Submitted by the experts of OICA and CLEPA

Informal Document: ACSF-10-08

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ESF Definition

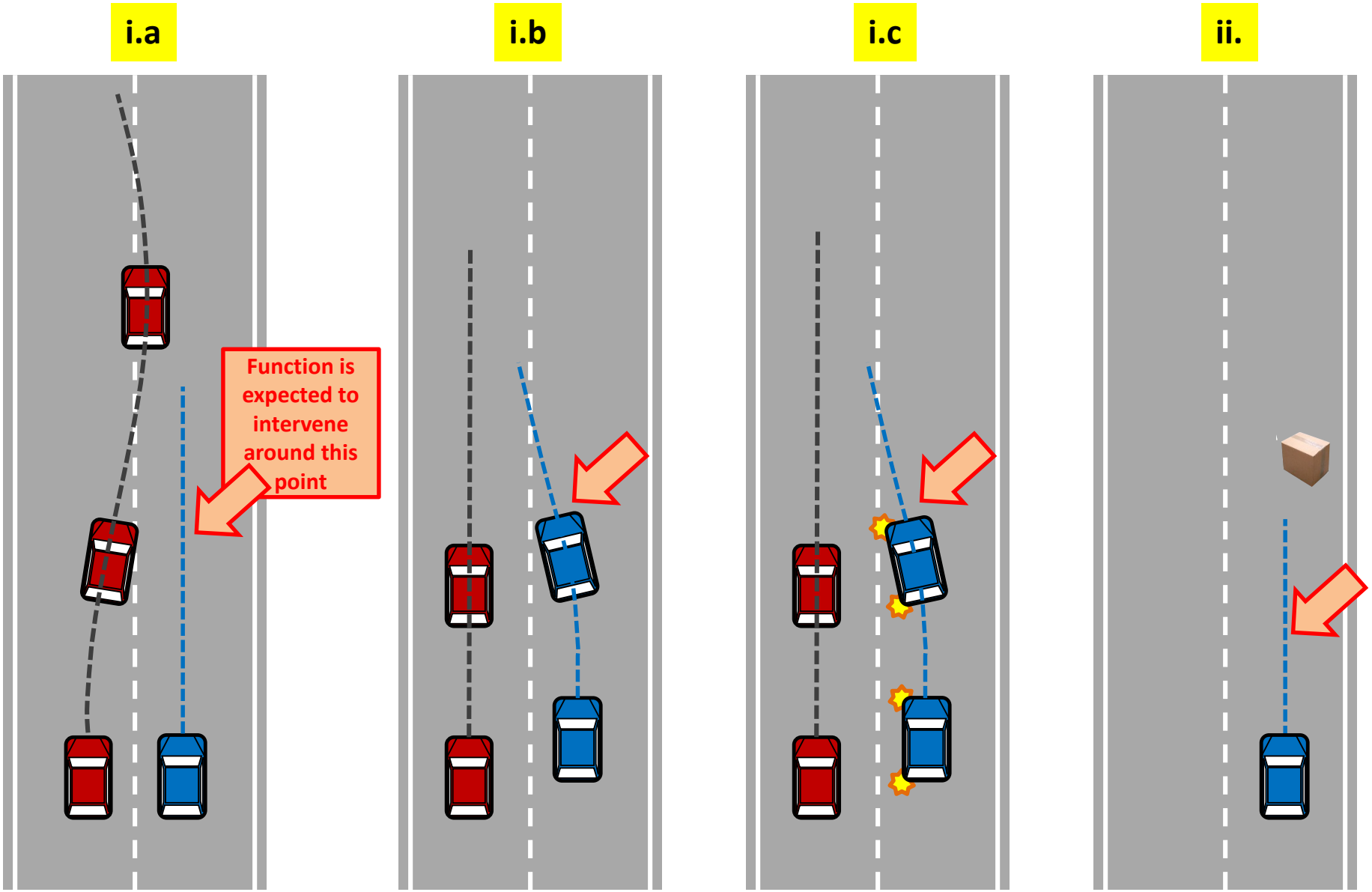
2.3.4.3 “Emergency Steering Function (ESF)" means a control function within an electronic control system whereby, for a limited duration, changes to the steering angle of one or more wheels may result from the automatic evaluation of signals initiated on-board the vehicle, in order to assist the driver in avoiding [or mitigating] a collision with:

i. another vehicle driving in an adjacent lane,
   a. drifting towards the path of the subject vehicle and/or,
   b. into which path the subject vehicle is drifting and/or,
   c. into which lane the driver initiates a lane change manoeuver.

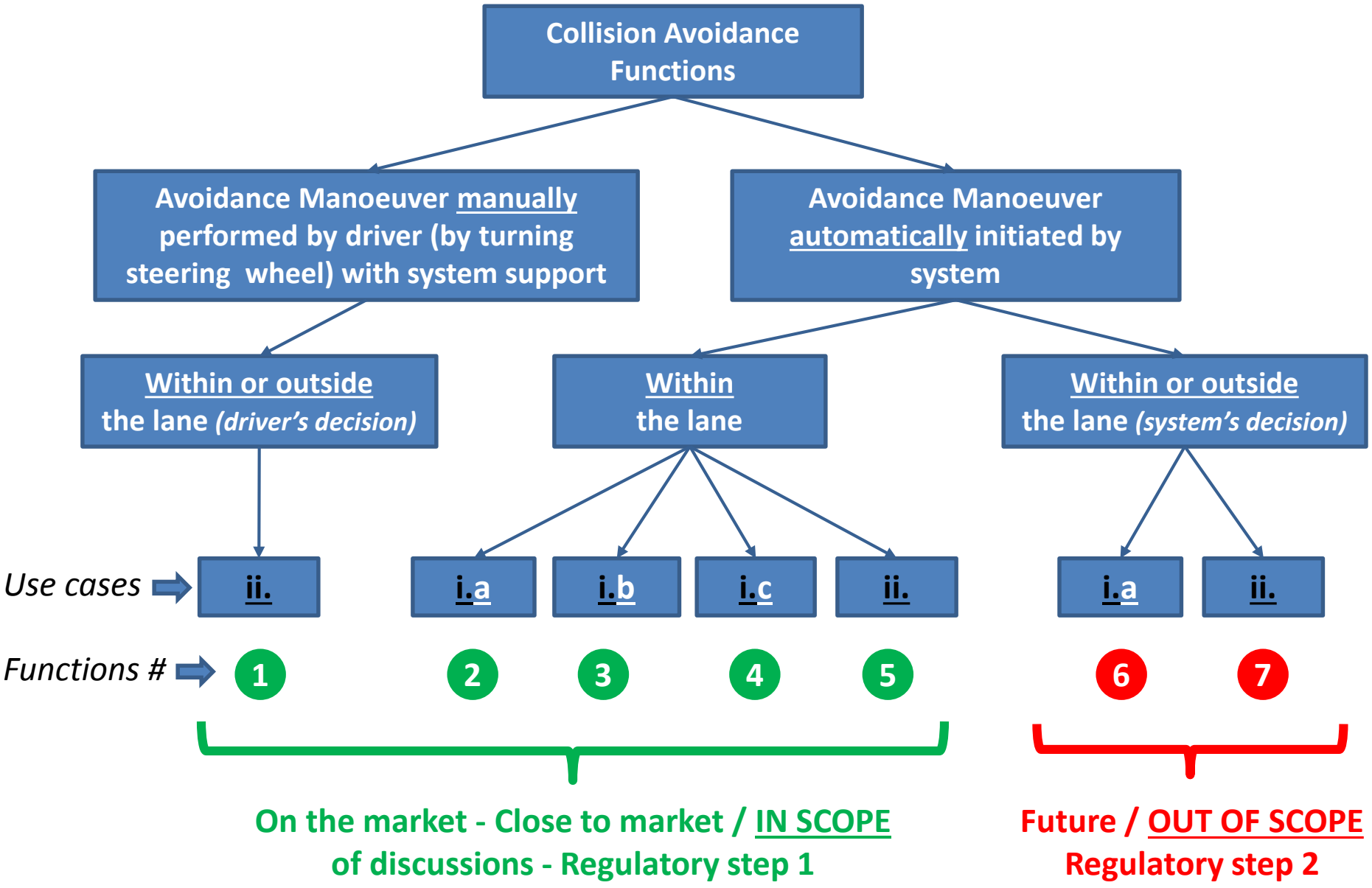
ii. an obstacle obstructing the path of the subject vehicle or when the obstruction of the subject vehicle’s path is deemed imminent.

ESF shall cover one or several use cases from the list above.

Use Cases


i.a
i.b
i.c
ii.
Function is expected to intervene around this point

Taxonomy of collision avoidance functions

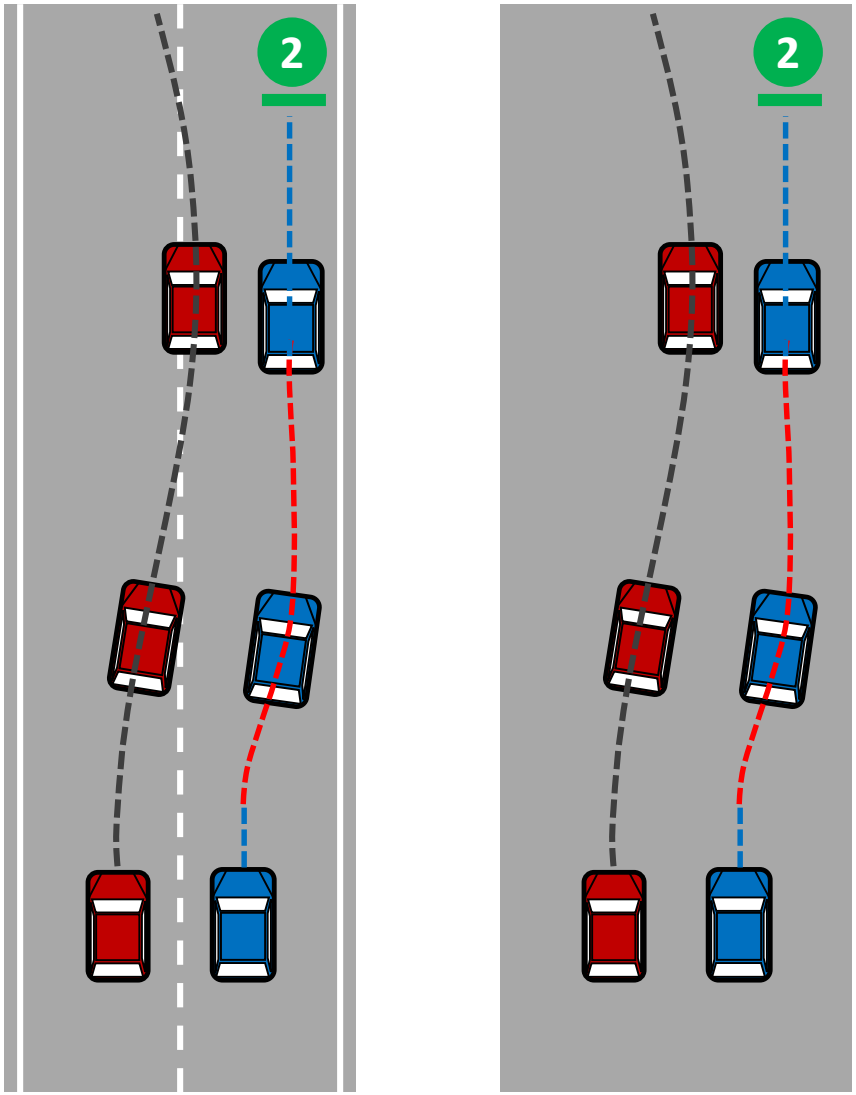


Use Case i.a

"Another vehicle drifts towards the subject vehicle"

Function type

1 **2** 3 4 5 **6** 7



Description:

- The function automatically intervenes by steering when detecting another vehicle is drifting towards its path.

- **Function 2 :**
  - **On the market**
  - Avoidance within the lane.
  - Forward and side looking sensors.
  - Detection of lane marking / boundaries.
  - The system is able to work on a road without lane marking (provided road boundaries are detected).
  - Warning during intervention
  - Blind spot detection may separately provide a warning prior ESF intervention

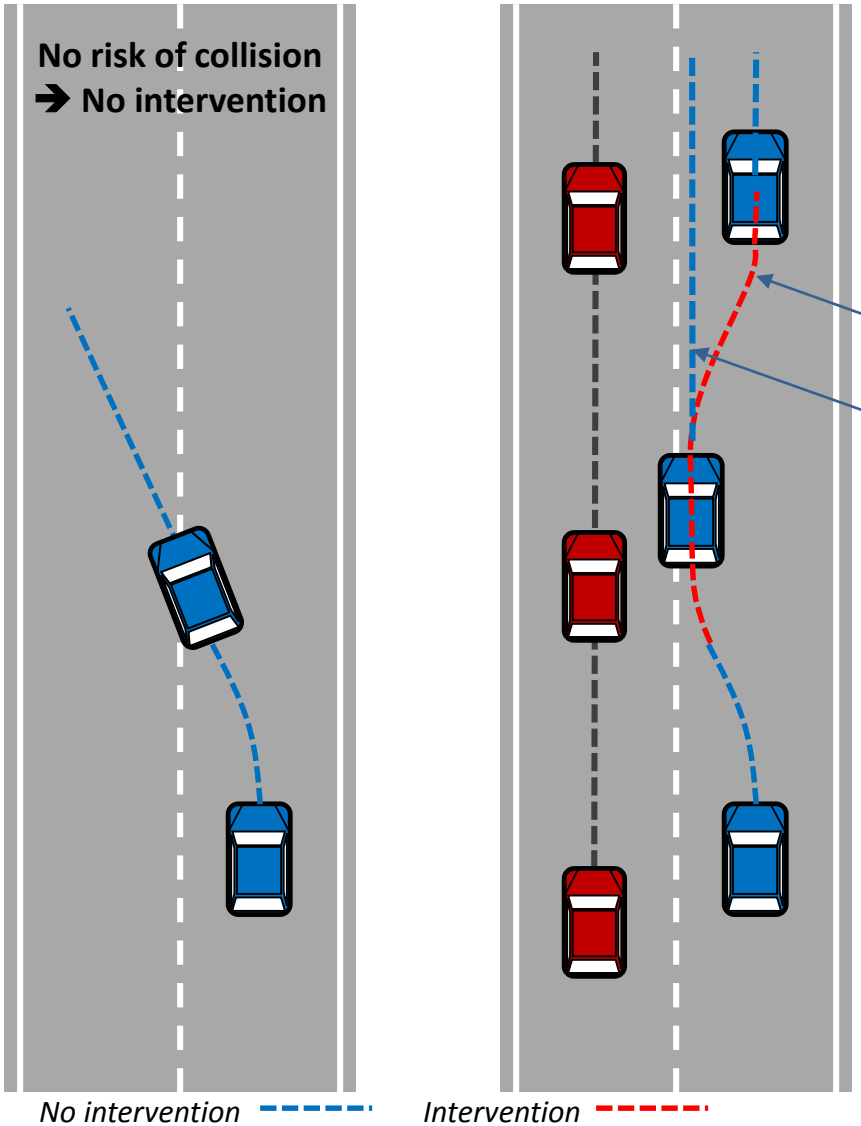
- **Function 6 :**
  - **Future evolution**
  - Function able to cross lane markings.

Use Case i.b

"The subject vehicle drifts towards the adjacent lane"

Function type

1 2 **3** 4 5 6 7



Description:

- **On the market**
- The function automatically intervenes by steering when detecting:
  - a vehicle in the blind spot or
  - an oncoming vehicle at higher speed.
- The manoeuver ends:
  - after the subject vehicle is back in the "center" of the original lane, or
  - after "stopping the drift",

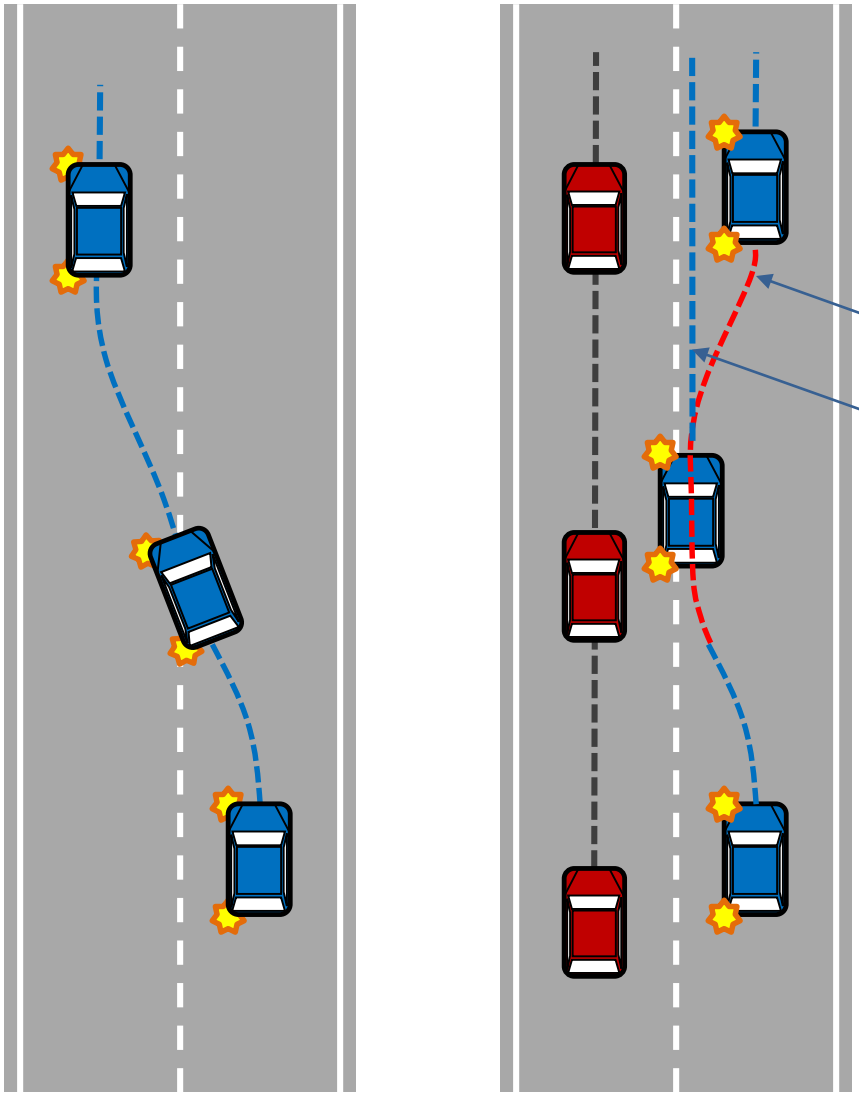
  as specified by VM
- Avoidance within the lane.
- Forward and side looking sensors.
- Detection of lane marking / boundaries.
- The system is able to work on a road without lane marking (provided road boundaries are detected).
- Warning during intervention
- Blind spot detection may separately provide a warning prior ESF intervention

Use Case i.c

"The driver of the subject vehicle performs a lane change"

Function type

1 2 3 **4** 5 6 7



Description:

- **On the market**
- The function automatically intervenes by steering when detecting:
  - a vehicle in the blind spot or
  - an oncoming vehicle at higher speed.
- The manoeuver ends:
  - after the subject vehicle is back in the "center" of the original lane, or
  - after aborting the LC
- Avoidance within the lane.
- Forward and side looking sensors.
- Detection of lane marking / boundaries.
- The system is able to work on a road without lane marking (provided road boundaries are detected).
- Warning during intervention
- Blind spot detection may separately provide a warning prior ESF intervention

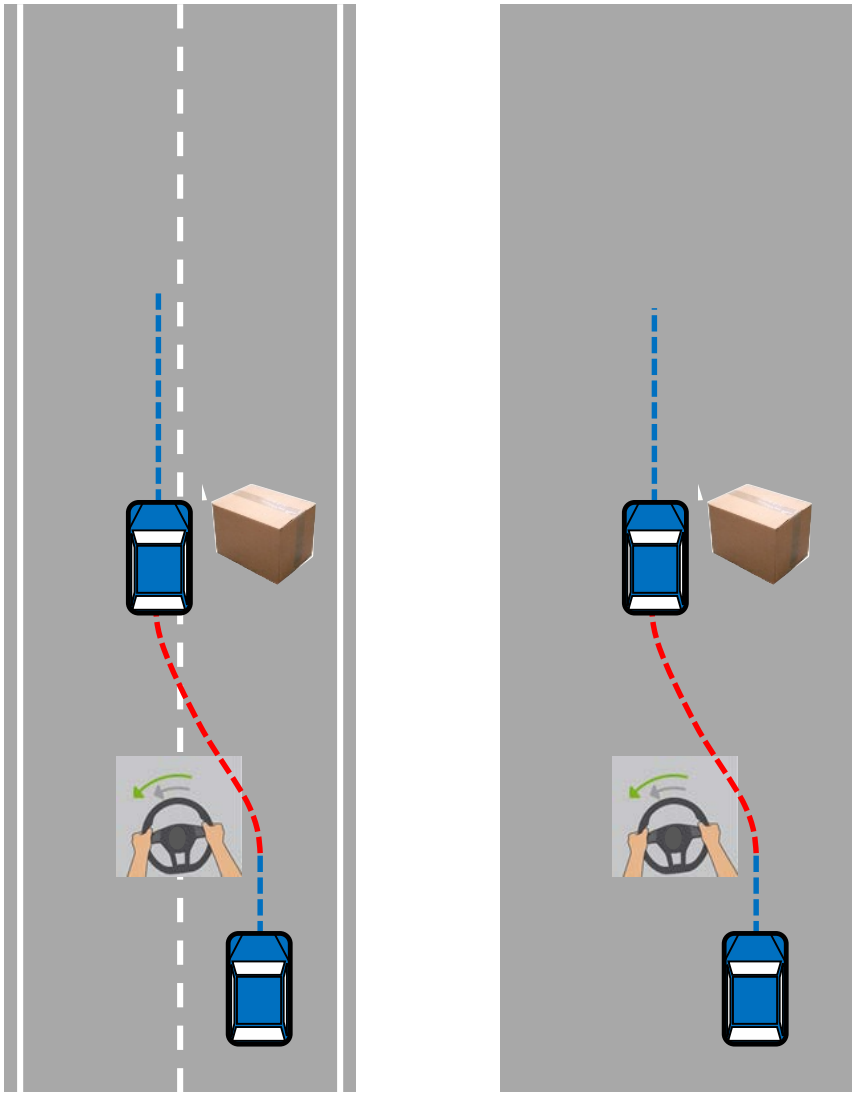
Use Case ii.

"An obstacle obstructs the path"

"Obstruction of the path is imminent"

Function type

1 2 3 4 5 6 7



No intervention *Intervention*

Description:

- **On the market.**
- The driver performs the evasive manoeuver
- The system assists the driver to avoid collision
- The driver decides to cross the lane marking, not the system
- Lane markings not required
- Only forward looking sensors needed
- The system does not check side or rear traffic

more details on next slide

Use Case ii.

"An obstacle obstructs the path"

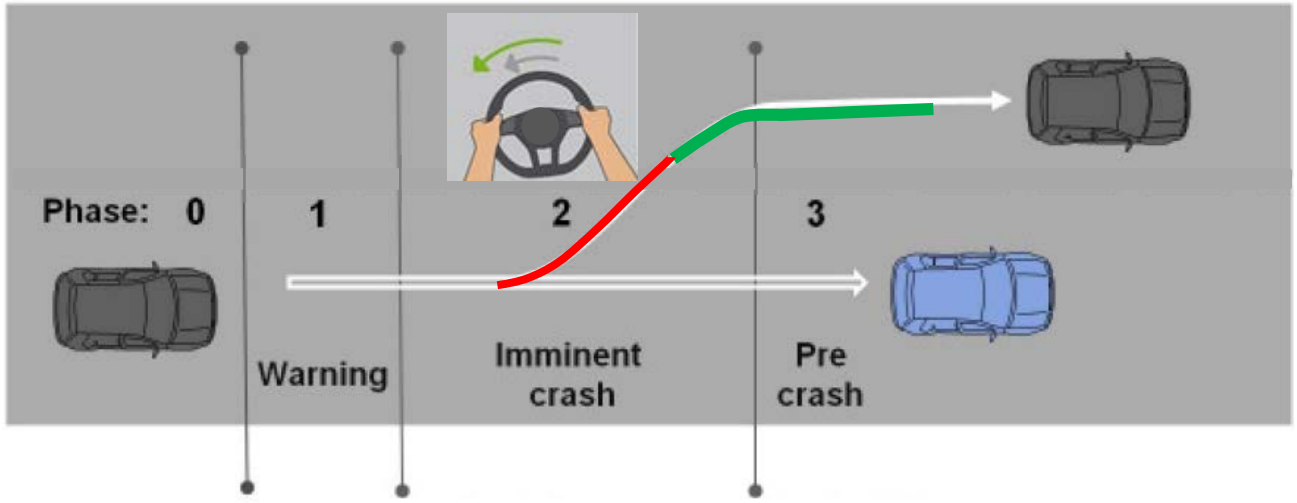
"Obstruction of the path is imminent"

Function type

1 2 3 4 5 6 7

Description:

- When the driver performs an evasive manoeuvre **(red path)** by turning the steering wheel, the system provides assistance by adding precisely calculated steering torque (i.e. amplifying driver's torque) to support the movement of the steering wheel and avoid the collision. Given the added torque is limited and the driver is hands-on, the driver is free to follow the *steering recommendation given by the system* or to override the system recommendation.
- If the driver does not perform any evasive manoeuver, the function does not intervene.
- If the driver performs a second steering actuation to the right **(green path)**, the system will assist the same way as during the red actuation, to follow the intended path.
- If the driver does not performs a second steering actuation to the right, the system may provide a steering recommendation to the right, which again the driver is free to follow or not. This is very similar to what a CSF function of type (c) is doing to prevent lane departure.



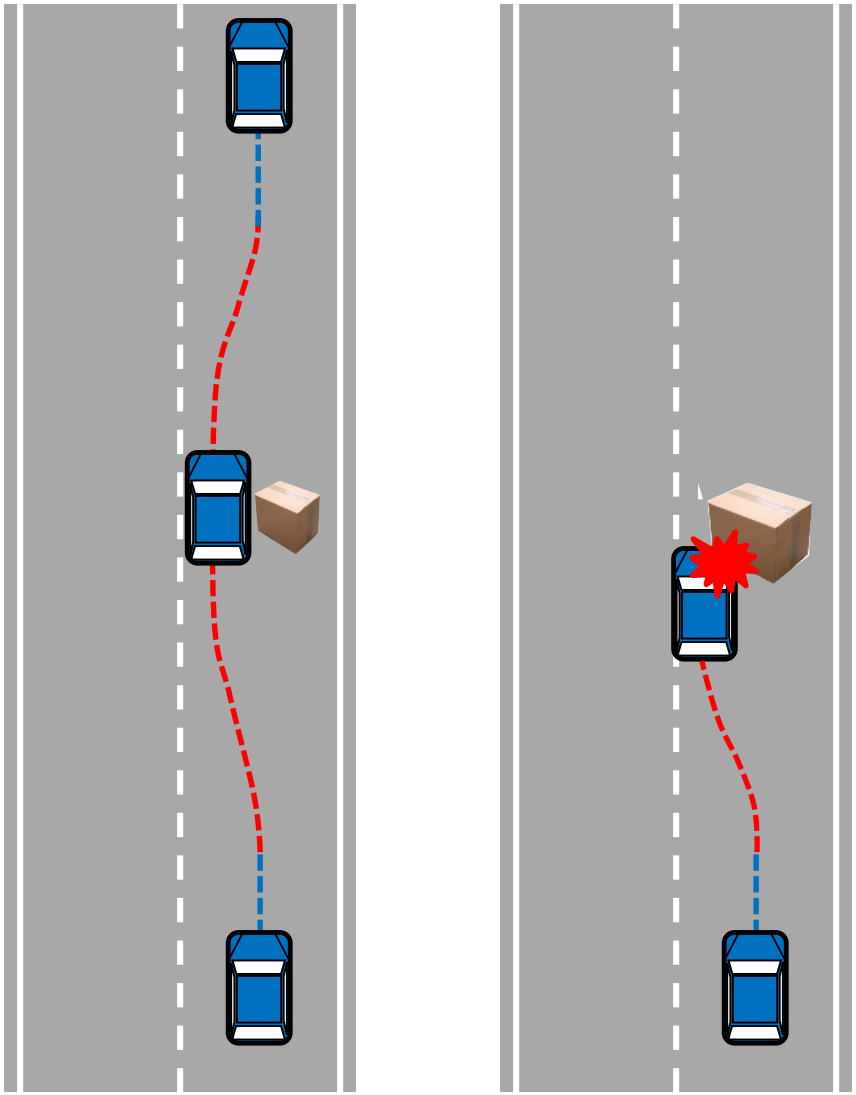
Use Case ii.

"An obstacle obstructs the path"

"Obstruction of the path is imminent"

Function type

1 2 3 4 **5** 6 7



Description:

- **On the market / close to market.**
- The system performs automatic avoidance within the lane
- Only forward looking sensors required
- The system does not check side or rear traffic

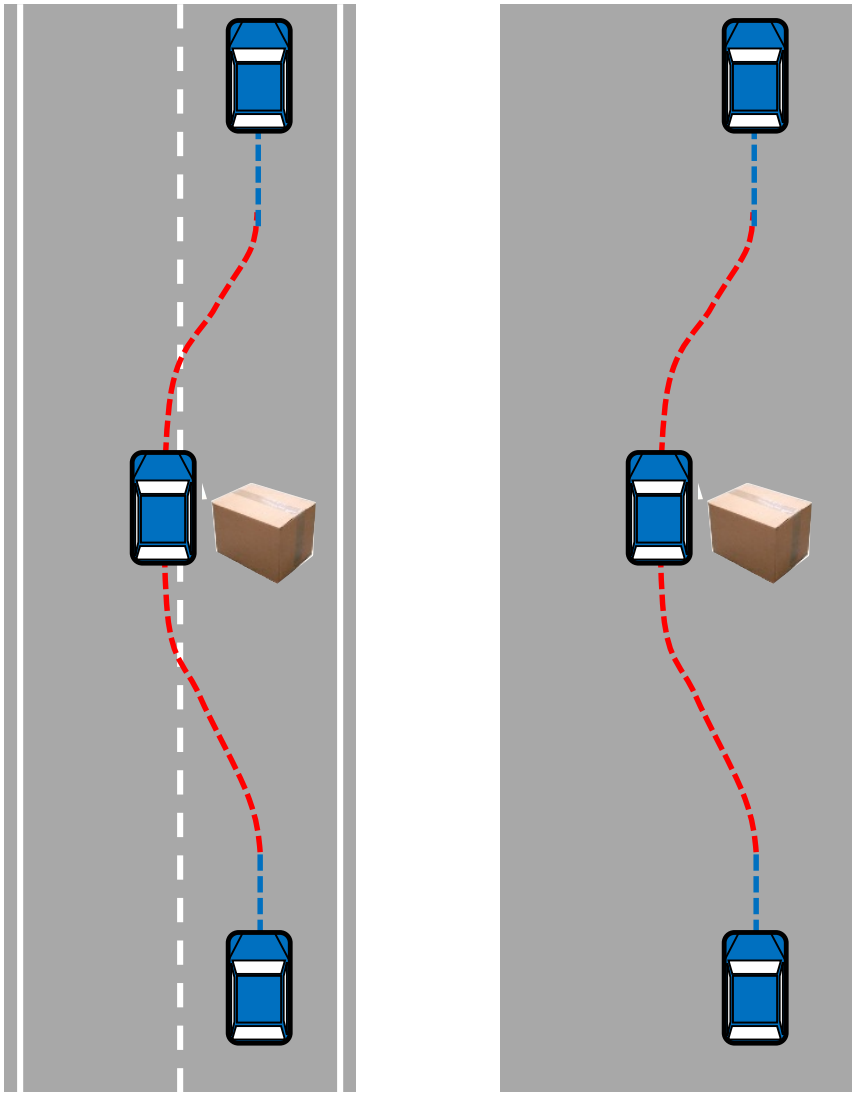
Use Case ii.

"An obstacle obstructs the path"

"Obstruction of the path is imminent"

Function type

1 2 3 4 5 6 **7**



No intervention *Intervention*

Description:

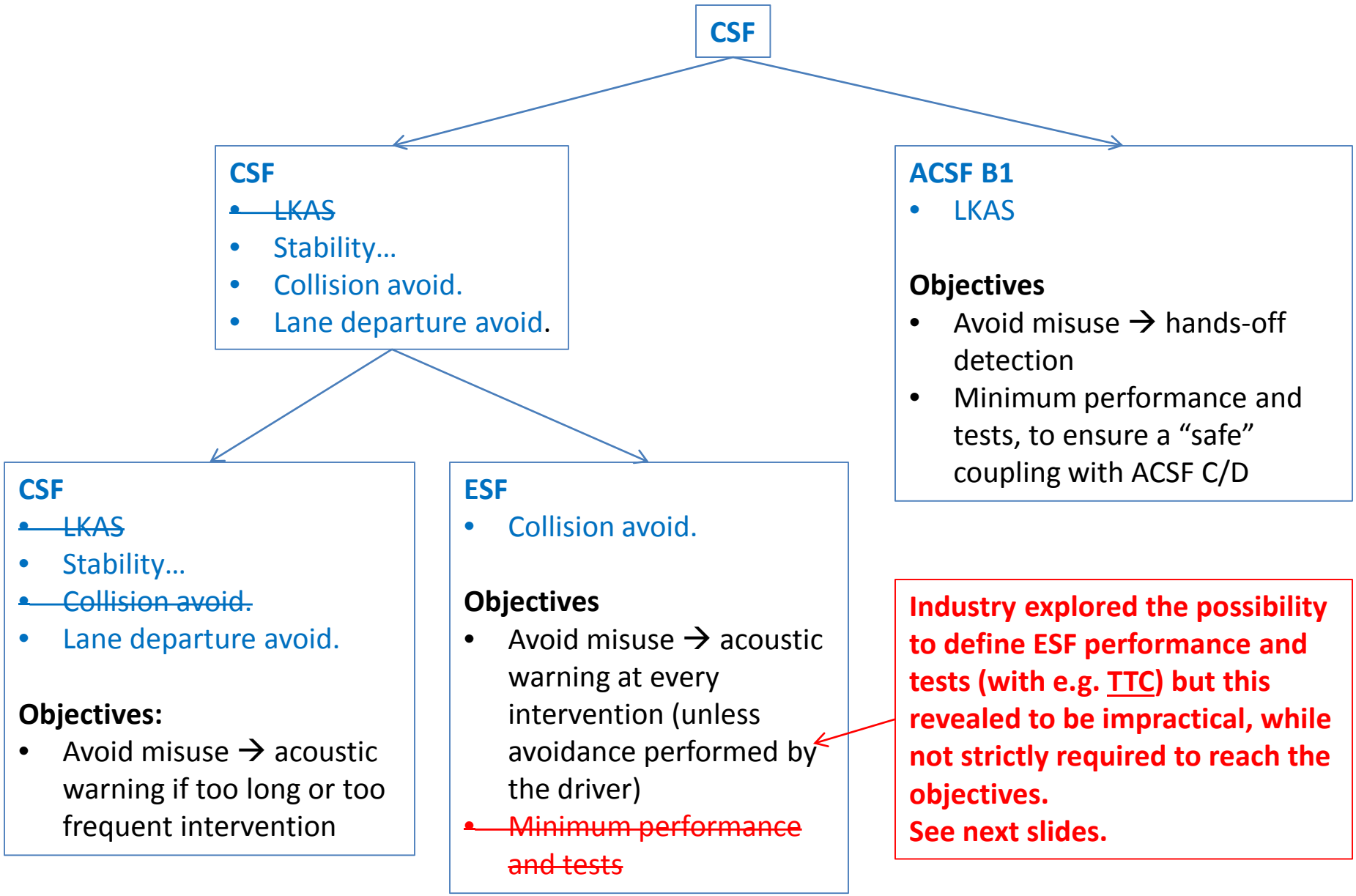
- **Future evolution, out of scope**
- Lane markings not required
- Forward, side and rearward looking sensors required.
- The system checks if there is enough space to perform the avoidance manoeuver

ESF Tests

- Since Osaka ACSF-09 meeting, industry explored the possibility to define performance and tests for ESF.
- This approach led us to a dead-end, and revealed the definition of performance and tests are not required to achieve the main objective, which is to avoid misusing ESF as a B1 system.
- Industry proposal is to follow the same approach as for CSF (while making it more stringent):
  - Acoustic and optical warning at every avoidance manoeuver automatically initiated by system
  - Acoustic and/or optical warning when avoidance manoeuver manually performed by driver
  - Describes the conditions for collision risk detection and demonstrates them
  - 50N max overriding test (to be tested)

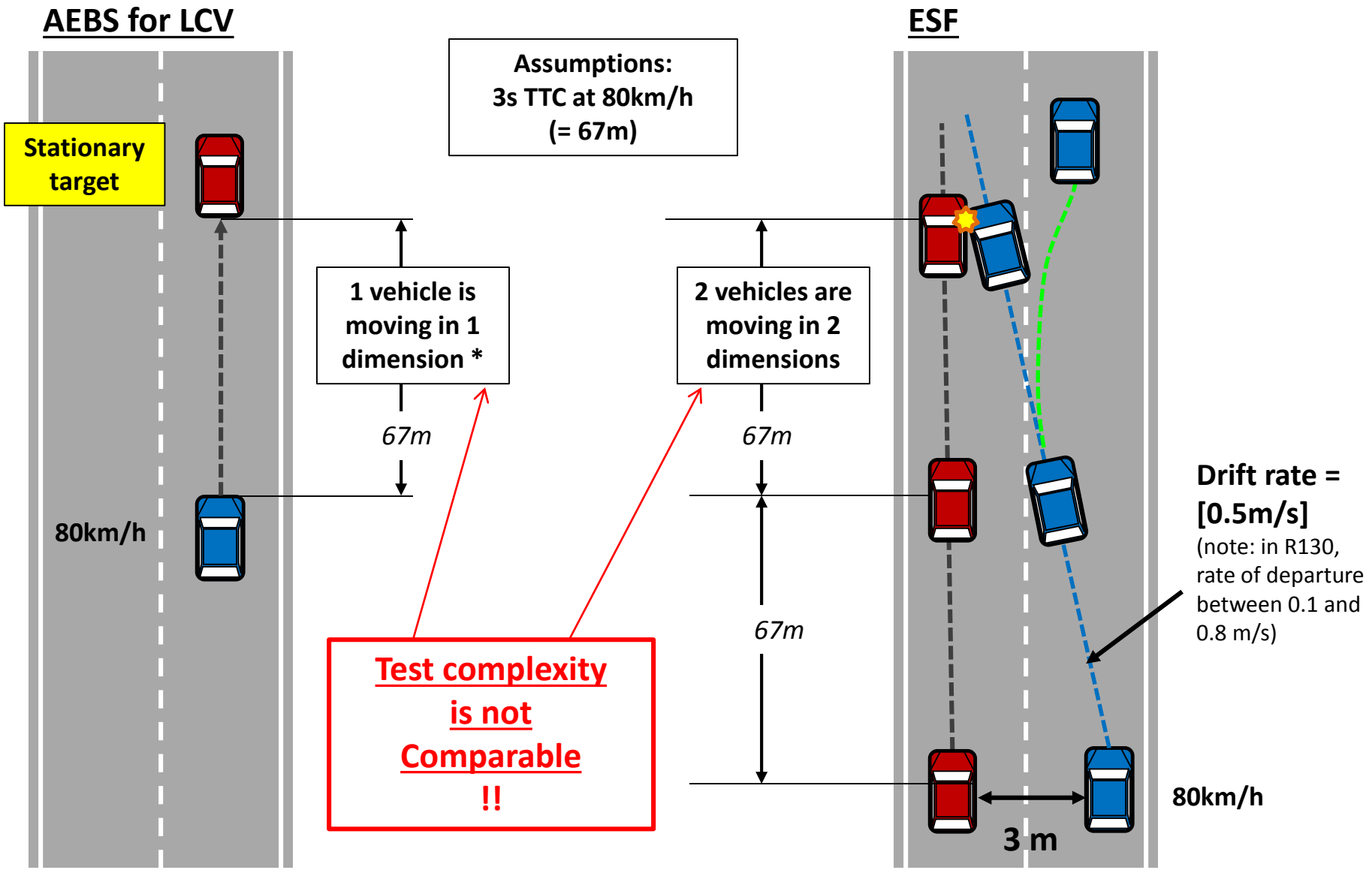
- Rationales in next slides

Rationale #1


CSF
CSF
~~• LKAS~~
• Stability…
• Collision avoid.
• Lane departure avoid.
ACSF B1
• LKAS
Objectives
• Avoid misuse → hands-off detection
• Minimum performance and tests, to ensure a "safe" coupling with ACSF C/D
CSF
~~• LKAS~~
• Stability…
~~• Collision avoid.~~
• Lane departure avoid.
Objectives:
• Avoid misuse → acoustic warning if too long or too frequent intervention
ESF
• Collision avoid.
Objectives
• Avoid misuse → acoustic warning at every intervention (unless avoidance performed by the driver)
~~• Minimum performance and tests~~
Industry explored the possibility to define ESF performance and tests (with e.g. TTC) but this revealed to be impractical, while not strictly required to reach the objectives.
See next slides.

Rationale #2

Time to Collision (TTC) - AEBS vs ESF



** With a moving target at 67km/h, 2 vehicles are moving but the distance become 11 m…*

Conclusions

1. Such a test is impractical: TTC not measurable, due to high tolerances on drift rate, leading to variation in the collision point.
2. In many cases, a TTC is not relevant for collision risk detection; there are other potential criteria (safety distance, speed, vehicle type, road conditions, use case etc.).
3. Industry proposal is to stick to the CSF approach and provide a warning at every intervention of ESF.
4. In addition, the manufacturer should describe the conditions for collision risk detection and demonstrate them with documentation, test results, virtual or physical tests etc.
5. 50N max overriding test (to be tested)
6. This will ensure no misuse and easy overriding.