Secure Autonomous Systems

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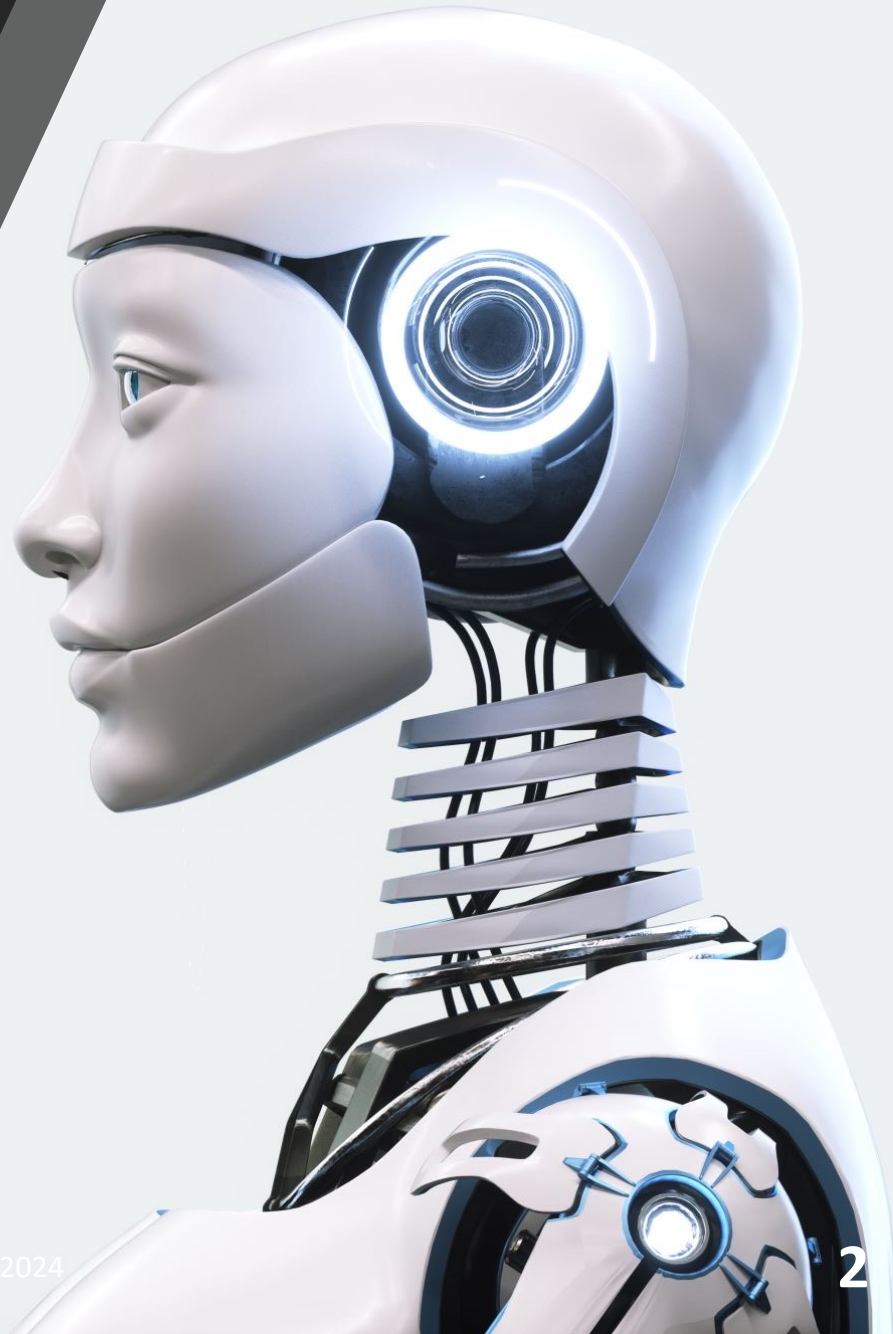
https://bit.ly/secureauto-spring24

Autonomy | A Definition

Autonomy is the **ability to perform given tasks** based on the **system's perception without human intervention**



Aspects of Autonomy

- Perception
- Compute
- Actuation
- Planning
- Sensing
- Motion

Functional Architecture

- specification of
  - **intended functions** and
  - **necessary interactions**

  to achieve **desired behaviors**

Some Common Definitions

OEM → original equipment manufacturers [integators]

ECU → electronic control units

CAN, **Flexray** → communication buses/standards

AUTOSAR → software technology platforms

Automotive Standards and Definitions

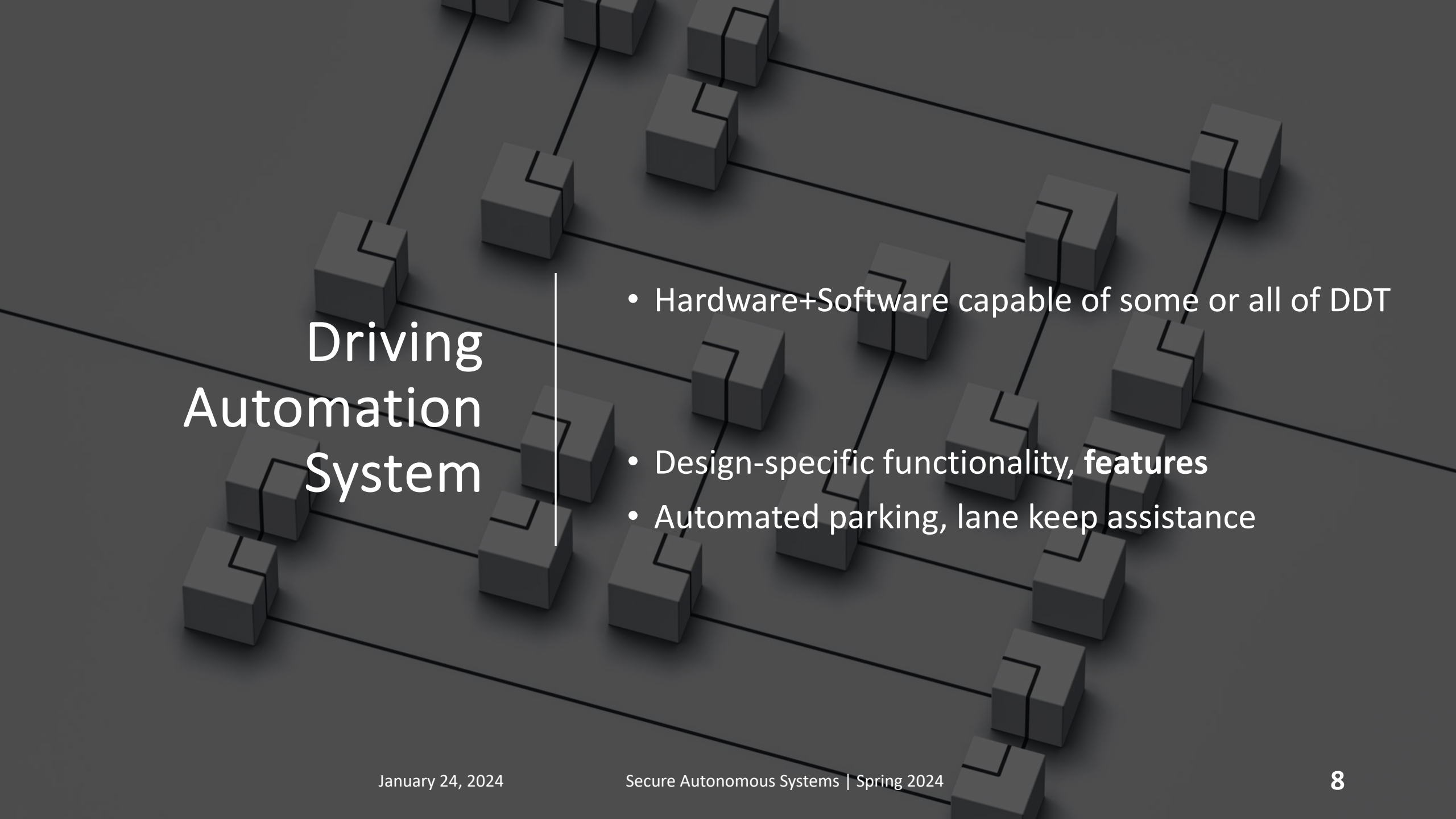
SAE J3016 Standards

- Dynamic Driving Task (DDT)
- Driving Automation System
- Operational Design Domains (ODD)
- DDT fall-back
- DDT fall-back-ready user
- DDT feature

Dynamic Driving Task [DDT]

- Real-time **operational** and **tactical** functions to operate a vehicle

- Driving a car on fixed trajectory
- Actuator control
- Keeping vehicle in lanes
- Maintaining distance from other vehicles



Driving Automation System

- Hardware+Software capable of some or all of DDT

- Design-specific functionality, **features**
- Automated parking, lane keep assistance

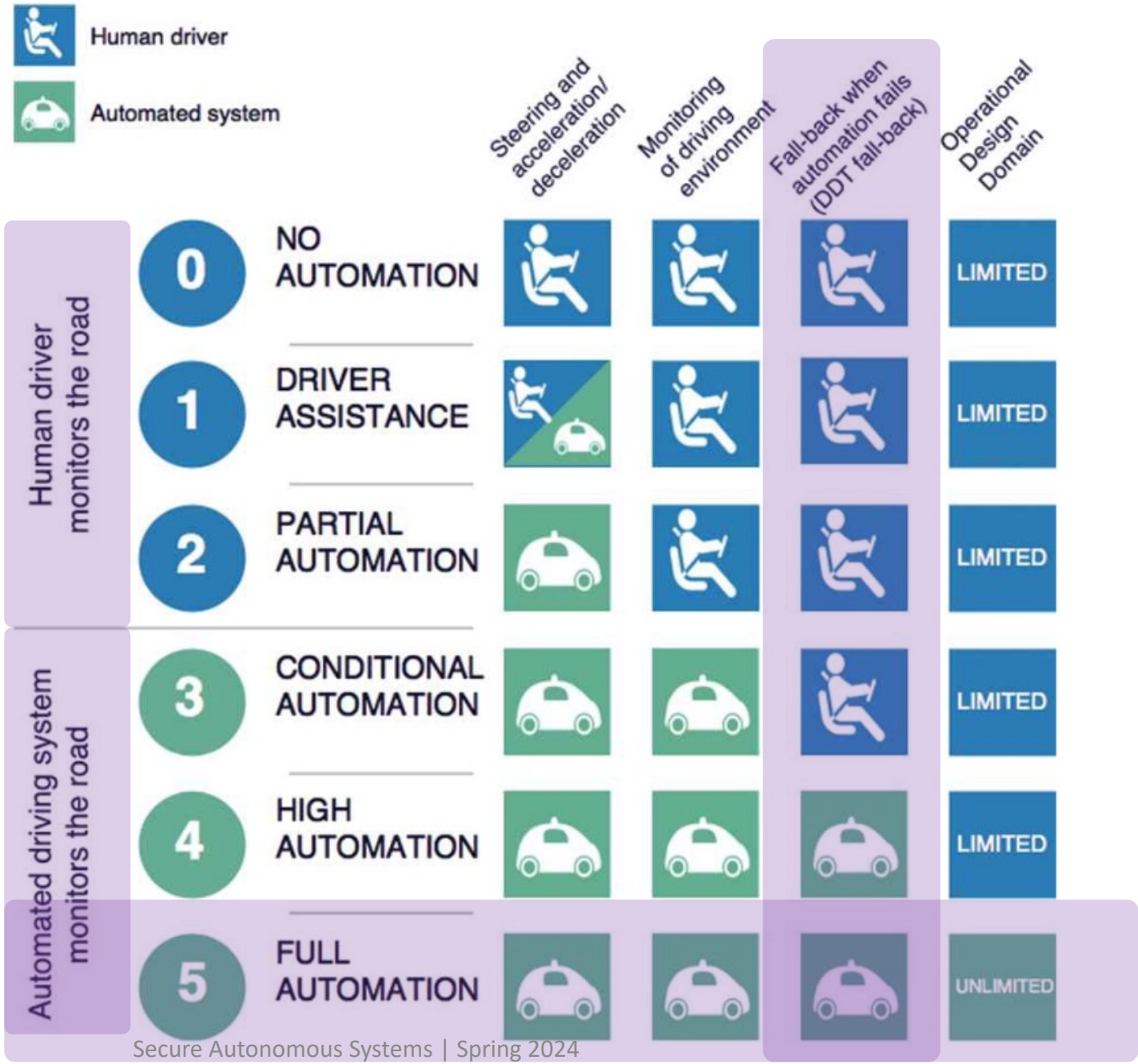
Operational Design Domains [ODD]

- **Specific conditions** under which driving automation system is to function
- **Design phase** requirements
- E.g., Work in sunny weather in city grid

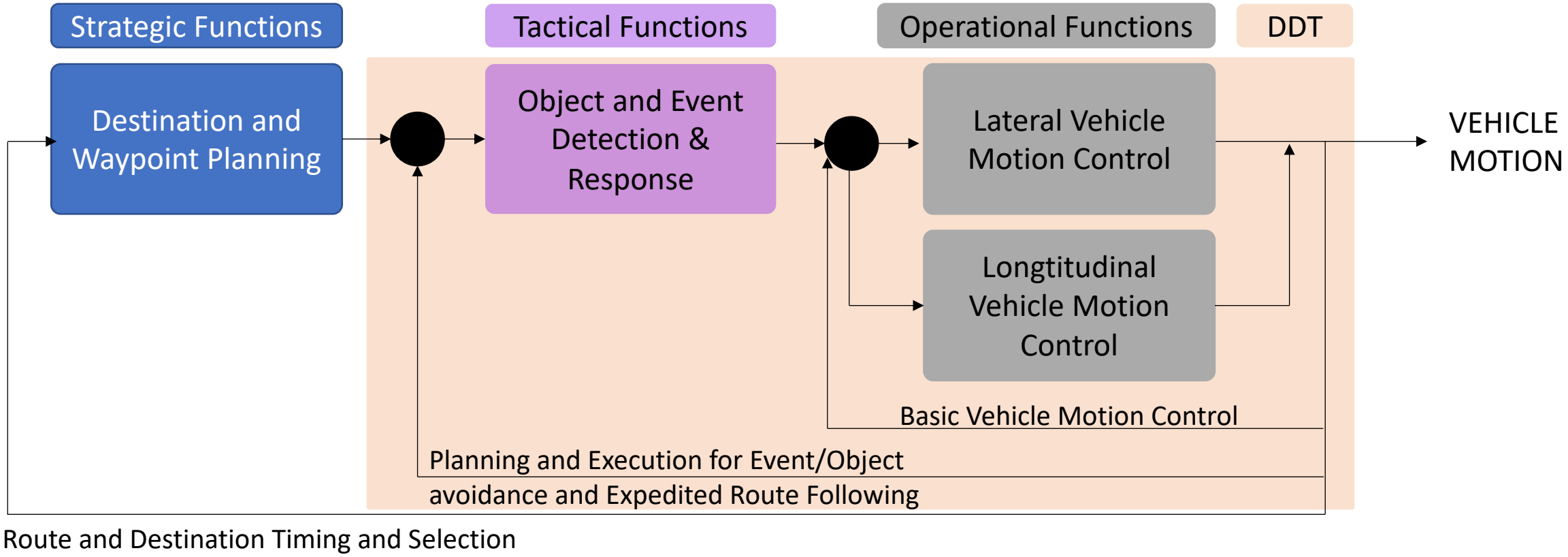
Some more definitions

- DDT fall-back
- DDT fall-back-ready-user
- DDT feature

SAE Classification

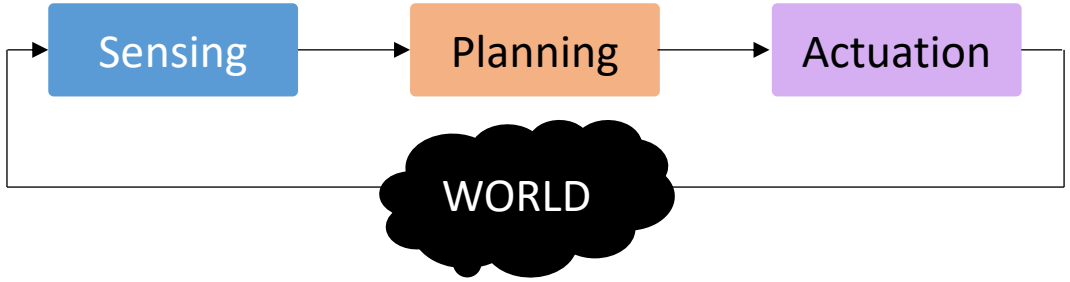


Functional Components



Software Design

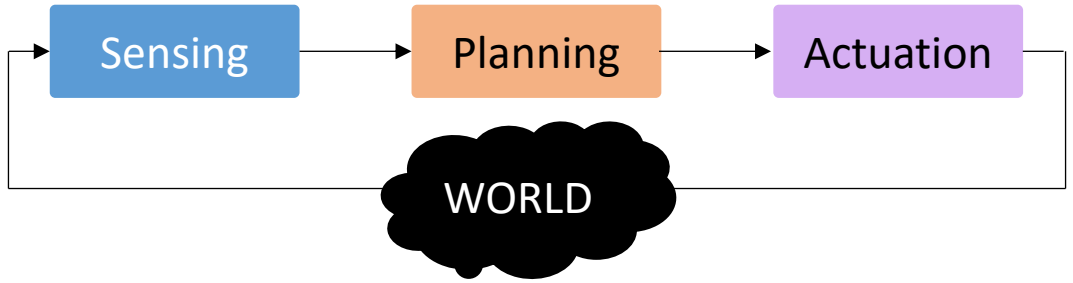
- Analogous to real-time systems design



Planning

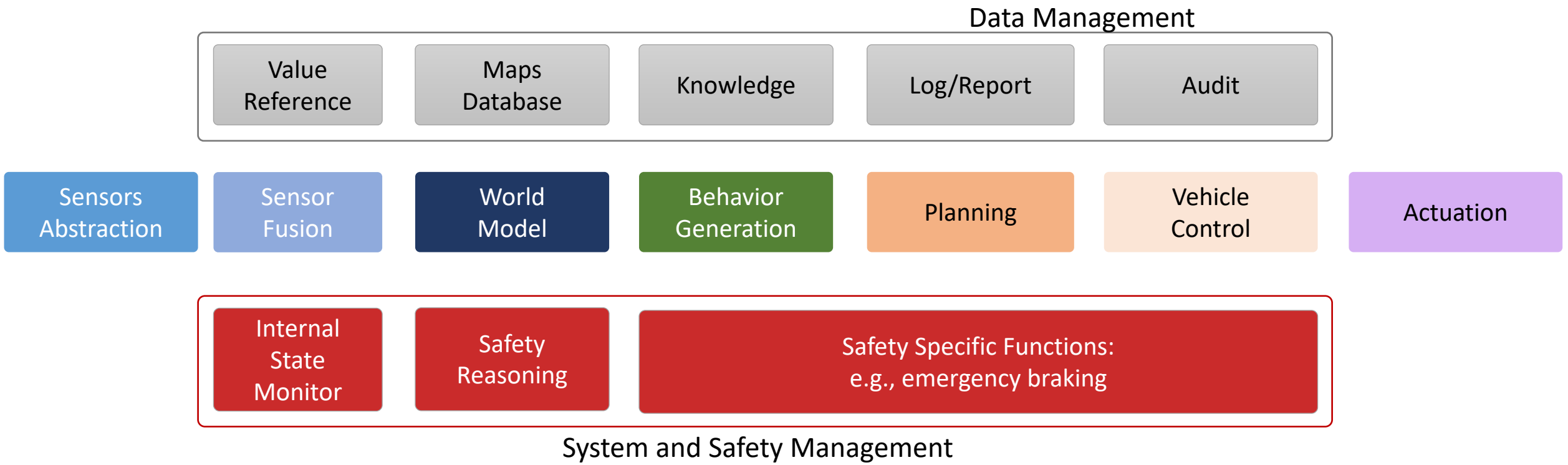
- system maintains an **internal state representation**
  - position itself in environment
  - plan next actions
- Must be up-to-date and accurately reflect environment
  - requires **a lot of information**!
- With increasing complexity of operational environment
  - complexity of internal representation also increases
  - More time to plan next steps
  - New plans may be obsolete **before** they're deployed!

Sensing, Planning, Actuation
Functional Decomposition

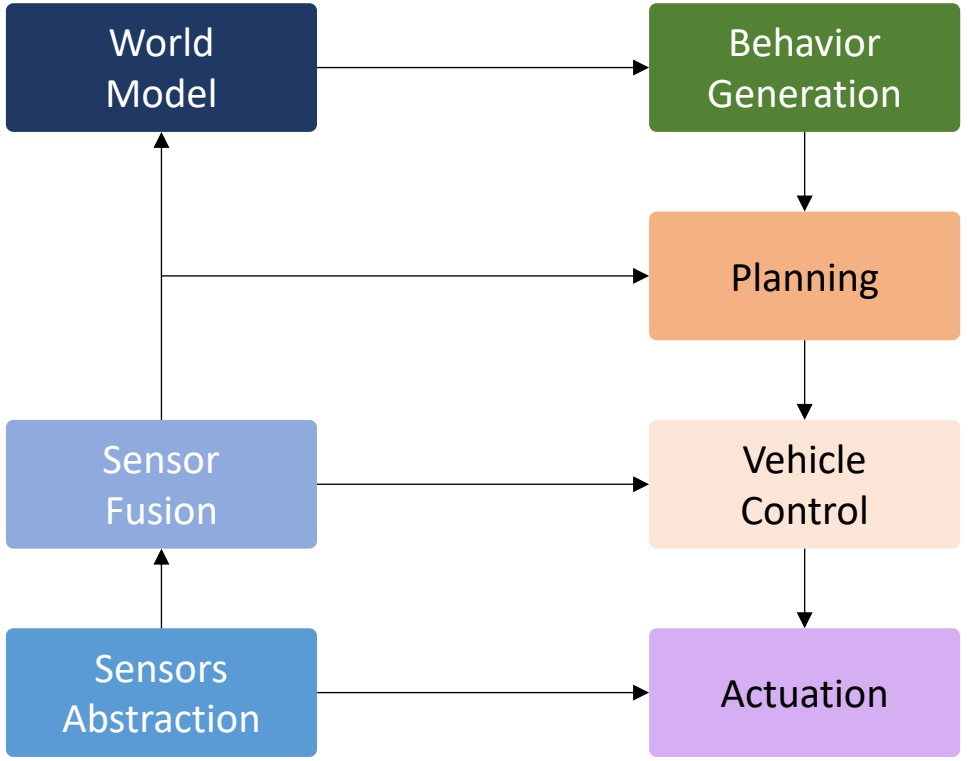


Sensors Abstraction	Sensor Fusion	World Model	Behavior Generation	Planning	Vehicle Control	Actuation
RADAR LIDAR Cameras GPS V2X Internal St	Object Det Global Pos Local Pos Vehicle State	Internal Model External Model Data Sinks Bird's Eye View	HMI Route i/p Global Routing Behavior Gen. Behavior Select	Path Planning Monitoring Lane Keeping Lane Change Collision Avoid HMI Driver Alert	Lateral Longitudinal Trajectory Intention Comm.	Steering Brake Throttle Transmission

Orthogonal Classes



Functional Architecture



References

- SAE J3016 Standard:

https://sibin.github.io/teaching/csci6907_88-gwu/secure_autonomous/fall_2022/other_docs/J3016_201609.pdf

- A better explanation of the standard and its components:

https://www.atlantis-press.com/journals/jase/125934832/view