T25 - Software Systems Architecture - M.EIC010

Rita Kiss - Laura Lumijärvi - Yana Peycheva - Juan José Osorio - Amanda Oliveira - Tiago Marques

Homework 3 - part 1

List of questions

1. How will the system differentiate between different types of vehicles (e.g., cars, trucks, bicycles) when detecting oncoming traffic, and what considerations are made for each type's impact on traffic flow optimization?

2. Can the system adapt to changing traffic patterns, such as rush hour versus off-peak times, and how does it ensure consistent optimization under varying conditions?

3. What measures are in place to prioritize emergency vehicles' passage through the traffic signals while maintaining overall flow optimization?

4. Are there specific considerations for pedestrian traffic at intersections, and how does the system accommodate pedestrian safety while optimizing vehicle flow?

5. How does the system handle intersections with multiple lanes and varying traffic densities, ensuring fair and efficient signal changes for all lanes?

6. How quickly should the system adapt to unexpected events, such as accidents or road closures, to optimize traffic flow?

7. Can the system provide real-time feedback or data analytics on traffic flow patterns and optimization effectiveness for continuous improvement, and what tools or interfaces are available for traffic management authorities to monitor and adjust system parameters?

8. How big is the area for which the system needs to include? How many traffic signals need to be integrated in the system?

9. Is the system expected to grow in future? Should the system be open to expansion in future by adding additional areas and additional traffic signals?

10. How reliable should the system be? What is an acceptable time for the system not to be working? (Maybe updates at night, or at times where we know there is usually not a lot of traffic)

11. Is there an existing dataset with information about the area, the vehicles and their velocities, which you can provide for development and training of the data model?

12. What is the expected size of data with which our system needs to work with?

13. What type of crossroad junctions should the system be able to consider and manage with traffic lights? Are there also traffic lights with no crossroads? E.g. to only let pedestrians cross the street?

14. Where are the sensors for detecting the traffic and velocity positioned relative to each traffic light? (Having the velocity of the vehicle and the distance between the sensor and the traffic light it's important for decision making when to switch the traffic lights)

15. Should there be some vehicles with higher priorities?E.g emergency, public transportation?

16. When having big traffic on the street and a lot of pedestrians waiting, which one should be prioritized? (If we have to consider pedestrian traffic)

17. Can you provide a default traffic light system? In case of failure of the data model at the moment it's good to have a backup with default settings to use, so the whole transportation system doesn't fail.

18. How will the system handle atypical situations, e.g. parades, demonstrations, or road maintenance, which may require temporary adjustments to traffic flow?

19. How does the system take into consideration potential cybersecurity threats or vulnerabilities, especially considering the reliance on AI and data connectivity?

20. How does the system address potential weather-related challenges, such as reduced visibility due to fog, rain, or snow, and should it adjust signal timings accordingly? Furthermore, can the system detect and respond to hazardous road conditions, such as ice, to optimize traffic flow and enhance safety during changing weather?

21. As cultural and/or social factors may influence traffic behavior, such as driving habits or attitudes towards traffic regulations, are there any considerations for this aspect?

22. What are the strategies to minimize the impact of system failures or downtime on overall traffic management and public safety?

23. (If we have to consider pedestrian traffic) Are there any considerations for special needs populations, such as accessibility features for individuals with disabilities or seniors?

24. What data is provided and what data types are there?

25. In what ways do traffic lights communicate both locally and globally? What factors influence the operation of traffic lights beyond their immediate surroundings, and to what extent should these factors impact their function?

26. What methods should be used to carry out the validation of the system and the reliability of the AI based optimization?

27. What resources are available for testing the software before its deployment? Are we able to test it in a simulated environment?

28. What is the average velocity and interval (minimum/maximum) we should consider for the vehicles?

29. When should the project be deployed and concluded? Are there any other important milestones we need to consider?

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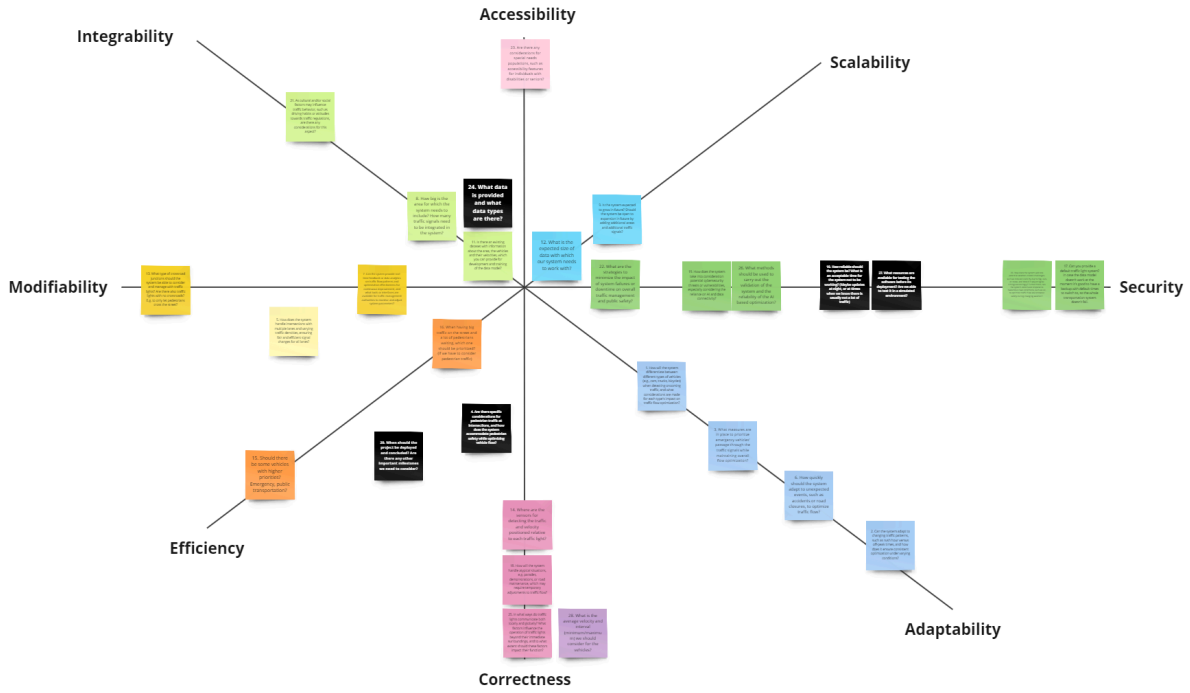
Homework 3 - part 2

Spiderweb

The spiderweb is provided in two formats:

- **Spiderweb image**
  (to give an overall and quick impression of the spiderweb)
- **Spiderweb link**
  (to open the spiderweb in miro, platform used to develop the spiderweb, and better view and read each post it)

Spiderweb image



Spiderweb link

https://miro.com/app/board/uXjVNpyPwC0=/?share_link_id=102793658214

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Homework 3 - part 3

Five particularly important questions

1. **What data and what data types are we dealing with?**

    a. **Why?** Knowing what data we will be storing helps solve important architectural questions and building fitting data models which correspond to the needs of the application.. For different types of data different storage methods are suitable. It's crucial to know what entities are there and what relationships they are between them for developing a clean architectural model of the software. A well-designed data model can accommodate future changes and expansions to the system more easily. It allows for scalability by providing a framework that can grow and evolve as the application requirements change over time. Furthermore, it can help performance, because building a good design model means also storing data in an appropriate way, so when queried the response times are minimal. Data types also influence tech stack decisions. Choosing the right techstack is one of the most important decisions in the planning of a project, because later big changes in the tech stack require a lot of effort and technical debt. Dealing with traffic lights in a certain area suggests dealing with geo spatial information. This means that depending on the amount and type of geospatial information, as well as what queries we need to execute on this information, we might need to consider using spatial databases.

    b. **Whom?** This question is important for many different stakeholders. First for the developers, because depending on the data, a different tech stack could be used, and they will need to work daily with the selected technologies. Another important stakeholder is the project manager. Choosing the right database and techstack involves considering the cost of using this database. Is this database/techstack open source and free? Is there a monthly subscription? Does it fit in the budget for the project? If that's the case this means that the cost will also be relevant to the maintenance phase. That question also concerns the client as a stakeholder, because they might have a preference in what database is used.

    c. **When?** This question needs to be answered already at the beginning planning phase of the project. If this question is answered at a later point, e.g in the development phase, this could lead to inconsistency and errors in the already developed code. Additionally developers would need to get used to new tools, which is also time and resource intensive. Additionally, the cost of the project might change, which would lead to additional effort from the project management side in order to reevaluate the overall cost.

d. **How?** Choosing a right database and tech stack based on the data and the essence of the data is a crucial question for the architecture of the project. Different technologies allow the use of different design patterns and practices. Because of this reason this question will have a huge impact on the way our system is built and how we design the architecture because it depends on the capabilities which these technologies offer and for what they are the best optimized for.

2. **How reliable should the system be? What is an acceptable time for the system not to be working?**

    a. **Why?** It is important to know the consequences if the system is not working for a short period of time and how big is the risk connected to this down time of the system. It could be for example due to an error or a failure. Knowing what is the upper border of how long it's acceptable for the system to not work, would help distribute the resources and answer the question how much time and resources should be invested into making the system more reliable. For example, hiring a dedicated quality assurance and testing team for that purpose. Or planning a longer test phase after the project is developed. Another reason for the system to be switched off could be a need for an update. Answering the question would also define how the process of running updates would look like and how efficient it should be.

    b. **Whom?** This question is relevant for developers, because they need to know for what reliability they need to strive while developing. There are a lot of trade offs while developing a project, and for example, in case of time pressure, it might be a better decision to develop more parts of the software, but at cost at reliability. For the users the reliability might lead to satisfaction if the reliability is really high, or also the opposite, of frustration if the system is unreliable and doesn't offer the promised functions for longer periods of time.

    c. **When?** This question needs to be answered in the planning phase. The reason for this is that this way it would be possible to achieve a good resource allocation. For example, hiring certain specialists like quality assurance, and testers might require time and for that purpose it should be clear already in the beginning for making a good resource and time management plan.

    d. **How?** This question would influence the architecture of the software by choosing, how and how much testing for reliability is made, and which technologies could be used to improve the quality and the overall reliability of the software.

3. **What resources are available for testing the software before its deployment? Are we able to test it in a simulated environment?**

    a. **Why?** It ensures thorough testing, identifying and addressing issues before deployment, and simulated environments offer controlled testing conditions for accurate evaluation.

    b. **Whom?** Development, QA, and operations teams are involved in managing resources and testing processes.

    c. **When?** Testing should occur throughout the development lifecycle, from early stages to deployment.

    d. **How?** Resources include dedicated testing environments, virtual technologies and testing tools. Simulated environments provide controlled testing conditions.

4. **Are there specific considerations for pedestrian traffic at intersections, and how does the system accommodate pedestrian safety while optimizing vehicle flow?**

    a. **Why?** Ensuring pedestrian safety is crucial to prevent accidents and create inclusive urban environments where everyone can move safely.

    b. **Whom?** Urban planners, engineers, and community members collaborate to consider pedestrian needs and safety measures.

    c. **When?** Pedestrian considerations start from the planning phase and continue through design and implementation.

    d. **How?** It guides the design of intersections, sidewalks, and crossings, incorporating features like clear markings, pedestrian signals, and traffic management systems to enhance safety while maintaining efficient traffic flow.

5. **When should the project be deployed and concluded? Are there any other important milestones we need to consider?**

    a. **Why?** Determining deployment and conclusion dates sets clear targets, ensuring project progress aligns with business objectives and stakeholder expectations. It also helps manage resources effectively and avoid potential delays.

    b. **Whom?** This question impacts project managers, development teams, stakeholders, and end-users who rely on timely delivery and completion of the project.

c. **When?** This question is typically addressed during the early planning stages of the project, but it requires periodic reviews throughout the lifecycle to adapt to changing requirements or constraints.

d. **How?** The deployment and conclusion dates influence architectural decisions such as technology selection, scalability, and modularity. Tight timelines may prioritize simpler architectures to expedite development, while longer timelines allow for more complex and scalable solutions. Additionally, considering milestones can prompt the integration of features or functionality at specific stages to ensure alignment with project goals.