Ambiguity and Architectural Questions

Software Systems Architecture

Group 4 - Class 3

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Introduction

Efficient traffic management is critical for urban infrastructure, necessitating the development of advanced traffic signal control systems. This essay focuses on eliciting requirements for such a system, emphasizing the need for real-time traffic detection, signal coordination, and AI-driven optimization. By clarifying key objectives and considerations, the aim is to inform the design of a solution that minimizes congestion, reduces fuel consumption, mitigates emissions, and enhances overall transportation efficiency.

Part 1 - Questions

After careful consideration, we managed to come up with 28 questions that we believe would make an impact on the architecture of the system. They are as follows:

1. How will the system adapt to unique situations (events, festivals, etc..) when deviating from the ideal traffic flow is necessary?
2. What is the deadline for the implementation of the traffic control system and are there any “checkpoints” that need to be achieved within specific timeframes?
3. How much has been allocated for the development and implementation of the application?
4. What are the strengths and weaknesses of existing traffic control systems in the market? How will this new system differentiate itself from competitors?
5. How does the system detect oncoming traffic?
6. Are there any limitations to the sensors that can be implemented?
7. What redundancies or fail-safes should be in place to guarantee that the traffic signals will keep working in case of sensor failure?
8. How will coordination between traffic systems be made possible?
9. What systems are currently in place to detect the speed and volume of oncoming traffic?
10. Is the traffic system for single intersections or should it work across multiple traffic lights?
11. Should public transportation, emergency vehicles, or priority vehicles be able to control traffic in order to improve traffic for these vehicles?
12. How will the system address potential challenges such as adverse weather conditions, road construction, or special events that may affect traffic flow?
13. In case of traffic on all roads, how should the traffic signals proceed?
14. How will the system balance the competing objectives of optimizing traffic flow and ensuring pedestrian safety at intersections?
15. How will the system make sure that the drivers don’t exceed the speed limit?
16. Is the system supposed to integrate with current infrastructure or will it be a whole new system?

17. How will the system handle pedestrian crossings, and what measures are in place to prioritize pedestrian safety?
18. What protocols will be established to handle system upgrades or potential fixes without causing disruptions to regular traffic operations?
19. Are there any specific safety protocols or regulations that the system needs to adhere to?
20. How will the system handle traffic incidents or accidents, and what measures are in place to reroute traffic and minimize disruptions?
21. What communication protocols will be used for coordination between traffic signals?
22. How will the system handle intersections with different traffic priorities, such as major roads versus side streets?
23. What technologies/AI models will be utilized for detecting oncoming traffic speed and volume?
24. What level of accuracy is required for detecting oncoming traffic speed and volume?
25. What European/International directives or regulations govern the design and implementation of traffic signal control systems?
26. How will the system transmit Signal Phase and Timing (SPAT - message that the traffic lights send to cars, to tell them when it's safe to go or when to stop in advance) data to connected vehicles?
27. Will the system be able to communicate with vehicles equipped with CITS (smart cars and roads that talk to each other to make driving safer and easier. Helps cars share important information, like where they are and if there's traffic ahead.) technology?
28. Will the system support dynamic updating of MAP (mapping of the information about roads, streets, intersections) data to account for changes in road infrastructure?

Part 2 - Question Organization

After looking at the questions we presented earlier, we realized we could organize them into different groups based on what area they relate to. Also, each question will be assigned a timeline, meaning when they should be answered. This means that questions that need to be answered early on (problem space) are more urgent than the ones that could be answered afterwards. Questions related to comprehending the requirements and the core problem should take precedence over those belonging to the solution space.

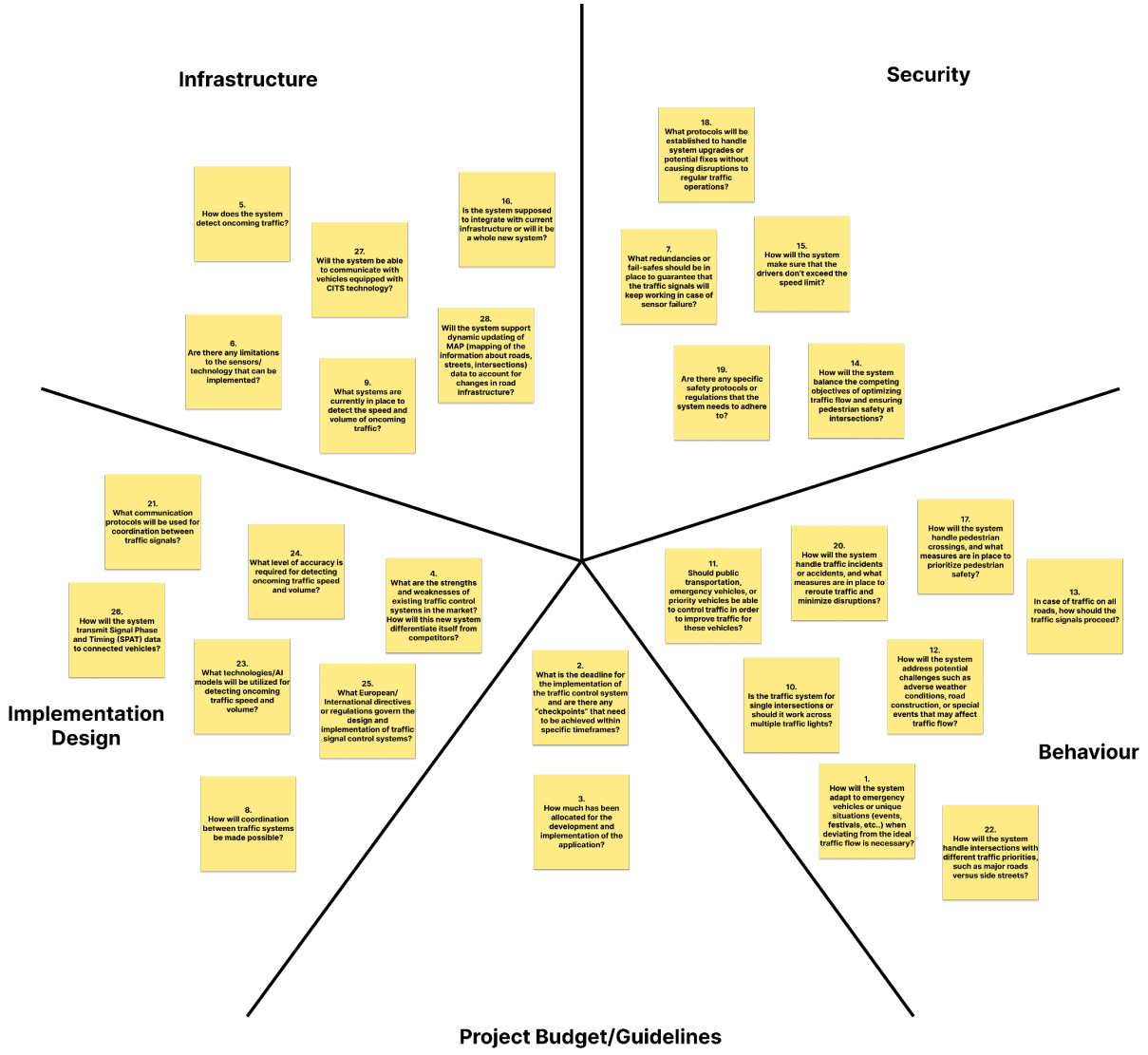

Fig. 1 - Spiderweb that best organizes our topics and time when they should be asked

When creating our spiderweb we managed to distribute our questions between 5 different groups which we then designated them as follows (the colors are represented in the questions, part 1):

- Infrastructure
- Security
- Behaviour
- Project budget/guidelines
- Implementation Design

On top of that, we also organized them along the “Time when the questions need to be answered” dimension which is represented by the distance to the center (the middle is “now”).

Part 3 - Importance of the Questions

In this section we will highlight the 5 questions we deem important, choosing 1 from each of our groups, and explain the reasons why they are fundamental to the systems' architecture.

1. Is the system supposed to integrate with current infrastructure or will it be a whole new system?

WHY is this question important?

This question is crucial because it directly influences the overall design and development approach of the system. Understanding whether or not the system is supposed to integrate with the current infrastructure helps in making certain decisions about technology and design choices. It may also limit the architects to follow a certain direction that perhaps they wouldn't follow if it wasn't for the existing infrastructure.

WHOM does this question impact?

This question impacts the various stakeholders involved in the development process of the system such as software architects, developers

WHEN can this question be answered?

This question should be addressed as early as possible in the project lifecycle as its answer will impact the whole system's architecture. Delaying this decision will most likely lead to complications such as rework and project delays.

HOW does the answer to this question impact the architecture of the system?

The answer to this question significantly shapes the system architecture. While being a whole new system offers more flexibility in technology choices, less dependencies and the freedom to make choices without having to worry if it will fit the current infrastructure, on the other hand integrating the system with the current infrastructure will require careful consideration of existing technologies, protocols, and standards. Integrating with the current infrastructure demands a meticulous approach to ensure compatibility and seamless communication between the new and existing components.

2. What communication protocols will be used for coordination between traffic signals?

WHY is this question important?

The choice of communication protocols is critical as it directly impacts the efficiency and reliability of our traffic signal control system. Different communication protocols offer varying levels of performance, security, and interoperability, which can significantly influence the system's effectiveness and adaptability to changing traffic conditions. Moreover, the selected protocols must align with the system's architecture and hardware capabilities.

WHOM does this question impact?

This question affects various stakeholders involved in the design, development, deployment and maintenance of the system as it will dictate all interactions any technical stakeholder has..

WHEN can this question be answered?

This question should be addressed during the early analysis of system design and planning. Uncertainties in selecting communication protocols can hinder progress in other areas of system development, such as software design and hardware choices. Therefore, it is crucial to establish clear communication requirements and protocols early in the project lifecycle.

HOW does the answer to this question impact the architecture of the system?

The answer will affect the networking infrastructure, data exchange mechanisms and system interoperability. Different protocols may require specific hardware components, such as routers or other communication modules, which must be integrated into the overall system design. Therefore, the answer to this question fundamentally shapes the system's architectural design, impacting its performance, reliability, and adaptability to future requirements.

3. What protocols will be established to handle system upgrades or potential fixes without causing disruptions to regular traffic operations?

WHY is this question important?

The question addresses the critical need for protocols and procedures to manage upgrades and maintenance activities in a way that minimizes disruptions to regular traffic operations. System upgrades and fixes are inevitable throughout the lifecycle of a system therefore establishing clear and effective protocols is essential to ensure the continuous operation and reliability of the traffic control system while minimizing disruptions to daily traffic flow.

WHOM does this question impact?

This question impacts various stakeholders involved in the design, development and, most importantly, maintenance and operation of the traffic control system. System administrators, maintenance personnel and software developers are directly responsible for implementing upgrade and fix protocols. Ultimately, the question ends up affecting all road users who rely on the efficient functioning of traffic signals for safe and timely travel.

WHEN can this question be answered?

This question should be answered by the design phase. By establishing upgrade and fix protocols during the design phase, stakeholders can incorporate them into the system architecture, software design and operational procedures. Waiting until after deployment to define these protocols can lead to less efficient solutions as the architecture is mostly locked-up.

HOW does the answer to this question impact the architecture of the system?

The answer to this question influences the architecture of the system, particularly in terms of system redundancy and failover mechanisms. Robust upgrade and fix protocols may involve redundant hardware and software components to facilitate seamless switchover during maintenance activities. Integrating these protocols into the system architecture ensures that upgrades and fixes can be performed efficiently without compromising traffic operations, thereby enhancing system reliability and user satisfaction.

4. Is the traffic system for single intersections or should it work across multiple traffic lights?

WHY is this question important?

This question is crucial as it defines the scope of the traffic system. Whether it operates at single intersections or across multiple traffic lights significantly impacts the complexity of the system design and functionality.

WHOM does this question impact?

This question impacts various stakeholders, including software developers, architects and ultimately, the general public.Software architects need to design an effective and efficient traffic management system, while software developers need a clear understanding of the system's scope to implement the appropriate features.

WHEN can this question be answered?

This question should be answered early in the project lifecycle during the requirements gathering and analysis phase to set the system's scope and objectives.

HOW does the answer to this question impact the architecture of the system?

If the system is designed for single intersections, the architecture may be simpler with a focus on optimizing signal timing and coordination within each intersection. To manage traffic flow across a network of intersections, the architecture would need to include communication protocols, coordination algorithms, and possibly centralized control mechanisms if it was meant to operate across many traffic lights.

5. What is the deadline for the implementation of the traffic control system and are there any "checkpoints" that need to be achieved within specific timeframes?

WHY is this question important?

Having a deadline for the project is crucial for its planning, resource allocation and overall project success. Having regular checkpoints sets expectations for stakeholders and ensures timely delivery.

WHOM does this question impact?

This question impacts various stakeholders, including software architects, developers, testers and clients. Clear deadlines ensure effective coordination among team members and satisfy client expectations.

WHEN can this question be answered?

This question is typically addressed early on in the project lifecycle. The deadline is established based on factors like project scope, complexity, and client requirements. Checkpoints may be identified during the project timeline for progress assessments.

HOW does the answer to this question impact the architecture of the system?

Having a deadline influences architectural decisions. If there are strict time constraints, the architecture may prioritize simplicity and efficiency over complex features. It also affects the choice of technologies, development methodologies and the level of system scalability.

Conclusion

In conclusion, the task of eliciting questions for the traffic signal control system project has emphasized the necessity of clarifying requirements and considering architectural implications.

The questions, grouped logically and timed within the project lifecycle, demonstrate the interconnectedness of system design aspects. By diving into the questions we also learned how these have the potential to reshape the system architecture and impact stakeholders significantly.