Document Information

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5.1 Green Light Optimal Speed Advisory (GLOSA)

### 5.1.1 General description

The Green Light Optimal Speed Advisory (GLOSA) application provides a speed advisory to the rider by sharing information with traffic light infrastructure, so that the PTW can pass the oncoming intersection while the traffic light is green.

This will enable a smoother traffic flow and optimum efficiency by avoiding unnecessary braking and acceleration. The application can also display the remaining time till green in case the light is red, and so mitigates rider's stress.

5.1.2 Use case description

The GLOSA application uses Infrastructure-to-Vehicle (I2V) communication information, such as Signal Phase and Timing Extended Message (here in after referred to as SPATEM), AdvisorySpeed and Map Data Extended Message (here in after referred to as MAPEM), transmitted by signalised intersections to provide speed advice to vehicles approaching and passing the intersection. The infrastructure such as Road Side Unit (RSU) will broadcast either a set of current phase state of the traffic lights and road topology of the intersection(s) ahead, an already calculated advisory speed information for multiple road segments of approach to the intersection or a pre-defined/planned green-wave speed advice to pass through a sequence of traffic-light-controlled, synchronised intersections. The approaching PTW will receive the message, take their own location and velocity into account and extract the optimal speed for the approaching intersection and/or the remaining time till the signal phase to change. This application is mainly a comfort function and will have a very limited effect in preventing traffic accidents. However, some accidents could be addressed, either when a vehicle is strongly braking in front of the PTW due to changing traffic light (e.g. yellow → red) and the PTW has a rear end collision with the vehicle in front or when another vehicle crashes into the rear end of the PTW because the PTW is strongly decelerating in front of a changing traffic light.

5.1.2.1 Scenario description
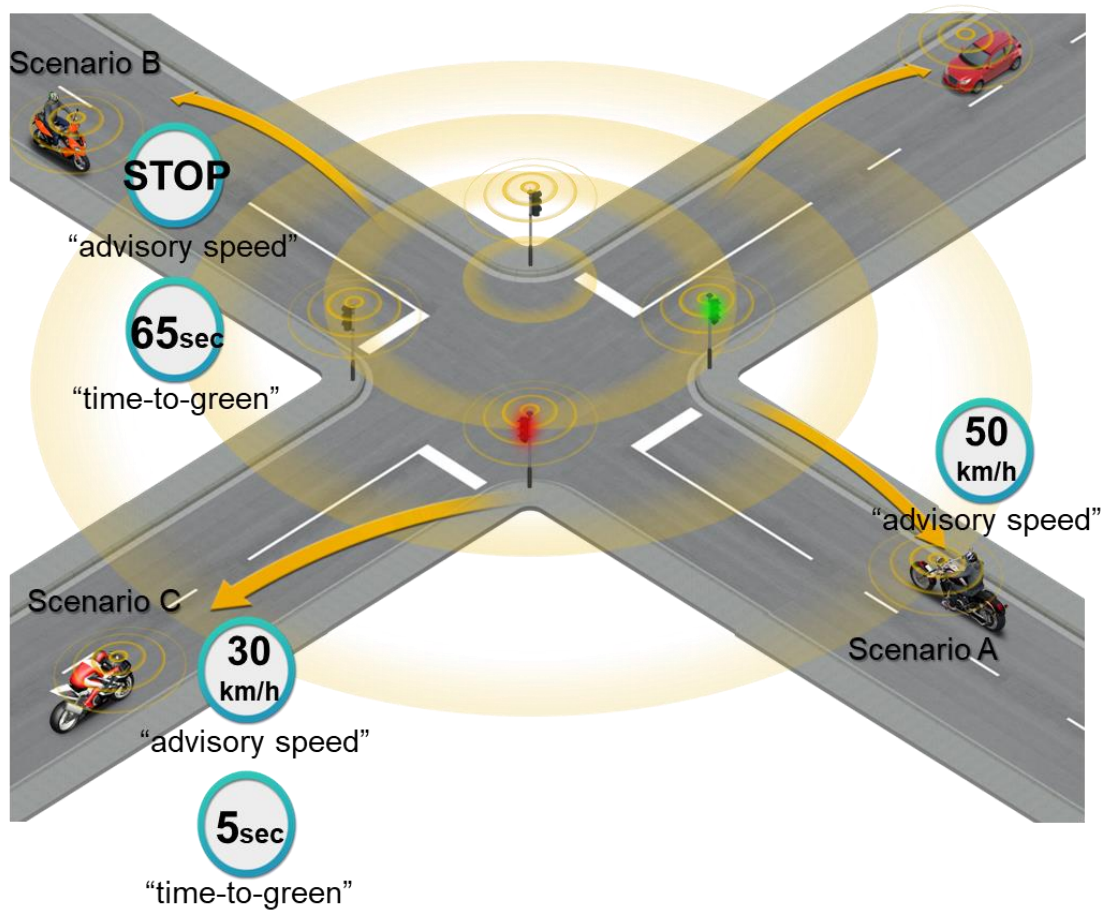
© This picture was created using the C2C-CC Illustration Toolkit, owned by the CAR 2 CAR Communication Consortium

Figure 1: Overview of GLOSA

5.1.2.1.1 Scenario A: Green light, able to pass through the intersection within the green phase.

A PTW is travelling towards a signalised intersection.

The traffic signal in travelling direction is green.

While the signal is green and it appears to be possible for the approaching vehicle to ride through the intersection within the green phase, the optimal speed to safely ride through the intersection is provided to the PTW rider.

The PTW travels through the intersection.

5.1.2.1.2 Scenario B: Green light, unable to pass through the intersection within the green phase.

A PTW is travelling towards a signalised intersection.

The traffic signal in travelling direction is green.

The signal is green, but the remaining time of the green phase and the optimal speed to minimize the latency time till the next green phase is provided to the PTW rider.

The PTW rider adjusts his/her speed or decelerates accordingly.

The signal turns to yellow, then red.

The remaining time till the next green phase is provided to the rider.

The signal turns to green.

The PTW accelerates and travels through the intersection.

5.1.2.1.3 Scenario C: Red and Yellow light.

A PTW is travelling towards a signalised intersection.

The traffic signal in travelling direction is red (or turning from yellow to red).

While the signal is red, the remaining time till the next green phase and the optimal speed to minimize the latency time is provided to the PTW rider.

The PTW rider adjusts his/her speed or stops accordingly.

The signal turns to green.

The PTW accelerates and travels through the intersection.

5.1.3 Technical description

5.1.3.1 Scenario A: Green light, able to pass through the intersection within the green phase.

5.1.3.1.1 State Flow

The function state flow from Service-In to Service-Out of scenario A is indicated in the following figure.
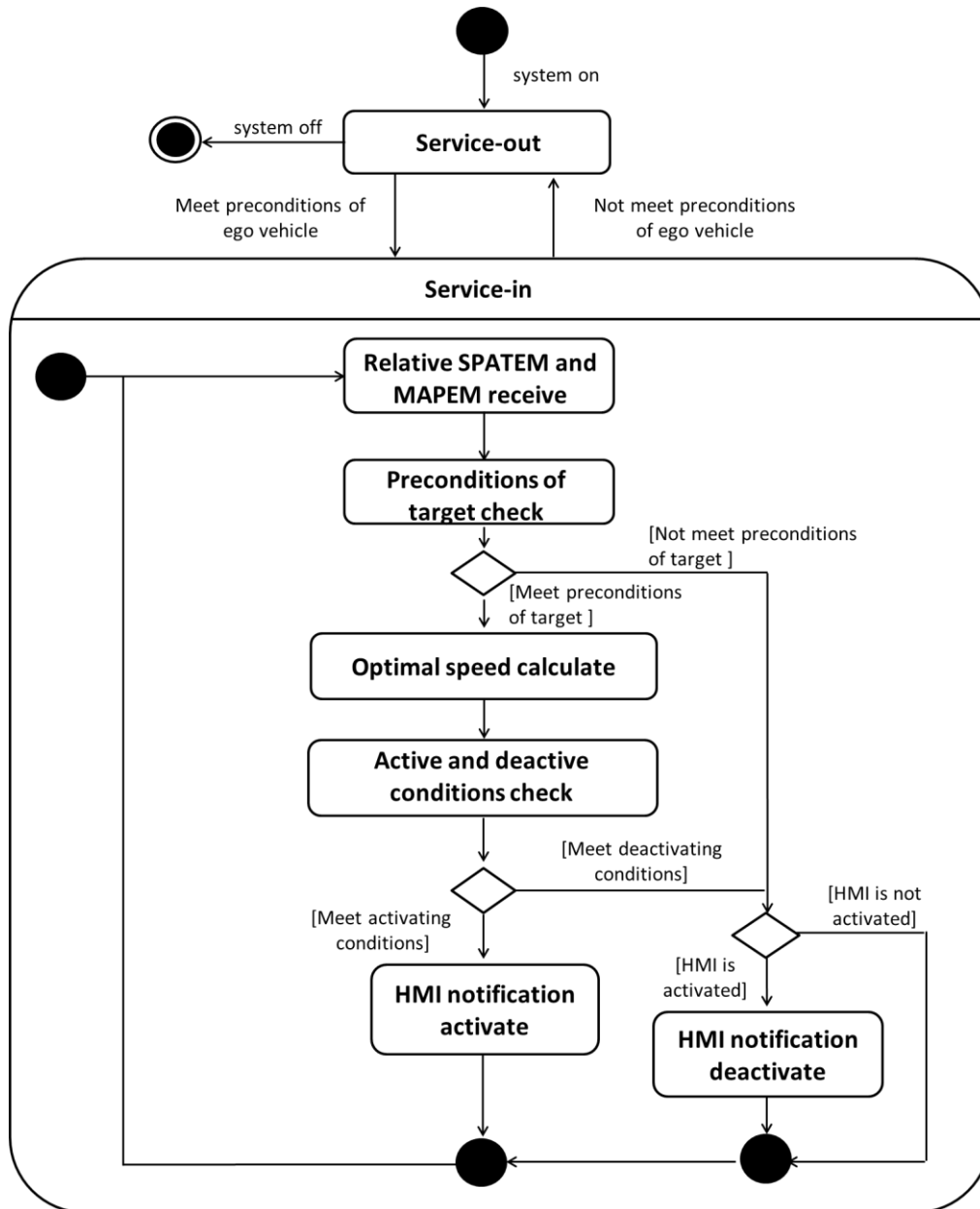

Figure 2: State Flow of GLOSA (scenario A)

5.1.3.1.2 Preconditions

The preconditions of scenario A is stated below.

All of the following preconditions (PC_1 to PC_8) shall be satisfied every time before this use case is activated:

Table 1: Preconditions of ego vehicle (scenario A)

#	Item	Condition
PC_1	Ego vehicle	PTW
PC_2	Speed range	Up to 100km/h
PC_3	Location	Any (Vicinity of signalised intersections)
PC_4	Road type	Any (Vicinity of signalised intersections)
PC_5	Time	-
PC_6	Weather	-
PC_7	Other conditions	-
PC_8	Out of scope	-

All of the preconditions of target (PC_9 to PC_12) shall be satisfied before active and deactivate condition check.

Table 2: Preconditions of target (scenario A)

#	Item	Condition
PC_9	Target	Traffic signal
PC_10	Relative distance	< 400m
PC_11	causeCode	NA
PC_12	Vehicle type	NA

5.1.3.1.3 Activation and deactivation requirements

The activating and deactivating requirements of scenario A are stated below.

Activate the indication scheme when all of the conditions below (AC_1 to AC_5) are satisfied.

Table 3: Activating conditions of scenario A

#	Item	Condition	Used Data[1]
AC_1	Target	Relative SPATEM and MAPEM received	SPATEM/MAPEM Pattern1: Spat & mapData Pattern2: advisorySpeed & mapData Pattern3: advisorySpeed(greenwave) & mapData
AC_2	Position	Target signal is within the estimated route of ego vehicle	Estimated route of ego vehicle (latitude, longitude, pathHistory, etc) Target signal position (mapData, intersectionGeometry, etc)
AC_3	Signal phase	Green	Signal phase (Spat)
AC_4	Travel timing	Ego vehicle is able to pass through the intersection within the green phase	Signal timing (Spat) Ego vehicle speed Distance of target signal (mapData, intersectionGeometry, etc)
AC_5	Calculated optimal speed	The calculated optimal speed does not exceed the legal speed limit	Calculated optimal speed Legal speed limit (speedLimits)

Also, the traffic conditions between the ego vehicle and the target signal is recommended to be considered if the information is available.

e. g. Cameras and other on-board sensors, CAM from the leading vehicles, so on.

The information will be deactivated when the condition below (DC_1) is satisfied.

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[1] Some of the Used Data is described by reference to Common C-ITS Service Definitions Version 1.5 of the C-ROADS platform.

(https://www.c-roads.eu, accessed on 17.11.2020)

Table 4: Deactivating conditions of scenario A

#	Item	Condition	Used Data
DC_1	Position	Target signal has deviated from the ego vehicle's estimated route	Estimated route of ego vehicle (latitude, longitude, pathHistory, etc) Target signal position (mapData, intersectionGeometry, etc)

5.1.3.2 Scenario B: Green light, Unable to pass through the intersection within the green phase.

5.1.3.2.1 State Flow

The function state flow from Service-In to Service-Out of scenario B is as same as scenario A.

5.1.3.2.2 Preconditions

The preconditions of scenario B is as same as scenario A.

5.1.3.2.3 Activation and deactivation requirements

The activating and deactivating requirements of scenario B is stated below.

Activate the indication scheme when all of the conditions below (AC_1 to AC_5) are satisfied.

Table 5: Activating conditions of scenario B

#	Item	Condition	Used Data
AC_1	Target	Relative SPATEM and MAPEM received	SPATEM/MAPEM Pattern1: Spat & mapData Pattern2: advisorySpeed & mapData Pattern3: advisorySpeed(greenwave) & mapData
AC_2	Position	Target signal is within the estimated route of Ego vehicle	Estimated route of ego vehicle (latitude, longitude, pathHistory, etc) Target signal position (mapData, intersectionGeometry, etc)
AC_3	Signal phase	Green	Signal phase (Spat)

AC_4	Travel timing	Ego vehicle is unable to pass through the intersection within the green phase	Signal timing (Spat) Ego vehicle speed Distance of target signal (mapData, intersectionGeometry, etc)
AC_5	Calculated optimal speed	The calculated optimal speed does not exceed the legal speed limit	Calculated optimal speed Legal speed limit (speedLimits)

Also, the traffic conditions between the ego vehicle and the target signal is recommended to be considered if the information is available.

e. g. Cameras and other on-board sensors, CAM from the leading vehicles, so on.

The deactivating conditions of scenario B is as same as scenario A.

5.1.3.3 Scenario C: Red and Yellow light

5.1.3.3.1 State Flow

The function state flow from Service-In to Service-Out of scenario C is as same as scenario A.

5.1.3.3.2 Preconditions

The preconditions of scenario C is as same as scenario A.

5.1.3.3.3 Activation and deactivation requirements

The activating and deactivating requirements of scenario C is stated below.

Activate the indication scheme when all of the conditions below (AC_1 to AC_4) are satisfied.

Table 6: Activating conditions of scenario C

#	Item	Condition	Used Data
AC_1	Target	Relative SPATEM and MAPEM received	SPATEM/MAPEM Pattern1: Spat & mapData Pattern2: advisorySpeed & mapData Pattern3: advisorySpeed(greenwave) & mapData
AC_2	Position	Target signal is within the estimated route of Ego vehicle	Estimated route of ego vehicle (latitude, longitude, pathHistory, etc) Target signal position (mapData, intersectionGeometry, etc)
AC_3	Signal phase	Red or Yellow	Signal phase (Spat)
AC_4	Calculated optimal speed	The calculated optimal speed does not exceed the legal speed limit The lower limit threshold is also set according to the vehicle type. Note: The low speed may lead to a PTW's instability.	Calculated optimal speed Legal speed limit (speedLimits)

Also, the traffic conditions between the ego vehicle and the target signal is recommended to be considered if the information is available.

e. g. Cameras and other on-board sensors, CAM from the leading vehicles, so on.

The deactivating conditions of scenario C is as same as scenario A.

Abbreviations

Please refer to the abbreviations in Preamble document.