

# DAT360 / DIT345

## Fundamentals of Software

### Architecture Final Exam

Time: 8:30-12:30  
Examiner: 0760268580 - Rebekka Wohlrab  
Place: January 4, 2024. Lindholmen  
**I'm coming to the exam hall at approximately 9:45 and at 11:30.**  
Max Score: 100  
Exam aids: *none (except for generally allowed aids, such as dictionaries)*

Grading Scale: 3:  $\geq 50$  4:  $\geq 70$  5:  $\geq 85$

The exam consists of the following parts:

- P1: Identifying architectural drivers
- P2: Quality attribute scenarios and utility trees
- P3: Architectural styles and patterns
- P4: Architectural trade-offs

Answer in full sentences or paragraphs in questions where a description, explanation or similar is required.

Please write legibly. If we cannot read your handwriting, we cannot give you points.

Read each assignment thoroughly before starting to work on it.

Begin each assignment on a new sheet.

Only write on the front of each sheet.

Label each sheet with:

- The assignment number and sub-assignment number (e.g., P1.1, P2.2, ...)
- The anonymous code provided by the student office. (The exam is anonymous.)

Before handing it in: Sort your sheets in the assignment order and enumerate them as 1, 2, 3, ...

#### **Additional information**

Keep in mind that we always require you to motivate your answer and to demonstrate your understanding of the subject matter. Max points will be given for:

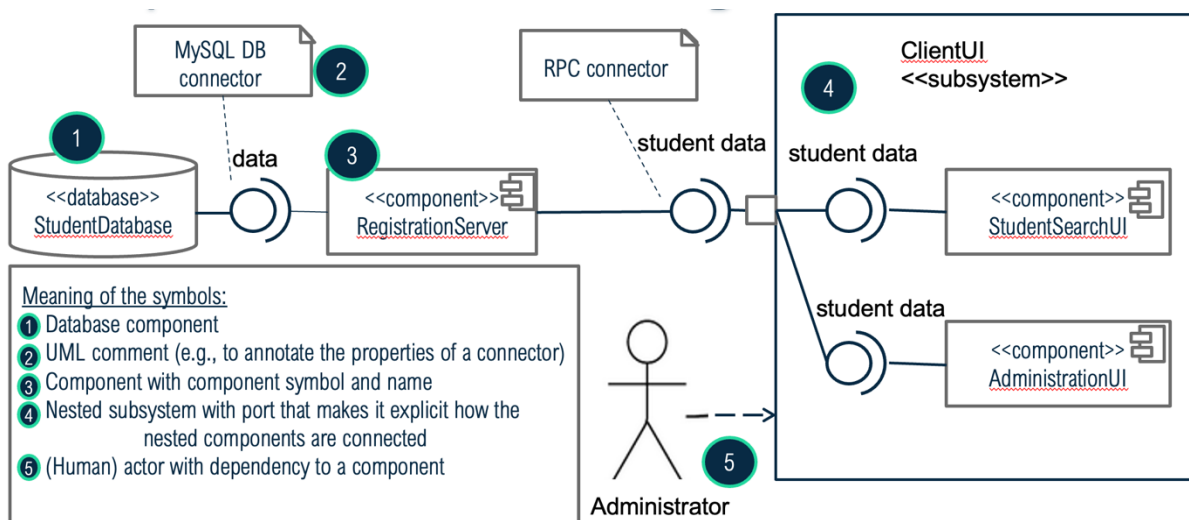
- Correctness.
- Soundness of your argumentation.
- Demonstration of knowledge and skills.
- Clearness, readability, and correct use of English.

Good luck!

## Breakdown of tasks:

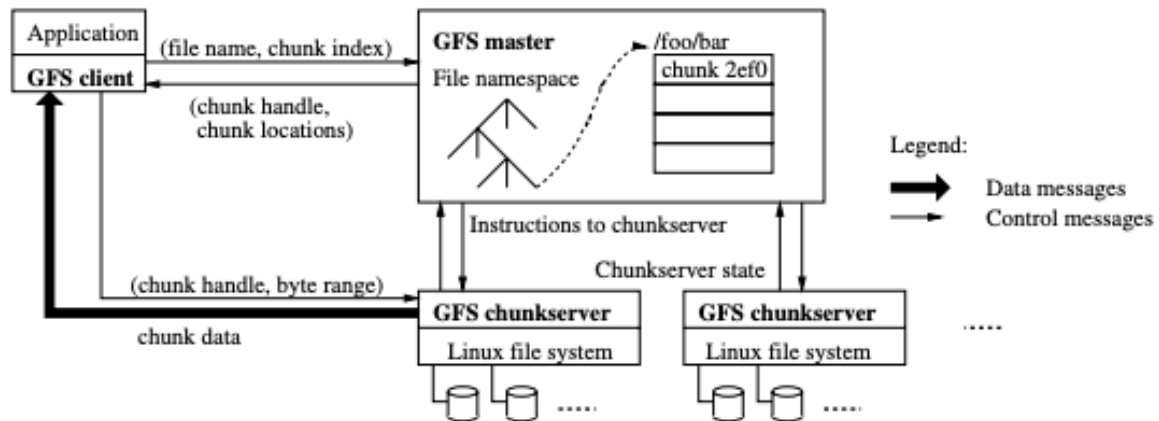
- Part 1: Identifying architectural drivers (16p)
- Part 2: Quality attribute scenarios and utility trees (24p)
- Part 3: Architectural styles and patterns (38p)
- Part 4: Architectural trade-offs (22p)

## Cheat sheet to clarify the notation for component diagrams:



## P1: Identifying architectural drivers (16p)

Look at the image of the Google File System (GFS) that we discussed in class. The designers of the GFS state: “The file system consists of hundreds or even thousands of storage machines built from inexpensive commodity parts and is accessed by a comparable number of client machines. The quantity and quality of the components virtually guarantee that some are not functional at any given time and some will not recover from their current failures. We have seen problems caused by application bugs, operating system bugs, human errors, and the failures of disks, memory, connectors, networking, and power supplies.”<sup>1</sup>



### Your Task:

- Specify a technical constraint and a functional requirement that were relevant when building the GFS (3p).
- What are the two most important quality attributes for the GFS? Describe how you can see that they were relevant for the designers of the GFS architecture. To do that, write down one tactic per quality attribute and argue how you can see in the figure above that those tactics have been applied. (8p)
- For each of the two quality attributes in P1.B, specify a quality attribute scenario (5p). Make sure that each scenario is precise and testable.

<sup>1</sup> <https://static.googleusercontent.com/media/research.google.com/en/archive/gfs-sosp2003.pdf>

## **P2: Quality attribute scenarios and utility trees (24p)**

### **A. Your manager has informed you of the following requirements:**

- The application on the client size will become more complex, with more sub-components. We want to be able to change the application's GUI without affecting more than one other component.
- We want to have a quick recovery when Denial of Service attacks happen.

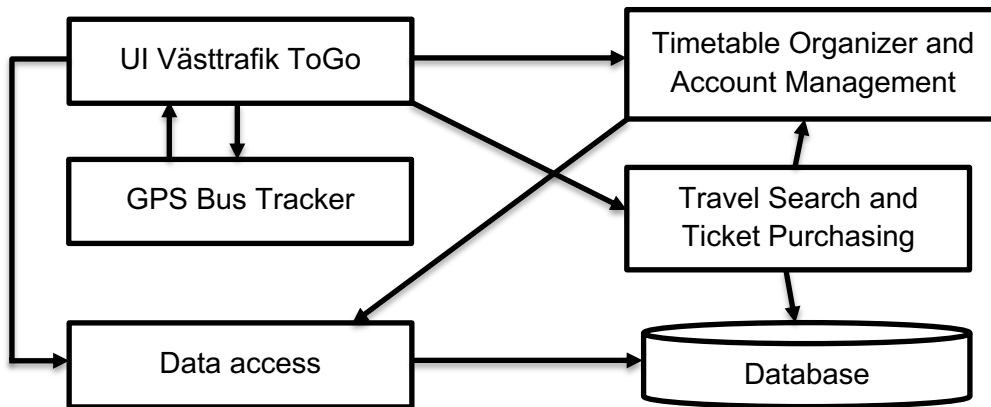
**Formulate a quality attribute scenario for each of those quality attribute requirements (12p), by describing the source, stimulus, artifact, environment, response, and response measure.**

### **B. Draw a complete utility tree for your quality attribute scenarios (both from P2.A and P1.C) (12p). You don't need to justify the assigned business value and architectural impact level.**

### P3: Architectural styles and patterns 38p

You want to build a new version of Västtrafik. A junior software architect within your company has produced the following diagram as a suggestion for the new software product.

It looks a bit strange. Since you are an architecture expert, you are asked to look at the diagram and give the junior software architect feedback.



#### Your task:

- Elaborate on what style the junior software architect might have tried to use. Explain whether you think the architecture is satisfactory or not, by focusing on two quality attributes of your choice. (7p).
- How does the junior software architect's solution follow the software architecture design principles that we learned in the course? Name two principles and elaborate on how they have been followed (7p).
- Create a component diagram and propose a new architecture. The first page of this exam includes a cheat sheet that you can use to get the notation right. Explain in simple terms your designed architecture, the style you chose, and at least two tactics that you used (17p).
- Argue why your solution is better than the one presented by your coworker in terms of two quality attributes of your choice (7p).

## P4: Architectural trade-offs (22p)

You need to do either P4.Normal or P4.Alt. Don't do both!

**Reminder:** We learned how to illustrate tradeoff points. You show a pair of conflicting quality attributes and indicate which of the quality attributes is prioritized. This tradeoff point illustration means that the tradeoff between cost and reliability is decided slightly **in favor of cost**:



This tradeoff point illustration means that the tradeoff between cost and reliability is decided **strongly in favor of reliability** – so reliability is the only thing that counts:



**Write down on a sheet of paper:**

**Did you participate in one of the role-playing workshops?**

**Do you remember the tradeoff points and decisions that your group made?**

If you chose no at least once: see task P4.Alt at the bottom of the page.

If you chose yes: do task P4.Normal.

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### P4.Normal

**A. Think about two of the tradeoffs that your group discussed when developing the Bästtrafik system.**

**Draw two tradeoff point illustrations for those pairs of quality attributes. Explain why it is necessary to make a tradeoff for the depicted quality attributes (i.e., why they are not compatible). For each tradeoff point illustration, explain why you chose to put the point at that position (1-2 sentences). (8p)**

**B. Explain what architectural style your group chose. After reflecting on the solution and listening to other groups' presentations, would you still choose that style? Why? Why not? (8p)**

**C. What was the main insight you got from the discussions in the workshop? Write 4-5 sentences. Your points will be reduced if you write more than 5 sentences. (6p)**

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### P4.Alt: If you did not attend the workshop or don't remember your group's solution:

**This task is concerned with the system from P3.**

**A. Draw two tradeoff point illustrations for two pairs of quality attributes that are relevant for that system. For each, explain why you chose to put the point at that position (1-2 sentences). (6p)**

**B. Formulate a tactic that you used to improve the QA you prioritized, or explain how the architectural style you chose makes sure that that QA is achieved. (8p)**

**C. Formulate a tactic that you could apply to improve the QA you did not prioritize. (8p)**