Ambiguity and Architectural Questions

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Part 1 - List of questions without any particular order

1. How does the system guarantee the adaptability of traffic in the event of urban changes?
2. Are there already, in the market, solutions geared towards controlling traffic?
3. If technologies for detecting oncoming traffic already exist, which should we use?
4. How accurately does the system need to detect the speed of approaching traffic?
5. Should the traffic signals have a long-distance speed detector to change the signal?
6. Should there be any concerns in scenarios such as peak times to optimize traffic?
7. How should the system behave if someone disrespects the traffic laws?
8. What protocol should the system follow in order to handle traffic accidents?
9. What types of sensors or technologies should be used to accurately detect oncoming traffic?
10. How does the system intend to be reliable, when there are adverse weather conditions?
11. How should the system distinguish and handle different types of vehicles and pedestrians?
12. How should the system address potential privacy issues related to data collection and processing?
13. Should we take into account different types of terrain when placing the sensors for the system or should we assume it is only going to be used in flat terrains with straight lines?
14. How should the system handle emergency vehicles or situations that require immediate intervention?
15. Are there any requirements that need to be considered when implementing an AI-based traffic signal system in terms of bias to certain situations that could be exploited, in terms of safety?
16. Are there specific communication protocols that should be followed to ensure interoperability with third-party systems?
17. If such infrastructure exists, should the system also integrate with existing traffic management infrastructure?
18. Are there any specific budgetary constraints that should be considered during the development of the system?
19. How should the system mitigate biases in traffic flow optimization, particularly in diverse or densely populated areas?
20. How will the system handle software updates to ensure long-term stability/effectiveness of the system?
21. Should the system be air-gapped, which means not being connected to another network either by wire or wirelessly?
22. Are there any failsafe mechanisms that the system should implement?
23. Are there specific scenarios or intersections where the system needs to be more critical?

24. What are the metrics used to measure the impact of the system, e.g., emissions, saved fuel?
25. Is a user interface for displaying traffic information necessary to exist?
26. If a user interface is required, what kind of features are expected?
27. Who are the clients of the system?
28. Who are the end-users of the system?
29. With which entities should the system share the collected or produced information?
30. What are the desired system interfaces, e.g, should it have video streaming to the police or an app for electronic operators?
31. How much time is expected before delivering a prototype of the system?
32. What is the system's desired uptime ratio?
33. What is the expected lifetime of the system?
34. How long is the system supposed to be maintained/supported?
35. In which administrative regions, i.e., countries, is this system going to be used?
36. Should the system produce some form of analytics, e.g., vehicles detected?
37. How does the system create revenue?
38. Is the AI a third-party service that runs on the cloud or a service created from scratch that runs locally?

Part 2 - Spyderweb with questions organized in 2 dimensions

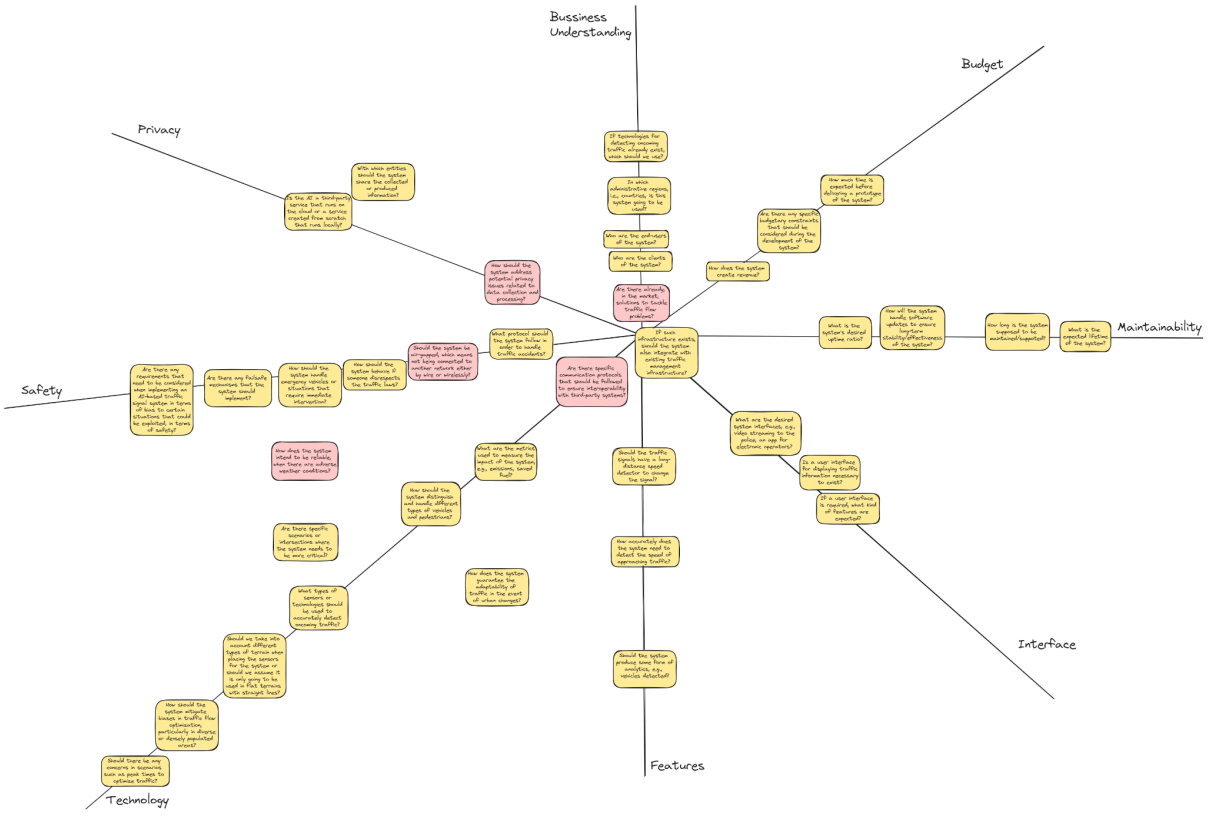

Fig. 1 – Spyderweb with the questions organized in two dimensions. The different lines represent the domains and the distance to the center represents the time.

A better looking version of the spyderweb is available here (zoom available).

Part 3 - Five questions that are particularly important

Are there already, in the market, solutions to tackle traffic flow problems?

Why is this question important?

Market research helps identifying gaps in current solutions, and avoiding redundant efforts in development, which saves on development costs. It also provides insight into existing solutions and technologies available in the market, thus developers can better understand the problems they offer and how to tackle them with a better solution.

Whom does this question impact?

This question mainly impacts architects, speeding up the design of the architecture but also impacts the client and other stakeholders since it can reduce costs of development of the architecture and solution.

When can this question be answered?

This question can be answered in the early analysis phase, e.g., during an initial product-market fit.

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

In case a solid solution already exists, the architecture may focus on improving upon it and integrating the solution using those technologies instead of starting building an architecture from scratch. Also, it can influence the choice of hardware, software, communication protocols, and data management techniques.

Are there specific communication protocols that should be followed to ensure interoperability with third-party systems?

Why is this question important?

The importance of this question is trivial. Ensuring interoperability with third-party systems that are already implemented is usually a desire of many clients. It may provide benefits at many different levels, namely, migration and upgrade to a new system.

Whom does this question impact?

This question can have an impact on various stakeholders depending on the context. However, the most obvious that come to mind are the end-users, who will be familiar with the new system due to its interoperability with the older one.

When can this question be answered?

This question must be asked very early into the project to avoid surprises with the architecture. It is a fundamental question related to functional requirements and can have a deep impact on the system design and architecture.

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

Providing interoperability with third-party systems may require some trade-offs at various dimensions. Naturally, which dimensions suffer from those trade-offs depends on the context. An example of that impact has to do with the fact that third-party systems may have some interfaces incompatible with the designed systems, hence the need for adapters.

How should the system address potential privacy issues related to data collection and processing?

Why is this question important?

It is essential to ensure that the system complies with relevant privacy laws and regulations and protecting user privacy fosters trust in the system among the public which is important for the client's reputation. More importantly, respecting the user's privacy is just ethically correct and should be respected.

Whom does this question impact?

The answer to this question directly impacts the end users, since it is related to the collection and processing of its own information. The way the system uses the information collected can deeply affect the security and privacy of personal data and if used incorrectly can create unnecessary risks. Affects the client since its reputation is affected when the user's privacy is valued. This also affects the law team, since they need to ensure legal requirements are met. Finally, it affects the developers responsible for the use of this data since they need to keep in mind the security concerns when developing the architecture.

When can this question be answered?

Throughout the whole project lifetime, from the early stages of analysis and design to development, testing, and deployment, this issue needs to be answered. Instead than trying to retrofit privacy protections later, developers can build privacy features into the system's architecture and design by taking privacy implications into account early on.

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

The system might be built to only gather and use the bare minimum of data required for its intended use, lowering the possibility of privacy violations. Sensitive information must be encrypted to reduce the risk of unwanted access while it is in transit and at rest. Authentication systems can also be used to limit authorized personnel's access to sensitive data.

Should the system be air-gapped, which means not being connected to another network either by wire or wirelessly?

Why is this question important?

Signaling systems are very sensitive. In case of a malfunction, it puts road users' lives in danger. It must be formally verified, and on top of that it must be robust to any sort of

attacks. Since it is such a critical system, ensuring it is air-gapped provides an extra layer of security.

Whom does this question impact?

This question impacts the developers, who design the systems; the system maintainers, who have to design its workflows taking such a fact into account; and also, the road users', who have the guarantee that the system is there to their benefit and it tries to be as safe as possible.

When can this question be answered?

Even though this is a relevant question, the fact is that it isn't one of the first things to consider when thinking of a solution. It might be the case that it may not even be desired by the one who is purchasing the system, or even impossible, in case of interoperability with other systems.

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

Designing air-gapped systems is always a massive challenge. Usually, the nature of these systems is very sensitive. Furthermore, the interactions with the system must be thought carefully in order to ensure that it does not enter in a state that is not desirable. Also, could lead to limitations since it reduces the amount of features the system can support.

How does the system intend to be reliable, when there are adverse weather conditions?

Why is this question important?

The relevance of this question relates to the fact that these systems are critical to road user's safety. Therefore, they must be able to perform under the most adverse conditions, namely, hazardous weather.

Whom does this question impact?

This question is in the interest of various stakeholders. Again, the developers, who have to design the system to be resilient under such conditions. The system operators, who may have special procedures to follow under adverse weather conditions. Or the clients, who desire the system to have a special behavior if certain weather conditions are met. Once more, the answer to this question depends on the context.

When can this question be answered?

After the project has undergone some development, and after some prototyping and testing has occurred, this question can be addressed. In certain places, it might be of utmost importance, while in others not while still being always required to some degree.

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

Designing a reliable system always poses a challenge. The architects may be confronted with a variety of different solutions and picking up the best one is, at best, hard. Each solution may have its unique trade-offs, and sometimes constraints imposed by the client

exist, making the task even more difficult. This question will affect the reliability of the system throughout the development of the solution.