

# Embedded System in Automobiles



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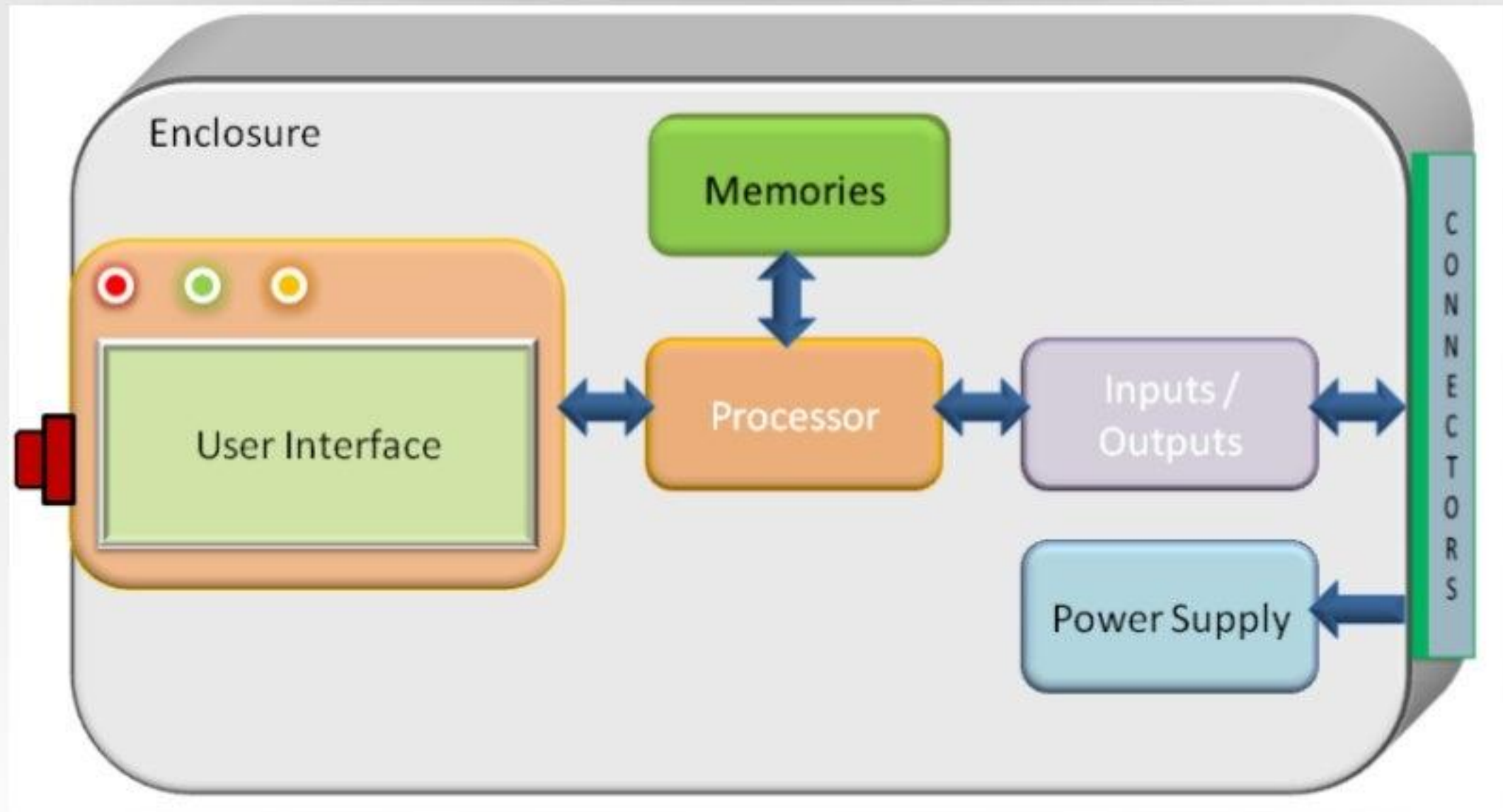


# EMBEDDED SYSTEM



- A combination of hardware and software which together form a component of a larger machine.
- An example of an embedded system is a microprocessor that controls an automobile engine.
- An embedded system is designed to run on its own without human intervention, and may be required to respond to events in real time.

# Block Diagram of A Typical Embedded System



# CHARACTERISTICS OF EMBEDDED SYSTEMS

- **Sophisticated functionality**

Often have to run sophisticated algorithms or multiple algorithms. Often provide sophisticated user interfaces.

- **Real-time operation**

- ✓ Must finish operations by deadlines.

- **Hard real time**: missing deadline causes failure.

- **Soft real time**: missing deadline results in degraded performance.

- ✓ Many systems are multi-rate: must handle operations at widely varying rates.

- **Low manufacturing cost.**

- **Low power.**

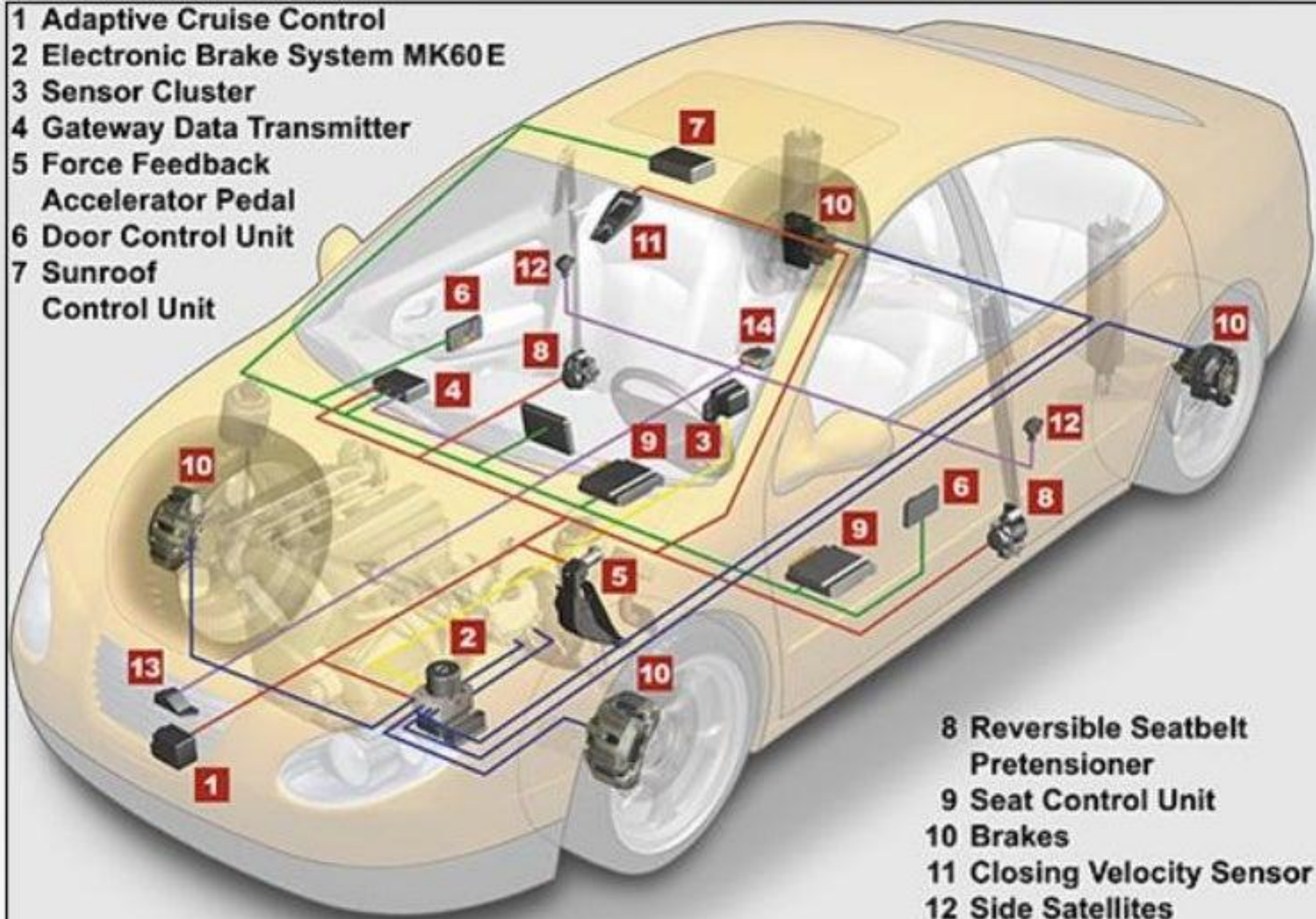
- **Designed to tight deadlines by small teams.**



# APPLICATIONS IN AUTOMOTIVE SYSTEM

- Air Bags
- Traction Control
- The Black Box
- Automatic Parking
- Anti-lock Brake
- Adaptive Cruise
- Heads-up display Control
- Night Vision
- Drive by wire
- Satellite Radio E.g.: XM
- Back-up collision sensor
- Telematics E.g.: OnStar
- Rain-sensing Wipers
- Navigation Systems
- Emission Control
- Tire Pressure Monitor
- Climate Control

- 1 Adaptive Cruise Control
- 2 Electronic Brake System MK60 E
- 3 Sensor Cluster
- 4 Gateway Data Transmitter
- 5 Force Feedback Accelerator Pedal
- 6 Door Control Unit
- 7 Sunroof Control Unit



- 8 Reversible Seatbelt Pretensioner
- 9 Seat Control Unit
- 10 Brakes
- 11 Closing Velocity Sensor
- 12 Side Satellites
- 13 Upfront Sensor
- 14 Airbag Control Unit



# CAN (CONTROLLER AREA NETWORK)

- CAN is a hardware and software communication protocol for in-vehicle networks in cars.
- The applications of CAN in automobiles include engine control communications, body control, and on-board diagnostics.
- A CAN bus enables microcontrollers in a car to talk to each other without the need for a network host.
- A typical automobile today has dozens of microcontrollers that communicate with each other via various CAN buses.

## Key Features

**Maximum Data Rates:** 1Mbps at 40m, 125Kbps at 500m, 50kbps at 1000m

**Circuit Type:** Differential

**Physical Layer:** Twisted Wire Pair, 9 pin D-Sub

**Transmission Format:** Asynchronous

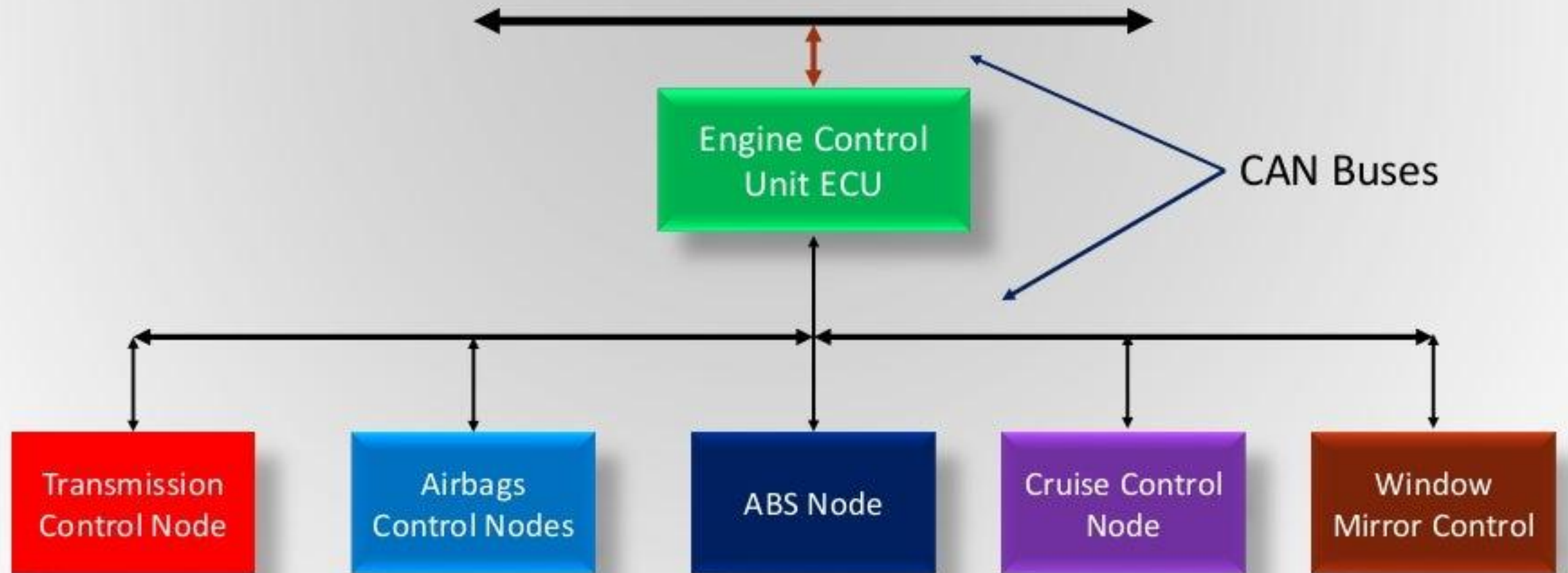
**Drive Voltage:** High: 2.75v ~ 4.5v; Low: 0.5v ~ 2.25v;

**Differential:** 1.5v ~ 3.0v

**Network Topology:** Point to Point

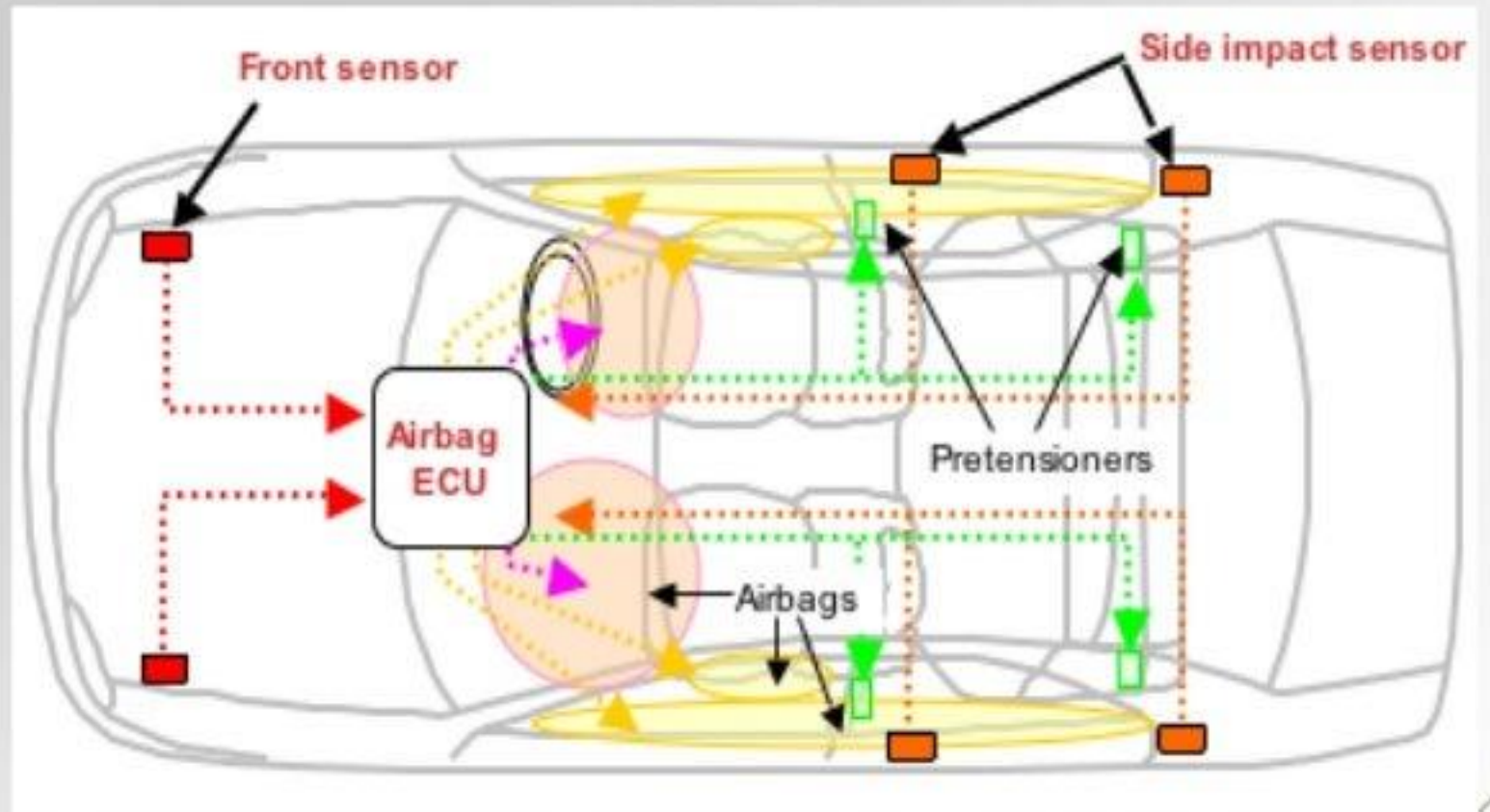
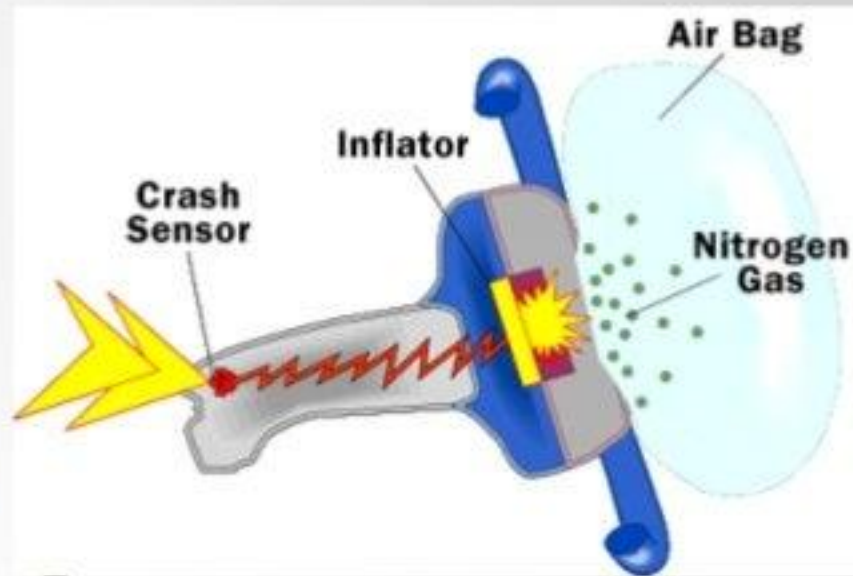
**Standards:** ISO 11898/11519

# CAN BUS INTERFACE





# AIRBAG SYSTEM

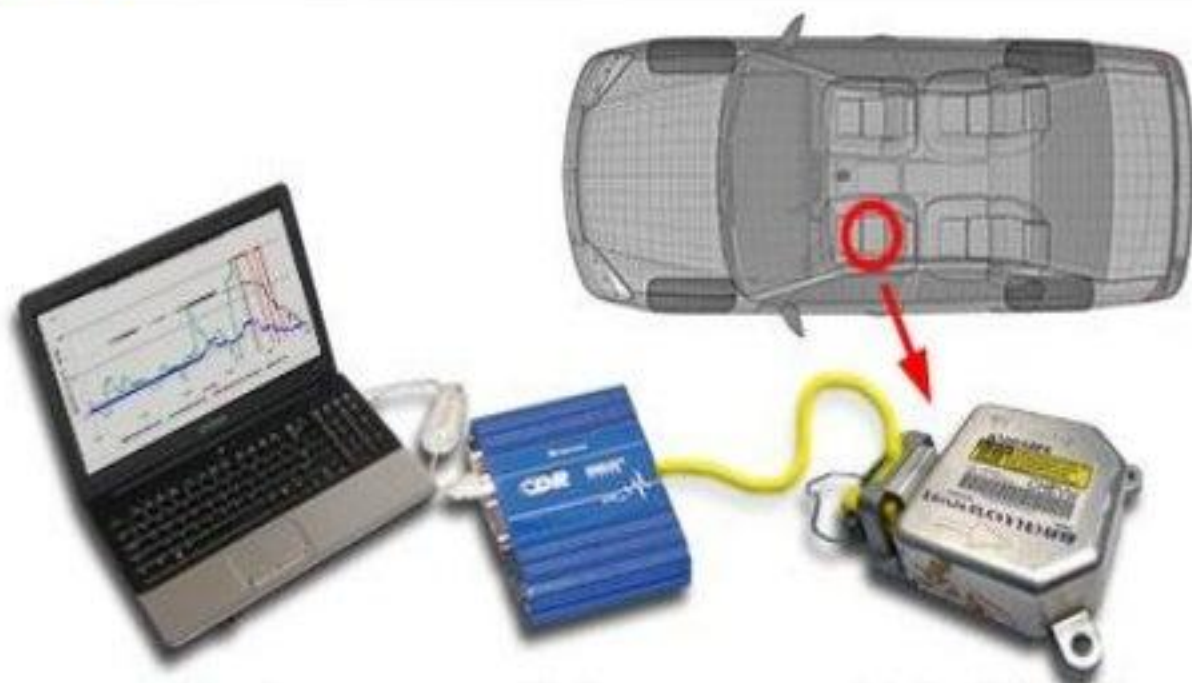


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# EDR-ELECTRONIC DATA RECORDERS

- Electronic data recorders- similar to the 'Black Box' flight recorders used on airplanes
- It records a few seconds of a vehicle's operation immediately before the crash.
- EDRs usually are connected to a vehicle's air bag control system and continuously record and rerecord data from connected sensors.
- In an accident in which air bags are deployed , EDR records are captured for analysis.



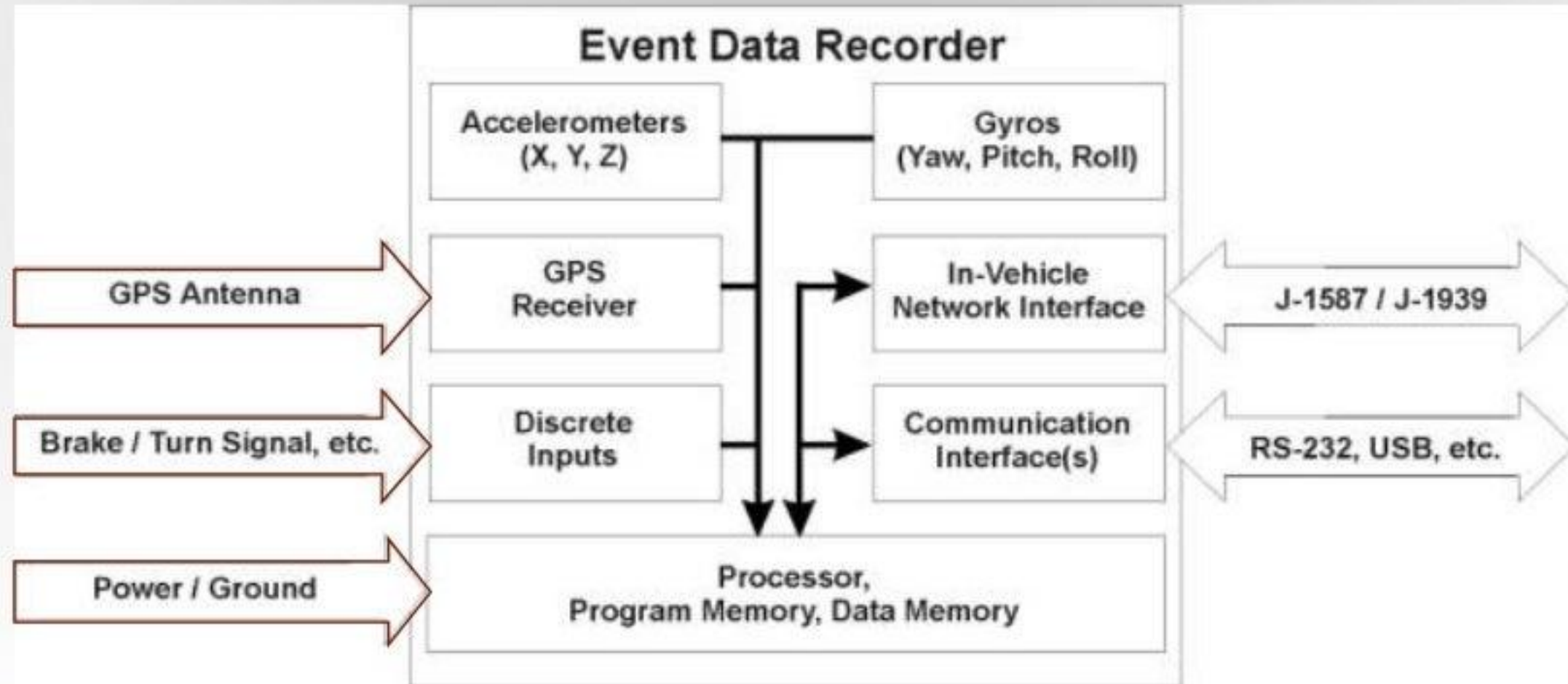


Event  
Data

Interface  
Device

Electronic Control  
Module

# EDR BLOCK DIAGRAM



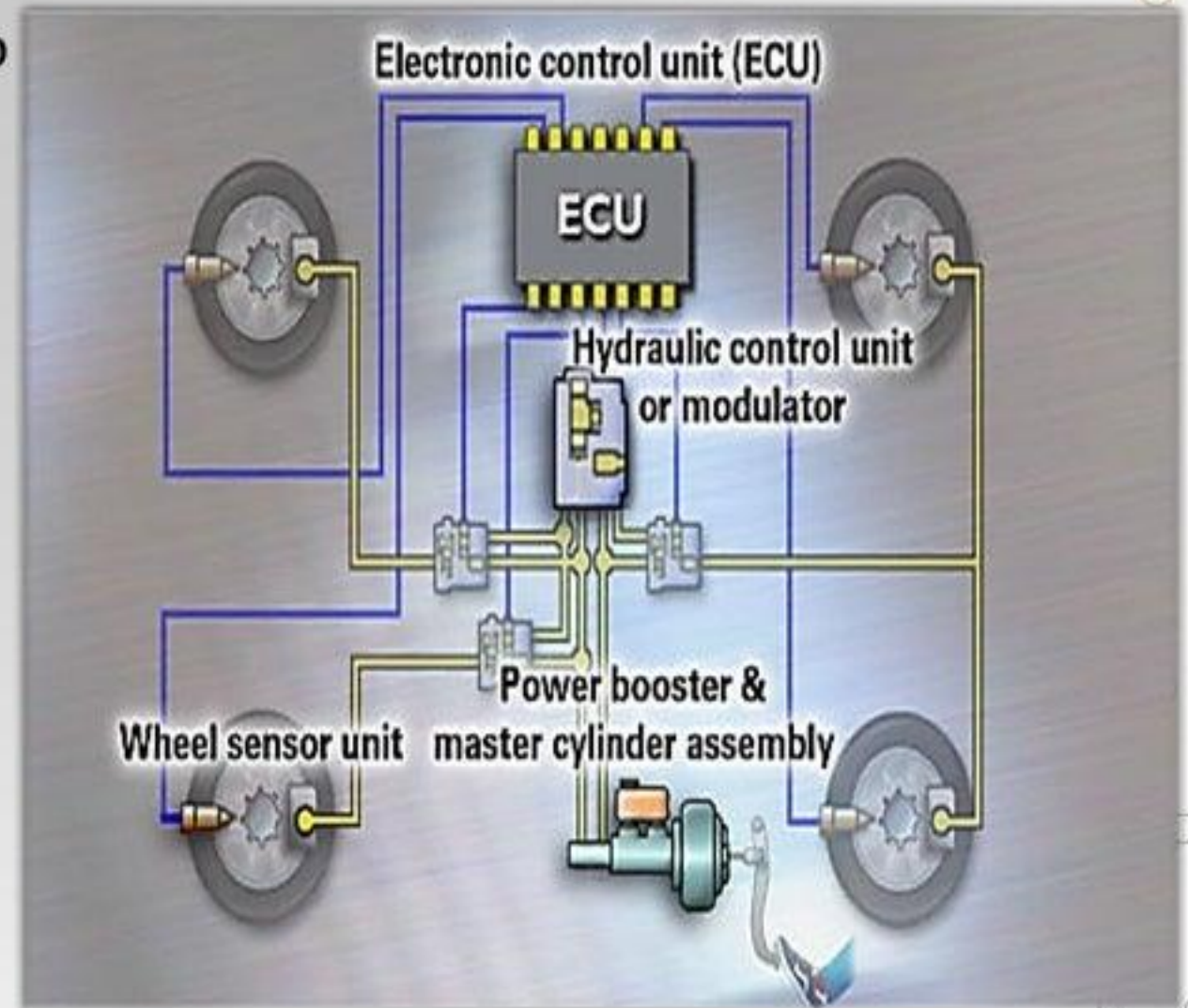


# ANTI-LOCK BRAKE SYSTEM (ABS)

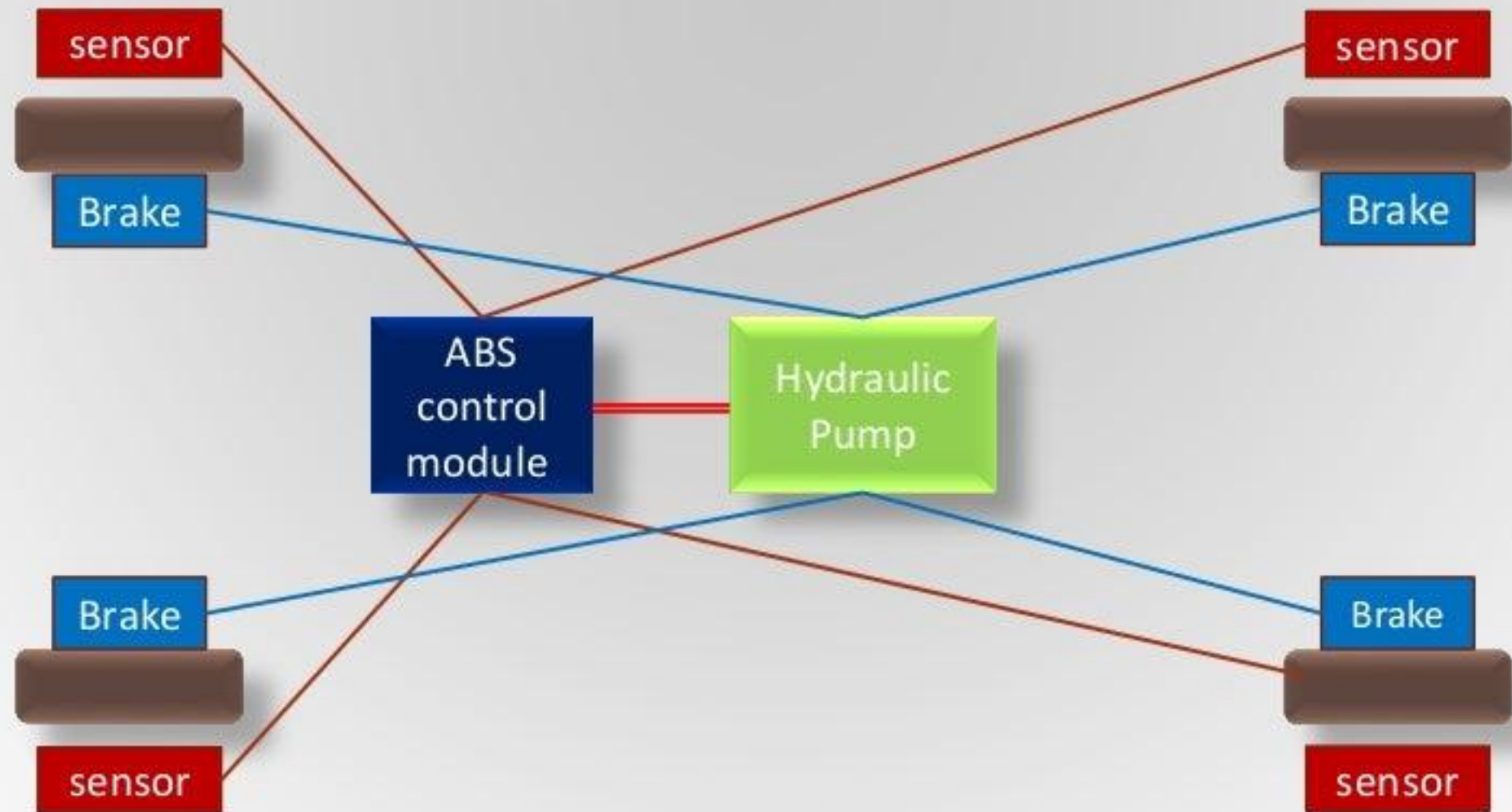
The antilock braking system is designed to prevent wheels locking or skidding, no matter how hard brakes are applied, or how slippery the road surface.

The primary components of the ABS braking system are:

- Electronic control unit (ECU)
- Hydraulic control unit or modulator
- Power booster & master cylinder assembly
- Wheel sensor unit



# BASIC ANTI-LOCK BRAKE SYSTEM





# PRINCIPLE OF FUNCTIONING



- Wheel-speed sensors detect whether a wheel is showing a tendency to lock-up.
- In case of a lock-up tendency, the electronic control unit reduces the braking pressure individually at the wheel concerned.
- High-speed correction of the braking pressure up to shortly before the lock-up threshold.
- The brake-fluid return together with the closed-loop brake circuits makes this a safe, reliable, and cost-effective system.

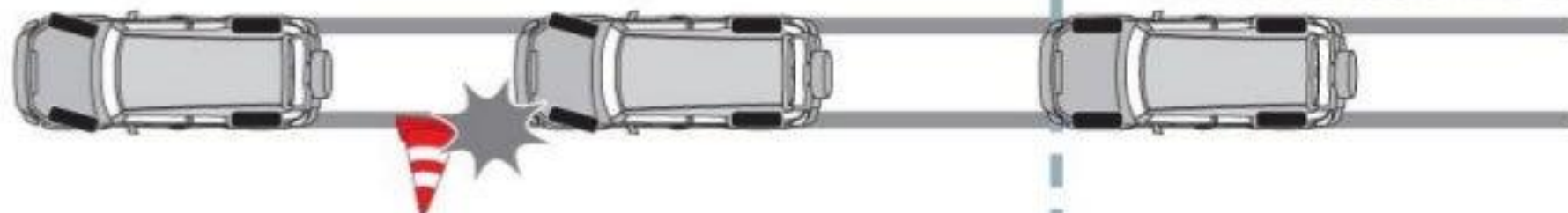
The vehicle remains steerable  
even during panic braking



**With ABS**

**Braking Point**

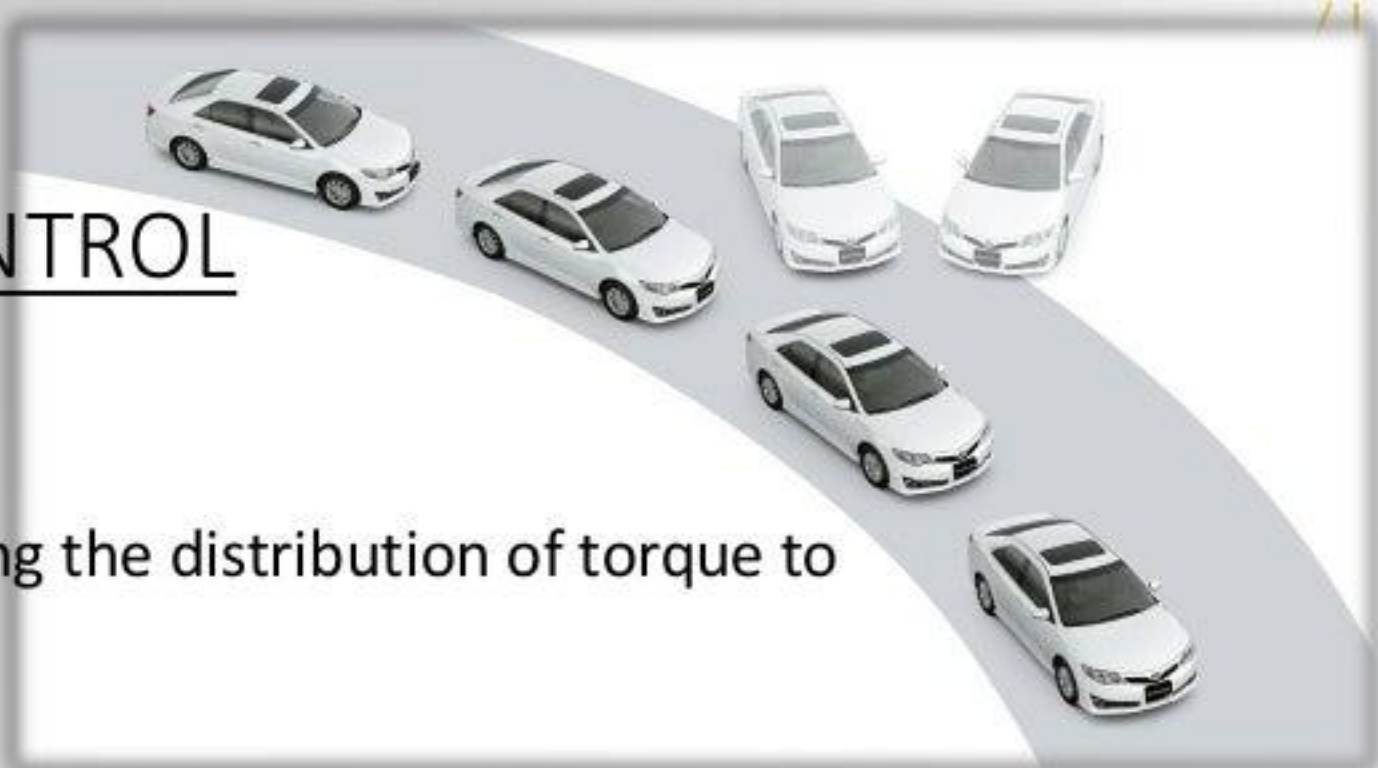
**Without ABS**



The vehicle is remains no longer steerable  
when the driver hits the brake



# TRACTION CONTROL



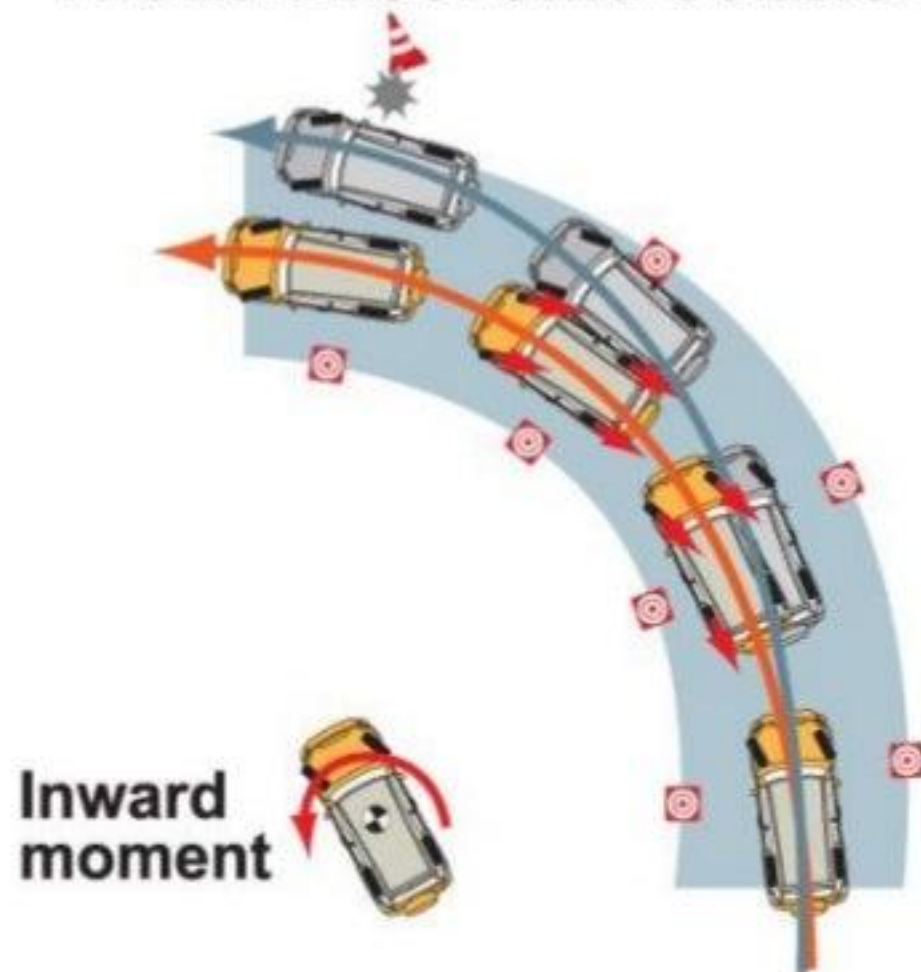
- Traction Control works by regulating the distribution of torque to each wheel of the vehicle.
- This stops the tires from spinning, and ensures that the car moves forward.
- It also ensures that brake pressure is electronically controlled at each wheel to suppress wheel spin and maintain optimum traction, so drive force is optimally distributed to all four wheels.

## VEHICLE STABILITY CONTROL (VSC)

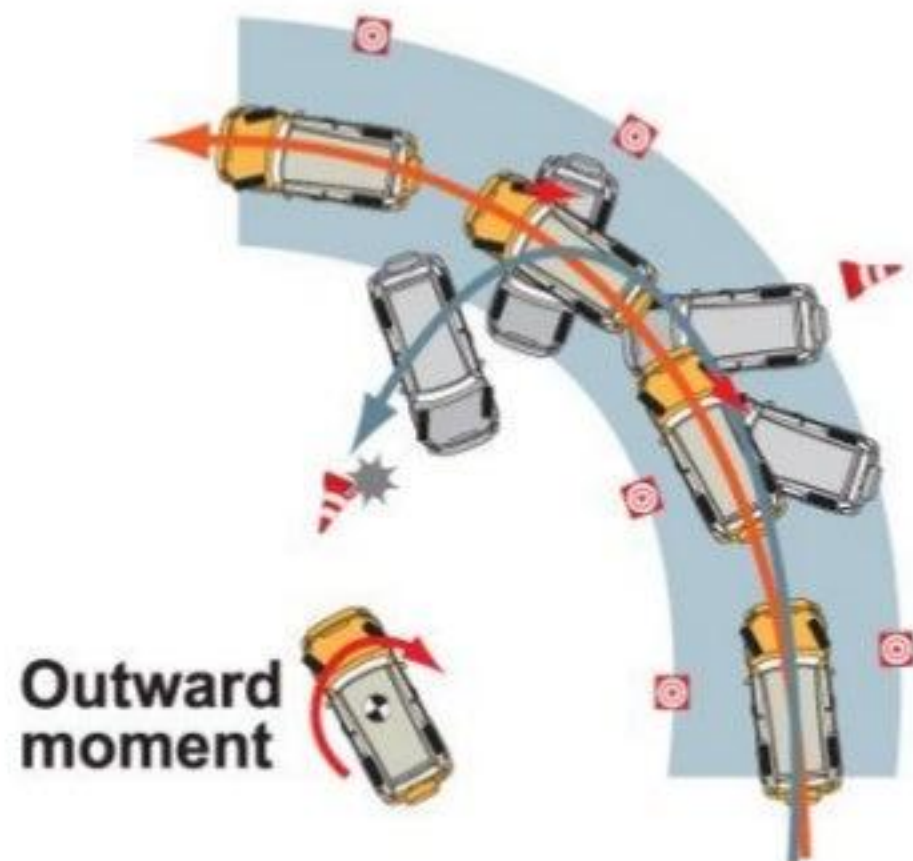
- System that ensures control in concerning situations the way ABS does under braking and TRC does under acceleration .
- The VSC system utilizes electronics sensors in conjunction with the ABS and TRC hardware to help control any potential understeer or oversteer situations.
- **Understeer** is when the vehicle loses front-wheel traction and wants to push forward nose first
- **OverSteer** is when the rear wheels lose traction and tail begins to slide



## Front wheel skid control



## Rear wheel skid control



# CRUISE CONTROL SYSTEM

- The cruise control system controls the speed of the car by adjusting the throttle position, so it needs sensors to tell it the speed and throttle position.
- It also needs to monitor the controls so it can tell what the desired speed is and when to disengage.

