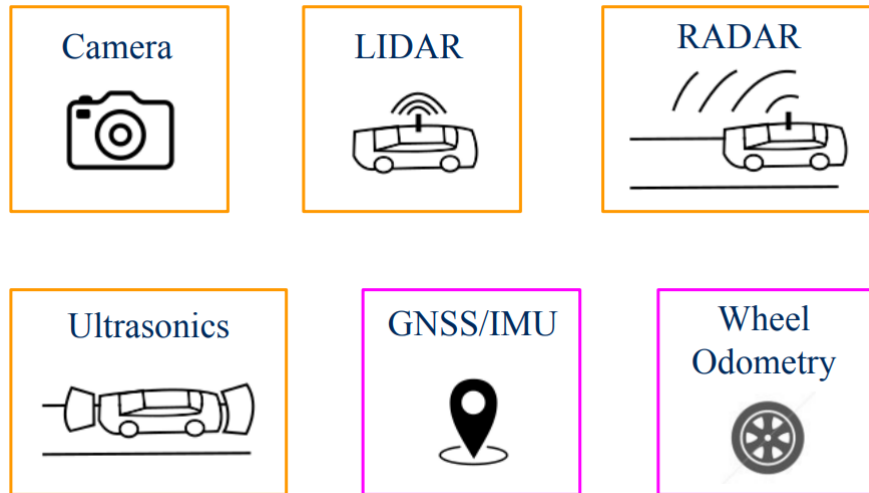# Module 2 - Lesson 2

Course 1 - Introduction to Self-Driving Cars

Module 2

Self-Driving Hardware and Software Architectures

Lesson 2

Hardware Configuration Design

The **stereo camera** for **depth information**, **LIDAR** for all whether **3D input**, **RADAR** for **object detection**, **ultrasonic** for **short-range 3D input** and **GNSS/IMU data** and **wheel odometry** for **ego state estimation.**

Assumptions:

1. Aggressive deceleration = 5 m / s ^ 2
2. Comfortable deceleration = 2 m / s^ 2
3. Stopping Distance d = (v^2) / 2a , Here V is velocity of the car and A deceleration.

Where to place sensors ?

- Need sensors to support maneuvers within our ODD.
- Broadly, we have two driving environments,

|	Highway	Urban / Residential
Traffic Speed	High	Low - Medium
Traffic Volume	High	Medium - High
No of lanes	More	2-4 typically
Other Features	Fewer, gradual curves; merges	Many turns and intersections

Highway Analysis:

Broadly, **3 kinds of maneuvers**:
1. Emergency Stop
2. Maintain Speed
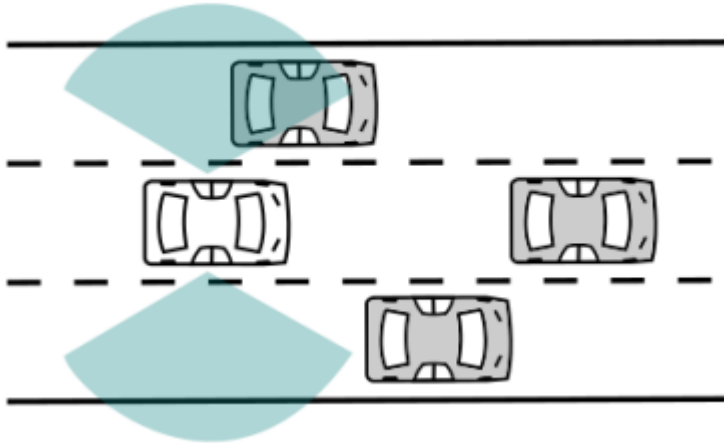3. Lane Change

Highway Analysis:

Scenario 1 - Emergency Stop:
If there is a blockage ahead, we want to stop in time.
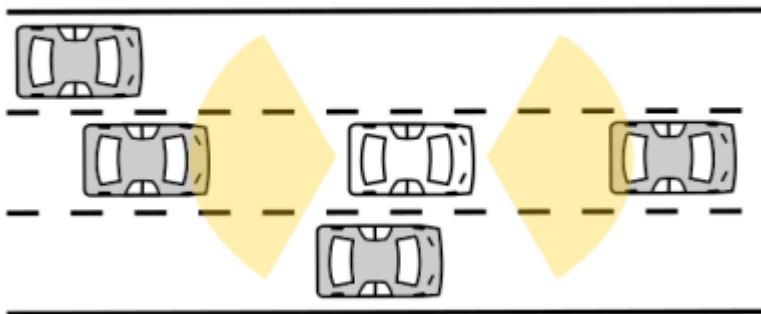
Longitudinal Coverage - Assume we are speeding at 120 kmph. Stopping distance could be ~110 metres, **Aggressive deceleration.**
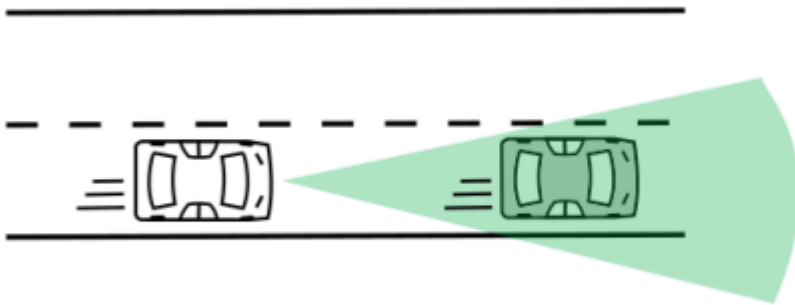
To avoid collision, either we stop or change lanes.

Lateral Coverage - At least adjacent lanes, since we may change lanes to avoid a hard stop.
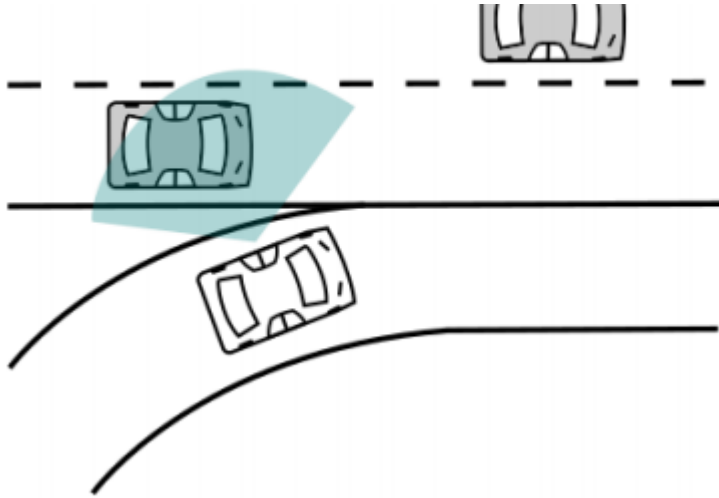
Scenario 2 - Maintain Speed:
Relative speeds are typically less than 30 kmph.

Longitudinal coverage - At least ~100 metres in front. Both vehicles are moving, so don't need to look as far as emergency-stop case.
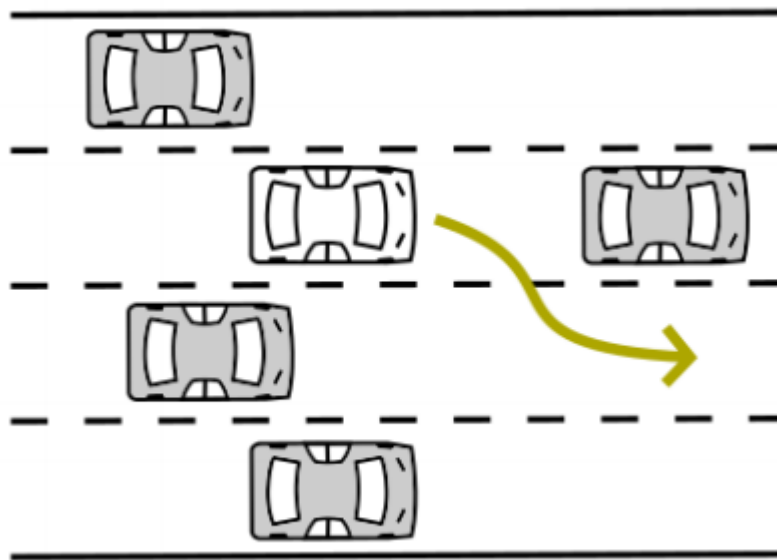
Scenario 3 - Maintain speed with Merge:

Lateral Coverage - Usually current lane and Adjacent lanes would be preferred for merging vehicle detection.
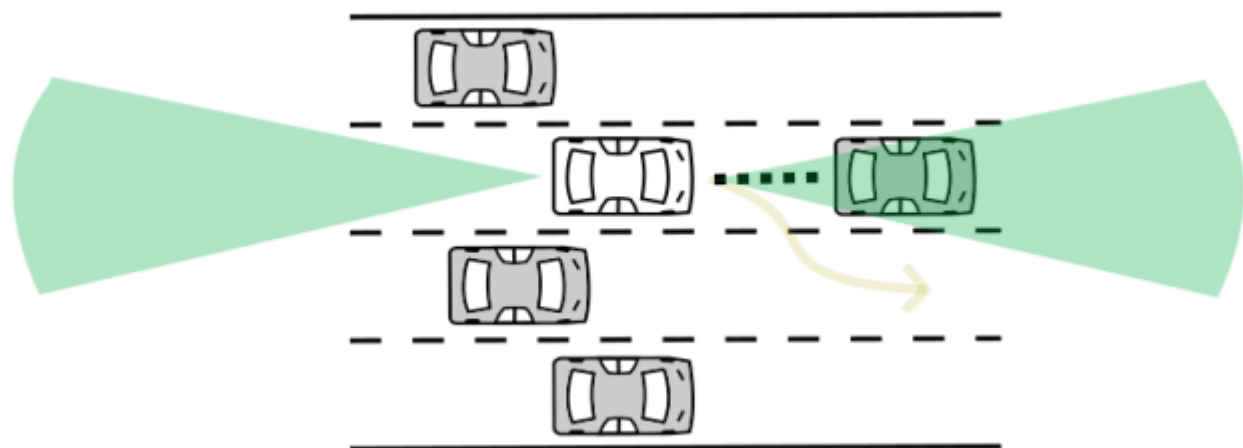
Scenario 4 - Lane Change:
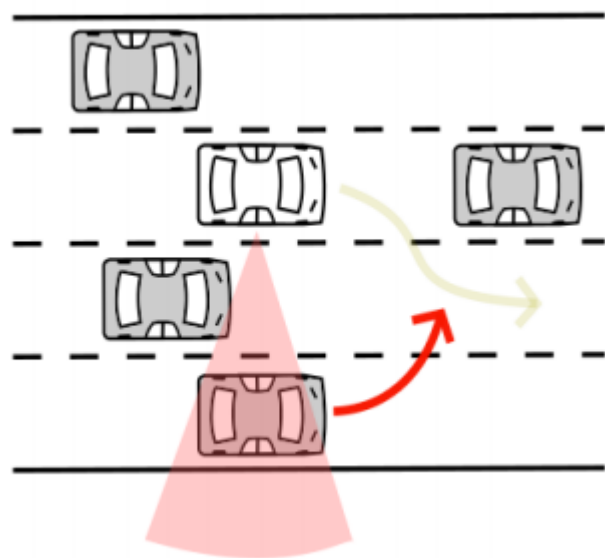Consider this possible lane change scenario.

Intended lane change.

Longitudinal coverage - Need to look forward to maintain a safe distance.
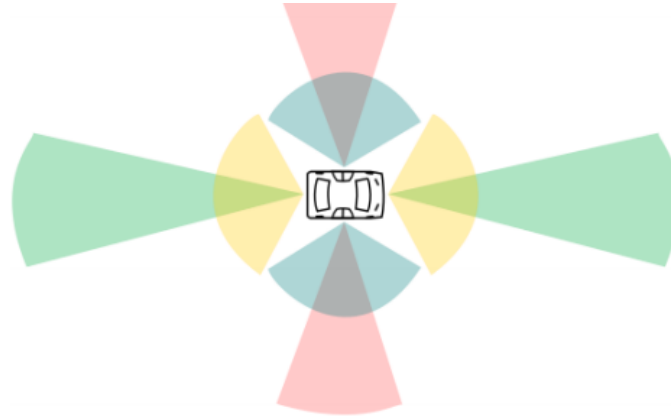
Need to look behind to see what rear vehicles are doing. Laterally, we need to look not just in the adjacent lanes, but probably further.

Lateral coverage - Need wider sensing.
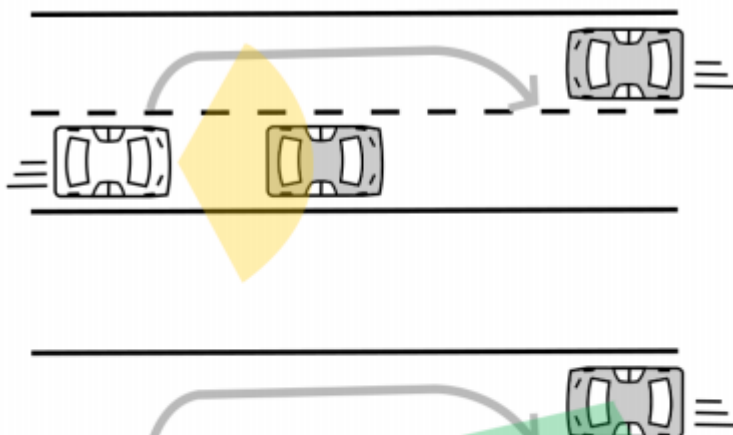
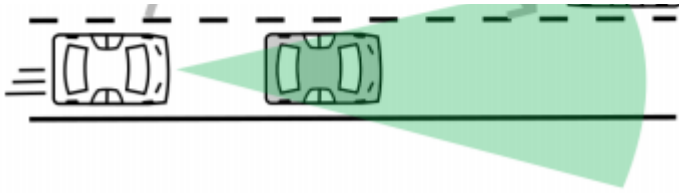**Highway Analysis: Overall Coverage:**

Urban Analysis:
Broadly, 6 kinds of maneuvers,

1. Emergency Stop
2. Maintain Speed
3. Lane Change
4. Overtaking
5. Turning, crossing at intersections
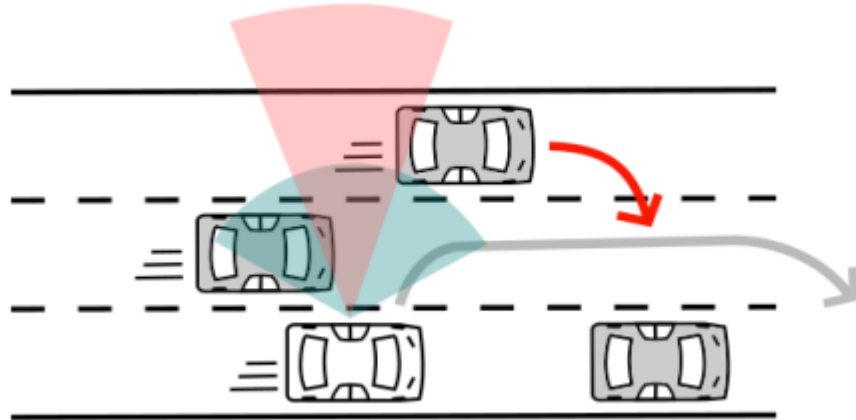6. Passing roundabouts

Urban Analysis:
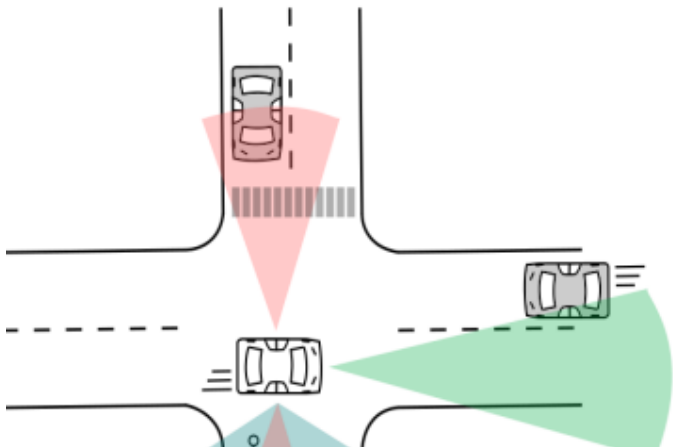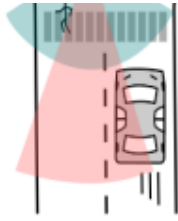
Scenario 1 - Overtaking:

Longitudinal coverage - If overtaking a parked or moving vehicle, need to detect oncoming traffic beyond point of return to own lane.

Always need to **observe adjacent lanes.** Need to observe additional lanes if other vehicles can move into adjacent lanes.
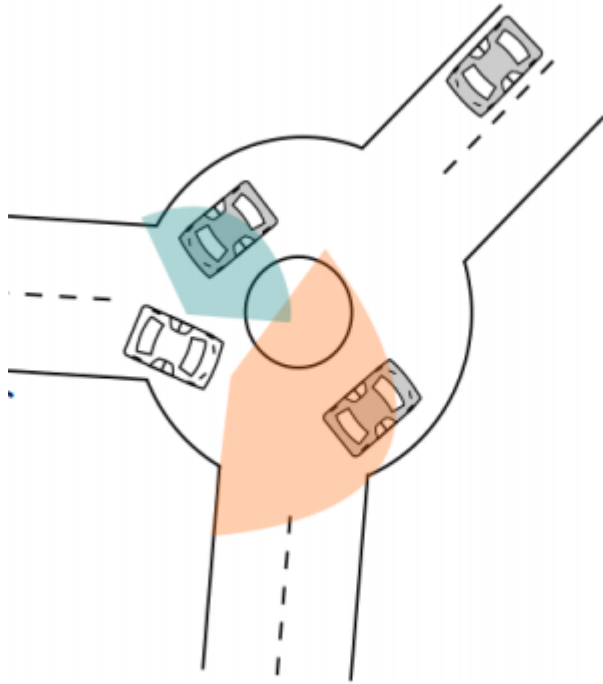
Scenario 2 - Intersections:

Observe beyond intersection for approaching vehicles, pedestrian crossings, clear exit lanes. Requires near omnidirectional sensing for arbitrary intersection angles.

Scenario 2 - Roundabouts:
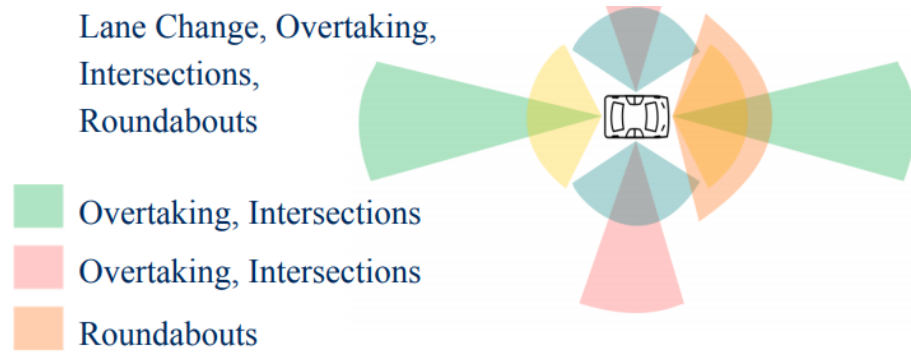**Lateral coverage** - Vehicles are slower than usual, limited range requirement.

Longitudinal coverage - Due to the shape of the roundabout, need a wider field of view.

Urban Analysis - Overall Coverage:

Emergency Stop, Overtaking

Emergency Stop, Maintain Speed,

Lane Change, Overtaking,
Intersections,
Roundabouts

Overtaking, Intersections

Overtaking, Intersections

Roundabouts

Overall Coverage & Sensors Analysis:

Long range

Medium range

Short range (ultrasonics)