

Priority services for target groups

Functional description for Emergency
Services, Public Transport and Logistics
version 1.0.0



Over deze publicatie

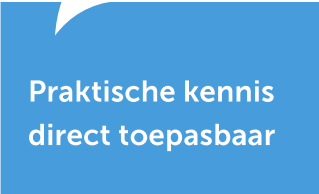
De internationale ontwikkeling van Smart Mobility zorgt voor flinke vernieuwingen in verkeer, vervoer en mobiliteit. Dit raakt direct ook de verkeersregelinstallaties in de Nederlandse steden en provincies en op rijkswegen. Als verkeersregelinstallaties kunnen communiceren met voertuigen en weggebruikers kunnen weggebruikers worden geïnformeerd over actuele fasewisselingen van verkeersregelinstallaties en hierop hun rijgedrag vroegtijdig aanpassen, kunnen doelgroepen als openbaar vervoer, nood- en hulpdiensten en vrachtwagens conform beleidswensen van overheden worden geprioriteerd en kan data van voertuigen zelf worden gebruikt voor betere netwerkregelingen. Dit bevordert doorstroming, bereikbaarheid, verkeersveiligheid en duurzaamheid, legt de basis voor connected en automated driving en speelt in op een digitale samenleving waarin data en connectiviteit bijdragen aan economisch aantrekkelijke en duurzame steden.

Voor het effectief, veilig en leveranciers- en overheidsonafhankelijk communiceren van intelligente verkeersregelinstallaties (iVRI's) met voertuigen en weggebruikers hebben bedrijven en overheden in het Innovatiepartnership Talking Traffic binnen internationale standaarden gezamenlijk specificaties en koppelvlakken voor iVRI's vastgelegd. Eenduidig gebruik door alle overheden en betrokken bedrijven van deze uniforme afspraken binnen internationale standaarden is noodzakelijk voor interoperabiliteit en een goede en betrouwbare werking. Deze standaarden zijn daarom vastgesteld door de landelijke publiek-private Strategic Committee 'Borgen en beheren iVRI standaarden en producten'. Na vaststelling gelden deze standaarden voor alle bedrijven en overheden die in Nederland (willen gaan) werken aan iVRI's t.b.v. intelligente mobiliteit. Vanuit de rol van onafhankelijk en landelijk kennisinstituut verzamelt CROW deze landelijk vastgestelde standaarden en stelt deze transparant ter beschikking aan overheden, adviesbureaus en leveranciers.

About this publication

The international developments in Smart Mobility technology are boosting innovations for traffic, transportation and mobility. This has a direct effect on traffic control systems in Dutch cities and provinces, as well as national highways. When traffic controllers are able to communicate with vehicles and road users, the latter can be informed about real-time phase changes in traffic lights, enabling them to anticipate and adjust driving behaviour accordingly. Also, special interest groups, such as emergency services, public transport and freight carriers, can be prioritized in line with public policy guidelines. The data provided by vehicles themselves can be utilised to improve network-based traffic control programmes. This has a positive effect on flow, accessibility, traffic safety and sustainability, laying out the fundamentals for connected and automated driving and preparing for a digital society in which data and connectivity contribute to economically viable and sustainable cities.

In order to let intelligent traffic controllers (iVRI) communicate with vehicles and road users in an effective, safe and platform independent way, businesses and governments have created and recorded common specifications and interfaces for iVRI technology. These are compliant to international standards and developed within the framework of the Talking Traffic Innovation partnership. The unambiguous use of these uniform agreements, within international standards, by all governmental bodies and businesses is necessary for interoperability and a good and reliable operation. These standards are adopted by the national public-private Strategic Committee 'Ensuring and maintaining iVRI standards and products'. After adoption, these standards apply to all businesses and governmental bodies in the Netherlands that work, or plan to work, on iVRI technology for intelligent mobility purposes. Being an independent national knowledge institute, CROW collects these national standards and provides them to governments, consultants and suppliers in a transparent way.



Praktische kennis
direct toepasbaar

Priority services for target groups

**Functional description for Emergency Services,
Public Transport and Logistics**

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1 Introduction

1.1 Overview

Until the end of 2020, the Dutch ministry of infrastructure (I&W), local authorities and commercial companies are investing 90 million Euro in the Partnership Talking Traffic. The partnership of the traffic, telecommunications, internet, and automotive industry has been formed to develop and deploy innovative traffic solutions: intelligent traffic light controllers (iTLCs), cloud services and improved information services.

An important use of these systems is to provide priority to specific target groups. For example a traffic controller (iTLC) can provide a bit more green time to heavy trucks, reducing the need to brake and accelerate. This reduces emissions and improves the traffic flow. Also other target groups like public transport and emergency services can be given priority, dependent on their location, route and the policy of the local authorities. By aligning traffic flows and individual road users the overall traffic flow, safety and air quality are improved.

1.2 Goal of this document

This document describes how, in the Talking Traffic environment, priority services must be handled by intelligent traffic controllers (iTLCs) for the target groups public transport, emergency services and logistics.

In chapter 2 the generic principles of the priority services are described. Chapter 3 captures the generic priority use case, including exceptions. The chapter 4, 5 and 6 describe use cases for the specific target groups.

The use cases refer to the specific Dutch standards to specify the data elements that have to be exchanged. See <https://www.crow.nl/thema-s/verkeersmanagement/landelijke-ivri-standaarden>.

1.3 Revisions

Revisions		
Version	Date	Description
0.1	20-11-2019	Werkdocument concept versie opgesteld.
0.2	13-12-2019	Opmerkingen uit eerste werkgroep overleg (29/11) te verwerken. Use cases eerst op abstracter niveau, minder technisch niveau, beschrijven.
0.3	16-01-2020	Opmerkingen verwerkt n.a.v. het tweede werkgroep overleg (19/12) en aanvullende review binnen de werkgroep.
0.4	10-2-2020	Opmerkingen verwerkt n.a.v. het derde werkgroep overleg (23/1/2020)
0.5	14-2-2020	Opmerkingen verwerkt n.a.v. het vierde werkgroep overleg (20/2/2020)
0.6	04-03-2020	Use cases toegevoegd: Openbaar Vervoer, Vrachtverkeer (Eco)
0.7	18-03-2020	Use cases Openbaar Vervoer aangepast n.a.v. werkgroep overleg (6/3/2020) Tabel m.b.t. prioriteitslevels / uitgangspunten toegevoegd.
0.71	29-03-2020	Excepties uitgewerkt na aanvullende review binnen de werkgroep.
0.8	31-03-2020	Hoofdstuk 2 verwijderd i.v.m. overlap in uitwerking. ETA berekening en SSM status naar hoofdstuk 2 verplaatst. Hoofdstuk 3 beschrijft nu de generieke use case prioriteren (inclusief excepties). Hoofdstuk 4 t/m 6 beschrijven specifieke use cases door middel van afwijkingen t.o.v. de generieke use case van hoofdstuk 3.
0.81	07-04-2020	Paragraaf 2.7 SRM role en subrole toegevoegd, Paragraaf 2.8 StationType en 2.9 Openbaar Vervoer toegevoegd. Role en subrole uitgewerkt bij de use cases onder Normale Flow
0.9	08-04-2020	Afronding na werkgroep overleg. Versie gereed voor praktijk beproeving.
0.9	14-04-2020	English translation
1.0.0	29-07-2020	Correction H2.5 ETA calculation (travel time MAP area) and table 2 (SSM states)

2 General Priority Services

2.1 Use Cases

The next chapters contain various priority use cases for specific target groups. A use case defines the interaction between a number of actors to provide priority for an oncoming vehicle. Each use case description contains the following sections:

- Goal: a short description of the aim of the use case.
- Actors: the actors active in this use case. An actor describes the role being played by a person or a system.
- Pre-condition: the requirements that have to be met before the use case can start.
- Trigger: the event that starts the use case.
- Normal flow: the flow of events under normal conditions (happy flow).
- Post-condition: the state reached after the use case ends.

2.2 Actors

iTLC: An iTLC controls the traffic lights at one intersection. It consists of the following three components:

- ITS-application: contains the traffic control algorithm and supports among others the use cases informing, optimising and/or prioritising.
- The Traffic Light Controller (TLC) that controls and safeguards the traffic lights.
- The Roadside ITS Station (RIS) that provides the connection to the cloud. It also provides map matching of vehicles, bicycles and pedestrians on a digital map.

RO: The Road Operator uses policy rules to define the way traffic is controlled at an intersection. The RO also makes sure the rules for priority services are captured in the PBC.

PBC: The PBC (Priority Broker Configurator) is a central place where road operators (ROs) can digitally capture and maintain the criteria for vehicles that want to get priority at intersections. The rules defined in the PBC are used by the PRG to determine if a priority request is allowed to be serviced.

OBU: The OBU (On Board Unit) is a vehicle system that allows real time communication. It sends real time location information (GPS coordinates, heading and speed) to the PRG. An OBU can have a Human Machine Interface (HMI) to interact with the driver (the HMI is out of scope of this document).

PRG: The PRG (Priority Request Generator) is the function that sends priority requests to an iTLC. To be able to do this the PRG receives real time information from the OBU. Optionally, the PRG can use information from other sources. The PRG reports the status of the priority service to the OBU. Based on the rules from the PBC the PRG verifies if a vehicle is eligible to get priority at an intersection.

EB: The EB (External Blocking) is the collection of external input that can impact the priority service. For example information on an open bridge, tunnel closure or a closed railway crossing.

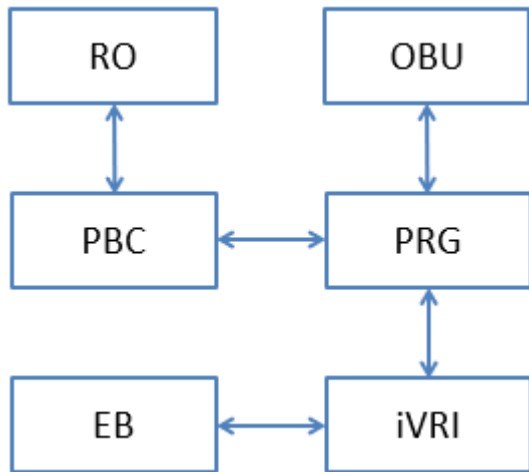


Figure 1. The relations between actors

2.3 Principles and Conditions

The following principles and conditions have been determined for the handling of priority for public transport, emergency services and logistics:

- The conditions that determine if a vehicle can get priority (for example blue light and siren for emergency vehicles, schedule deviations for public transport) are captured in the rules of the PBC.
- Privacy by design.
- The use cases are implemented in the Talking Traffic eco system. The communication between the Cloud and the road side systems runs through the TLEX and is based on ETSI messages (MAP, SPAT, CAM and SRM) according to the Dutch Profile.
 - MAP Data, Dutch Profile version 2.x.x
 - SPaT Data, Dutch Profile version 2.x.x
 - SRM Data, Dutch Profile version 2.x.x
 - SSM Data, Dutch Profile version 2.x.x
 - CAM Data, Dutch Profile version 2.x.x
- The HMI (in the vehicle) is outside the scope of the use cases.
- The PRG can request priority when the vehicle is at a large distance from the intersection (outside the range of the MAP).
- It is possible that there will be controlled and uncontrolled intersections, roundabouts etc. between the vehicle and the intersection for which priority is requested by the PRG.
- De PRG may request priority if the vehicle can reach the intersection in less than [5] minutes (MaxETA).
- When an iTLC answers a priority request with granted, the request cannot be cancelled by the iTLC anymore. The vehicle priority is guaranteed.
- The way an iTLC controls the traffic, and for examples reduces queues, is outside the scope of this document.
- Possible future functionality will be supported where possible:
 - Use of local knowledge in the iTLC to route vehicles. To know via which connection priority can be provided can become important for autonomous vehicles.
 - Support for situations where the other traffic cannot detect that priority is given. For example when providing priority to police vehicles.
- All actors between the vehicle and the iTLC must be able to provide diagnostic information on the processing of priority requests.
- CAM messages for a vehicle must be provided to the iTLC once per second as long as the vehicle is on the MAP. This is compliant with Talking Traffic. Outside the MAP CAM delivery is optional.

2.4 Priority Broker Configurator

The RequestImportanceLevels in the PBC uses the following principles:

- The iTLC uses the RequestImportanceLevel to determine the weight of a priority request. A higher number in the RequestImportanceLevel has a higher weight.
- The RequestImportanceLevels 1 up to and including 10 are used for conditional priority.
- The RequestImportanceLevels 11 up to and including 14 are used for absolute priority.
- The RequestImportanceLevels 0 and 15 are not used.

2.5 ETA calculation

The calculation of the Estimated Time of Arrival is based on the following principles:

- The ETA is calculated from the current vehicle position until the stop line in the ITF.
- The ETA is the addition of two travel times:
 - ETA = Travel time to MAP area + Travel time on MAP area.
 - Travel time to MAP area = determined by C2
 - Travel time on MAP area = Distance to the stop line / global SpeedLimit

2.6 SSM status

The unambiguous SSM status values, as used in this document, are defined in the table below.

ETSI	Dutch profile D3046-4 SSM data	According to this document
Unknown(0), Unknown state	unknown (0) not used	
requested (1), This prioritization request was detected by the traffic controller	requested (1) e.g. request was detected, awaiting map matching data	Acknowledge that the request has been received by the ITS application. The contents of the request have not yet been validated by the ITS application. The request is not used by the ITS application to determine the traffic control.
processing (2), Checking request (request is in queue, other requests are prior)	processing (2) e.g. request is technically approved, request is in queue.	The request has been validated by the ITS application, and is being processed. The request is used by the ITS application, and if necessary the traffic control is adapted accordingly. If the iTLC produces SPAT timing information the request has been incorporated.
watchOtherTraffic (3), Cannot give full permission, therefore watch for other traffic Note that other requests may be present	watchOtherTraffic (3) for emergency vehicles this value implies 'all red' priority.	A variant of the granted status, only used for emergency vehicles. All traffic signals are set to red (or will be set to red soon) allowing the emergency vehicle to pass the intersection while the other traffic is waiting for a red light. It is allowed to provide the watchOtherTraffic state to multiple emergency vehicles, from conflicting directions, that request priority at the same time.
granted (4), Intervention was successful and now prioritization is active	granted (4) prioritization is active, timing data to be derived from SPAT.	The ITS application will keep the traffic light green until the vehicle has passed the intersection. If the iTLC produces SPAT timing information the request has been incorporated. Specific for emergency vehicles (A1): the granted status can already been given at a

		moment that not all traffic lights are green and the intersection is still being cleared.
rejected (5), The prioritization or pre-emption request was rejected by the traffic controller	rejected (5) request was rejected	The priority request is rejected.
maxPresence (6), The Request has exceeded maxPresence time. Used when the controller has determined that the requester should then back off and request an alternative.	maxPresence (6) -- maximum presence time exceeded	The priority request is rejected with reason 'maxPresence'. This status can only appear after: - a timeout exception in the granted status, - a timeout exception in the processing status.
reserviceLocked (7), Prior conditions have resulted in a reservice locked event: the controller requires the passage of time before another similar request will be accepted	reserviceLocked (7) -- maximum number of requests for manoeuvre within time frame exceeded	The priority request is rejected with reason 'reserviceLocked'. In general this means that priority cannot be provided at the moment.

Table 1 SSM state

2.7 SRM role and subrole

The SRM fields role and subrole determine the requested use case.

2.7.1 Role

The role [BasicVehicleRole] is defined conform the CAM definition, ETSI TS 102 894-2 (CDD):

- default(0): default vehicle role as indicated by the vehicle type (DE_StationType),
- publicTransport(1): vehicle is used to operate public transport service,
- specialTransport(2): vehicle is used for special transport purpose, e.g. oversized trucks,
- dangerousGoods(3): vehicle is used for dangerous goods transportation,
- roadWork(4): vehicle is used to realize roadwork or road maintenance mission,
- rescue(5): vehicle is used for rescue purpose in case of an accident, e.g. as a towing service,
- emergency(6): vehicle is used for emergency mission, e.g. ambulance, fire brigade,
- safetyCar(7): vehicle is used for public safety, e.g. patrol,
- agriculture(8): vehicle is used for agriculture, e.g. farm tractor
- commercial(9): vehicle is used for transportation of commercial goods
- military(10): vehicle is used for military purpose
- roadOperator(11): vehicle is used in road operator missions
- taxi(12): vehicle is used to provide an authorized taxi service
- reserved(13-15)

Note: this definition is the same as the VehicleRole definition in the IDD RIS-FI (CROW D3047-4)

2.7.2 Subrole

The subrole [RequestSubRole] uses the following definition:

- requestSubRoleUnKnown (0),
- requestSubRole1 (1), -- bus
- requestSubRole2 (2), -- tram
- requestSubRole3 (3), -- metro
- requestSubRole4 (4), -- train
- requestSubRole5 (5), -- emergency (with or without blue light and/or siren)
- requestSubRole6 (6), -- smooth transport
- requestSubRole7 (7), -- timetable drive
- requestSubRole8 (8), -- regularity drive

- requestSubRole9 (9), -- high quality public transport ("HOV")
- requestSubRole10 (10), -- outside service public transport vehicle
- requestSubRole11 (11), -- platoon
- requestSubRole12 (12), -- EcoDriving
- requestSubRole13 (13),
- requestSubRole14 (14),
- requestSubRoleReserved (15)

Remarks:

- Subrole 11 has been added to indicate a platoon or convoy of vehicles that must pass the green light together.
- Subrole 12 has been added to support EcoDriving trucks.
- The definition of VehicleSubRole in the IDD RIS-FI (CROW D3047-4) must be changed to include these new definitions.

2.8 StationType

The iTLC cannot determine the use case to use when the SRM message contains a role value default (0). Consequently priority will be rejected unless the iTLC has received a CAM message prior to the SRM message. In that case the iTLC will use the StationType (from the CAM message) to select the use case.

Note: the above does not apply to the use cases described in this document. As no roles have been defined for, among others, bicycles and pedestrians, the StationType can be used to select future priority use cases.

2.9 Public Transport

2.9.1 SRM

It is mandatory to set the line number of a public transport vehicle in the routeName [Descriptive-Name] field.

The line number must be identical to the line number in the PtActivation data (CAM).

2.9.2 CAM:PtActivation

For public transport vehicles that request priority the following requirements for the PtActivation data in the CAM message must be met:

- The line number is mandatory.
- The other fields are optional, if the value is unknown the value 0 must be used.
- The Vehicle ID must only be used if also the Company number is provided. The combination of Vehicle ID and Company number must be unique.

Octet #	Field name	Value
0,1	Line nr PT	The line number of the vehicle (1..9999)
2,3	Vehicle ID	The vehicle ID (1...9999)
4,5	Block nr	Vehicle Service number/Block number (1...)
6,7	Journey nr	Journey number (1...)
8,9	Support journey nr	
10	Company nr	The number of the transport company
11,12	Occupancy	The number of passengers in the vehicle

3 Priority Use Case

3.1 Actors

- iTLC, RO, PBC, OBU, PRG, EB

3.2 Pre-Conditions

- The intersection is controlled by an iTLC that supports the Priority Use Case.
- The OBU of the vehicle provides the required data.
- The PBC has been configured for the intersection according to the policy for priority vehicles of the RO.
- The full chain of the services, including the PRG, is operational.
- All system clocks of the actors are synchronised.

3.3 Trigger

- The PRG determines, based the current vehicle data from the OBU, that the vehicle will pass the intersection within [5] minutes.

3.4 Normal Flow

- The PRG determines which connection of the intersection the vehicle will take.
- The PRG validates the priority request with the rules stored in the PBC and determines the priority level.
- The PRG validates that the estimated time of arrival (ETA) of the vehicle is within [5] minutes.
- De PRG sends a priority request (SRM – priorityRequest) to the iTLC.
- The iTLC acknowledges the receipt of the SRM message within [1] second and sends a response (SSM – Requested, Processing, Granted/WatchOtherTraffic) to the PRG.
- The PRG forwards the status to the OBU.

3.4.1 Feedback

- Periodically the iTLC determines the actual status (requested, processing, granted, watchOtherTraffic) of the priority request.
- On a status change the iTLC will inform the PRG (SSM - requested, processing, granted, watchOtherTraffic).
- The PRG forwards the current status to the OBU.
- The iTLC will inform the PRG on changes in the SPAT timing information.
- The PRG forwards the timing information to the OBU.
- For directions that will encounter additional waiting time the iTLC will send out SPAT messages with 'reason for waiting' information.

3.4.2 Update

- The PRG determines that the last priority request message (SRM – priorityRequest, priorityRequestUpdate) has been sent more than [10] seconds ago.
- The PRG sends a priority update message (SRM – priorityRequestUpdate) with the current ETA to the iTLC.
- The iTLC replies to the PRG with an SSM message containing the current status.
- The PRG forwards the current status to the OBU.

3.4.3 ETA change

- The PRG periodically calculates the ETA, and determines that the ETA differs from the previously sent one.
- The PRG sends a priority update (SRM – priorityRequestUpdate) with the current ETA to the iTLC.
- The iTLC replies to the PRG with an SSM message containing the current status.
- The PRG forwards the current status to the OBU.

3.4.4 Change in vehicle features

- The PRG determines that the vehicle characteristics have changed.
- The PRG validates the priority request based on the PBC rules and determines the priority level.
- The PRG sends a priority update (SRM – priorityRequestUpdate) to the iTLC.

- The iTLC replies to the PRG with an SSM message containing the current status.
- The PRG forwards the current status to the OBU.

3.4.5 Passing the stop line

- The PRG determines that the vehicle has passed the stop line and terminates the priority request (*SRM - priorityCancellation*) with the iTLC.
- The iTLC removes the priority request and adapts the traffic control if necessary.
- The PRG forwards the current status to the OBU.

3.5 Post-Conditions

- Normal traffic control is active in the iTLC.
- The PRG will not request priority again as long as the vehicle continues on the planned route over the intersection, not yet passing the intersection and the trigger condition being true.

3.6 Exception flows

For the handling of exceptions the following exception flows are used:

3.6.1 Flow: PRG_end_priorityrequest

- The PRG send a cancellation message (*SRM - priorityCancellation*) to the iTLC.
- The PRG forwards the current status (*cancellation*) to the OBU.
- The iTLC removes the priority request.
- The iTLC adapts, if necessary, the traffic control (normal control).

3.6.2 Flow: iTLC_reject

- The iTLC sends a rejection message (*SSM - rejected*) to the PRG.
- The PRG send a cancellation message (*SRM - cancellation*) to the iTLC.
- The iTLC removes the priority request.
- The PRG forwards the current status (*rejected*) to the OBU.

3.6.3 Flow: iTLC_reject_max_presence

- The iTLC sends a rejection message (*SSM - maxPresence*) to the PRG.
- The PRG send a cancellation message (*SRM - cancellation*) to the iTLC.
- The iTLC removes the priority request.
- The PRG forwards the current status (*maxPresence*) to the OBU.

3.6.4 Flow: iTLC_reject_reservice_locked

- The iTLC sends a rejection message (*SSM - reserviceLocked*) to the PRG.
- The PRG send a cancellation message (*SRM - cancellation*) to the iTLC.
- The iTLC removes the priority request.
- The PRG forwards the current status (*reserviceLocked*) to the OBU.

3.6.5 Flow: iTLC_ETA_out_of_range

- The iTLC sends a rejection message (*SSM - rejected*) to the PRG.
- The iTLC adapts the traffic control if necessary.
- The PRG send a cancellation message (*SRM - cancellation*) to the iTLC.
- The iTLC removes the priority request.
- The PRG forwards the current status (*rejected*) to the OBU.

3.7 Exceptions

3.7.1 Exception #1 (Rejected by iTLC – invalid priority request)

The iTLC cannot fulfil a priority request because it is invalid. Possible causes among others: missing ETA, ETA in the past or more than [5] minutes in the future, missing priority class.

Handling:

- The priority handling is not activated.
- Flow: iTLC_reject

3.7.2 Exception #2 (Reject – reservice locked - by iTLC)

The iTLC cannot fulfil a priority request because too many priority requests have been allowed previously. Providing priority again would have too much impact on the other traffic.

Handling:

- The priority handling is not activated.
- Flow: iTLC_reject_reservice_locked

3.7.3 Exception #3 (Reject by iTLC)

The iTLC cannot fulfil a priority request. Reasons could be that *EB* is active or that another priority request (with a higher priority) has already been planned.

Handling:

- The priority handling is not activated.
- Flow: iTLC_reject

3.7.4 Exception #4 (SRM Update timeout)

The iTLC did not receive an update (SRM) for a vehicle for more than [10 + 5] seconds.

Handling:

- The iTLC ends the priority service.
- Flow: iTLC_reject

3.7.5 Exception #5 (ETA increase)

The iTLC receives an update with an ETA value later than the previous value, as a result the priority request cannot be handled anymore.

Handling:

- The iTLC sends a message (*SSM - requested*) to the PRG.
- The iTLC adapts the traffic control if necessary.

3.7.6 Exception #6 (Reject by iTLC during priority handling)

The iTLC is servicing a priority request (*SSM - requested* has been sent) but concludes that the request cannot be handled anymore.

Handling:

- The iTLC ends the priority service.
- Flow: iTLC_reject

3.7.7 Exception #7 (Processing timeout by iTLC)

The iTLC concludes that a priority request has been in the state processing for too long [MaxProcessing].

Handling:

- The priority handling is not activated.
- Flow: iTLC_reject_max_presence.

3.7.8 Exception #8 (Granted timeout)

The iTLC has locked the traffic control for a vehicle for too long, longer than the maximum time defined by the road operator (RO).

Handling:

- The iTLC ends the priority service.
- Flow: iTLC_reject_max_presence.

3.7.9 Exception #9 (Vehicle characteristics)

The PRG determines (based on the PBC rules) that a vehicle is not eligible to get priority.

Handling:

- The PRG will not request priority at this specific intersection.
- The PRG indicates to the OUB that the vehicle is not eligible to get priority. The reason why is passed to the OBU by the PRG.

3.7.10 Exception #10 (Invalid ETA)

The PRG determines during the re-calculation of the ETA that the ETA is larger than MaxETA.

Handling:

- Flow: PRG_end_priorityrequest

3.7.11 Exception #11 (Vehicle characteristics have changed)

The PRG determines (while validating a priority request update) that, based on the PBC rules, the vehicle no longer is eligible to get priority.

Handling:

- Flow: PRG_end_priorityrequest

3.7.12 Exception #12 (Change in Connection and/or approach at the same intersection)

The PRG determines that the vehicle will take a different connection and/or approach at the intersection.

Handling:

- Flow: PRG_end_priorityrequest
- The PRG initiates a new priority request (normal flow).

3.7.13 Exception #13 (Changed route, not involving the intersection anymore)

The PRG determines that the vehicle will no longer pass the intersection.

Handling:

- Flow: PRG_end_priorityrequest

3.7.14 Exception #14 (No cancellation received by the iTLC)

The iTLC expects a cancellation, but did not receive it after [60] seconds.

Handling:

- The iTLC removes the priority request.

3.7.15 Exception #15 (SSM not received on time)

The PRG did not, within [1] second, receive an SSM after sending an SRM.

Handling:

- The PRG logs the error
- The PRG sends an SRM update
- After [3] successive errors, the PRG the Flow: *PRG_end_priorityrequest*

4 Use case: Priority for Emergency Vehicles (A1-drive, smooth transport)

4.1 Goal

The use case for Emergency Vehicles (A1-drive) aims to provide a safe and quick passage over a controlled intersection. In case of 'smooth transport' the aim is to provide a safe passage avoiding decelerations and accelerations.

A1-urgency (A1-drive)

An emergency drive ordered by a central operator in case of an acute threat to the vital functions of a patient, or in case of a danger that can only be excluded by local assessment of an ambulance unit. The drive is ordered as soon as possible and the ambulance unit should be at spot as quickly and safely as possible.

The ambulance uses optical and audible signals. For an emergency vehicle that is performing an A1-drive altered traffic rules apply (allowing to violate the maximum speed limit, etc.).

<https://www.ifv.nl/kennisplein/Documents/20160101-VVN-AmbulancezorgNL-Brancherichtlijn-optische-en-geluidssignalen-SMH.pdf>

Smooth transport

During smooth transport the driver complies with the normal traffic rules, the vehicle must pass a traffic light during the green phase.

4.2 Actors

- iTLC, RO, PBC, OBU, PRG, EB

4.3 Pre-Conditions

- The intersection is controlled by an iTLC that supports the use case Emergency Vehicle Priority.
- The PBC has been, according to the policy of the RO, configured to allow A1-drives or smooth transport for emergency vehicles.

4.4 Trigger

- The PRG determines, based on current vehicle data from the OBU, that the emergency vehicle is executing an A1-drive or smooth transport drive and will pass the intersection within [5] minutes.

4.5 Normal Flow

- The iTLC determines, based on the *role*= emergency (6) and *subrole*= requestSubRole5 (5), -- emergency, that A1-drive priority has been requested.
- The iTLC determines, based on the *role*= emergency (6) and *subrole*= requestSubRole6 (6), -- 'smooth transport', that smooth transport priority has been requested.

4.6 Post-Conditions

4.7 Exceptions

4.7.1 Exception #20 (Unknown Connection)

The PRG is not able to determine which *connection* the vehicle will take across the intersection.

Handling:

- The PRG uses a priority request based on an *approach*.
- The PRG finds all signal groups of the approach in the PBC, and uses the highest priority class found.

5 Use Case: Public Transport Priority

5.1 Goal

The Public Transport Priority use case aims to let public transport vehicles to pass a controlled intersection faster, given that certain criteria are met (for example the vehicle is late with respect to the time table).

5.2 Actors

- iTLC, RO, PBC, OBU, PRG, EB

5.3 Pre-Conditions

- The intersection is controlled by an iTLC that supports the use case Public Transport Priority.
- The PBC has been, according to the policy of the RO, configured to allow priority for public transport vehicles at the intersection.

5.4 Trigger

- The PRG determines, based on current vehicle data from the OBU, that the public transport vehicle is in service and will pass the intersection within [5] minutes.

5.5 Normal Flow

- The iTLC determines, based on role= publicTransport (1) and subrole= don't care, that priority for a public transport vehicle has been requested.
- The iTLC uses the routeName field in the SRM to determine the line number.

5.6 Post-Conditions

5.7 Exceptions

5.7.1 Exception #21 (Unknown Connection)

The PRG is not able to determine which *connection* the vehicle will take across the intersection.

Handling:

- Flow: PRG_end_priorityrequest

6 Use Case: Priority for Trucks

6.1 Goal

The use case Priority for Trucks lets trucks pass an intersection with a minimum use of energy as possible ("green"), at moments this is possible within the control policy. This is realised by minimising the number of stops, leading to less accelerations and decelerations.

6.2 Actors

- iTLC, RO, PBC, OBU, PRG, EB

6.3 Pre-Conditions

- The intersection is controlled by an iTLC that supports the use case Priority for Trucks.
- The OBU of the truck provides the required data (among others the route the truck will take across the intersection).
- The PBC has been, according to the policy of the RO, configured to allow priority for trucks at the intersection.

6.4 Trigger

- The PRG determines, based on current vehicle data from the OBU, that the truck is in service and will pass the intersection within [5] minutes.

6.5 Normal Flow

- The iTLC determines, based on role= commercial (9), that priority for a truck has been requested.
- Based on the subRole it is determined which use case for commercial traffic must be selected:
 - subRole=requestSubRoleUnKnown (0)
 - subRole=requestSubRole11 (11), -- 'platoon'
 - subRole=requestSubRole12 (12), -- 'EcoDriving'
- The iTLC determines, based on role= dangerousGoods (3) and subRole=don't care, that priority for a truck with dangerous goods is being requested.
- The iTLC determines, based on role=specialTransport (2) and subRole=don't care, that priority for special transport is being requested.

Note: For EcoDriving the iTLC will provide priority if the vehicle can pass the intersection without stopping.

6.6 Post-Conditions

6.7 Exceptions

6.7.1 Exception #21 (Unknown Connection)

The PRG is not able to determine which *connection* the vehicle will take across the intersection.

Handling:

- Flow: PRG_end_priorityrequest

7 Appendix A: SSM status diagram

7.1 Normal flow

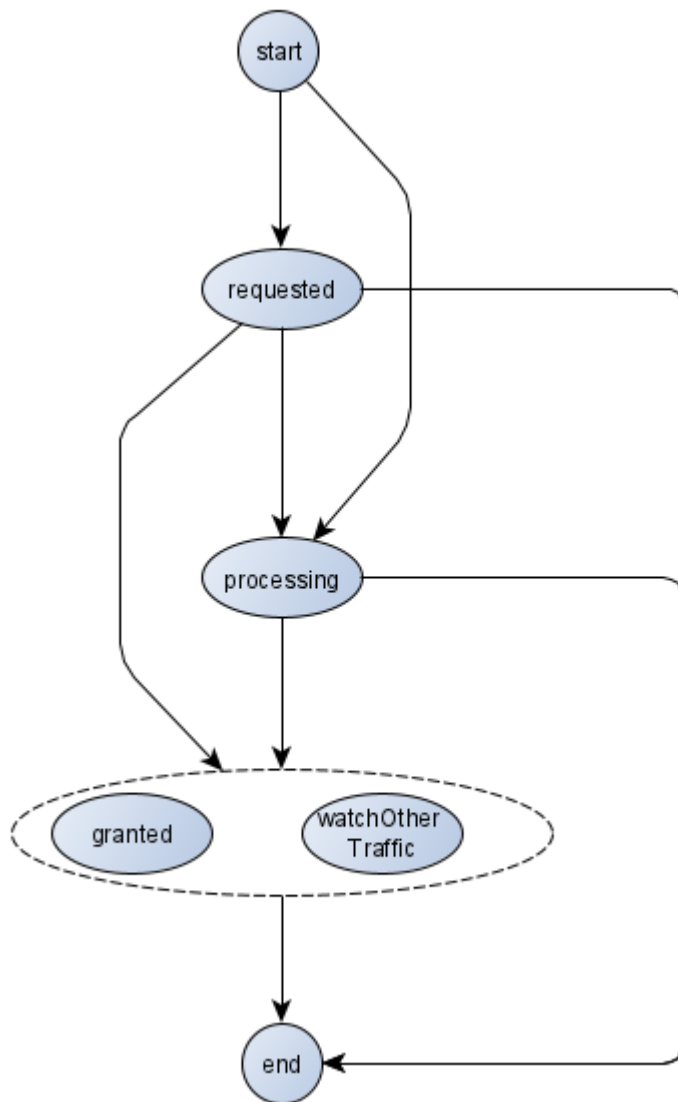


Figure 2 SSM status diagram – normal flow

7.2 Exceptions

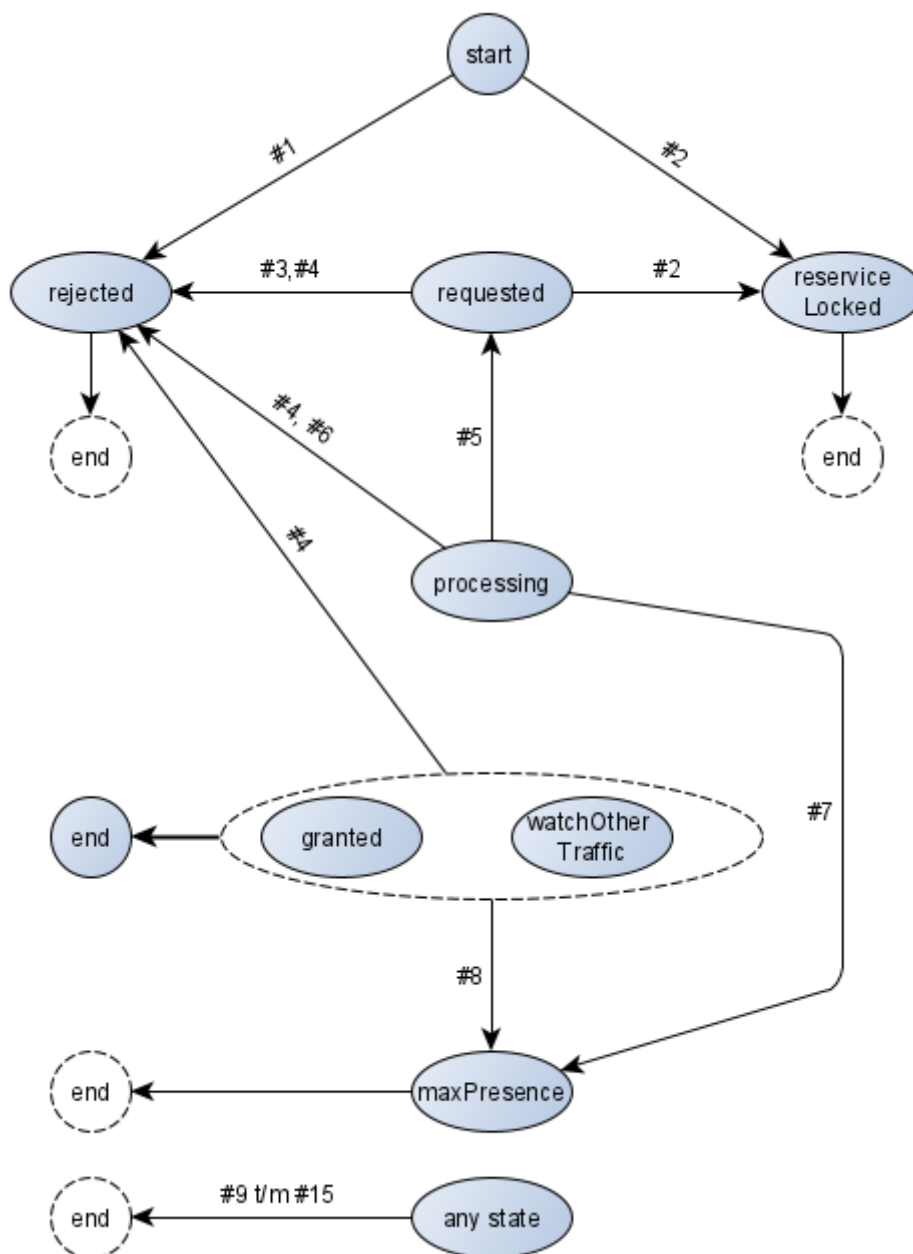


Figure 3 SSM status diagram - exceptions

#1 (Rejected by iTLC – invalid priority request)	#9 (Vehicle characteristics)
#2 (Reject – reservice locked- by iTLC)	#10 (Invalid ETA)
#3 (Reject by iTLC)	#11 (Vehicle characteristics have changed)
#4 (SRM Update timeout)	#12 (Change in Connection and/or approach at the same intersection)
#5 (ETA increase)	#13 (Changed route, not involving the intersection anymore)
#6 (Reject by iTLC during priority handling)	#14 (No cancellation received by the iTLC)
#7 (Processing timeout by iTLC)	#15 (SSM not received on time)
#8 (Granted timeout)	

8 Appendix B: SSM status sequences

For diagnostic purposes the order of the SSM status values can be used to draw conclusions on the handling of the priority request. This is explained in the table below.

Status	Explanation
[requested] → [processing] → granted	This is the normal flow. The ITS application has used the priority request in its control and possibly the vehicle has passed the intersection more quickly.
[requested] → processing	The normal flow, without granted. The ITS application has used the priority request in its control and possibly the vehicle has passed the intersection more quickly.
[requested] → rejected.	The priority request has been rejected. This could have been caused by for example: <ul style="list-style-type: none"> - The ITS application does not support the requested priority service. - The priority service in the ITS application has been (temporarily) disabled. - The intersection is not being controlled by an ITS application (for example it is amber flashing or turned off).
[requested] → processing → rejected	The priority request was accepted, however it cannot be serviced at this moment (any more). This could have been caused by for example: <ul style="list-style-type: none"> - An incoming priority request with a higher priority - An eco-driving truck cannot pass the intersection without stopping, therefore the priority service is cancelled. - Exception #4 (SRM Update timeout)
[requested] → reserviceLocked	The priority request has been accepted, however the priority service is not available because it would have too much of a negative impact on the traffic flow at the intersection.
[requested] → processing → reserviceLocked.	The priority request was accepted, however it cannot be serviced at this moment any more. This sequence will normally only happen when a priority request was made from a large distance; initially the request was accepted, but later on the ITS application concludes that the priority service is not available because it would have too much of a negative impact on the traffic flow at the intersection
[requested] → processing → maxPresence	Exception #14
[requested] → [processing] → granted → maxPresence	Exception #11
[requested] → [processing] → granted → rejected	Exception #4 (SRM Update timeout)

Tabel 2 SSM status sequencies

9 Appendix C: Background information

<https://www.ifv.nl/kennisplein/Documents/20181119-IFV-Het-gebruik-van-optische-en-geluidssignalen-in-de-nacht.pdf>

Emergency vehicle drivers are authorized to drive with optical and audible signals (OAS) during emergency drives (Priority 1 and A1 incidents). When drivers use these signals, they are a priority vehicle and may use certain exemptions from the Road Traffic and Traffic Signs Regulations 1990 (RVV 1990).

- Drivers working with the ambulance may in some cases also use OAS for A2 trips. This research focuses only on A1 rides.
- The police may also use exemptions from the RVV 1990 without optical and audible signals.

<https://www.ifv.nl/kennisplein/Documents/20171019-IFV-Overzicht-van-verkeersbevoegdheden-bij-gebruik-van-vrijstellingen.pdf>

Ignoring a red traffic light occurs at a speed of up to 20 kilometres per hour. At bridges and level crossings, the red light is not ignored and driving is prohibited (article 3 ROGs and industry directive).

Approaching and crossing intersections is done at an adjusted speed. When entering the intersection, the driver of the priority vehicle should assume that other road users have not noticed him and may therefore not let him go ahead. Therefore the driver must stop if necessary (Industry directive).

The driver crosses the intersection as close to the centre of the intersection as possible. Preferably, existing free traffic space is used instead of creating free space. Preferably, the following is chosen, in order of preference:

- the normal driving lane for the chosen direction,
- the driving lane in the opposite direction (Guideline for special traffic rights).

Colophon

Priority services for target groups. Functional description for Emergency Services, Public Transport and Logistics

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