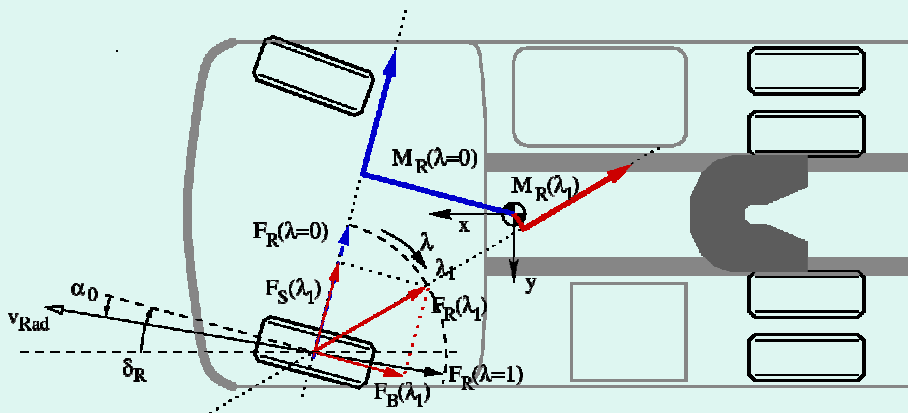


Vehicle Stability Function

- Directional Control
- Roll-over Control



A functional overview
with regard to
commercial vehicles

Vehicle Stability Function – functional overview

Definitions *

- **Vehicle Stability Function**

an electronic control function for a vehicle which improves the dynamic stability of the vehicle.

- **Directional Control**

a function within a vehicle stability function that assists the driver, in the event of under steer and over steer conditions, within the physical limits of the vehicle in maintaining the direction intended by the driver in the case of a power-driven vehicle, and assists in maintaining the direction of the trailer with that of the towing vehicle in the case of a trailer.

- **Roll-over Control**

a function within a vehicle stability function that reacts to an impending roll-over in order to stabilise the power-driven vehicle or towing vehicle and trailer combination or the trailer during dynamic manoeuvres within the physical limits of the vehicle.

* UN ECE Regulation 13 paragraph 2.34.

Vehicle Stability Function – functional overview

Conditions influencing functionality

- High unladen/laden ratio (7,5 tons to >40 tons)
- Complex physics due to additional degrees of freedom (tractor/semi-trailer combinations)
- High/variable center of gravity
- Huge number of vehicle variants (geometry, axles, suspension, engines, cabs etc.)
- Large number of different vehicle combinations and payloads (unknown trailers, load etc.)
- High demands concerning driver acceptance (professional drivers and priority placed on traction)



Vehicle Stability Function – functional overview

Over-steering – directional control stabilizing interventions

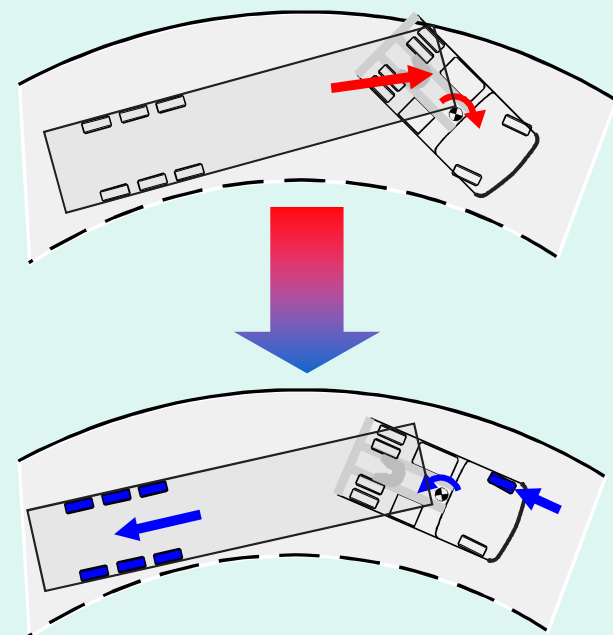
Over-steering

- Loss of lateral control at motor vehicle rear axle
- Danger of jack-knifing for tractor/semi-trailer combinations

Directional control intervention

- Braking of outside front wheel
- Reduction of engine torque
- Braking of trailer (stretch braking)

=> Vehicle stability maintained



Vehicle Stability Function – functional overview

Under-steering – directional control stabilizing interventions

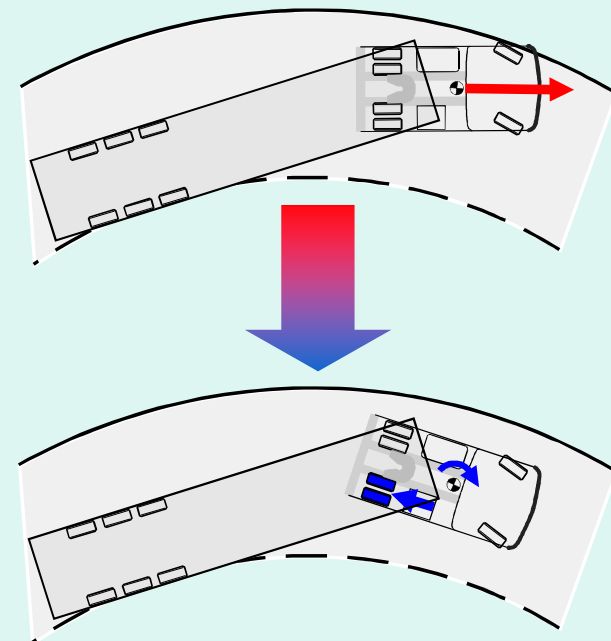
Under-steering

- Loss of lateral control at motor vehicle front axle
- Danger of running off the road

Directional control intervention

- Braking of inside rear wheel
- Reduction of engine torque

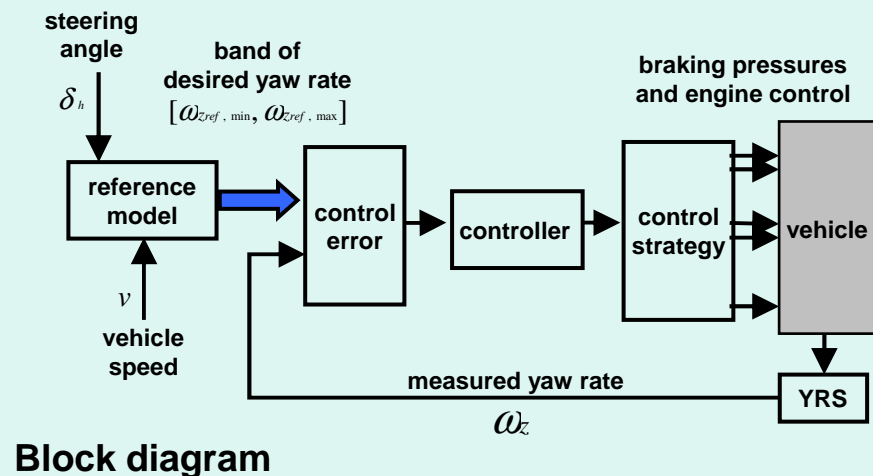
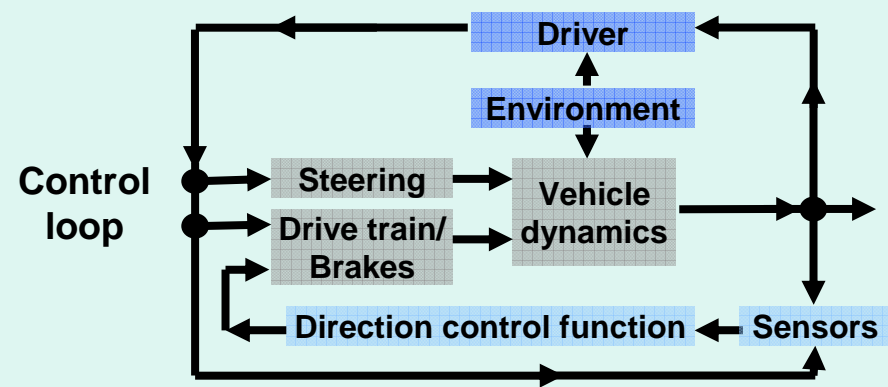
=> Vehicle stability maintained



Vehicle Stability Function – functional overview

Directional control process

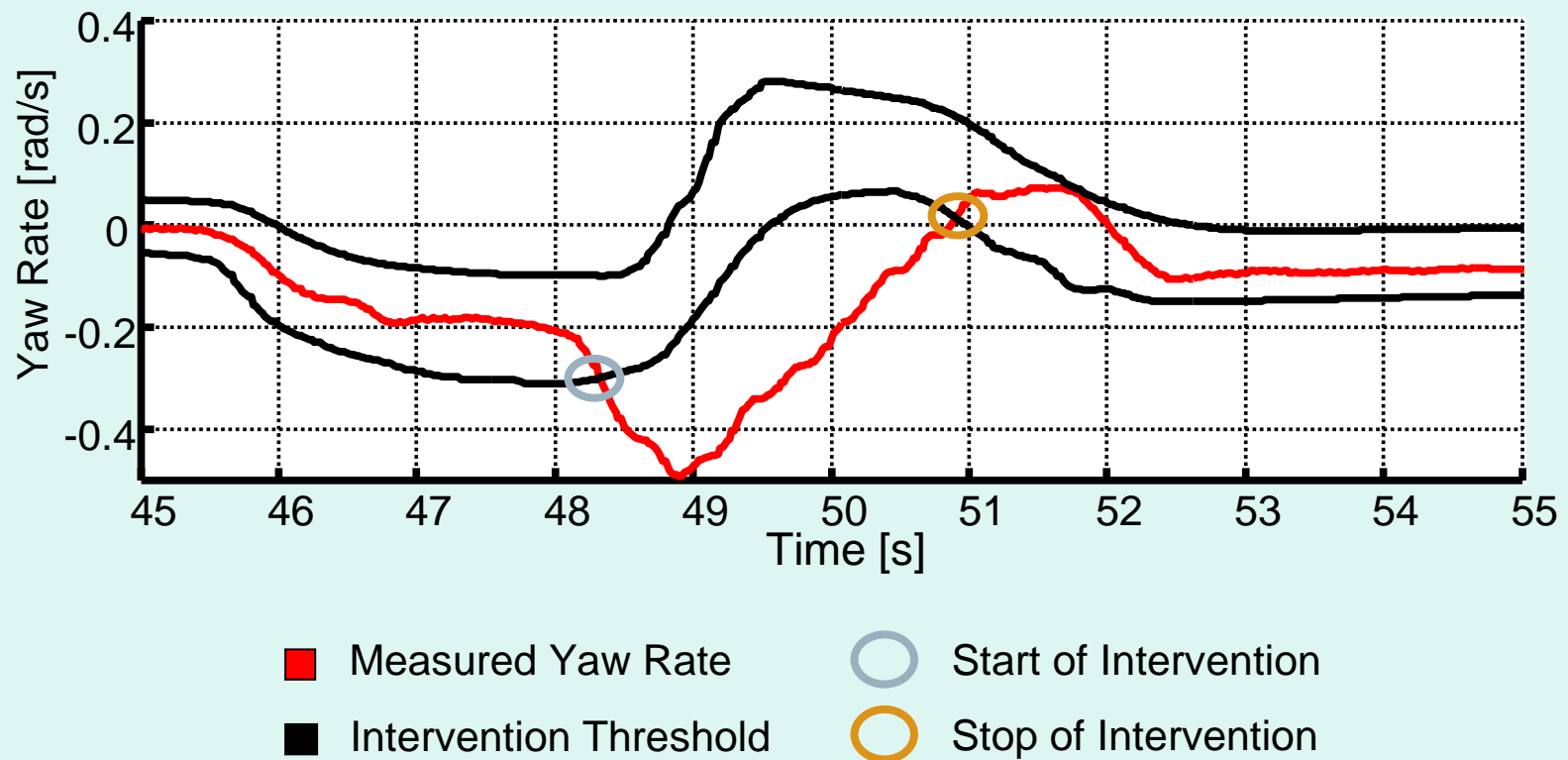
- Control algorithm adapted to actual vehicle configuration and wheelbase through end-of-line programming - intervention threshold adapted
- Driver selected direction of travel – steering wheel angle sensor
- Actual direction of travel – yaw rate sensor
- Vehicle speed – ABS wheel speed sensors
- Appropriate application of brakes and engine torque reduction when actual yaw rate crosses the intervention threshold



Block diagram

Vehicle Stability Function – functional overview

Directional control process



Vehicle Stability Function – functional overview

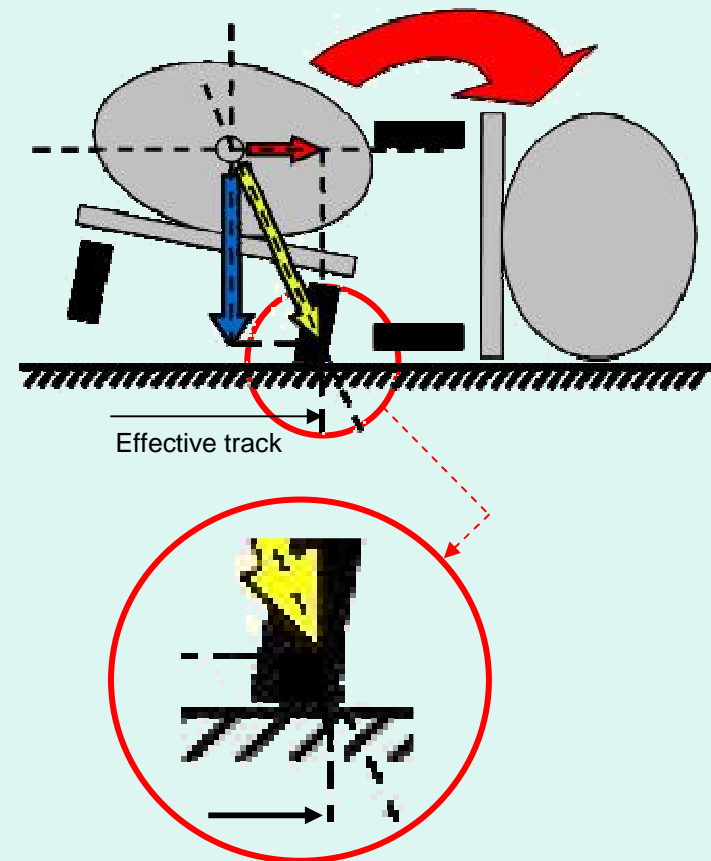
Roll-over control stabilizing interventions

Rolling-over

- The force resulting from the vehicle weight and its centrifugal force at the centre of gravity, acting outside the effective track causes the vehicle to roll-over

Roll-over control intervention

- Once the lateral acceleration of the vehicle exceeds the intervention threshold, the vehicle speed is reduced by automatically applying the brakes and reducing the engine power
- If wheel 'lift off' is detected maximum vehicle speed reduction is requested



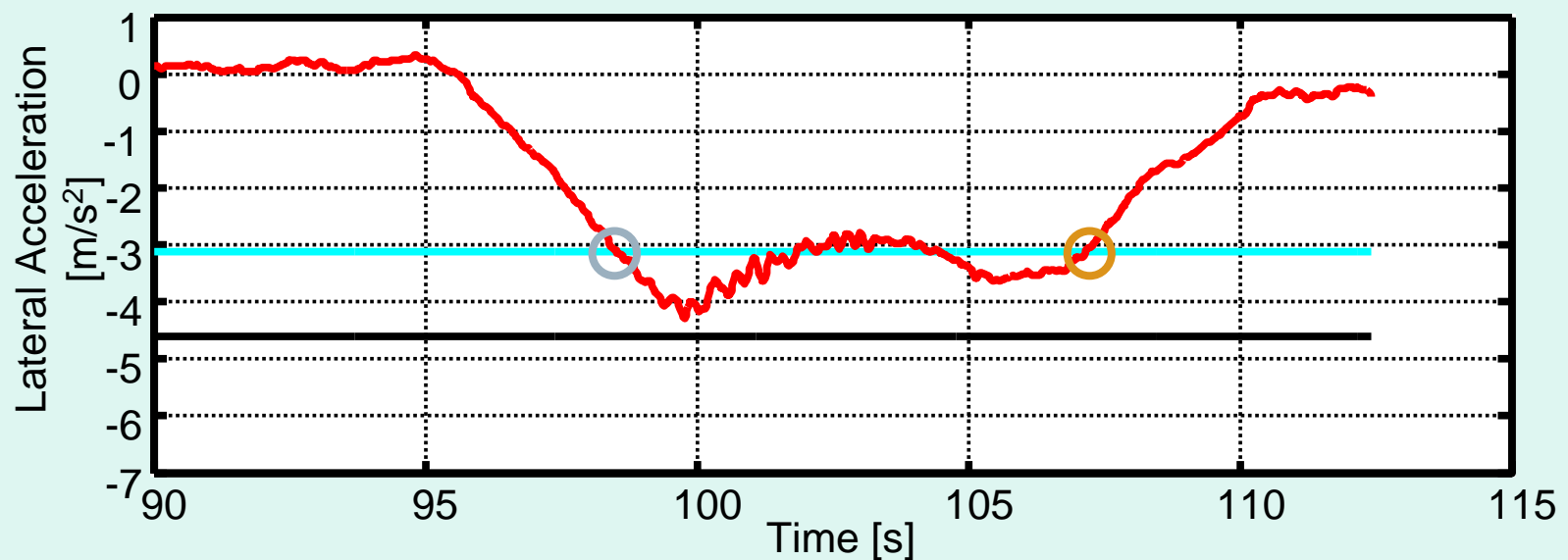
Vehicle Stability Function – functional overview

Roll-over control process

- Control algorithm based on lateral acceleration with intervention threshold derived from vehicle type, loading condition, fast/slow steering, travelling uphill/downhill, demanded engine torque by driver, taking into account e.g. frame stiffness, suspension, tires and driver acceptance considerations
- Control algorithm adapted to actual vehicle configuration through end-of-line programming - intervention threshold adapted
- Control algorithm adapts intervention threshold to actual loading condition of vehicle (centre of gravity height) – vehicle mass estimated from engine torque (engine management system information modified to account for drive-line losses) and vehicle acceleration (driver demand and wheel speed information)
- Appropriate application of brakes and engine torque reduction when actual lateral acceleration exceeds the intervention threshold

Vehicle Stability Function – functional overview

Roll-over control process



- Measured Lateral Acceleration
- Intervention Threshold
- Roll-over Threshold
- Start of Intervention
- Stop of Intervention

Vehicle Stability Function – functional overview

Towing vehicle and trailer combinations - trailer

- Motor vehicle establishes if a trailer is connected using the trailer electrical demand via the electrical connectors between motor vehicle and trailer
 - 24N (ISO 1185) – stop lights
 - 5 pin ISO 7638 – ABS power and warning light
 - 7 pin ISO 7638 – CAN communication between trailer and motor vehicle braking ECU
- Only stop light demand indicates a non ABS equipped trailer – typically no demand for trailer braking with unladen trailer, pulsed braking with laden trailer
- ABS equipped trailer – no/low trailer braking demand with unladen trailer, trailer braking demand as determined appropriate by motor vehicle for part/fully laden trailer
- CAN communication enables the motor vehicle to evaluate the trailer and request appropriate trailer braking. In the case of a self generated braking demand, e.g. trailer roll-over control, and motor vehicle requested trailer braking, the highest value is implemented

Vehicle Stability Function – functional overview

Typical hardware – electronic braking system (EBS) (2 axle motor vehicle)

