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Smart Urban Traffic Zones

System/Subsystem Specification

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Redefining solutions

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Document distribution

City of Gothenburg
Jonas Malmryd

City of Stockholm
Victoria Herslöf

Technolution B.V.
Edwin Mein
Tobias Beckman
Peyman Tavakoli

This report was created by

Technolution B.V.
Burgemeester Jamessingel 1
P.O. Box 2013
2800 BD GOUDA
The Netherlands

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1. Scope

This chapter describes the scopes for the individual pilot sites (i.e. Gothenburg and Stockholm) from a system perspective.

1.1. Document overview

This document describes the System and Sub-System requirements from a high-level perspective. Chapter 2 gives an overview to referred documents. Chapters 3, 4, and 5 describe the system specifications for respectively Pilots 1, 2, and 3. Chapter 6 contains the non-functional specifications. Notes can be found in Chapter 7.

1.1.1. Purpose of the document

The purpose of the document is to give a high-level overview of all system and sub-system requirements. These requirements can be used as input for the development of the depicted system.

1.1.2. Reading directions

No specific directions.

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2. Referenced documents

The listing below provides an overview of the documents and other sources of information that have been referenced in this document.

Short name	Full name
JSTD	J-STD-016-1995 Standard for Information Technology, Software Life Cycle Processes, Software Development, Acquirer-Supplier Agreement
Viscando OTUS External API, version 1	Describes Version 1 of Viscando's External API for accessing data from OTUS server.
Ramudden's Traffic Fleet REST Interface Description	Describes Ramudden's version 1.6 (released on Dec. 2018) of the Traffic Fleet REST API.

3. Pilot 1 – Stockholm (Hornsgatan)

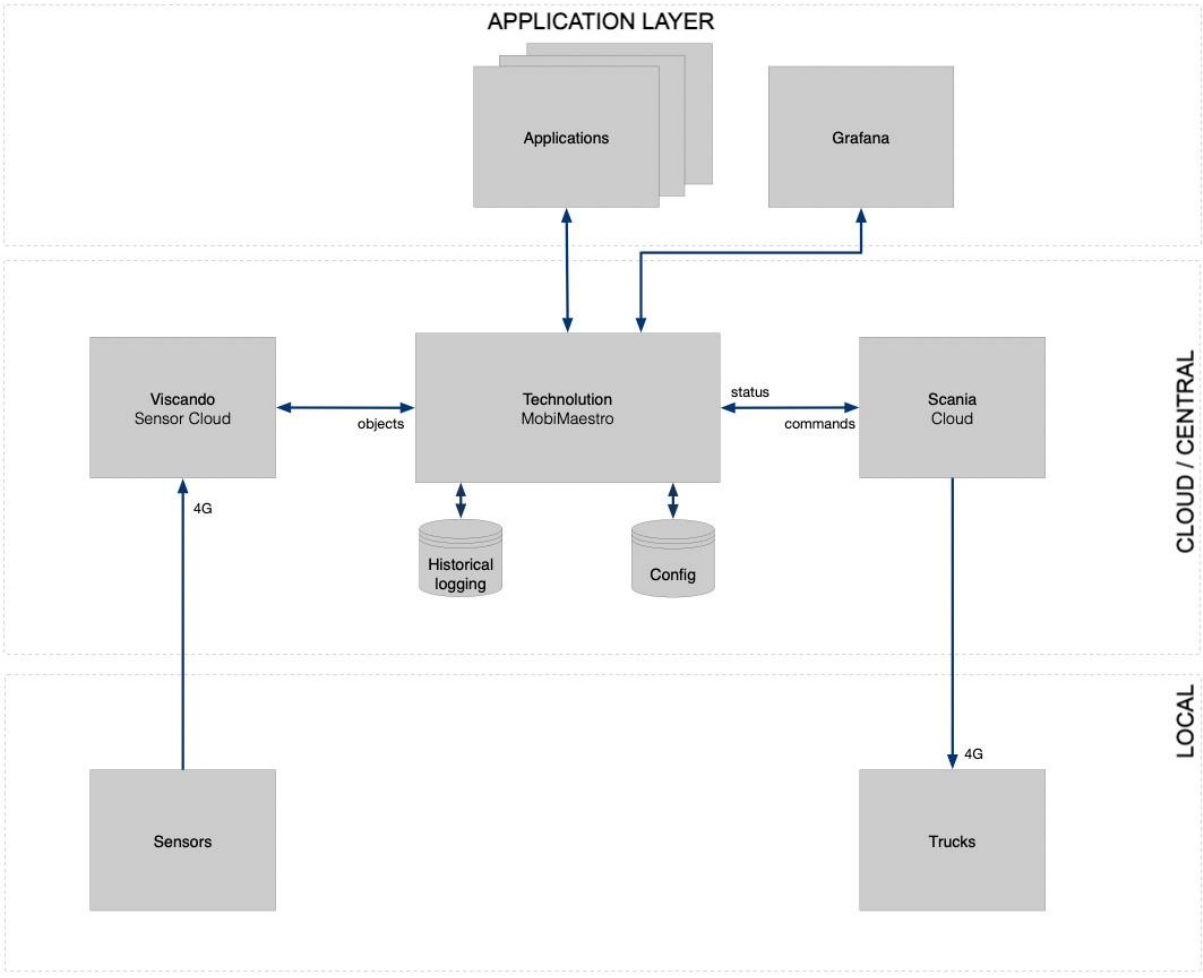
3.1. System Overview

In Stockholm the Smart Urban Traffic Zones project aimed at the truck behavior at Hornsgatan and truck access to dedicated loading areas.

The basic rule for the system is:

IF the system detects a busy pedestrian path THEN inform the trucks to lower speed AND set a speed limit on the trucks (That can be overridden in case of emergency)

The system is not replacing safety systems like traffic light controls or fixed barriers. It is intended as an additional warning system for example at loading areas at curb level.



The overview below shows the different components of the system. Three main layers can be identified:

- An Application Layer where the applications reside for configuration, editing, and viewing of smart urban traffic zones, sensor data, actuator information, and so forth;
    - Grafana offers the graph and statistical visualization of the data in the databases. See also Appendix A for screenshot examples;
- A Cloud environment that combines the Sensors from their cloud environment with the Scania's cloud from their respective cloud environment and offers the central backbone of the solution;
- A Local environment with the sensors at street level and the Scania trucks.

The interfaces and business logic are described in the next sections.

3.1.1.Loading zone surveillance

This functionality was added at the end of the pilot. A Viscando sensor is monitoring a loading zone on the street. Through the interface between Viscando and MobiMaestro, the central system is gathering and stores the data from the monitored loading zone. This data is then displayed in real-time on MobiMaestro's map with the current status of the specific loading zone and the historical data is also shown in Grafana.

3.2. Interfaces

The interfaces in this system are in the table below. For each interface, this document describes the protocol.

ID	A ⇔ B	Protocol	Description
1	Viscando ⇔ MobiMaestro	RESTful API	This interface shares the object detections from the sensors to the central system and real time data monitored from a loading zone.
2	Scania ⇔ MobiMaestro	RESTful API Datex II[1]	This interface sends commands to the Scania cloud to inform drivers to lower speed if needed and to set a speed limit in the trucks. This interface is also used by Scania to send trucks position data to MobiMaestro with a frequency of once every 5 seconds.
3	Sensors ⇔ Viscando	Proprietary/4G	Sensors send their data to Viscando's cloud environment
4	Trucks ⇔ Scania	Proprietary/4G	Trucks communicate with Scania's cloud through this interface
5	Applications ⇔ MobiMaestro	HTTPS	The applications/GUIs communicate with the central system via HTTPS for the representation of data and user interface.

[1] The API delivers a Level C DATEX II message in JSON format to the requestor. Level C here means that it is not part of the Swedish DATEX II profile at this moment.

3.3. Business Logic

The business logic for this system is located in the central system MobiMaestro. That system collects all data from the sensors, decides on thresholds and sends commands to the Scania cloud to inform drivers.

The basic rules are described below:

```
IF number_of_detections < normal_threshold
  speed_limit = normal_speed_limit
ELSE
  IF number_of_detections > low_threshold
    speed_limit = low_speed_limit
  ENDIF
ENDIF
IF truck IN geofence
  ADVICE speed_limit
  START recording the position, heading, and speed of the truck
ENDIF
```

The parameters and variables are:

Name	Description
number_of_detections	Contains the number of detected objects from the sensors
normal_threshold	Threshold value to switch to normal speed, e.g., 144 objects
low_threshold	Threshold value to switch to lower speed, e.g., 240 objects
speed_limit	Variable containing the actual speed limit value
normal_speed_limit	Parameter with the speed representing a normal speed, e.g., 30 km/h
low_speed_limit	Parameter with the speed representing a normal speed, e.g., 20 km/h

The parameter and threshold values are configurable items in the business logic and are used to control and tune the system's behavior.

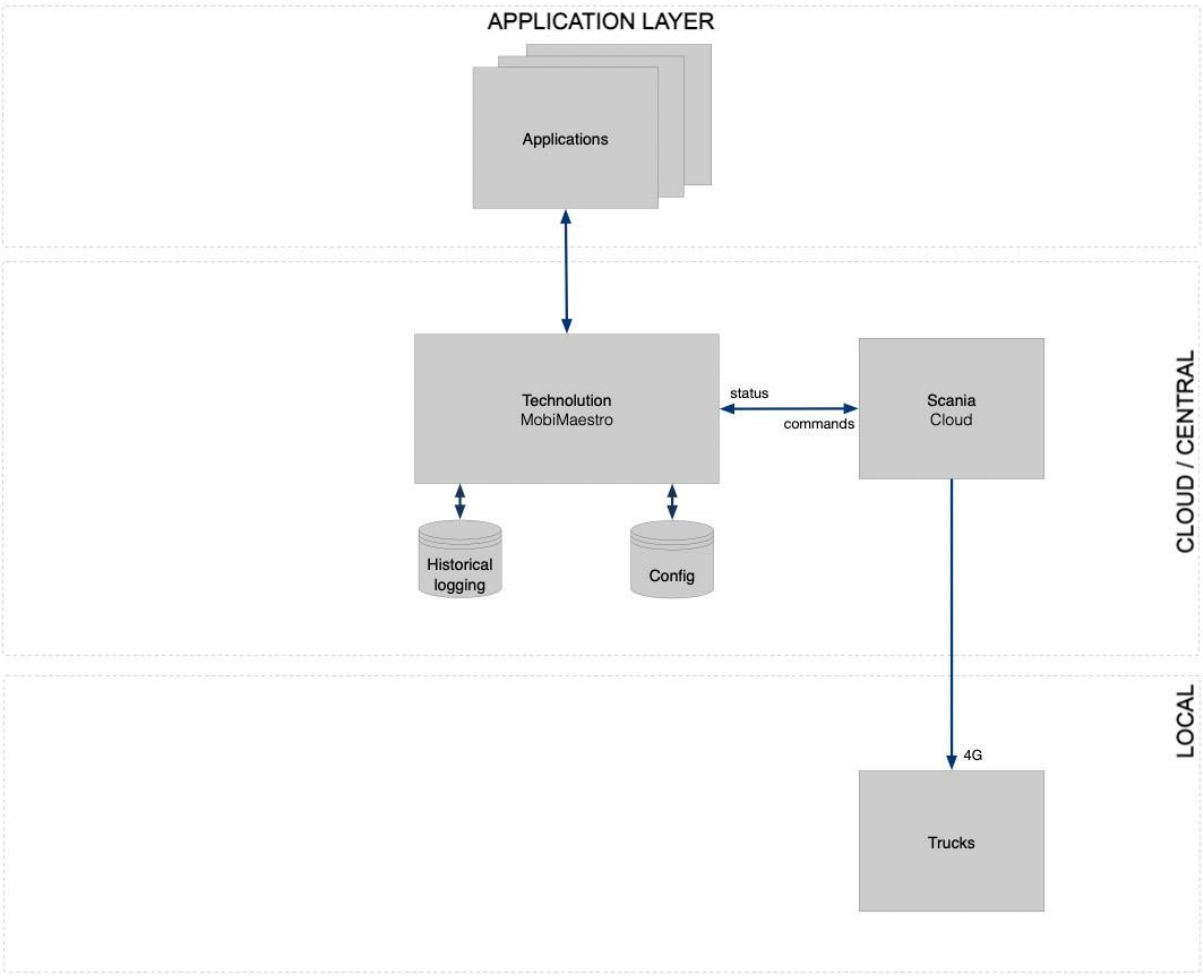
4. Pilot 2 – Stockholm

4.1. System Overview

In Stockholm Smart Urban Traffic Zones project pilot 2 aims to digitally issue exemptions for construction transports. With speed and route-controlled heavy mass vehicles, it may allow heavier vehicles within the city boundaries. If vehicles can load more concrete in their tanks fewer trips are needed to the construction site which will decrease the total number of heavy mass transports and help create a better urban environment.

The basic rule for the system is:

IF a truck is within the geofenced area AND truck weight is larger than the specified limit THEN limit the speed of the truck



The overview below shows the different components of the system. Three main layers can be identified:

- An Application Layer where the applications reside for configuration, editing, and viewing of smart urban traffic zones, sensor data, actuator information, and so forth;
- A Cloud environment with the Scania's cloud from their respective cloud environment offers the central backbone of the solution;
- A Local environment with the Scania trucks.

The interfaces and business logic is described in the next sections.

4.2. Interfaces

The interfaces in this system are in the table below. For each interface, this document describes the protocol.

ID	A ⇔ B	Protocol	Description
1	Scania ⇔ MobiMaestro	RESTful API Datex II[2]	This interface sends commands to the Scania cloud to inform drivers to lower speed if needed. This interface is also used by Scania to send trucks position data to MobiMaestro with a frequency of once every 5 seconds.
2	Trucks ⇔ Scania	Proprietary/4G	Trucks communicate with Scania's cloud through this interface
3	Applications ⇔ MobiMaestro	HTTPS	The applications/GUIs communicate with the central system via HTTPS for the representation of data and user interface.

4.3. Business Logic

The business logic for this system is located in the central system MobiMaestro. That system collects all data.

The basic rules are described below:

```
IF truck IN geofence AND truck weight is larger than the specified limit
  ADVICE "speed_limit = low_speed_limit"
  START recording the position, heading, and speed of the truck
ENDIF
```

[2] The API delivers a Level C DATEX II message in JSON format to the requestor. Level C here means that it is not part of the Swedish DATEX II profile at this moment.

5. Pilot 3 – Gothenburg

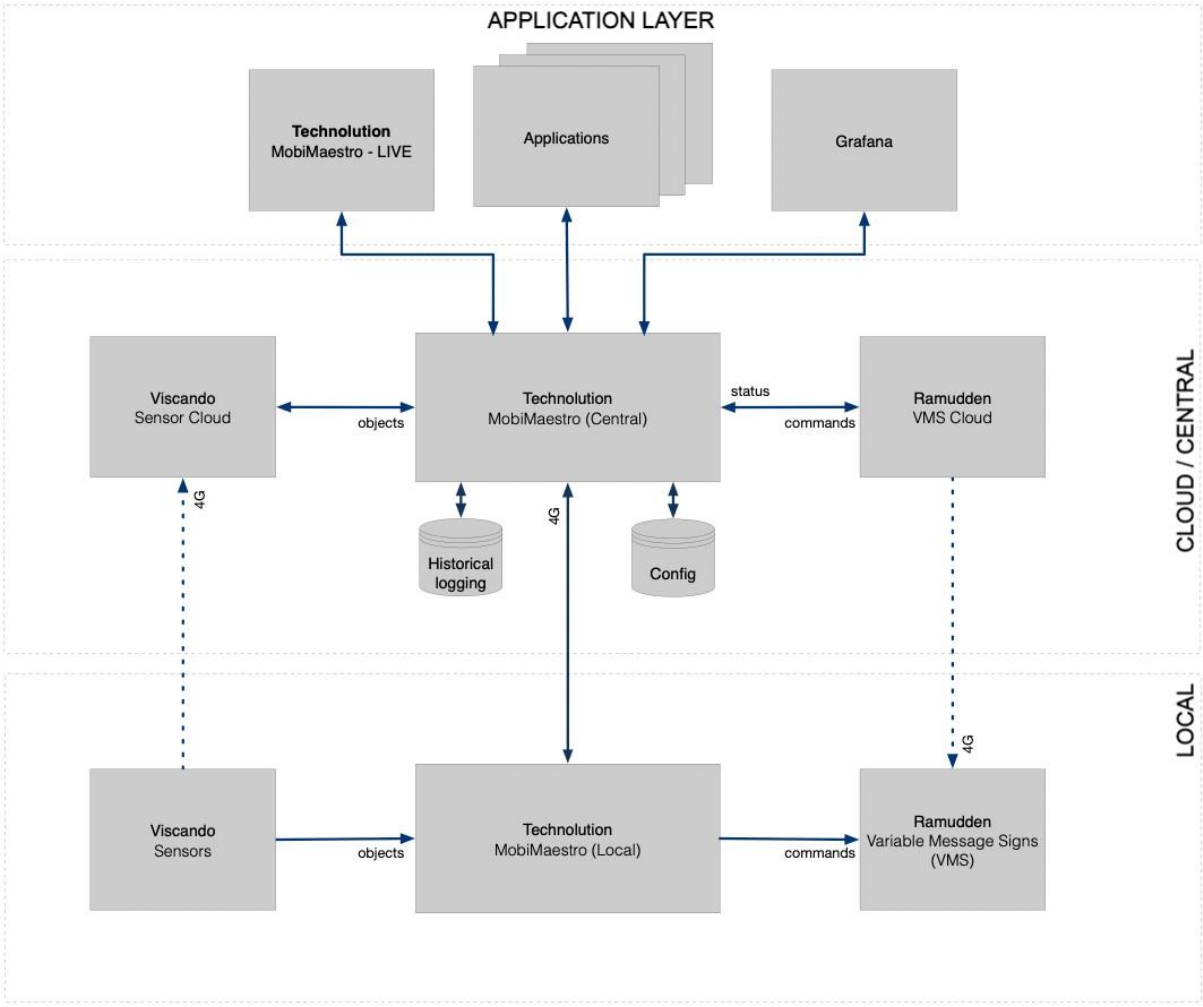
5.1. System Overview

Pilot 3 is all about making sure that passages in and out thru the temporary work site are as safe as possible for both the vehicles, pedestrians, cyclists and others. This will be done with smart sensors, digital signs, and connected vehicles.

The basic rule for the system is:

IF the system detects a potential hazard THEN inform the road users

The system is not replacing safety systems like traffic light controls or fixed barriers. It is intended as an additional warning system for example at a construction site exists.



The overview above shows the different components of the solution. Three main layers can be identified:

- An Application Layer where the applications reside for configuration, editing, and viewing of smart urban traffic zones, sensor data, actuator information, and so forth;
    - MobiMaestro Live shows the real-time location of objects on the map;
    - Grafana offers the graph and statistical visualization of the data in the databases. See also Appendix A for screenshots examples from Pilot 1;
- A Cloud environment that combines the Sensors from their cloud environment with the Actuators from their respective cloud environment and offers the central backbone of the solution;
- A Local environment with the actual sensors and trucks and the local backup system that can run without a Central Solution if for any reason the Central Solution is not able to connect to any of the surrounding peripherals.

The interfaces and business logic are described in the next sections.

5.2. Interfaces

The interfaces in this system are in the table below. For each interface, this document describes the protocol.

ID	A ↔ B	Protocol	Description
1	Viscando ↔ MobiMaestro C	RESTful API	This interface shares the object detections from the sensors to the central system.
2	Ramudden ↔ MobiMaestro C	RESTful API	This interface sends commands to the Scania cloud to inform drivers to lower speed if needed.
3	Sensors ↔ Viscando	Proprietary/4G	Sensors send their data to Viscando's cloud environment
4	VMSs ↔ Ramudden	Proprietary/4G	Trucks communicate with Ramudden's cloud through this interface
5	Applications ↔ MobiMaestro C	HTTPS	The applications/GUIs communicate with the central system via HTTPS for the representation of data and user interface.
6	Viscando ↔ MobiMaestro L	RESTful API	This interface shares the object detections from the sensors to the local system.
7	Ramudden ↔ MobiMaestro L	RESTful API	This interface sends commands to the Scania cloud to inform drivers to lower speed if needed.
8	MobiMaestro C ↔ MobiMaestro L	Proprietary/4G	The connection between the central and local MobiMaestro shares the

monitoring information for visualization in the applications.

5.3. Business Logic

The business logic for this system is located in the central system MobiMaestro and a copy is hosted in the local MobiMaestro. That system collects all data from the sensors, decides on thresholds, and sends commands to the VMS displays to inform road users.

The basic rules are described below:

Bicyclists priority

> **IF** a bicycle is detected with a heading that is towards the crossing +- *X* degrees **AND** is within *Y* meters of the crossing **THEN** show red light on wigwags for trucks **AND** show yellow animation on VMS for bicyclists (This also means that **IF** no bicycle is detected **OR** only bicycle with wrong heading is detected THEN turn off wigwags).

There is only one heading that is towards the crossing for bicyclists.

Trucks priority

> **IF** a truck is detected with a heading that is towards the crossing +- *X* degrees **AND** is within *A* meters of the crossing **THEN** show yellow animation on VMS for bicyclists **OR** is within *B* meters of the crossing **THEN** show red animation on VMS for bicyclists. (This also means that **IF** no truck is detected **OR** truck with wrong heading is detected **THEN** turn off animations on VMS).

There are 2 different headings that are towards the crossing for trucks.

Name	Description
X	Contains the heading threshold for a possible collision with a truck or pedestrian
Y	Contains the distance between the bicycle and the intersection
A	Contains the distance between the truck and the intersection
B	Contains the distance between the bicycle and the intersection

6. Nonfunctional specifications

6.1. Data and cyber security

In the development of a system, as specified in the previous chapters, data and cybersecurity-related requirements are crucial to the overall solution.

The solution for all pilots uses the same industry standards for this purpose:

- TLS (Transport Layer Security) protocol between the individual components ensuring that the data is encrypted;
- VPN (Virtual Private Network) towards the central system;
- APN (Access Point Name) as a gateway to the mobile network.

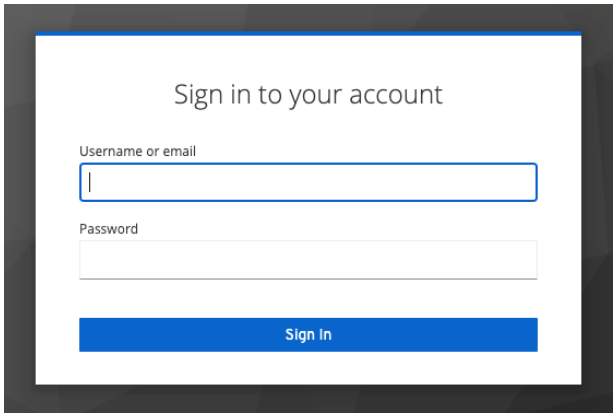
Besides the protocol data security, the application layers use personalized login names and passwords to ensure only authorized personnel can access the system.

6.2. Hosting

The solution can be hosted on-premise or as a cloud solution, depending on the road authority's requirements. During the pilot, we hosted the central system as a cloud solution and connected it to the local systems in place.

6.3. User authentication

The solution offers a two-factor authentication method in addition to user authentication with a username and password. For the pilot, we decided on skipping the two-factor authentication for simplicity as the hosted machine was only accessible from IP-whitelisted environments.



In general, two-factor-authentication should be the default standard for an operational system where several users access the system for monitoring and maintenance. Two-factor-authentication can be provided for example Google Authenticator or similar products.

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7. Notes

7.1. Abbreviations

A list of used abbreviations.

Abbreviation	Meaning
API	Application Programming Interface
APN	Access Point Name
HTTPS	HyperText Transfer Protocol Secure
REST	Representational State Transfer
SSS	System/Subsystem Specification
TLS	Transport Layer Security
VPN	Virtual Private Network

7.2. Terminology

A list of used terminology.

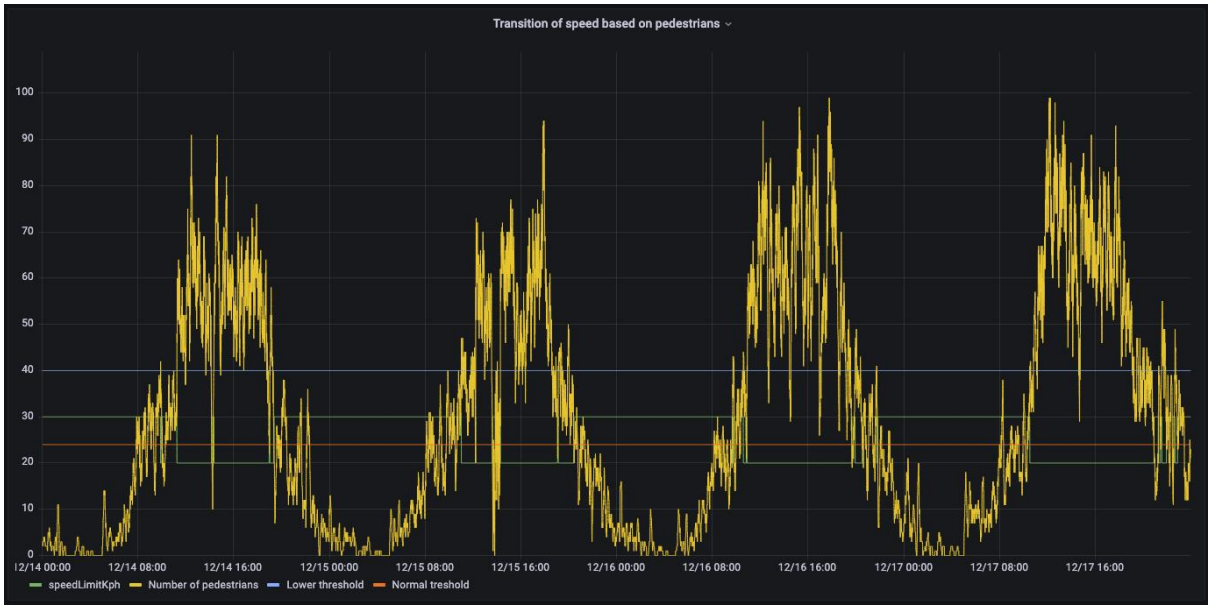
Term	Explanation
DATEX II	A standardized data exchange standard for exchanging traffic information between traffic management centers, traffic service providers, traffic operators, and media partners
RESTful	A RESTful API is an architectural style for an application program interface (API) that uses HTTP(S) requests to access and use data.
Software	Generic term for computer programs

A. Grafana screenshots

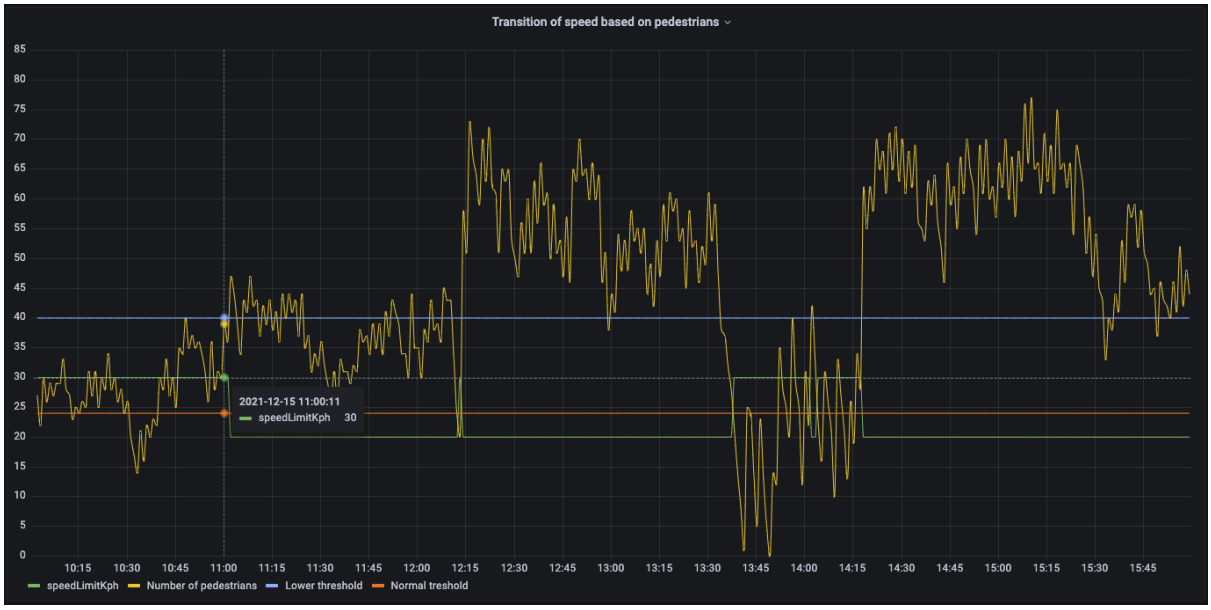
Data for Pilot 1 is shown in Grafana graphs. Pedestrians count and the current speed limit are based on pedestrian count as described in the business rules.

- Yellow line: the pedestrian count
- Green line: active speed advise (LOW or HIGH)
- Blue line: pedestrian threshold for low speed advise
- Red line: pedestrian threshold for removal of low speed advise

Overview (last 4 days):



Detailed (last 5,5 hours):



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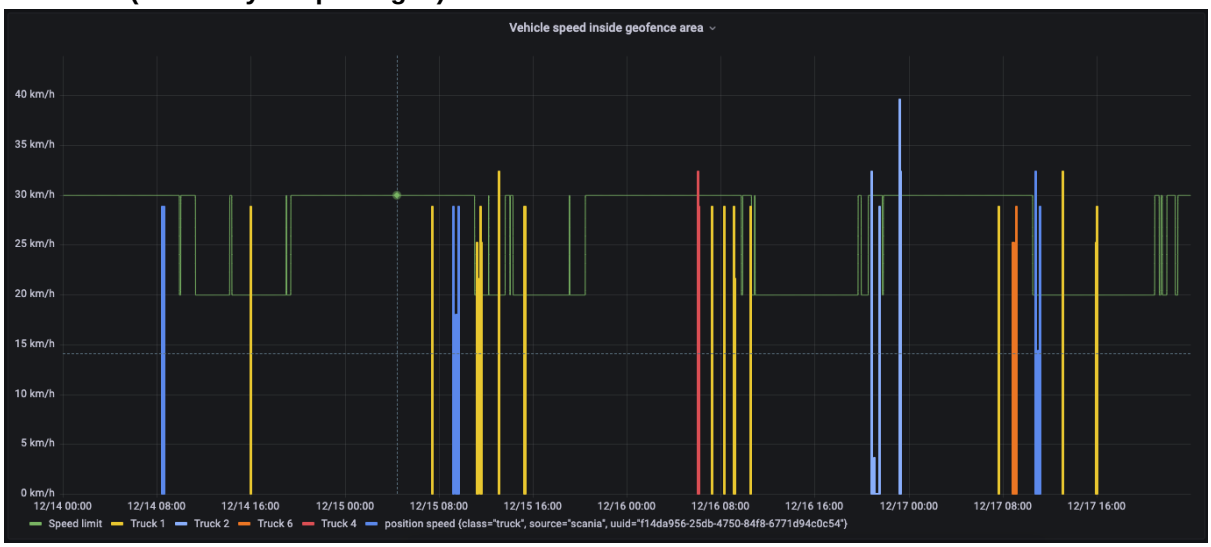
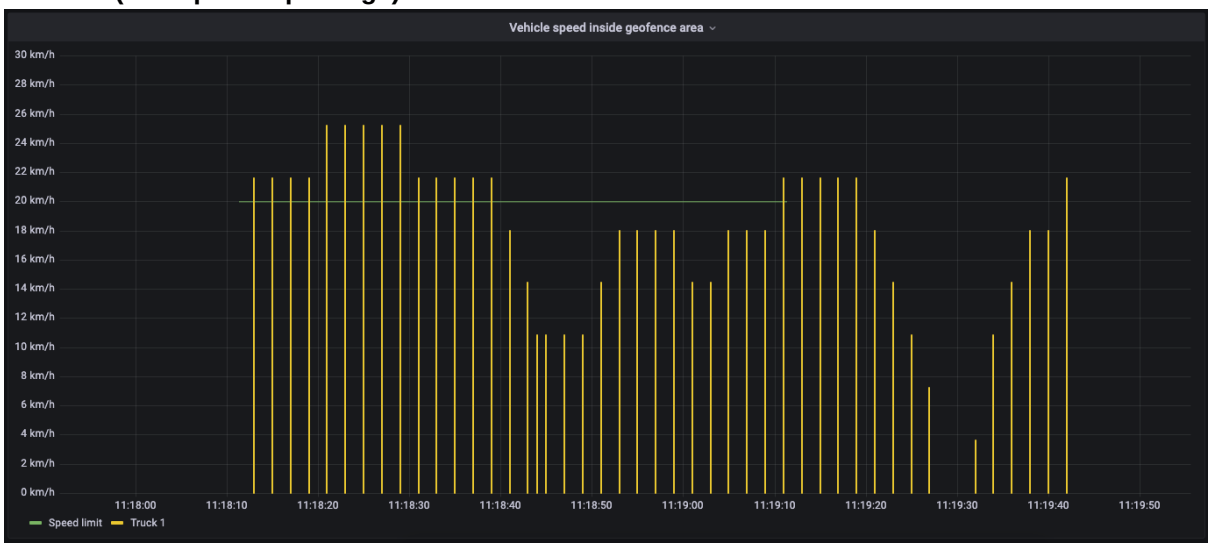
Current speed limit and truck passages through the geofenced area and the trucks' current speed on each passage.

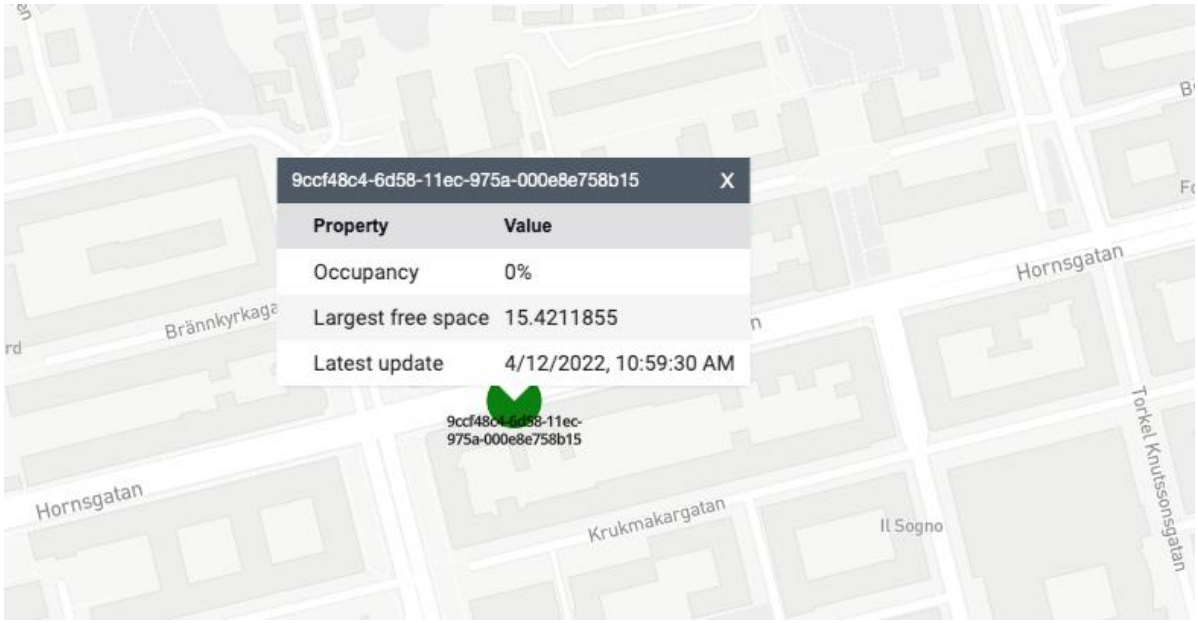
Overview (last 4 days of passages):



Detailed (one specific passage):



Real-time data showing the status of the monitored loading zone



Historical data of the occupancy shown in the monitored loading zone

Detailed (last 6 hours):