GR24 CE Capstone Presentation

Team Overview

TEAM LEAD

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SOFTWARE

Henrique da Ponte

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HARDWARE / PCB

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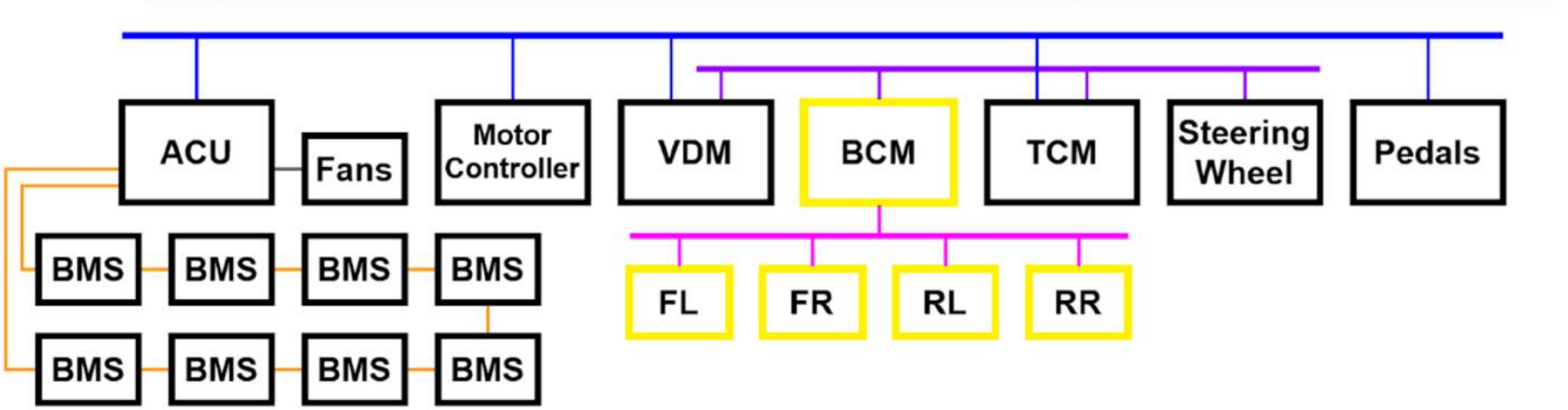
Goals

54	264	Univ of Calif - Santa Barbara	-10	38.3	56.7	20						105.0

Gaucho Racing at FSAE Electric Michigan 2023

- Place in the top 30 colleges at the FSAE Michigan 2024 Competition
  - Primary goal of passing the rigorous technical inspection
- Positively impact educations and careers of UCSB students
- Establish lasting organizational structure to support iterative vehicle improvement

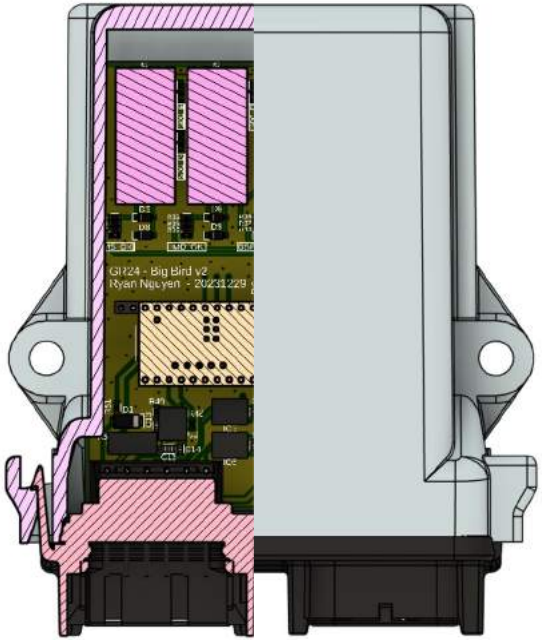
Control Architecture



Primary CAN
Data CAN
BCM CAN
isoSPI
Analog

VDM - Vehicle Dynamics Module
BCM - Body Control Module
TCM - Telecommunications Module
ACU - Accumulator Control Unit

Capstone Overview



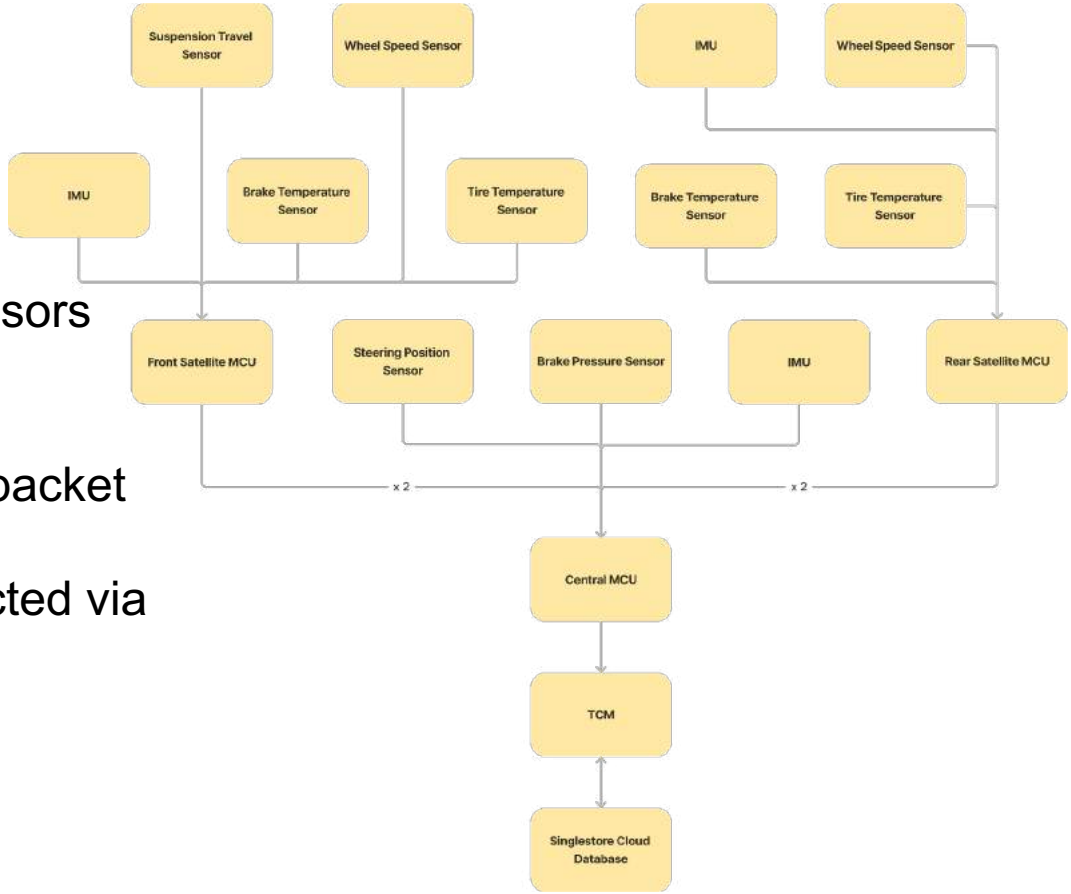
Example Control Node

Design Motivations

- Monitor the performance of the vehicle
- Ensure the vehicle won’t operate over its physical limits
- Look for potential improvements

Block Diagram of the BCM

- Comprised of 5 Teensy 4.1 Microcontrollers
- 4 MCUs on the wheel handle sensors near it
- Center MCU for sending master packet
- All the Microcontroller are connected via BCM CAN

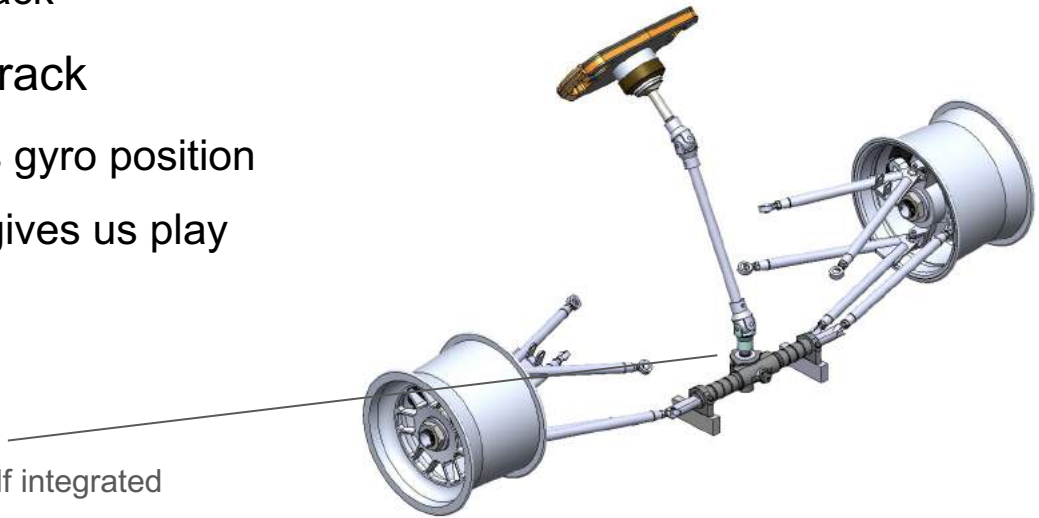


Single Pixel IR Sensor

- Used for sensing brake temperature
- Mounted on Suspension A-arm
- Temp range: -70°C to 380°C
- Provide real time brake performance monitoring for driver
- Avoid brake heat decay

Steering Position Sensor

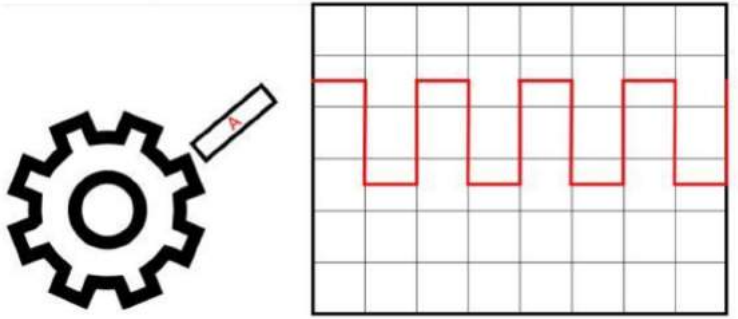
- Potentiometer
- Comes integrated into Kaz* Steering rack
  - *Our off the shelf steering rack
- Mounted directly on steering rack
  - Comparing steering wheel’s gyro position and Steering rack position gives us play in system



Off the shelf integrated mounting

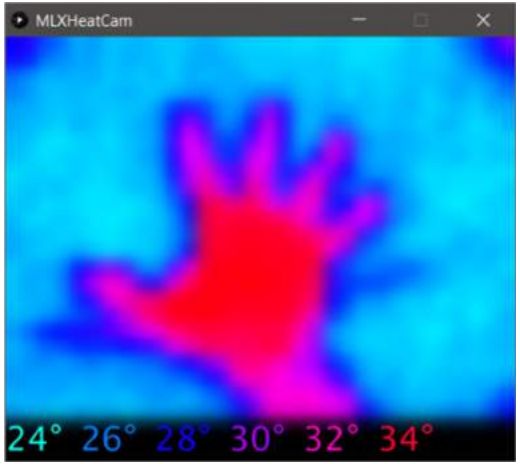
Hall Effect Sensor

- Track RPM of each wheel
- Reading on a separate thread
- Uses interrupts to measure RPM
- RPM Derivation:
  - Number of the valid edges sampled at / teeth on the gear



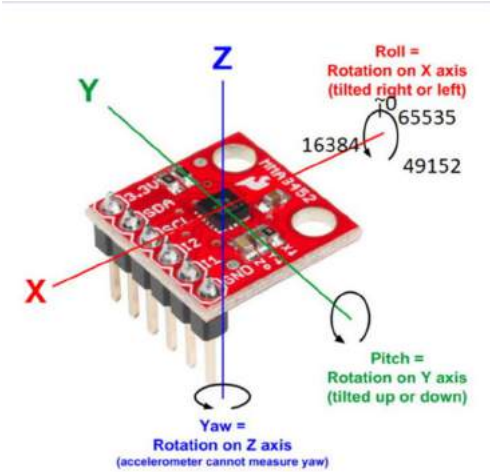
Multi Pixel IR Sensor

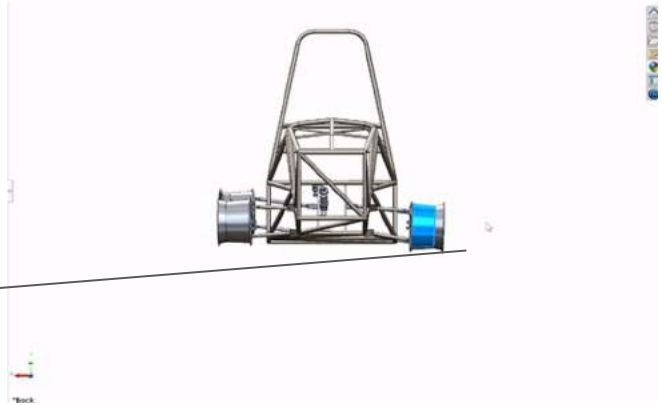
- Used for sensing tire temperature
- Comprised of 768 pixel sensors
- Provide real time average / maximum temperature of Tire
- Make it easier for Mechanical team to analyze the aero and dynamic of the car



IMU

- 3 - axis Gyroscope and Accelerometer
- Mounted at nose cone and in wheels
- Used to record car’s gravitation transfer, and each wheel’s dynamic performance
- Combined with Suspension Travel to get wheel and suspension dynamic data





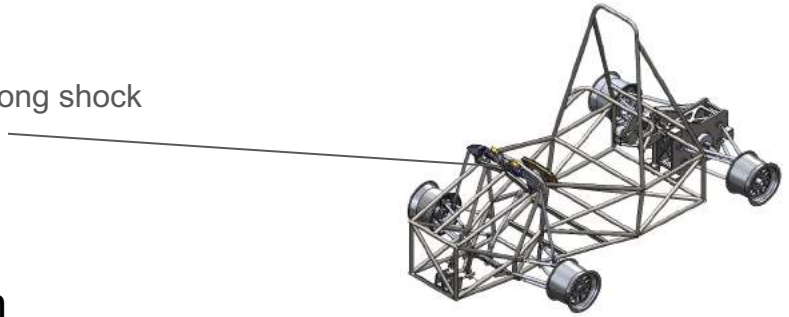
IMU Sensory Range

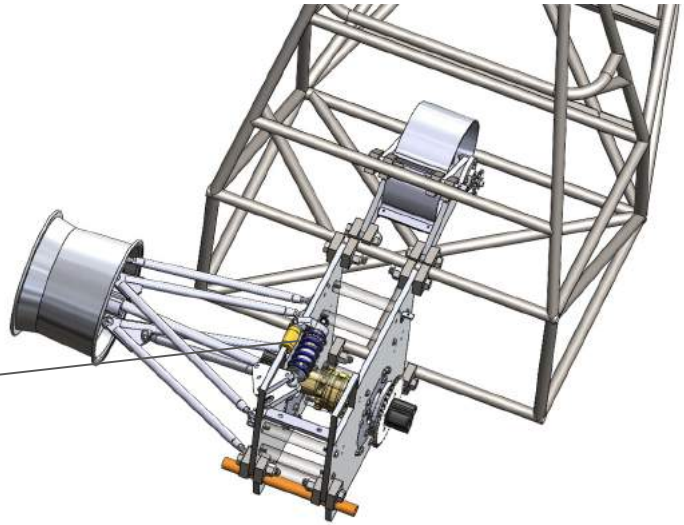
Brake Pressure Sensor

- Industrial Pressure Transducer
- Mounted on front and rear brake circuits
  - Located in the pedal box
- Used to measure the force applied by brakes
- Collecting data for verifying brake performance
- Make sure there is no leaking in the brake line

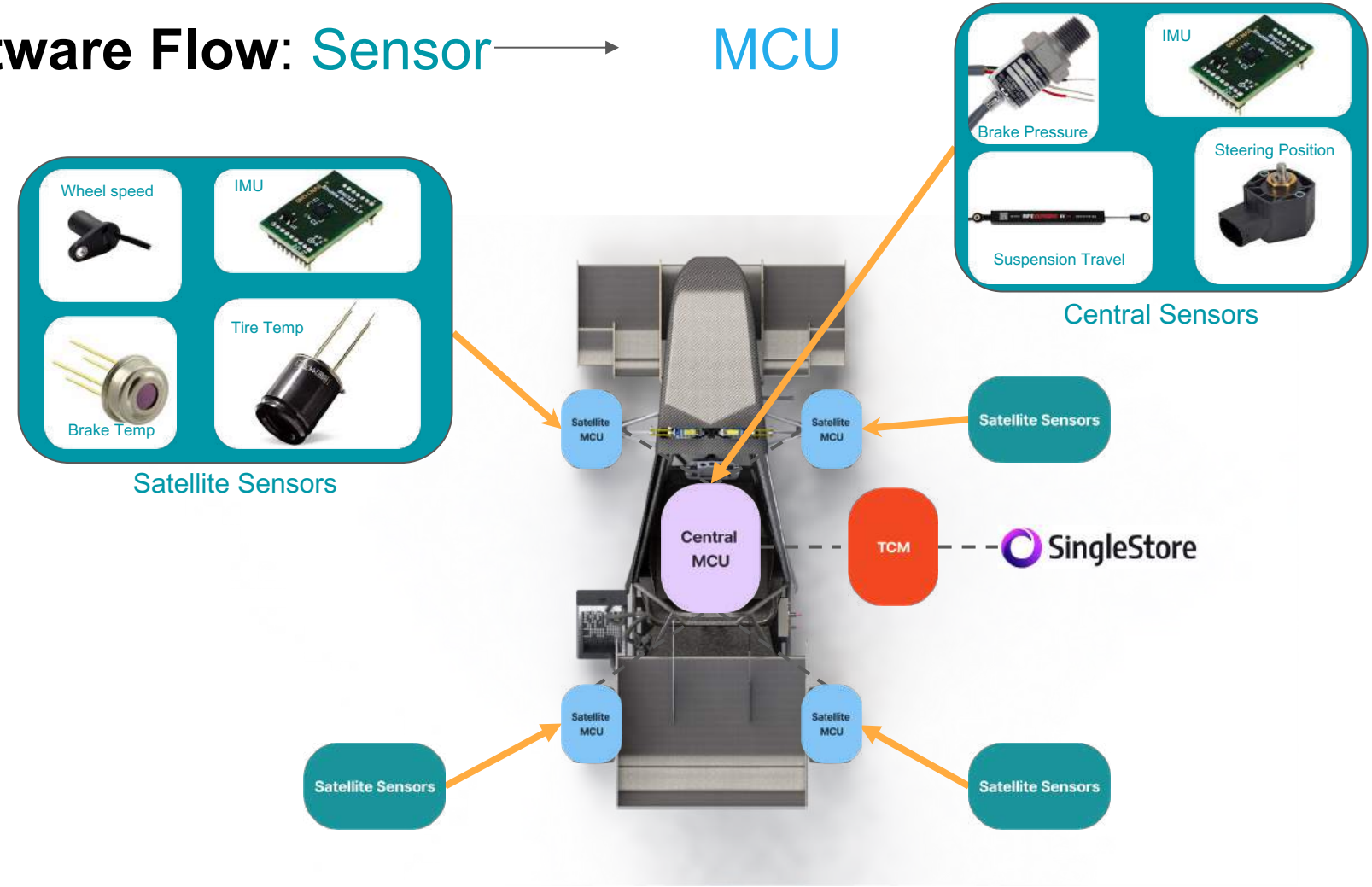
Suspension Travel Sensor

- Linear Potentiometer
- RIFE G-Series
- Used to record suspension actuation
- Mounted in parallel with shocks
  - Skips rocker arm assembly
- This with the in-wheel IMU gives us detailed data about suspension

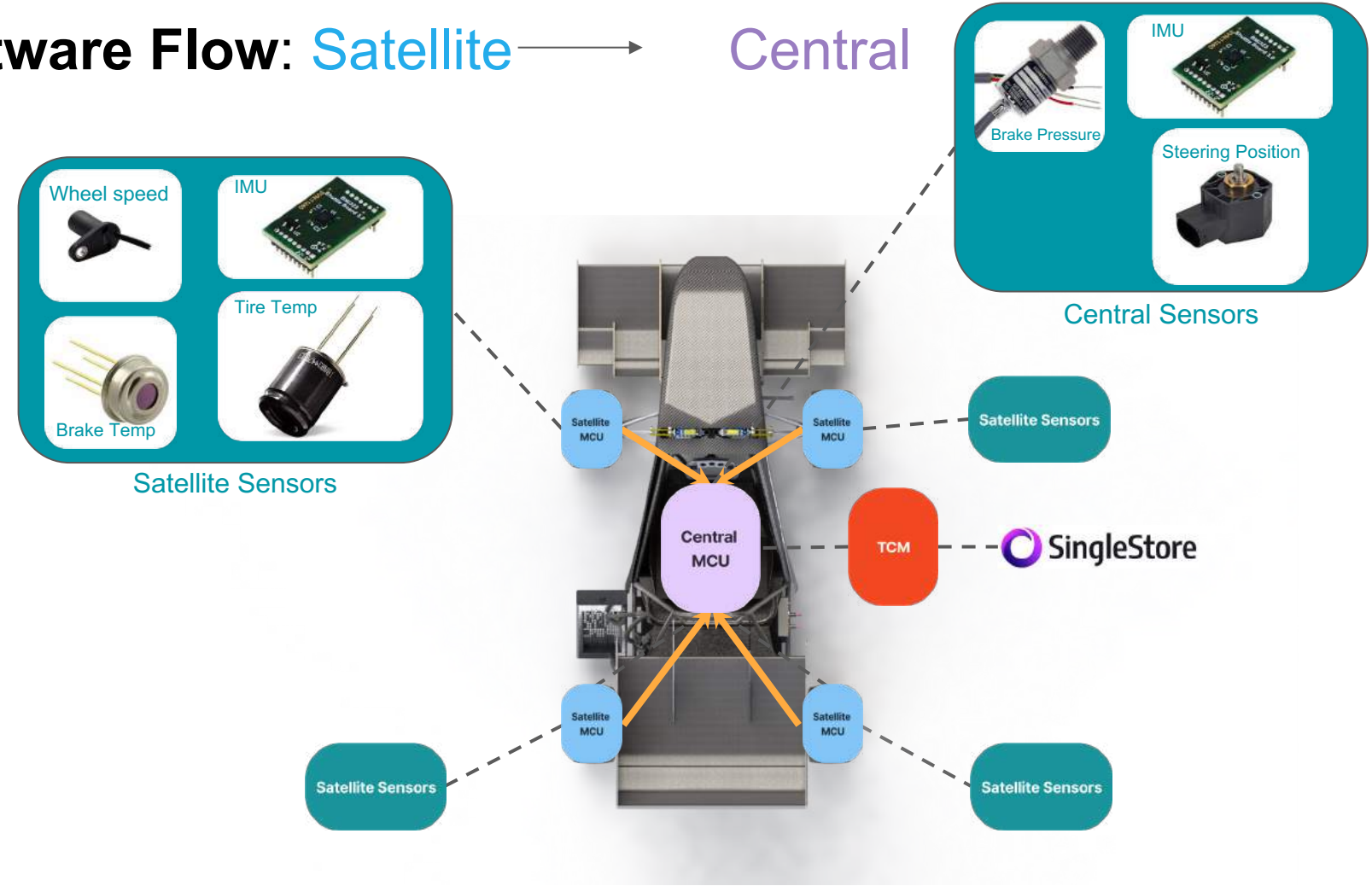




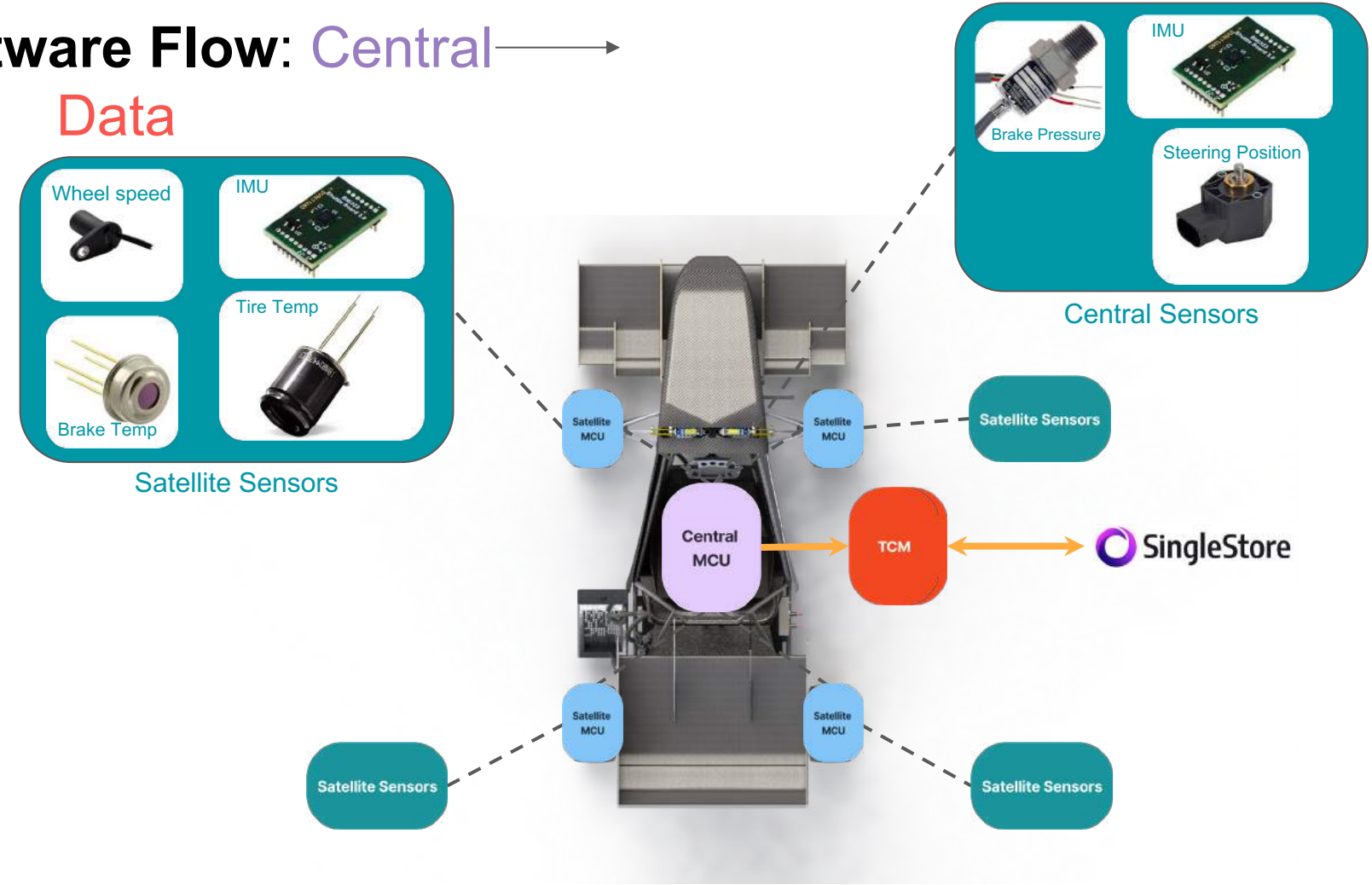
Software Flow: Sensor → MCU



Software Flow: Satellite → Central

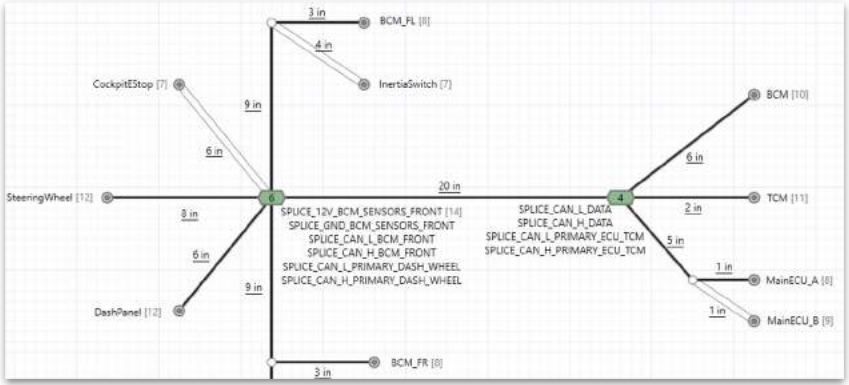


Software Flow: Central → Data



Mounting and Harnessing

- Harness split into 3 parts
  - Primary, Front, Rear
- Measure twice, cut once
  - Measurements from CAD
  - Measurements from the chassis
- Encase wire in protective sleeve to prevent chafing and EMI
- Epoxy sensors to waterproof them



Demo Video

Thank you!

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Sponsor: SingleStore

Backup Slides