

# Common technical specifications for use cases K1 – Level Crossing Abnormal Situation (do not cross) (I2V) / K2 – Level Crossing Approaching (I2V) / K3 – Level Crossing Closed (I2V)

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## Deliverable 2.4.1.2\_H\_K1-2-3

### Activity 2: Studies

### Sub Activity 2.4 > Specifications

Version 4.00

Publication Date: 14/11/2019



Co-financed by the Connecting Europe  
Facility of the European Union

## Information on the document

Document: Common technical specifications for use cases SCooP, InterCor, C-Roads - K1 – Level Crossing Abnormal Situation (do not cross) (I2V) K2 – Level Crossing Approaching (I2V) K3 – Level Crossing Closed (I2V)

Date of publication: 14/11/2019

Responsible, Entity: Virginie Taillandier, SNCF

Status: Version 4.00 – Release 4

## Publication history

Date	Version	Author(s)	Updates & changes	Diffusion
14/11/2019	4.00	V TAILLANDIER A AUDIGE	Consolidated version for release 4	Release 4

Black highlighted texts are issues with standards.

Yellow highlighted texts are topics that need to be finalized.

The following legend is used on master document tables (next sub-chapters) and on profiles in each UC documents :

Standard / Field: if status is mandatory in standard: **bold**, If optional: *italic*.

Profile / Status:

- If mandatory: **I**
- If optional in standard:
  - Used (**U**) when always used
  - Not used (**I**) when never used.
  - Sometimes (**S**) when it depends.

Profile / Content: important settings or information are in ***bold italic pink underline***.

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# Acronyms & abbreviations

CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport Systems
C-ITS-S	Central ITS Station (national ITS station)
DENM	Decentralized Environmental Notification Message (réf. ETSI standard for C-ITS messages)
GPS	Global Positioning System
ITS-G5	ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). ITS-G5 refers to the approved amendment of the IEEE 802.11 (standard IEEE 802.11p). This technology (possibly others) uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications. In this document ITS-G5 stands for IEEE802.11p/ETSI ITS-G5.
IVI	Infrastructure to Vehicle Information (réf. ETSI standard for C-ITS messages)
MAPData	Geometric information for the intersection (réf. ETSI standard for C-ITS messages)
R-ITS-S	Roadside ITS Station (RSU or ITS-S R in the French Terminology)
SPAT	Signal Phase and Timing (réf. ETSI standard for C-ITS messages)
TCC	Traffic Control Centre (the place where road management measure are decided)
TMS	Traffic Management System (the usual system in which the road operator sets its road measures and events)
V-ITS-S	Vehicle ITS Station (any vehicles)
Vro-ITS-S	Road operator vehicle ITS Station
Vu-ITS-S	User vehicle ITS Station (in that case, road operator vehicle are excluded when they are not in user mode)
SNCF	Société Nationale des Chemin de fer Français
CCH	Control Channel
SCH	Service Channel

N/A	<i>Not Applicable</i>
TBC	<i>To Be Checked, with MS or associated partner</i>
WIP	<i>Work in progress : when mentioned next to the version number, it means the document is an in-between version</i>

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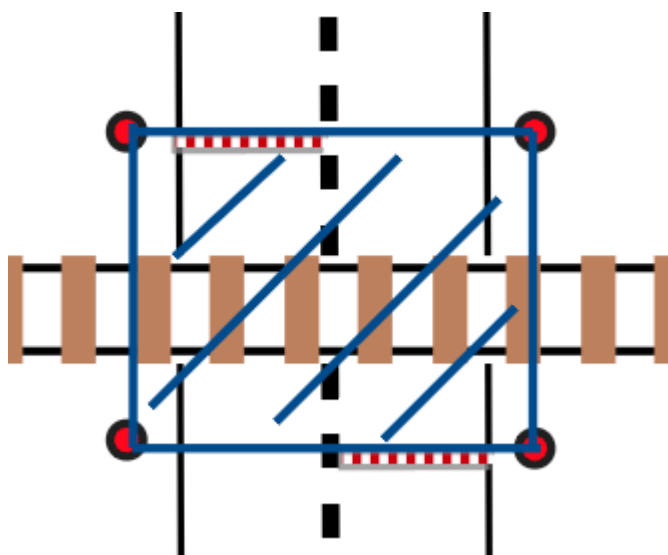
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# 1 - Introduction

The R-ITS-S will be installed into automatic level crossing (in France). The following use cases concern the automatic level crossing.

In the following paragraphs, we define how some parameters are set.

The level crossing zone is defined between the 2 crossing lights as described in the picture below:



*Illustration 1: Level crossing zone delimitation*

The level crossing is considered as a permanent event, so DENM messages are issued continuously. Indeed level crossing are considered as particular point of roads, even when opened. Some users are likely to want to know their mere presence.

The content of the DENM message is modified, depending of the status of the level crossing.

The level crossing has 4 different possible status: Abnormal Situation (do not cross), nominal, closed, road&railworks, which lead to 4 different use cases (respectively K1, K2, K3, B1a&b).

Traffic restriction can be applied depending of the level crossing configuration. These restrictions are broadcasted with IVI messages.

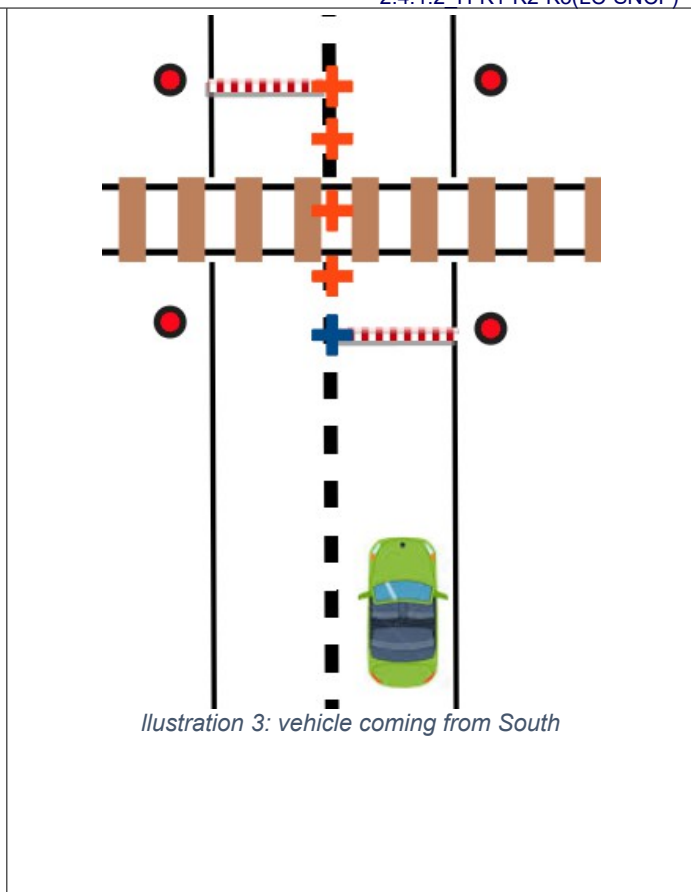
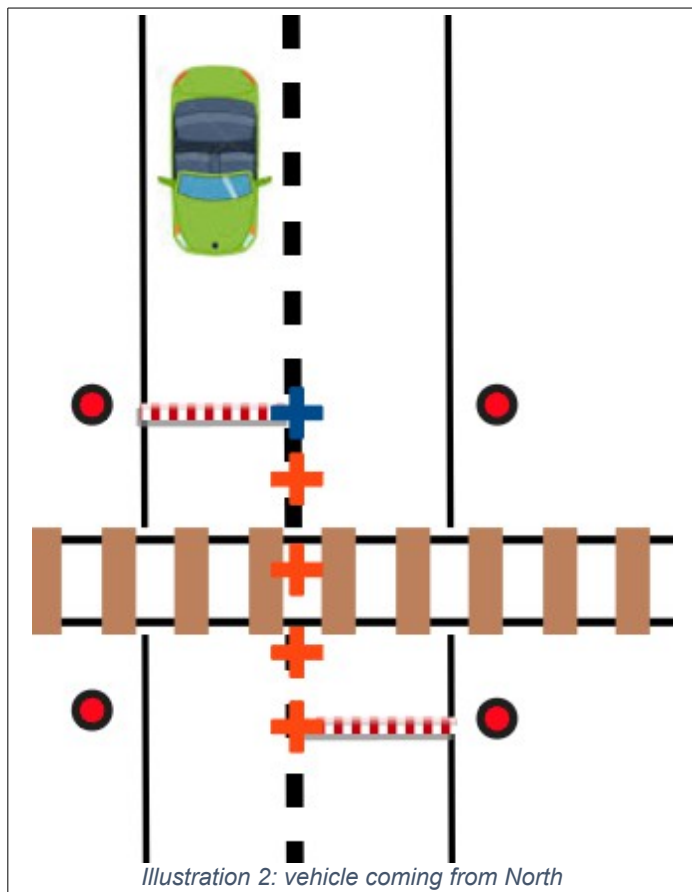
In the previous picture (illustration 1), we have a railway that is crossed by a two-way road.

The eventPosition is different depending of the vehicle direction.

In the next two pictures, the eventPosition is set at the beginning of the level crossing zone, from the vehicle point of view. The eventPosition is illustrated with the blue cross.

The eventHistory is then defined between the eventPosition and the other light on the other side of the level crossing. The eventHistory is illustrated with the orange cross.

Thus, 2 DENM messages are issued for a two-way road, one for each direction.

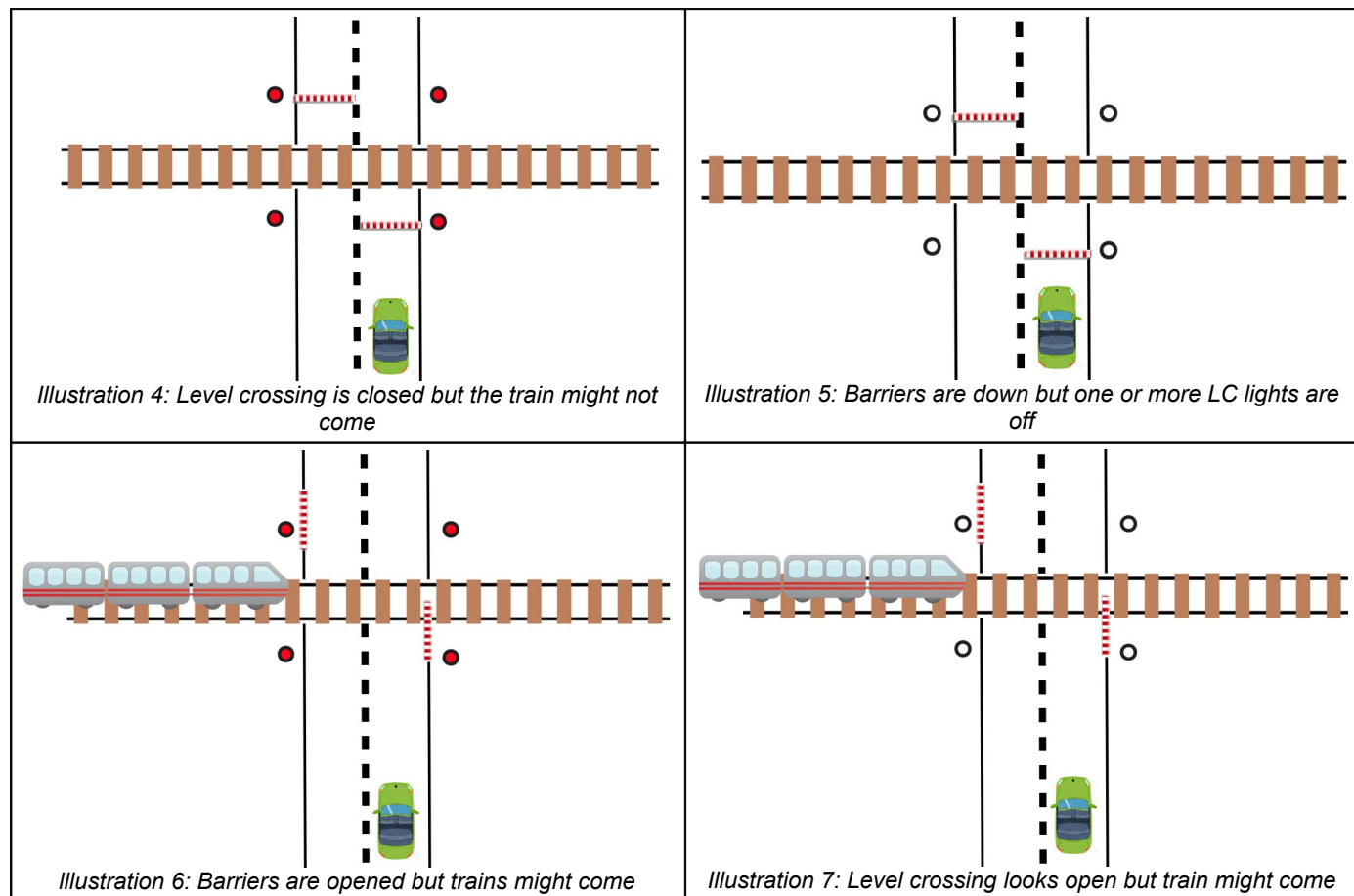


## 2 - Level crossing status

### 2.1 - Figures

#### 2.1.1 - K1 – Level Crossing Abnormal Situation (do not cross)

There are different cases when a Level crossing is considered as Abnormal Situation but for all these cases, all road users **must not** cross it. The following figures show different scenarios of Abnormal Situation (do not cross).

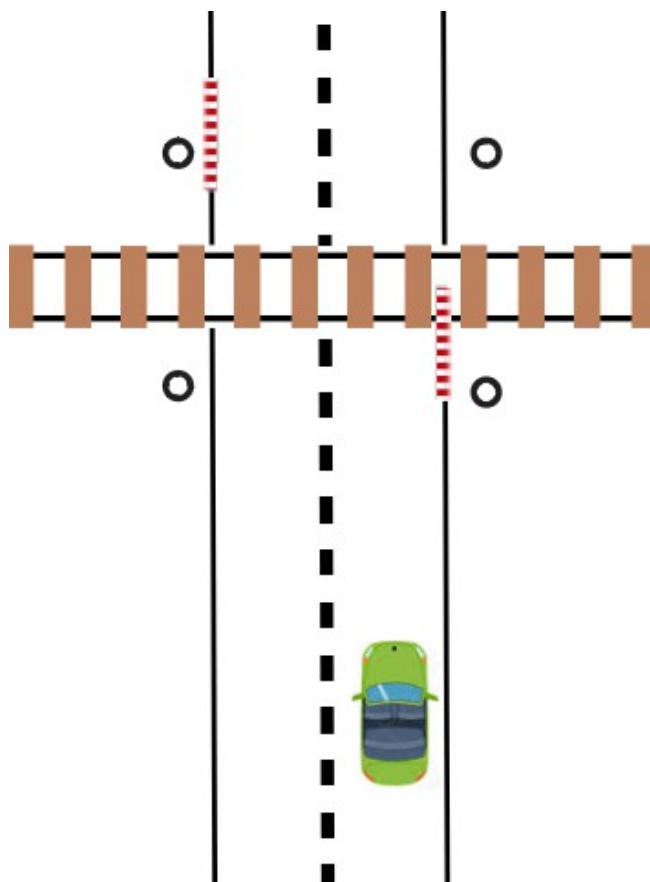


#### 2.1.2 -

#### 2.1.3 - K2 – Level Crossing Approaching (I2V)

The road user receives a notification on the presence of a level crossing in nominal mode as he is heading toward it.

**example illustration:**



*Illustration 8: The level crossing is in nominal status, which means the lights are off, the barriers open and no default are detected*

#### 2.1.4 - K3 – Level Crossing Closed (I2V)

When a train arrives near a level crossing there are mechanical switches announced to the level crossing automated signal system of train arrival and departure on a level crossing segment. These are placed at distance calculated to detect train presence minimum 25 seconds before the train start to run on the road and railway shared portion. Maximum speed of train on a level crossing is 160 km/h but there is no defined minimum speed. Currently there is no information on the speed provided from the train to the level crossing system. Therefore we cannot give precise timing for this event. However SNCF considers that a close for more than 10 minutes is an abnormal situation.

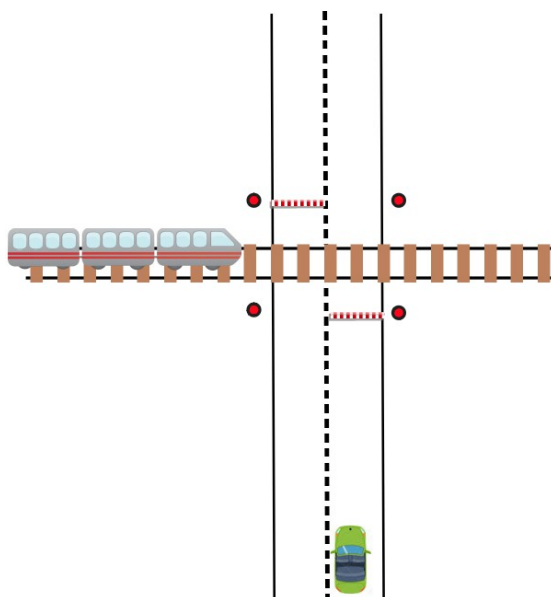
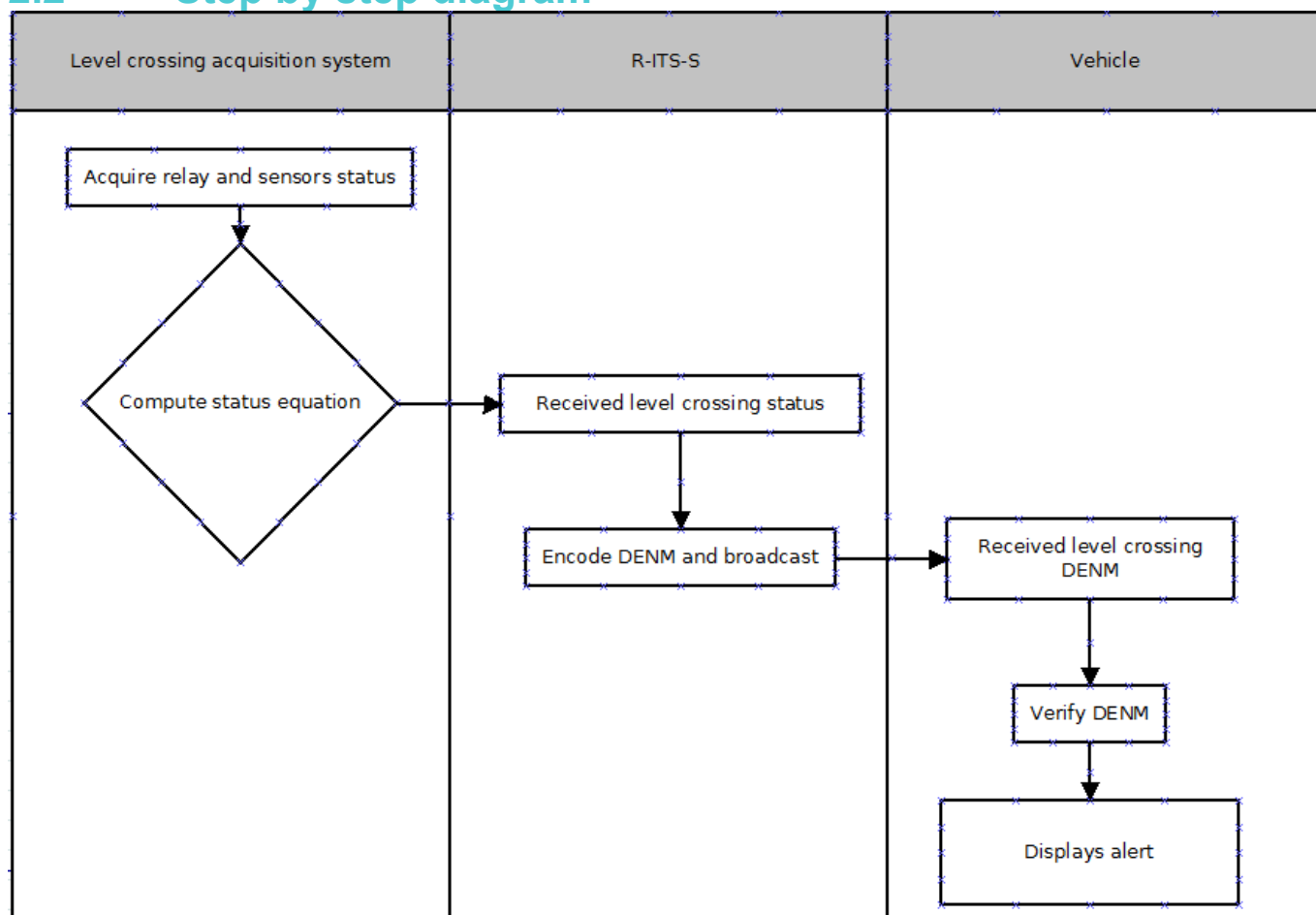


Illustration 9: Train is coming; light are red and barriers down

## 2.2 - Step by step diagram



**Acquire relay and sensor data:** A specific system is installed next to the Railway level crossing system. It acquires relays and sensors status at a maximum frequency of 2000 Hz and log all these status internally.

**Compute level crossing status equation** : A combinatorial equation was developed by the SNCF to determinate whether or not the level crossing is presenting an abnormal situation (i.e do not cross), in a nominal state or closing. Then information are sent to the R-ITS-S system.

- Abnormal Situation (do not cross) is when something wrong is detected by SNCF equation, including level crossing is closed more than 10 minutes long.
- Nominal state is when the level crossing has its lights off and barriers opened and not have another status (Abnormal Situation (do not cross), Closed or Road/RailWorks).
- Closing is when the level crossing is closing (lights on) then when it is closed (barriers down). Additionally there is a timer to monitor how long the level crossing stay closed and the status switch to "Abnormal Situation (do not cross)" if it exceeds ten minutes.

**Received level crossing status (R-ITS-S)** : Determine whether or not the situation requires to create or update a DENM.

If the status changes from a situation to another the DENM is updated to broadcast the new situation.

If the status do not change: the current situation is continuously broadcasted.

If end of validityDuration is about to occur, a DENM update is done with modification of detection and reference time in order to continue the broadcasting of the situation of the level crossing.

In parallel level crossing status will be sent in signed DENM format to the Nfr-ITS-S.

**Encode DENM and broadcast:** Construction and Encoding of DENM would be done by R-ITS-S. By definition the event is linear. If a (or successive) level crossing overpass this several event (DENM) will be generated.

Canal CCH for 100%-G5 scenario and SCH for hybrid scenario **should** be used (see 241H for more details). Geonetworking dissemination and forwarding for 100%-G5 would be the same that for SCooP1 use-cases (10km area and ten times).

**Received level crossing status (vehicle)** : through architecture. Architecture options are not treated in this document (see 241H). Anyway, whatever the route the information has followed, **DENM of an event must have same actionID and same detectionTime (as presented below in profile)**. So that vehicle can treat one message or the other, but not both of them.

**Verify DENM and display alert:** an alert is given to warn the driver :

- **With "Abnormal Situation (do not cross)"** information, he **should** change his itinerary since the level crossing is closed for undetermined time. **Road users shall not cross it under any circumstances.**
- With "Nominal state" (level crossing approaching), he is only informed that he is approaching a level crossing.
- With "Closing", an alert is given to warn the driver he **must** stop and wait until the level crossing is re-opened. He could also change his itinerary if he want to bypass it.

Following steps are followed by vehicles:

1. The vehicle checks actionID and detectionTime to verify if event already known, new event or is an update.
2. The vehicle checks validityDuration to know if event is still active.
3. The vehicle checks eventPosition to determine if it is near or far of its position and calculate its time-to-event (car manufacturer domain : to determine the proper moment to display the information in the vehicle).
4. The vehicle checks CauseCode/SubCauseCode:
  - **If CC/SCC is 100/1, there is a Level Crossing and it is Abnormal Situation. The displayed information should be it is closed for an undetermined time and shall not be crossed.**
  - **If CC/SCC is 100/4, there is a Level Crossing in nominal status (be careful, a risk can always occur and situation can always change)**
  - **If CC/SCC is 100/2, there is a Level Crossing closing or closed (note that during closing users are not allowed to pass)**
  - **If CC/SCC is 100/3, there is a unguarded Level Crossing (i.e a Saint Andrew cross level crossing without detection of train). The road user may cross but with extreme caution.**
  - **If CC/SCC is 100/0, there is a Level Crossing, but the information is unavailable. The user should not cross it or with extreme caution.**
1. The vehicle checks traces. If vehicle is following one of traces, it is concerned by event (which is upstream). If not, the vehicle can check with his own map if the level crossing is on its way.

- If concerned, the vehicle displays the event before eventPosition (match with one of the barrier) to alert the driver (proper moment is car manufacturer domain). EventHistory is the segments of the road from barrier to barrier.

## 2.3 - Information profile - Message description (in details) for DENM

DENM Master status		Profile LCOoO		
Field	Status (Master)	Status For the UC	Comments	Value set
<b>Header</b>				
protocol			See Master document / DENM	
Version			See Master document / DENM	(is 1)
messageID			See Master document / DENM	
stationID			See Master document / DENM	
<b>Management container</b>				
actionID			See Master document / DENM	
detectionTime			See Master document / DENM (case no defined end time)	
referenceTime			See Master document / DENM	
termination	S	S	See Master document / DENM. Note that the DENM termination will be send only when the Level crossing status changes or when end of validity duration is about to occur (update of the DENM).	
eventPosition >			See next two lines	
>latitude			latitude of position of the lights/barrier of the Level crossing (for the direction concerned)	
>longitude			longitude of position of the lights/barrier of the Level crossing (for the direction concerned)	
>confidencePositionElipse			See Master document / DENM	
>altitude			See Master document / DENM	
relevanceDistance				
relevanceTrafficDirection	U	U	Concern the vehicle coming to the level crossing (upstream).	Is 1
validityDuration			Generally, no end time is known for doNotCross-AbnormalSituation or nominal state situation so 7 200 may be broadcasted (default value which can evolve with experimentations). For closing, 600 (ten minutes) should be broadcasted.	
transmissionInterval				
stationType			See Master document / DENM	(is 15)
<b>Situation container</b>				
informationQuality			Detection is considered as certain since the equation developed by SNCF gives a binary result.	Is 6
eventType			No event type matches with this situation so a new causeCode is proposed . <b>The CauseCode is set to 100 (RailwayLevelCrossing).</b> <ul style="list-style-type: none"> <li>The SubCauseCode is set to 0 (unavailable) for non-available information on status.</li> <li>The SubCauseCode is set to 1 (doNotCross-AbnormalSituation) for Level Crossing Abnormal Situation use case (abnormal situation).</li> <li>The SubCauseCode is set to 2 (Closed) for Level Crossing Closing/Closed use case.</li> <li>The SubCauseCode is set to 3 (unguarded) for non equipped LC.</li> <li>The SubCauseCode is set to 4 (nominal) for Level Crossing Approaching use case.</li> </ul>	

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DENM Master status		Profile LCOoO		
Field	Status (Master)	Status For the UC	Comments	Value set
<i>linkedCause</i>	<b>S</b>	<b>I</b>	Not used	
<i>eventHistory</i>	<b>U</b>	<b>U</b>	The eventHistory is between the eventPosition and the barrier of the opposite direction. See Master document / DENM	
<b>Location container</b>				
<i>eventSpeed</i>	<b>I</b>			
<i>eventPosition</i>	<b>S</b>	<b>I</b>	<b>Event is motionless. Not used.</b>	
<i>Heading</i>				
<i>traces</i>	<b>I</b>	<b>I</b>	Sequence of delta position from event position to "start" of each trace	
<i>roadType</i>	<b>U</b>	<b>U</b>	See Master document / DENM	
<b>À la carte container</b>				
<i>lanePosition</i>	<b>S</b>	<b>I</b>	Not used all lanes of the road are concerned	
<i>impactReduction (DF)</i>	<b>I</b>			
<i>externalTemperature</i>	<b>I</b>			
<i>roadWorks (DF)</i>	<b>S</b>	<b>I</b>	Not applicable for this UC.	
<i>positioningSolution</i>	<b>I</b>			
<i>stationaryVehicle (DF)</i>	<b>I</b>			

In **Bold** the entry that is added to the existing norm :

ETS.asn1

```

CauseCodeType ::= INTEGER {
    reserved (0),
    trafficCondition (1),
    accident (2),
    roadworks (3),
    adverseWeatherCondition-Adhesion (6),
    hazardousLocation-SurfaceCondition (9),
    hazardousLocation-ObstacleOnTheRoad (10),
    hazardousLocation-AnimalOnTheRoad (11),
    humanPresenceOnTheRoad (12),
    wrongWayDriving (14),
    rescueAndRecoveryWorkInProgress (15),
    adverseWeatherCondition-ExtremeWeatherCondition (17),
    adverseWeatherCondition-Visibility (18),
    adverseWeatherCondition-Precipitation (19),
    slowVehicle (26),
    dangerousEndOfQueue (27),
    vehicleBreakdown (91),
    postCrash (92),
    humanProblem (93),
    stationaryVehicle (94),
    emergencyVehicleApproaching (95),
    hazardousLocation-DangerousCurve (96),
    collisionRisk (97),
    signalViolation (98),
    dangerousSituation (99),
    railwayLevelCrossing(100)
} (0..255)

```

```

RailwayLevelCrossingSubCauseCode ::= INTEGER {
    unavailable(0),
    doNotCross-AbnormalSituation (1),

```

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**closed (2),  
unguarded (3),  
nominal (4)  
} (0..255)**

## 3 - Traffic restrictions

### 3.1 - Figures

Depending of the level crossing, restrictions about height, width and weight of the vehicle (with load) can apply. In some case restriction about speed limit of road can also be applied.

example illustrations:

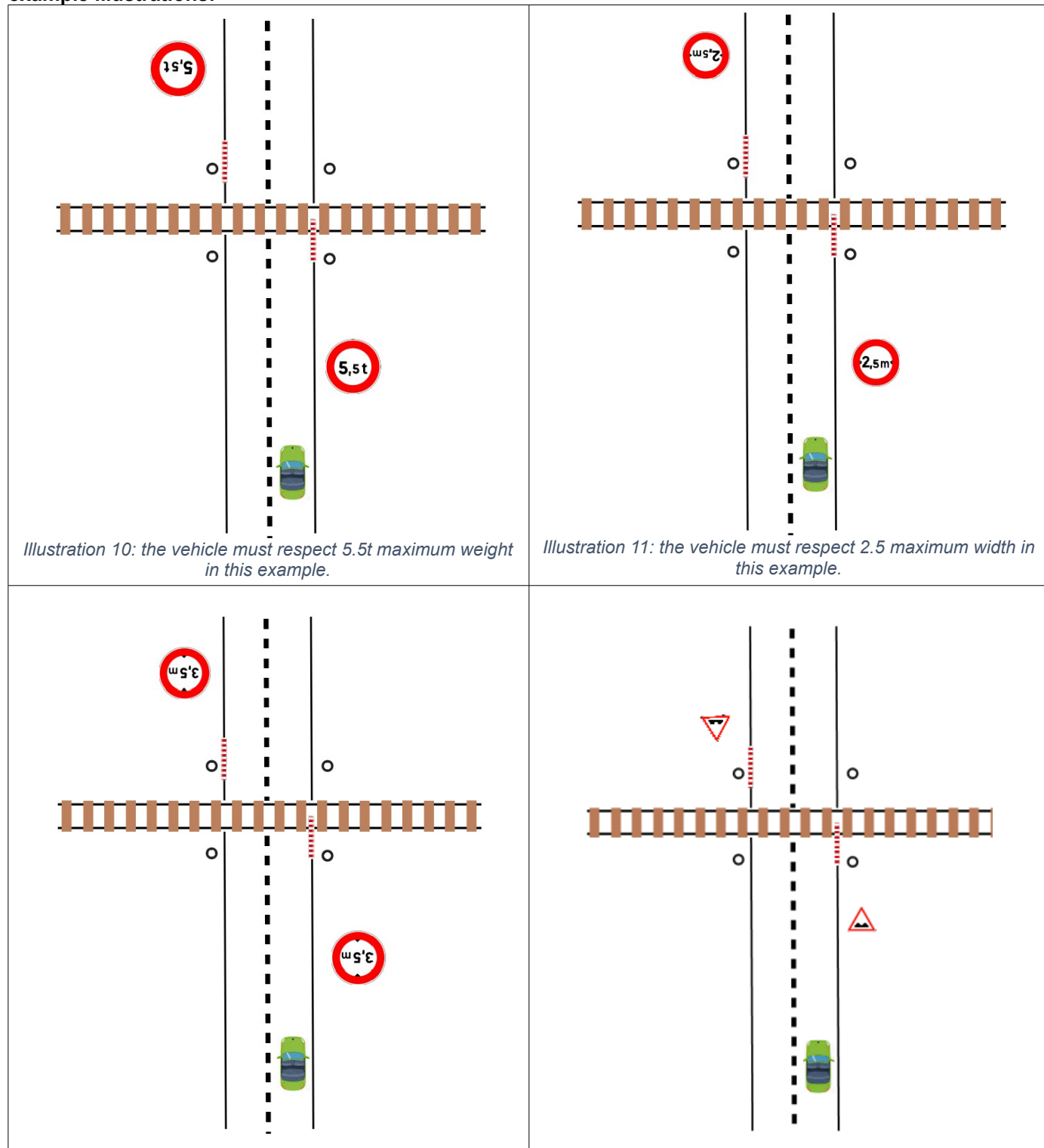


Illustration 12: the vehicle **must** respect 3.5 maximum height in this example.

Illustration 13: the driver had to know if its vehicle is able to cross without any risk of remaining blocked by the road profile

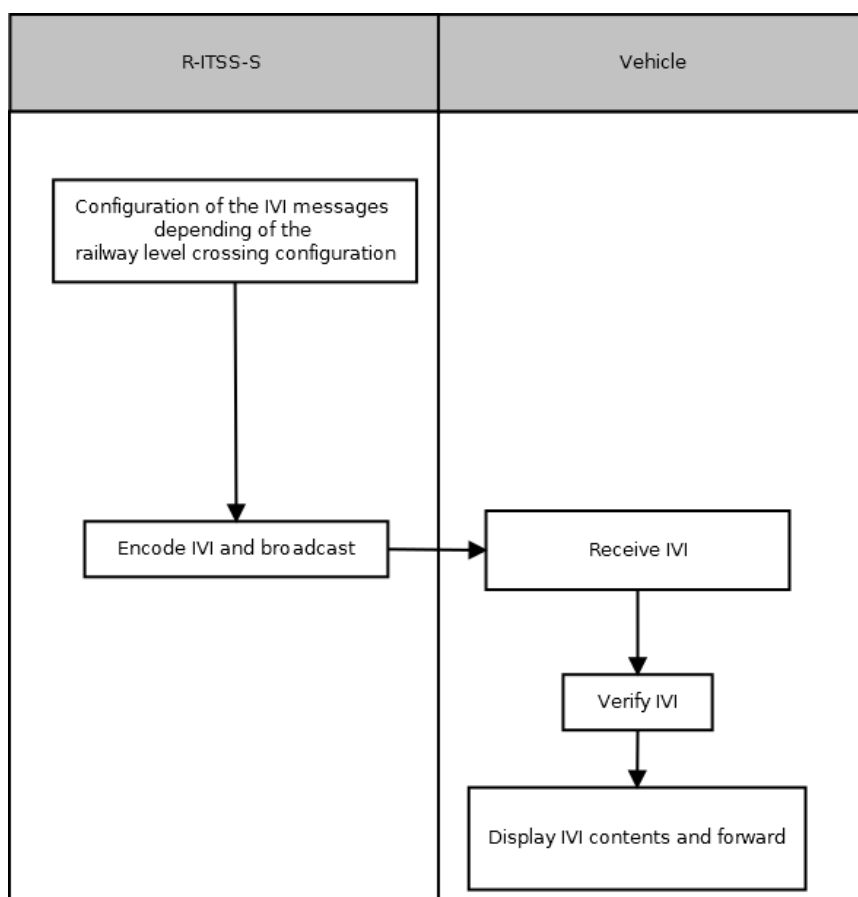
The information given via IVI are static information.  
They concern all vehicles (restriction is given by the roadsign itself).

The IVI messages will be issued in each direction (one by direction). In case of several restriction applies for the level crossing, with same relevance and detection zones (and direction), one IVI message is issued for the group of restriction.

Additional IVI messages can be issued upstream the physical position of roadsigns in the field (e.g 250m upstream), to avoid vehicles-turn-back in the level crossing or its vicinity. **In that case, the referencePosition is localized where the message is about to be displayed from railway operator point of view (e.g 250m upstream of the physical roadsign). The relevanceZone of this message runs from this referencePosition at most to the physical roadsign of the same direction.** Indeed, we **must** avoid to have an overlap of relevanceZone between the restricted zone (between physical roadsigns) and the pre-information of this restricted zone. In other words, the relevanceZone of the pre-information stops at the restricted area.

## 3.2 -

## 3.3 - Step by step diagram



### Configuration of the IVI messages depending of the railway level crossing configuration :

Depending of the situation of the level crossing (maximum vehicle dimensions allowed and/or weight), the SNCF parameters the IVI messages inside the R-ITS-S during its installation.

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### Encode IVI and broadcast :

Construction and Encoding of IVI would be done in R-ITS-S from the configuration file and broadcast them. In parallel level crossing status will be send in signed IVI format to the Nfr-ITS-S.

**Receive IVI (vehicle) :** through architecture. Architecture options are not treated in this document (see 241H). Anyway, whatever the route the information has followed, **IVI must have same serviceProviderId+ivIdentificationNumber and same timeStamp (as presented below in profile)**. So that vehicle treats one message or the other, but not both of them.

**Verify IVI and display IVI :** message is displayed on HMI from **referencePosition** (start of regulated section) or before it (pre-awareness / car manufacturers domain). The information is displayed all the **relevanceZone** long. To classify and prioritize the information between several messages, the receiving vehicle **may** use the data element IviType (see below for further details), that provides the message category.

The process of vehicle-receiver can be as followed :

1. The vehicle checks serviceProviderID+ivIdentificationNumber and timestamp to verify if event already known, new event or is an update.
2. The vehicle checks validFrom and validTo to determine if active.
3. The vehicle checks referencePosition to determine if near of far of its position and calculate its time-to-event.
4. The vehicle checks detectionZone. If vehicle is following the linear described by zone(s) and is heading toward the referencePosition (using direction and zoneHeading ), it is concerned by event.
5. The vehicle checks presence of extraText container. None are provided for these use case (extraText are used with eVMS UC).
6. The vehicle checks trafficSignPictogram, nature and serialNumber.

**There can be (according to ISO14823\_2017):**

- **Regulatory, nature 4 , serial 99 (restriction about vehicle width) with VED/WID attributes.**
  - **Regulatory, nature 5 , serial 11 (restriction about vehicle height) with VED/HEI attributes.**
  - **Regulatory, nature 5 , serial 12 (restriction about vehicle weight) with VED/WEI attributes.**
  - **Regulatory, nature 5, serial 57 (restriction about speed limit) with SPE/SPM attributes**
  - **Warning, nature 2, serial 68 (warning about irregular ground)**
1. HMI displays the message from referencePosition point or before (pre-awareness) and displays it all relevanceZone long.
























































For DENM situation “doNotCross-AbnormalSituation” use-case or in case of activation of a K4 use-case, the R ITS-S **may** send an additional IVI with :

- **Public facilities, nature 1, serial 14 (phone) with extra text**

## 3.4 - Information profile - Message description (in details) for IVI

IVI transverse state		Profile DSL		
Field	Status from transverse]	Status For the UC	Comments	Value set
<b>Header</b>				
protocolVersion			See Master document / IVI	
messageID			See Master document / IVI	(is 6)
stationID			See Master document / IVI	
<b>Management container</b>				
serviceProviderId			See Master document / IVI	
ivIdentification Number			See Master document / IVI	
timestamp			See Master document / IVI	
validFrom			See Master document / IVI <b>Same value as timestamp</b>	
validTo			See Master document / IVI	86400
connectedIviStructures				
iviStatus			See Master document / IVI	
<b>Geographic Location Container</b>				

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IVI transverse state		Profile DSL		
Field	Status from transverse]	Status For the UC	Comments	Value set
referencePosition			Position of the start of the relevance zone. It is the position of the danger RoadSign which warns the user about the presence of a level crossing. In France, the danger road sign is placed 150m before for extra-urban roads and 50m on urban roads.	by R-ITS-S
referencePosition Time				
referencePosition Heading				
referencePositionSpeed				
parts			See 5 next lines	
>zoneld			First zone(s) lds <b>may</b> be used to define the "detection zone(s)", approach of the relevance zone (similar to Traces in DENM). Next zone(s) for "relevance zone" (similar to eventHistory in DENM). Detection zone(s) is defined upstream the referencePosition (position of the restriction roadSign). Relevance zone(s) is defined between the start and the end of the restriction.  Minimum is 2 zone (e.g. one trace / detection zone and one eventHistory / relevance zone)	by R-ITS-S
>laneNumber				
>zoneExtension				
>zoneHeading			See Master document / IVI	
>zone			See Master document / IVI	
General IVI Application Container				
detectionZonelds			See Master document / IVI	
its-rrid				
revelanceZonelds			See Master document / IVI	
direction			See Master document / IVI	
driverAwareness Zonelds				
minimumAwareness Time				
applicableLanes			<b>Always applied to all lanes.</b>	
iviType			The IVI messages issued are regulatoryMessages (1).	is 1
iviPurpose				
laneStatus				
vehicleCharacteristics			Not used, but still optional. Restriction is given by roadsign in priority.	
driverCharacteristics				
layoutId				
preStoredLayoutId				
roadSignCodes			The roadSignCodes used are : <ul style="list-style-type: none"> <li>◦ Regulatory, nature 4, serial 99 with VED/WID attributes (restriction about vehicle width).</li> <li>◦ Regulatory, nature 5, serial 11 with VED/HEI attributes (restriction about vehicle height).</li> <li>◦ Regulatory, nature 5, serial 12 with VED/WEI attributes (restriction about vehicle weight).</li> <li>◦ Regulatory, nature 5, serial 57 with SPE/SPM attributes (restriction about speed limit)</li> <li>◦ Warning, nature 2, serial 68 (warning about irregular ground)</li> <li>◦ Public Facilities, nature 1, serial 14 (use the emergency phone)</li> </ul>	
extraText			May be used to complete the roadsign of "emergency phone" with a message which can be "USE THE EMERGENCY PHONE".	
Road Configuration Container				
Text Container				
Layout Container	