Software Engineering for Business Information Systems
Informatik
Technical University of Munich

E0017
Place student sticker here

Note:

- During the attendance check a sticker containing a unique code will be put on this exam.
- This code contains a unique number that associates this exam with your registration number.
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Advanced Topics of Software Engineering

Exam:	IN2309 / Retake	**Date:**	Thursday 21st April, 2022
Examiner:	Prof. Dr. Florian Matthes	**Time:**	11:00 – 12:40

	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8
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Working instructions

- This exam consists of **16 pages** with a total of **8 problems**.
  Please make sure now that you received a complete copy of the exam.
- The total amount of achievable credits in this exam is 100 credits.
- Detaching pages from the exam is prohibited.
- Allowed resources:
  - one **non-programmable pocket calculator**
  - one **analog dictionary** English ↔ native language
- Subproblems marked by * can be solved without results of previous subproblems.
- **Answers are only accepted if the solution approach is documented.** Give a reason for each answer unless explicitly stated otherwise in the respective subproblem.
- Do not write with red or green colors nor use pencils.
- Physically turn off all electronic devices, put them into your bag and close the bag.

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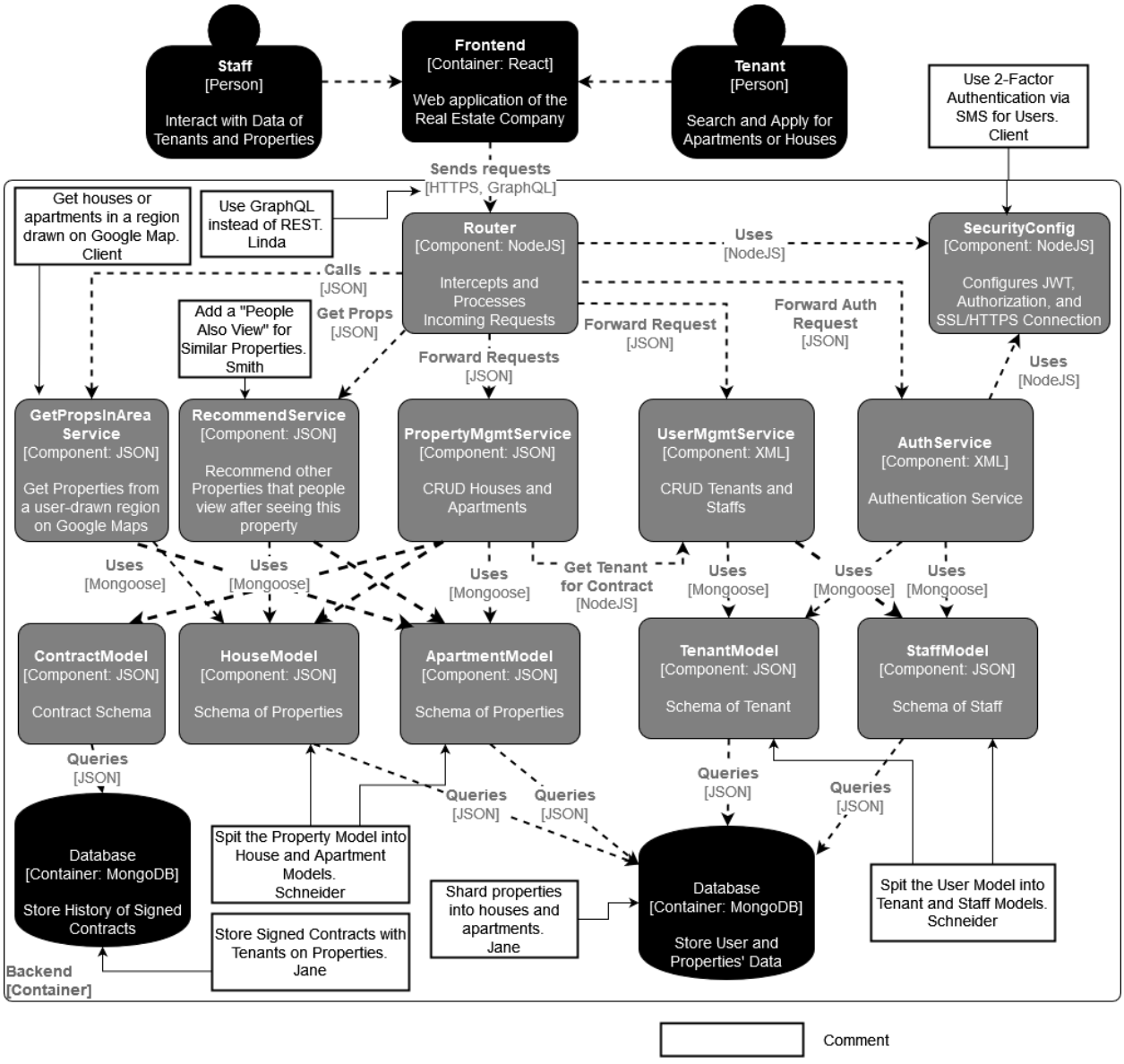
Problem 1 Anti-pattern (12 credits)

Jonas and his team is extending a web application to showcase apartments and houses of Semobilien, a small real estate company. Each month, Semobilien offers around 20 active real estates for rent and purchase in five areas: Munich city, Freising, Dachau, Eching and Ismaning. 50 percent of Semobilien's properties are in Munich City. The company requires their customers to register and login for applying to a house or apartment. Semobilien only aims to serve customers in the Munich and nearby districts, without expanding to another area.

Jonas and his teammates are designing the backend. Below is the most recent sketch of their backend architecture expressed as a C4 Component Diagram:



a) * What is the anti-pattern in the backend architecture design? Give two reasons to justify.

0 1 2 3 4 5

b) * Propose one solution to solve the anti-pattern. Briefly justify your answer

0 1 2 3

c) * Name and briefly explain **two** of the seven deadly sins in software engineering.

0 1 2

d) * Briefly explain what is a software quality.

0 1 2

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Problem 2 Dependency Structure Matrix (13 credits)

You are a project manager at a software company and for your next project, you are assembling a web development team. To better understand the relationship between the developers, you asked an intern to build a Dependency Structure Matrix (DSM) of all existing web developers in the company.
After a week, she proposed the following matrix where weights indicate the number of projects in which one developer depends on the other:

	Alice	Bob	Carrie	Dennis
Alice	-		5	
Bob	1	-	1	2
Carrie	3		-	4
Dennis				-

0 1

a)* In how many projects does Carrie depend on other developers?

0 1 2 3 4 5 6

b)* Upon further examination, you realized that the DSM is not partitioned yet. Draw a partitioned version of the DSM such that it is in a block triangular form (use crosses (X) instead of exact weights to represent dependencies).

0 1 2 3 4

c) After partitioning the DSM, justify whether it is in an **optimal form** (lower triangular) or not. If not, propose a way to achieve it.

0 1 2

d)* List **two** benefits of using a DSM as discussed in the lecture.

Problem 3 Message-oriented Architectures (14 credits)

A world-famous sushi restaurant in New York City, U.S.A contacted you for getting consultancy regarding their supply chain. Currently, the restaurant is ordering fresh fish from a market in Japan, and it takes up to a day for the fish to be delivered. The restaurant utilizes the following software and hardware components to track the location of their deliveries and do menu planning:

- Sensors: Continuously transmits data about the location of the deliveries
- Track-App: Provides a web interface for restaurant managers to track the location of the deliveries
- Whats-on-the-Menu-App: Provides available product information based on the location of the deliveries (e.g. "Tuna sushi will be on the menu if the deliveries pass the Pacific Ocean by 10 AM"). Updates app users daily with the new menu

a) * Your first task is to identify which message queue pattern should be used between which components and entities (e.g. app users). Justify your decisions.

0 1 2 3 4 5 6

b) * After your initial inspection, you realized that a traditional message-oriented middleware is used between the components. You know that with the current setup, communication between each component is handled separately and each publisher needs its own configuration. Propose a solution that would create a *hub and spoke* communication infrastructure for integrating the components (just the name is sufficient) and briefly explain **two** challenges of it.

0 1 2 3 4

c) *Briefly explain **two** motivations for using messaging.

0 1 2 3 4

Problem 4 Security (12 credits)

CriticalEater is an online delivery application exclusively for high-end restaurants. The application provides an interface for users to order food from available restaurants and pay instantly through the payment service. The application also has a forum section where users can write their reviews about restaurants.
Recently, users started complaining about getting blackmailed by people who claim to have their credit card information. You have been hired by the company as a security consultant to analyze this issue and explore any vulnerabilities in the codebase.
After inspecting the codebase, you discovered the following issues:

- No input sanitization is done on the reviews entered into the forum section
- Upon login, user credentials (including the credit card data) are stored in a **non-Http-Only cookie** on the client-side

0 1 2 3 4

a)* Name the attack (and its type) which can be used to send the credentials of every user that visits the forum section, to a malicious server. Briefly explain how the attack can be executed.

0 1 2 3

b) Briefly explain how this attack can be prevented to some extent and why it is not trivial to prevent it completely.

0 1 2 3 4 5

c) Besides the attack you have discovered initially, you also found the following ways to steal the credit card information of users:

- By intercepting the client/server communication
- By stealing the SQL database content

You know that any of these three options (including the attack you have discovered initially) are sufficient enough to steal users' credit card information. Draw an attack tree including all these attacks and find **two** ways to steal the SQL database content (show them in the attack tree as well).

Problem 5 **Blockchain (14 credits)**

a)* Blockchain is one of the most hyped technologies these days, and one of the reasons for that is the advantages it provides over centralized platforms. It is known that centralized platforms can suffer from *availability*. Briefly explain how blockchain-based architectures overcome this problem. Also, list **two** more drawbacks of centralized platforms as described in the lecture.

0 1 2 3 4

b) * Proof-of-Work (PoW) is the protocol that has been utilized by some of the popular blockchains such as Bitcoin and Ethereum (1.0) for determining the next block creator. Explain how PoW makes it impractical for an attacker to successfully operate a 51% attack.

0 1 2 3 4

c)* Smart contracts cannot directly access external data available outside the blockchain (e.g., weather data, exchange rates). Name the characteristic property of smart contracts that ensures this and briefly explain why it is needed. Also, name the entity that allows smart contracts to access external data.

0 1 2 3 4

d)* Decentralized platforms such as blockchains are not the most fitting architecture for every use case. List **two** advantages of centralized platforms over decentralized platforms as described in the lecture.

0 1 2

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Problem 6 SCRUM (13 credits)

Steven and his team is developing a web application for ordering online fruits and vegetables for a grocery store. Currently, the shop owner requires the system to elegantly display the information of the shop and its goods, enable pick-and-go ordering of food in the store with credit or debit card payment, and the website is displayed in German or English.

However, in the future, the system can have other features that the owner have not decided yet, such as purchasing coupon, shop-to-home delivery, supporting various payment methods, or reserving seasonal food items.

Steven's team consists of five members: one UI Design expert, an experienced full stack developer, and three newly graduated Master's students who do not have remarkable practical experience in full-stack software development.

0 1 2 3 4 5 6 7

a) * Steven's team plans to use SCRUM for developing the web application. Is SCRUM applicable to the current scenario? Briefly explain **two** reasons to support your answer.

* Briefly state **two** activities in each of the following SCRUM events:

0 1 2

b) Sprint Planning

0 1 2

c) Daily Scrum

d) Sprint Retrospective

0
1
2

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Problem 7 Microservice and Database (14 credits)

a) * Briefly explain **four** challenges of microservice development.

0 1 2 3 4 5 6

b) * Which problem is solved by the Service Discovery pattern?

0 1

c) * Briefly explain what is a server-side service discovery and what is a client-side service discovery?

0 1 2 3

d) * Briefly describe **two** properties of document-oriented databases.

0 1 2

e) * Given the following *students* Table:

0 1 2

ID	name	study_program	grade
1	Alice	Computer Science	1.7
2	John	Bioinformatics	1.7
3	Stein	Computer Science	3.0
4	Mary	Medicine	1.3

Transform the following query into Map-Reduce:

```
SELECT study_program, COUNT(*) FROM students GROUP_BY study_program
```

Note: Use function **size(array)** to get the number of elements in an array object.

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Problem 8 Quiz (8 credits)

0 1 2 3 4 5 6 7 8

Evaluate the following statements (correct answers + 1 point, incorrect answers -1 point, you cannot get less than 0 points for this exercise):

Statement	True	False
The state modified by transactions is not stored on the blockchain.		
Safety ensures the protection of the system from external hazards.		
Software should aim to achieve content coupling, not data coupling.		
The non-repudiation security property ensures that it is impossible for a user to inappropriately deny a transaction or having sent a message.		
A high domain range ratio leads to a good testability.		
Task parallelism focuses on distributing tasks across multiple cores.		
To develop a robust system, Autonomous Vehicles Architecture includes redundant functions and systems.		
In Function as a Service, the consumer has to allocate resources for handling triggered events.		

Additional space for solutions–clearly mark the (sub)problem your answers are related to and strike out invalid solutions.

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