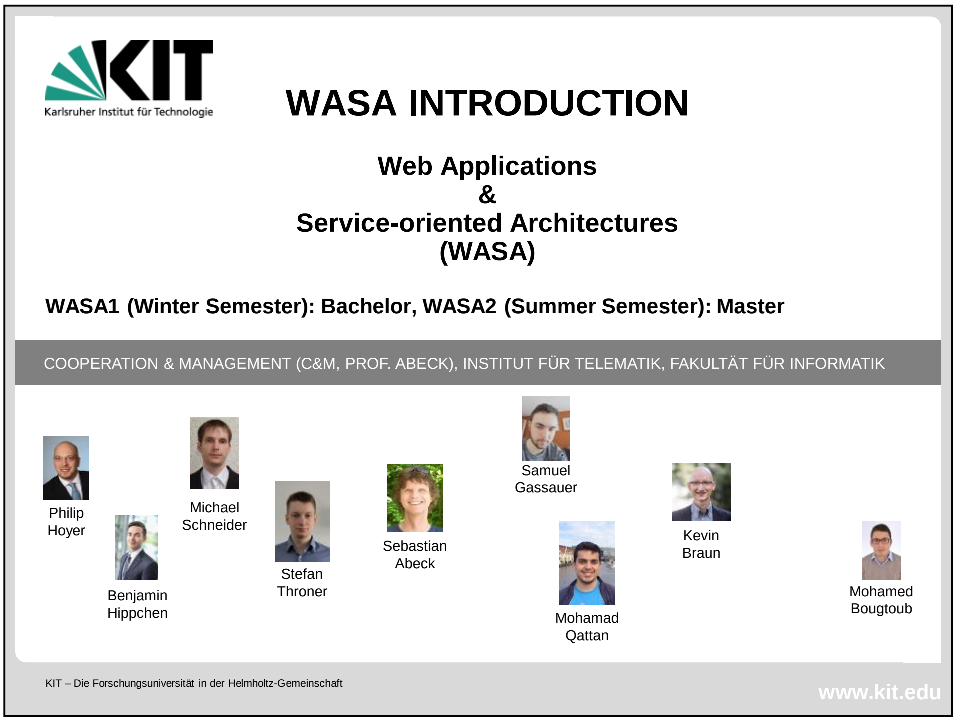


Abstract

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

Current concepts of software development and architectures (including Domain-Driven Design, Behavior-Driven Development, Microservices, RESTful Webservices) as well as related standards and technologies (including HTTP, JavaScript/TypeScript, Angular, Spring) are introduced which are needed to develop advanced mobile web applications. The web applications stem from the connected car domain which includes concepts from the domain of Internet of Things. 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 and/or seminar course.

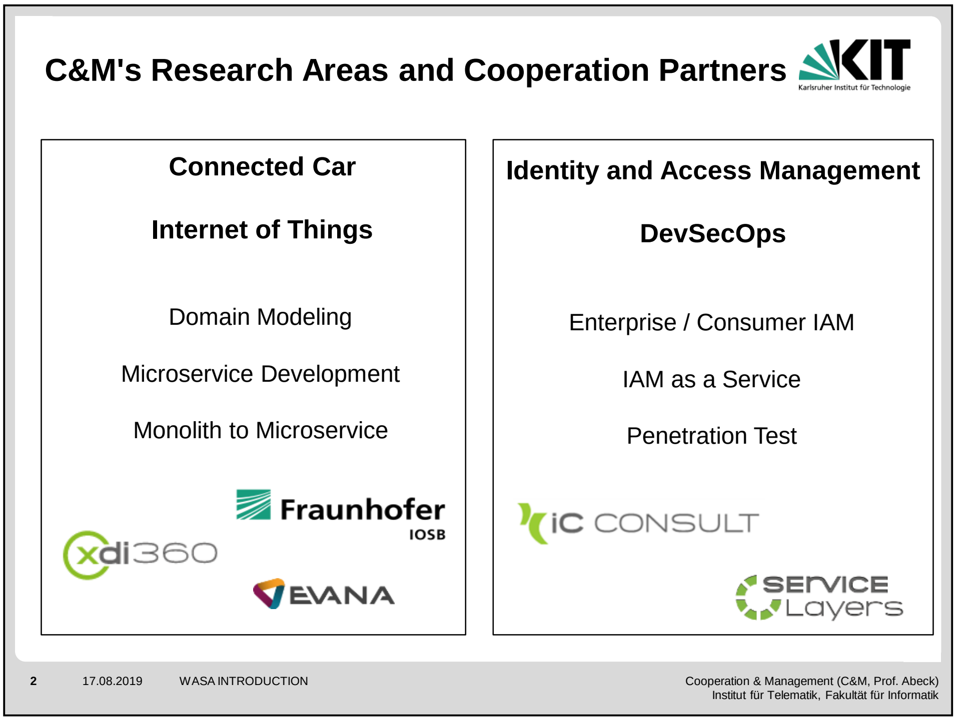
The lecture takes place each Wednesday from 9:45 am to 11:15 am in the computer science building "Am Fasanengarten" (building number. 50.34) in the room "SR301".

Keywords

Software, Web Application, Web Technologies, Domain-Driven Design, Behavior-Driven Development, Microservices, RESTful Webservices, Development Tools, Connected Car

C&M	Cooperation & Management
HTTP	HyperText Transfer Protocol
KIT	Karlsruhe Institute of Technology
REST	REpresentational State Transfer
WASA	Web pplications und Serviceoriented Architekturen

[CM-W-INT] Cooperation & Management: WASA), WASA-Kurseinheit. *https://team.kit.edu/sites/cm-tm/Mitglieder/2-1.WASA*

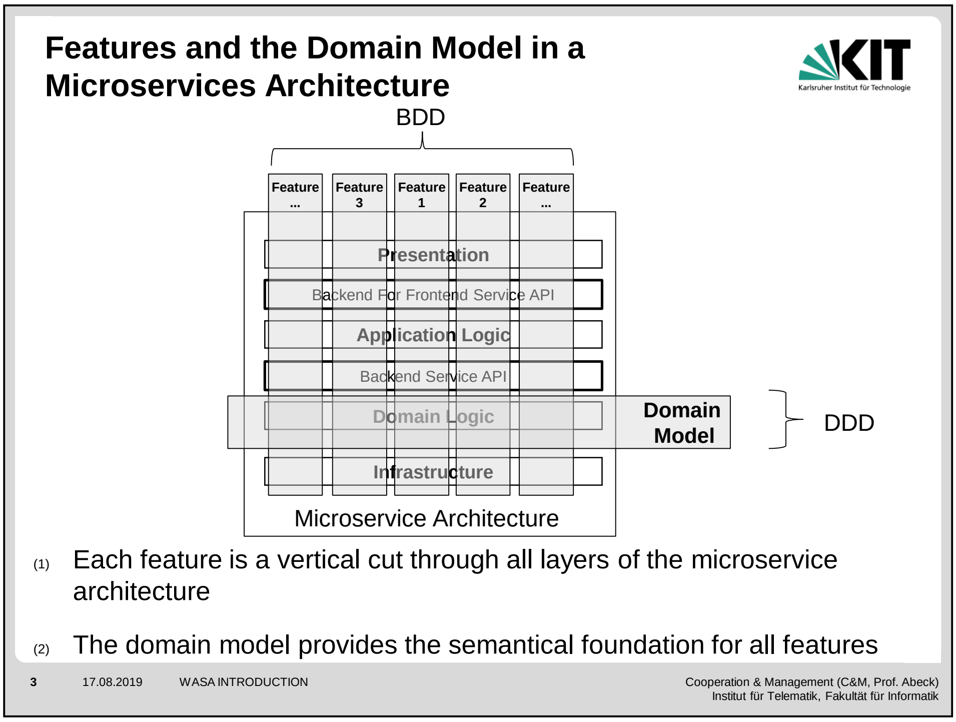


The research work carried out by C&M can be divided into two main areas:

(Connected Car, Internet of Things) The development of connected car application and IoT application based on the concept of domain modeling and microservice architectures.

(Identity and Access Management, DevSecOps) The Identity and Access Management (IAM) is a highly relevant crosscutting concern appearing in almost every web application. one of the projects is concerned with the provisoning of IAM as a flexible cloud service.

DevSecOps	Development Security Operations
IAM	Identity and Access Management
IOSB	Institut für Optronik, Systemtechnik und Bildauswertung
IoT	Internet of Things

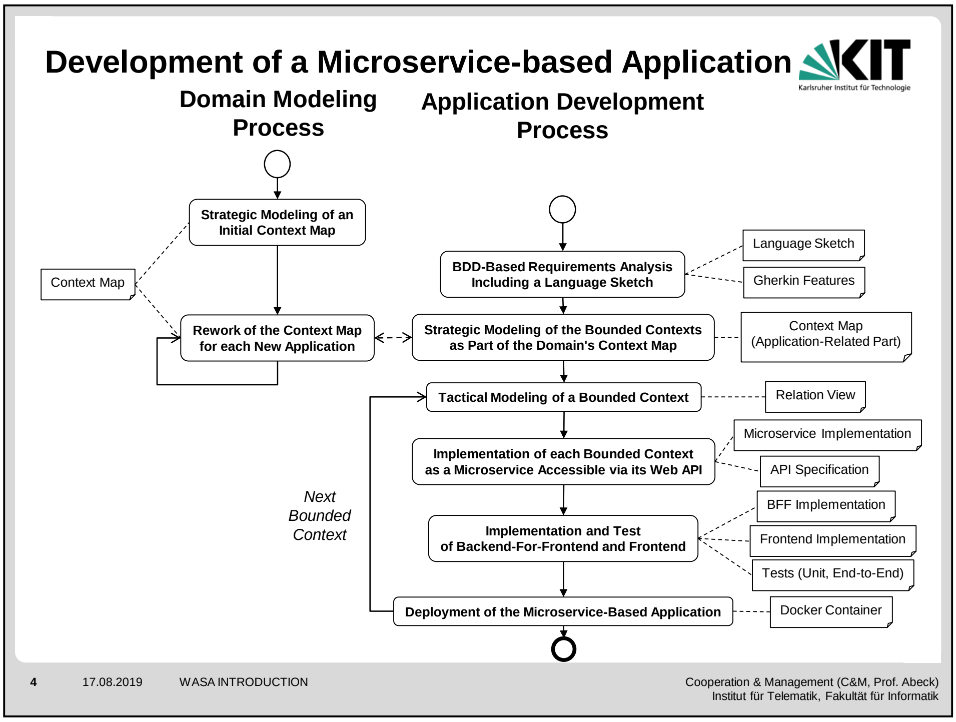


The software development process applied by C&M combines the concepts of Behavior-Driven Development (BDD) and Domain-Driven Design (DDD). Both concepts provide complementary contributions to the layered microservice architecture as the figure illustrates.

(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 other features.

BDD	Behavior-Driven Development
DDD	Domain-Driven Design



The activity diagram gives an overview of the whole engineering process which in fact is divided into two sub-processes: According to our understanding of DDD, a domain model is the foundation of all software applications belonging to this domain. We regard the domain model as the knowledge of a domain expert he or she makes available to the software developer by the model. This knowledge is the application-agnostic part of the application meaning that each application of the domain implements this knowledge in its domain logic layer. We understand this domain knowledge as the "physics" that each application must adhere to. Evans calls this part of functionality the heart of the software system [Ev03].

(Starting Points) (Strategic Modeling of the Initial Context Map) The starting point of the domain modeling process is set earlier as the starting point of the application development process. The reason is that it makes sense to have an initial context map of the domain before the development of the first application starts. In the following we describe the main characteristics of the application development process.

(Context Map) The main artifact of the domain modeling process is the context map in which all micro-service-based applications belonging to the domain must fit into.

(Strategic Modeling of the Bounded Contexts as Part of the Domain's Context Map) In the application development process, the integration of the application under development into the context map of the domain is done in the second step after the first step in which the the BDD-based requirements analysis is carried out.

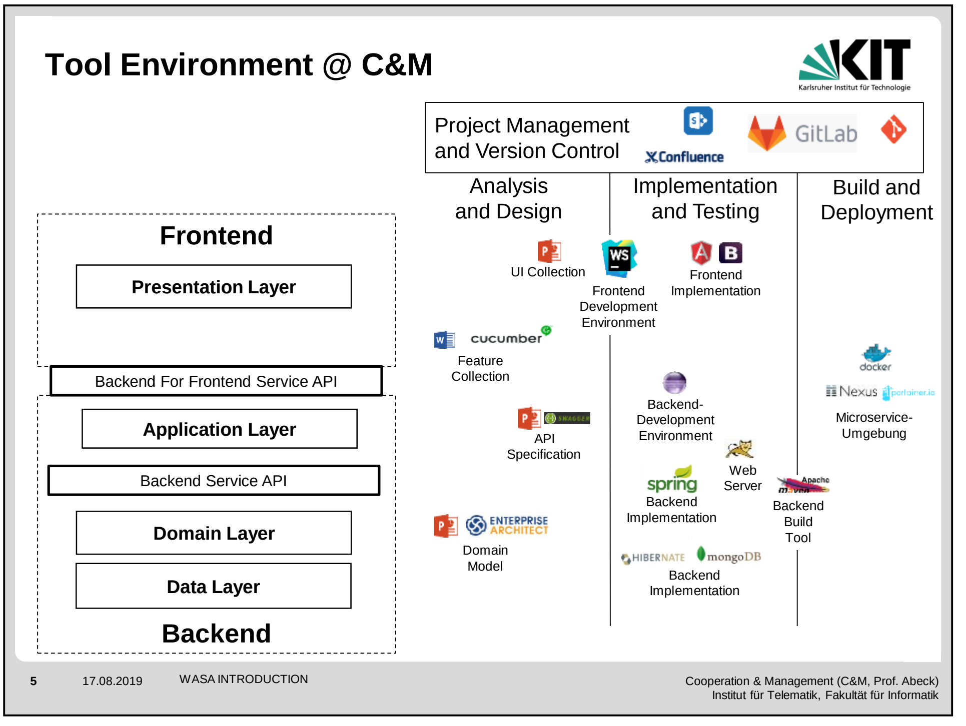
(Tactical Modeling of a Bounded Context) A bounded context is part of a context map. It represents a candidate for a microservice which can be developed by an independent team [Ne15]. DDD considers the modeling of the content (i.e. the functionality) of a bounded context as tactical modeling.

(Relation View) The most relevant artifact of the tactical modeling is the relation view which is built in the third step. By the relation view central DDD concepts (such as entity and value objects) including their relationships and operations are represented.

(Implementation of each Bounded Context as a Microservice Accessible via its Web API) The functionality modeled by the relation view is implemented in the domain logic layer of the microservice architecture. A systematic approach to implement the bounded context as a microservice (fourth step) is a core characteristic of the proposed development process. One of the key demands of DDD is to keep the model and its implementation in sync in order to assure that the model and the implementation is the same.

The two remaining steps concern development activities around the core implementation of the microservice, namely the implementation and test and the deployment of the application.

[Ev03] Eric Evans, Domain-Driven Design: Tackling Complexity in the Heart of Software. Addison-Wesley Professional, 2003.
[Ne15] Sam Newman: Building Microservices, O'Reilly Media, Inc., 2015.



The main dimension according which the development tools can be ordered are the development phases (from analysis to deployment). The tools supporting the analysis and design and the implementation and testing can be grouped according to the software architecture (which in our case is a microservice architecture).

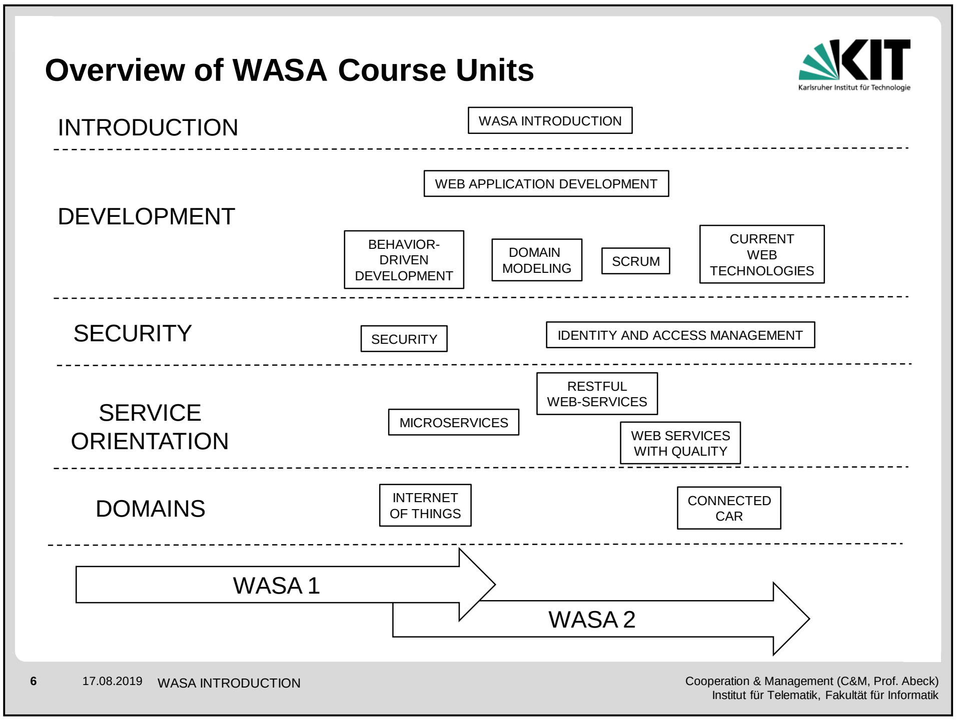
(Project Management and Version Control) These tools support the overall organization of the software project and the communication between the project members. At C&M two different tools sets are used: the Atlassian toolset extended by Microsoft tools, esp. SharePoint on which the C&M Teamserver is based.

(Analysis and Design) Analysis requirements at C&M is done by taking the approach of behavior-driven development (BDD) based on the tool Cucumber. For the design the two most relevant tools are Enterprise Architect for the domain model and Swagger for the API specification. In addition to these tools the Microsoft Office tools (Word, PowerPoint) and Atlassian Confluence (in the case of iCC/xdi projects) are applied for documentation purposes.

(Implementation and Testing) In this phase the frontend and backend of the web applications are constructed. The integrated development environment (IDE) used for frontend development is JetBrain's WebStorm and frontend frameworks are Angular and Bootstrap. As IDE for backend development Eclipse is used and Apache Spring (esp. Spring Boot for the microservice implementation) is used as backend framework.

(Build and Deployment) The build and deployment of the microservices is carried out via a build pipeline by which the concept of continuous integration and continuous deployment is provided. The result of the build pipeline is a Docker image (= application container image) since Docker is used as the container environment at C&M. Kubernetes is used to manage the Docker containers in order to reach a high scalability and robustness of the service landscape.

BDD	Behavior-Driven Design
IDE	Integrated Development Environment



The WASA course units can be grouped into the following parts:

(INTRODUCTION) This part contains the actual course unit.

(DEVELOPMENT) These course units handle the development of web applications and the needed concepts and technologies.

(SECURITY) Besides general IT security aspects of web applications the identity and access management is in the focus of this part of the lecture.

(SERVICE ORIENTATION) The microservice architecture and the restful web services are introduced in this part.

(DOMAINS) Connected car is the main domain for which web application are developed by C&M.

(WASA 1, WASA 2) The assignment of course units to WASA1 and WASA2 is highly flexible.

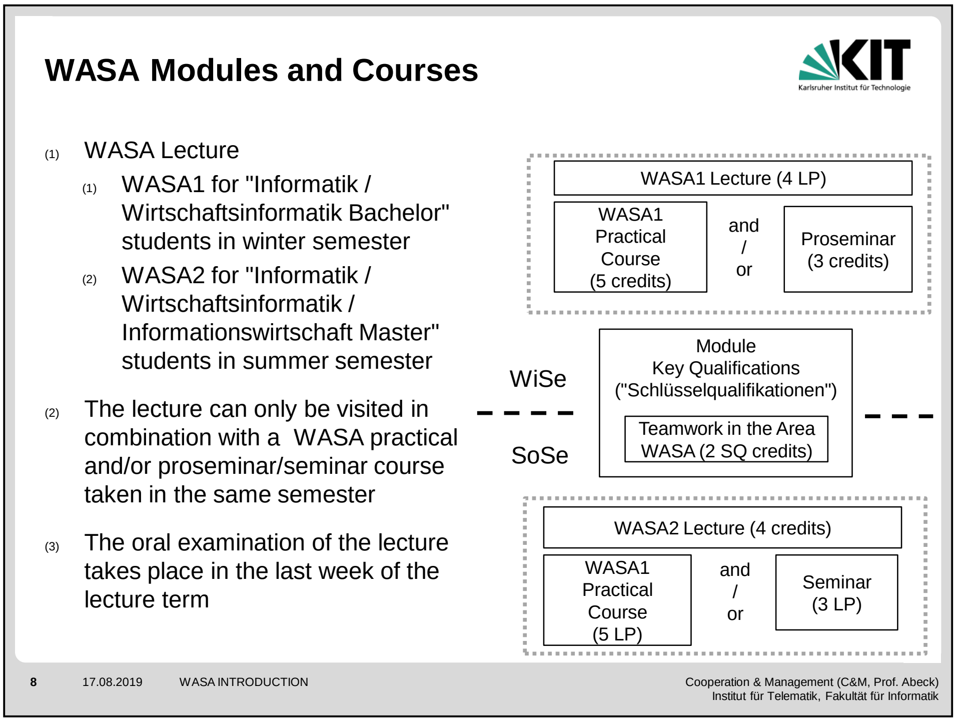
Lecture Plan

Date	Content	Lecturer(s)
19-10-16	WASA INTRODUCTION, C&M-TEAMARBEIT	Abeck, PhD Researchers, SeniorStudents
19-10-23	WEB APPLICATION DEVELOPMENT	Abeck
19-10-30	WEB APPLICATION DEVELOPMENT	Abeck
19-11-06	WEB APPLICATION DEVELOPMENT	Abeck
19-11-13	WEB APPLICATION DEVELOPMENT	Abeck
19-11-20	CONNECTED CAR	Abeck
19-11-27	CONNECTED CAR	Abeck
19-12-04	INTERNET OF THINGS	Schneider
19-12-11	MONOLITH TO MICROSERVICE	Hippchen
19-12-18	DEVOPS AND CI/CD	Throner
20-01-08	IDENTITY AND ACCESS MANAGEMENT	Abeck
20-01-15	Practical Talk from iC Consult, Project Teams	iCC, Students
20-01-22	Practical Talk from xdi360, Project Teams	xdi360, Students
20-01-29	Practical Talk from IOSB, Project Teams	IOSB, Students
20-02-05	Oral Examination	

Location where the oral examination takes place:
Building 50.34, Room 032 (team room)

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.



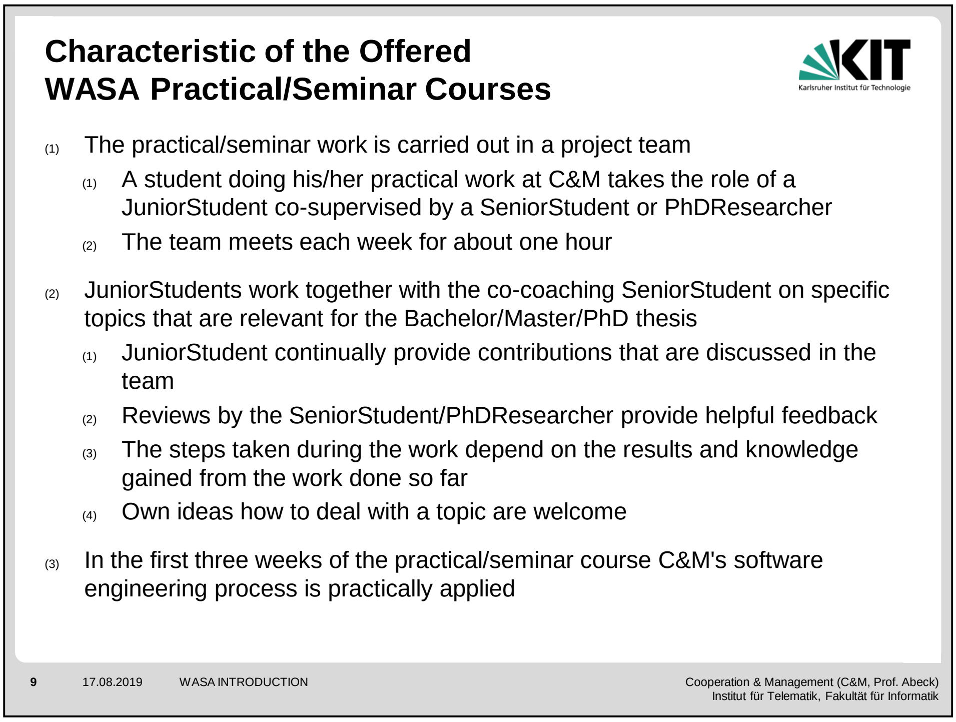
The acronym WASA stands for "Web Applications and Service-orientierted Architectures". Four different types of WASA courses are offered: (i) lecture courses WASA1 an WASA2 (ii) practical courses WASA1 and WASA2 assoiciated to the lecture courses (iii) proseminar course associated to WASA1 lecture course 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 (germ. Leistungspunkt LP).

(2) The practical course runs in parallel with the lecture course and counts 5 credit points meaning a workload of 150 hours. The capacity of students C&M can offer the practical course depends on the current projects carried out in the research group.
Hint: In the Wirtschaftsinformatik study programme the name of the module is "Microservice-basierte Web-Anwendungen".

(3) The duration of the oral exam is 20 minutes. 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.

LP	Leistungspunkt (credit point)
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 flexibilty and liberty concerning the focal points of the practical/seminar work.

(3) During the first phase of the practical/seminar course all JuniorStudents fulfill the same tasks. After the successful completion of this phase each JuniorStudent knows how to use the major tools (esp. GitLab) to build microservice-based applications.

Task Document (Aufgabendokument)

(1) The practical/seminar course is split into two phases
- (1) Initial phase which focusses the C&M development process
- (2) Project phase in which a specific research topic is elaborated

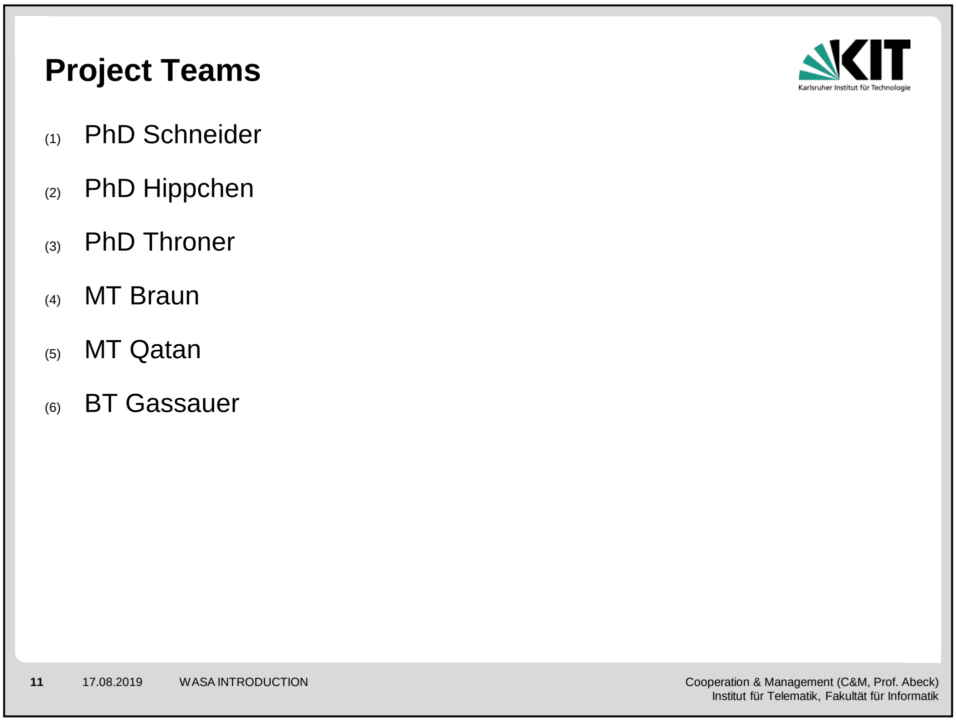
(2) The initial phase closes with the delivery of an intermediate status of the practical/seminar thesis
- (1) Review by the co-coaching PhDResearcher/ SeniorStudent

Aufgabe Ersteller	Beschreibung	Ergebnisse	Dauer Termin	Status
	Ausarbeitung einer in der WASA-Vorlesung zu haltenden Präsentation in Form eines C&M-konformen Dokuments	ca. 4 Seiten C&M-konformes Dokument		
…				
6 <<PhDResearcher oder SeniorStudent>>	<<Bearbeitung einer projektspezifischen Aufgabe>>			
13.11.18: Abgabe eines reviewfähigen Zwischenstands der Ausarbeitung				
4 Abeck	Editiorielle Arbeiten, um den erreichen Stand der Ausarbeitung in einen reviewfähigen Zustand zu bringen		5 Std. 13.11.18	
3 Abeck	Durcharbeiten des TLM PRACTICAL COURSE unter https://team.kit.edu/sites/cm-tm/Mitglieder/2-2.Leitf%C3%A4den	8 Seiten	20 Std. 06.11.19 30.10.19	geplant
2 Abeck	Erster Beitrag in der eigenen Ausarbeitung (Word- oder LaTex- Dokument): Beschreibung des bei C&M praktizierten BDD/DDD-basierten Entwicklungsprozesses und eines selbst gewählten Werkzeugs https://team.kit.edu/sites/cm-tm/Mitglieder/2-1.WASA/1-1.web_application_development.pptx Hinweis: Vorlage des Ausarbeitungsdokuments liegt im persönlichen Arbeitsordner	3 Seiten	7 Std. 30.10.19	geplant
1 Abeck	Einarbeitung in die C&M-TEAMARBEIT https://team.kit.edu/sites/cm-tm/Mitglieder/1-1.Teamarbeit	Teamarbeitsdokumente angelegt, Profil erstellt bzw. aktualisiert, Stundenkonto angelegt und erste Stunden eingetragen	5 Std. 23.10.19	geplant

The task document (Aufgabendokument) is a Word document which describes the tasks a JuniorStudent has to fulfill during his/her practical/course. The document is stored in the personal working folder on the C&M Teamserver (further described on a following page <<C&M Teamserver>>).

(1.1) The single tasks to be carried out and the results to be achieved during the initial phase can be found in the task document.
(1.2) These tasks are specified individually for each JuniorStudent by the co-coaching PhDResearcher or SeniorStudent.

(2) The exact delivery date can be found in the task document.
(2.1) The result of the review is available one week after the delivery of the document (stored in the review folder of the JuniorStudent).



The project team meetings take place in the team room 032 (alternatively in the seminar room of NZ1 in the case that room 032 is occupied).

Relevant Dates for Practical / Seminar Course

(1) Project team meeting each week
  - (1) The dates are individually fixed by the PhDResearcher or SeniorStudent and his co-supervising JuniorStudents
  - (2) Kickoff meetings are in the next week

(2) Delivery of a preliminary version of the practical / seminar thesis
  - (1) Precise date is given in the task document
  - (2) Students who want to pass both a practical course and a seminar course should have completed their practical course (= 150 working hours) at least 5 weeks before the end of the lecture period

(3) Presentation of the results in the WASA lecture
  - (1) See dates for each project team on the page <<Lecture Plan for ...>>

(4) Delivery of the final practical /seminar thesis

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.

(2) This preliminary version is reviewed by the co-supervising PhDResearcher or SeniorStudent.

(3) The presentation material are in conformity with English slides and additional English text (see the WASA course material as an example).

(4) The delivery date is the last day of the lecture period.

Next Steps

KIT Karlsruher Institut für Technologie

(1) Personal decision if you want to participate in the WASA lecture and an accompanying practical/seminar course

(2) If YES
   (1) TODAY: Send an email with your depseudonymised KIT mail address to sebastian.abeck@kit.edu and michael.schneider@kit.edu which contains the following information
      (1) Prename, surname, immatriculation number, interest in practical and/or seminar course
      (2) Personal motivation and experiences in this area (e.g. conducted IT projects)
      (3) Project teams of interest (2 or 3, sequence expresses priority)

(3) The answer to your email will contain all relevant information to start the lecture and practical/seminar course
   (1) Access to team server, date of kickoff meeting, first work packages

13 17.08.2019 WASA INTRODUCTION Cooperation & Management (C&M, Prof. Abeck) Institut für Telematik, Fakultät für Informatik

(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 depseudonymised.
(2.3) The motivation and the experiences should be summarized in at least one or two paragraphs.
(2.4) 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.
(3.1) The current lecture material is available on the C&M Teamserver accessible via the following link: https://team.kit.edu/sites/cm-tm/Mitglieder/2-0.Aktuelles_Semester

Activation of the Name-Related E-Mail Address (Depseudonymisation)

(1) Can be carried out via Shibboleth (https://my.scc.kit.edu/shib/pseudonymisierung.php)

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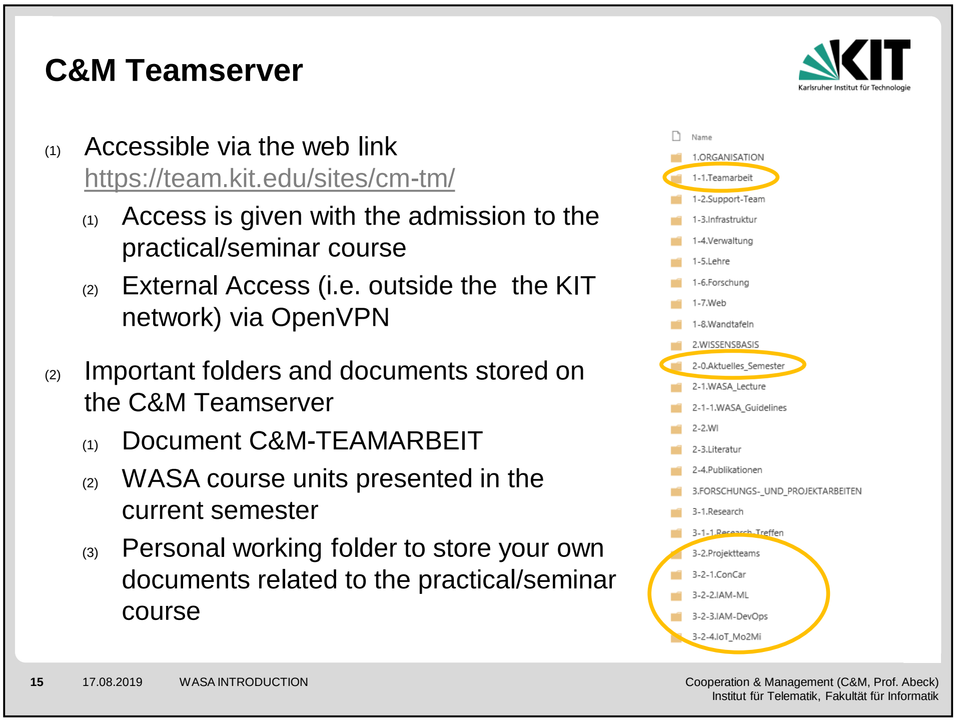
This function can be found in the Studierendeportal by clicking on "Meine Benutzerdaten" > "De-/Pseudonymisierung" and accepting "Ich stimme der Sichtbarkeit meiner namensbezogenen Daten zu". Die name-related E-Mail-Adress <prename><surname>@student.kit.edu" exists additionally to the "uxxx@student.kit.edu" email address.



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