

Vehicle dynamics

Active safety and ADAS

Driver tasks and vehicle interaction with the environment

Navigation:

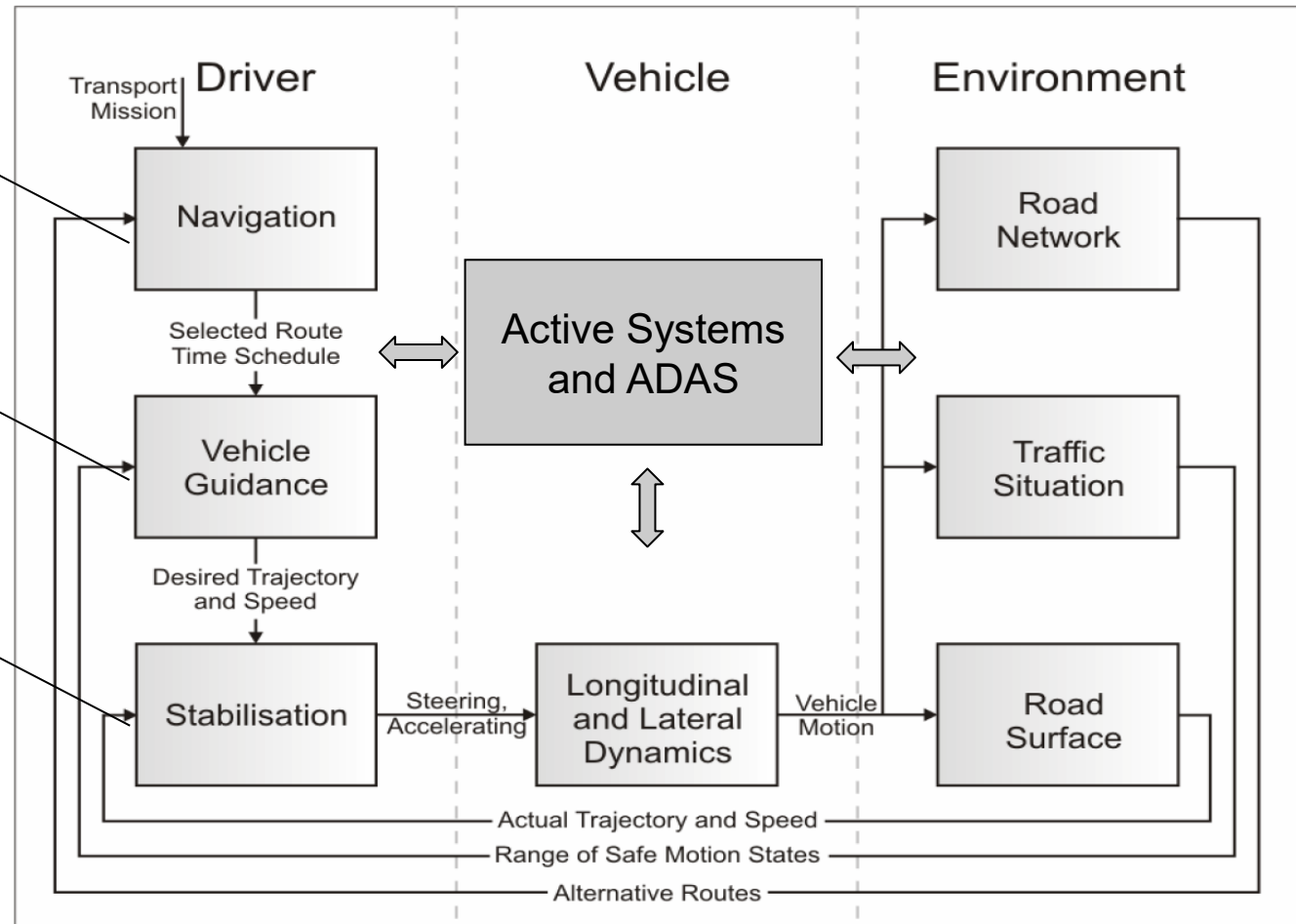
- Route planning
- Avoid traffic jams

Vehicle Guidance:

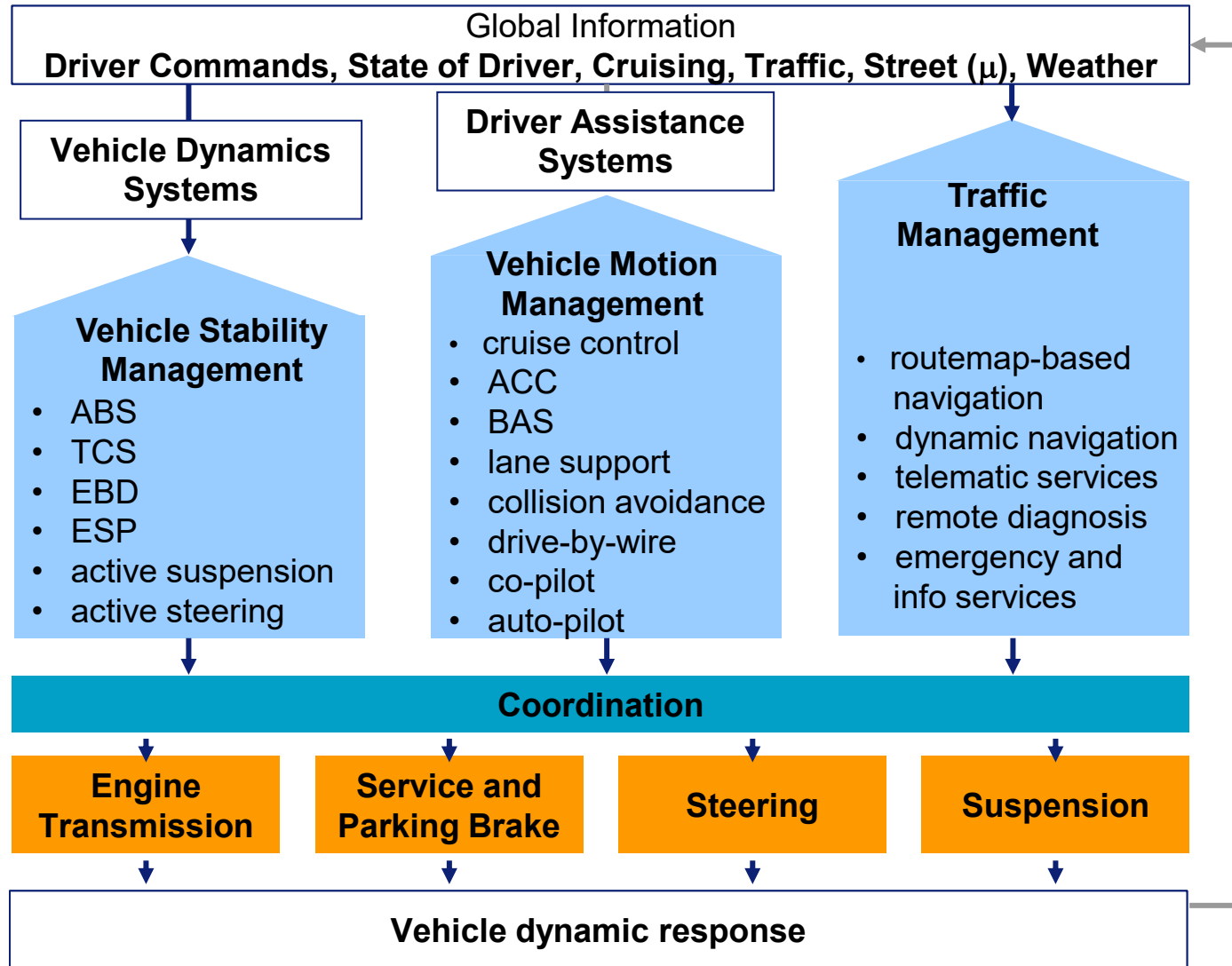
- Maintain desired speed or distance to the car in front
- Maintain the drive Lane
- Lane change
- Overtaking maneuvers

Stabilization:

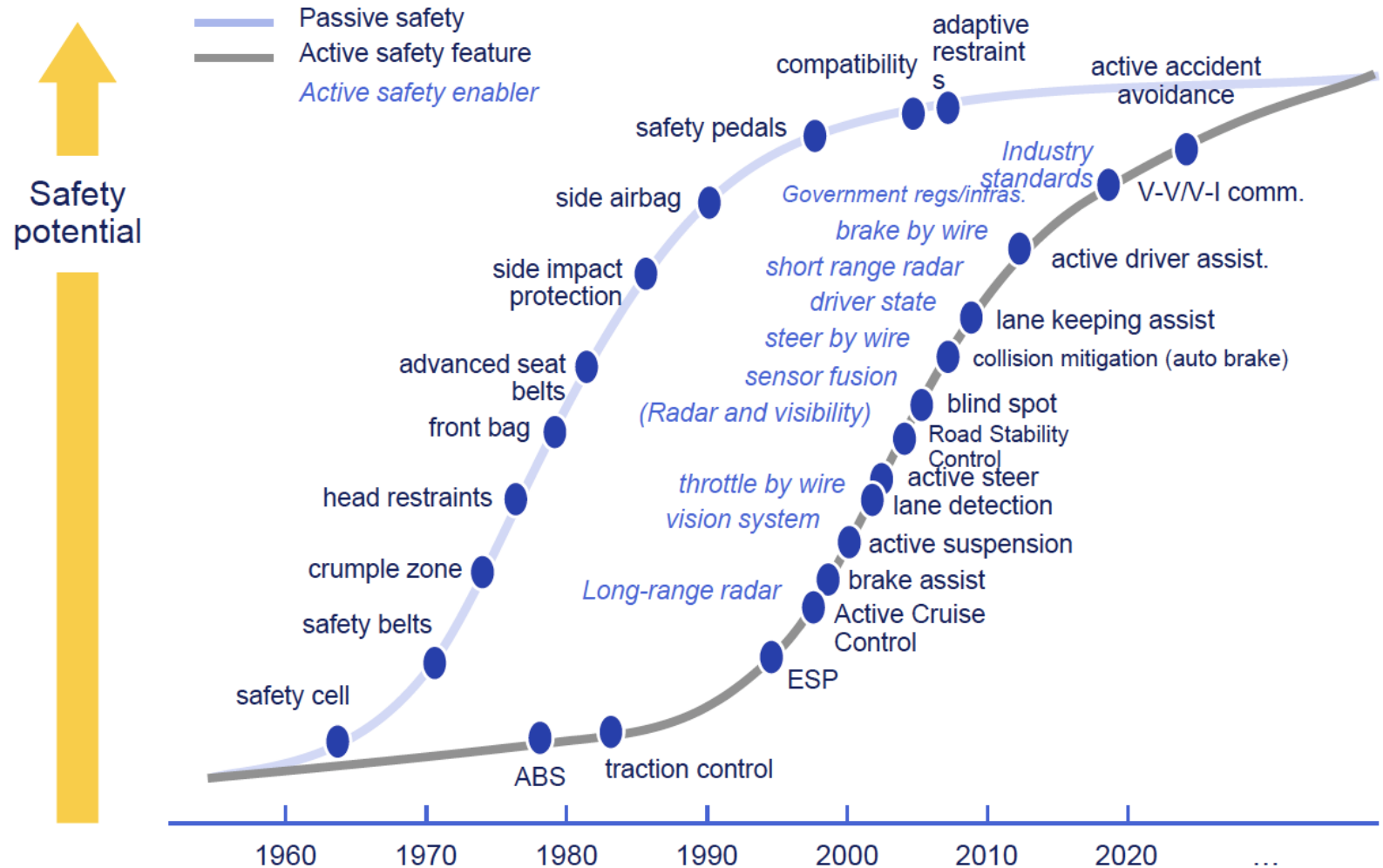
- Maintain the vehicle in a linear region
- Avoid:
 - excessive wheel spin
 - blocked wheels
 - excessive yaw rate



Active systems for driver assistance



Active vs passive safety over the time



Source: Ford, BMW 2005

Active safety systems: braking systems

Electronic Brake-force Distribution (EBD)

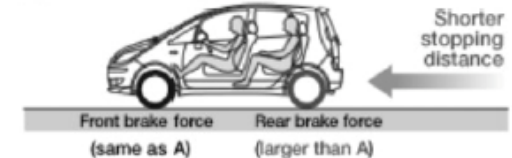
EBD electronically distributes the brake hydraulic pressure between front and rear wheels depending on vehicle load and driving conditions sending relatively more braking power to the axle with the greater load.

EBD Function (Same pedal force applied)

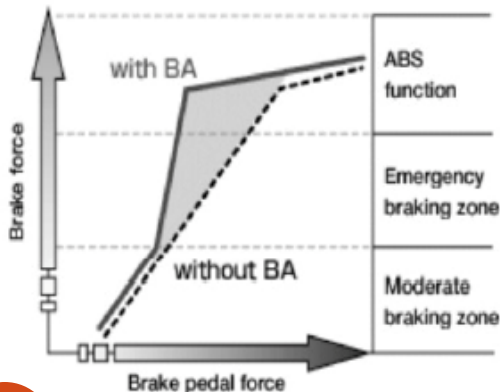
[A] one passenger



[B] more than one passenger with EBD



[C] more than one passenger without EBD

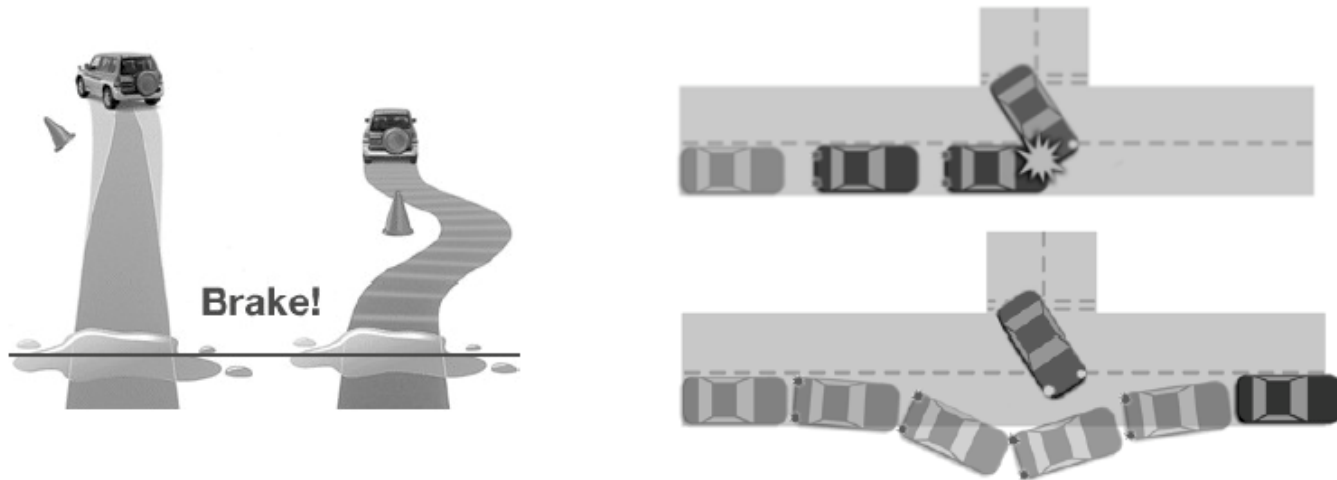


Brake Assist (BA)

This system supports pedal actuation during emergency braking by providing additional braking force.

Active safety systems: braking systems

Anti-lock Braking Systems (ABS) assist drivers in maintaining vehicle control and avoiding wheel lock during emergency stop situations or on slippery surfaces.

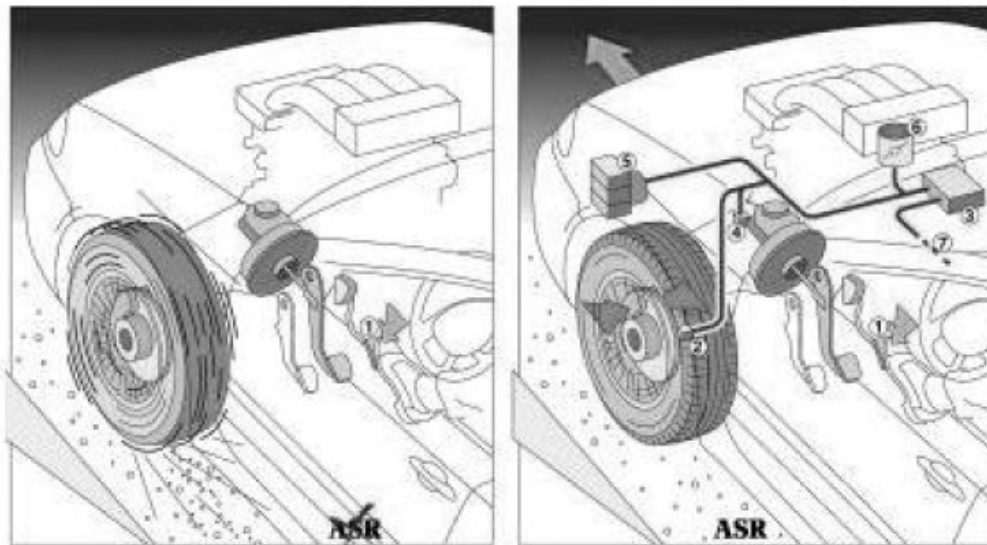


ABS uses four independent sensors which individually monitor each wheel's speed. When wheel lock or skidding is sensed, a signal is sent to the *ABS Electro-hydraulic Control Unit (EHCU)* which controls the system and can determine when a panic situation exists.

Active safety systems: traction control

Traction Control Systems (TCS), combine brake and engine management to transfer power to the wheels with the best grip on the road.

TCS **automatically** applies the brakes at the drive wheel(s) and reduces engine power, as needed, to help **reduce wheel spin** during acceleration. This can improve traction and vehicle stability to help maintain control when accelerating on slippery surfaces like slick, wet roads or gravel.



ASR – Anti Skid Regulator

Active safety systems: stability systems

Electronic Stability Program (ESP) system combines the capabilities of anti-lock brakes (ABS) and traction control with a lateral stability control feature. While ABS and Traction Control improve the longitudinal stability of the vehicle by limiting wheel slip, ESP primary function is to enhance vehicle control during cornering.



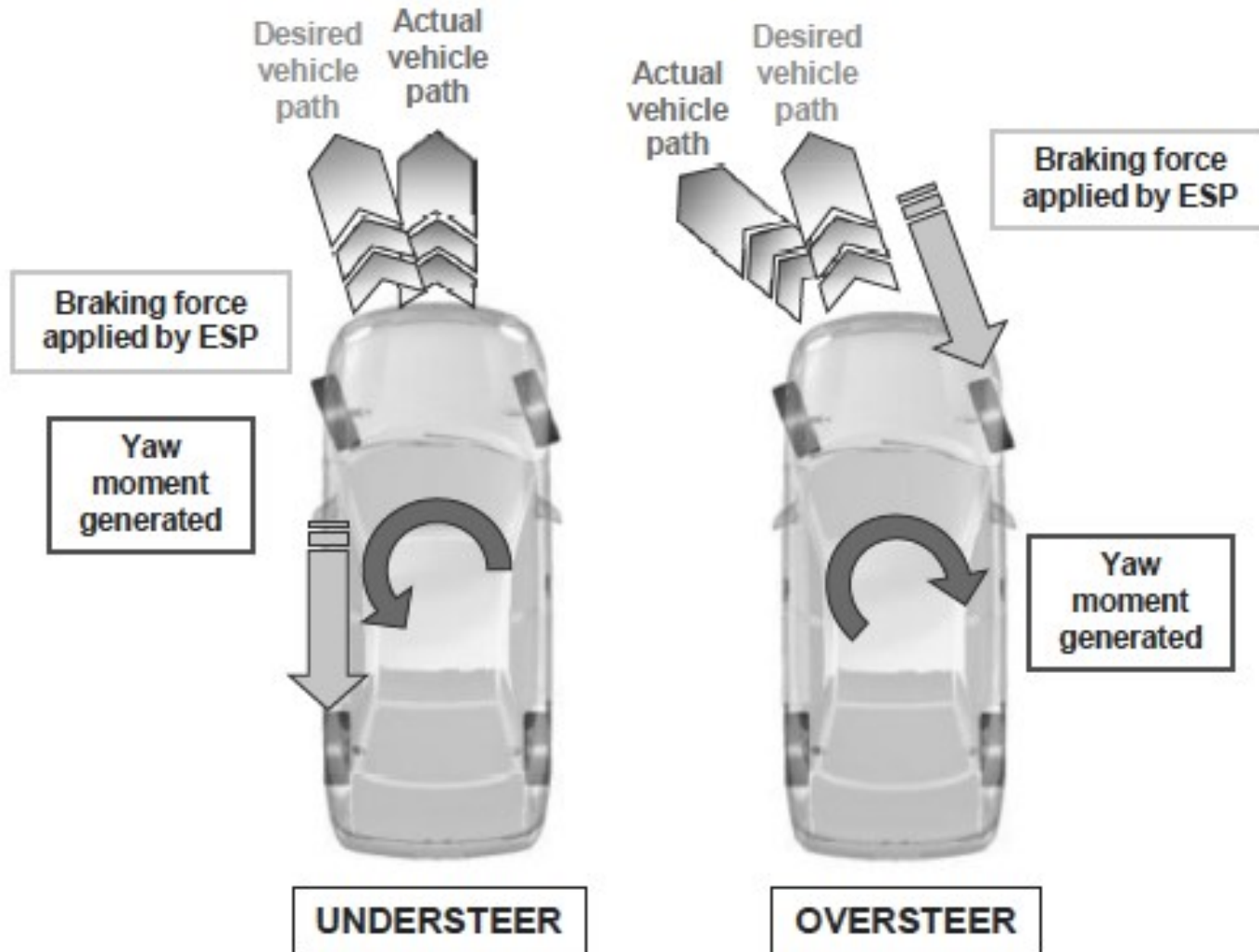
With Electronic Stability Control System



Without Electronic Stability Control System

Depending on the automotive producers the Stability Control has been commercialized with different names: **ADC** (Active Dynamic Control), **ASC** (Active Stability Control), **DSC** (Dynamic Stability Control), **ESC** (Electronic Stability Control), **PSM** (Porsche Stability Management), **ESC**

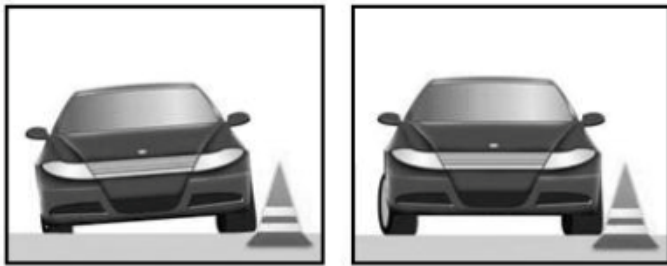
ESP: the basic concept



Active safety systems: body control

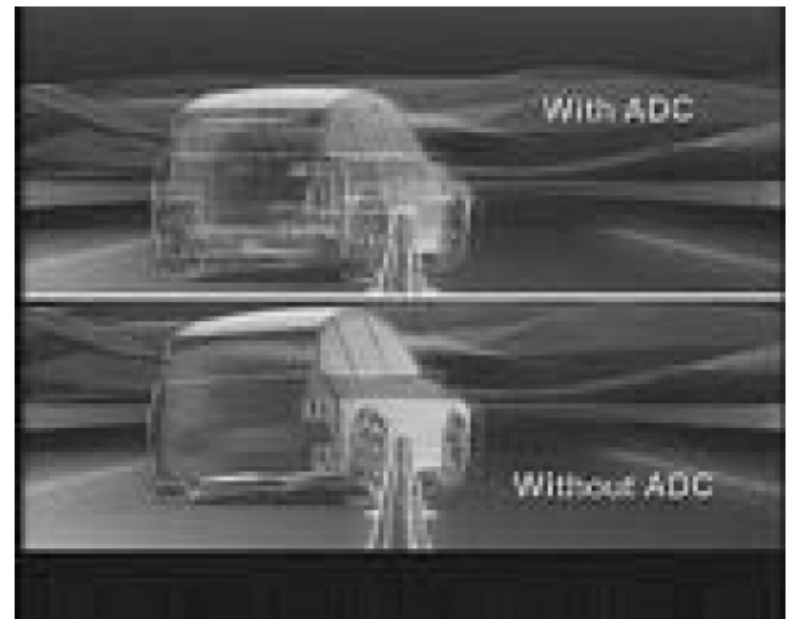
Through a combination of hydraulic and electronic technologies, the Active Body Control systems limits vehicle load transfers due to body modes of pitch and roll providing enhanced safety.

Those kind of systems can act through different suspension elements such as roll bars or actuated damper elements.

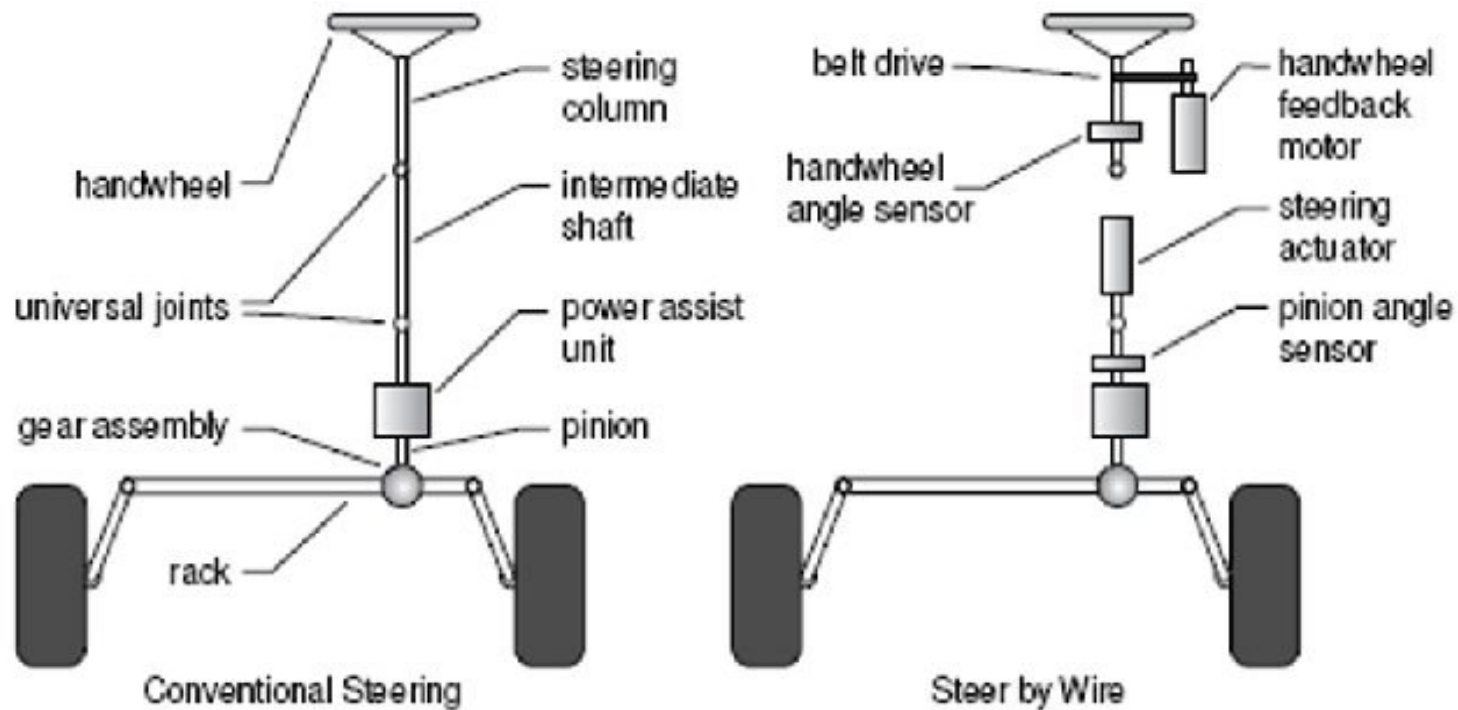


Reduction of body roll through ADC (Active Dynamic Control)

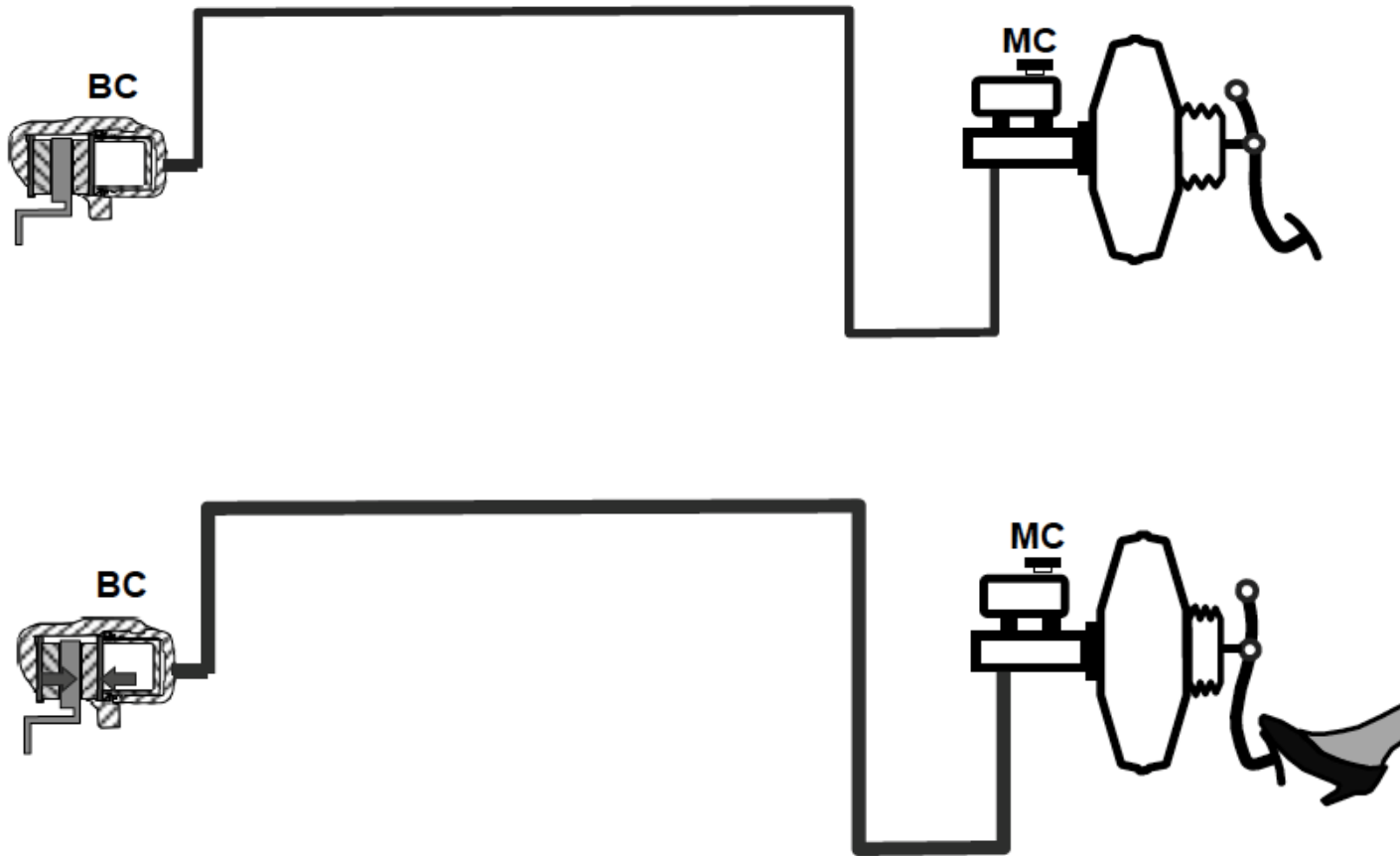
ADC (TRW)



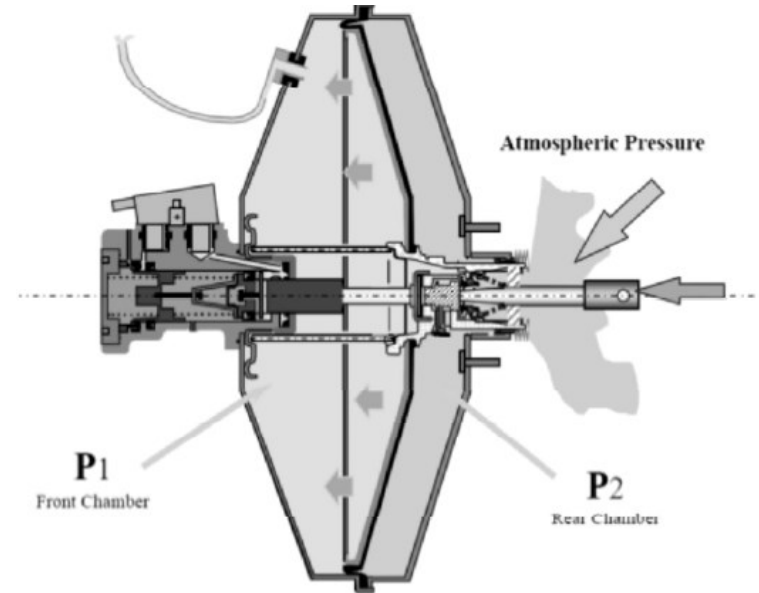
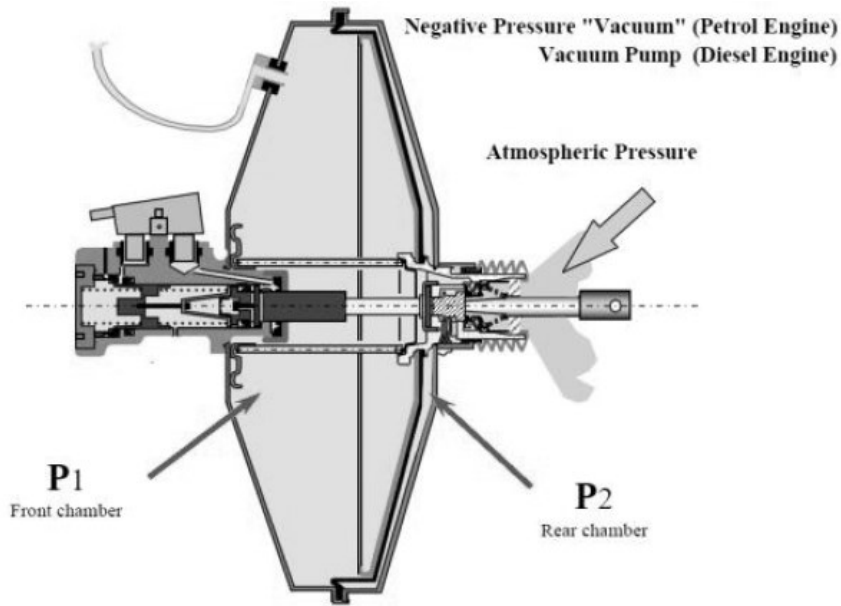
Active safety systems: Steer-by-wire (SBW)



Braking system: normal braking action

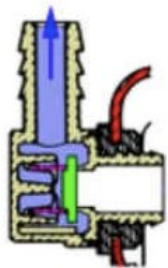
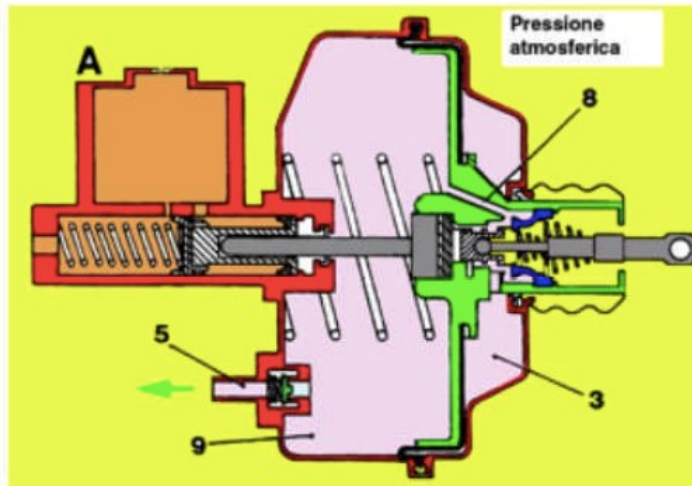


Braking system: auxiliary devices

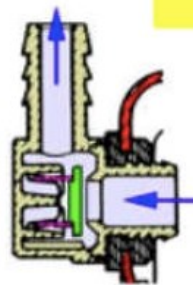
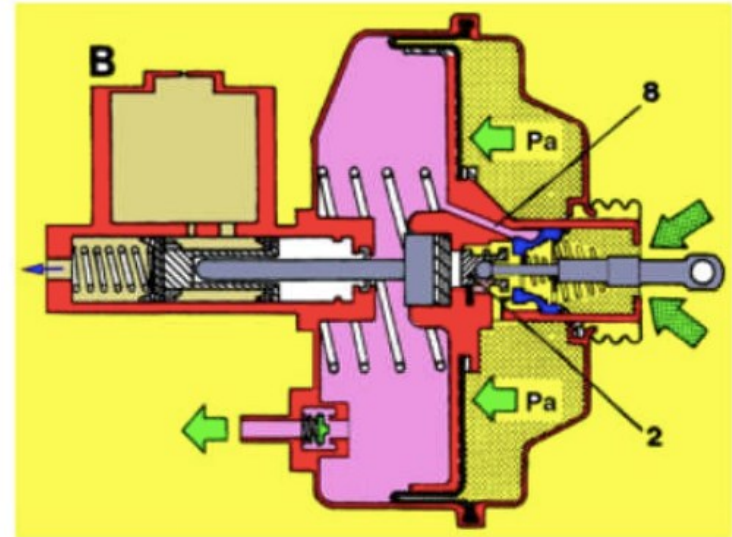


Booster
to amplify driver's pedal force effect on Tandem Master
Cylinder (TMC)

Braking system: auxiliary devices



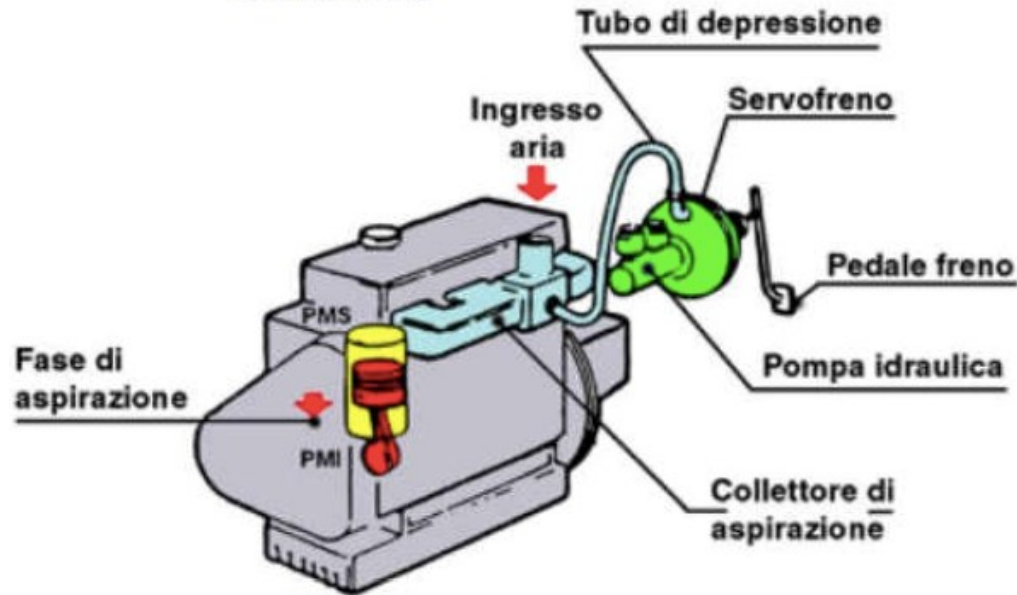
3. Camera posteriore;
5. Valvola di ritegno depressione;
8. Canale di collegamento camere;
9. Camera anteriore.



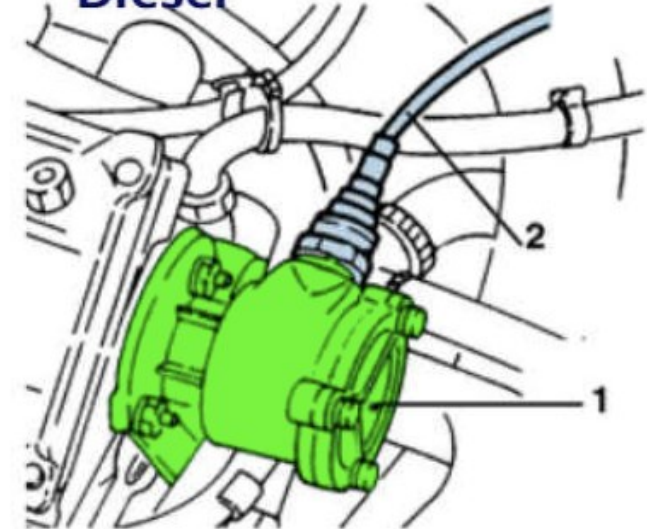
2. Sede puntale;
8. Canale di collegamento camere.

Braking system: auxiliary devices

Alimentazione benzina

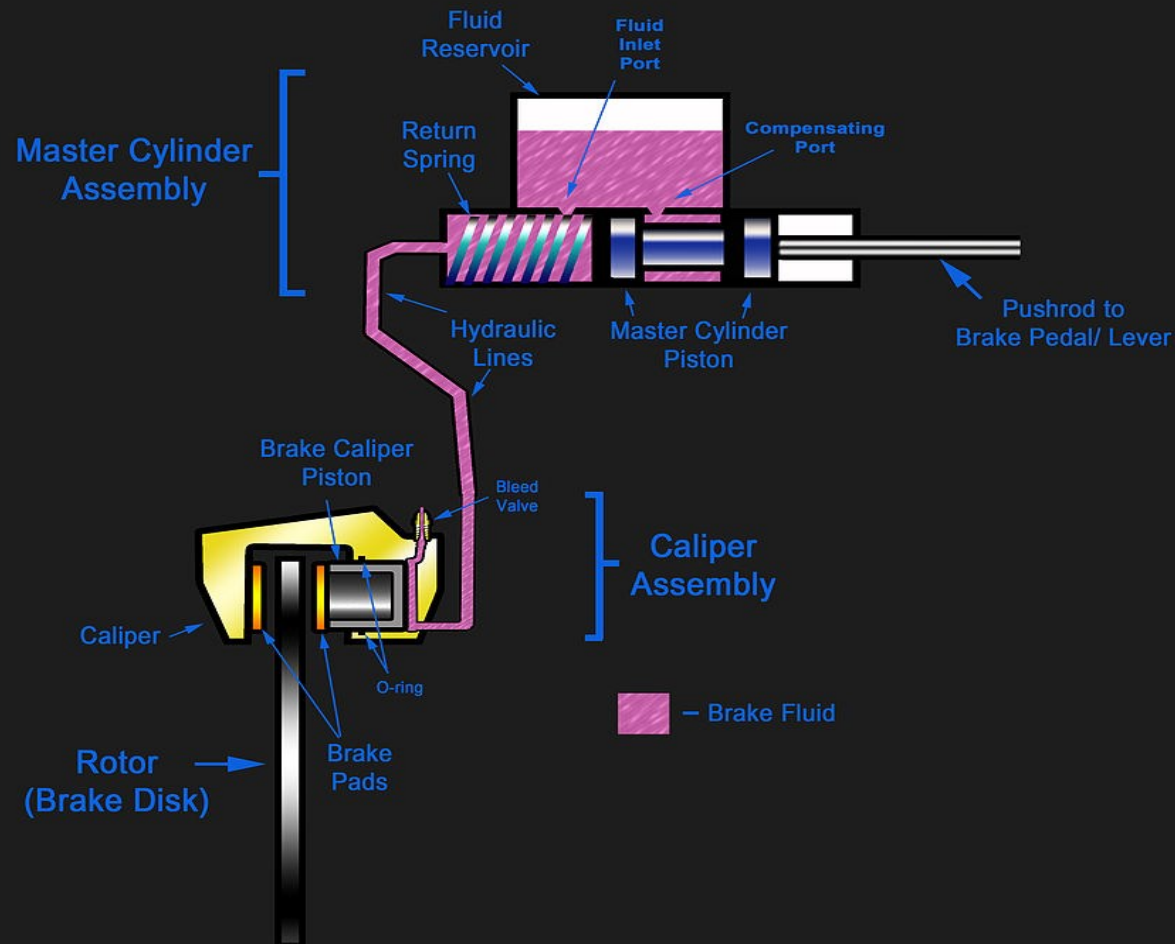


Alimentazione Diesel



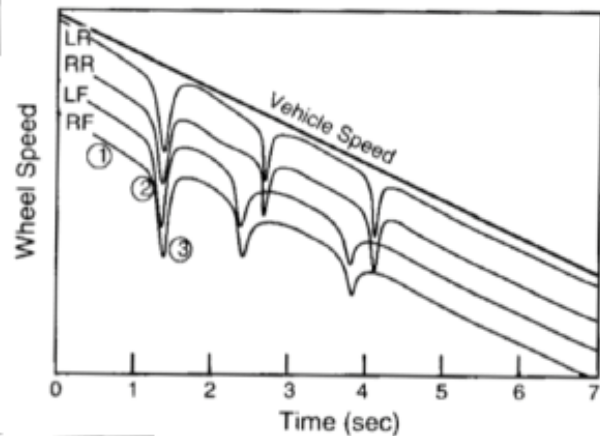
1. Depressore;
2. Tubo di depressione

Braking system: auxiliary devices

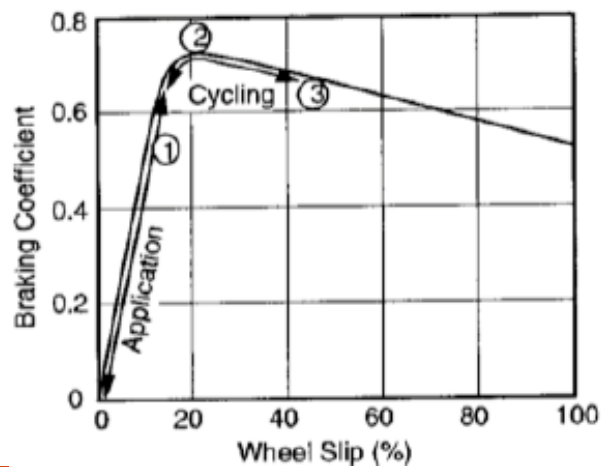


Braking system: ABS control logics

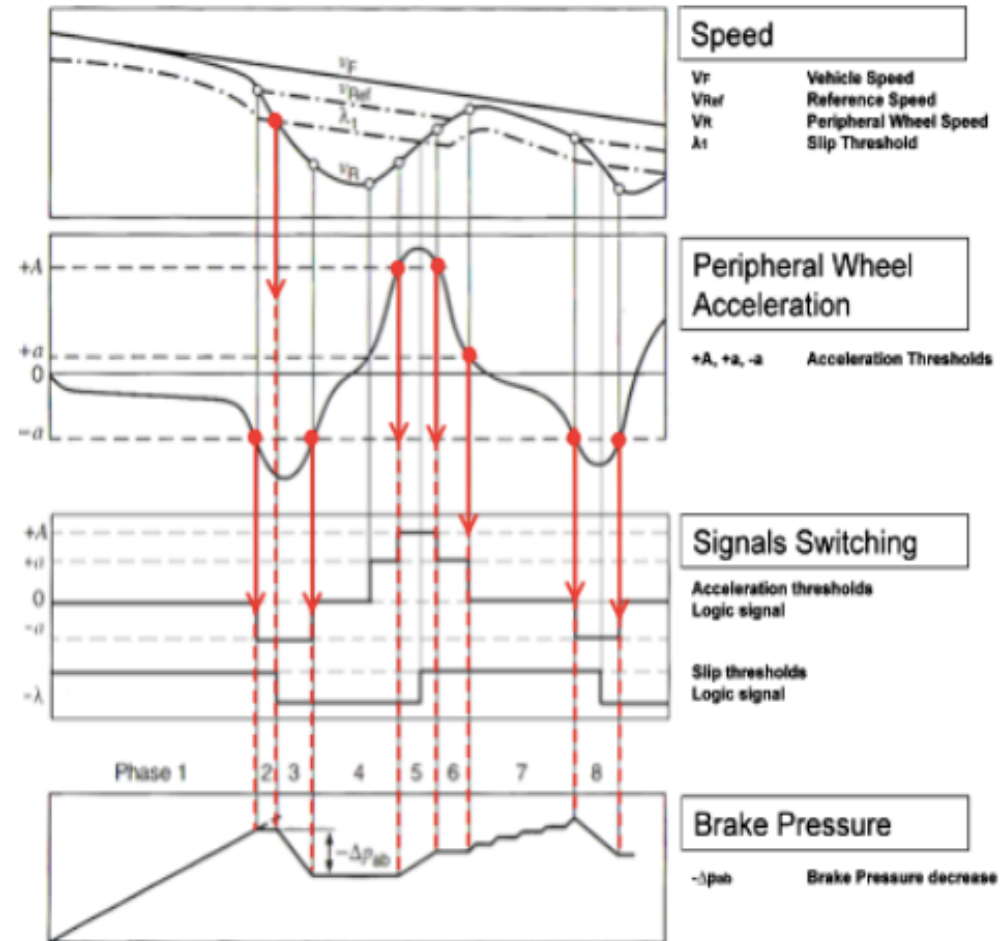
Velocità periferica della ruota nel tempo



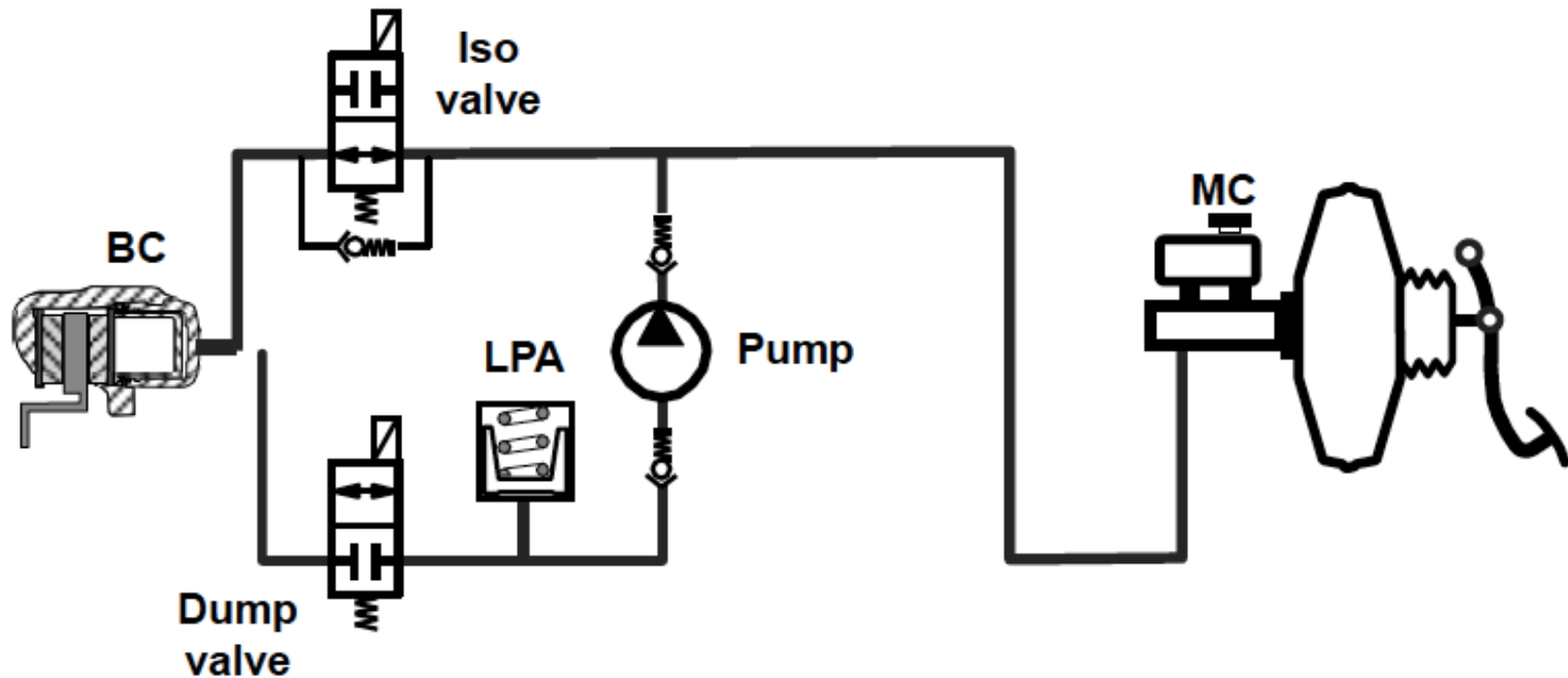
Zona di lavoro del freno



Logica di controllo

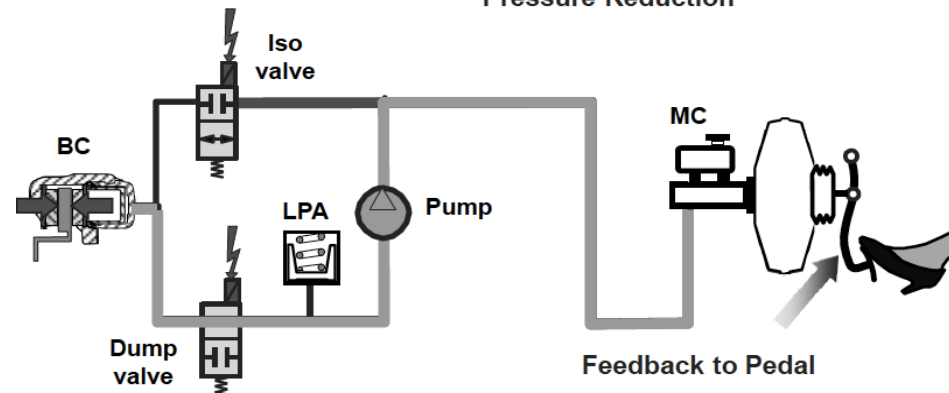
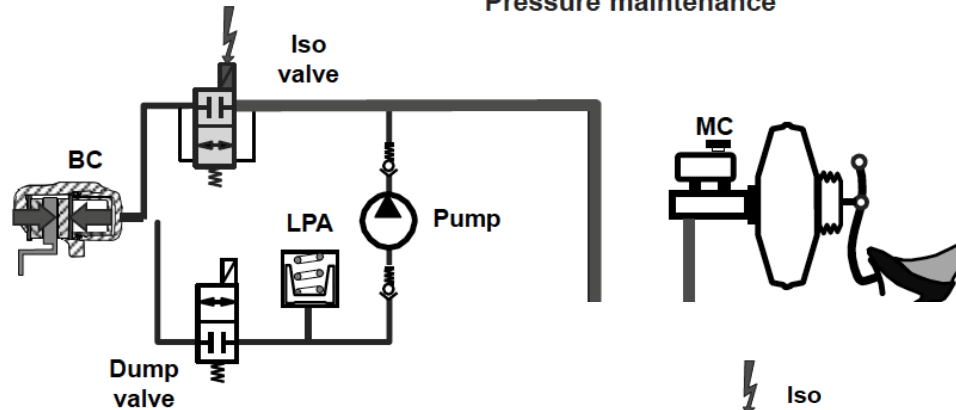
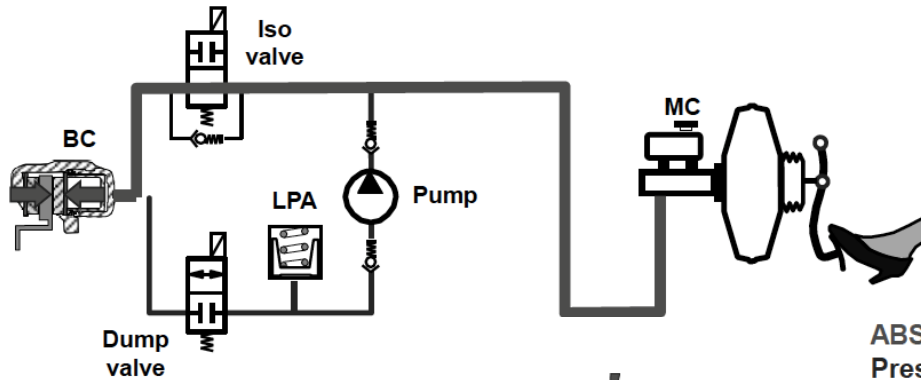


Braking system: ABS hydraulic circuit

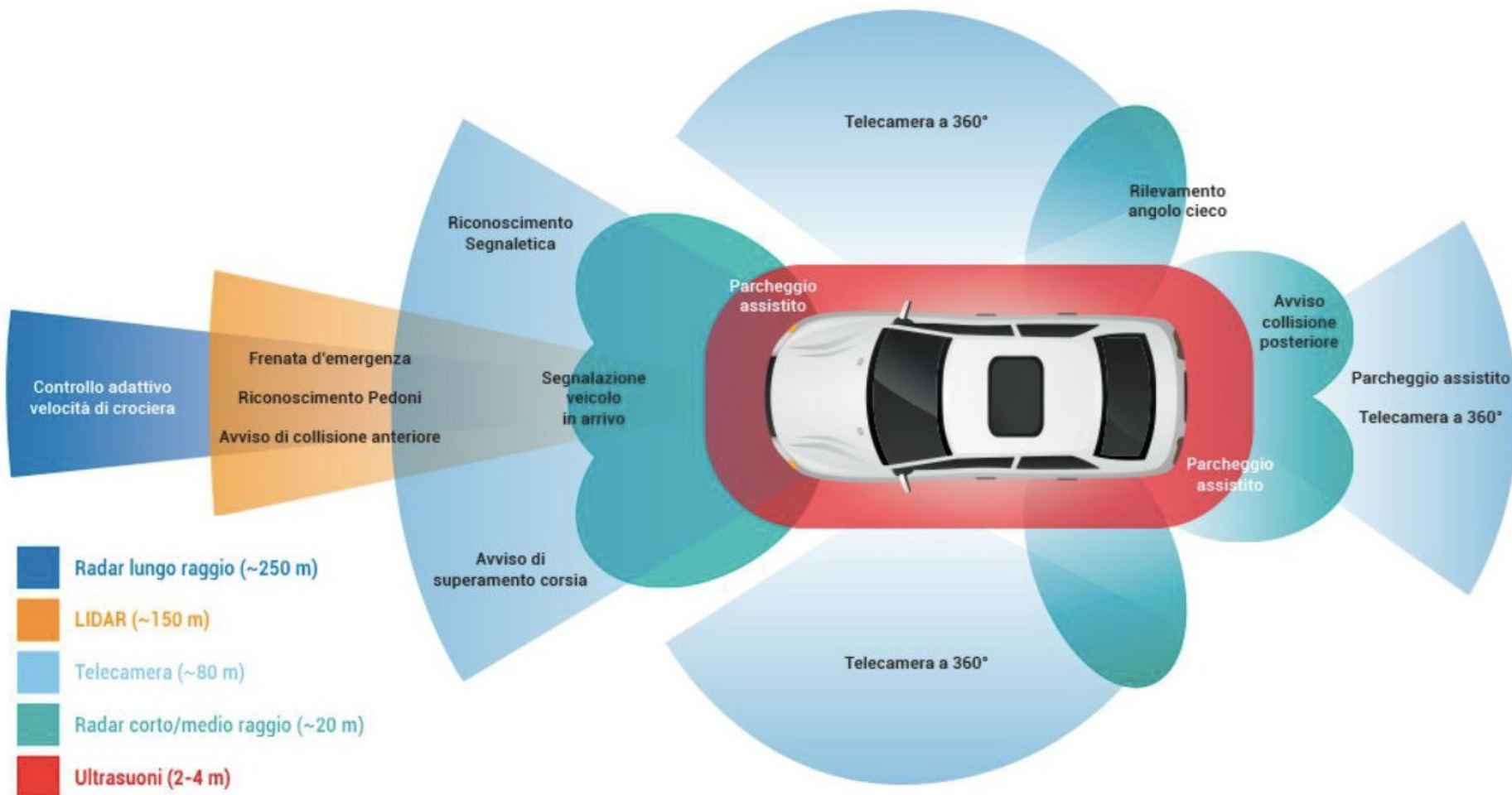


Braking system: ABS hydraulic circuit













Emergency Braking Action



Active safety systems by ADAS



The 5 levels of Autonomous Driving

	L0 No Automation	L1 Driver Assistance	L2 Partial Automation	L3 Conditional Automation	L4 High Automation	L5 Full Automation
DRIVER	 <p>In charge of all the driving</p>	 <p>Must do all the driving, but with some basic help in some situations</p>	 <p>Must stay fully alert even when vehicle assumes some basic driving tasks</p>	 <p>Must be always ready to take over within a specified period of time when the self-driving systems are unable to continue</p>	 <p>Can be a passenger who, with notice, can take over driving when the self-driving systems are unable to continue</p>	 <p>No human driver required—steering wheel optional—everyone can be a passenger in an L5 vehicle</p>
VEHICLE	<p>Responds only to inputs from the driver, but can provide warnings about the environment</p> 	<p>Can provide basic help, such as automatic emergency braking or lane keep support</p> 	<p>Can automatically steer, accelerate, and brake in limited situations</p> 	<p>Can take full control over steering, acceleration, and braking under certain conditions</p> 	<p>Can assume all driving tasks under nearly all conditions without any driver attention</p> 	<p>In charge of all the driving and can operate in all environments without need for human intervention</p> 

L1: Guida
assistita

L2: Guida
semi-autonoma

L3: Guida
automatizzata

L4: Guida
altamente
automatizzata

L5: Guida
autonoma