Multimodal Cargo Transport Optimisation

Service high level description

Service introduction	
Summary	The Multimodal Cargo Transport Optimisation (MCTO) is a service helping the truck driver when transporting containers to a terminal and crossing the channel.
Background	Often truck drivers have to wait for some time when they arrive on a logistic hub / terminal. This service is meant to provide a more accurate estimated time of arrival and to optimize the planning for (un)loading trucks at logistic hubs terminals.
Objective	Optimizing the predictability of travel times for cargo transport, decreasing waiting times at logistics hubs / terminals, simplifying access to the port and terminals.
Expected benefits	For the driver: Simplification of terminal access, gain of time, less stress, problem anticipation. For Terminal operator: Optimized truck flow management around the port. For Port authorities, reduction of the traffic volume of trucks at the entrance of the port and reduction of risks of accidents and congestion.
Use Cases	1. Estimated Time of Arrival (ETA) for trucks 2. Estimated Time of Arrival (ETA) for terminal operators 3. Dock reservation 4. Optimal route advice for trucks 5. Balanced Priority for dedicated vehicles

1. Estimated Time of Arrival (ETA) for trucks

Functional description

Use case introduction	
Summary	Optimization of cargo transport to logistic hubs by improving predictability of truck travel times.
Background	Often truck drivers have to wait for some time when they arrive on a logistic hub. This service is meant to provide a more accurate estimated time of arrival.
Objective	Optimizing the predictability of travel times for cargo transport (a more precise prediction of estimated time of arrival (ETA)) and decreasing waiting times at logistics hubs.
Desired behaviour	Transport planners planning routes for trucks taking into account real-time traffic information.
Expected benefits	The expected impact is a reduction in loss of time (less waiting time) for truck drivers at logistic hubs.
Use case description	
Situation	Transport planners plan trucks arriving in specific timeslots, based on real-time traffic information. Transport planners provide this information to truck drivers.
Logic of transmission	Will be provided at technical description phase
Actors and relations	• Vehicle driver / truck driver: Receives his route, based on real-time traffic information. • Road operator: n/a. • Service provider: n/a. • End user: see vehicle driver & transport planner. • Vulnerable road user: n/a. • Other: 1. Transport planners: Receive real-time traffic information and plan cargo transport. 2. Traffic system operators: Provide real-time traffic information. 3. Data provider: Collects information from traffic systems and aggregates them into a single data source which can be accessed at a data access point.
Scenario	1. Traffic systems provide real-time traffic information to a data access point. 2. In the data access point real-time traffic information is available. 3. This service provides information on real-time traffic information to transporters. 4. Transport planners use this service to assign routes to trucks. 5. Truck drivers receive the routes assigned by transport planners on their HMI.

Display / alert principle	The end user (truck driver) receives his route on his HMI.
Functional Constraints / dependencies	

High level technical description

<table>
<tr><th colspan="2">Use case implementation</th></tr>
<tr><td>Model implementation</td><td>
1. Transport planners assign routes to trucks, based on real-time traffic information.
2. Truck drivers receive the routes assigned by transport planners.
3. This service provides to transporters (transport planners and truck drivers) real-time traffic information.
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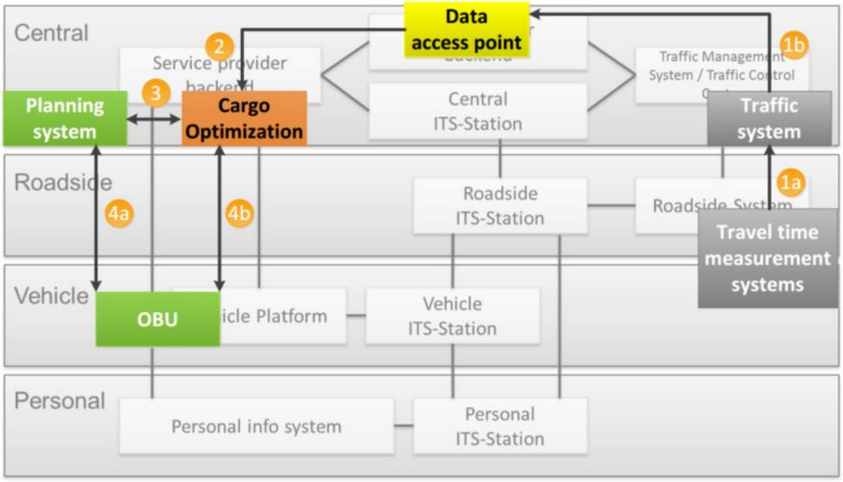
<tr><td>Reference architecture</td><td>


Every color could indicate another stakeholder

The process for this service contains several steps:
1. A traffic system gains information on travel times from travel time measurement systems (1a) and provides this gained information to a data access point (1b). It is possible to have more than one traffic system.
2. The service Cargo optimization gets information about travel times from a data access point (2) and provides this information as a service to its customers, transport companies:
- Planning systems (3) &
- OBUs (4b) (= monitoring system in a truck like Fleet Management Systems)
3. Planning systems use this information to plan routes for (a fleet of) trucks and send these routes to the trucks (4a).
</td></tr>
<tr><th colspan="2">Functional and non-functional requirements</th></tr>
<tr><td>Sources of information</td><td>Travel time measurement systems.</td></tr>
<tr><td>Standards</td><td>n/a.</td></tr>
<tr><td>Technical Constraints / dependencies</td><td></td></tr>
</table>

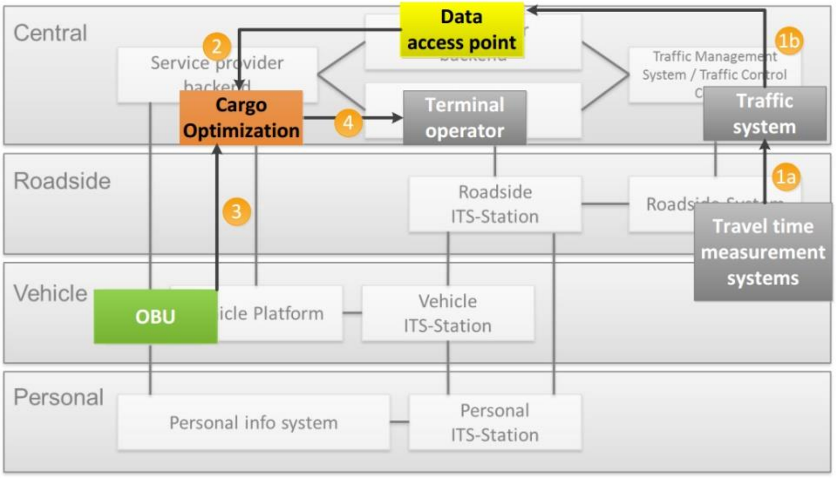
2. Truck ETA (Estimated Time of Arrival) for terminal operators

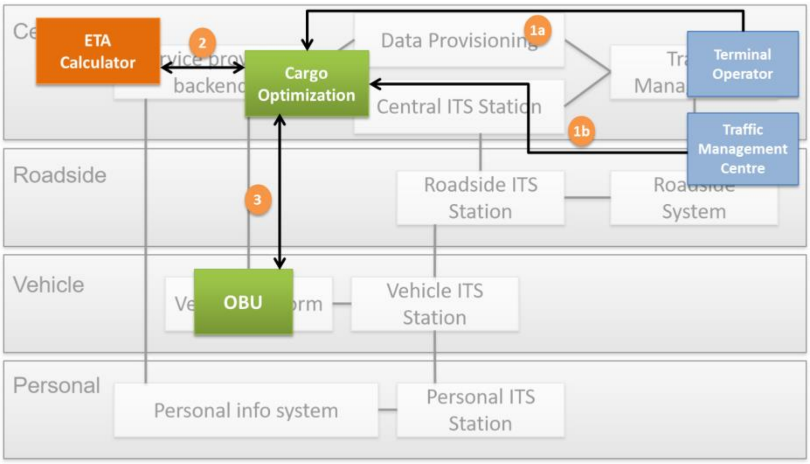
Functional description

Use case introduction	
Summary	Optimization of cargo transport to logistic hubs by giving to the terminal a real-time information on truck ETA (Estimated Time of Arrival).
Background	Often truck drivers have to wait for some time when they arrive on a logistic hub. This service is meant to provide to terminal operators at logistic hubs a more accurate estimated time of arrival. When terminal operators know the ETA of the trucks, then it is possible to optimize the planning for (un)loading trucks.
Objective	For a terminal operator to be informed regularly (in real time) of the ETA of a truck, to broadcast information on port entrance, and decreasing waiting time at logistics hubs.
Desired behaviour	The terminal operators consult the ETA of trucks on a user interface taking into account real-time traffic information. The Terminal operators plan the (un)loading of trucks based on their ETA.
Expected benefits	The expected impact is a reduction in loss of time (less waiting time) for truck drivers at logistic hubs and better management of resource utilization.
Use case description	
Situation	A vehicle driver must transport a container from a storage location to a port (or to a logistic hub in general) to load it on a ship (or on another mode of transport). Truck drivers heading for logistic hubs provide to terminal operators their estimated time of arrival based on real-time traffic information. A vehicle driver must transport a container from a storage location to a port (or to a logistic hub in general) to load it on a ship (or on another mode of transport).
Logic of transmission	Will be provided at technical description phase
Actors and relations	• Vehicle driver / truck driver: Provides his location and destination via an HMI to a service provider. • Road operator: n/a. • Service provider: Receives real-time traffic information of a data provider Receives location and destination of trucks Calculates the estimated time of arrival (ETA) based on the information received Provides the ETA of trucks to end users • End user: o Truck driver : visualizes his ETA o Terminal operators at logistic hubs: receive information about Truck ETA and plan (un)loading trucks.

	◦ And possibly service providers that are the end-receivers of the data • Vulnerable road user: n/a. • Other: 1. Traffic system operators: Provide real-time traffic information. 2. Data provider: Collects information from traffic systems and aggregates them into a single data source which can be accessed at a data access point.
Scenario	<u>Main scenario</u> 1. Traffic systems provide real-time traffic information to a data access point. 2. In the data access point real-time traffic information is available. 3. Truck drivers provide their location and destination via an HMI to service providers. 4. This service calculates the ETA and provides the ETA to terminal operators. 5. Terminal operators use this service to plan (un)loading trucks at logistic hubs. <u>Alternative scenario</u> 1. The vehicle driver of the truck indicates his destination via his HMI. 2. The vehicle driver starts his trip. 3. This service receives this information, calculates an initial ETA and makes it available to the end user (terminal operator, road operator…). 4. The vehicle passes through geofenced areas. 5. This service receives new positions and detects the crossing of geofence zones. 6. It updates the ETA. 7. It centralizes the information to make it available to the end user.
Display / alert principle	The terminal operator or port operator visualises trucks ETA and other information (container number, booking reference, etc.) on their HMI.
Functional Constraints / Dependencies	The final destination (port or terminal) of the truck must be available / declared. Privacy : • Vehicle driver must accept to be tracked if he wants to use InterCor services because, for example, the position of the vehicle is important information for the operation of the services. Standardization : • Information about waiting time at entrance of port should be published using a common format.

High level technical description

Use case implementation	
Model implementation	The terminal operators will have access to an HMI displaying the ETA of each truck arriving at their terminal and will plan (un)loading of trucks. The truck driver visualizes on an HMI an update in real time of his ETA.
Reference architecture	<u>Main reference architecture</u>  *Every color could indicate another stakeholder* The process for this service contains several steps: 1. A traffic system gains information on travel times from travel time measurement systems (1a) and provides this gained information to a data access point (1b). It is possible to have more than one traffic system. 2. The service Cargo optimization receives real-time traffic information of a data access point (2) and receives the location and destination of truck drivers (3). 3. The service Cargo optimization calculates the ETA of all trucks. 4. The service Cargo optimization provides the ETA of all trucks with a specific terminal set as destination to terminal operators (4). 5. Terminal operators plan (un)loading trucks based on the ETA of trucks. <u>Alternative reference architecture</u>

	 The process for this service contains several steps: 1. The service Cargo optimization gets information about waiting time at port entrance (1a) 2. The service Cargo Optimization gets information about traffic conditions and travel time measurement (1b) 3. The service Cargo Optimization sends this information to the service ETA calculator (2a) 4. The service ETA calculator sends the ETA information to the service Cargo Optimization (2a) 5. The service Cargo optimization provides this information to terminal operators
Functional and non-functional requirements	

Sources of information	The different sources of information are :
	- The driver who entered information on the HMI like :
	  ○ his destination (port , terminal)
	  ○ container number, booking reference, if it is a loading/unloading
	- The OBU which
	  ○ Sends the GPS position of the truck at regular intervals.
	  ○ Displays information on ETA.
	- The TMC (Traffic Management Centre) or Traffic system which broadcasts traffic conditions and travel time measurement.
	- The Terminal operator who sends information about the entrance to the port.

Standards	3G/4G communication, GPS positioning (system geofence), security standards.
Technical Constraints / dependencies	OBU must be active : - To provide positions in real time. - To receive information and notifications in real time. The 3G/4G communication must be active and the driver must be in an area with 3G/4G coverage. The GPS positioning must be active.

	Information about waiting time at entrance of port must be available. All information systems used in the different scenarios shall ensure and provide API for connection with the service Cargo Optimization to send or publish data. Interfaces shall be intuitive for the end user and shall be available in the local language.

3. Dock reservation

Functional description

Use case introduction	
Summary	Optimization of cargo transport to logistic hubs by improving predictability of dock availability in time.
Background	Often truck drivers have to wait for some time when they arrive on a logistic hub. This service is meant to optimize the planning for (un)loading trucks at logistic hubs.
Objective	Decreasing waiting times at logistics hubs.
Desired behaviour	Terminal operators make a planning for (un)loading trucks based on the estimated time of arrival (ETA) of trucks. The other way around is that terminal operators release timeslots for (un)loading trucks. Transport planners make a reservation for a specific timeslot and plan a truck arriving in that timeslot.
Expected benefits	The expected impact is a reduction in loss of time (less waiting time) for truck drivers at logistic hubs.
Use case description	
Situation	Terminal operators at logistic hubs provide timeslots for (un)loading trucks at docks. Transport planners make a reservation for a specific timeslot and plan a truck arriving in that timeslot. Transport planners provide this information to truck drivers.
Logic of transmission	Will be provided at technical description phase
Actors and relations	• Vehicle driver / truck driver: Receives a reservation for a timeslot at the terminal. Has the possibility to make dock reservations on-trip. • Road operator: n/a. • Service provider: n/a. • End user: see vehicle driver. • Vulnerable road user: n/a. • Other: 1. Transport planners: Receive available timeslots for (un)loading docks, plan cargo transport and make timeslot reservations. 2. Terminal operators (at logistic hubs): Receive timeslot-reservations of transport planners and provide to a data access point available timeslots for (un)loading trucks at docks. 3. Traffic system operators: Provide real-time traffic information. 4. Data provider: Collects information from terminal operators and aggregates them into a single data source which can be accessed at a data access point.
Scenario	1. Terminal operators at logistic hubs provide available timeslots for (un)loading trucks at docks to a data access point. 2. In the data access point information about available timeslots is available. 3. This service provides information on available timeslots to

	transporters. 4. Transport planners use this service to assign docks to trucks. 5. Transport planners reserve docks for (un)loading trucks. 6. Truck drivers receive the reserved docks on their HMI.
Display / alert principle	The end user (truck driver) receives dock reservations at logistic hubs on his HMI.
Functional Constraints / dependencies	• Available docks should be counted in a correct manner. • Reserved docks should be available at the reserved timeslot.

High level technical description

<table>
<tr><th colspan="2">Use case implementation</th></tr>
<tr><td>Model implementation</td><td>
1. Transport planners assign docks to trucks.
2. Transport planners reserve docks for their trucks.
3. Truck drivers receive the reserved docks and an overview of available docks as well.
4. Terminal operators at logistic hubs provide an update of current and future (based on reservations made) available docks to a data access point.
5. This service provides to transporters (transport planners and truck drivers) an overview of available docks.
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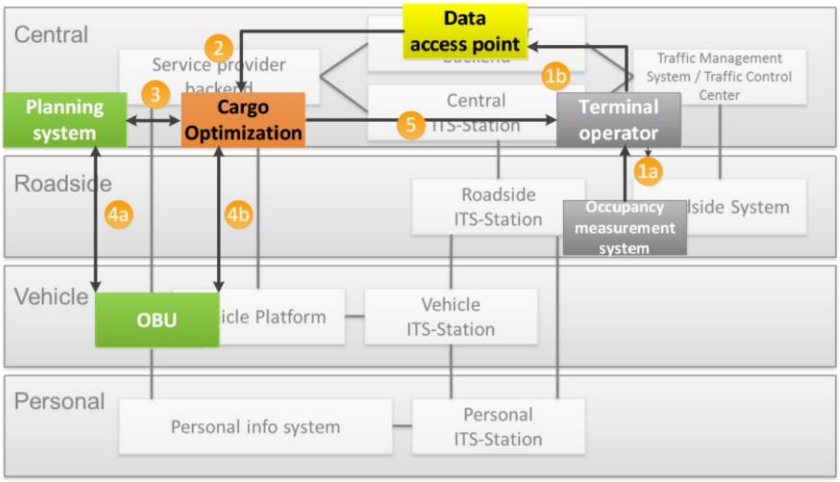
<tr><td>Reference architecture</td><td>


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The process for this service contains several steps:
1. Terminal operators gain information on available loading docks from occupancy measurement systems (1a) and provide this gained information to a data access point (1b). It is possible to have more than one terminal operator.
2. The service Cargo optimization gets information about available docks from a data access point (2) and provides this information as a service to its customers, transport companies:
- Planning systems (3) &
- OBUs (4b) (= monitoring system in a truck like Fleet Management Systems)
3. Planning systems use this information to make a planning for (a fleet of) trucks and
- Requests to reserve an available dock (3);
</td></tr>
</table>

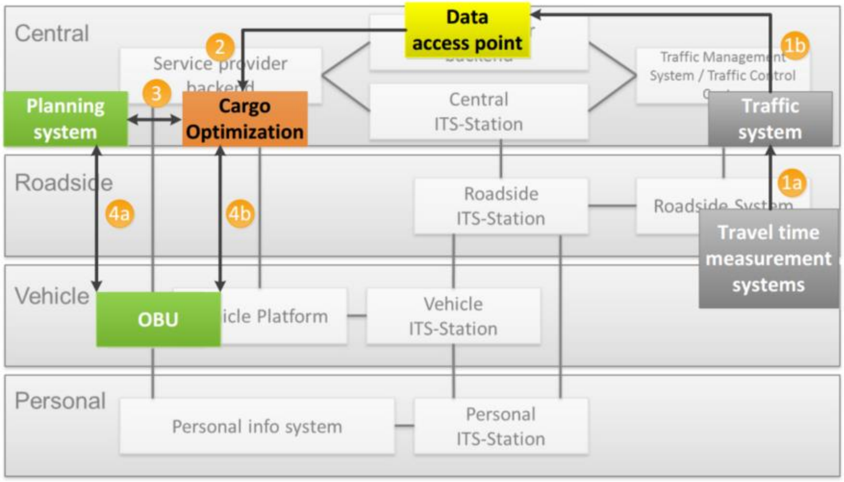
	- Send these routes to the trucks (4a). 4. The service Cargo optimization reserves the available dock at the logistic hub requested (5).
Functional and non-functional requirements	
Sources of information	An occupancy measurement system for docks at logistic hubs.
Standards	n/a.
Technical Constraints / dependencies	Development of an occupancy measurement system.

4. Optimal route advice for trucks

Functional description

Use case introduction	
Summary	Optimization of cargo transport from logistic hubs by providing optimal routes.
Background	During traffic jams, road operators want to reduce the inflow and logistic companies do not want any delays ('time is money'). Providing information on traffic jams, both goals can be achieved.
Objective	Reduction in loss of time for trucks caused by traffic jams and a reduction of traffic jams (in time and distance).
Desired behaviour	Truck drivers on-trip change their original, delayed routes.
Expected benefits	The primary expected impact is a smoother route for the truck driver and therefore less loss of time (and money) for the transporter. The secondary expected impact is a shorter duration of traffic jams.
Use case description	
Situation	Truck drivers receive real-time traffic information and choose, in case of traffic jams on their route, another available route.
Logic of transmission	Will be provided at technical description phase
Actors and relations	• Vehicle driver: The truck driver receives his route, based on real-time traffic information. • Road operator: n/a. • Service provider: • End user: see vehicle driver. • Vulnerable road user: n/a. • Other: 1. Traffic system operators: Provide real-time traffic information. 2. Data provider: Collects information from traffic system operators and aggregates them into a single data source which can be accessed at a data access point.
Scenario	1. Traffic systems provide real-time traffic information to a data access point. 2. In the data access point information on real-time traffic information is available. This service provides real-time traffic information. 3. Truck drivers adapt their routes based on real-time traffic information.
Display / alert principle	The end user (truck driver) receives his optimal route on his HMI.
Functional Constraints / Dependencies	• Truck drivers should be allowed to change their 'usual' route.

High level technical description

<table>
<tr><th colspan="2">Use case implementation</th></tr>
<tr><td>Model implementation</td><td>1. Traffic systems provide real-time traffic information to a data access point.
2. This service provides real-time traffic information.
3. Truck drivers use this service to find their optimal route to their destination.</td></tr>
<tr><td>Reference architecture</td><td>


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The process for this service contains several steps:
1. A traffic system gains information on travel times from travel time measurement systems (1a) and provides this gained information to a data access point (1b). It is possible to have more than one traffic system.
2. This service gets information on real-time traffic information from a data access point (2) and provides this optimal route to its customers, transport companies:
- Planning systems (3) &
- OBUs (4b) (= monitoring system in a truck like Fleet Management Systems)
3. OBUs in trucks share their routes with planning systems to help transport planners plan the work that has to be done (4a). It could happen that transport planners change the original routes of their truck fleet because of real-time traffic information (e.g. trucks in a traffic jam caused by a road closure (not planned)).</td></tr>
<tr><th colspan="2">Functional and non-functional requirements</th></tr>
<tr><td>Sources of information</td><td>Travel time measurement systems.</td></tr>
<tr><td>Standards</td><td>n/a.</td></tr>
<tr><td>Technical Constraints / dependencies</td><td>The traffic system gains information in real-time.</td></tr>
</table>

5. Balanced Priority for dedicated vehicles

Functional description

Use case introduction	
Summary	Dedicated vehicles like heavy trucks get a limited form of priority at signalised intersections, saving fuel and emissions and reducing maintenance on both roads and vehicles.
Background	Traffic lights interrupt traffic flow and therefore cause delay and emissions. For emergency, safety, environmental, traffic flow efficiency and business reasons it may be advantageous to give priority at traffic lights to dedicated vehicles like heavy trucks.
Objective	To give priority at traffic lights to specific classes of road users.
Desired behaviour	The traffic signal is green when the vehicle arrives at the intersection and the vehicle can pass the intersection with no (control) delay.
Expected benefits	The primary expected impact is reduced delay and less stops (therefore less emission) for the priority classes. These classes are expected to have reduced travel times and fuel consumption.
Use case description	
Situation	Priority for Trucks A truck is approaching a signalised intersection.
Logic of transmission	Will be provided at technical description phase
Actors and relations	• Vehicle driver: receives acknowledgement of priority. • Road operator: defines the policy objectives and priorities. • Service provider: implements the traffic signal priority service. • End user: fleet owners and fleet operators may amend routes based on priority rules. • Vulnerable road user: n/a. • Other: n/a.
Scenario	A priority vehicle approaches a signalised intersection. Vehicle information such as the vehicle class, load properties and punctuality is provided to the signal controller. Subject to the applicable priority policies, the vehicle is given priority green and therefore can pass the intersection unhindered.
Display / alert principle	The SPAT / MAP information broadcasted from the RSU among others reflects the real-time signal phase & timing status for each lane. Based on the SPAT / MAP information dedicated vehicles may send a priority request to the RSU. The RSU gives feedback if the request will be assigned to the dedicated vehicle.
Functional Constraints / Dependencies	n/a.

High level technical description

Use case implementation

<table>
<tr>
<td>Model implementation</td>
<td>There are two mechanisms for requesting traffic Signal Priority. The first mechanism detects the approach of a truck by map-matching the received CAM messages onto the topology of the intersection. If an approaching CAM of a heavy truck is detected, a truck priority request is sent to the traffic controller. When the truck has passed the stop line, the request is cancelled. The traffic controller decides if, and how much, priority the truck will get, and it will adapt the traffic lights and their predictions accordingly.

The second mechanism is induced by equipped vehicles. For instance, trucks will request priority explicitly via an SRM message. A truck detects that it is approaching an intersection by map-matching its own location on the MAP topology received. Next, an SRM message is sent that describes the signal the truck requests priority for. The incoming SRM is combined with the CAM from the truck, and a priority request to the traffic light controller is sent. Feedback from the traffic controller is passed to the truck via an SSM message. When the truck has passed the stop line, the request is cancelled. The traffic controller decides if, and how much, priority the truck will get, and it will adapt the traffic lights and their predictions accordingly.</td>
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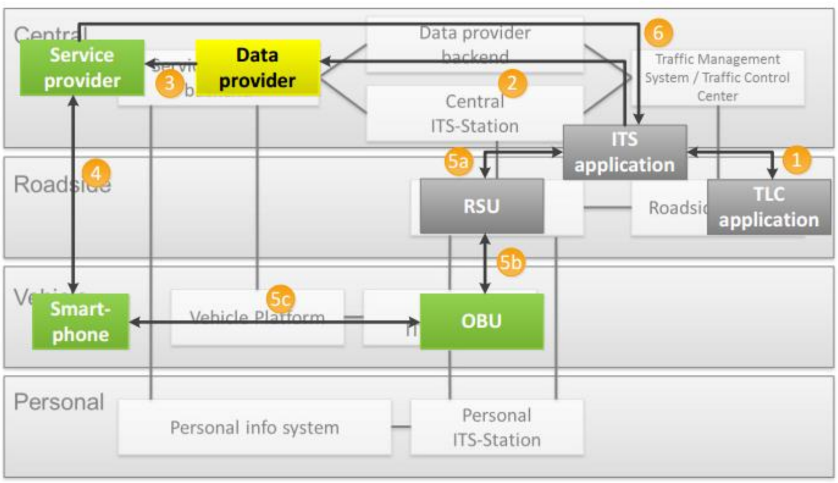
<tr>
<td>Reference architecture</td>
<td>In the Netherlands, the Traffic Signal Priority is used for designated heavy trucks, emergency vehicles and Public Transport vehicles. The Traffic Signal Priority for designated vehicles service is implemented following the architecture of the ‘intelligent Traffic Light Controller (iTLC) . The architecture allows for integration of the C-ITS domain with the TLC domain by allowing ITS Applications to use facilities from both the Traffic Light Controllers (TLC) and Roadside units (RIS or RSU) and therefore enable the implementation of various ITS use-cases related to TLC’s. The ‘TLC-Facilities’ and ‘RIS-Facilities’ describe the functionality of respectively TLC and RIS. The goal of the architecture is to provide the TLC Facilities and RIS Facilities functionality to ITS Application by defining open interfaces.



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The process for this application contains several steps:</td>
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</table>

	1. Dedicated vehicles (OBU / smartphone) send a priority request to an RSU (5c) or to its service provider (4). 2. The RSU (5a) or service provider (6) forwards this request to the TLC application via the ITS application (1). 3. The TLC application decides if, and how much, priority the truck will get, and it will adapt the traffic lights and their predictions accordingly. 4. The ITS application receives this TLC-information from TLC applications (1). 5. The ITS application sends messages containing SPAT / MAP information towards data providers (2) and towards RSUs (5a) to broadcast the message during the requested duration time with a specific repetition rate to OBUs (5b). In the vehicle the message of the OBU is forwarded to an application on a smartphone (5c). 6. Data providers collect the data of ITS applications and provide that to service providers (3). 7. Service providers determines whether SPAT / MAP information is required for individual users and send the appropriate information to smartphones (4).
Functional and non-functional requirements	
Sources of information	Cooperative Awareness Message (CAM) Signal phase and Timing message (SPaT) Intersection topology message (MAP) Service Request Message (SRM) Service Status Message (SSM)
Standards	• ETSI TS 103 301 Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services • ETSI EN 302 637-2 Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service • ETSI EN 302 637-3 Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service. • ETSI TS 101 539-1 Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification • ETSI TS 102 894-2 Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary • ISO TS 19321:2015 Dictionary of in-vehicle information (IVI) data structures. • ISO/TS 14823:2008(en) Traffic and travel information; Messages via media

	independent stationary dissemination systems; Graphic data dictionary for pre-trip and in-trip information dissemination systems • SAE J2735 Dedicated Short Range Communications (DSRC), Message Set Dictionary. • CEN ISO/TS 19091 Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections.
Technical Constraints / dependencies	• The Traffic application must be made capable to actually give the requested priority. • TLC is connected to RSU and can provide information on the current and next phase. • Special precautions should be taken to connect dynamically timed TLCs. • RSU is able to send information on the static topology of the signalised intersection. Optionally this static information is provided to the HMI by other methods. • RSU supports I2V services and can send information on signal phase and timing. • The HMI supports I2V services and can receive information on signal phase and timing.