

Safety Assurance for Self Driving

Module 3, Lesson 1



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

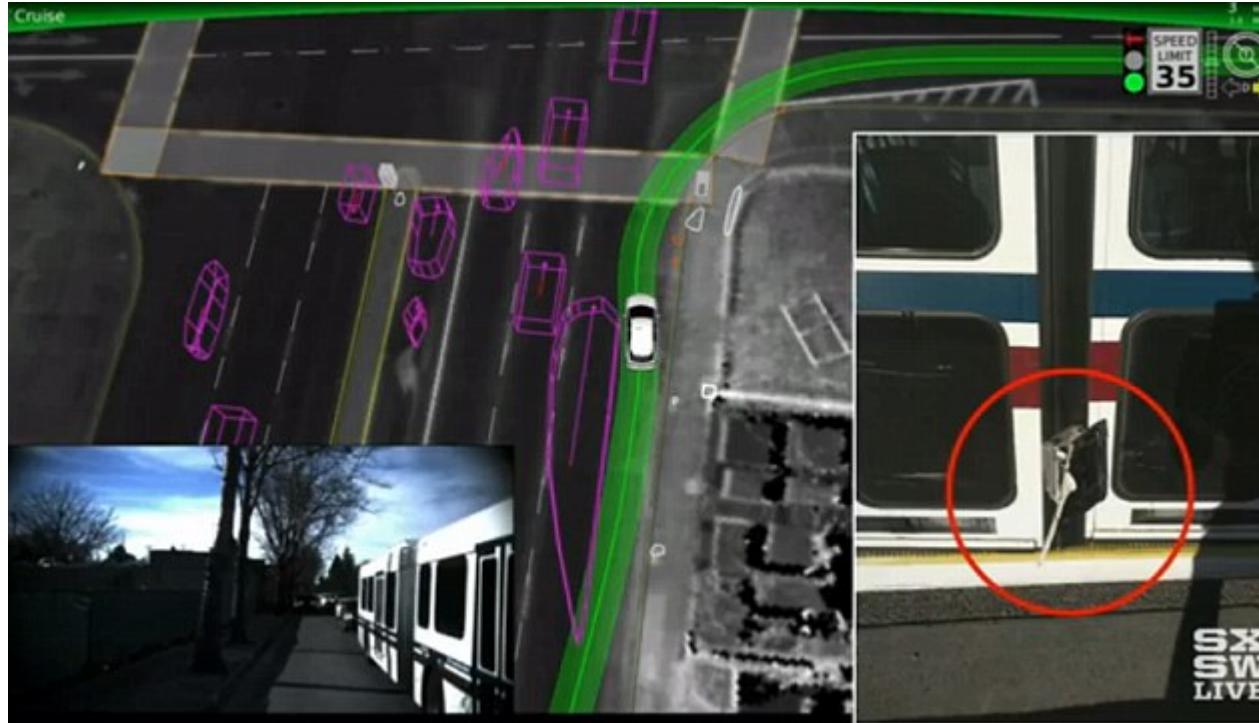
In this module ...

- Autonomous vehicle crash reports
- Safety concepts
- Hazard sources
- Industry perspectives on safety
- Safety frameworks for self driving

In this video ...

- Autonomous driving crashes
- Formal definitions
- Major hazard sources
- Safety requirements

Examples of Automated Vehicle Crashes



Examples of Automated Vehicle Crashes



Examples of Automated Vehicle Crashes

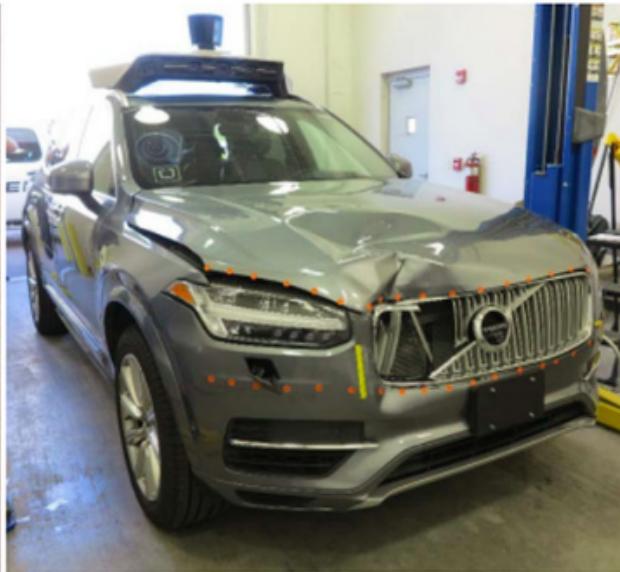


Examples of Automated Vehicle Crashes



Image Source: The Verge
Based on NTSB Report (2018)

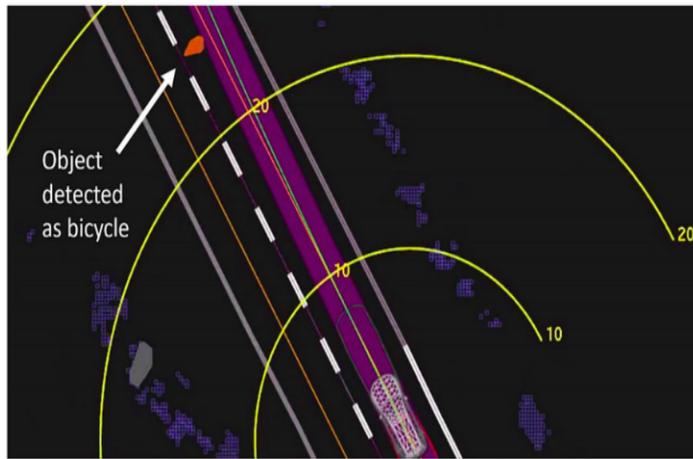
Uber Crash



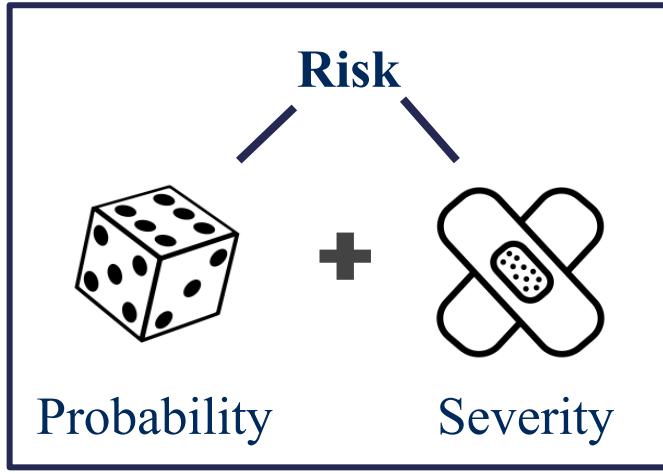
Source: The Verge

Uber Crash: Multiple Things Gone Wrong

- No real time checks on safety drivers
- After the woman was detected on the road (6 sec before)
 - first classified as unknown object
 - then misclassified as a vehicle
 - then a bicycle
- 1.3 sec before, Volvo system tried to do emergency braking maneuver
 - but Uber had disabled it for testing



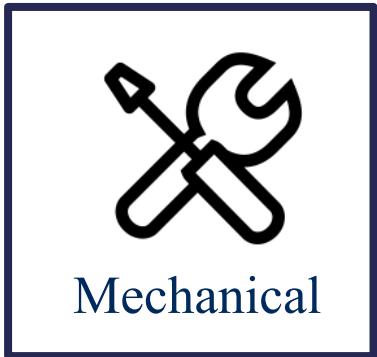
Basic Safety Terms



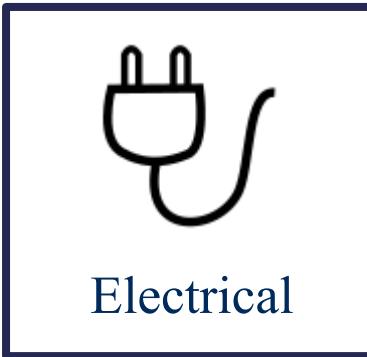
Safety - “absence of unreasonable risk of harm”

Hazard - “potential source of unreasonable risk of harm”

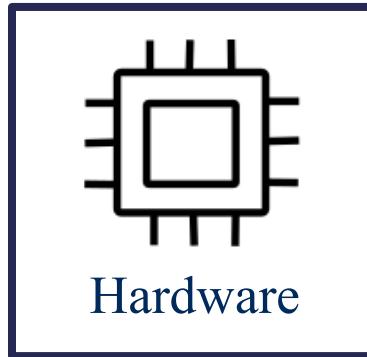
Major Hazard Sources



Mechanical



Electrical



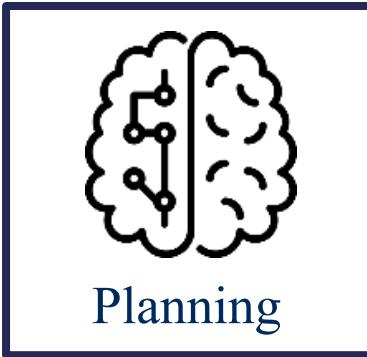
Hardware



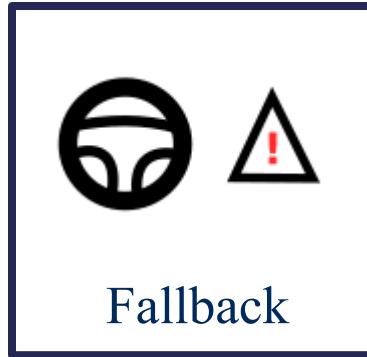
Software



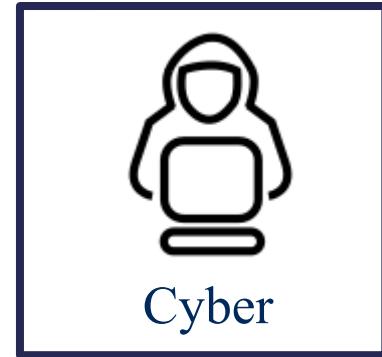
Perception



Planning



Fallback



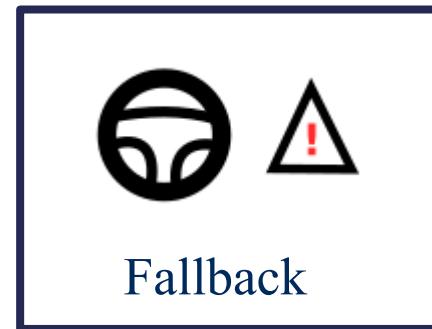
Cyber

NHTSA: Safety Framework



Based on NHTSA: A Vision For Safety 2.0 (2017)

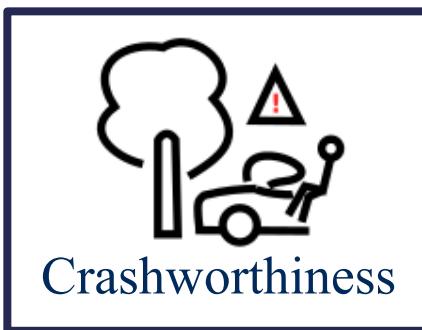
NHTSA: Autonomy Design



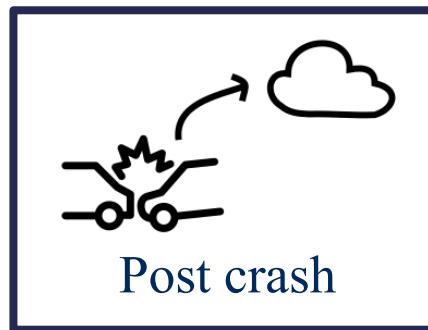
NHTSA: Testing & Crash Mitigation



Testing



Crashworthiness



Post crash



Data recording



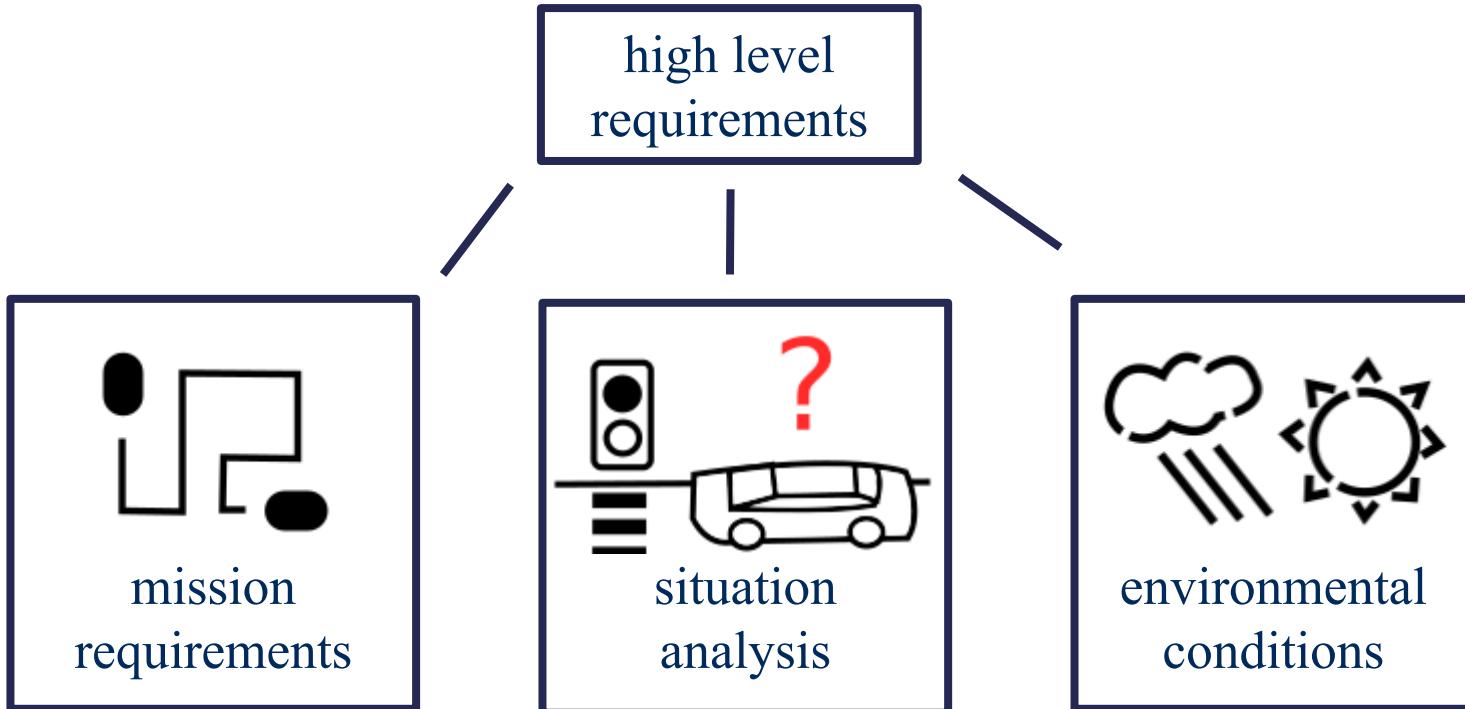
Consumer Ed

Summary

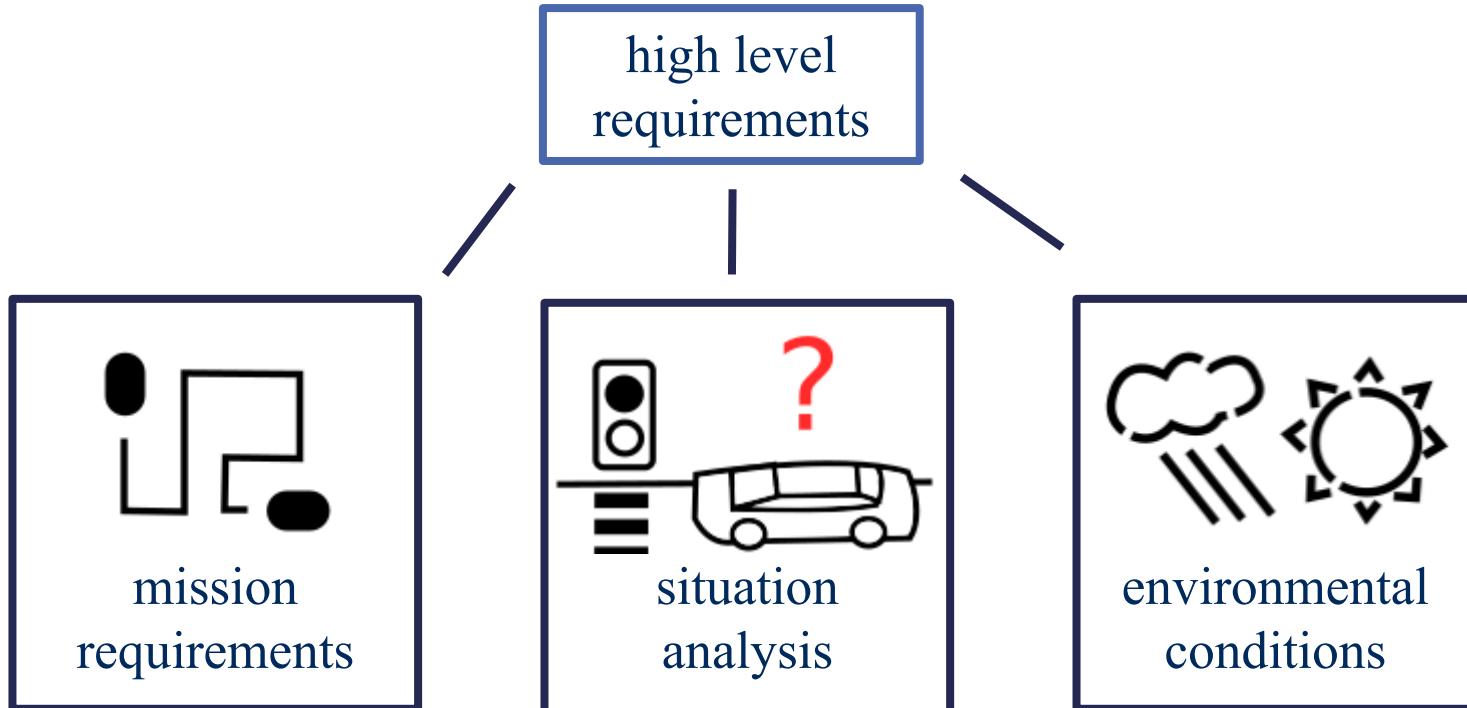
- Autonomous driving accidents
- Safety terms - harm, risk, hazard, safety
- Major hazard sources
- NHTSA safety framework

Extra

Safety Requirements: Big Picture

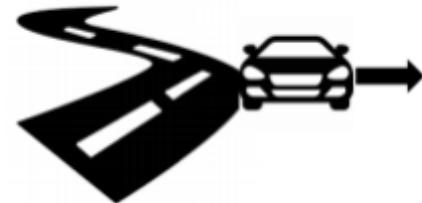


Safety Requirements: Big Picture

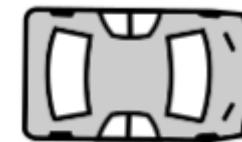


high level
requirements

formal,
informal
traffic rules

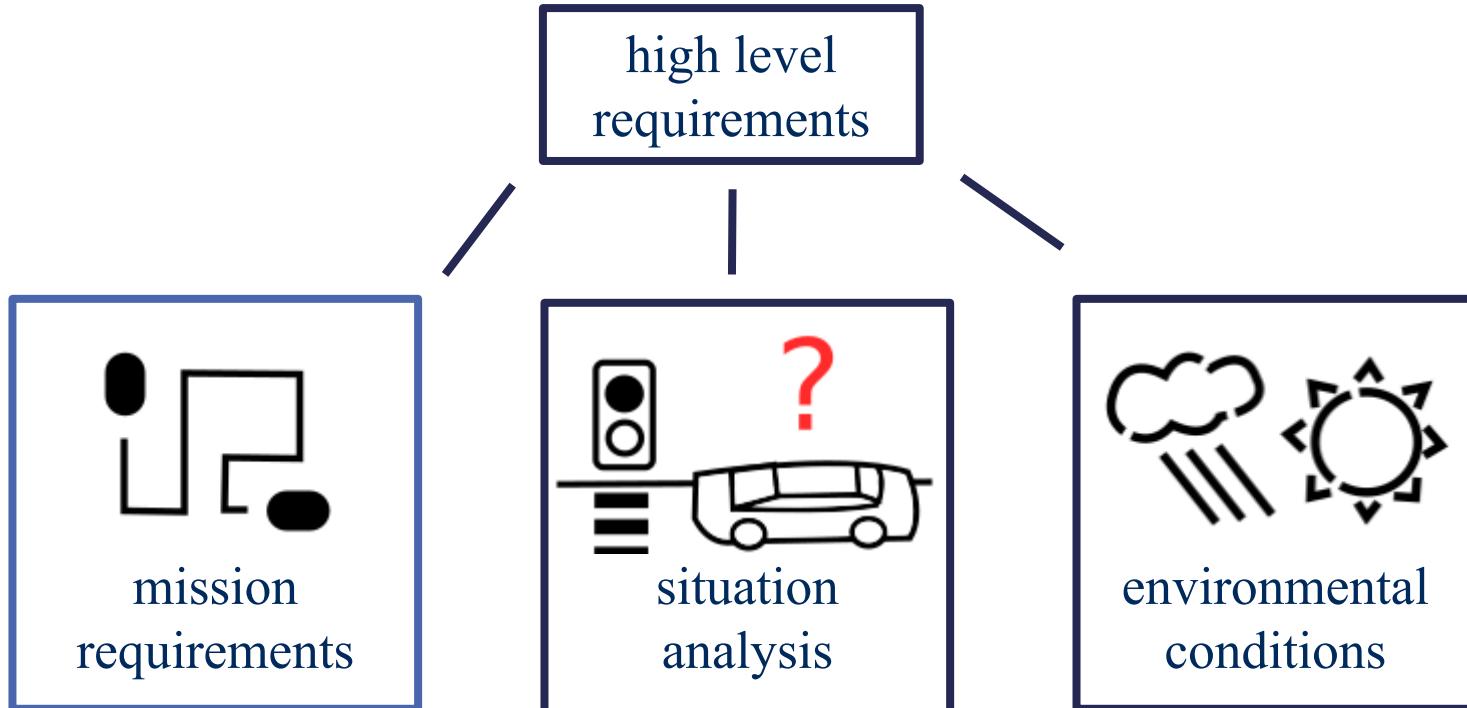


Stable Vehicle Trajectory - (roll & skid stability)

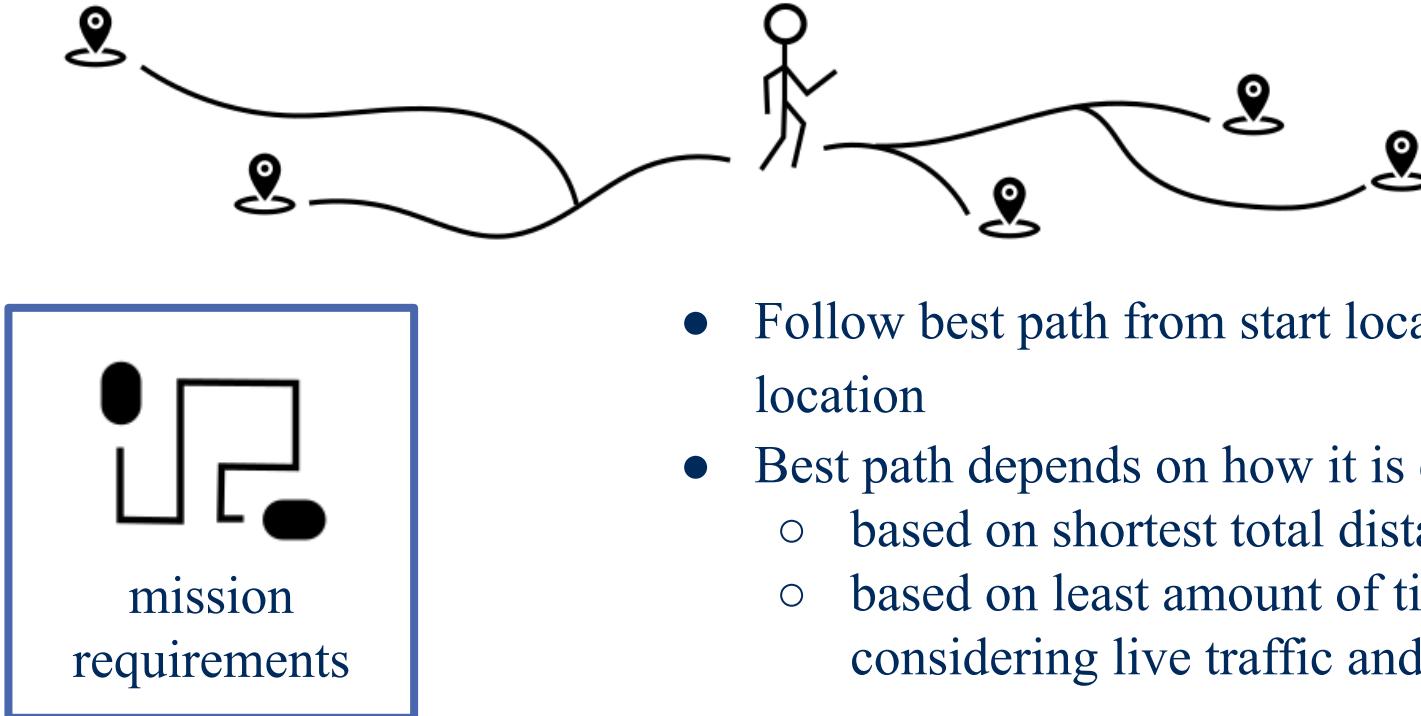


safe distance from other vehicles

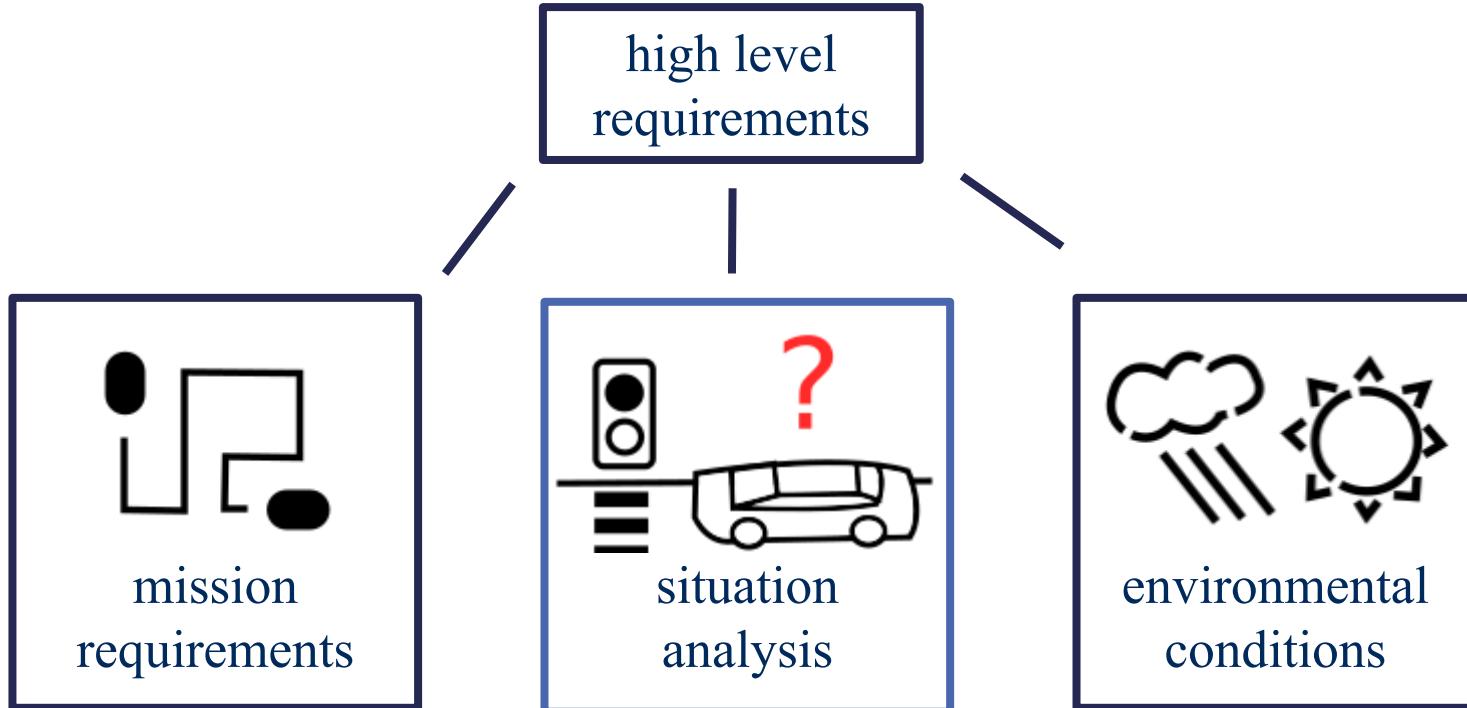
Safety Requirements: Big Picture



Safety Requirements: Big Picture



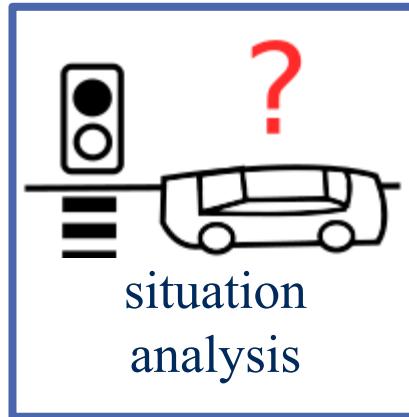
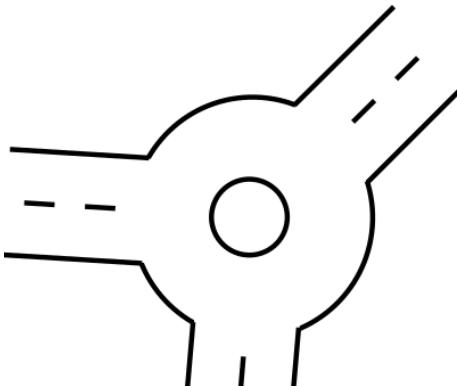
Safety Requirements: Big Picture



Safety Requirements: Big Picture

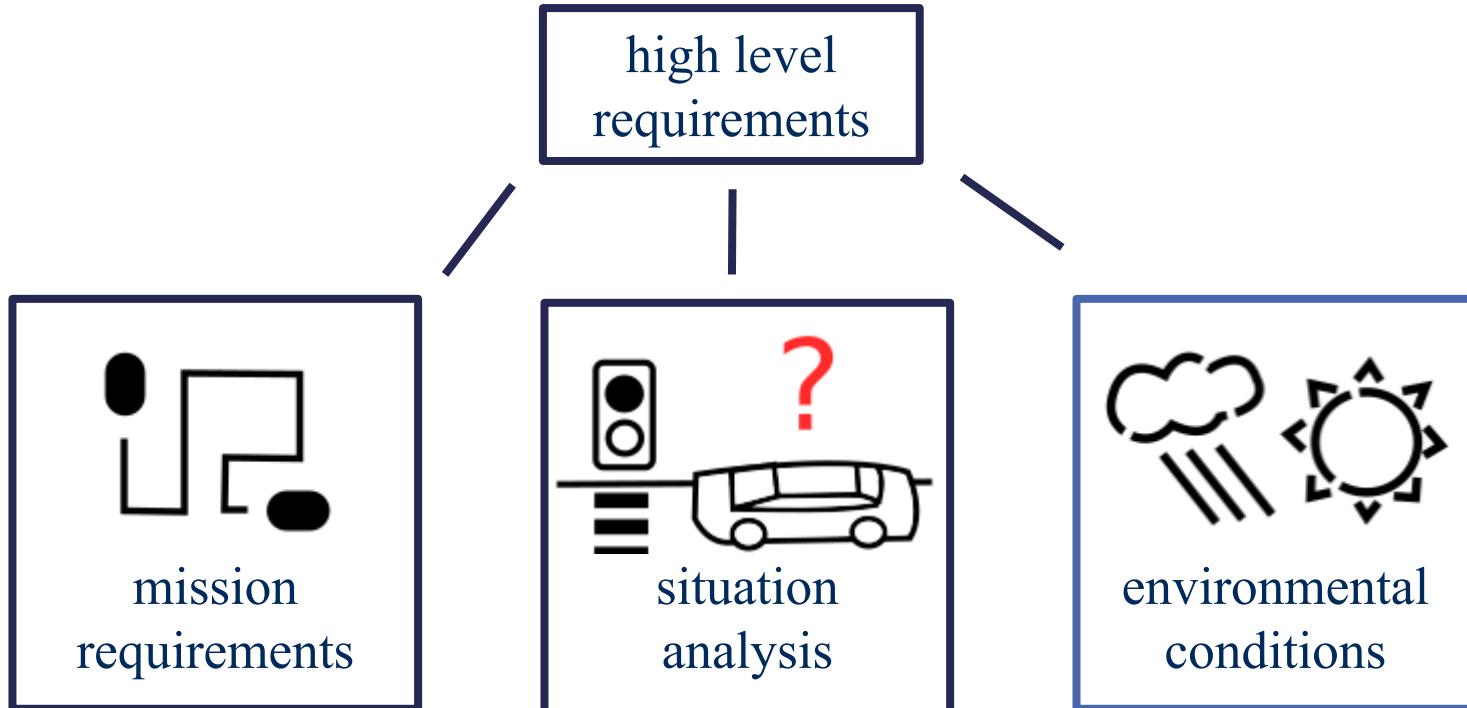
“decompose driving into **basic situations**”

examples - roundabouts, intersections, 2 way lanes, highways etc



finally, model all behaviors and plan out what to do for each scenario

Safety Requirements: Big Picture



Safety Requirements: Big Picture

- **weather:** rainy, sunny, cloudy etc.
- **road surface:** wet, smooth, gravel etc.
- **traffic:** jam, busy etc.

