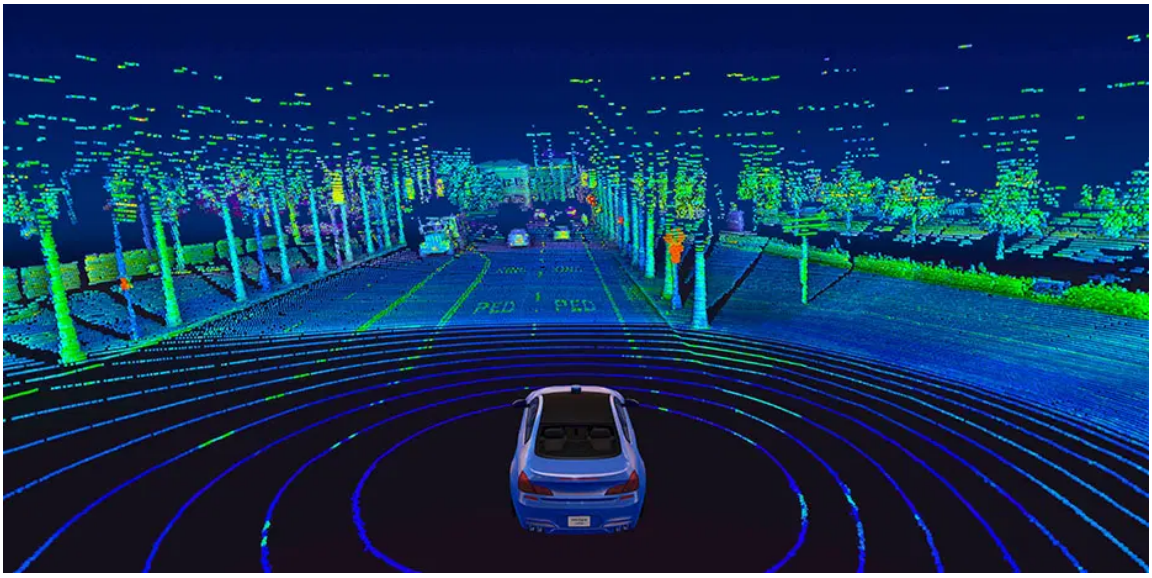
B_3_1

Sensors Used:

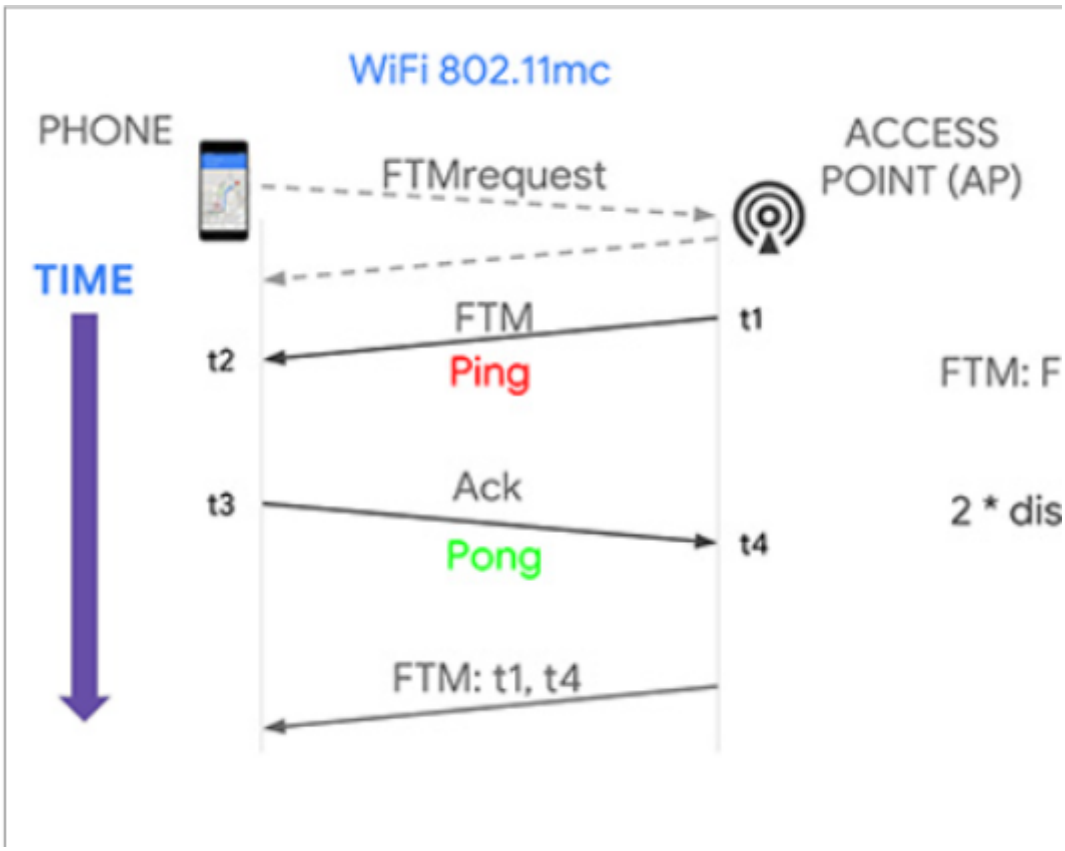
- 360 degree Camera
    - The main sensor of the navigation dash would be the 360 camera. This will be used in almost all areas as visual data is the most comprehensive to develop algorithms for
    - Area scan camera over line scan to take input of all directions for a better FOV.
    - A thermal vision feature for the camera would also be useful for detection and navigation
    - The disadvantage of camera’s is in poor lighting conditions. This can be overcome by using UV and IR sensors to make up where the camera could not.
- LiDAR
    - Lidar is a method for determining ranges by targeting an object or a surface with a laser and measuring the time for the reflected light to return to the receiver.
    - LiDAR sensors have the ability to measure 3D structures and generally aren’t affected by light. They have a large measurement range and very good accuracy. Small objects are generally detected well with LiDAR sensors as they have smaller wavelengths than sonar sensors. If you’re trying to detect something moving quick, the fast update rate will allow you to detect those targets as well.
    - The main disadvantages of LiDAR is the cost and its ineffectiveness in turbulent weather like rain,snow,dust. Another disadvantage is that the laser beams are harmful to human eyes.



- GPS
  - Most of satellite navigation is based on a global network of satellites that transmit radio signals from medium earth orbit. The general public are most familiar with the 31 Global Positioning System (GPS) satellites developed and operated by the United States. Three other constellations also provide similar services. Collectively, these constellations and their augmentations are called Global Navigation Satellite Systems (GNSS). The other constellations are GLONASS by the Russian Federation, Galileo by the EU, IRNSS-NavIC by India and BeiDou by China.
  - The disadvantage of GPS is that it can have an incaccuracy up to 100ft as buildings and other obstacles can throw of the reading
- IMU
  - The Inertial Measurement Unit (IMU) is used to detect the acceleration as well as the angular acceleration along the three axis'. It consists of an a**ccelerometer**, gyroscope and a magnetometer. The IMU combines the data from the sensors above in order to accurately output movement.
  - The disadvantage of the IMU is that is prone to give error over time. This is called "drift". Because the device is always measuring changes relative to itself (not triangulating against an absolute or known outside device), the IMU constantly rounds off small fractions in its calculations, which accumulate over time. Left uncorrected, these tiny imprecisions can add up to significant errors.
- Microphone

- The microphone would be used to detect unusual sounds and disturbances in the area where the camera and other sensors can not detect, ex. if a tire burst in a car beside our vehicle.
- The disadvantage of the microphone is its low range.

- 5G Sensor
  - This sensor would have many uses ranging from communication to tracking etc.
    - This would be used to accurately detect the position of the vehicle using the bounce back algorithm(RTT): 2* distance = ((t4-t1)-(t3-t2)*c



    - Communication with different vehicles and stations for seamless relay of information
    - The disadvantage of 5G technology is is very high wavelength results in range issues and in most cases requires a undisturbed single line between a transmitter and receiver to have fast transmission speeds.

Sensor Fusion:

Sensor fusion is to use input from multiple sensors to form get the required data from the environment. Some examples are:

- Environment Mapping
    - Using multiple radars, LiDAR’s and cameras to form a single model or image of the environment around a vehicle.
- Location
    - Using GPS and 5G RTT principles to keep track of location of the vehicle.
- PID
    - Proportional, Integral, Derivative (PID) is a flight control software that decides the
      RPM of rotors to retain the desired rotation speed of the wheel motors. It works by
      correcting the error between the gyro sensor measurement and the desired setpoint.
      The calculation is done by overshooting and undershooting values and then using
      that information to calculate the actual ideal setpoint to be obtained.