This WASA course unit [CM-W-INT] describes the content and the organization of the lecture and practical course “Web Applications and Service-oriented Architecture” (WASA) provided by the research group Cooperation & Management (C&M, Prof. Abeck).

WASA1 (Bachelor): Current concepts of software development and architectures (including Behavior-Driven Development, Domain-Driven Design, Microservices, RESTful Webservices, 12 Factor App, CI/CD Build Pipelines, DevOps, Container-virtualized Infrastructures) as well as related standards and technologies (including HTTP, Java, JavaScript/TypeScript, Angular, Spring, GitLab-Cl, Docker, Kubernetes, Prometheus) are introduced which are needed to develop advanced (i.e. microservice-based, IoT aware, cloud-native, mobile) web applications. The web applications stem from the connected car domain which includes concepts from the domain of Internet of Things.

WASA2 (Master): A compact summary of the concepts covered by WASA1 is provided. In WASA2, two advanced topics are focused: (i) API engineering and management and (ii) identity and access management. Both topics are highly relevant for the digitization strategy of companies. In the lecture, two leading products (MuleSoft, Okta) are introduced to illustrate how the topics are solved in IT practice.

Since the concepts presented in the lecture must be practically applied to really understand them the WASA lecture is only offered in a combination with the WASA practical course.

The WASA kickoff lecture will take place online on Wednesday, 20th April 2022 at 10:00 am.

Each student who wants to take part in WASA and in the kickoff lecture should send an email to cm.research@lists.kit.edu to receive the web link to the web session which is made available for their personal use. Please do ONLY use your DEPSEUDONYMISED KIT student email address (see https://my.sec.kit.edu/shib/pseudonymisierung.php for further information). Thank you!

The lecture material is made available in English. During the lecture, the content is presented and discussed in German. The oral examination is conducted exclusively in German. All students write their practical/seminar thesis in English. Thesis templates are made available in LaTeX. Overleaf is used for the collaborative writing of the practical thesis.

C&M Cooperation & Management
KIT Karlsruhe Institute of Technology
WASA Web Applications and Service-oriented Architectures

The research work, carried out by C&M, can be divided into two main areas:

(Connected Car, Healthcare, Environmental) In these business domains, applications based on the concept of domain modeling and microservice architectures are developed. Relevant concepts applied in the microservice engineering approach include Behavior-Driven Development (BDD) and Domain-Driven Design (DDD). In addition to development (Dev), the operational aspects (Ops) are intensively taken into account. DevOps concerns the continuous integration (CI) and continuous deployment (CD) of microservice-based software systems into a container-virtualized (Docker/Kubernetes-based) cloud infrastructure.

(API Integration and Management, Identity and Access Management) API Engineering and Management can be seen as the bridge between the two C&M's research areas since its task is to integrate and manage (i.e., configure, monitor, control) the developed APIs. Identity and Access Management (IAM) is a highly relevant crosscutting concern appearing in every web application. An advanced approach is IAM as a Service (IAMaaS) by which the IAM functionality is provided in a cloud infrastructure.

- **BDD**: Behavior-Driven Development
- **CI/CD**: Continuous Integration / Continuous Deployment
- **DDD**: Domain-Driven Design
- **IAM**: Identity and Access Management
- **DevOps**: Development and Operations
The microservice engineering approach applied by C&M combines the concepts of Behavior-Driven Development (BDD) and Domain-Driven Design (DDD). Both concepts provide complementary contributions to the layered microservice architecture as the figure illustrates.

1. An implemented feature can be seen as a deployable increment of the software system. (Feature 1, Feature 2, ...) The ordering of the features in the figure implies that the first feature should cover the core functionality of the software system.

2. The domain model makes sure that the static and dynamic domain knowledge is consistently used by each feature. This ensures that the features build a consistent whole although each feature is developed and deployed independently from each other.

BDD  Behavior-Driven Development

DDD  Domain-Driven Design
The projects run in one or more of four different environments. In the research field "Microservice Engineering and Management", two environments have been built: (i) the academic environment "Domain-driven Microservice Engineering Approach" and (ii) the product-driven environment "MuleSoft's API-led Connectivity". The third environment "Okta's IAM as a Service Solution" is also product-driven and it belongs to the research field of Identity and Access Management (IAM).

(Domain-driven Microservice Engineering Approach) The approach consists of two development processes, a domain development process and an application development process. The result is an systematically engineered microservice-based application, such as the PredictiveCarMaintenance (PCM) which are based on a well-designed microservice architecture consisting of reusable, application-agnostic domain microservices and application-specific domain application microservices. The approach is described in detail in the course unit WEB APPLICATION DEVELOPMENT [CM-W-WEB].

(MuleSoft's API-led Connectivity) MuleSoft is a leading product in the area of Application Programming Interface (API) management. Its solution is based on an approach, called API-led connectivity, by which APIs are designed and integrated in a layered architecture. An introduction to API management can be found in the course unit API MANAGEMENT [CM-W-API] and a detailed description of the MuleSoft solution is provided by the course unit MULESOFT API ENGINEERING AND MANAGEMENT [CM-W-MUL].

(Identity and Access Management) Okta is a leading product in the area of IAM, especially IAM as a Service (IAMaaS) based on a cloud service infrastructure. It provides solutions both for workforce identity (i.e., Enterprise IAM) and customer identity (i.e., Consumer IAM). An introduction to IAM can be found in the course unit IDENTITY AND ACCESS MANAGEMENT [CM-W-IDE] and a detailed description of the Okta solution is provided by the course unit OKTA IAM SOLUTION [CM-W-OKT].

(Internet of Things) One characteristic of advanced web applications, such as PCM, is their use of environmental information provided by sensors from things (e.g., the car or the motor of the car) of the Internet. The FROST Server from Fraunhofer IOSB which implements the Internet of Things (IoT) standard "SensorThings API" is used for this purpose.

<table>
<thead>
<tr>
<th>API</th>
<th>Application Programming Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAM</td>
<td>Clinics/AssetManagement</td>
</tr>
<tr>
<td>IAM</td>
<td>Identity and Access Management</td>
</tr>
<tr>
<td>IAMaaS</td>
<td>IAM as a Service</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>PCM</td>
<td>PredictiveCarMaintenance</td>
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[CM-W-API] Cooperation & Management: API MANAGEMENT. WASA Course Unit. https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.WASA_Lecture
[CM-W-IDE] Cooperation & Management: IDENTITY AND ACCESS MANAGEMENT. WASA Course Unit. https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.WASA_Lecture
[CM-W-MUL] Cooperation & Management: MULESOFT API ENGINEERING AND MANAGEMENT, WASA Course Unit. https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.WASA_Lecture
[CM-W-OKT] Cooperation & Management: OKTA IAM SOLUTION, WASA Course Unit. https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.WASA_Lecture
[CM-W-WEB] Cooperation & Management: WEB APPLICATION DEVELOPMENT, WASA Course Unit. https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.WASA_Lecture
The table describes the planned sequence of course units presented during the lecture.

(Content) All titles printed in upper case are course units that are the basis for the oral examination carried out at the end of the semester. After the course unit was held a range of page numbers are added. This indicates which pages must be prepared by the student for the oral examination.

(COURSE UNIT X-Y) All course units written in upper case letter are primary examination material. If page ranges X-Y are indicated only these pages are treated in the oral exam. No page range means that questions of the complete course unit can be asked in the oral exam.
The table describes the planned sequence of course units presented during the lecture.

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COURSE UNIT (P. X – P. Y) All course units written in upper case letter are primary examination material. If page ranges are indicated only these pages are treated in the oral exam. No page range means that questions of the complete course unit can be asked in the oral exam.
The acronym WASA stands for "Web Applications and Service-oriented Architectures". Four different types of WASA courses are offered: (i) lecture courses WASA1 and WASA2 (ii) practical courses WASA1 and WASA2 associated to the lecture courses (iii) proseminar course associated to WASA1 lecture course and seminar associated to WASA2 lecture course (iv) key qualification course (germ. Schlüsselqualifikation SQ).

(1) The lecture courses WASA1 and WASA2 each comprise 2 semester hours. A student who attends one of the lectures acquires 4 credit points (German: Leistungspunkt).

(2) The practical course and the proseminar/seminar run in parallel with the lecture course. The practical course counts 5 credit points meaning a workload of 150 hours and the proseminar and seminar count 3 credit points meaning a workload of 90 hours.

Remarks:
(i) If the number of WASA applications is high, those students are preferred who want to pass the practical course.
(ii) In the Wirtschaftsinformatik study programme the name of the module is "Microservice-basierte Web-Anwendungen".

(3) The examiners are Prof. Abeck and one of the C&M's PhDResearchers. Since the examination is in the lecture term, the students should have a good personal resource management in order to have enough time for the preparation of the examination.

SQ Schlüsselqualifikation (Key Qualification)
On this page the specifics of the WASA practical/seminar courses which are offered in parallel to the WASA lecture are described.

(1) A project consists of about 4 to 6 practical/seminar students.
   (1.1) A SeniorStudent is a student who is writing his/her bachelor thesis or master thesis at C&M.
   (1.2) The meetings take place at a defined time which is fixed at the beginning of the semester.

(2) The topics dynamically evolve from the work done by the SeniorStudent in their bachelor/master thesis.
   (2.1) The JuniorStudent should actively participate in the discussion and make own proposals how the topic should be treated.
   (2.2) Reviews are an integral part of the work in the project team.
   (2.3) This means that the practical/seminar work has a dynamic characteristic.
   (2.4) There is a high flexibility and liberty concerning the focal points of the practical/seminar work.

(3) Therefore, different templates are made available for a practical course thesis and a seminar thesis.
The project team agenda is a markdown document by which the work of all project team members is coordinated.

(1) The project team leader takes care that all team members contribute to the agenda of each project team meeting.
(1.1) For each project team a subgroup exists in the C&M GitLab. In the README file of the repository "Projektteamtreffen" the agendas of the project team meetings are collaboratively worked out.
(1.2) The project team meets for one hour every week. The day and time are defined by the project team members.
(1.3) That is why the agenda is worked out in German.

(2) There are templates available for the practical thesis and the seminar thesis.

(3) C&M-TEAMARBEIT is a document [CM-CMT] which describes how the members of the research team C&M efficiently work together.

(Screen dump on the right hand side) This is an excerpt of the GitLab document "Projektteamtreffen" which provides an agenda draft of the first two project team meetings.

On the next pages, the following thesis offers are described in more detail:

(iPaaSEngineering) Engineering of Applications on a Cloud-based Integration Platform

(SecurityPolicyMicroservices) Development of Security Policies for Microservice-based Applications

(SoftwareQualityTesting) Use and Extension of Concepts of Software Quality Measurement and Testing for Microservice-based Applications

(DevOpsAPILifecycle) Adaption of a Template-based DevOps Concept to the Lifecycle Management of APIs
Engineering von Anwendungen auf einer cloudbasierten Integrationsplattform


Betreuer: Sebastian Abeck, Michael Schneider, Niklas Sänger (C&M)
Jan Meyer zu Holte (iC Consult)
Entwicklung von Sicherheits-Policies für Microservice-basierte Anwendungen


Betreuer: Sebastian Abeck, Michael Schneider, Niklas Sänger (C&M)
Seyedamir Zolfaghari (iC Consult)
Einsatz und Erweiterung von Konzepten der Softwarequalitätsmessung und des Testens für Microservice-basierte Anwendungen


Betreuer: Sebastian Abeck, Michael Schneider (C&M)  
Stephanie Zieschinski (ixdi360)
Anpassung eines Template-basierten DevOps-Konzepts auf das Lebenszyklus-Management von APIs


[Betreuer: Sebastian Abeck, Niklas Sänger (C&M)  
Stefan Throner (Service Layers), Jan Meyer zu Holte (iC Consult)]

This page summarizes all relevant dates that are relevant for each participant of the practical /seminar course offered in combination with the WASA lecture.

(1) It is absolutely necessary that a student has a free slot in his/her personal time table in order to be able to take part in these weekly meetings. The meetings start in the next week (i.e., the second week of the lecture period).

(2) The content produced for the presentation should conform to the WASA course material.

(3) This day is the Friday of the last lecture week. The whole Friday (i.e. 12 pm) is available to finish the documentation.
(1) It is absolutely important that a student who participates in the WASA lecture and practical/seminar course has the necessary resources to cope with the workload (lecture: 120 hours, practical course: 150 hours).

(2.1) Check on the page of the KIT Steinbuch Computing Centre if your email is already depseudonymized.
(2.1.2) The motivation and the experiences should be summarized in at least one or two paragraphs.
(2.1.3) This means that the first project team in the list is your favorite team.

(3) This email will be sent by the co-supervisor of the members of the project team which usually is a SeniorStudent.

The current lecture material is stored on the C&M Teamservr in the following folder: https://team.kit.edu/sites/cm-tm/Mitglieder/2-0.Aktuelles_Semester
The C&M Teamserver is described in detail in the document C&M-TEAMARBEIT (in German) which is available
(i) on the C&M web site: https://cm.tm.kit.edu/
(ii) on the C&M Teamserver: https://team.kit.edu/sites/cm-tm/Mitglieder/1-1.Teamarbeit
This function can be found in the Studierendeportal by clicking on "Meine Benutzerdaten" > "De-/Pseudonymisierung" and accepting "Ich stimme der Sichtbarkeit meiner namensbezogenen Daten zu". Die name-related E-Mail-Adresse <prename><surname>@student.kit.edu" exists additionally to the "uxxx@student.kit.edu" email address.