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CC_ITM Competence Center
Information Technology and Management
Institute at the University of Applied Sciences
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Service Computation 2022
April 24 – 28, 2022 – Barcelona, Spain

Keynote
A Journey through (over) 15 Years of Research about Service-based Computing for the Insurance Industry - From SOA to Microservices -

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Presenter: Andreas Hausotter

Dr. ANDREAS HAUSOTTER is a professor emeritus for distributed information systems and database systems at the Hannover University for Applied Sciences and Arts, Faculty of Business and Computer Science. His area of specialization comprises service computing – including service-oriented Architectures (SOA) and microservices – Java EE, webservices, distributed information systems, business process management, business rules management, and information modeling.

In 1979 he received his PhD in mathematics at Kiel University, Faculty of Mathematics and Natural Sciences. After graduation he started his career with KRUPP ATLAS ELEKTRONIK, Bremen, as a systems analyst and systems programmer in the area of real time processing. In 1984 he was hired as systems engineer and group manager SNA Communications for NIXDORF COMPUTER, Paderborn. After that, he worked for HAAS CONSULT, Hanover, as a systems engineer and product manager for traffic guidance systems.

In 1996 he was appointed professor of operating systems, networking and database systems at the University of Applied Sciences and Arts, Hanover. He has been retired since March 2018.

From the beginning he was involved in several research projects in cooperation with industry partners. During his research semester he developed a Java EE / EJB application framework. Based on this framework a web-based simulation software for securities trading was implemented by his research group to train the apprentices of the industry partner.

In 2005, the Competence Center IT & Management (CC_ITM) was founded in cooperation with industry partners. Different ambitious research projects have since then been carried out in the context of service-computing, microservices, cloud computing, business process management, and business rules management.

Andreas Hausotter is involved with IARIA since 2016. He regularly published at IARIA Service Computation conferences and journals. The co-authored contribution on microservices has been awarded as one of the top papers. In 2018 and 2021 he was a keynote speaker and participated in several panels (2016, 2017, and 2018). 2018 and 2019 he was a chair and coordinator of special tracks on microservices. Andreas Hausotter has been an IARIA fellow since 2020.

Presenter: Arne Koschel

Prof. Dr. Arne Koschel studied Computer Science, Technical Univ. Braunschweig, Diploma, 1993
1994-1999: PhD student, Research Centre for Comp. Sci. (FZI); PhD (Dr.-Ing.) from the Univ. Karlsruhe (now: KIT)
1999-2001: Freelance Enterprise Architect / Senior Consultant, customers included: dvg; SIZ; IONA Professional Services & Product Management; Focus: Heterogeneous, distributed information systems,
until May 2004: World wide: Technical PM / Product Manager at IONA (now: Microfocus)
Areas: CORBA, J(2)EE, Web Services, Mainframe Integration, SOA
until Sept. 2005: "Head of Application Integration", Dt. Post SOP Group (now: Sopera/Talend)

since Oct. 2005: Professor at the Hochschule Hannover, Univ. of Applied Sciences and Arts

- Main areas: Distributed systems / Distributed Information Systems, Integration, Microservices, SOA, Middleware (Java EE/Jakarta EE Application Server, Cloud Computing, EDA, Messaging, …) etc.
- Regularly: Conference speaker, co-authored well over 100 articles and books
- Aside work: Trainer and Consultant
- iSAQB.org (Intl. Software Architecture Qualification Board): Founding member, Active Board Member, Advanced Level Group
- Since 2005 member of the Competence Center IT & Management (CC_ITM) working in the context of service-computing, microservices, cloud computing, business process management, and business rules management.

- IARIA: Several articles, first one in Service Computation 2009 (Mainframe Integration), several chairing positions, best paper awards, tutorials, keynotes, IARIA fellow since 2011

Agenda

1. Introduction
2. Groundwork – SOA Guidelines and Registry/Repository
3. Process Automation – Implementation of Workflow Management
4. Integration of SOA, Business Process, Business Rules and Business Activity – A SOA Reference Architecture
5. Keeping Ahead – Investigation of the Implementation of the Microservices Architecture
6. The Big Picture – Towards a Microservices Reference Architecture
7. Conclusion

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CC_ITM@HsH

- **Competence Center Information Technology & Management (CC_ITM)**
  - Institute at the University of Applied Sciences and Arts, Hannover
  - Founded in 2005 by colleagues from the departments of **Business Information Systems and Computer Science**
  - Members: **Faculty staff**, **industry partners** (practitioners) of different areas of businesses
- Main objective
  - **Knowledge transfer** between university and industry
- Research topics
  - Management of information processing
  - Service computing, including Microservices, Service-oriented Architectures (SOA), Business Process/Rules Management (BPM/BRM)
  - Cloud Computing

CC_ITM Partners from German Insurance Industry

- Medium to larger size companies
- Typically „IT landscape grown up over decades“
- Technically heterogeneous
  - PCs, Linux servers, Mainframes
  - Own development: Java, C++, Cobol, Assembler, R
  - 3rd party software such as SAP Hana / R3

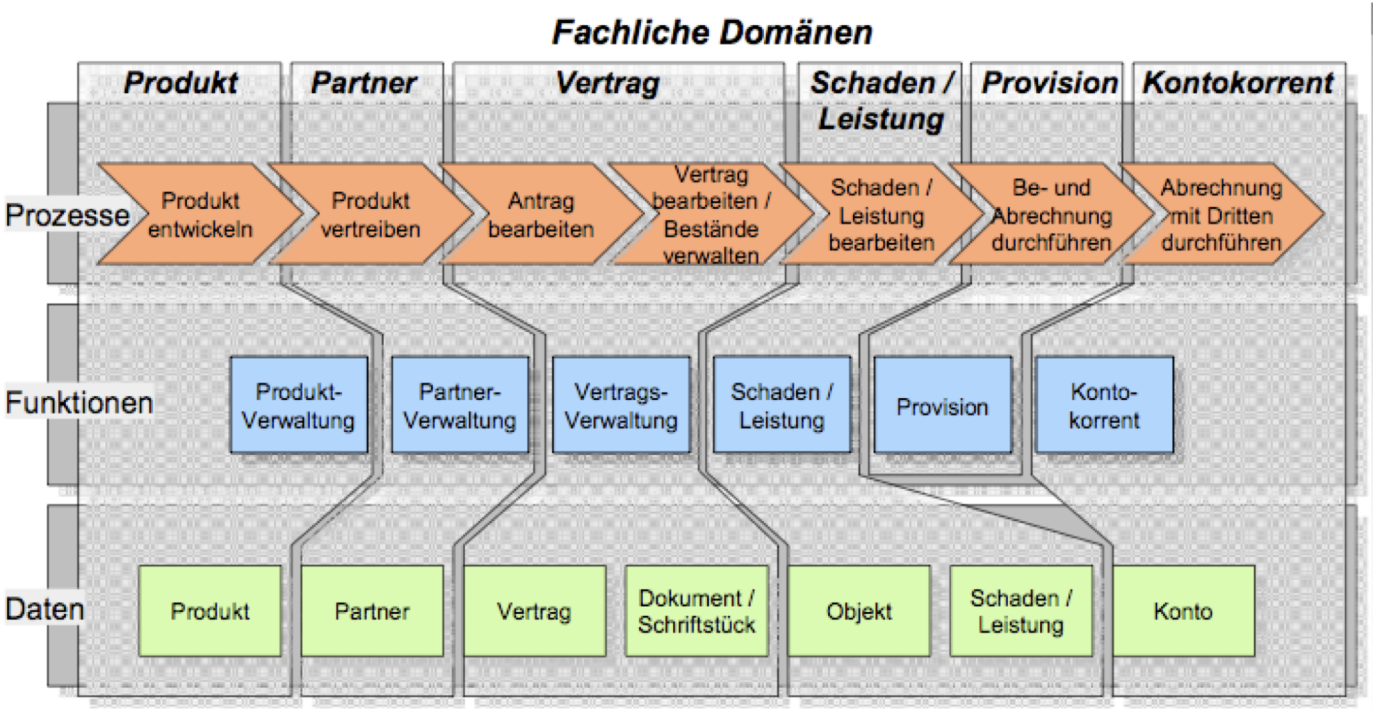
CC_ITM Partners from German Insurance Industry

- Heterogeneous software architecture styles:
  - Functional, processes (orchestration, choreography), SOA (often with ESB)
    relatively recent additions: Microservices & DevOps
  - For parts: high QoS demands for security and availability (GDPR, VAIT, …)
- Often process oriented, for example, ”car insurance coverage“
  - More general process orientation often ”VAA orientated“
    - VAA: “VersicherungsAnwendungsArchitektur“
      (reference architecture for German insurance companies)

➔ Key demand: Integration of all those aspects; none of it will vanish any time soon

Process Background: VAA (Versicherungsanwendungsarchitektur)

Business Reference Architecture from/for (German) Insurances



Source [ivv GmbH, Hannover]

CC_ITM and Insurances Cooperation Work

2006-2008	**Groundwork – SOA Intro Talks, Guidelines and Registry/Repository**
2008-2009	**Process Automation – Implementation of Workflow Management (WfM)**
2009-2011	SOA & Business Process Controlling (BPC)
2011-2013	SOA & Business Activity Monitoring (BAM)
2013-2015	**Integration of Business Rules Management, Business Process Management und Business Activity Management with/in SOA – A SOA Reference Architecture (RA)**
2015-2017	QoS @ SOA: Investigating quality of service aspects for combined BRM-, BPM- and SOA environments
2017-2019	**Initial MicsV and DevOps projects: Keeping Ahead – Investigating Microservices and DevOps for "Versicherungen" (Insurance Companies)**
Since 2020	**The Big Picture – Towards a Microservices based Reference Architecture for (at least) typical German Insurance Companies**

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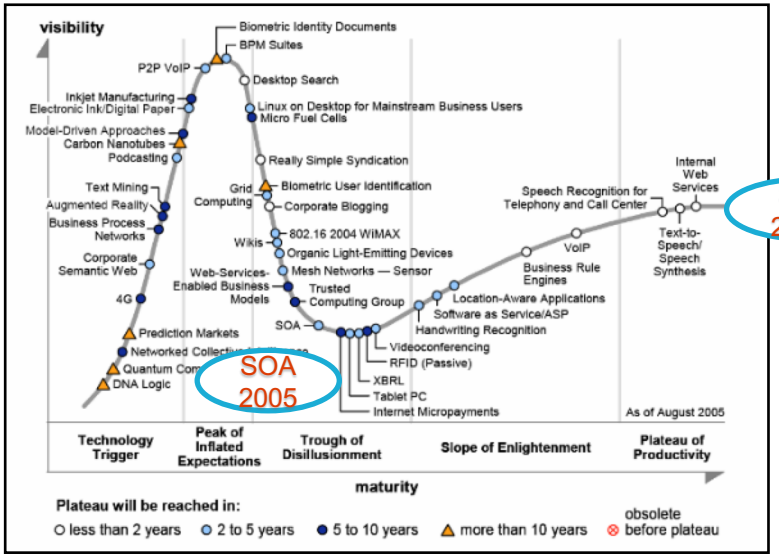
Groundwork – SOA Intro Talks

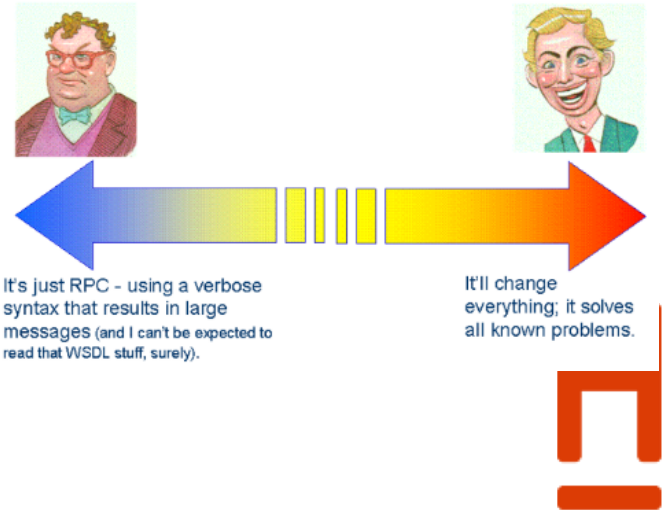
- SOA: Importance for IT



Adopted from
[https://www.gartner.com/en/documents/484310,
https://www.gartner.com/en/documents/1085912]

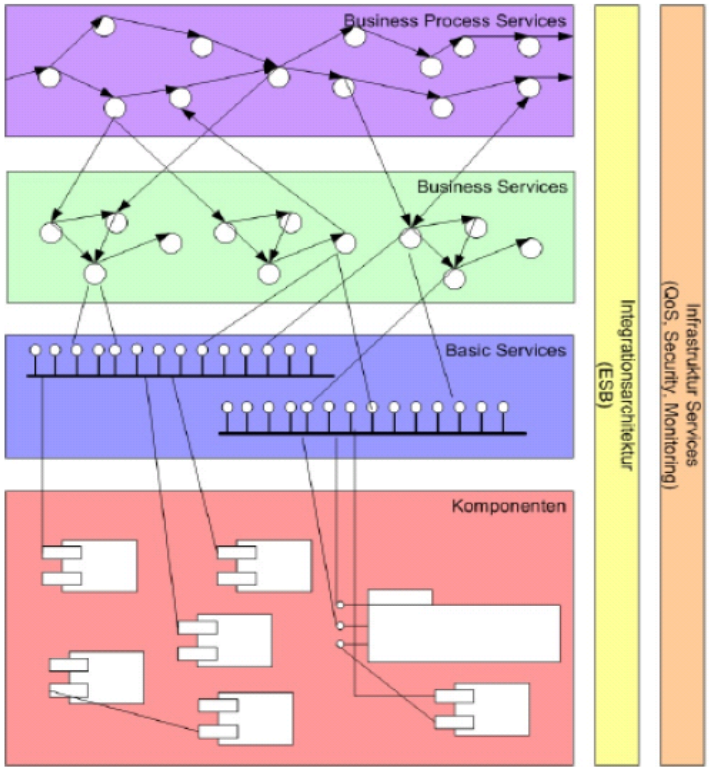
Is SOA new or just "the next silver bullet"?

- The SOA principles aren't really new;
  e.g. remember components & connectors [Garlan/Shaw, begin 90's]
- However, with the Web services hype it currently gets
  "massive vendor/user support"



Groundwork – SOA Guidelines

- SOA Patterns
  - E.g., Service classification, wrapper, versioning, …
- SOA Design Guidelines
  - E.g., naming, data types, granularity, …
- SOA Application Architecture
  - Frontend, service tier, …

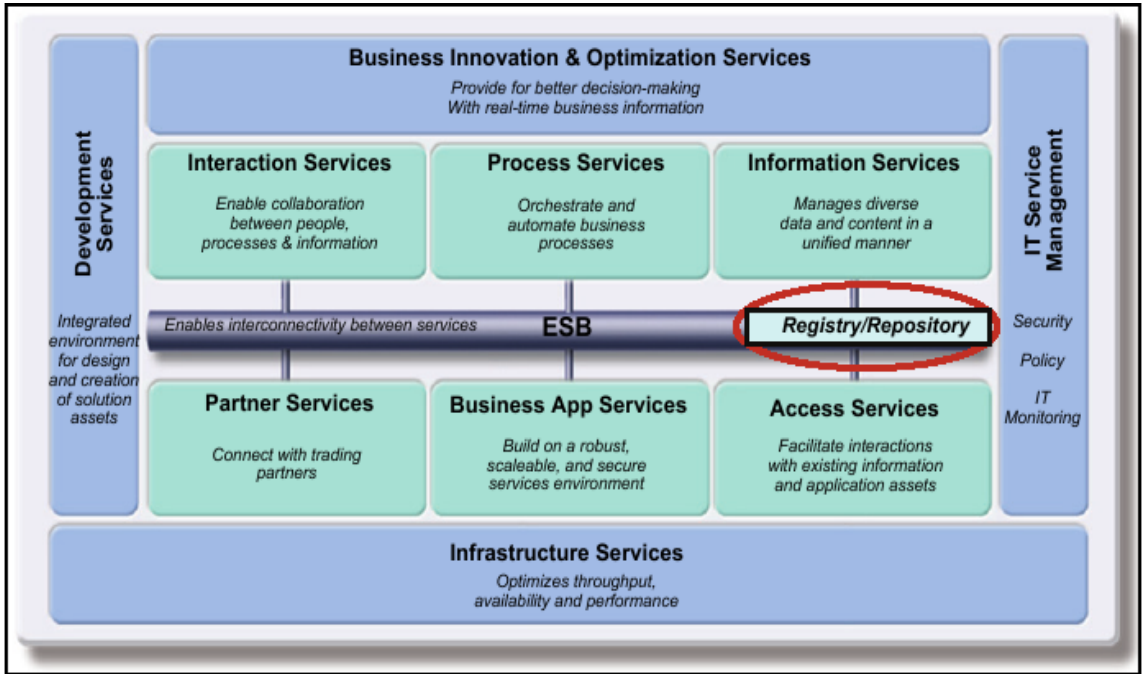


SOA Layers [6]

Groundwork – SOA R & R Evaluation

- SOA Registries and Repositories

  Evaluation



SOA: Registries and Repositories [7, 13]

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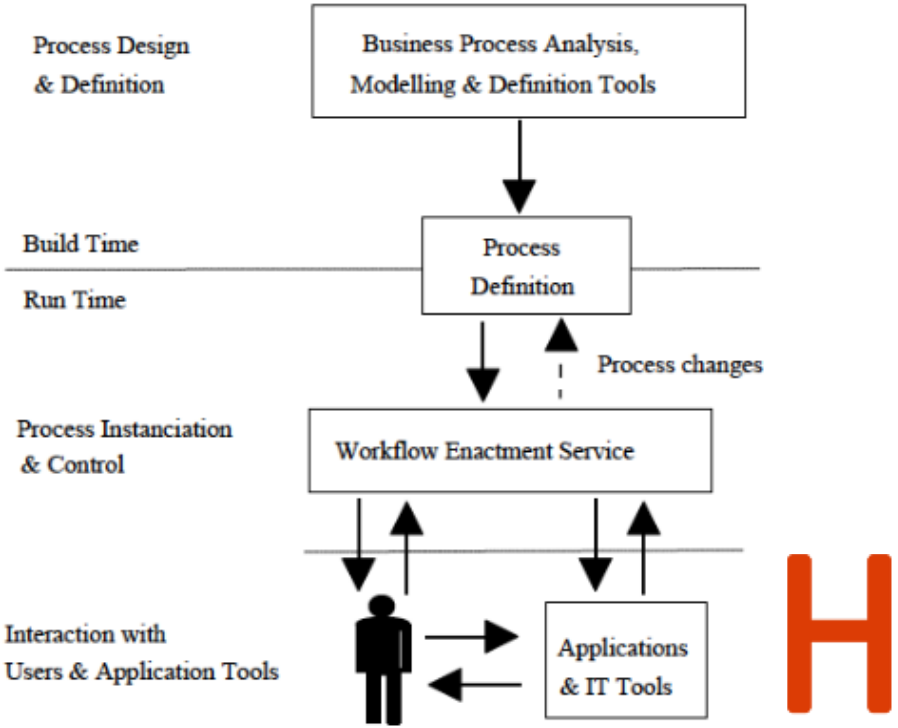
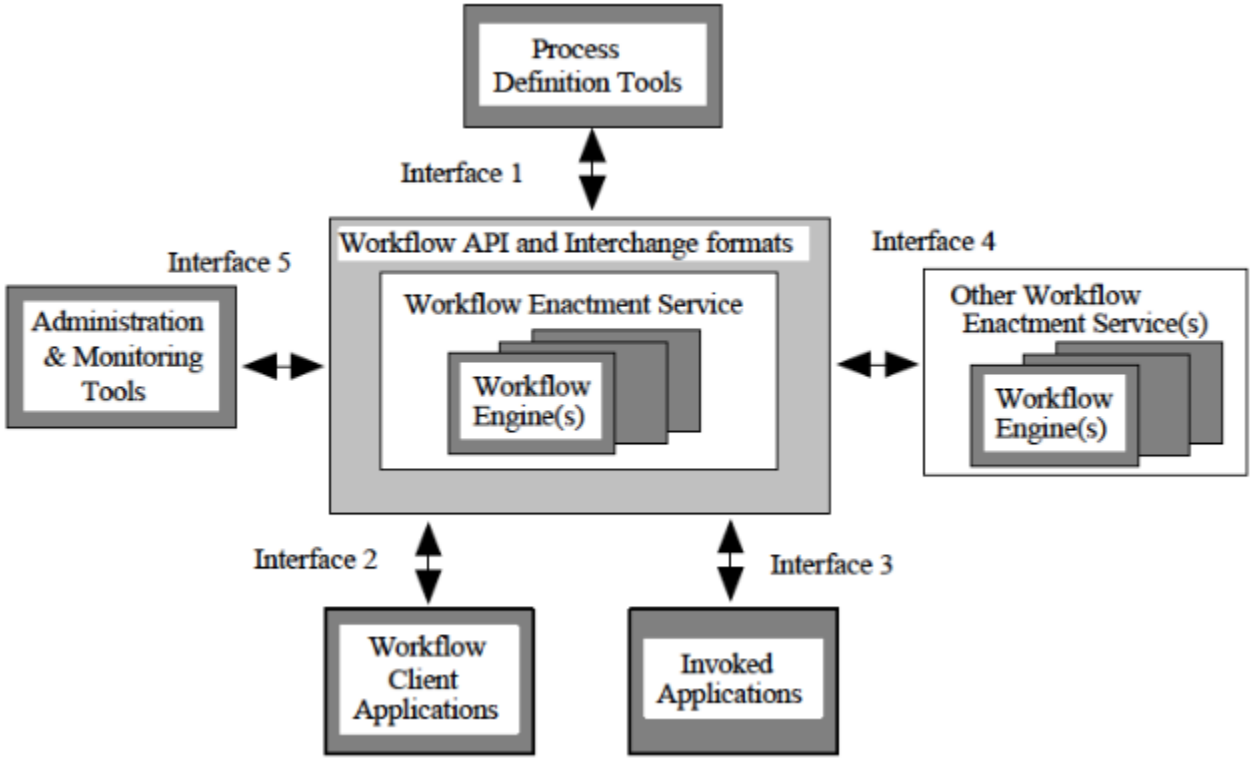
What is Workflow Management?

- **Workflow**: "The Computerized (…) automation of a process (…)." [8]
- **Workflow Management System (WfMS)**: "A system that (…) defines, manages and executes workflows through the execution of software whose order of execution is driven by a (…) representation of the workflow logic." [8]
- **Process Definition**: "The computerized representation of a business process that includes the (…) and workflow definition [8]."



Workflow System Characteristics [8]

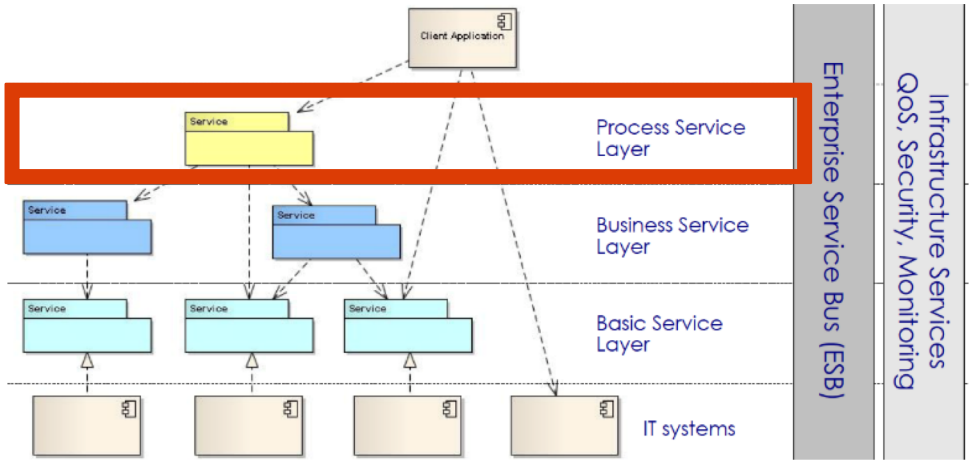
Workflow Reference Model



Workflow Reference Model – Components and Interfaces [8]

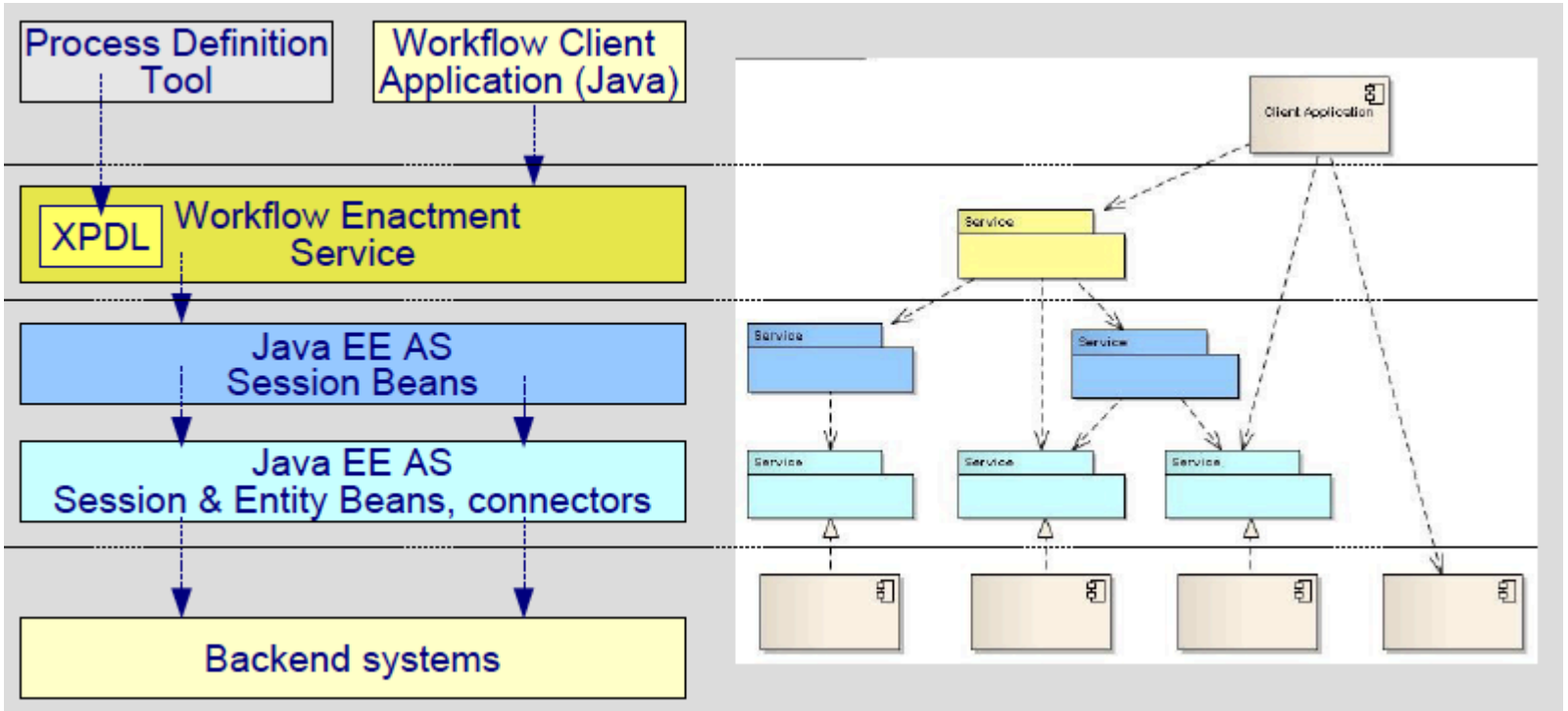
SOA and Workflow Management

- SOA
  - Method to **design application landscapes**
  - Based on **components** in association with **loose coupling** and **externalized flow control**.
- Externalized flow control
  - Business **Process Services** are **modelled**, not implemented.
  - Orchestration promotes **agility and flexibility**.
  - **WfMS** can be used to **model and run** Business Process Services.



SOA, Services and Service Layers [own representation].

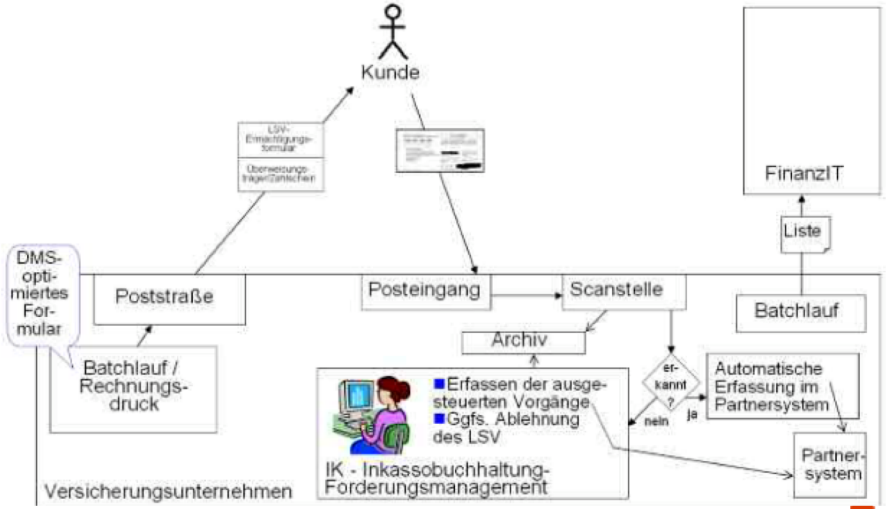
Java EE and WfMS: One Way to Implement a SOA



Mapping Services to Technology [own representation].

Debit Authorization Process

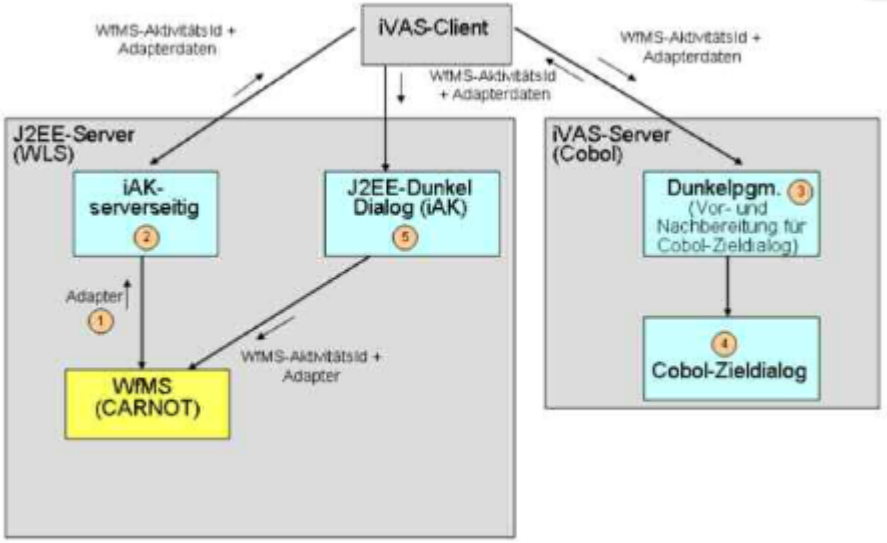
- **Debit authorization form** is attached to each invoice sent to a customer.
- If the **customer** wants to participate in the direct debit procedure, he/she **completes the form** and returns it to the company, e.g. by mail.
- The **data is automatically read out** from the received form via a scan path, **checked for completeness and consistency** and stored in the partner management system.
- Finally, the **direct debit procedure** can be set up.



Debit Authorization Process [ivv GmbH, Hannover].

Application Architecture

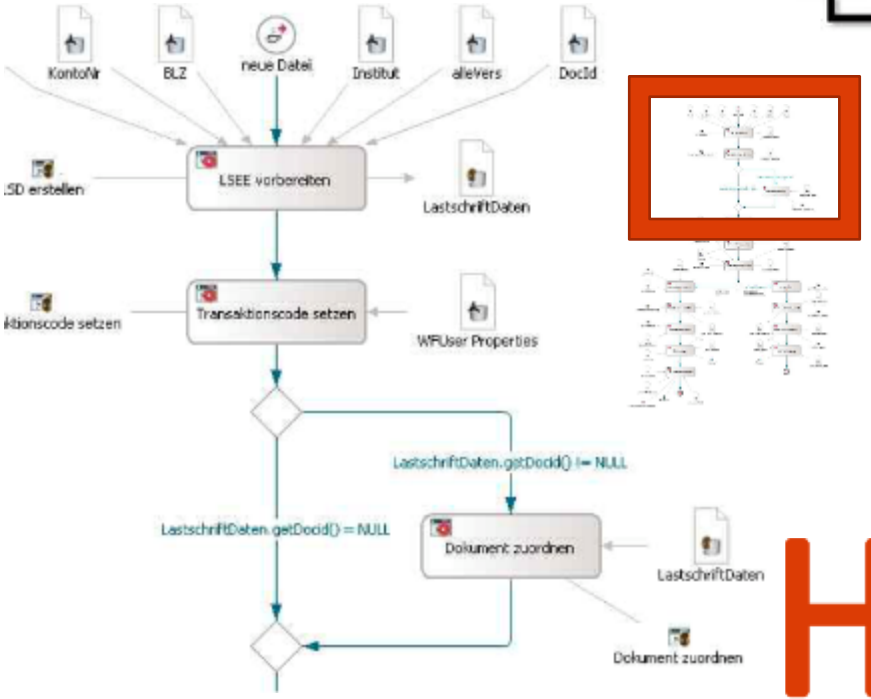
- **iVAS Client**: Java ivv Insurance Application System
- **J2EE-Server**: Application Server (BEA Weblogic 8.1)
- **iAK serverseitig**: Service that utilizes the WfMS worklist handler (Carnot)
- **iAK (J2EE-Dunkel)**: Service that utilizes the WfMS worklist handler for batch processing (Carnot)
- **iVAS-Server** (Cobol): Handels requests from the Cobol iVAS Client.



Debit Authorization Process [ivv GmbH, Hannover].

Business Process & Workflow Model

Business Process Model [ivv GmbH].



Excerpt from the Workflow Model [ivv GmbH, Hannover].

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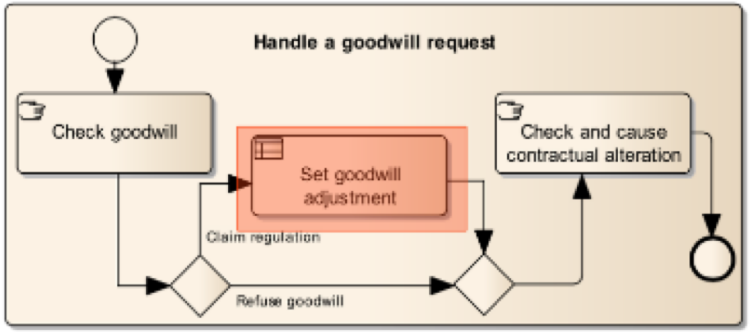
Motivation

Results: [4,9]

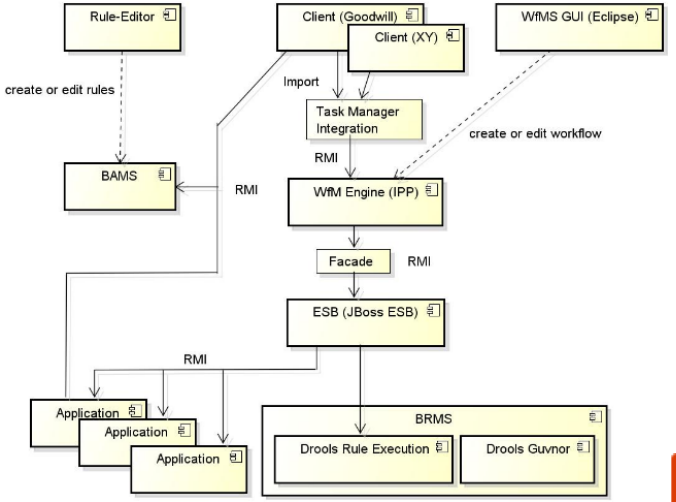
- **Challenges** in business processes / workflows
  - Activities often implement complex **business rules**
  - Intermixing of **process and decision logic** create complexity.
- Example from the VAA: „Goodwill payment“
  - **Compensation voluntary granted** by the insurance company
  - Triggering event: repudiation of cover
  - Goal: Preserve the business relation with the customer.
  - Red shaded activity realises **decision logic**.



Business Process “Handle a goodwill request” [9].

Approach

- **Service-oriented integration** of
  - Business Process Management (BPM)
  - Business Rules Management (BRM)
- **Separation** of **process** and **decision logic**
  - Reduces complexity
  - Promotes the required flexibility and agility.



Target Architecture [9].

What is Business Rules Management?

- **Business Rules Management (BRM)**
  - Holistic approach to identify, design, document, implement, monitor, and improve business knowledge in a continuous improvement process
- **Business Rules**
  - Directives, guidelines, regulations that are intended to influence and guide business behaviour, e.g. business processes.

Business Rules Life Cycle [own representation].

Business Rules Execution Approaches

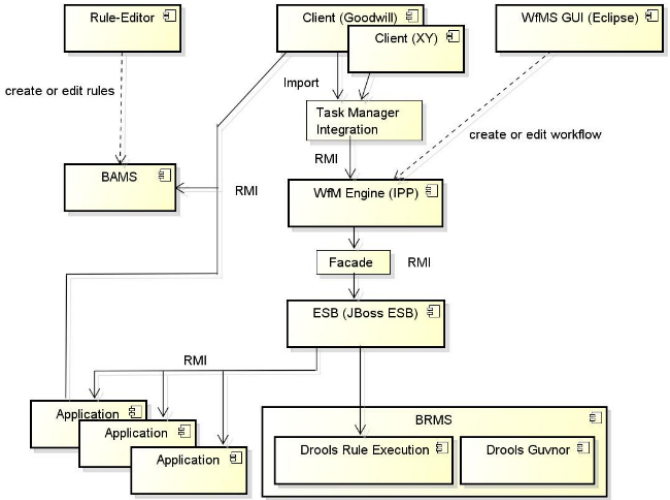
- Approaches
  - Business Applications
  - Configuration
  - Inference machine as part of a BRMS
- **Decision Framework:** combines factors and indicators to find the suitable approach.

Factor	Indicator		
	Business rules execution approach		
Frequency of rule change	High (hourly to weekly)	Low (monthly to annually)	Never
	Inference machine	Configuration / Database	Business Application

Applying the Decision Framework to “Handle a Goodwill Process” [9].

Design Decisions

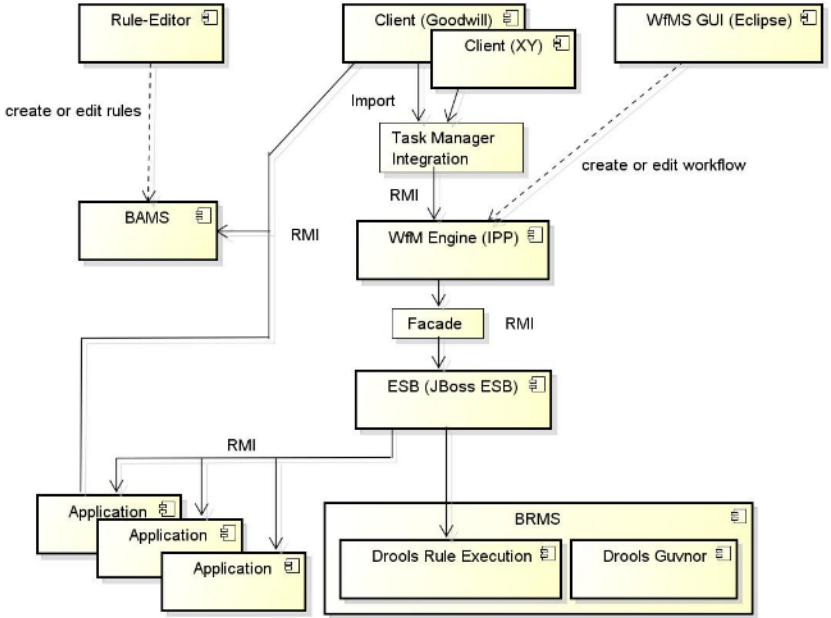
- **Business rules execution**
  - Application of the decision framework to the process „Handle a goodwill request“
  - Introduction of an inference engine, i.e. a **BRMS**
- **Logical vs. physical Enterprise Service Bus (ESB)**
  - Advantages of a physical ESB outweights the disadvantages
  - Decision: Introduction of a **physical ESB**



SOA Reference Architecture integrating BPMS and BRMS [9].

SOA Reference Architecture

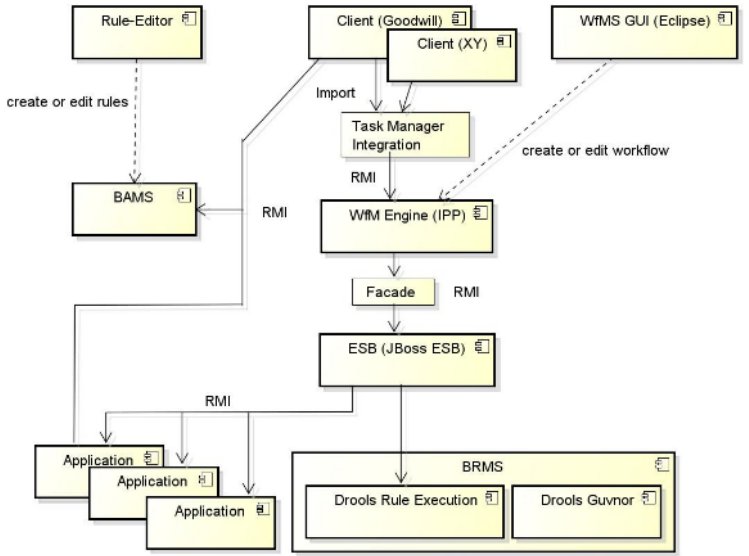
- **WfMS**
  - Accesses the facade Bean, instead of services
  - Process model (XPDL) has to be modified
- **Facade bean**
  - Called by the WfMS according to the process model (XPDL file)
  - Invokes the service calls.



SOA Reference Architecture integrating BPMS and BRMS [9].

SOA Reference Architecture

- **Enterprise Service Bus (ESB)**
  - Routes the service calls by the facade bean to the applications
  - Invokes the applications
  - Invokes the BPMS
- **Business Rules Management System (BRMS)**
  - Realizes the business rules
  - Integrated in the process definition (XPDL)
  - Invoked by the ESB on behalf of the process definition (XPDL)



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Case Study: Partner Management System with Microservices

Results: [2]

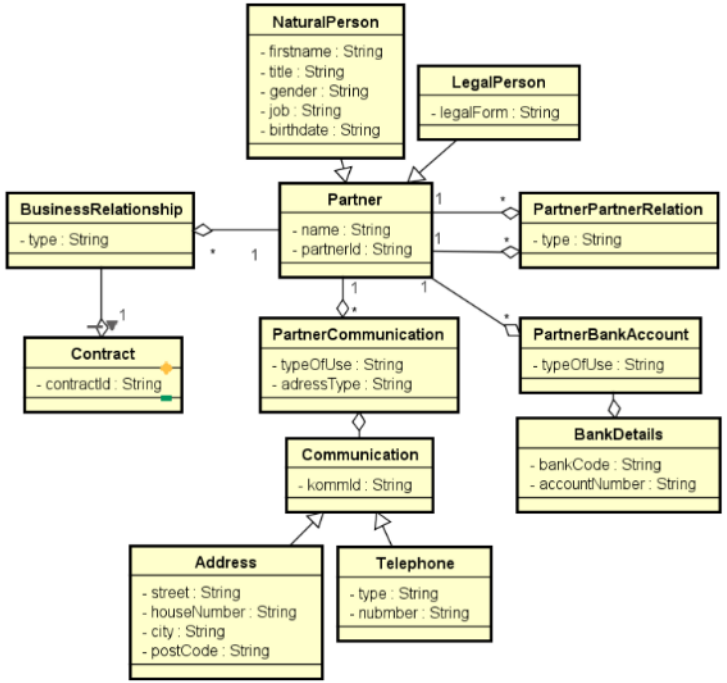
- A system for managing partners of an insurance company
- Based on the VAA

→ Basically a CRUD application

Motivation for microservices :

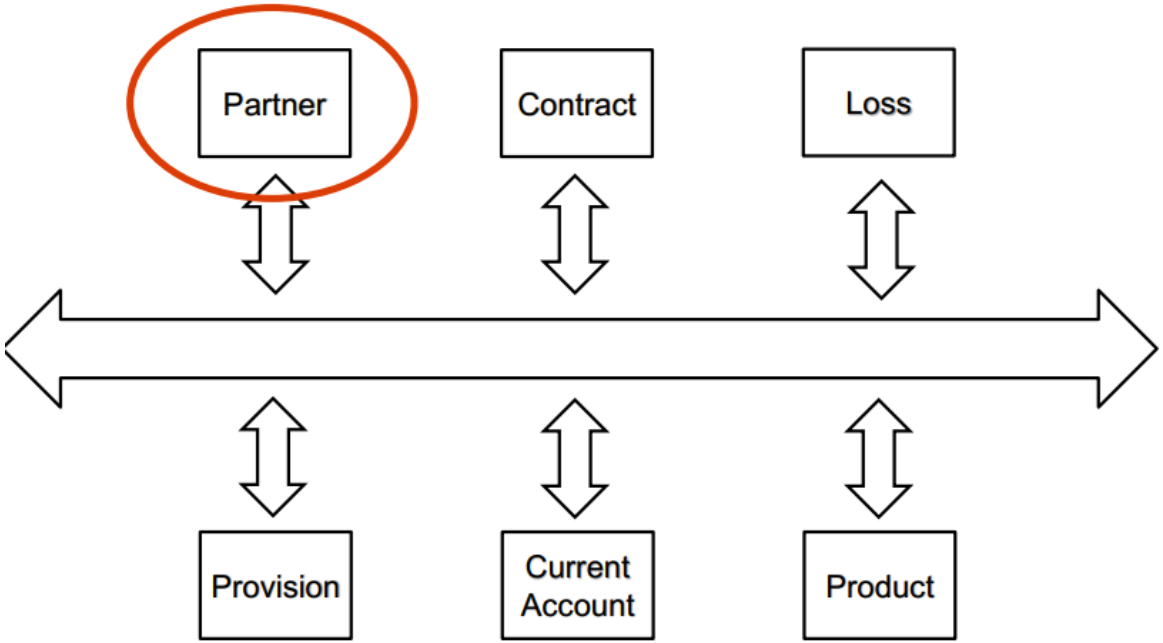
- Currently implemented as a single deployment unit
- Heavily changing load distribution
- Poor flexibility, scalability and fault tolerance

➔ Microservices approach



Business Objects of the Partner Management System [2].

Placement in the VAA



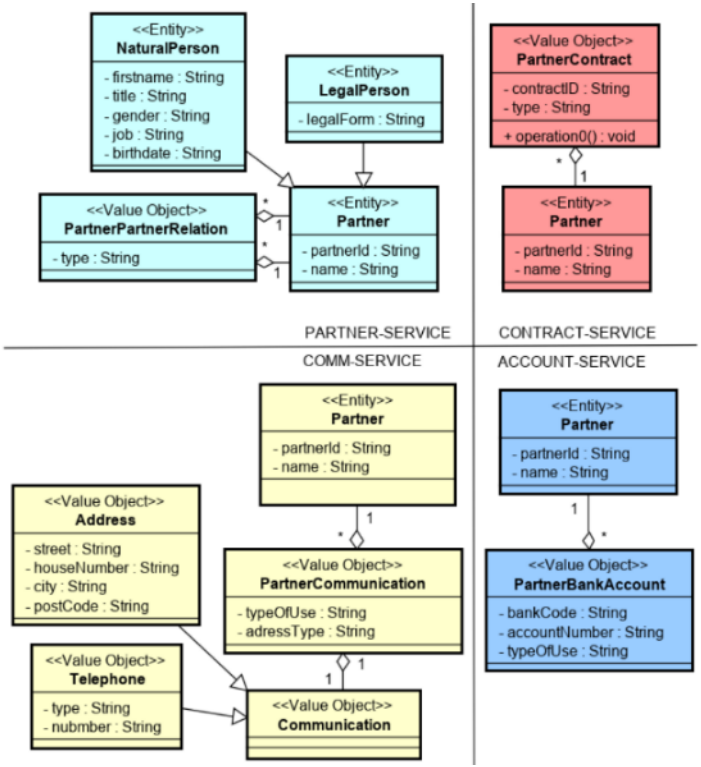
The Application Landscape of the Project Partner [own representation].

Service Design

Deriving

Bounded Contexts

based on DDD

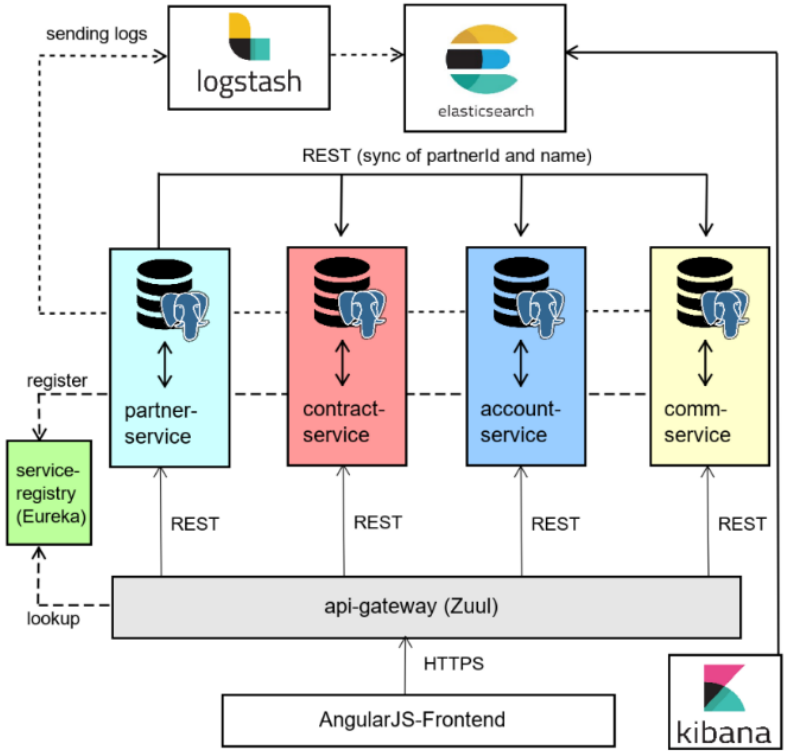


Bounded Contexts of the Partner Management System [2].

Case Study

Microservices

Technical Design



Infrastructure of the Partner Management System [2].

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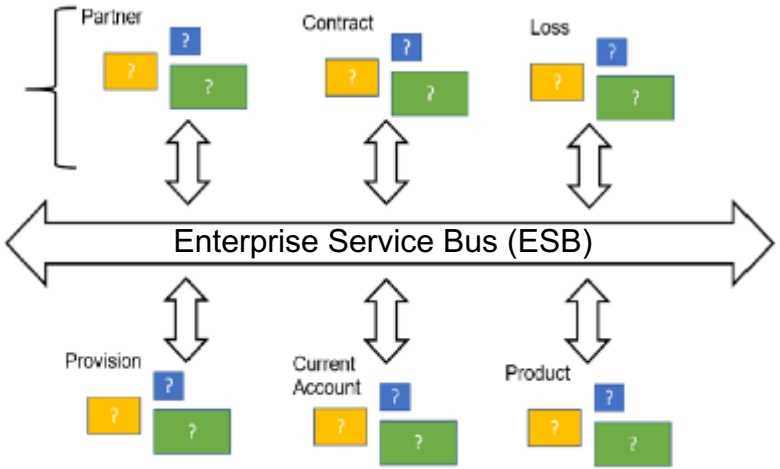
The Partner‘s Application Landscape

Results: [11]

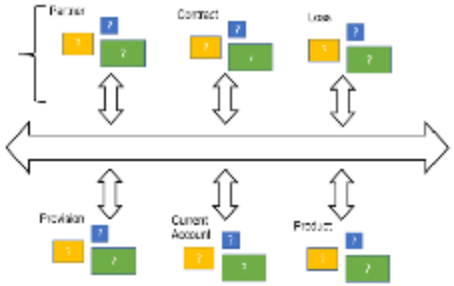
- **Service-oriented** application landscape
  - **Enterprise Service Bus (ESB)** – in-house development: Routing, Delivery and Transfomation
  - **Business Process Management System (BPMS)** – Camunda: Modelling, Execution and Monitoring of Business Processes.



Service-oriented Application Landscape [own representation].

How to Deal with Microservices et al.

- **Strategic decisions** of the project partner
  - Provision of new features as **microservices.**
  - **SOA** with ESB & BPMS must not be questioned.
- **Challenges** the project partner is faced
  - **SOA, Legacy** and **microservices** applications must **coexist** for a longer transition time.
  - Need to **integrate applications** from different architectural paradigms.



???

Sample Microservices Architecture [10].

Key Research Issues

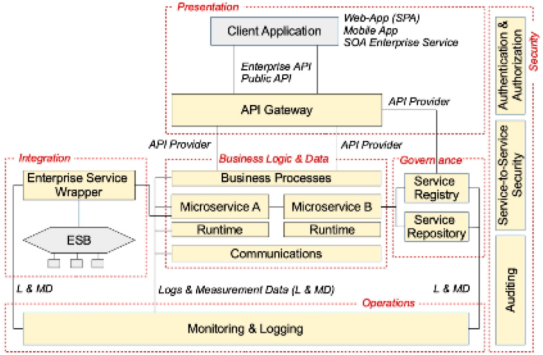
- **Main Research Question**
  - *According to which **rules** must a microservice-based application landscape in the insurance industry be designed?*
- Rules …
  - … must answer the **subordinate questions**
  - … must promote to **exploit the potential of the approach**: e.g. shorter time-to-market, scalability, resilience, …

Key Research Issues

- **Subordinate Questions** (selection)
  - **Service monitoring and logging**: „Which information from business and technical services must be provided to architects, developers, and operators?“
  - **Business processes**: „How to integrate with processes? Is orchestration of choreography (or perhaps both) more suitable for microservices?“
  - **Coexistence** of different architectural paradigms: „How can SOA and legacy applications be seamlessly integrated into a microservices architecture – and / or vice versa?“
  - **Consistency and Transactions**: „How to deal with transactions? Are ACID transactions (always) a ‚must‘?

Reference Architecture for Microservices

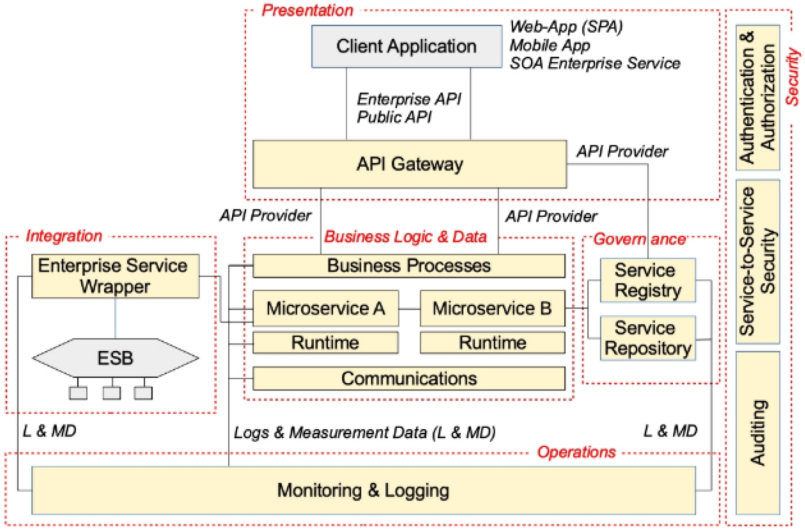
- **Research Goal**
  - Development of a **microservices reference architecture (RaMicsV)** for the cooperation partners from the insurance industry.
  - RaMicsV implements the findings that result from answering the main research and subordinate questions.
- **RaMicsV** allows architects and developers to build **compliant microservices-based applications**.



Microservices Reference Architecture RaMicsV [own representation].

RaMicsV – Research Areas

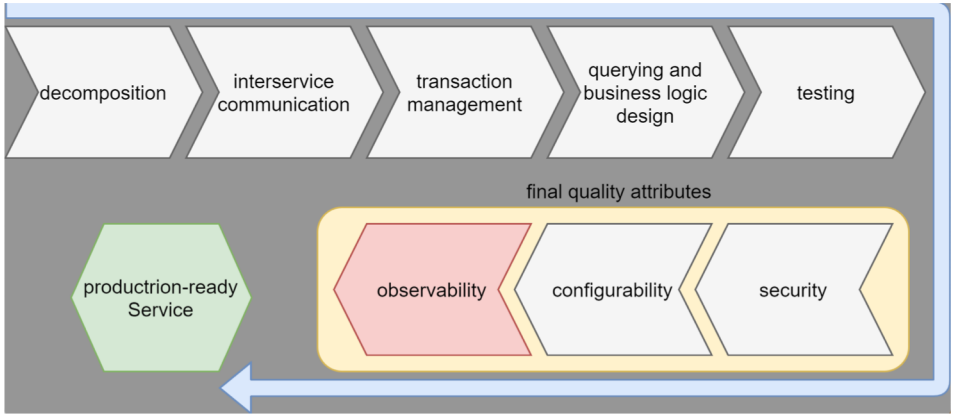
- **Observability**: Unified monitoring and logging approach
  - Presented on „Service Computation 2021“, Porto
- **Business processes**: Realization of workflows through orchestration and choreography
  - Presented on „Service Computation 2022“, Barcelona
- **Security**: Security issues with respect to regulations in Germany
  - Presented on „Service Computation 2022“, Barcelona



Microservices Reference Architecture RaMicsV [own representation].

Introduction to Logging and Monitoring

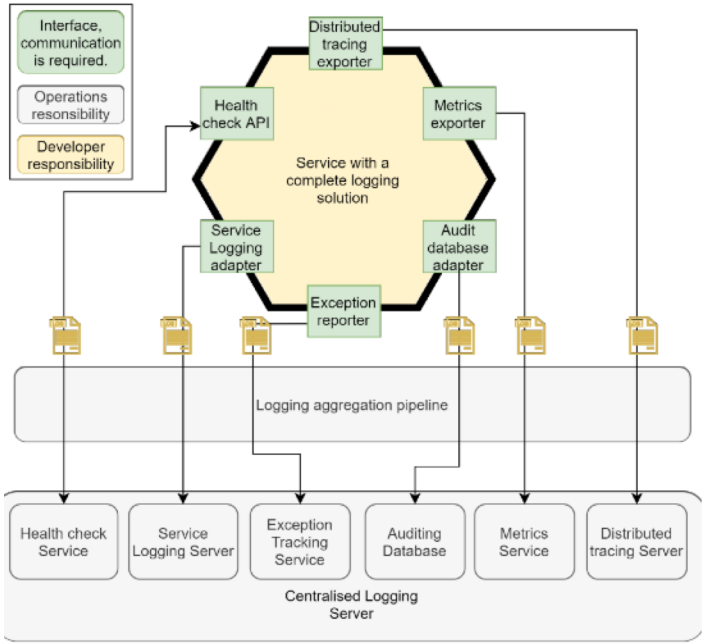
- Observability is a final **quality attribute**.
- Important to first **produce** the right data, **collect** it and then **monitor** it.
- We are concerned with the objective of how we can create a uniform, **fully comprehensive, traceable environment** for monitoring and logging.



Typical building blocks for the development of a (micro) Service [11].

Patterns for Logging and Monitoring

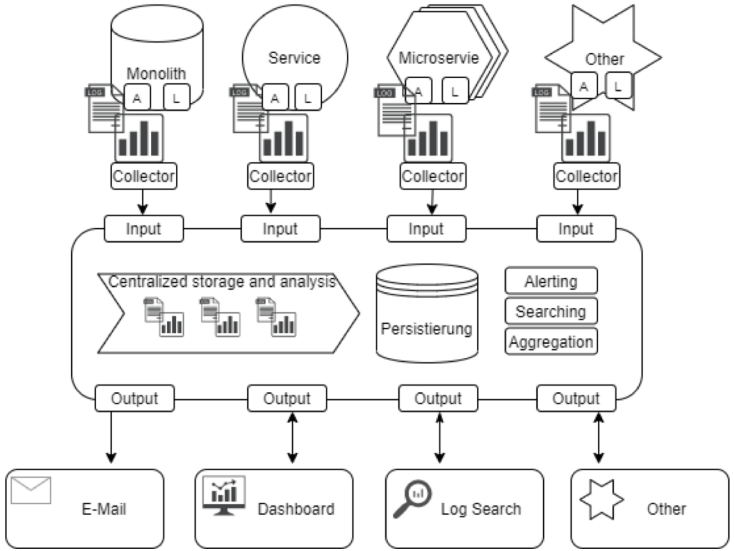
- **Health Check API** reports on the health status of the service.
- **Log Aggregation** is important for the evaluation of distributed systems.
- **Distributed Tracing** is for the traceability of distributed requests.
- **Application Metrics** is for application insights. Here, the value generated is strongly dependent on the content.
- **Exception Tracking** separate treatment of exceptions.
- **Audit Logging** provides information about the actions taken.



Exemplary implementation of all patterns in combination [10, adopted with modifications].

Logical Reference Architecture

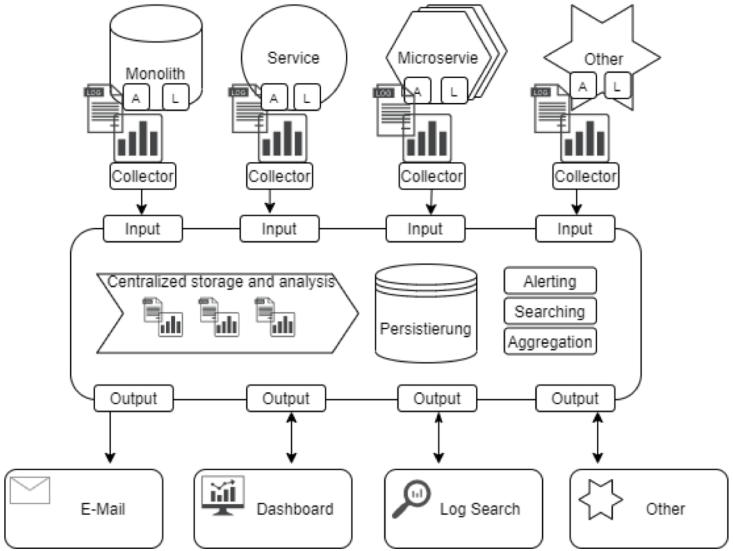
- **Agents (A):** Sort of external process to instrument processes at runtime. One of two methods are used to do so:
  - Injecting code through a external process.
  - In-process agent, that uses defined rules to trace specific actions.
- **Libraries (L):** Used in services to handle the key components for instrumentation and context propagation through a standardized API.



Logical reference architecture of the monitoring and logging environment [11].

Logical Reference Architecture

- **Collector:** Responsible for translating incoming data into another format, sampling and computing aggregate statistics about incoming data.
- **Centralized storage and analysis:** Gathering all telemetry data, storing and analysing.



Logical reference architecture of the monitoring and logging environment [own representation].

Agenda

1. Introduction
2. Groundwork – SOA Guidelines and Registry/Repository
3. Process Automation – Implementation of Workflow Management
4. Integration of SOA, Business Process and Business – A SOA Reference Architecture
5. Keeping Ahead – Investigation of the Implementation of the Microservices Architecture
6. The Big Picture – Towards a Microservices Reference Architecture
7. Conclusion

Conclusion

- Over 15 years of research about service-orientation for the (German) insurance industry; VAA as a process guideline
- The past (and present): A SOA success story
  - SOA Guidelines and Registry/Repository
  - SOA & Business Process Controlling (BPC)
  - SOA & Business Activity Monitoring (BAM)
  - BRM, BPM, BAM within a SOA Reference Architecture (RA)
  - QoS @ SOA
- Current work: Enhancing SOA with Microservices and DevOps
  - Initial MicsV and DevOps projects: Keeping Ahead – Investigating Microservices and DevOps for “Versicherungen” (Insurance Companies)
  - The Big Picture – Towards a Microservices based Reference Architecture for (at least) typical German Insurance Companies
- Services in their various flavors are “here to stay” – our successful journey continues

Thank you for your attention!

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