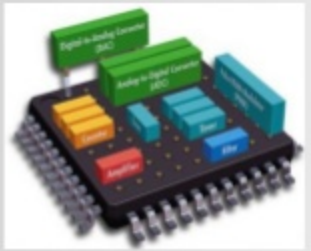
Embedded System in Automobiles

EMBEDDED SYSTEM

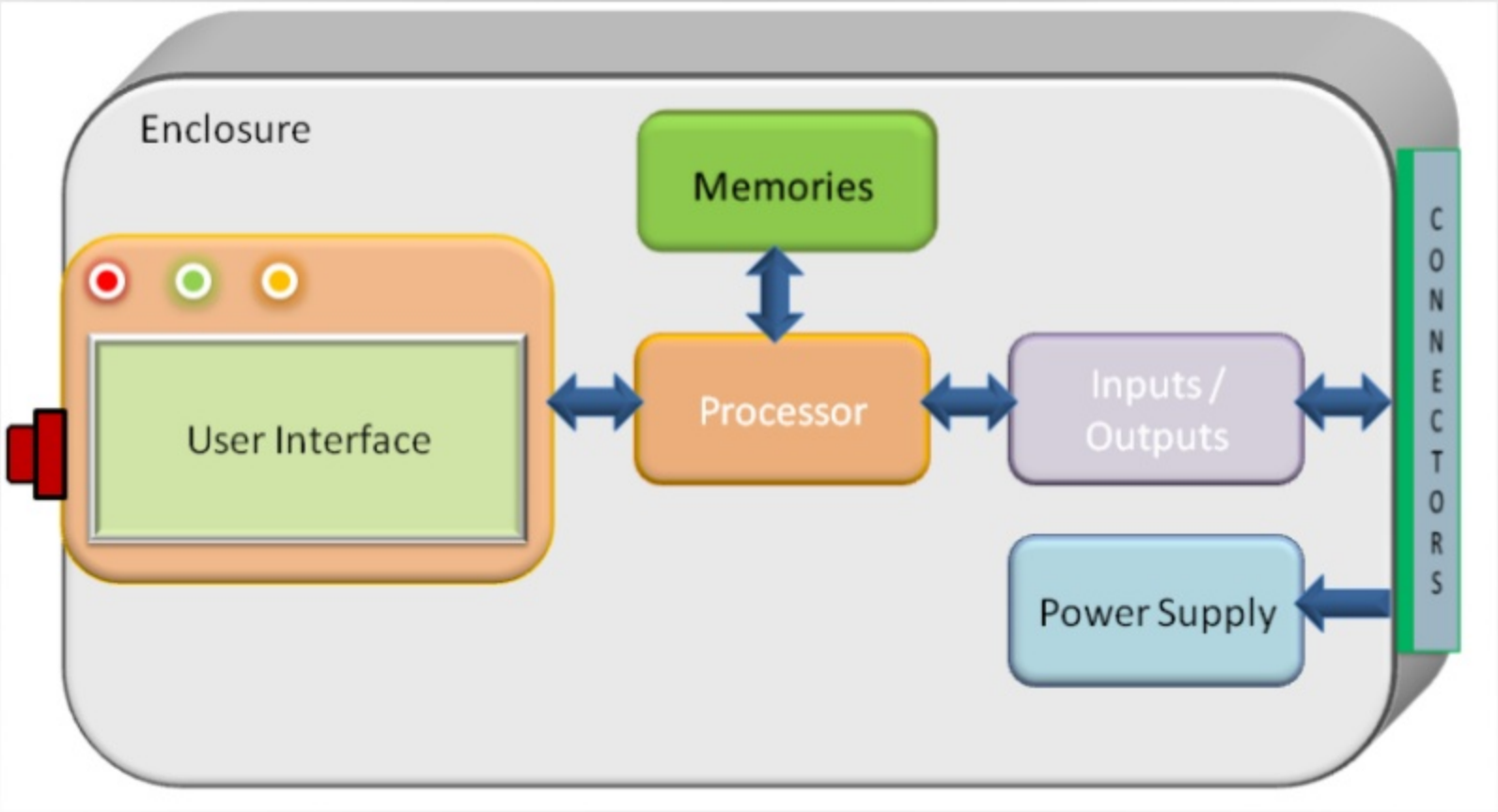


- A combination of hardware and software which together form a component of a larger machine.

- 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

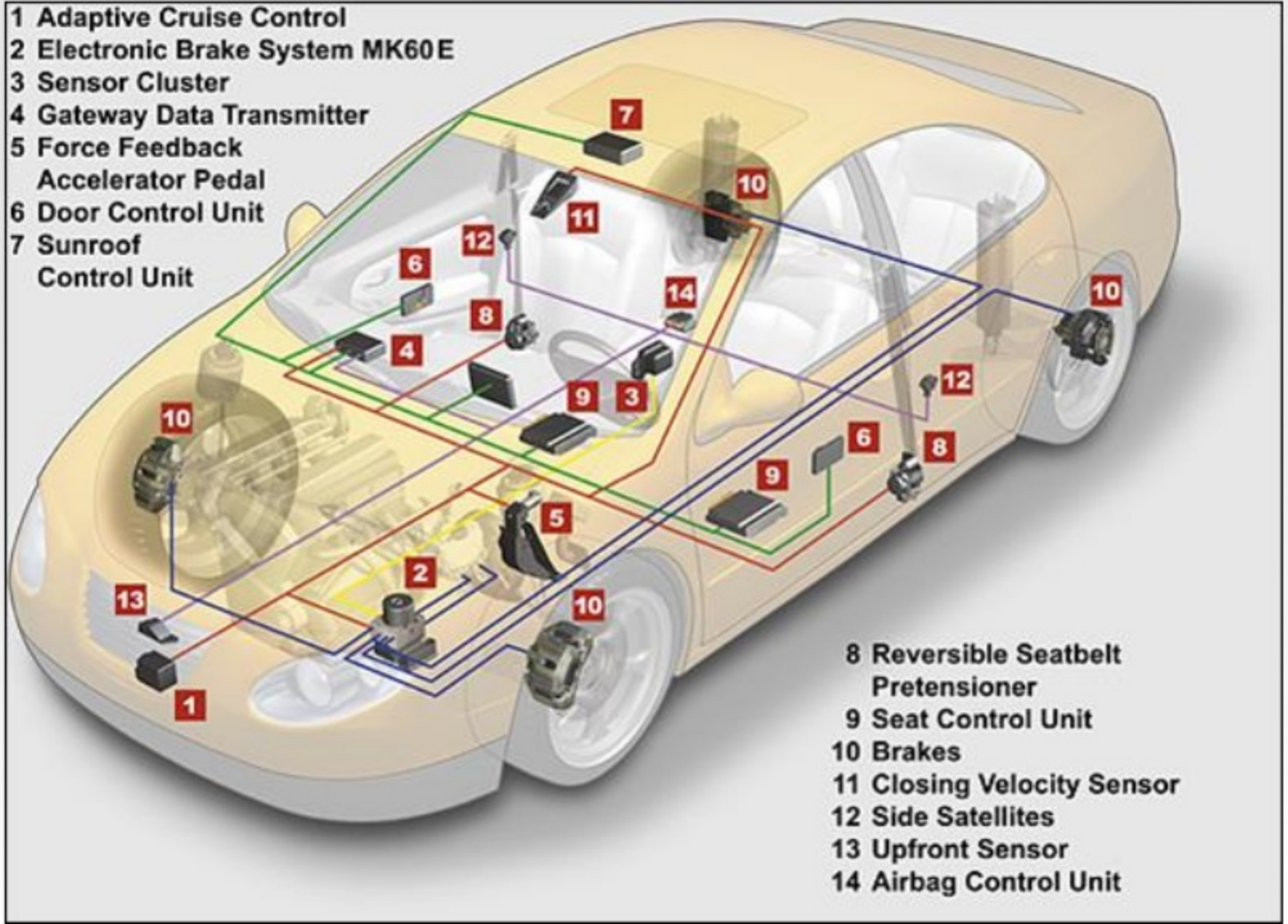
- Sophisticated functionality

  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 MK60E
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)

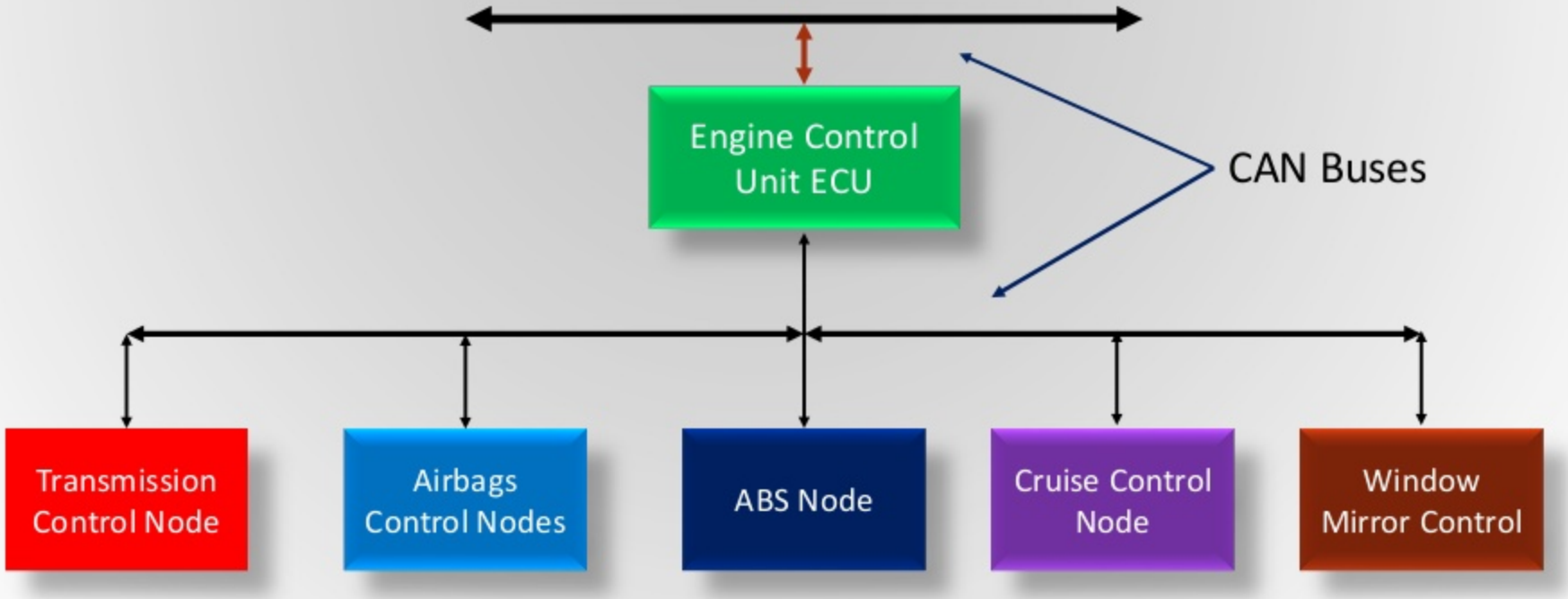
- CAN is a hardware and software communication protocol for in-vehicle networks in cars.
- The applications of CAN in automobiles include engine control communications, body control, and on-board diagnostics.
- A CAN bus enables microcontrollers in a car to talk to each other without the need for a network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

Key Features

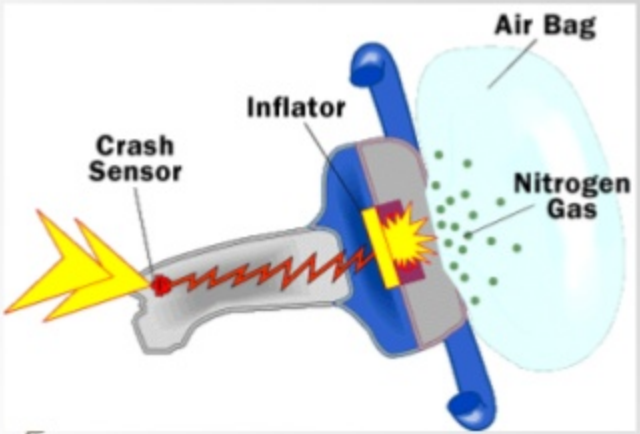
Maximum Data Rates: 1Mbps at 40m, 125Kbps at 500m, 50kbps at 1000m
Circuit Type: Differential
Physical Layer: Twisted Wire Pair, 9 pin D-Sub

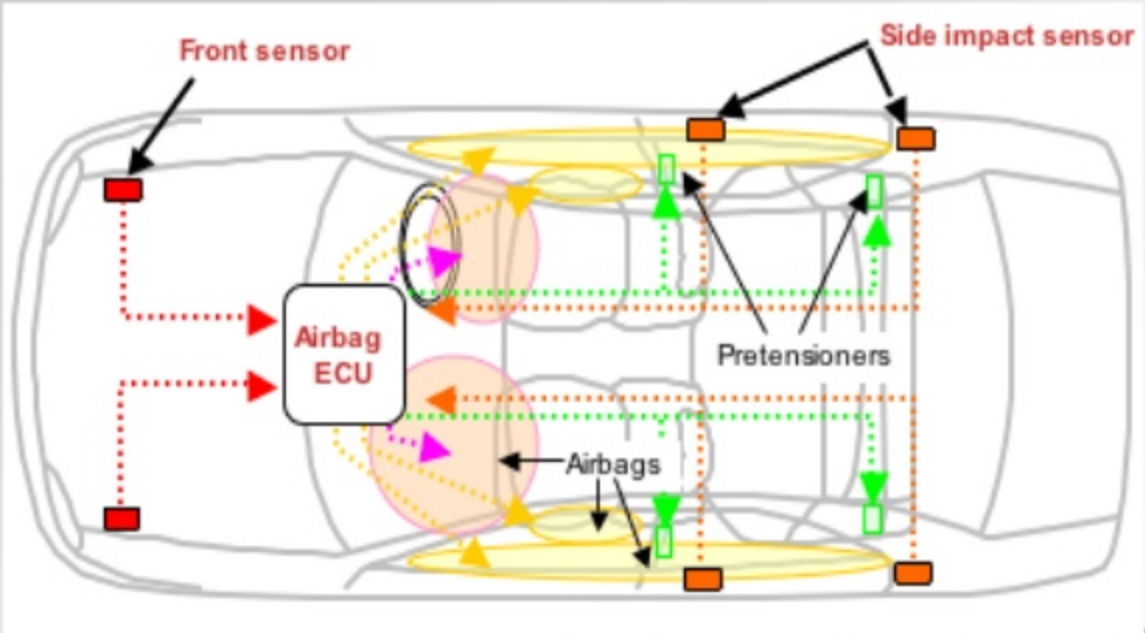
Transmission Format: Asynchronous
Drive Voltage: High: 2.75v ~ 4.5v; Low: 0.5v ~ 2.25v;
Differential: 1.5v ~ 3.0v
Network Topology: Point to Point
Standards: ISO 11898/11519

CAN BUS INTERFACE



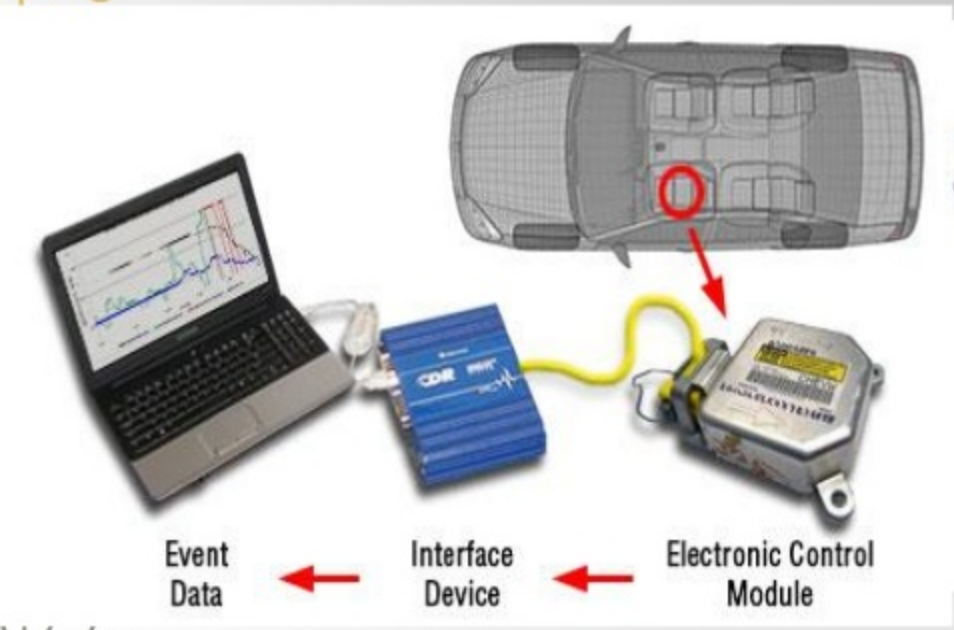
AIRBAG SYSTEM





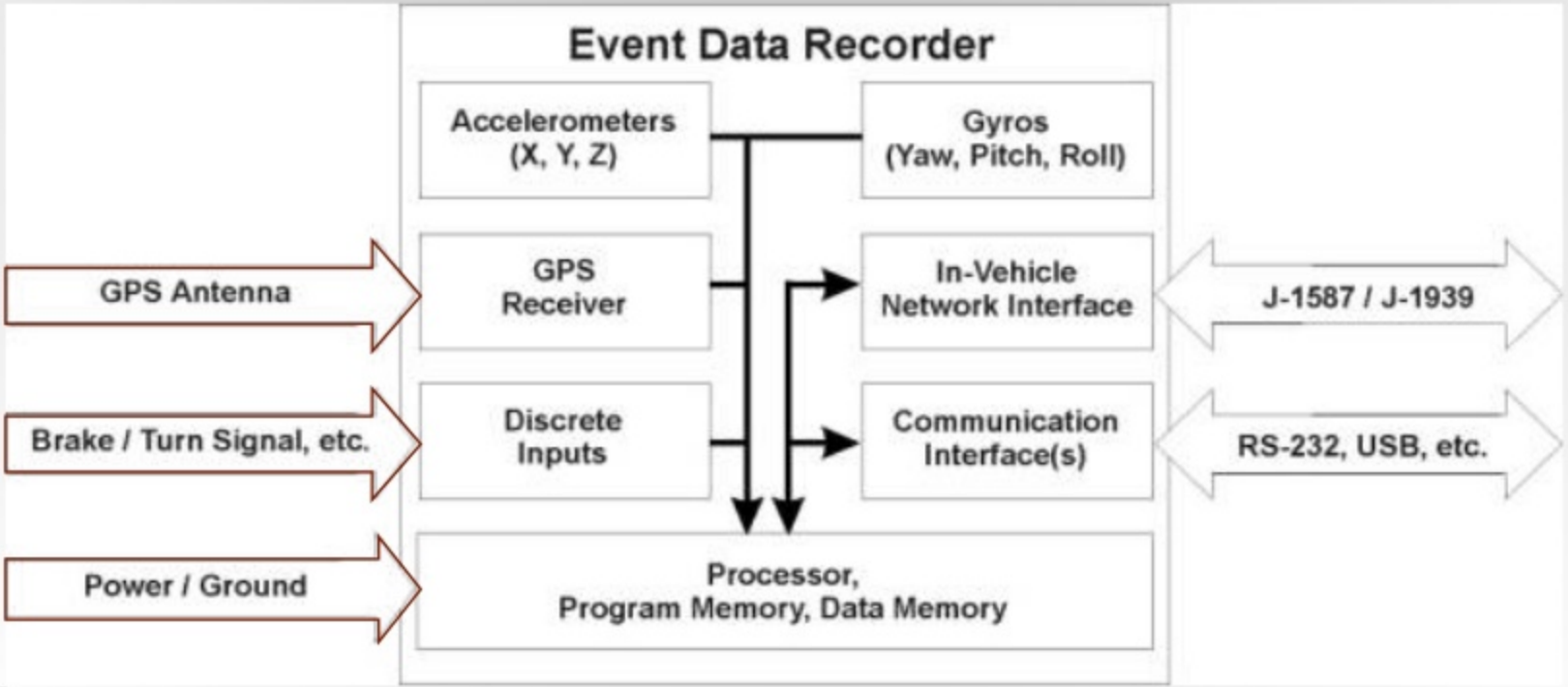
EDR-ELECTRONIC DATA RECORDERS

- 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


CAUTION
AIR BAG SENSOR
SDM

EDR BLOCK DIAGRAM

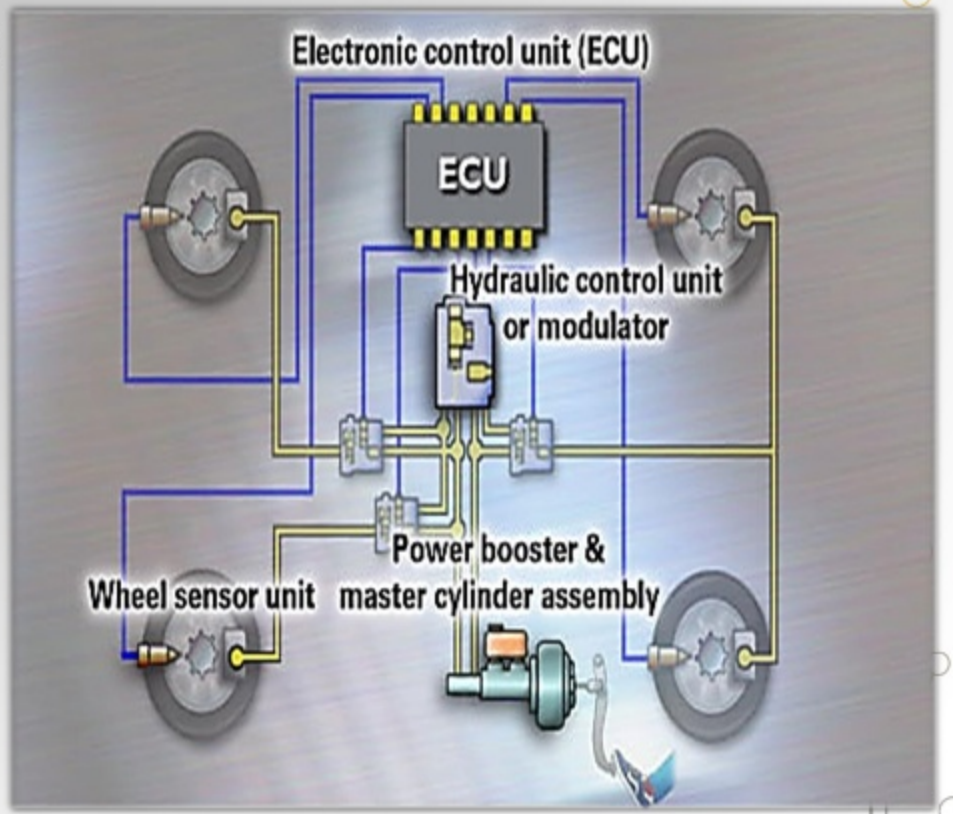


ANTI-LOCK BRAKE SYSTEM (ABS)

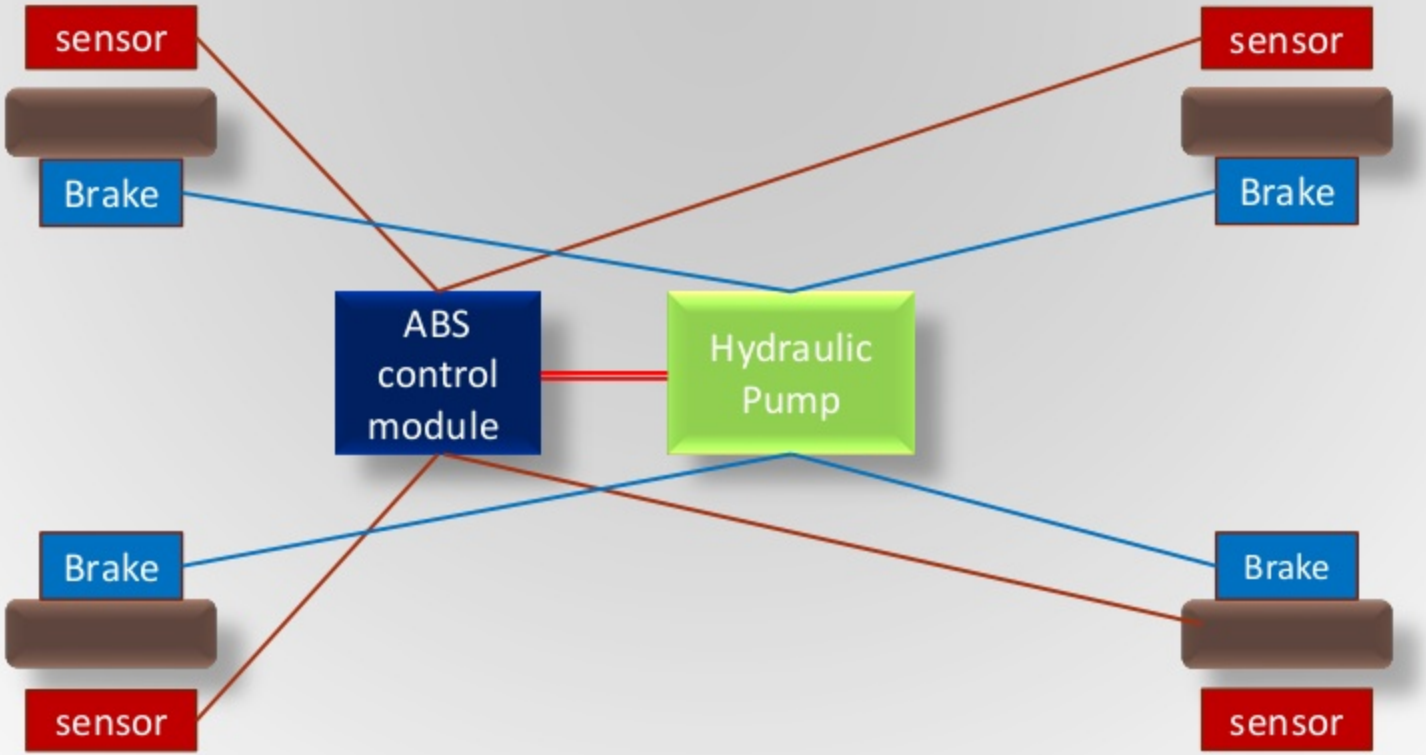
The antilock braking system is designed to prevent wheels locking or skidding, no matter how hard brakes are applied, or how slippery the road surface.

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

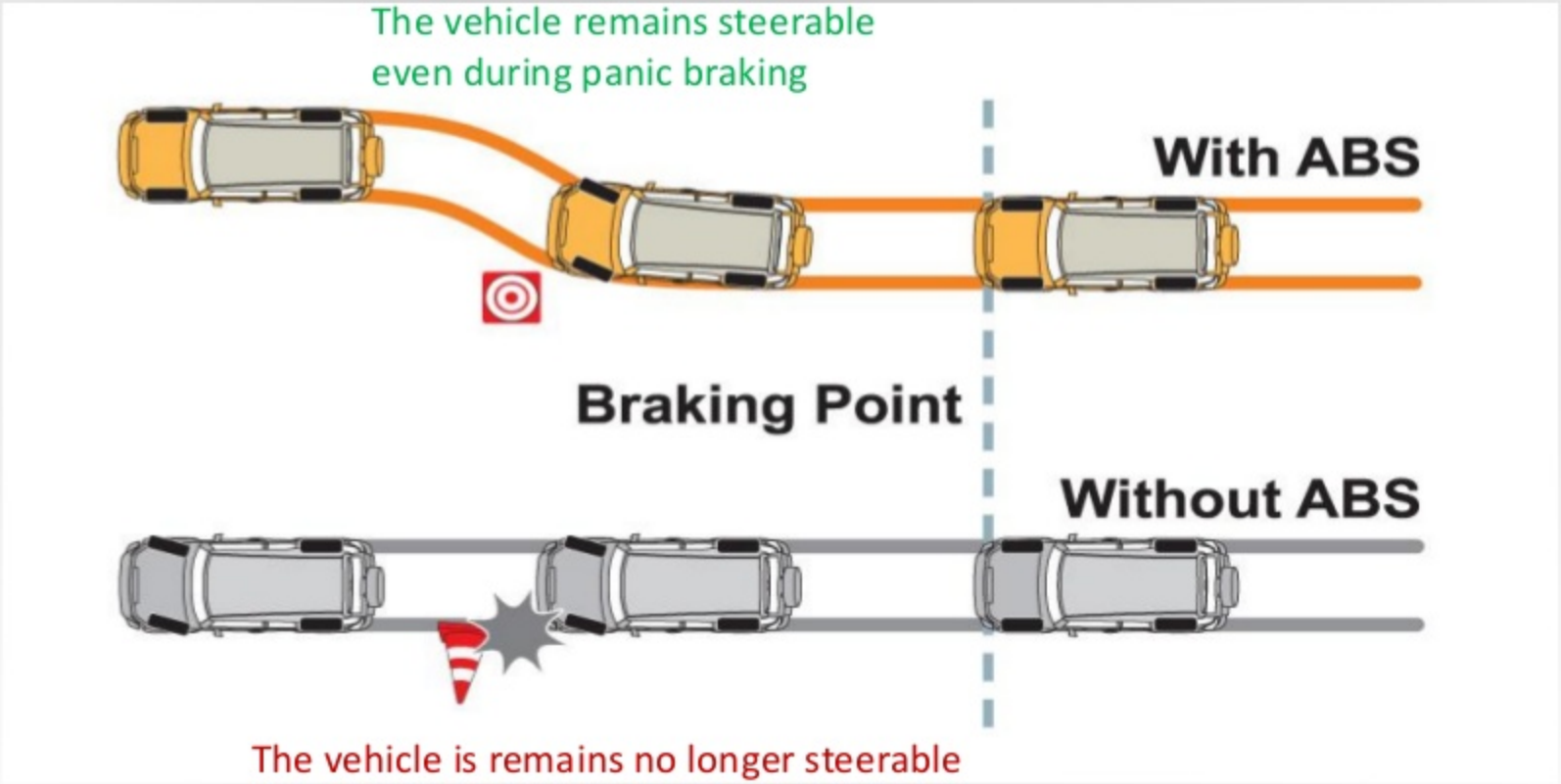


BASIC ANTI-LOCK BRAKE SYSTEM

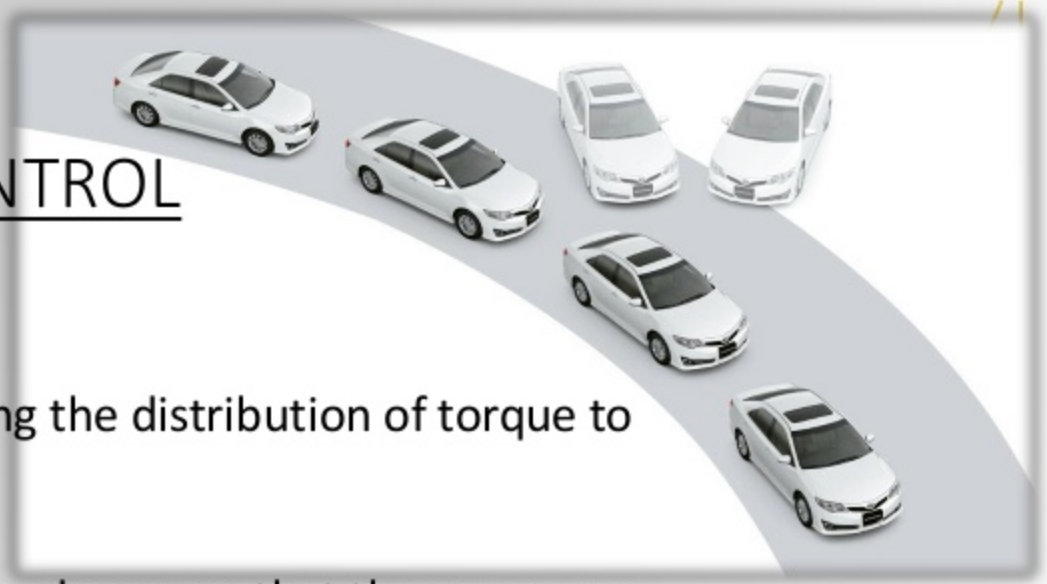


PRINCIPLE OF FUNCTIONING

- 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

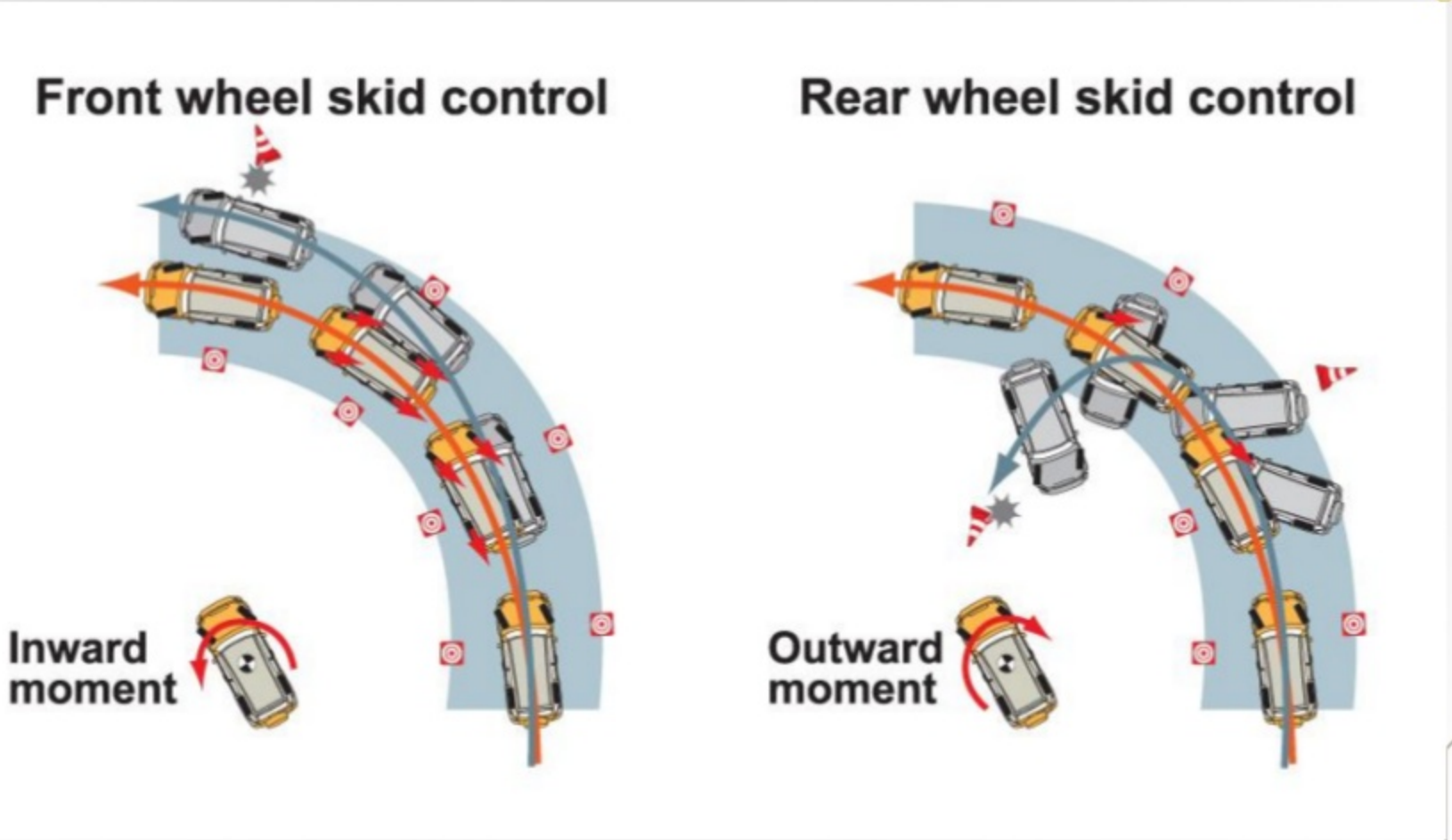
TRACTION CONTROL



- 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
Inward moment
Rear wheel skid control
Outward moment

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.