

Master's Thesis – Final Presentation

# ***Assessing the cost and benefit of a microservice landscape discovery method in the automotive industry***

Advisor: Martin Kleehaus, M.Sc.

Student: Nektarios Machner, B.Sc.

04.11.2019

Chair of Software Engineering for Business Information Systems (sebis)  
Faculty of Informatics  
Technische Universität München  
[www.matthes.in.tum.de](http://www.matthes.in.tum.de)

1. Motivation & Problem Description

2. Concept & Foundations

3. Implementation

4. Evaluation

5. Live Demonstration

6. Conclusion

7. Discussion

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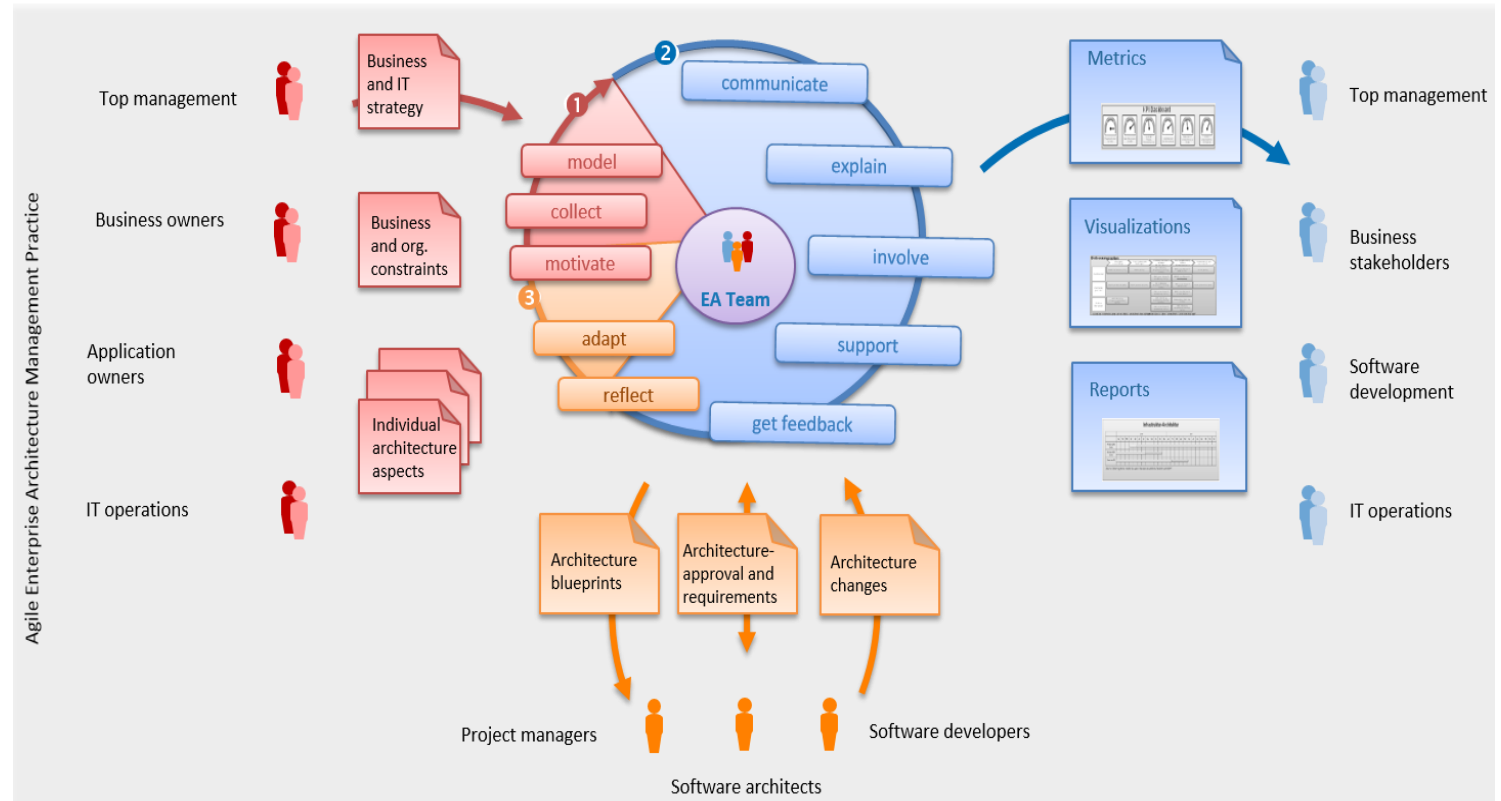
# 1. Motivation & Problem Description

**EAM** aims to document and manage the complexity of the business IT landscape in relation to business requirements

**Enterprise Architecture Documentation (EAD) challenges:**

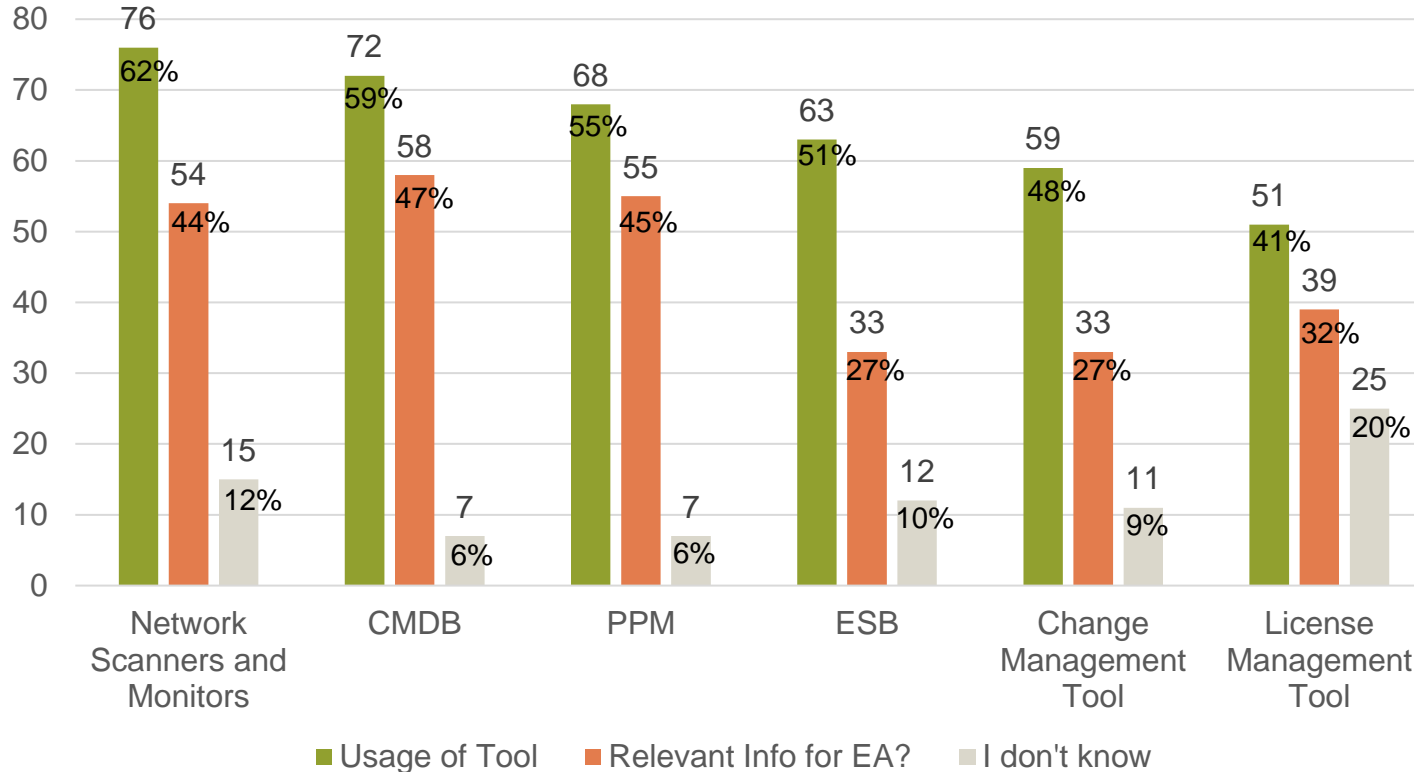
- time-consuming process
- mostly performed manually
- data incomplete and/or outdated
- lack of clear responsibilities
- IT landscape constantly changing

→ **Overcome challenges via automated documentation**



# 1. Motivation & Problem Description

Fig.: Usage and relevance as EA information sources (n=123).



- majority of organizations have no dedicated process for EA documentation defined
- only 23 participants (18.7%) stated that they have implemented some form of automated EA documentation mechanisms for their EA tool (mostly limited to simple file import mechanisms that are manually triggered)

source:

Farwick, M., Hauder, M., Roth, S., Matthes, F., Breu, R.: Enterprise Architecture Documentation: Empirical Analysis of Information Sources for Automation - In the Hawaii International Conference on System Sciences (HICSS 46), Maui, Hawaii, 2013

**RQ1**

Which IT artifacts and their communication relationships can be discovered through runtime data?

**RQ2**

What are benefits and limitations of this solution?

1. Motivation & Problem Description

**2. Concept & Foundations**

3. Implementation

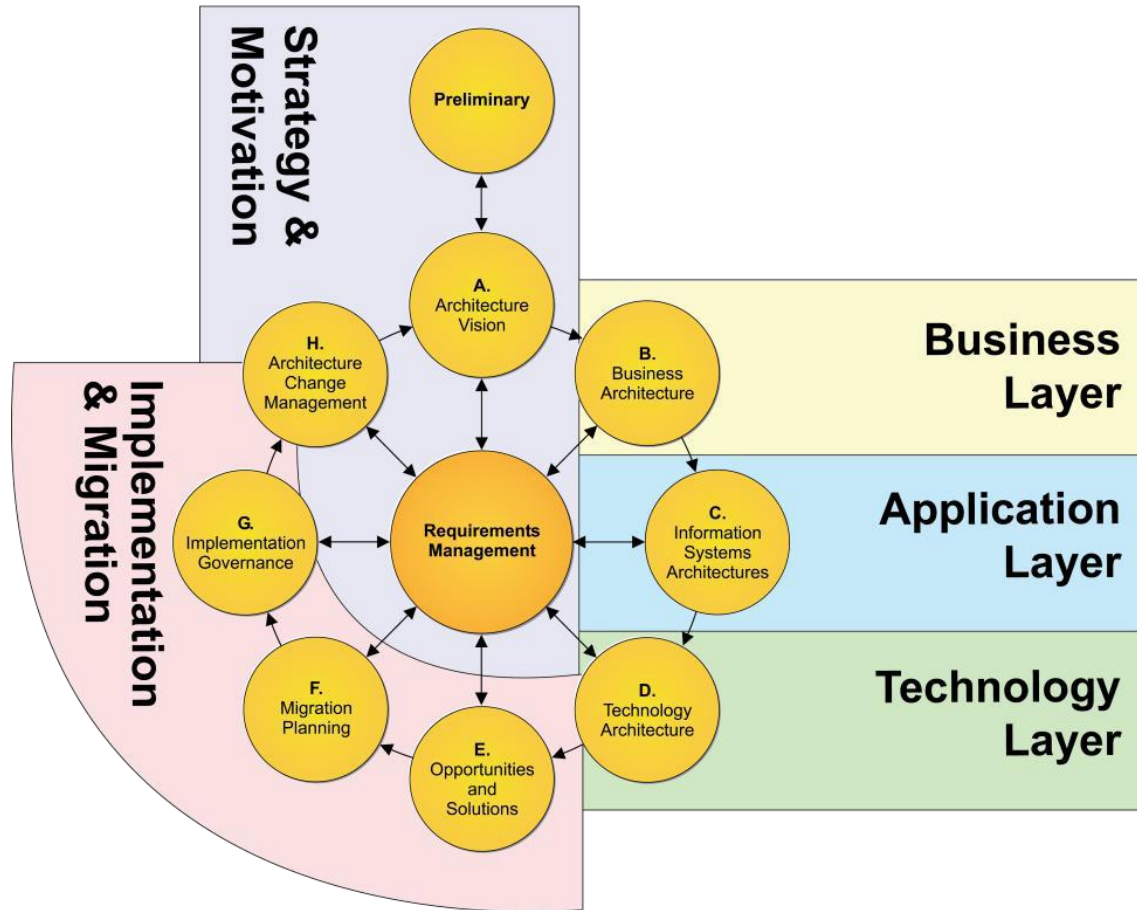
4. Evaluation

5. Live Demonstration

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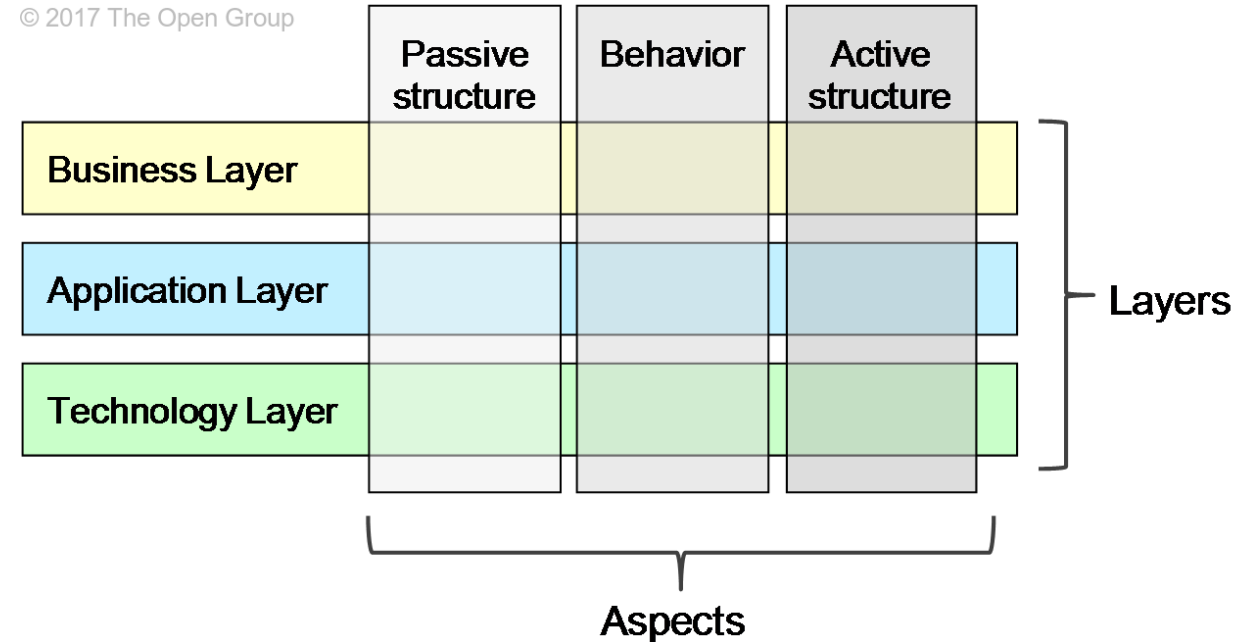
7. Discussion

## 2. Concept & Foundations – ArchiMate



Mapping between TOGAF ADM and ArchiMate language

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ArchiMate core framework

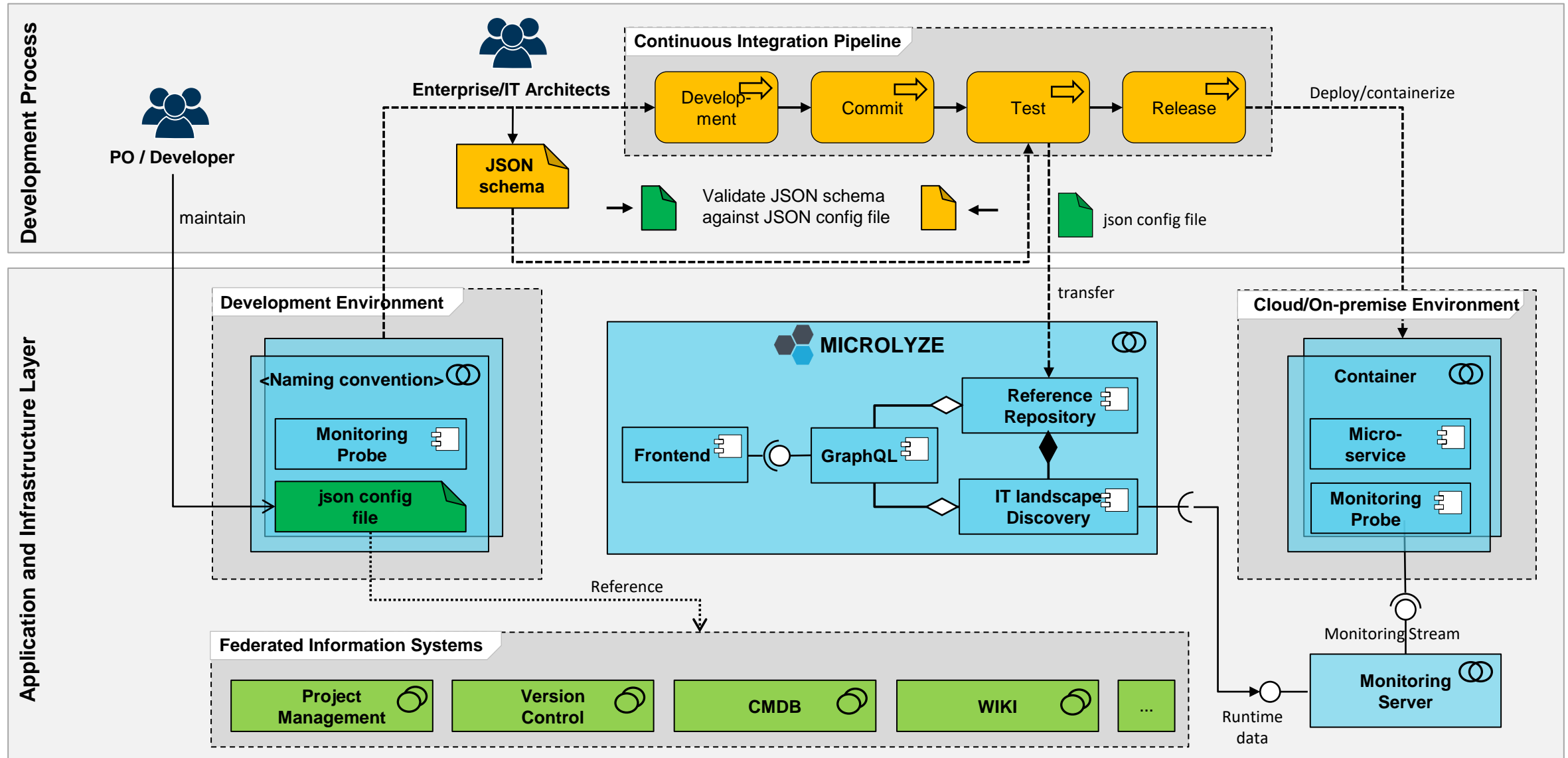
source:

<https://www.opengroup.org/togaf>

T. O. Group and V. H. Publishing. ArchiMate 3.0.1 Specification. 1st ed. Zaltbommel, Netherlands: Van Haren, 2017. isbn: 978-9-401-80235-2.



## 2. Concept & Foundations – Microlyze



source:

Kleehaus, M.; Hauder, M.; Uludag, O.; Corpancho, N.; Matthes, F.: IT Landscape Discovery via Runtime Instrumentation for Automating Enterprise Architecture Model Maintenance, The Americas Conference on Information Systems (AMCIS), Cancun, Mexiko, 2019.

1. Motivation & Problem Description

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**3. Implementation**

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# 3. Implementation – Environment

## Industry partner: BMW

- Department DE-810 (“vehicle data connectivity”)
- 200 BMW employees + external contractors → ~ 500 - 600 employees
- separated into agile teams
- mainly responsible for ConnectedDrive platform  
(backend for multiple services in the context of connected cars)
- mostly custom software
- Monitoring Tool in use: Dynatrace AppMon (April 2018)
- Monitoring scope: DE-81, DE-82, partially DE-83
- 100% manual documentation
- no centralized documentation of microservices at all

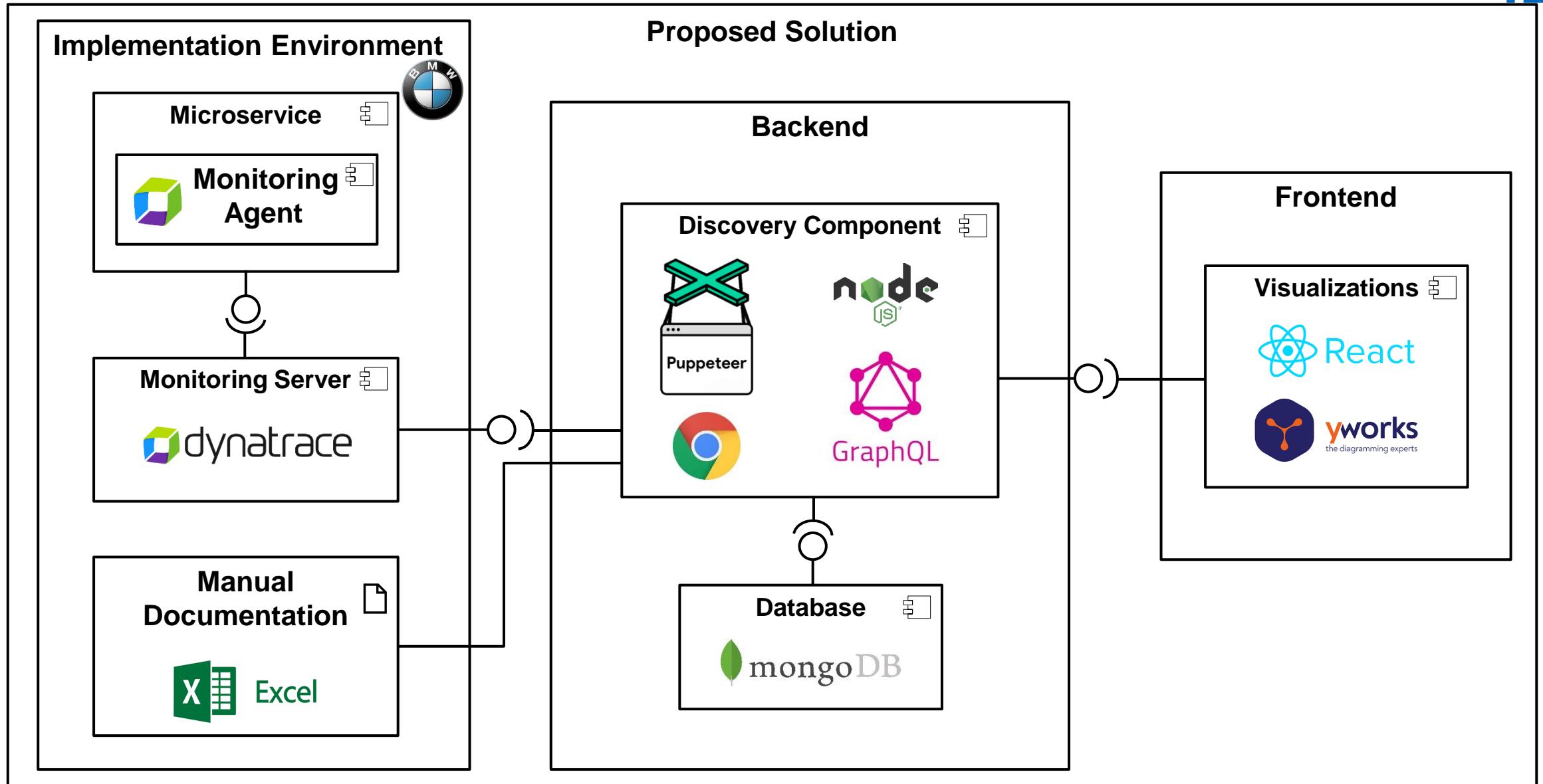


### 3. Implementation – Requirements Analysis



Rank	Artifact	Score
1	Data flow and dependencies between applications	18
2	Interfaces / APIs	18
3	Mapping and associations within application layer	18
4	Application Components (logical unit)	17
5	Communication technology (protocols)	17
6	Business Processes	15
7	Mapping and associations within infrastructure layer	15
8	Physical IT resources	14
9	Mapping and associations within business layer	13
10	Use Cases	13

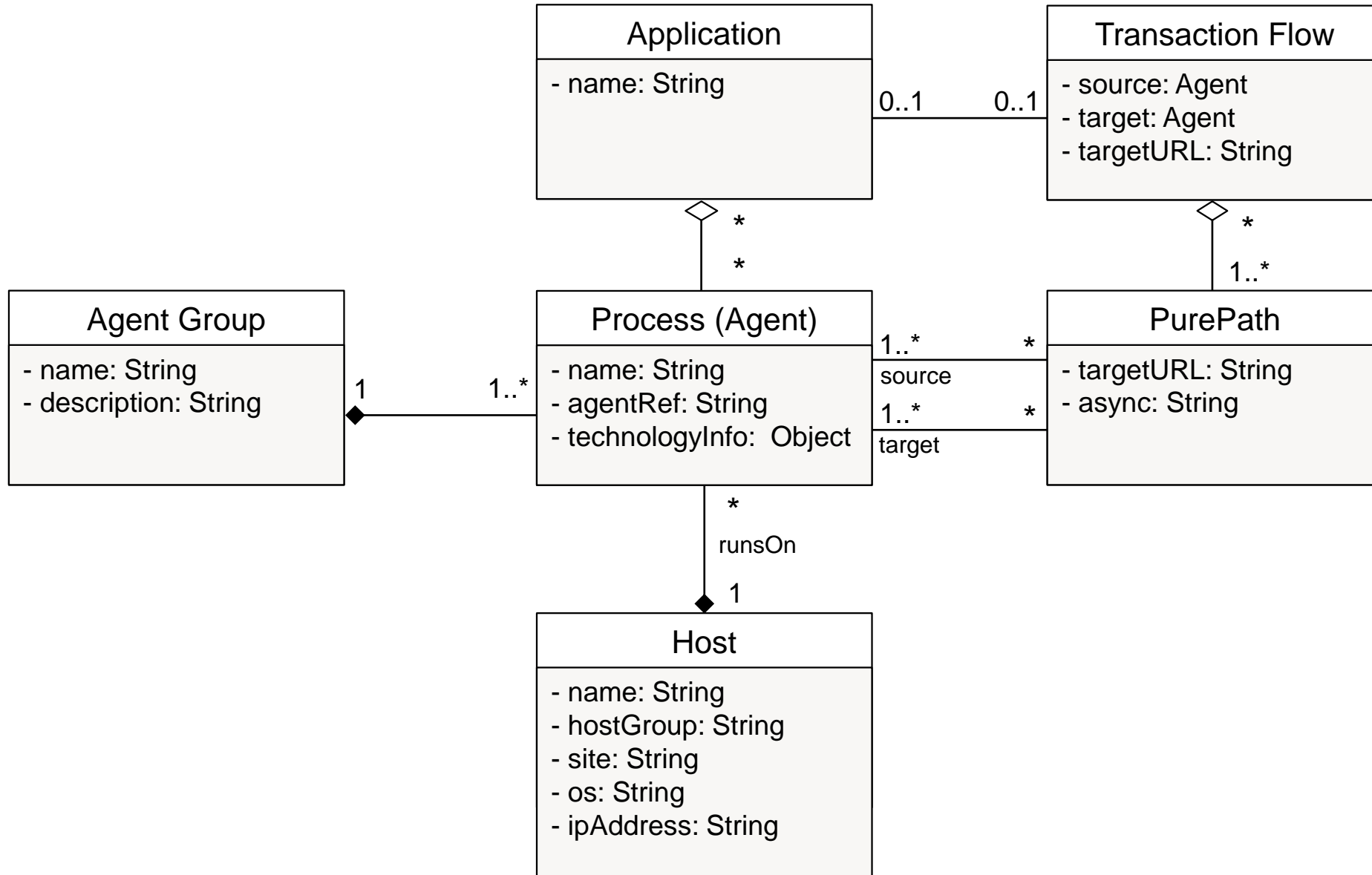
# 3. Implementation – Overview



### 3. Implementation – Monitoring Tool (Dynatrace AppMon)



dynatrace



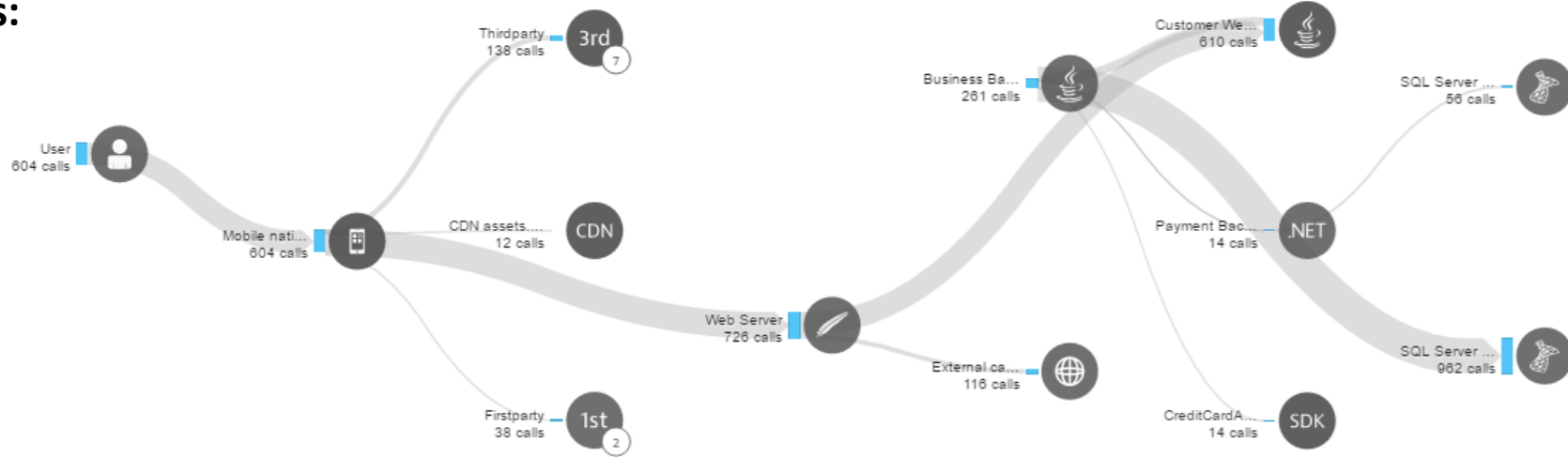
# 3. Implementation – Monitoring Tool (Dynatrace AppMon)



dynatrace

## Relevant data structures:

- Transaction flow



- PurePath

```

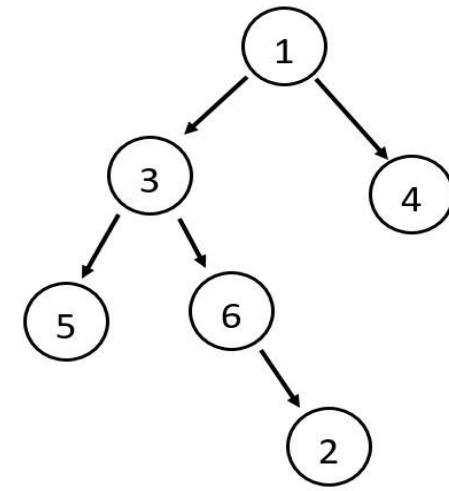
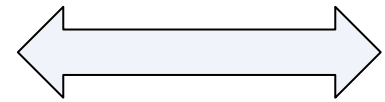
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  dtwsagent[Apache 2.2]

  ✓ Web server.Proxy Request()
    dtwsagent[Apache 2.2]

  ✓ /CalculateRecommendations
    CustomerFrontend_easyTravel_8080

  ✓ AsyncContextImpl$RunnableWra...
    CustomerFrontend_easyTravel_8080

/services/JourneyService/
BusinessBackend_easyTravel
    
```



# 3. Implementation – Monitoring Tool (Dynatrace AppMon)



dynatrace

## Transaction Flow:

```
"id" : "PROD_EM_API_GW_WEB_INTERNET_X_INTER|API_GW_WEB_INTERNET|lpwww202"
"nodeInfo" : {
  "name" : "PROD_EM_API_GW_WEB_INTERNET_X_INTER",
  "groupId" : "API_GW_WEB_INTERNET",
  "preDefGroup" : "NONE",
  "nodeType" : "WEBSERVER",
  "techType" : "APACHE"
},
"infrastructureInfo" : {
}
"callInfo" : {
}
"transactionInfo" : {
}
"targets" : [ {
  "targetId" : "PROD_EM_PAF_X_EMEA-PROD|PAF|paf-92-w2c4c|AGENT_JAVA",
  "callCount" : 104,
  "errorCount" : 0,
  "transactionCount" : 104,
  "failedTransactionCount" : 0
}, {
  "targetId" : "PROD_EM_PAF_X_EMEA-PROD|PAF|paf-92-020hz|AGENT_JAVA",
  "callCount" : 4,
  "errorCount" : 0,
  "transactionCount" : 4,
  "failedTransactionCount" : 0
} ]
```

## PurePath:

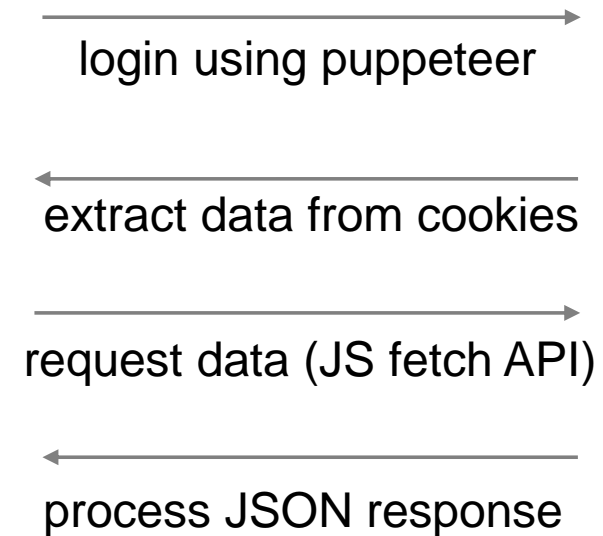
```
{
  "request": "/webapi/v1/user/vehicles/{VIN}/rangemap",
  "path": {
    "source": "API_GW_WEB_INTERNET",
    "target": "B2V_CE",
    "targetURL": "/spuWebAPI/api/v1/user/vehicles/{VIN}/rangemap",
    "async": false,
    "subPaths": []
  }
},
{
  "request": "/webapi/v1/user/vehicles/{VIN}/status",
  "path": {
    "source": "API_GW_WEB_INTERNET",
    "target": "WebAPI_Web",
    "targetURL": "/spuWebAPI/api/v1/user/vehicles/{VIN}/status",
    "async": false,
    "subPaths": [
      {
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        "target": "B2V_CE",
        "targetURL": "/spuWebAPI/api/v1/user/vehicles/{VIN}/status",
        "async": false,
        "subPaths": []
      }
    ]
  }
}
}
```



### 3. Implementation – Monitoring Tool (Dynatrace AppMon)

#### Limitations & Workarounds:

- Lack of "useful" APIs
- Automation
- Lack of applicable filters
- Naming convention
- Timeframe restrictions
- Completeness of data
- Parameters in requests
- No distinction regarding origin of requests
- Overly strained AppMon instance

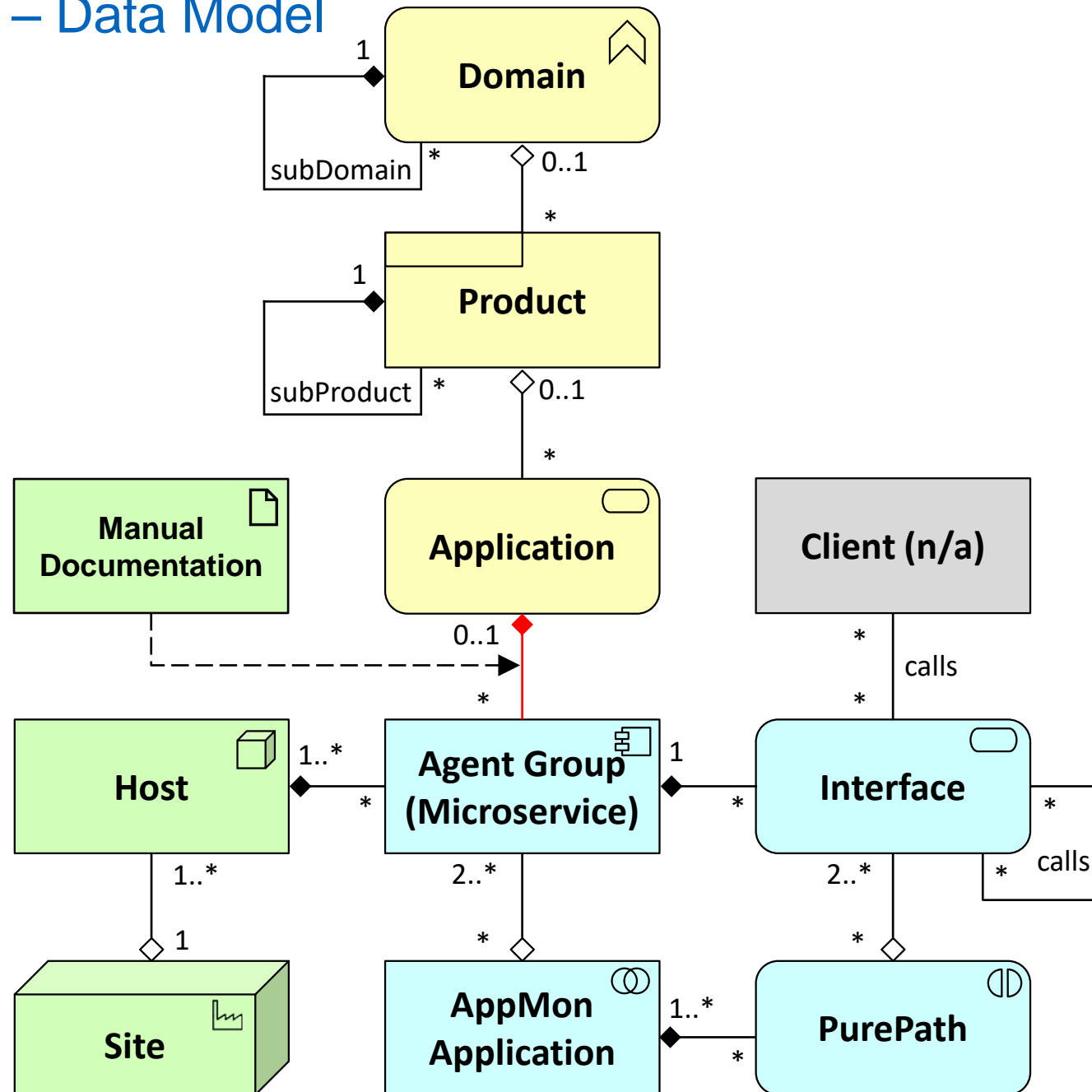


dynatrace

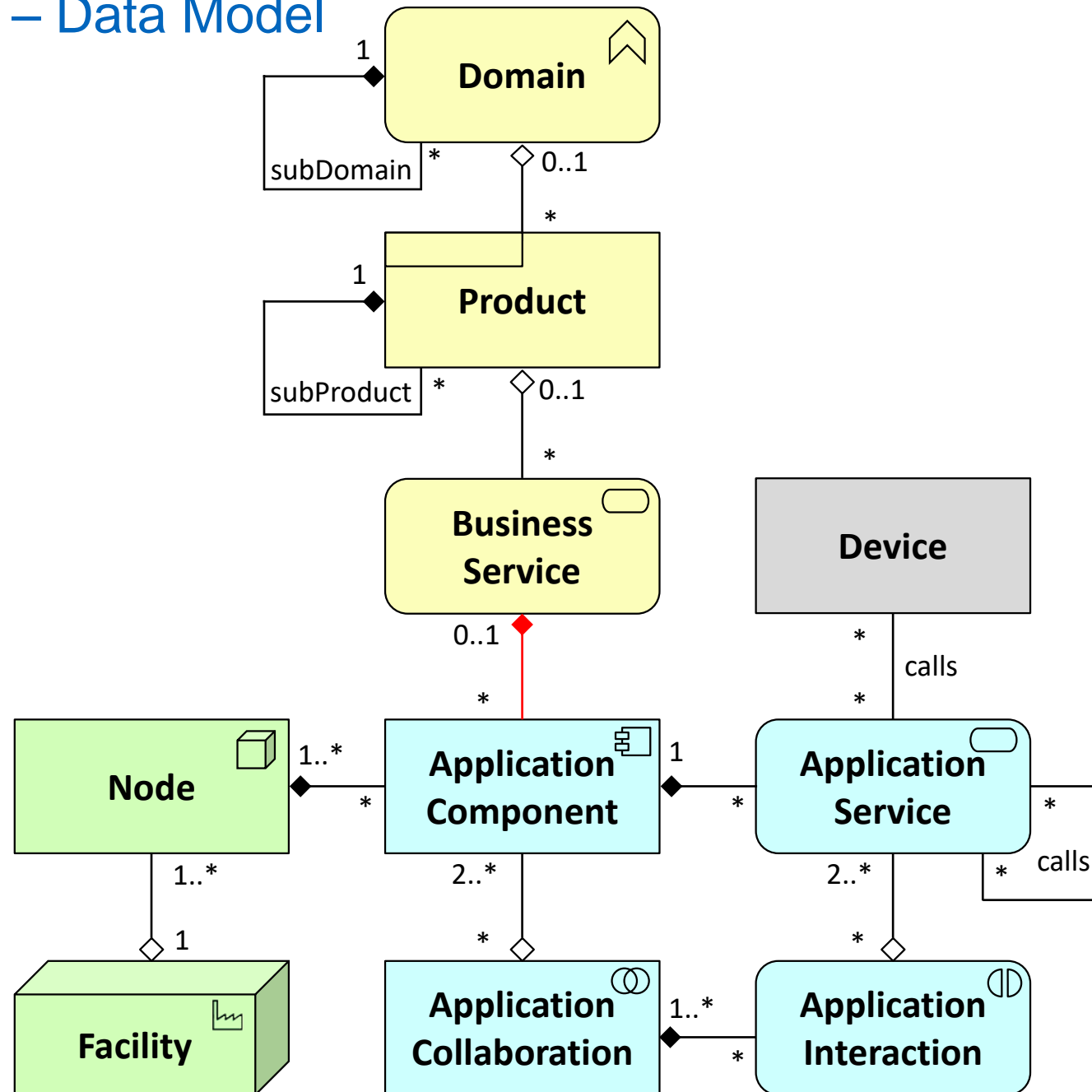


dynatrace

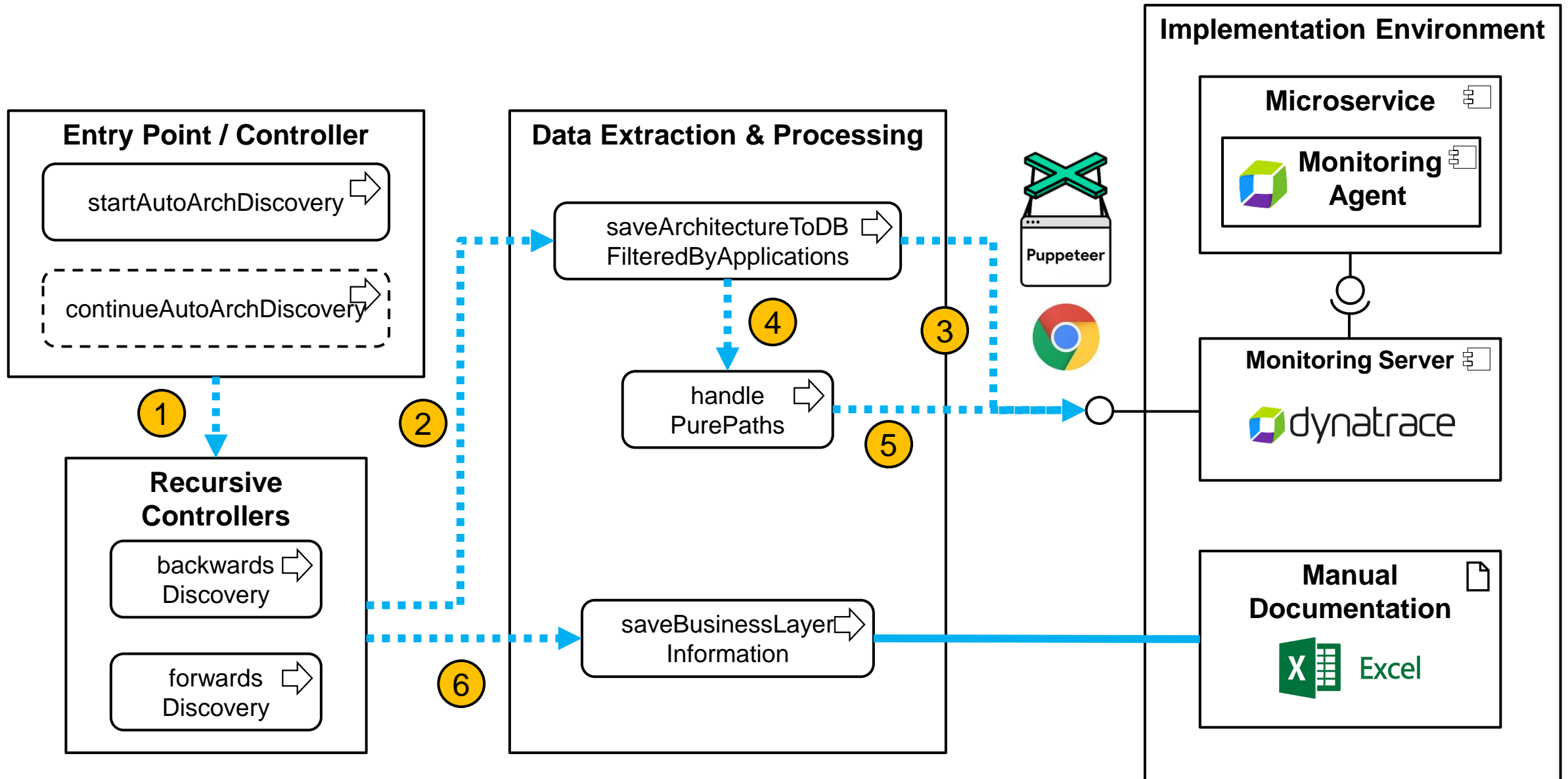
### 3. Implementation – Data Model



### 3. Implementation – Data Model



# 3. Implementation – Automated Architecture Discovery Algorithm (AADA)



1. Motivation & Problem Description

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**4. Evaluation**

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# 4. Evaluation – Quantitative Analysis

## Discovery Run:

- Start: September 12<sup>th</sup>
- Timeframe: 6 hours
- Iterations: 174 (112 backwards, 62 forwards)  
i.e. 28 days backwards, 15.5 days forwards
- Duration per iteration: 60 – 120 minutes

## Findings:

- High robustness
- No more PurePaths roughly 10 days into the past
- Increasing response times the further back in time
- coverage / accuracy:  
221 of 407 Microservices discovered → ~54%  
79 of 179 applications “discovered” → ~44%

## Discovered Elements:

### • Structural:

Application Components: 221

Nodes: 5805

Application Collaborations: 73

Annotations: 14991

### • Relationships:

Hierarchy: 12445

Grouping: 2250

Communication: 3031

### • Business Layer Elements:

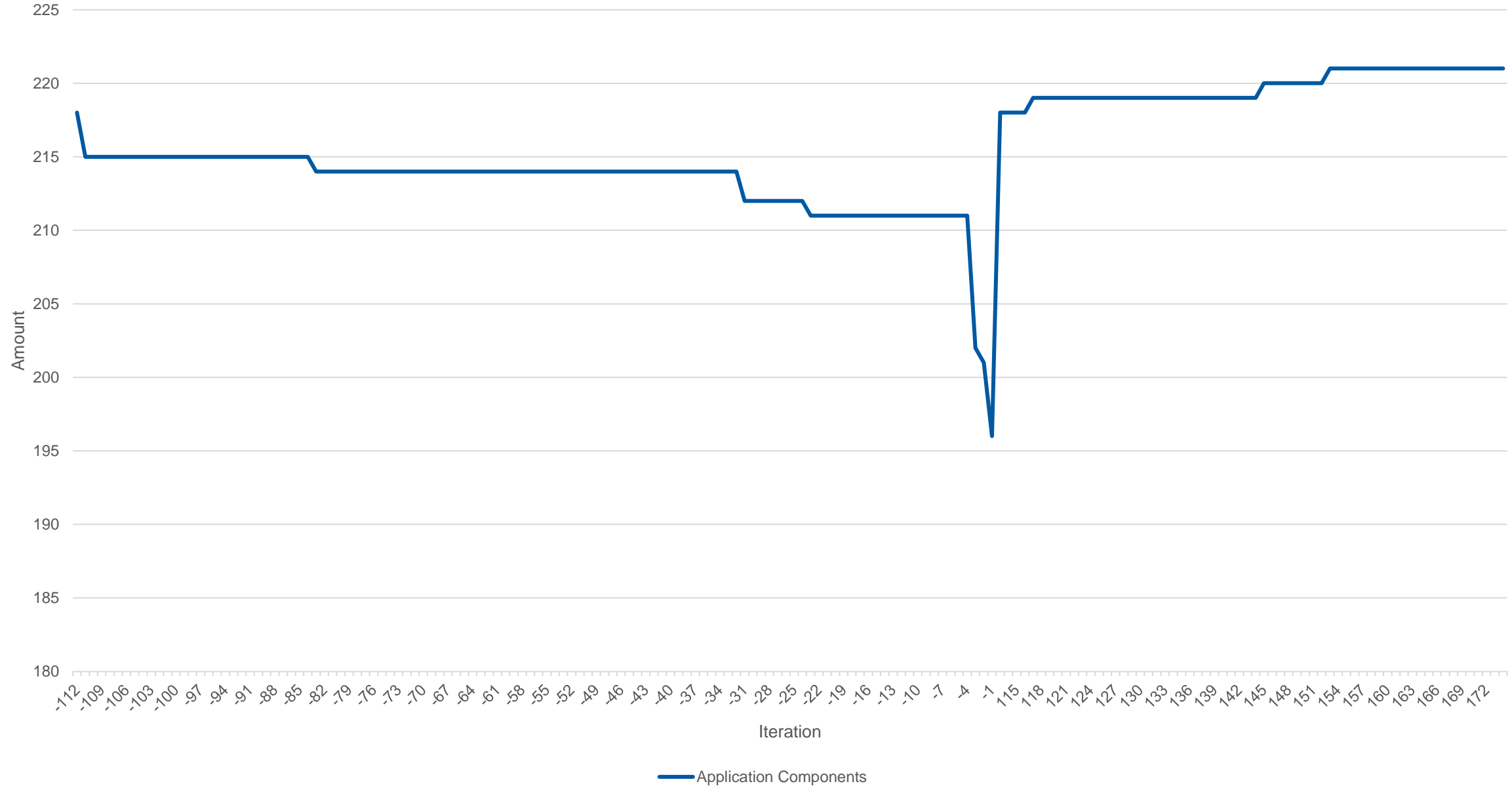
(Sub)Domains: 4

(Sub)Products: 46

Business Services: 79

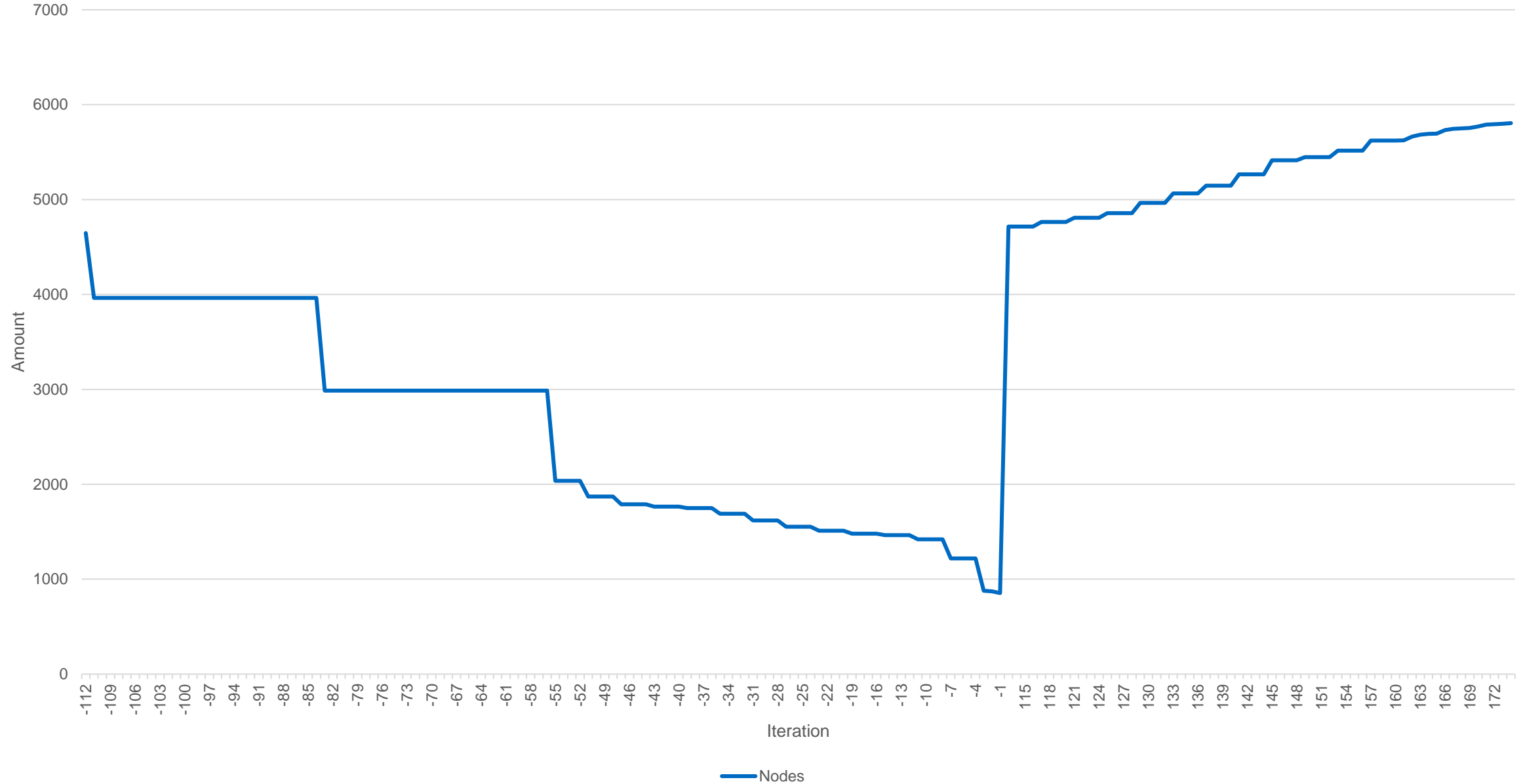
# 4. Evaluation – Quantitative Analysis

Discovered Architecture Elements over Time



# 4. Evaluation – Quantitative Analysis

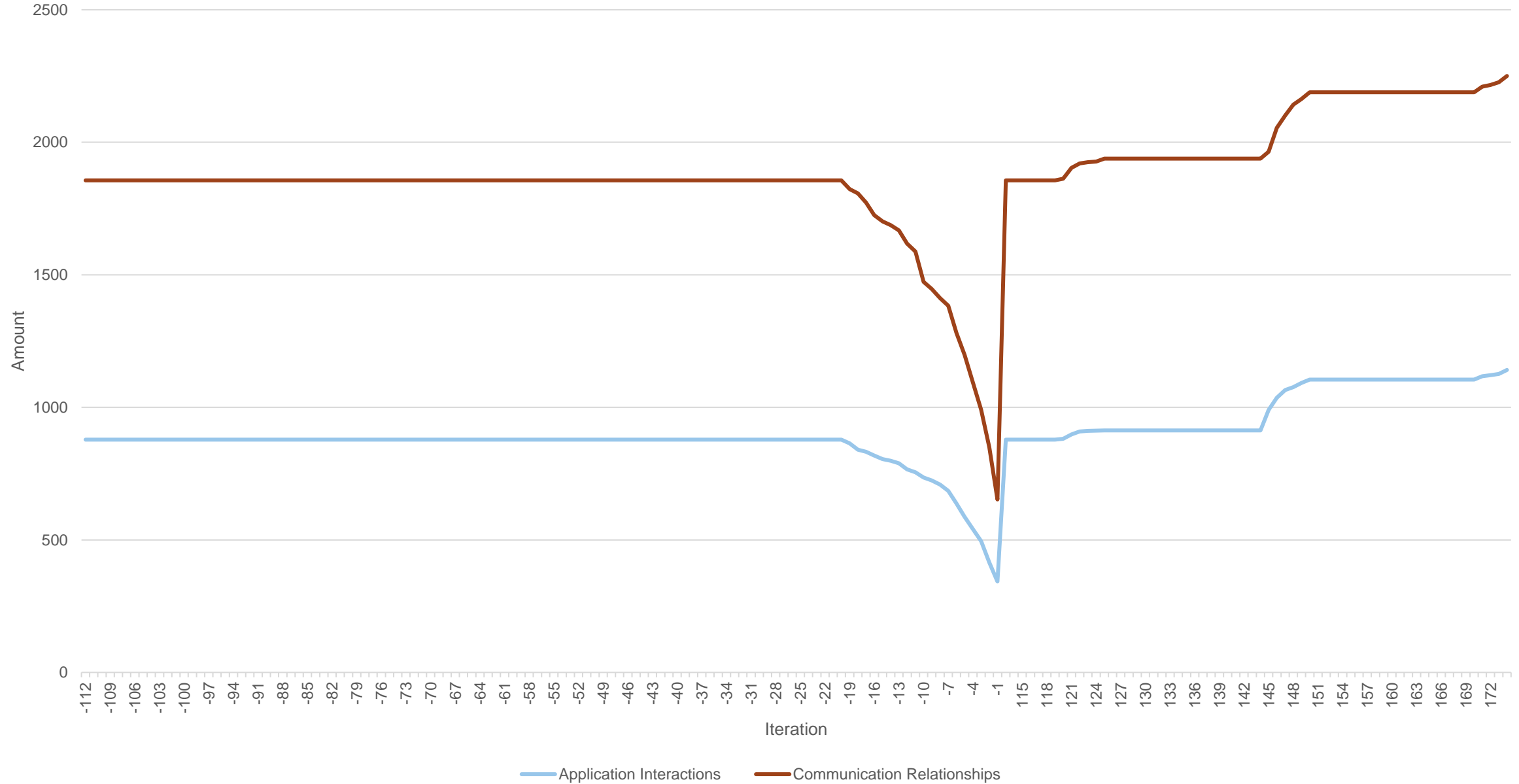
Discovered Architecture Elements over Time





# 4. Evaluation – Quantitative Analysis

Discovered Architecture Elements over Time



### Question 1:

To what extent do you accept the stated problem description? Do you differ in opinion?

### Feedback:

- fully support the problem description
- time and budget restrictions → documentation is not a priority
- data outdated and incomplete indeed true
- lack of clear responsibilities for documentation not true
- uncertainty whether problem is caused by lack of appropriate tools, lack of interest or lack of responsibility
- doubt that manual documentation is actually that time-consuming  
(compared to other activities manual documentation does not take that much time relatively seen)

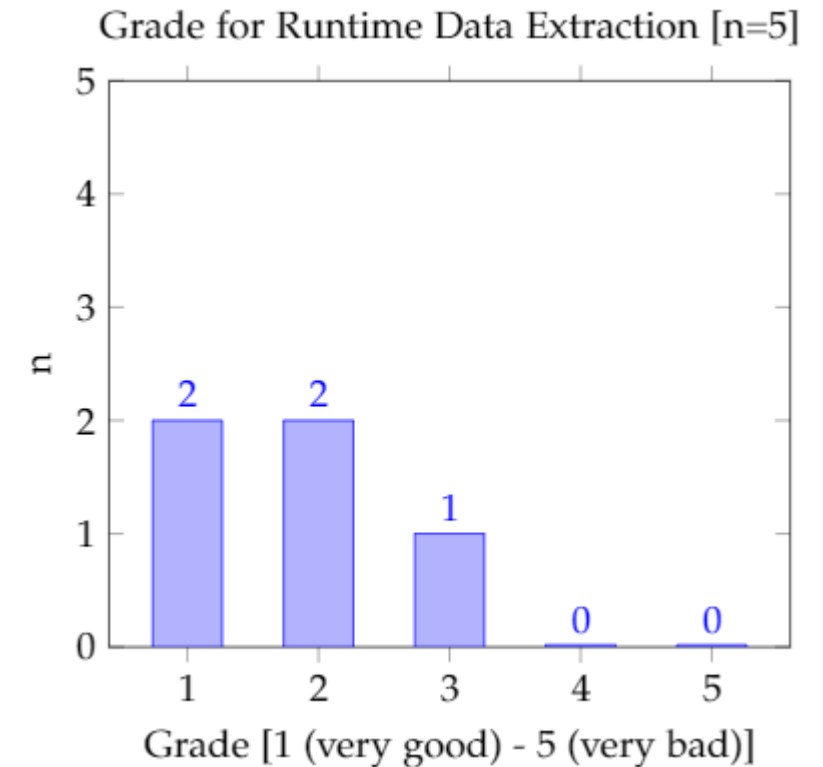
## 4. Evaluation – Qualitative Analysis

### Question 2:

How do you rate the approach of extracting architecture information from runtime data in order to assist the IT landscape documentation? What advantages and disadvantages do you see?  
How do you rate the approach on a scale from 1 (very good) to 5 (very bad)?

### Feedback:

- usage of runtime data extremely important
- medium to long-term no other way
- represents the truth
- certain inaccuracy always present
- important but insufficient (lack of explanation)
- understanding of architecture not possible
- connection to source code desirable
- $\emptyset$  Grade[n=5] = 1.8



## 4. Evaluation – Qualitative Analysis

### Question 3:

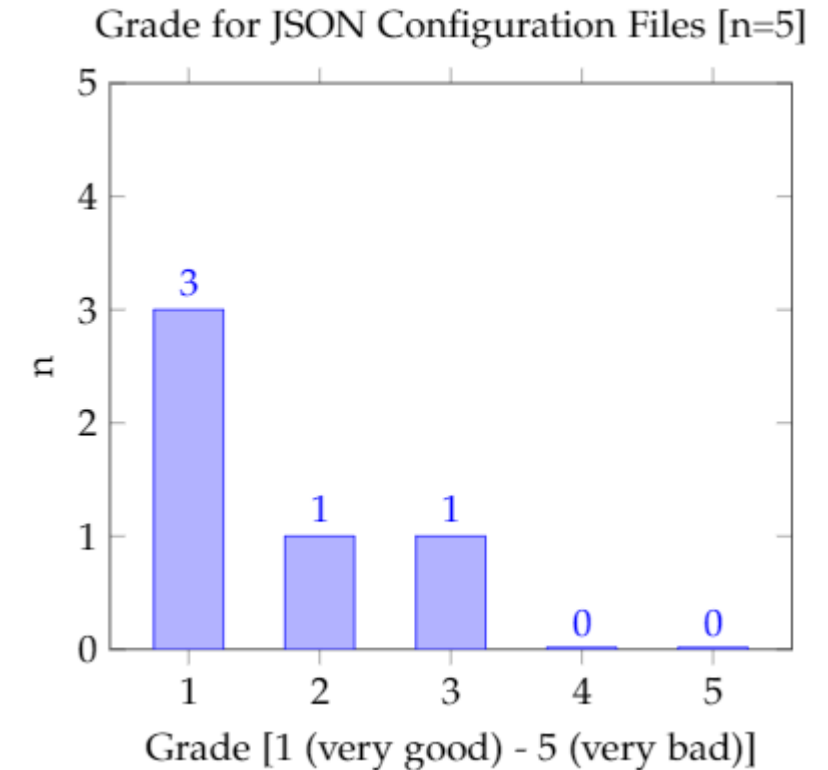
How do you rate the approach of maintaining further relationship information within configuration files?

What advantages and disadvantages do you see?

How do you rate the approach on a scale from 1 (very good) to 5 (very bad)?

### Feedback:

- necessary but not revolutionary
- good approach in relation in relation to other approaches
- every bit of contained information needs to add value  
(should not contain unnecessary information to minimize maintenance effort)
- JSON preferable to other formats due to validation ability
- handling of unclear or unknown information possibly an issue
- $\emptyset$  Grade[n=5] = 1.6



## 4. Evaluation – Qualitative Analysis

### Question 4:

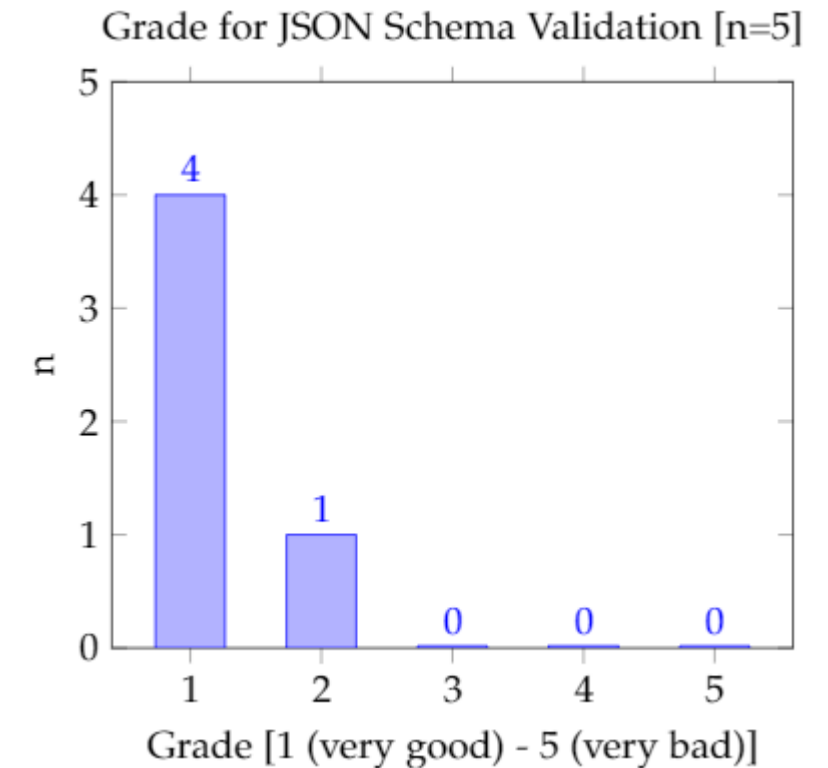
How do you rate the approach of ensuring the maintenance of the configuration files through JSON Schema validation?

What advantages and disadvantages do you see?

How do you rate the approach on a scale from 1 (very good) to 5 (very bad)?

### Feedback:

- indispensable
- no alternative
- contingency plan required
- $\emptyset$  Grade[n=5] = 1.4



## 4. Evaluation – Qualitative Analysis

### Question 5:

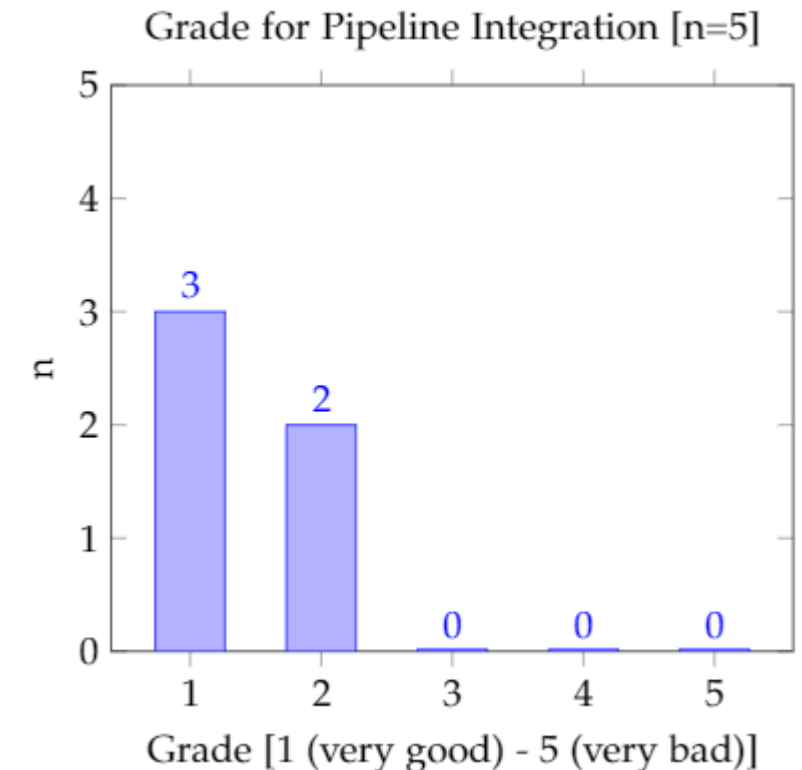
To what extent do you perceive the integration of the approach into a CI/CD pipeline as useful?

What advantages and disadvantages do you see?

How do you rate the approach on a scale from 1 (very good) to 5 (very bad)?

### Feedback:

- best approach to force people to do something
- no alternative
- reliability an absolute requirement
- possibility to arouse hatred
- $\emptyset$  Grade[n=5] = 1.4



### Question 6:

How do you rate the cost-benefit ratio of the approach in general?

### Feedback:

- estimated costs relatively low
- estimated benefits tremendous
- benefits difficult to quantify
  
- BMW context:
  - monitoring tools already in place → no extra cost
  - pipeline integration perceived as feasible → no big effort
  - benefits outweigh costs by far (one person estimated value for root-cause-analysis can reach six to seven figures)

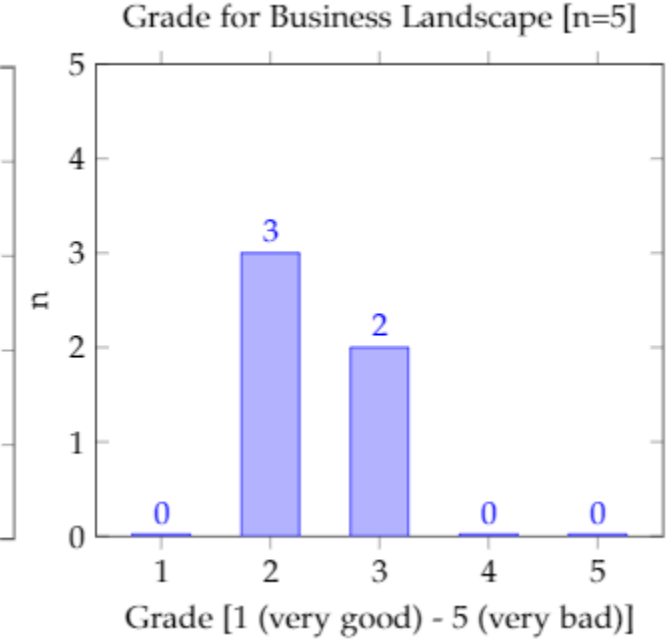
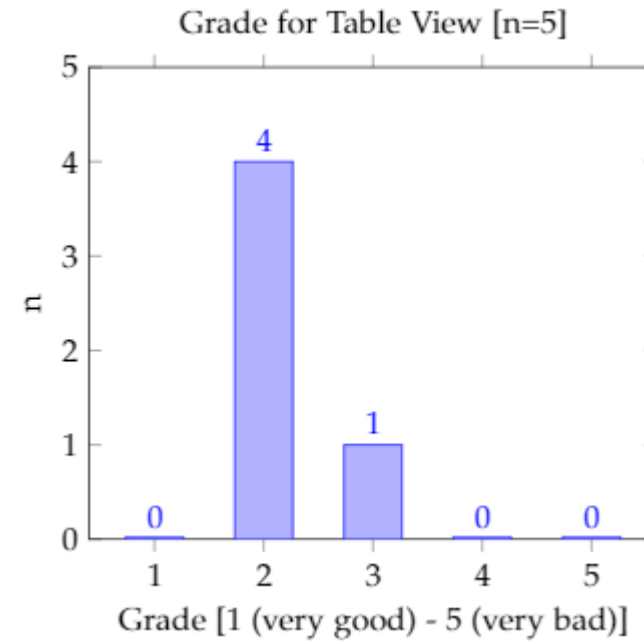
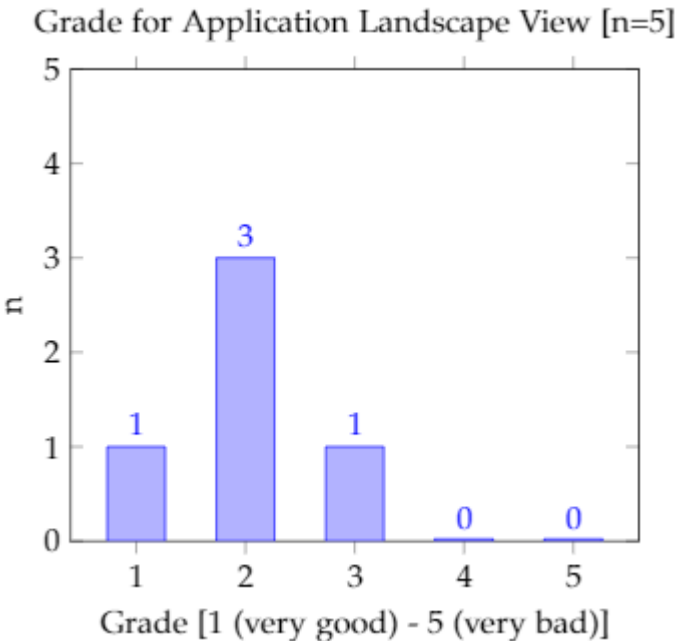
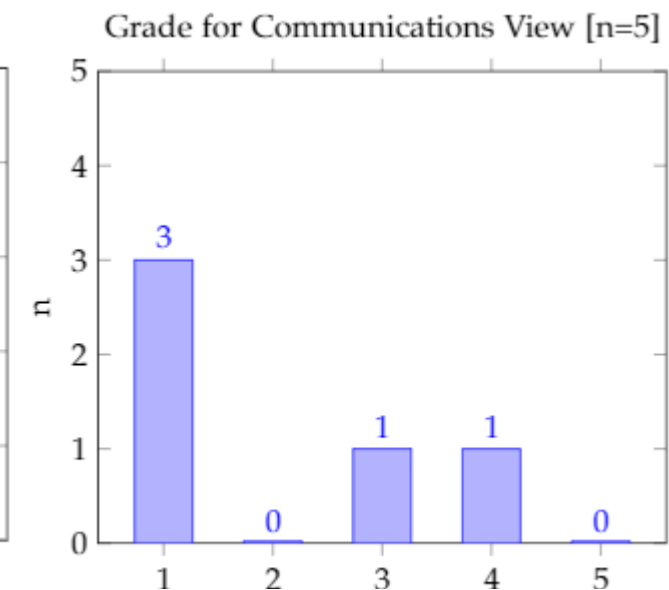
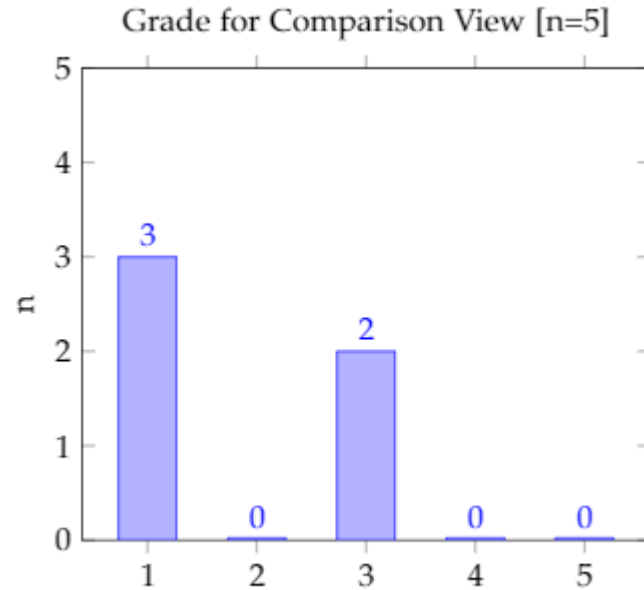
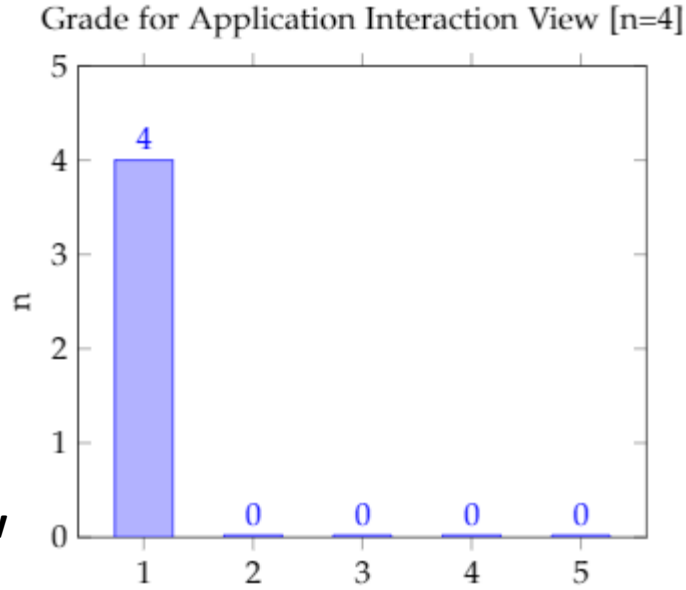
# 4. Evaluation – Qualitative Analysis



## Visualizations:

## Ranking:

- 1. App. Interaction View**  
( $\emptyset$  [n=4] = 1.0)
- 2. Comparison View**  
( $\emptyset$  [n=5] = 1.8)
- 3. Communications View**  
( $\emptyset$  [n=5] = 2.0)
- 3. App. Landscape View**  
( $\emptyset$  [n=5] = 2.0)
- 4. Table View**  
( $\emptyset$  [n=5] = 2.2)
- 5. Bus. Landscape View**  
( $\emptyset$  [n=5] = 2.4)





### **General feedback / Remarks:**

### **Approach:**

- manual documentation (in worst case) outdated the moment it is created → automation invaluable
- holistic approach difficult because of existing legacy systems and standard software
- further linking to business layer required

### **Tool / Visualizations:**

- good choice of visualization framework (built-in layouting impressive)
- more export capabilities (especially to MS Office)
- more colors / filters / search capabilities
- support for planned states

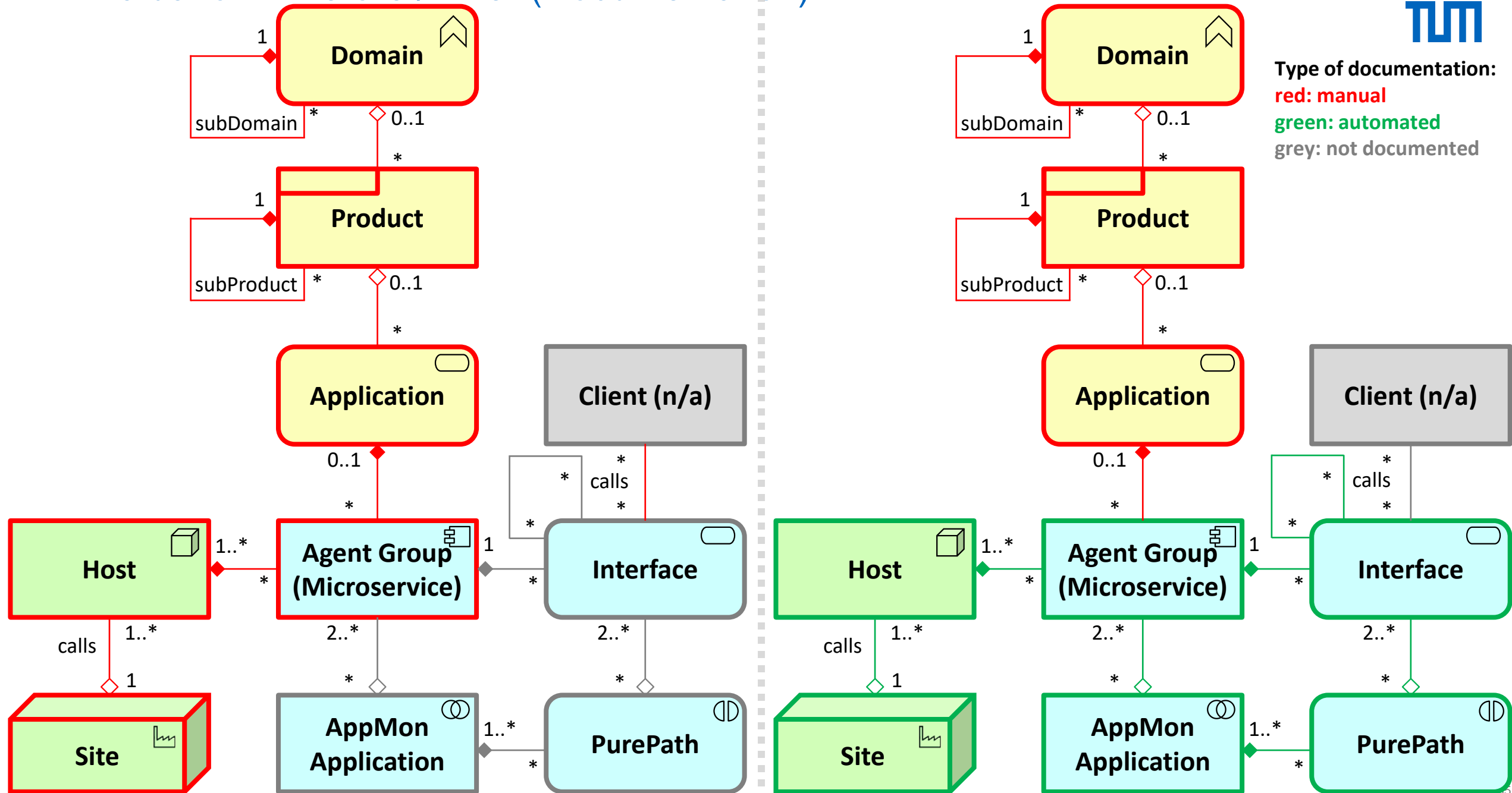
## 4. Evaluation – Before / After (Requirements Analysis)

Rank	Artifact
1	Data flow and dependencies between applications
2	Interfaces / APIs
3	Mapping and associations within application layer
4	Application Components (logical unit)
5	Communication technology (protocols)
6	Business Processes
7	Mapping and associations within infrastructure layer
8	Physical IT resources
9	Mapping and associations within business layer
10	Use Cases

# 4. Evaluation – Before / After (Documentation)



Type of documentation:  
**red: manual**  
**green: automated**  
 grey: not documented



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## Benefits:

- Automation
- Depiction of reality
- EA documentation assistance (long-term replacement?)

## Limitations:

- Monitoring tool
- Lack of explanation
- Focus on as-is landscape

## Outlook:

- Integration of different APM solutions
- Integration into existing landscapes
- Link to business use cases / scenarios

## BMW context:

- solution partly implemented in productive environment
- AADA runs in Jenkins pipeline triggered once a day
- creates export of discovered data
- data used to assist documentation
- automated documentation validated against manual documentation

→ **BMW advisors satisfied**



Thank you for your attention!

## ***Discussion***

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Student: Nektarios Machner, B.Sc.

04.11.2019

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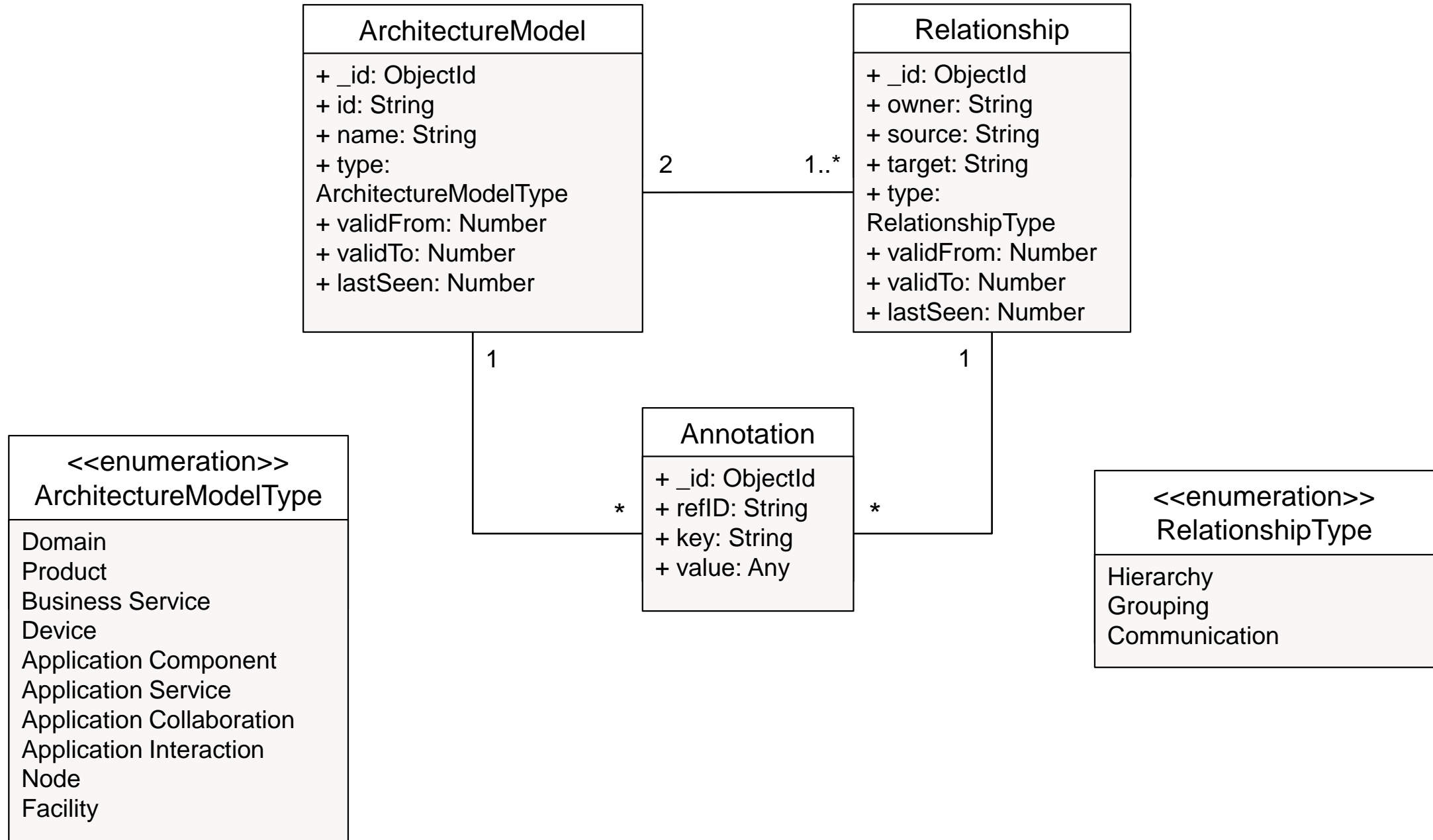
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# BACKUP

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**General Information**

**ID**  
Connected Backend Services

**Name**  
Connected Backend Services

**Architecture Model**  
domain

**Last Seen**  
11/26/51670 10:14

General Information

**ID**  
XCS

**Name**  
XCS

**Architecture Model**  
application-component

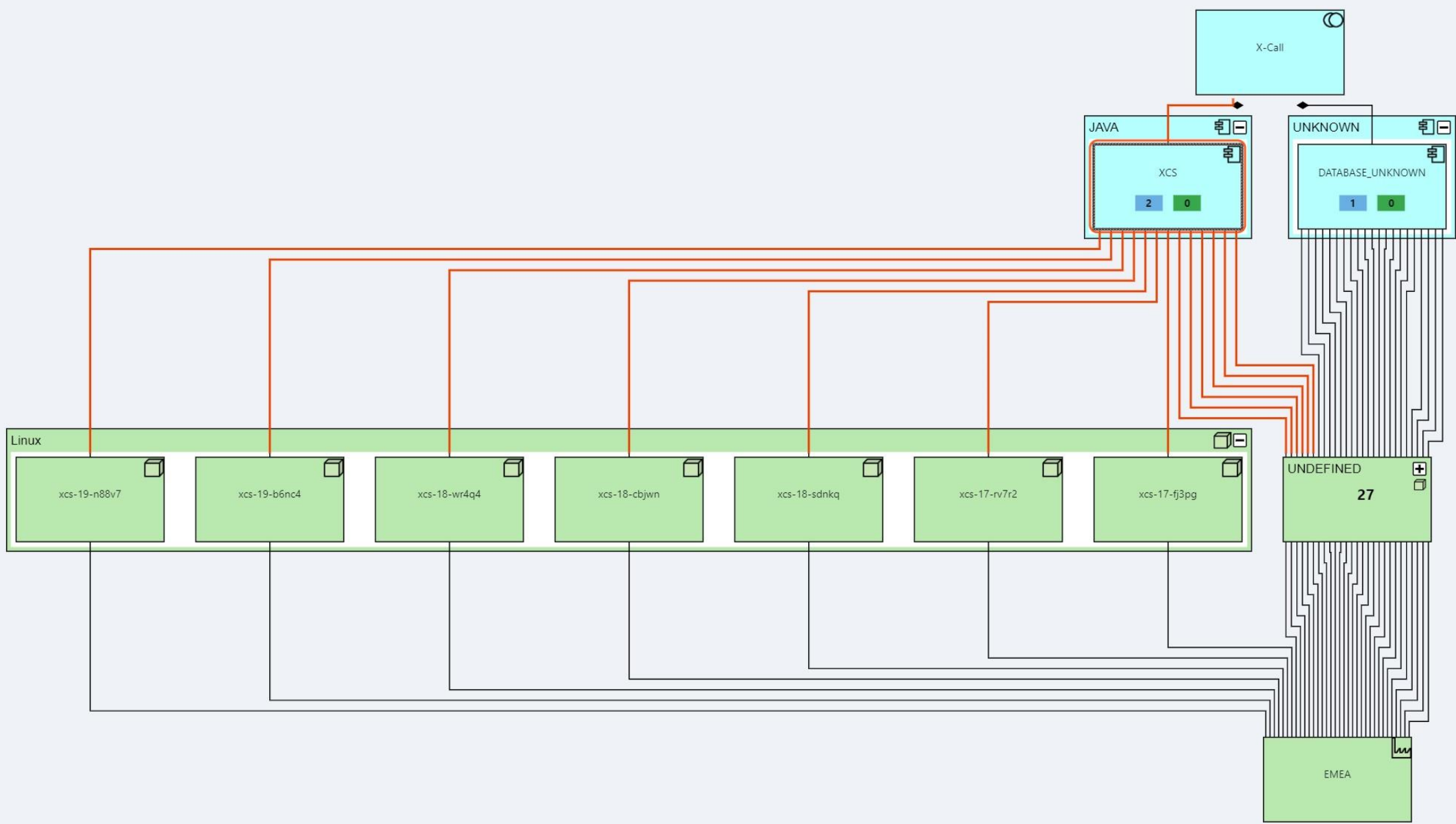
**Products**  
Vehicle Interaction Services

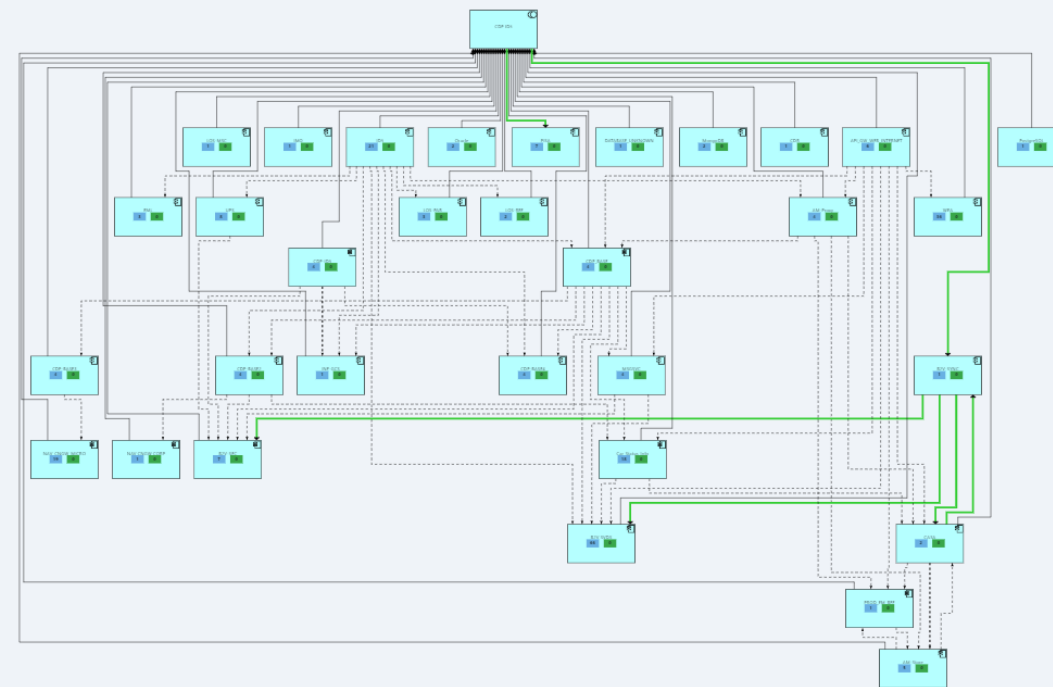
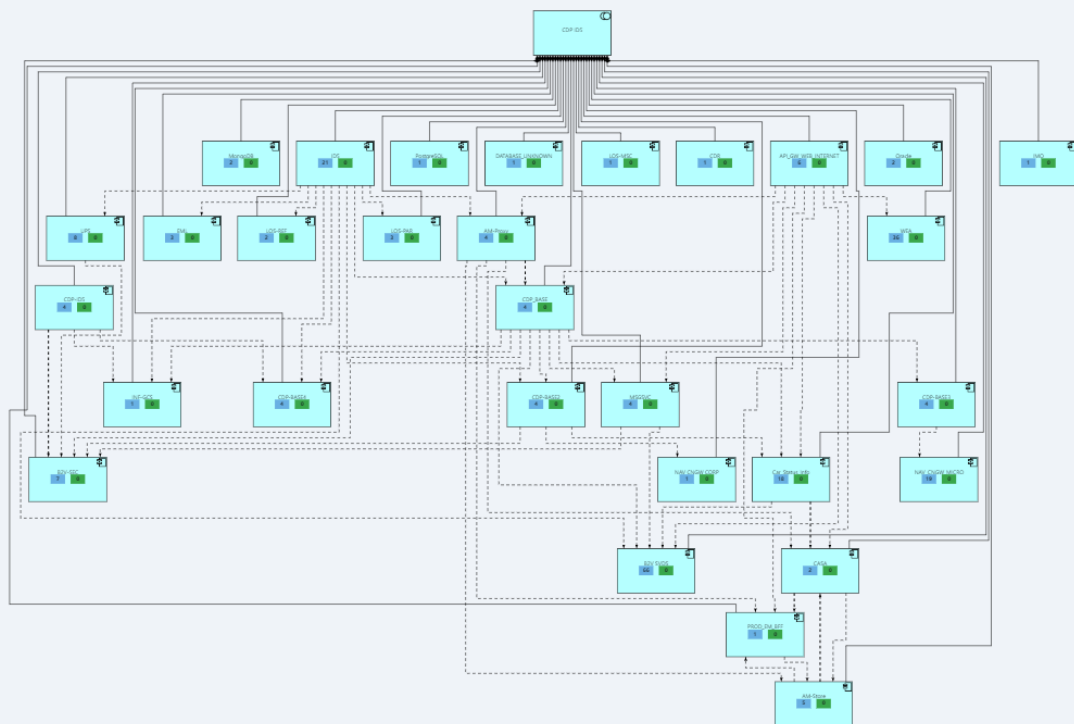
**Business Services**  
X-Call Services

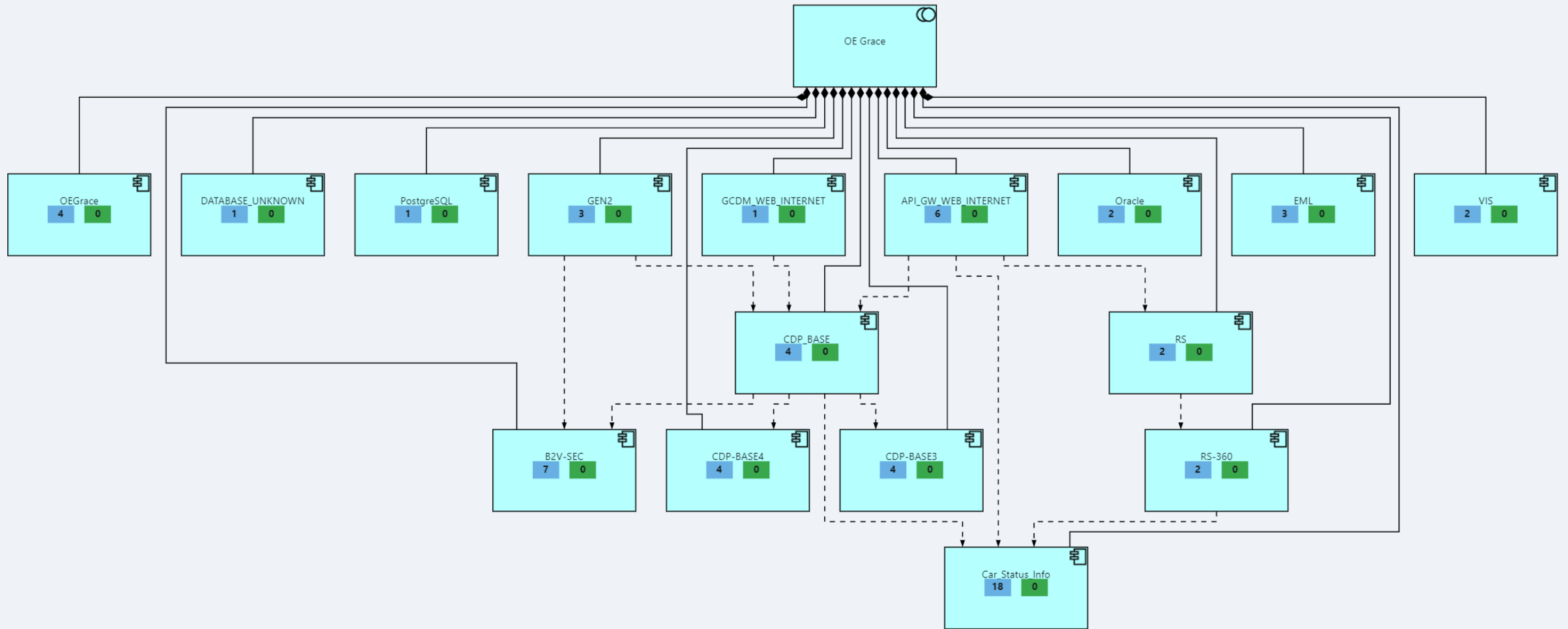
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09/27/2019 12:00

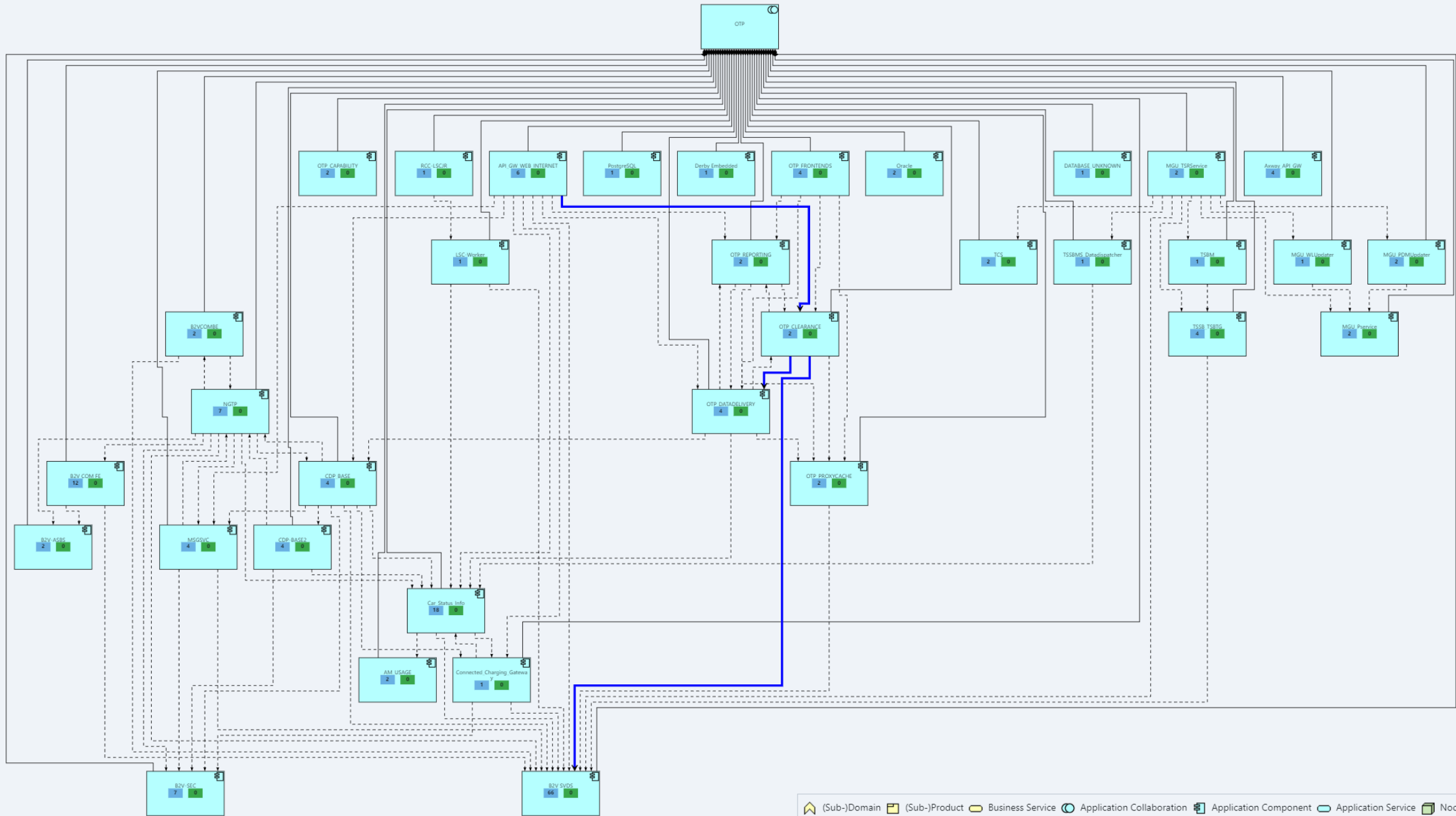
**Number of Instances**  
2

**Software Technologies**  
JAVA

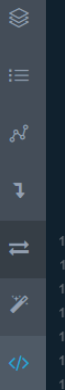












```

1 query {
2   database {
3     domains {
4       name
5       businessServices {
6         id
7         applicationComponents {
8           id
9           calls {
10            id
11          }
12          calledBy {
13            id
14          }
15        }
16      }
17    }
18  }
19 }
20

```



```

{
  "data": {
    "database": {
      "domains": [
        {
          "name": "Connected Backend Services",
          "businessServices": [
            {
              "id": "APP-17842",
              "applicationComponents": [
                {
                  "id": "NGTP",
                  "calls": [
                    {
                      "id": "B2V-SEC"
                    },
                    {
                      "id": "NOP-Trigger"
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                    {
                      "id": "B2V-ASBS"
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                      "id": "B2V COM FE"
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                    },
                    {
                      "id": "Car_Status_Info"
                    },
                    {
                      "id": "CCC"
                    },
                    {
                      "id": "XFCD"
                    }
                  ]
                }
              ]
            }
          ]
        }
      ]
    }
  }
}

```

DOCS SCHEMA

Search the docs ...

QUERIES

- domain(...): Domain!
- domains: [Domain!]!
- eamServices: [EamService!]!
- eamService(...): EamService!
- dynatrace: Dynatrace!
- appmon: AppMon!
- database: FromDB!
- cloud: AWSService!
- ea: [UnifiedService]!
- pmComponents(...): [PmComponent!]!
- pmComponent(...): [PmComponent!]!
- pmProjects: [PmProject]!
- pmProject(...): [PmProject]!

MUTATIONS

- eamService(...): EamServiceMutation!
- saveArchitectureState(...): [ArchitectureComponent]!
- backupArchitecture(...): [Boolean]!
- createArchitectureBackup(...): [Boolean]!
- saveInitialArchitecture: [Boolean]!
- saveDynatraceAuth(...): Boolean!
- startAutoArchDiscovery(...): Boolean!
- continueAutoArchDiscovery: Boolean!
- backwardsDiscovery(...): Boolean!
- forwardsDiscovery(...): Boolean!
- saveArchitectureToDBFilteredByApplicati: Boolean!
- saveBusinessLayerInformation: Boolean!
- saveArchitecture(...): Boolean!
- checkForOutdatedEntries: Boolean!
- saveArchitectureModelsToDB(...): Boolean!

database: FromDB!

TYPE DETAILS

type FromDB {

- source: String!
- architectureModels: [ArchitectureModel!]!
- latestArchitectureModels: [ArchitectureModel!]!
- architectureModelsAt(...): [ArchitectureModel!]!
- relationships: [Relationship]!
- latestRelationships: [Relationship]!
- relationshipsAt(...): [Relationship]!
- domains: [ProductDomain]!
- domainsAt(...): [ProductDomain]!
- domain(...): ProductDomain!
- domainAt(...): ProductDomain!
- products: [ITProduct]!
- productsAt(...): [ITProduct]!
- product(...): ITProduct!
- productAt(...): ITProduct!
- businessServices: [BusinessService]!
- businessServicesAt(...): [BusinessService]!
- businessService(...): BusinessService!
- businessServiceAt(...): BusinessService!
- devices: [ArchitectureModel!]!
- applicationComponents: [ApplicationComponent]!
- applicationComponentsAt(...): [ApplicationComponent]!
- applicationComponent(...): ApplicationComponent!
- applicationComponentAt(...): ApplicationComponent!
- applicationServices: [ApplicationService]!
- applicationServicesAt(...): [ApplicationService]!