

Team Project

Autonomous Intersection Management System (AIMS)

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The Problem

- Intersections are a critical part of road systems.
- **40% accidents occur in intersections.**
- **In 2010, 32,999 people were killed, 3.9 million were injured, and 24 million vehicles were damaged in motor vehicle crashes in the US.**

The Problem

- According to the 2021 Urban Mobility Report for the USA, from 2000 to 2019,
 - **traffic delay** rose from **5.1 to 8.7 billion hours**,
 - **wasted fuel** rose from **2.4 to 3.5 billion gallons**,
 - **excess greenhouse gas emissions** rose from **25 to 36 million tons**,
 - **congestion cost** rose from **\$77 to \$190 billions of dollars**. Intersections are a significant source of traffic accidents and delays in cities.

Autonomous Intersection Management System (AIMS) Conceptual Design

- Autonomous Intersections (also called smart intersections or intelligent intersections) are a part of the smart city concept; The customers are the cities; The users are the drivers, pedestrians, robots, and animals
- Autonomous intersections have a significant market potential due to
 - Potential to increase traffic safety
 - Potential to reduce costs associated with traffic
 - Scale (Lots of intersections)

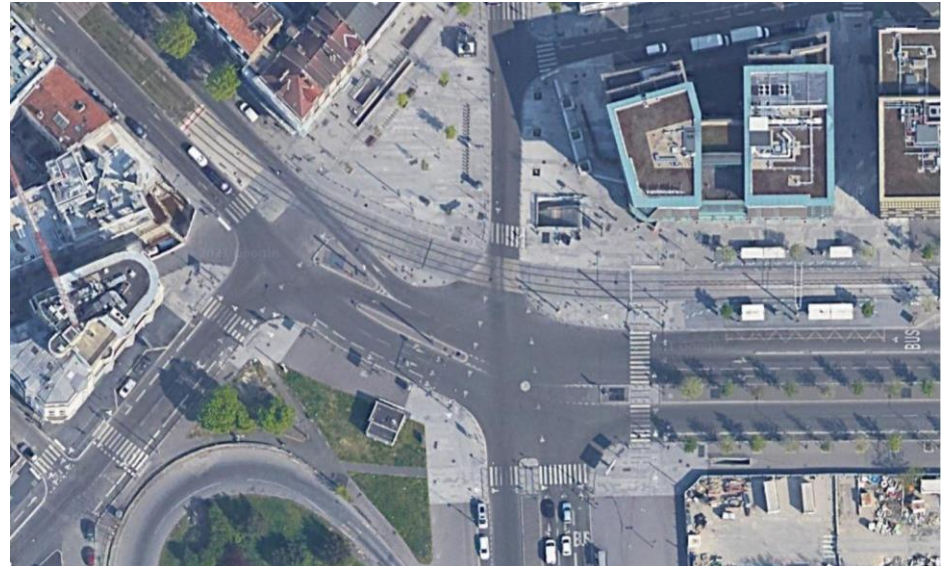
Autonomous Intersection Management System (AIMS) Conceptual Design

- Autonomous intersections, are real-time safety- and mission-critical systems. Therefore, system implementations should be of high quality.
- To ensure quality, conceptual and architectural designs should be carefully developed, discussed in-depth, and become mature before actual system implementations leading to large-scale deployments.

Autonomous Intersection Management System (AIMS) Conceptual Design

- Most studies focus on intersection traffic optimization policies and simulations to increase the efficiency of intersection use by connected and unconnected vehicles and pedestrians.
- The literature related to AIMS design is limited.
- A conceptual design of an autonomous intersection management system (AIMS) to guide system implementations

Intersection Examples

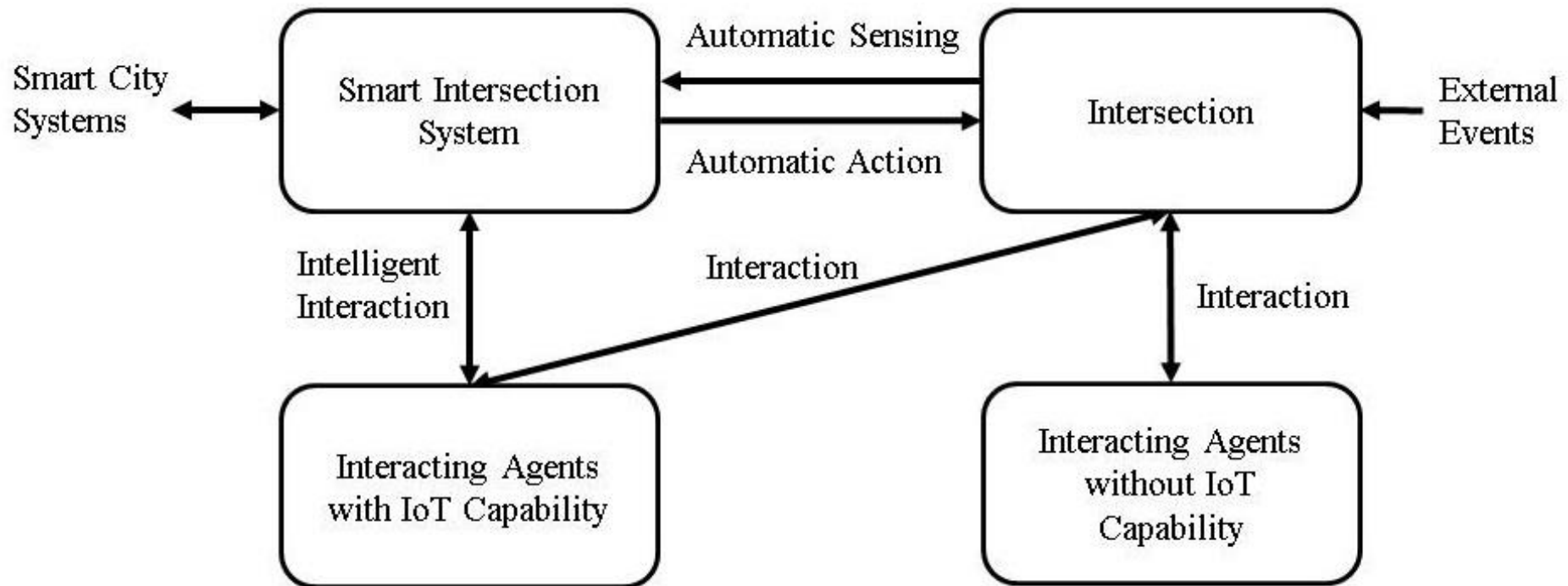


Autonomous Intersection Examples

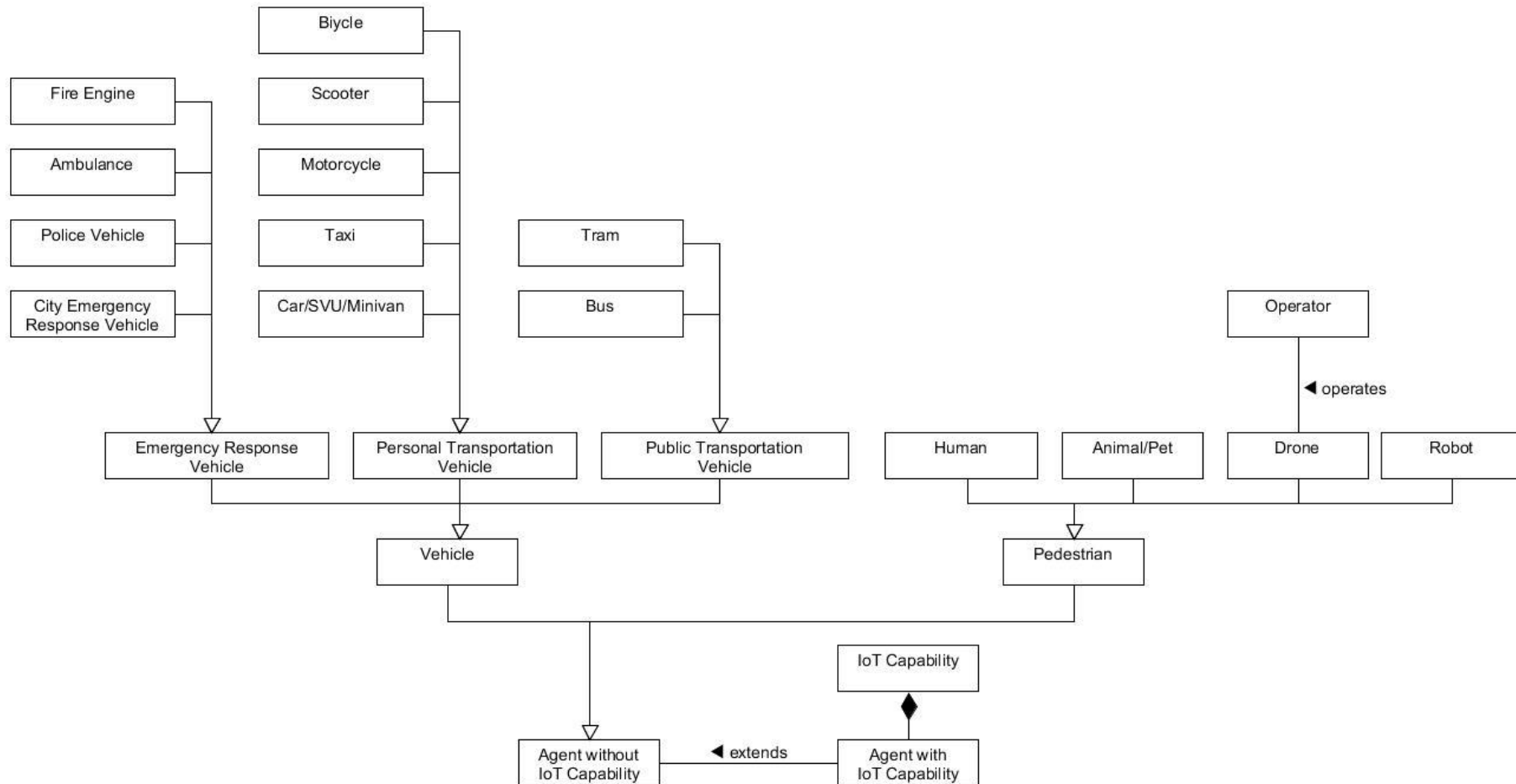


AIMS Concept

➤ AIMS may be viewed as an **ambient intelligence system**



AIMS Users



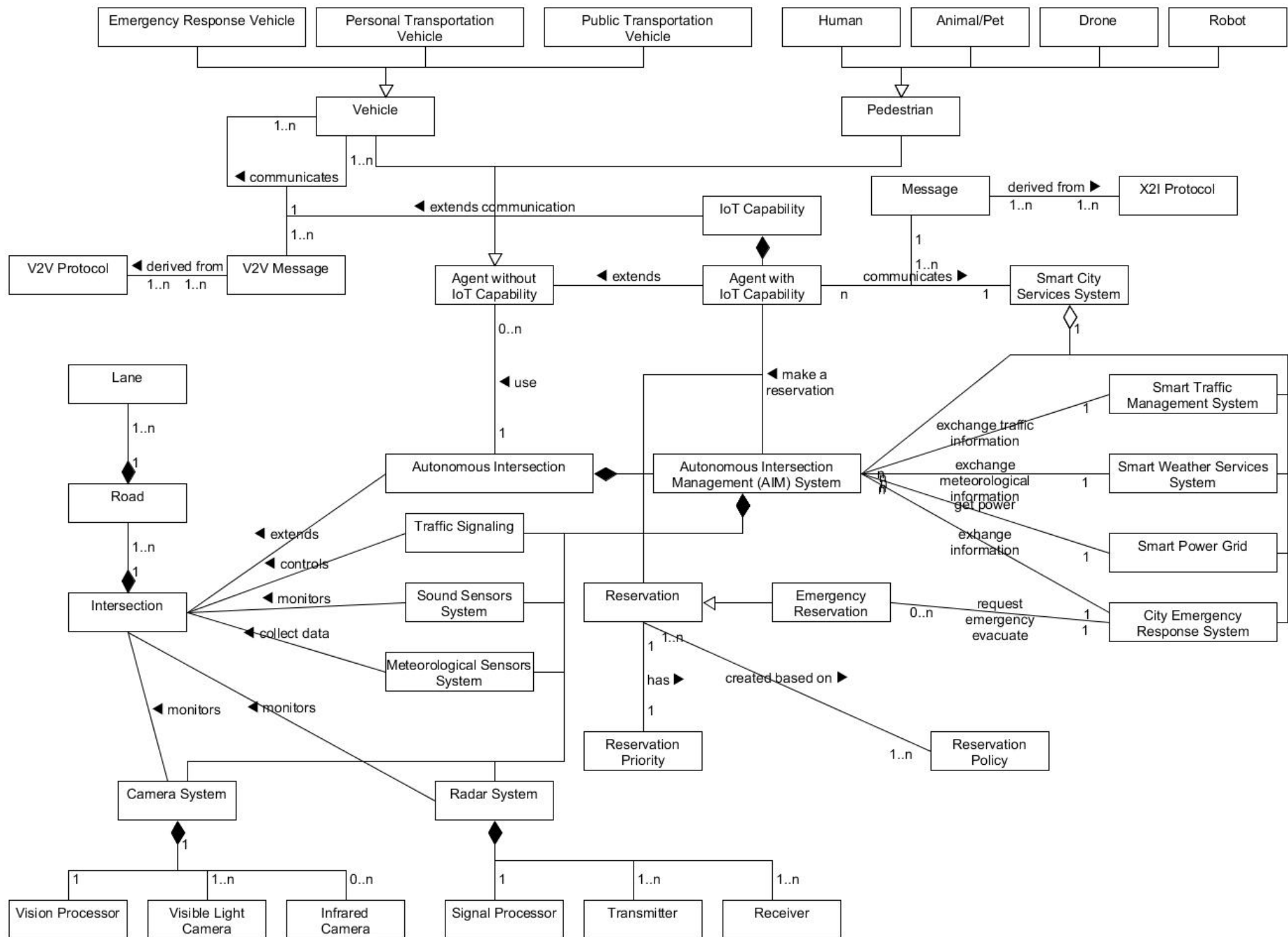
AIMS Conceptual Design

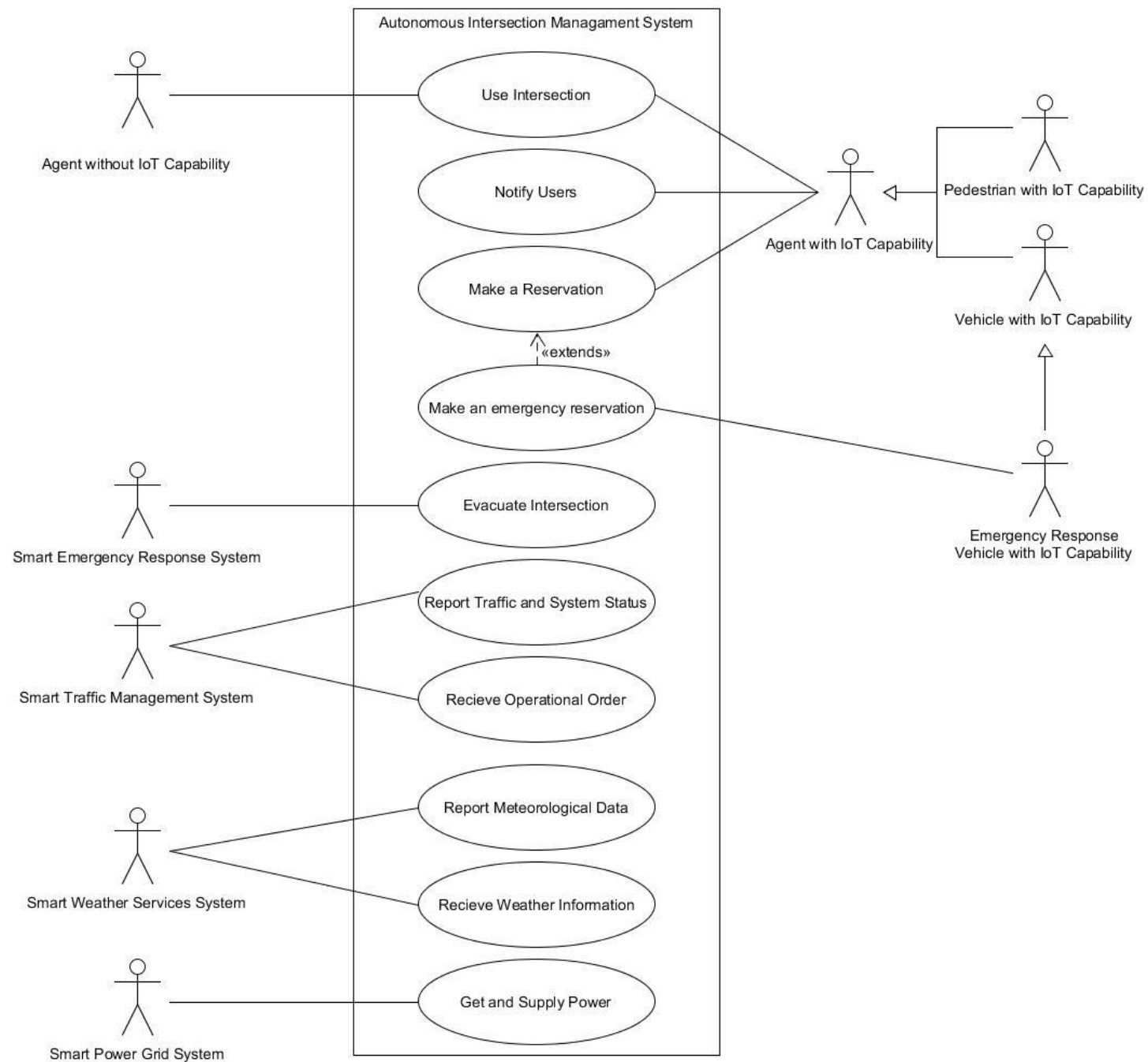
- Analyzed current academic and other types work on autonomous intersection management systems
 - Investigation of visions

- Analyzed existing system prototypes
 - COSMOS pilot testbed site in New York City, USA
 - Texas A&M University RELIS Campus, a smart intersection testbed
 - Ann Arbor, USA, more than 20 smart intersections

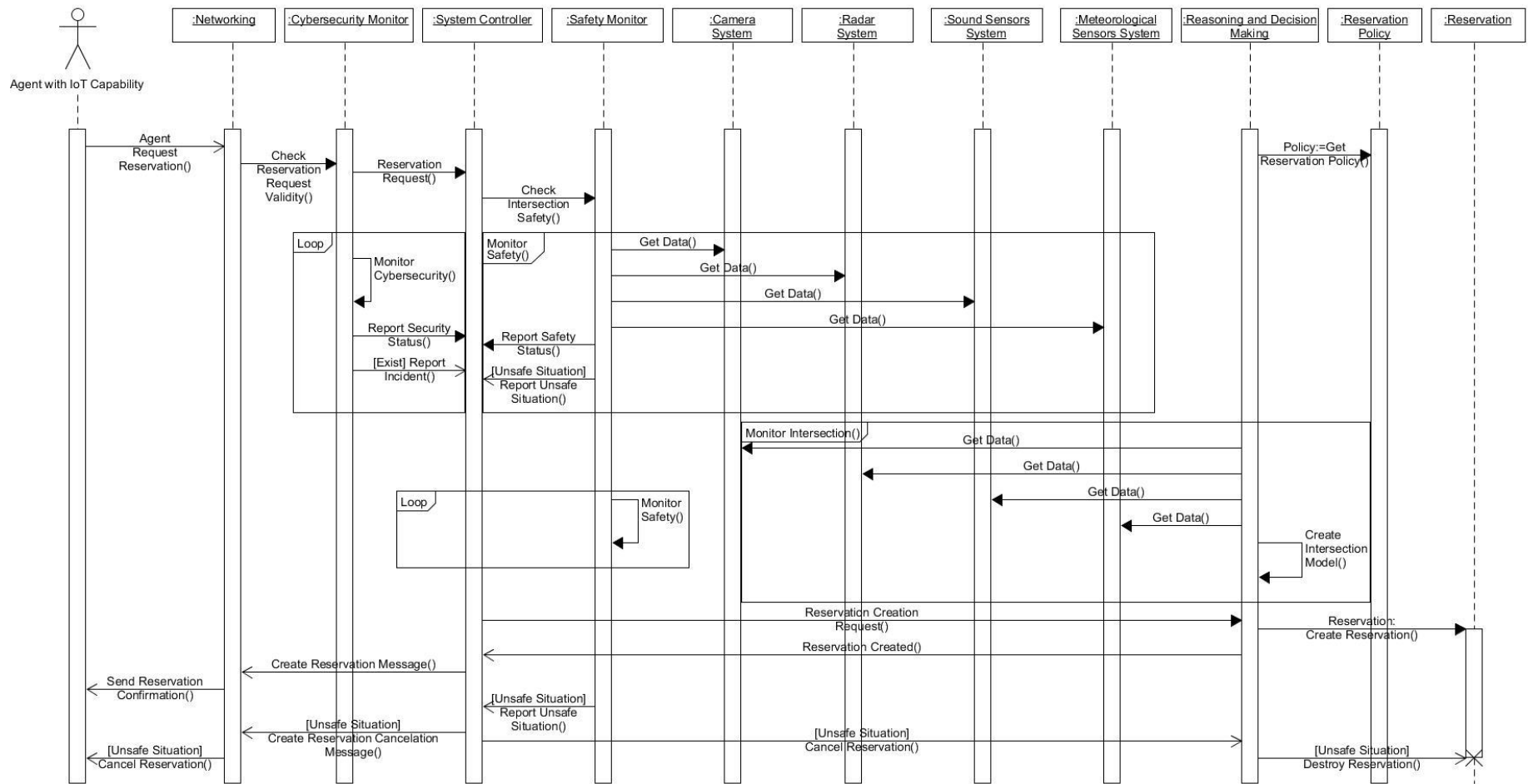
AIMS Conceptual Design

- Various cities started to develop vision and operational concept documents for smart city applications including autonomous intersection management systems or smart intersection management systems
- Analyzed operational concept documents
 - San Diego's (USA) Regional Planning Agency (SANDAG) recently published a concept of operations (ConOps) for smart intersection systems in February 2021





AIMS Conceptual Design – Make a Reservation Sequence Diagram



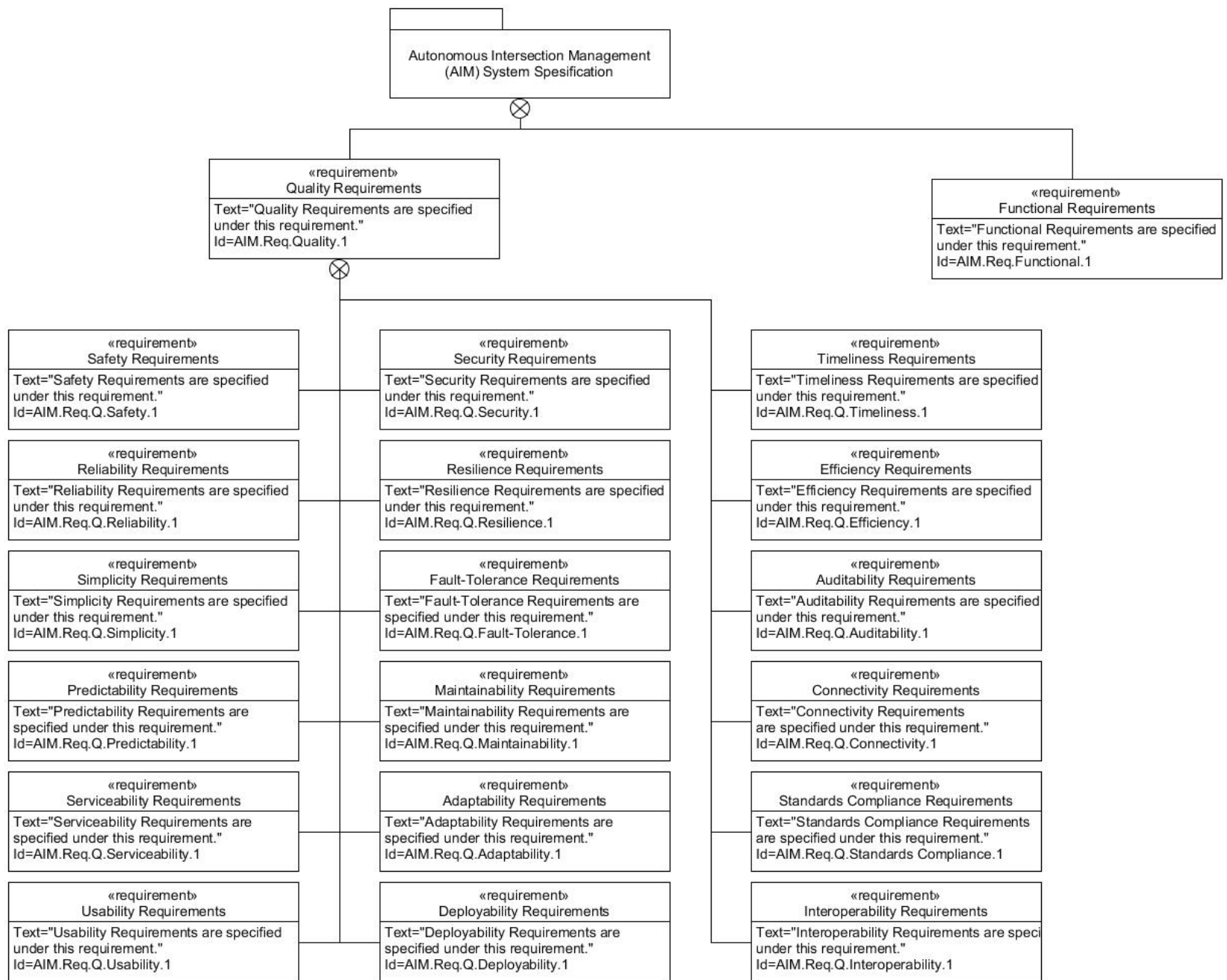
AIMS – Quality Attributes

- Safety
- Security
- Timeliness
- Reliability
- Simplicity
- Resilience
- Fault-Tolerance and Fault-Recovery
- Auditability
- Predictability
- Efficiency
- Connectivity
- Maintainability
- Serviceability
- Adaptability
- Standards Compliance
- Interoperability
- Usability
- Deployability

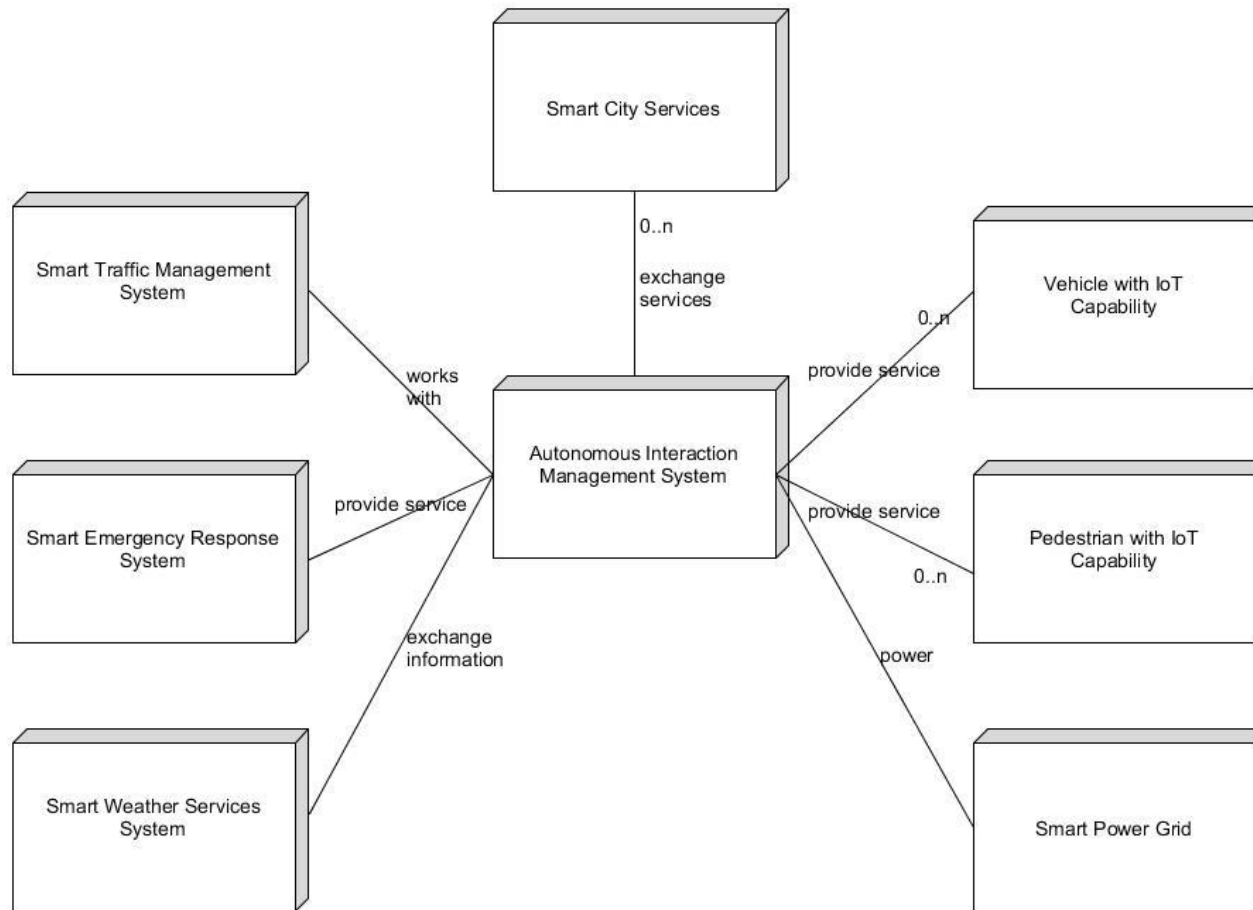
Development Tips



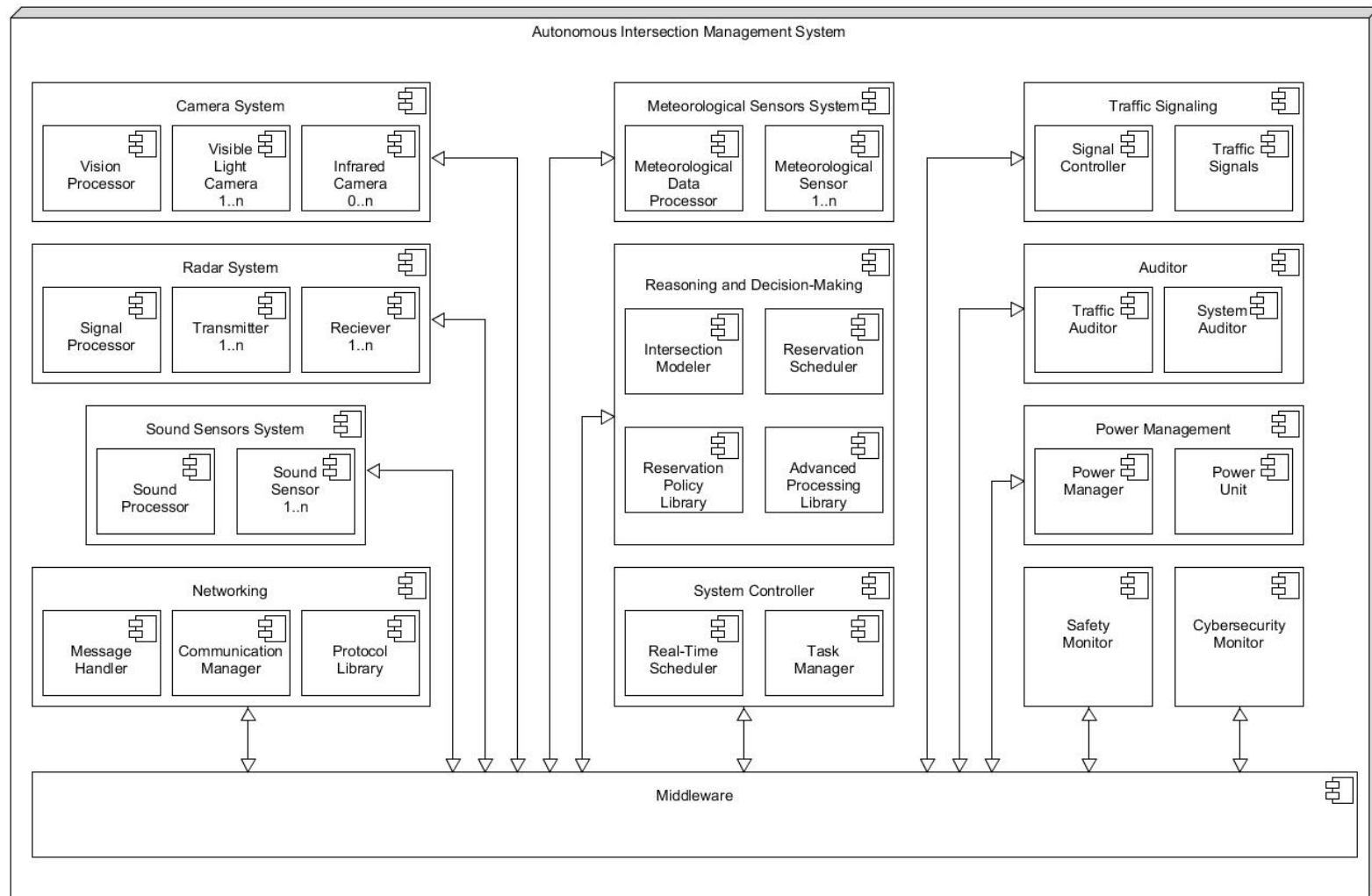
- Identify the quality attributes.
- For each quality attribute develop a strategy.



AIMS External Interfaces



AIMS Conceptual System Design



Questions?

Resources

- Icons by <https://icons8.com/>
- Cliparts by <https://www.pdclipart.org/> , <http://clipart-library.com/>