	Shared data / database configuration between two or more microservices
No API versioning	No version information in endpoints and URLs, no version headers in HTTP requests
Local logging	No distributed logging libraries in the dependencies
No healthcheck	No healthcheck libraries in the dependencies, no healthcheck URL, no healthcheck instructions
Insufficient monitoring	No monitoring libraries in the dependencies

Discussion

- There are no fully automated tool-based approach to identify microservice antipatterns in the literature, and our approach aims to fill this gap
- Our meta-model only requires source code and do not rely on documentation and other artifacts
- We aim to help developers minimize antipatterns in their source code
- We contribute to the maintenance and evolution of microservice-based system with a generic, comprehensive and consensual definitions of antipatterns and an approach to identify these antipatterns

Threats to validity

- They are potentially other antipatterns that we did not find / include in our study
- The detection rules are subject to our interpretation and can be subjective (eg. Mega service). However, we tried to minimize this by considering microservices as part of the system and not standalone.
- We rely on lists of libraries and frameworks to identify some antipatterns, this lists can be extended to include more libraries and frameworks.

Conclusion

- This presentation describe the foundation of our automatic tool-based approach for the identification of antipatterns in microservice-based systems
- We propose an approach that is robust enough to identify the described antipatterns, yet still extensible and flexible to evolve.
- The tool itself is currently work in progress
- The tool will be validated by manually analysing 28 microservice-based system to calculate precision and recall

THANK YOU !