Webinar Traffic Signals

Agenda
- 12.30 - 13.10 Traffic Signal Information
- 13.10 - 14.00 Traffic Signal Priority

➢ Flagship pilots!

Nettiquette:
- Webinar is recorded
- Chat open during presentation
- Camera/audio during Q&A

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Traffic Signal Information

On the road to deployment of C-ITS Traffic Signal Services in the Nordic Countries

Speakers: Örjan Tveit (NO), Kristina Jensen (SE), Mikael Ivari (SE).

Agenda:

- Traffic Signal Information Flagship
- Connected Traffic Signals Project in Gothenburg
- Connected Traffic Signal as a driver for new mobility services
- Q&A

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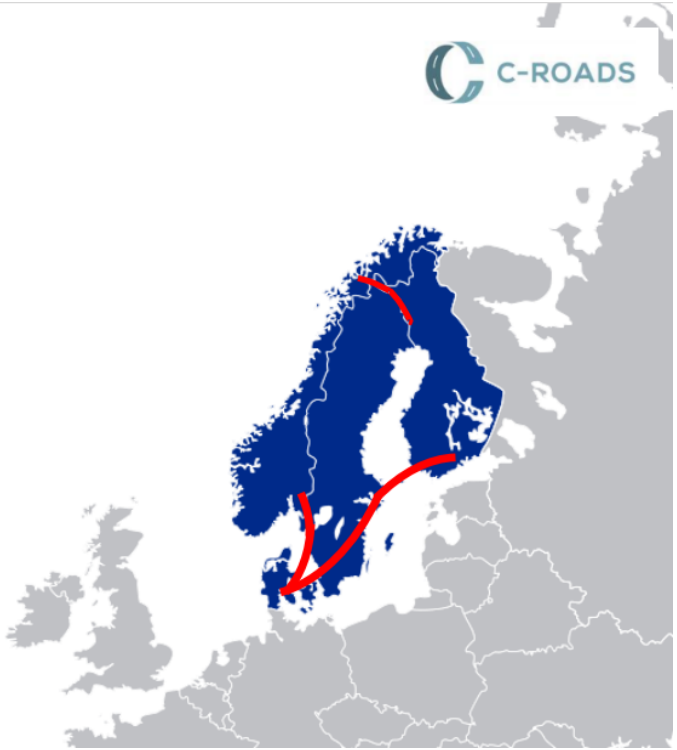
On the road to deployment of C-ITS Traffic Signal Services in the Nordic Countries



Ørjan Tveit, Statens Vegvesen Norway
Kristina Jensen, City of Gothenburg
Mikael Ivari, City of Gothenburg

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Nordic WAY

Traffic Signal Information Flagship

How to provide reliable predictions for traffic actuated signalling

Ørjan Tveit
Statens Vegvesen, Norway

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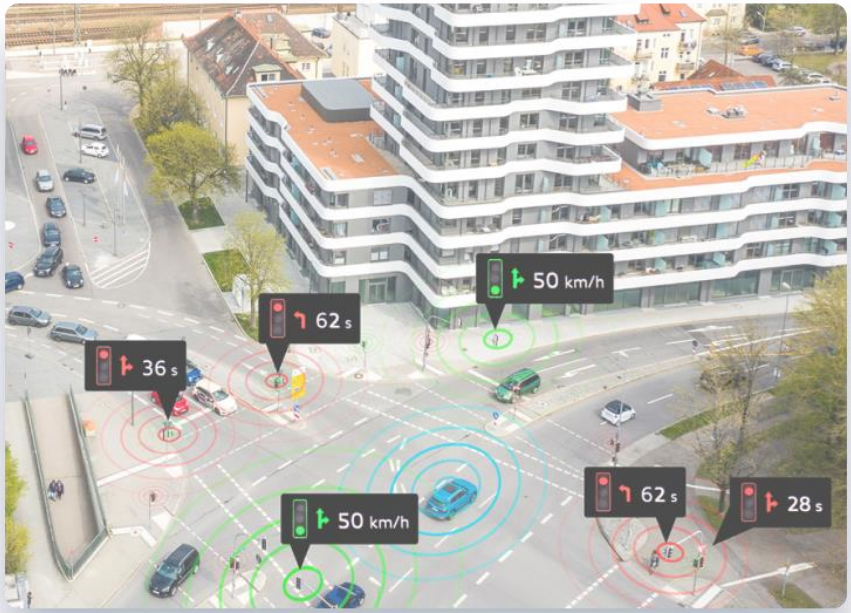
SPAT and MAP

How do we bring traffic light into the vehicle and at the same time provide predictions?

- SPAT/MAP (SAE-J2735 and ISO 19091):
  - Signal Phase and Timing (SPaT) message defines the current intersection signal light phases. The current state of all lanes at the intersection are provided, as well as any active pre-emption or priority.
  - By referencing to the standardized description of the intersection topology (MAP), it becomes clear for which signal group or driving relation the signaling is valid. MAP displays lanes and stop lines by means of coordinate dots.



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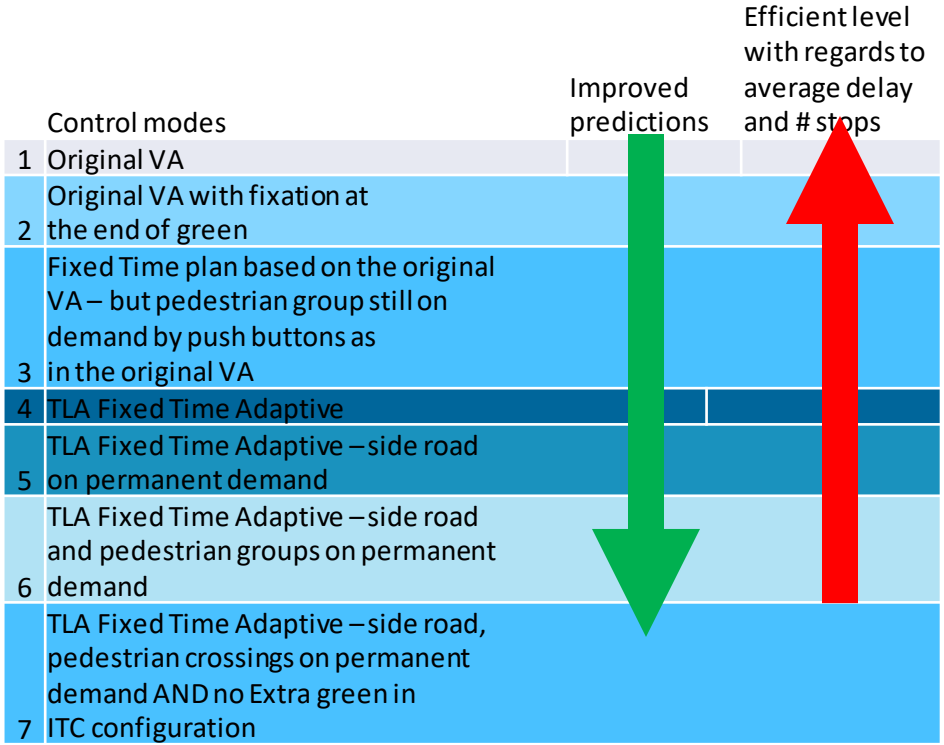
Prediction quality vs adaptive signaling

- A natural starting point for predictions is the supplier for traffic signal equipment.
- NPRA has together with Swarco tried different signalling schemes to detect how prediction quality and adaptive signalling work together.
- The conclusion is that we need more powerful algorithms for predictions.



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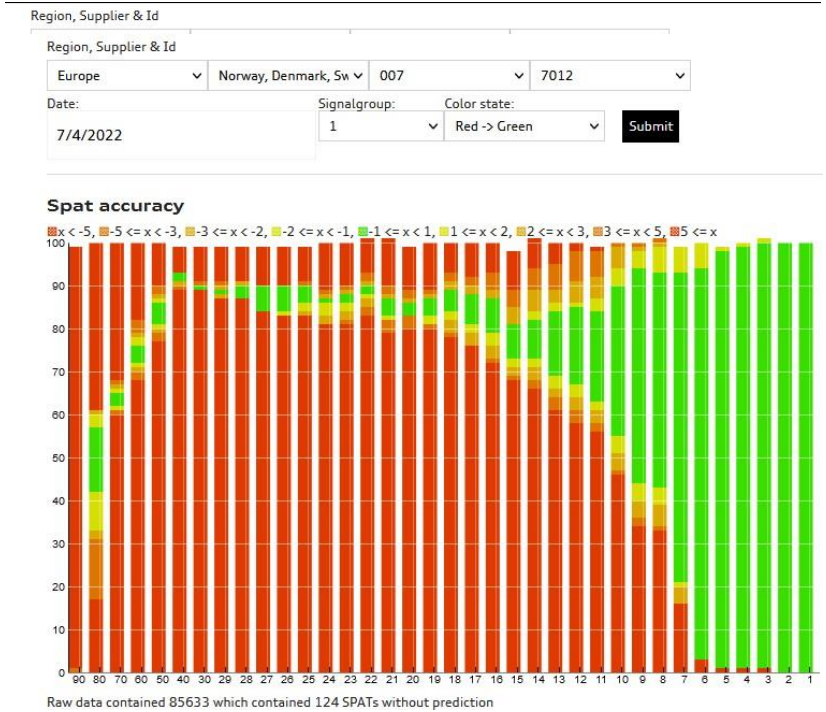
How to measure prediction quality

- When does the signal change from green to red?
- The predictions may be troublesome, but the quality check is not rocket science.
- Is the prediction spot on or off with several seconds?

  A good service will have 95 % of the predictions within a few seconds deviation.



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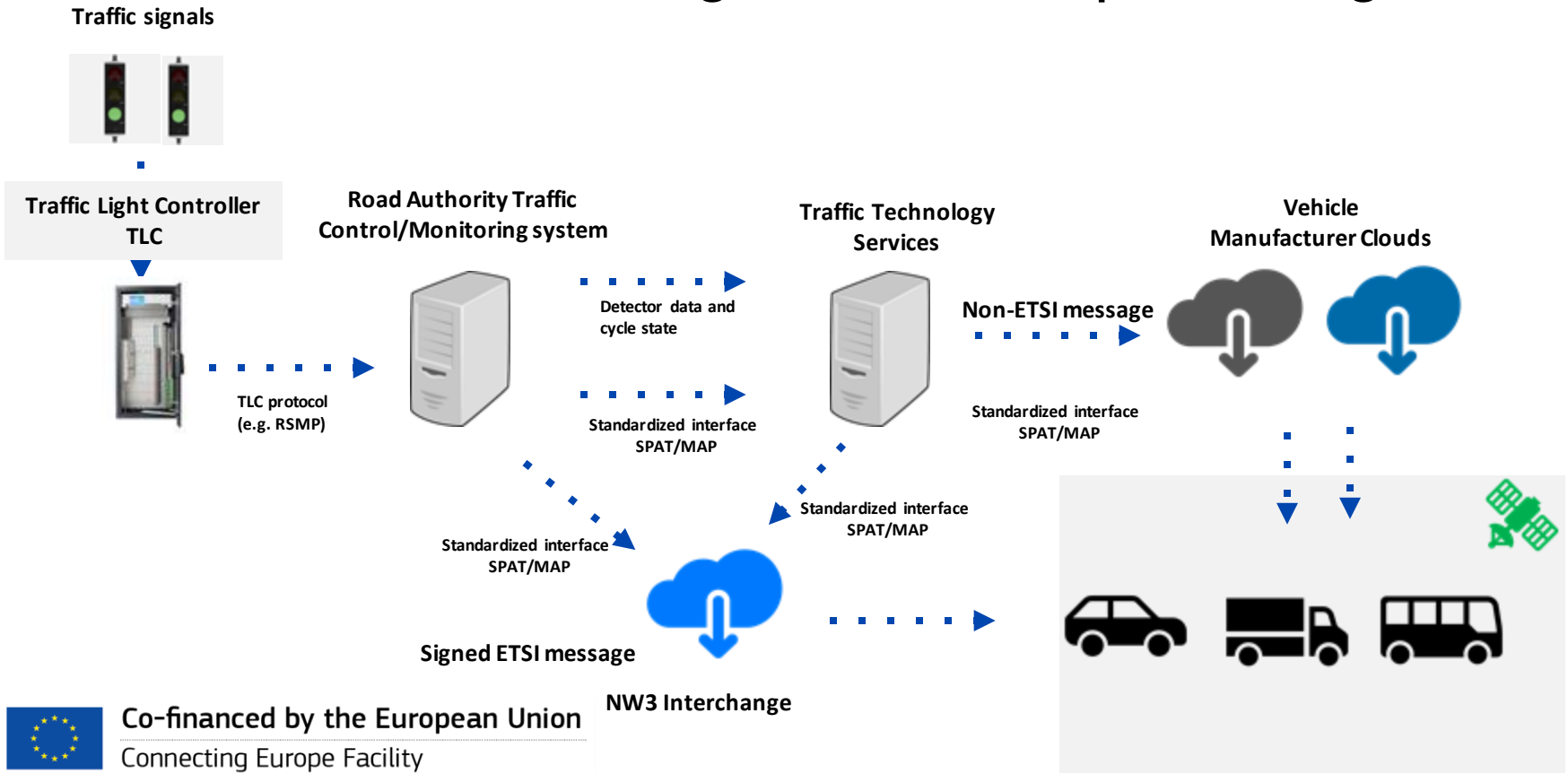
Methods for establishing SPAT & Map messages



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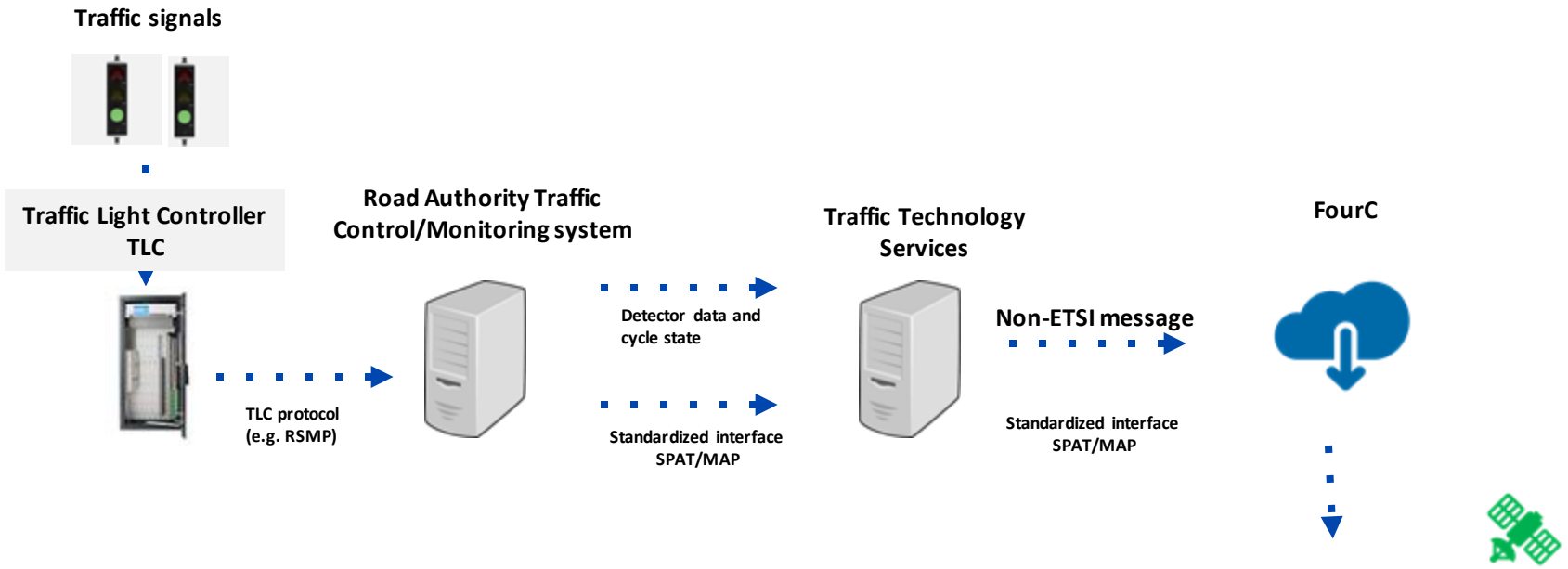
Methods for establishing SPAT and Map messages



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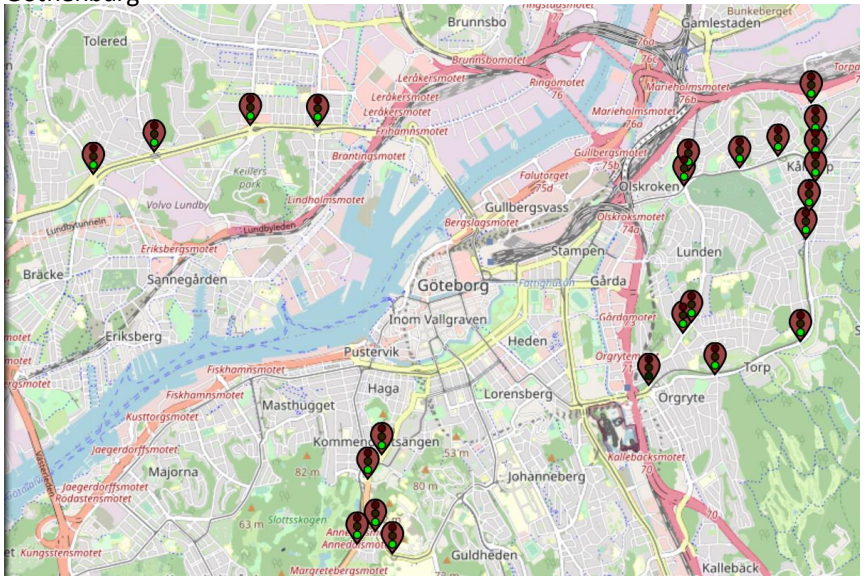
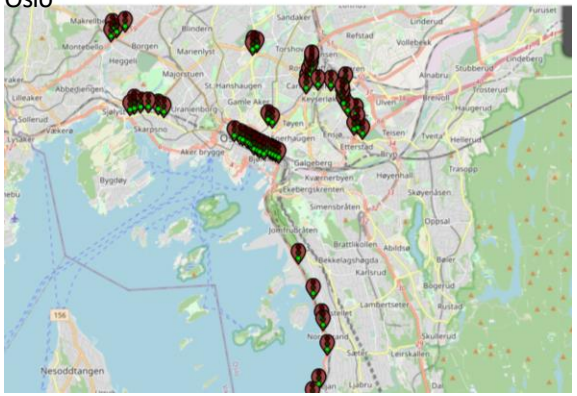
Installations in NW3 used for evaluation of GLOSA

Green Light Optimal Speed Advisory

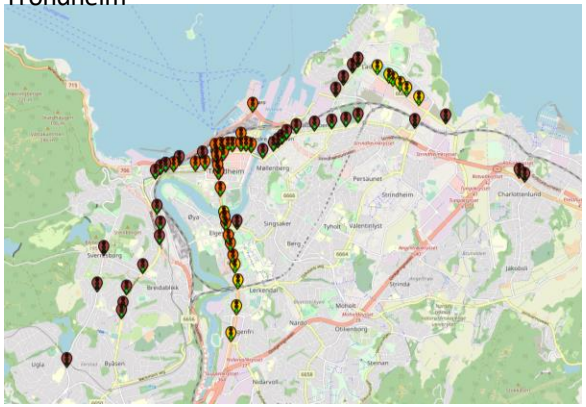
Gothenburg



Oslo



Trondheim



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Android Automotive app in Polestar 2 – predictions in the app

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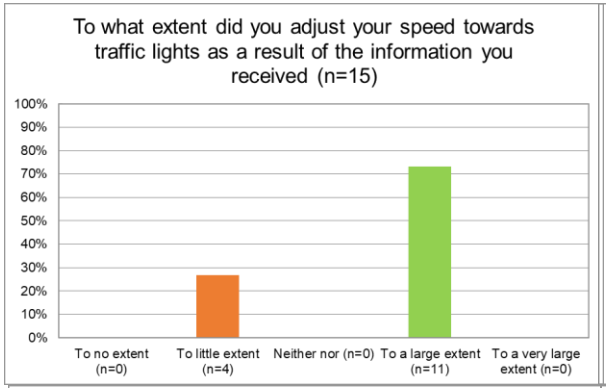
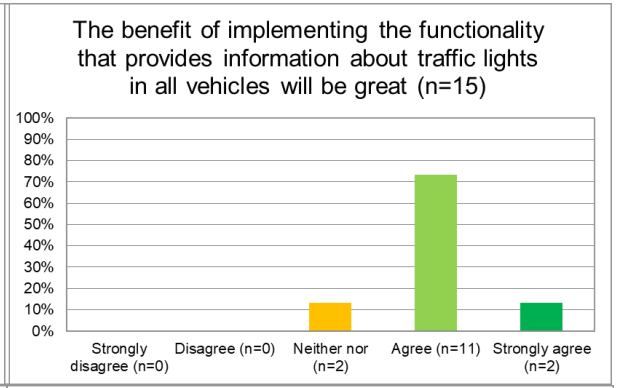
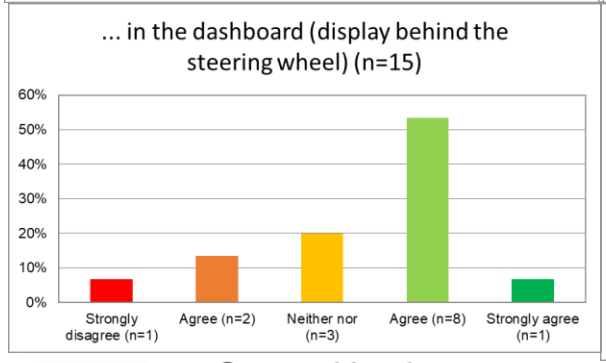
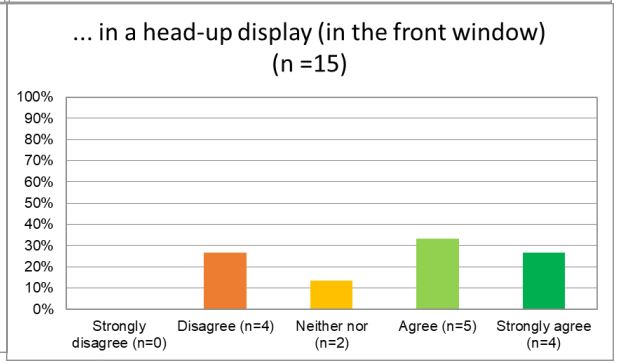
Survey i Trondheim

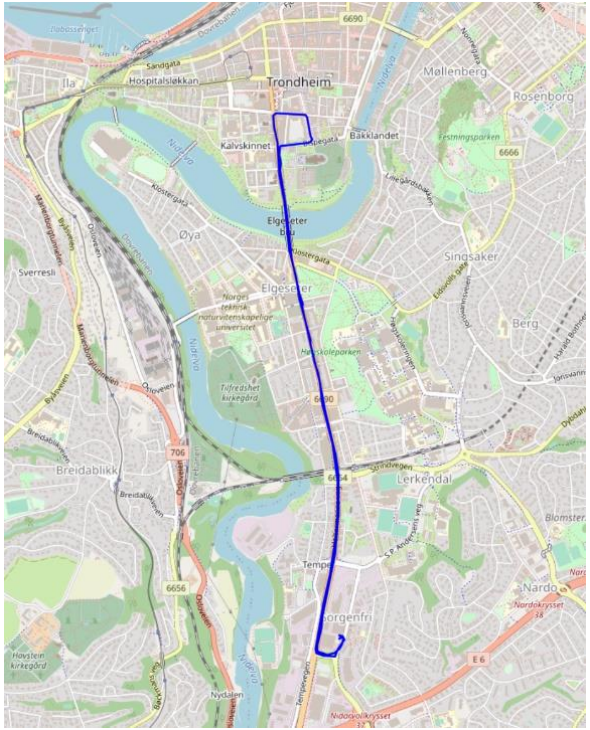
A small survey to get some feedback on our setup











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Traffic signal information - takeaways

- The Nordic way of setting up traffic actuated signals is problematic when we are making predictions. We might lose some of the flexibility if we in the future would accommodate autonomous vehicles.

- The eco system and business model for either public or user payment is essential for the roll out process.

- Traffic signal information is perceived as a user-friendly C-ITS service.

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Connected Traffic Signals Gothenburg

Kristina Jensen
City of Gothenburg. Sweden

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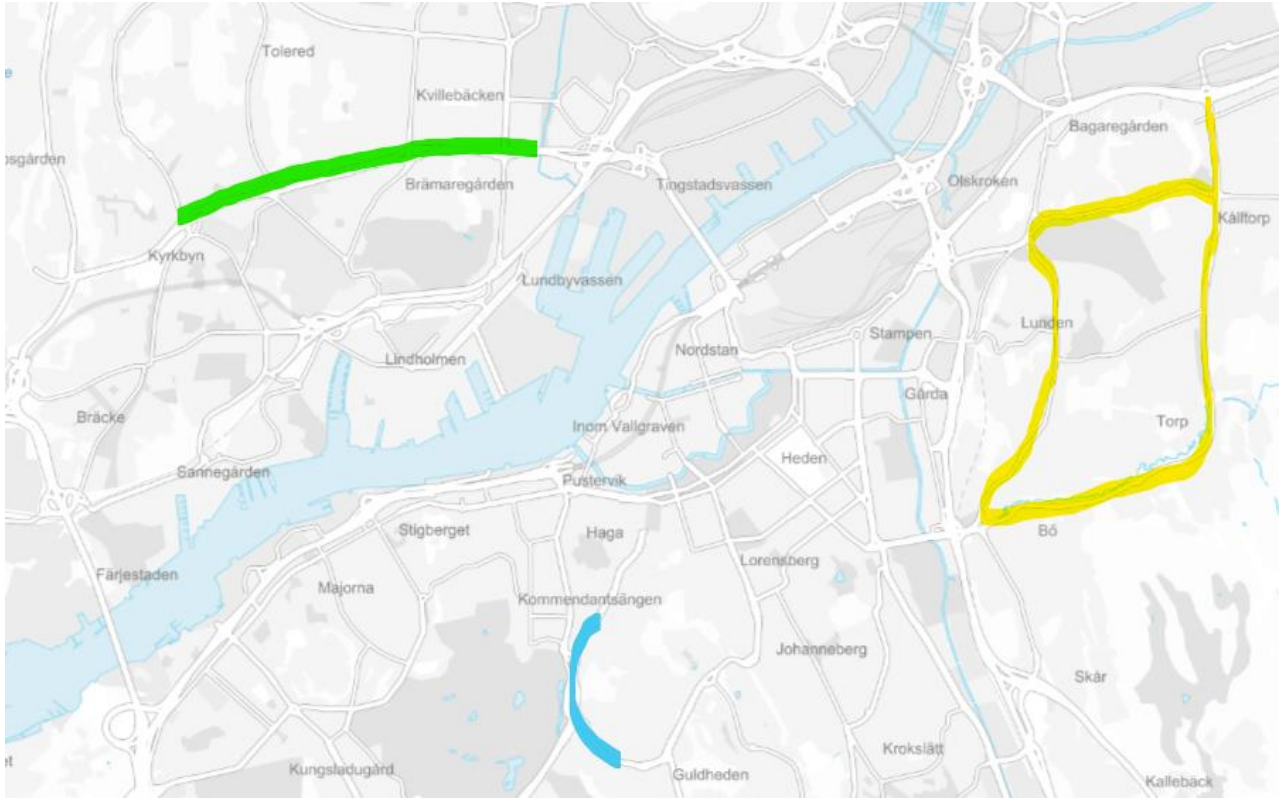
Gothenburg Routes



- Delsjövägen (15 NW3)
  Highly adaptive signals
- Hjalmar Branting (4 NW3)
  One adaptive, 3 fixed time
- Sahlgrenska (5 NW2)
  Highly adaptive

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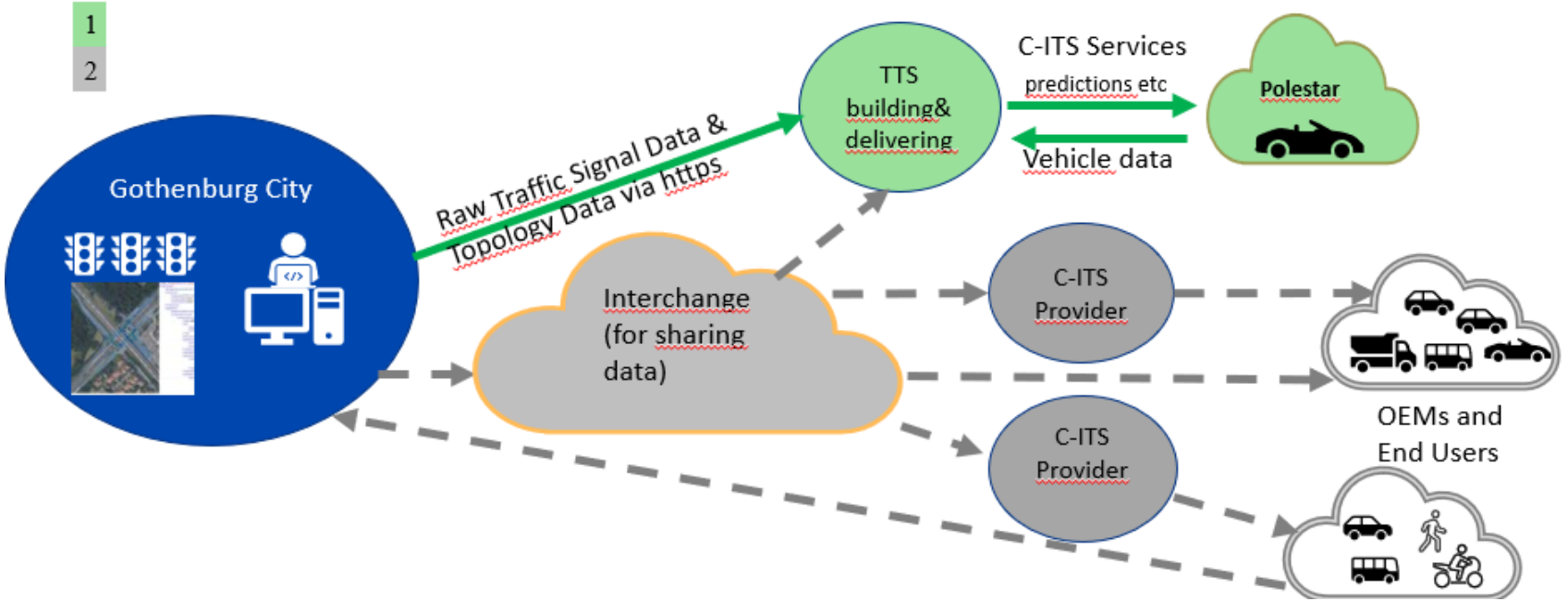
Data Sharing for C-ITS Traffic Signal Services



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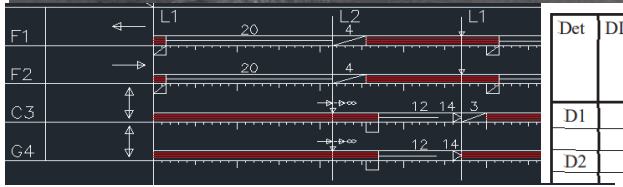
Challenges: Data Quality Issues



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		Avst m	Gr	Kmg + vmg	grupp	Funktion/tid				
						M-TID EJÄUT	M TID	F TID	G TID	R TID
D1		55	1		1		3,5	2,5		
D2		8	1		1		0,1			

- ITS Services require high quality data
- Today´s Legacy systems are often designed for human users
- Update Required of Traffic signal documentation used for MAP data production (Signal Plans, Detector Tables & Switching Schemes)

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Prediction Methods

1. FTE (Fixed Time Engine)
2. Emulator (Virtual Signal Controller)
3. AI (Self Learning Algorithm) → Gothenburg

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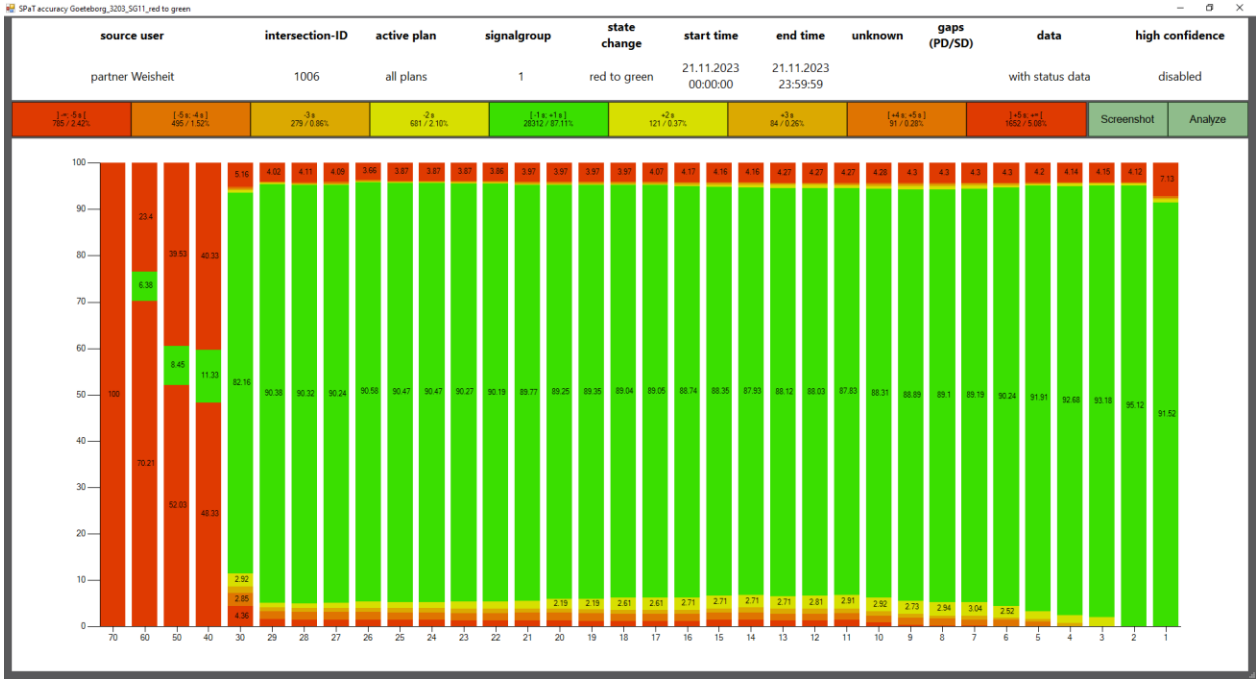
Delsjövägen (15) – Scored Green 90%



- Adaptive Signals
- Bus & Trams prioritized over cars and pedestrians
- Prediction Method:
  Self-learning algorithm with different priorities for public transport, cars and pedestrians.

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Findings – in general

- Traffic Signal Documentation not accurate enough (leads to low MAP data quality)
- Intersections quite representative for Gothenburg in general
  - High degree of Adaptive Signals
  - Bus and Trams are prioritized over cars and pedestrians
  - Highly adaptive to Requests from sideroads (pedestrians, cars)
- Correct Predictions – Variation 80-99%
  - Delsjövägen 90%, Sahlgrenska 80%, Hj Branting 88-99%
- Common reasons for Intersections with lower accuracy
  - Tremendous complexity (many road users and different kinds)
  - Instant reaction to pedestrians, side road and left-turners

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Findings - Pilot Testdriving 6 sep 2023

- The result showed that Predictions were correct on about 90 percent of the time
- Incorrect predictions = not a big impact on customers experience as the service was only displayed if the confidence value was high enough.
- The most frequent and important reasons to incorrect predictions
  - Pedestrian pushbutton triggers
  - Public transport being prioritized
  - Public transport not moving in an expected time range (taking too long or driving faster than usual)

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Room for improvement

- Solutions
  - Optimize the traffic flow by using realtime strategies and signal settings*
  - Delay the intersection reaction time (to events from Side roads or pedestrians)
  - Get public transport requests or calls from side roads earlier

- Next Step
  - Identify which Intersections has room for improvements according above
  - Update Traffic Signal documentation (signal plans detector tables etc)
  - Establish an Access Point for Data Sharing

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Connected traffic signals as a driver for new mobility services

Mikael Ivari
City of Gothenburg, Sweden

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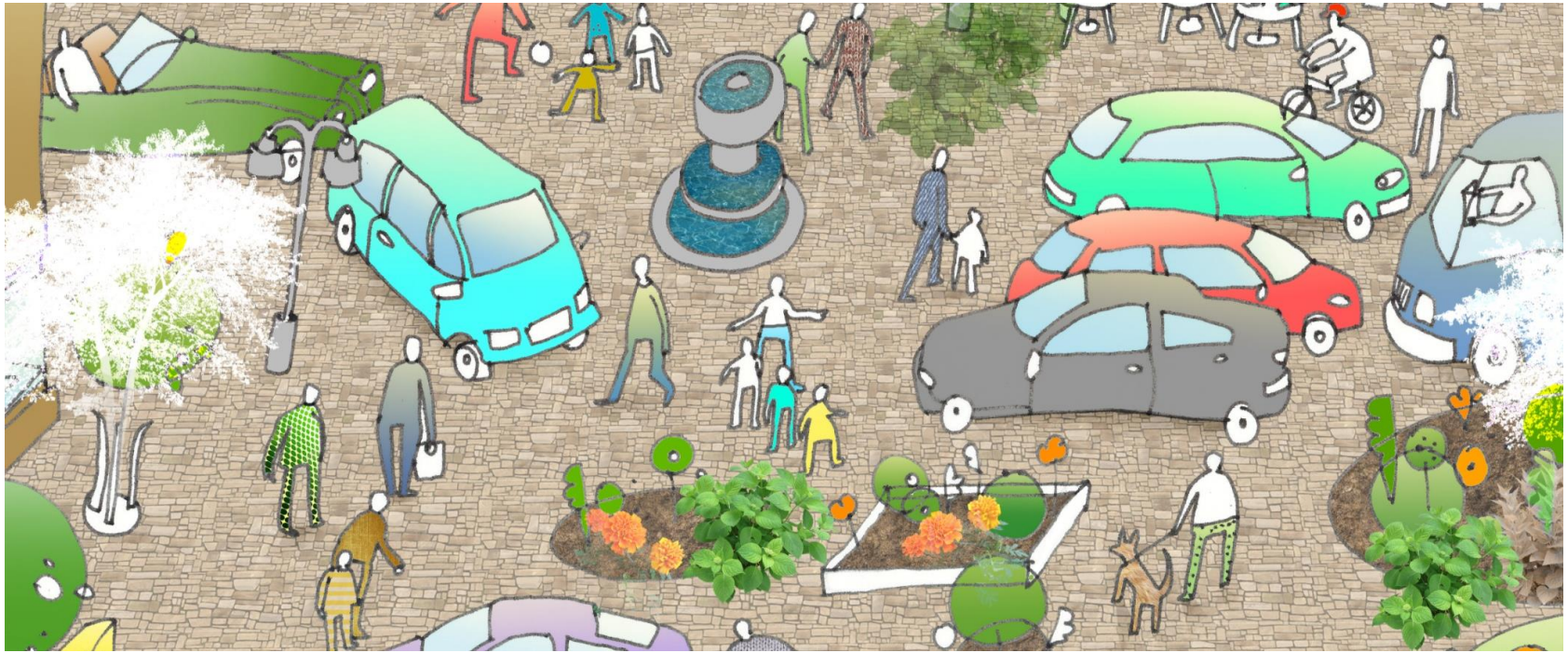
Why is C-ITS important?



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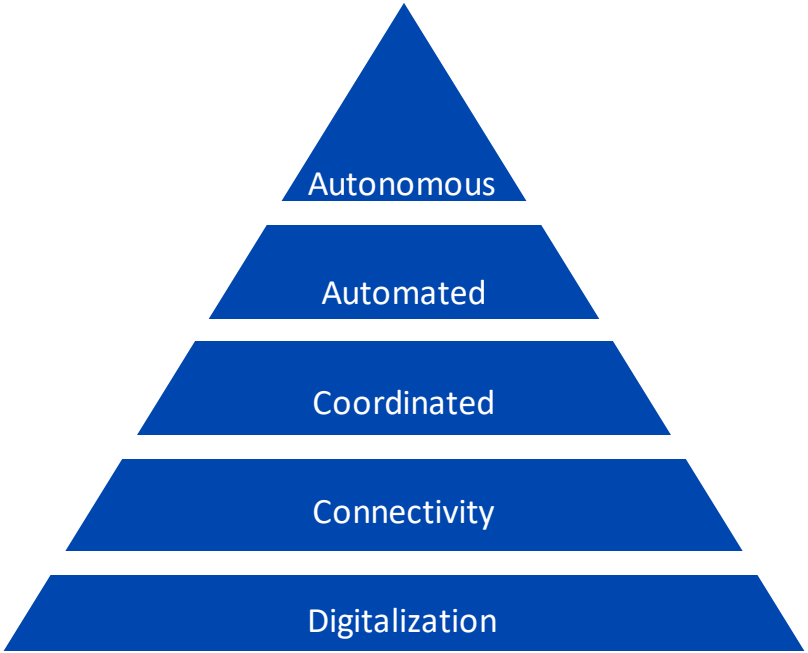
A long-term strategic approach



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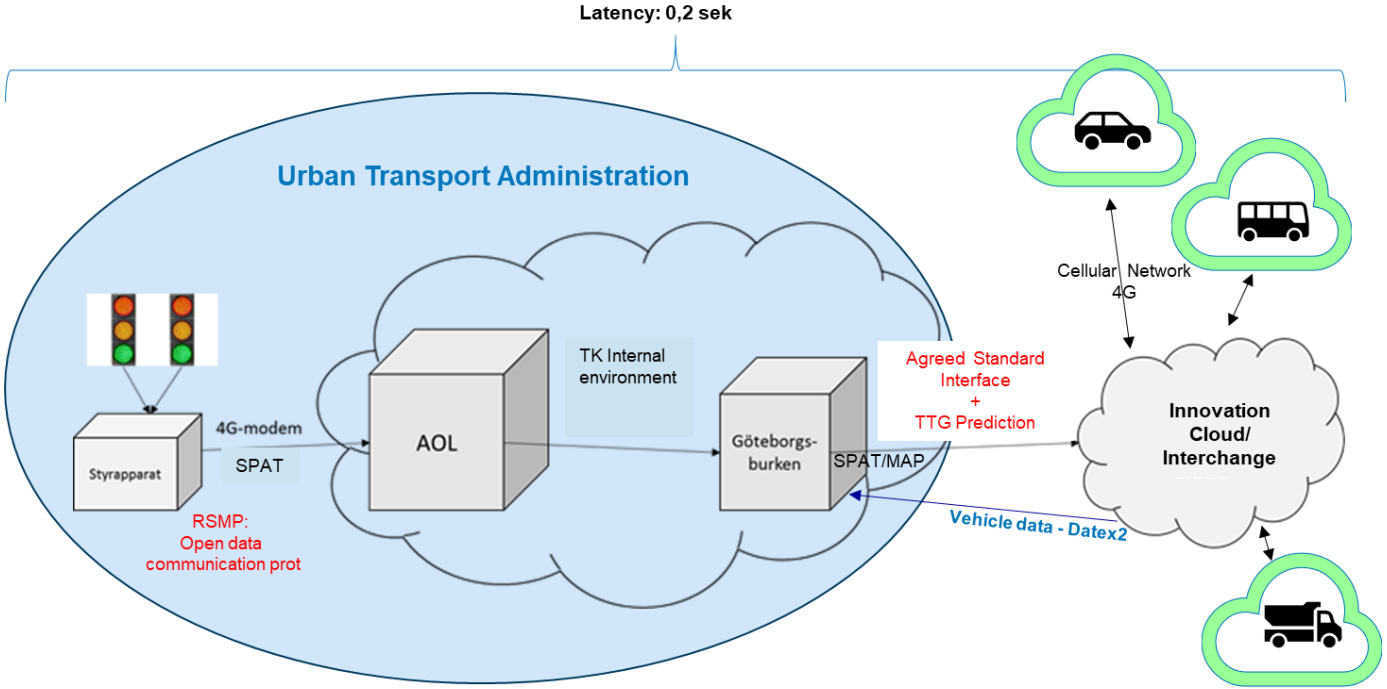
Exploring the concept in Nordic Way 2



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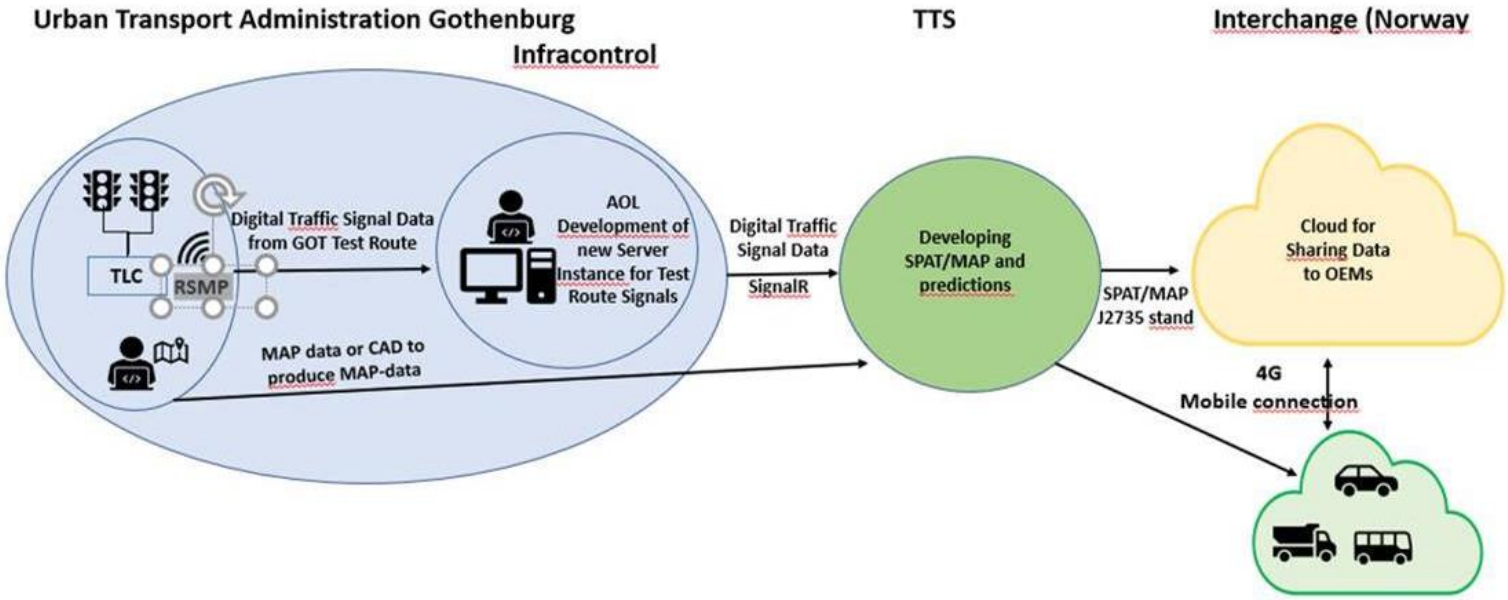
Preparing for deployment in Nordic Way 3



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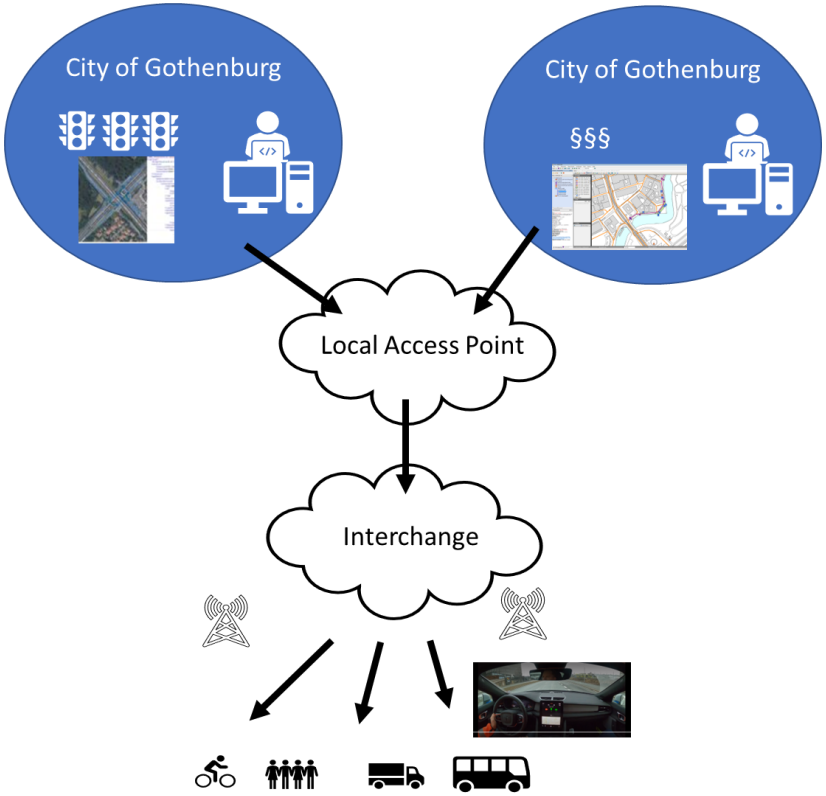
An emerging Eco System

- ITS Directive / RTTI
- National Access Point
- Facilitating exchange of data
- Platform for multiple services
- On the road to automation



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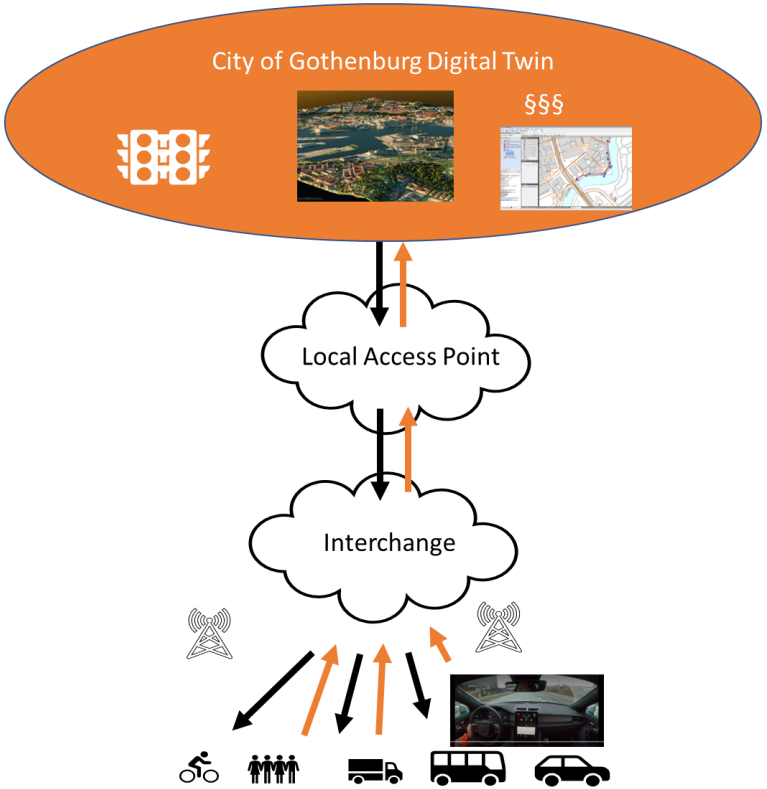
Towards a Phygital future



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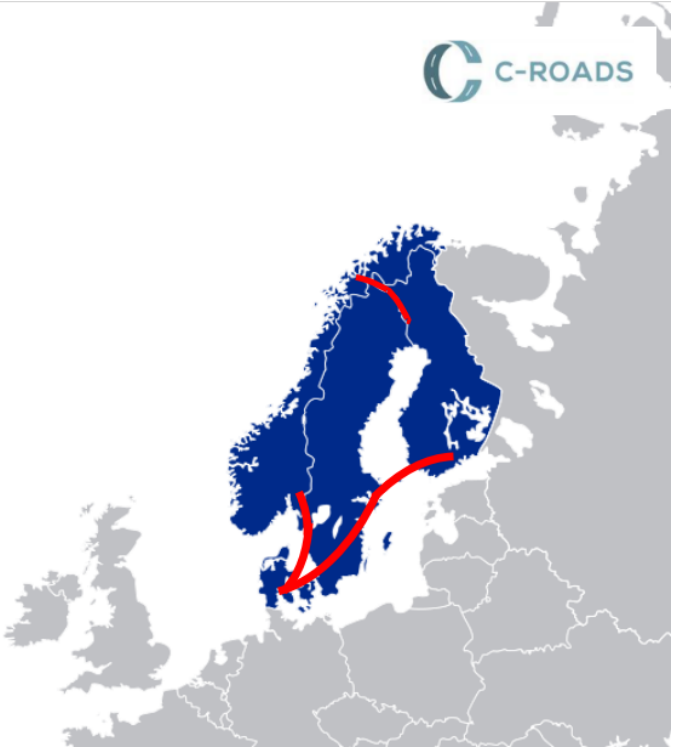
On the road to deployment of C-ITS Traffic Signal Services in the Nordic Countries

Nordic WAY 3

Thanks for listening!
Any Questions?



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Traffic Signal Priority Solution

The positive impact of deploying a technology ready, standardized Traffic Signal Priority within the cities as part of the C-ITS ecosystem in Europe.

Speakers: Trafikverket (SE), ITxPT (EU), EVAM (SE), Technolution (NL), Swarco (SE), Monotch (NL) and Sweco (SE)

- Presentations
  - Requirements of TSP as a Road Authority
  - Standards and integration of public transport and road transport system
  - Emergency vehicle priority saving lives
  - Technology and readability of TSP solutions
  - Findings from pilots and end goal of implementing TSP
- Q&A

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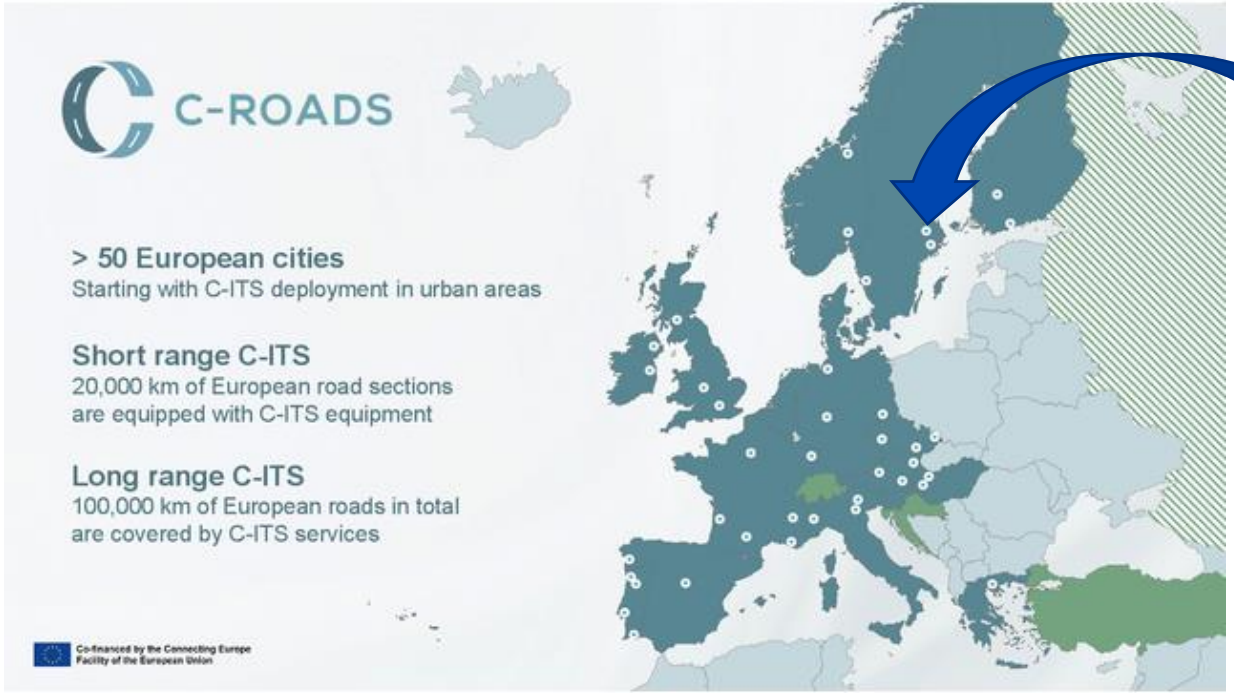
Traffic Signal Priority Solution



Pilot Sites

- Uppsala
- Stockholm

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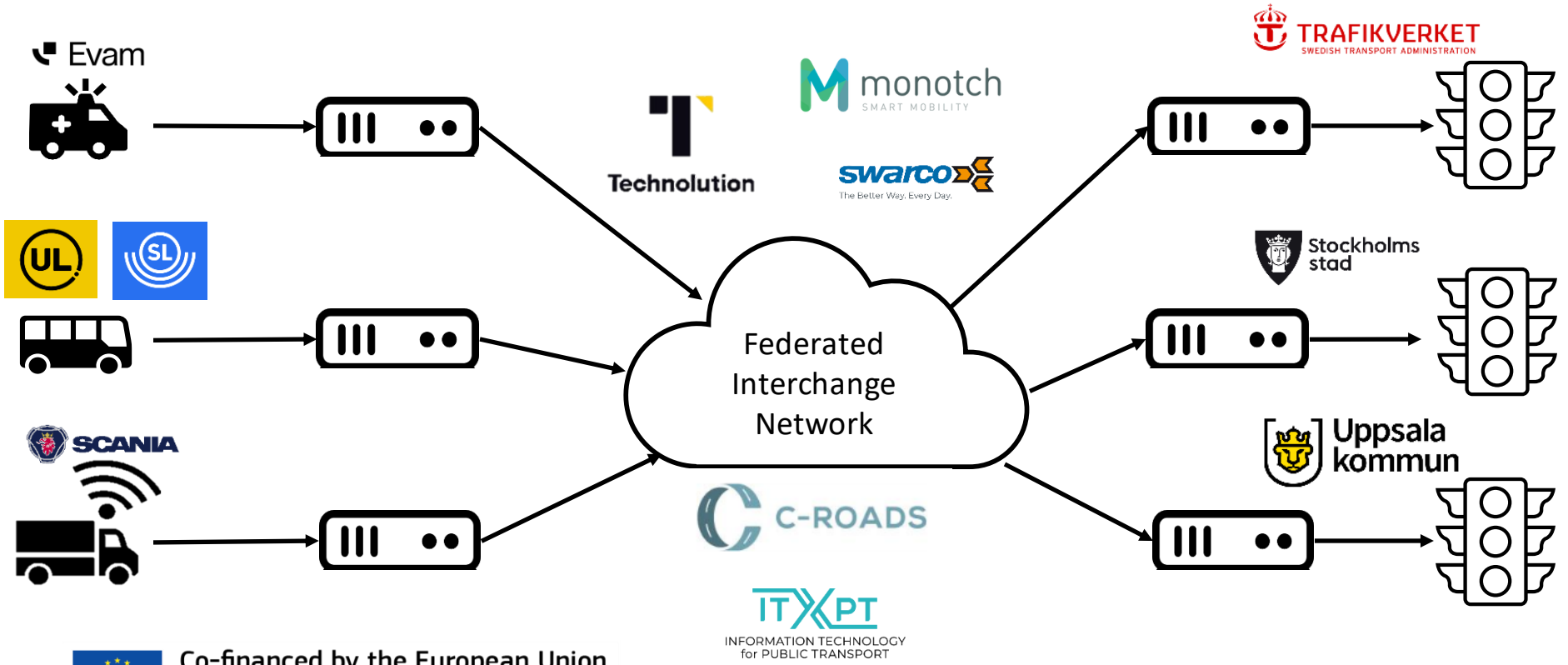
Nordic WAY

Traffic Signal Priority - Partners



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Pilot goals

- In a pilot setting, deploy C-Roads use cases
  - Signalised Intersection – Emergency Vehicle Priority
  - Signalised Intersection – Traffic Light Priority
- Define architecture
- Write technical documents ready for future TSP tenders
- If necessary, provide C-Roads with feedback on uppdate

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Requirements of TSP as a Road Authority

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Expectations

- Standard method of exchanging C-ITS messages
- No need for a special priority equipment
- Give priority anywhere when needed
- Find solution for existing systems and equipment

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Challenges

- Difficulty to find and interpret ETSI and C-roads standards. Many documents and many cross references
- A MAPEM process to be implemented and tools needs to support our workflow
- Differences between C-ITS standards and how existing priority systems works

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Findings

- Architecture can be implemented in several ways
- Participate in future standardization work in order to ensure compatibility with existing systems and priority functionality
- Identified a need of better guidance for navigating the large amount of documents, standards and C-Road's documents

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Benefits

- Early benefits by swift deployment
- Scalable since we use a standard method
- We can prioritize vehicles in new locations where it otherwise would have been difficult or too expensive

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Benefits

- Fewer errors using standardized machine readable MAPEM data
- Possibility for a step-by-step future development when reinvesting equipment and systems

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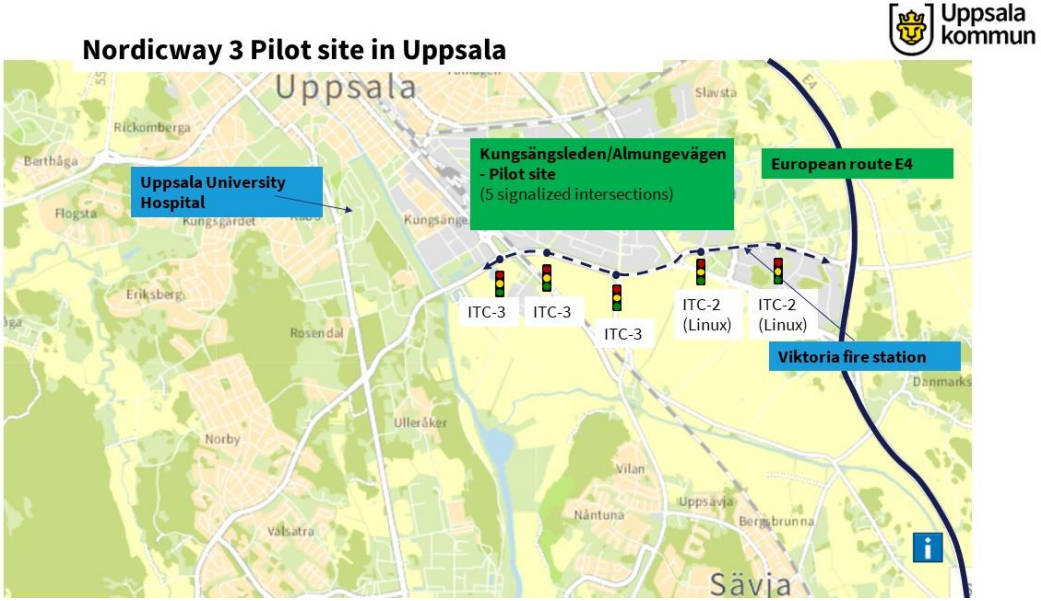
City of Uppsala



General expectations from the project:

- To improve signal priority systems together with other stakeholders
- To improve signal priority services in Uppsala in the slightly longer term

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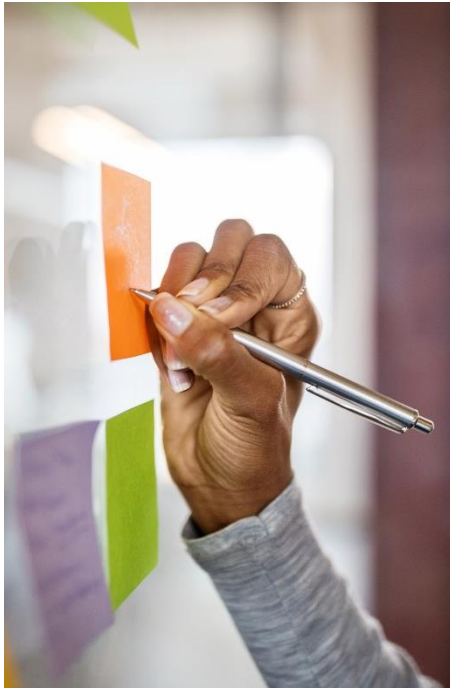
Challenges

- The internal knowledge about C-ITS is not that great
- When scaling up – local routines must be implemented for quality control (MAPEM, SREM, SSEM, CAM)
- Local emergency vehicle organization has not been involved in the project



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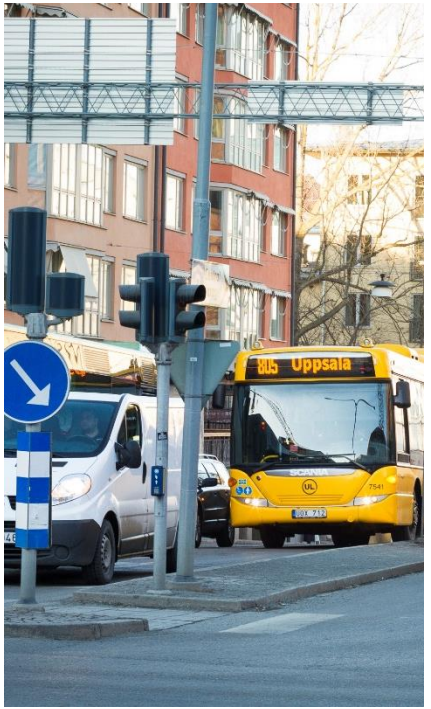
Our findings

- C-ITS supports functionality over administrative boundaries
- A national access point would support further development of standardization and scalability
- Rescue vehicles could be given priority in the whole city (Cellular communication). The entire process could be made fully automated



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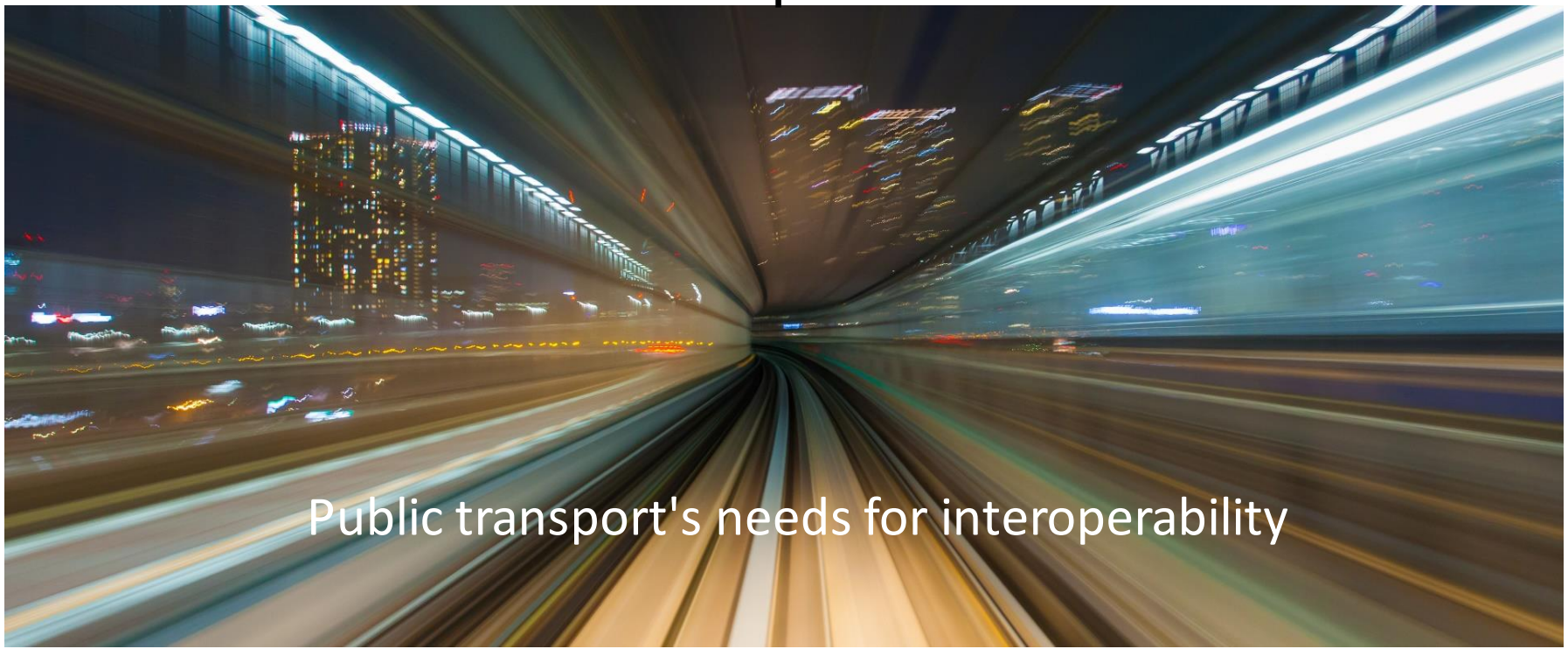
ITxPT and standards & specifications



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By: Anders Fromell, CTO

Our expectations on the project

- To spread understanding about public transport's needs
- Find PT related gaps in R-Roads
- Discover integration points needed

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Findings...

- Common understanding of public transport behavior not considered during the design of the concerned API's
- Feedback to driver
- National access point for ALL intersections details

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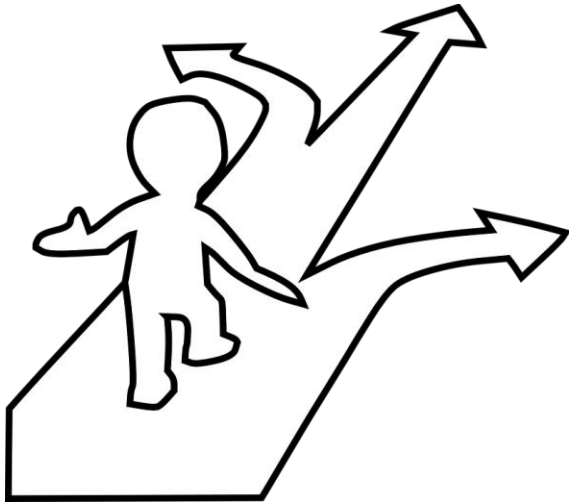
Challenges...

- National/EU road authorities need to use the same standardized API's
- Local road authorities have to use the same standards to get the expected over-all effect.
- To get a reasonable implementation roadmap, most likely EU funding is needed.



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Recommendations...

- Do a "readyness-level" analysis per EU nation, of how mature the nation is to implement ONE standard like C-Roads
- Select one nation to perform a nation wide POC based on best "readyness-level"

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Recommendations...

- Make sure PT & RA needs are adopted in R-Roads and ETSI standards
- Evaluate integration points between road authorities, PTA,PTO, ITS suppliers and vehicle manufacturers from a national perspective

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Our actions...

- Launch a Requirement Workgroup that will create use cases as well as functional requirements. This will eventually end up in a Technical Specification about what standards and specifications to use in public transport vehicles
- Investigate how PT vehicles can share data with road authorities, like road conditions, warnings, tunnel safety etc.
- Adopt our driver interaction API to support above
- Actively participate in related standardizations

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Conclutions

- To see the full functional as well as financial effect of standardization it is important that ALL stakeholders in the "chain" follows the same concept and standards
- Communicate the benefits to all stakeholders
- Do a reasonable roadmap based on "end-to-end" cost savings
- To use harmonized standards is the future..

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Traffic Signal Priority for Emergency Vehicles

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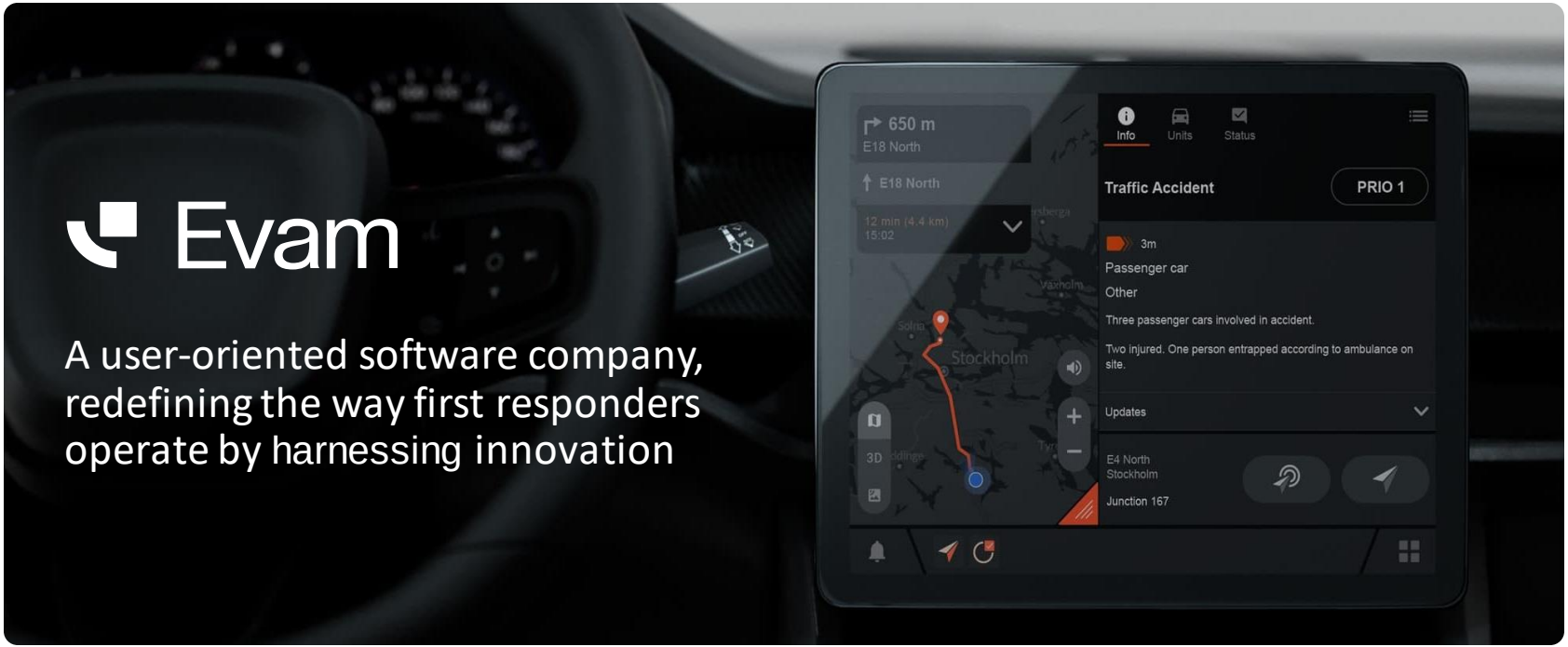

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Short facts about Evam

- Covering 100+ municipalities in Sweden
- Currently active in Ambulance and Fire & Rescue segments with a fast growth across Nordics
- Supplier of full on-board software platform including applications such as CAD-integration, Navigation, Information and C-ITS

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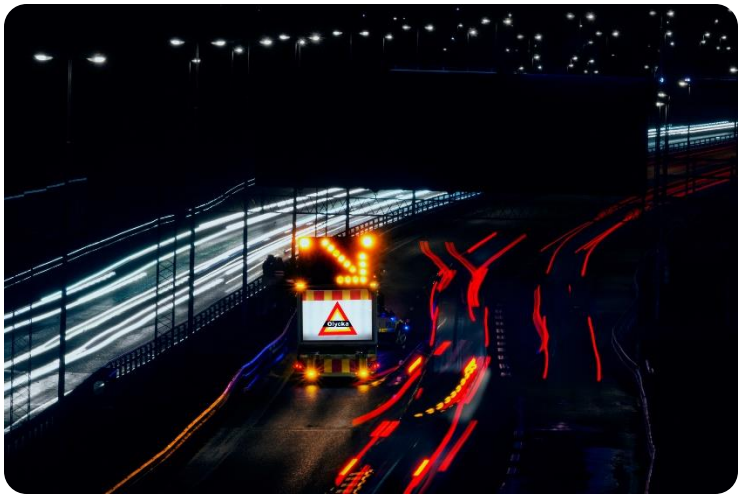
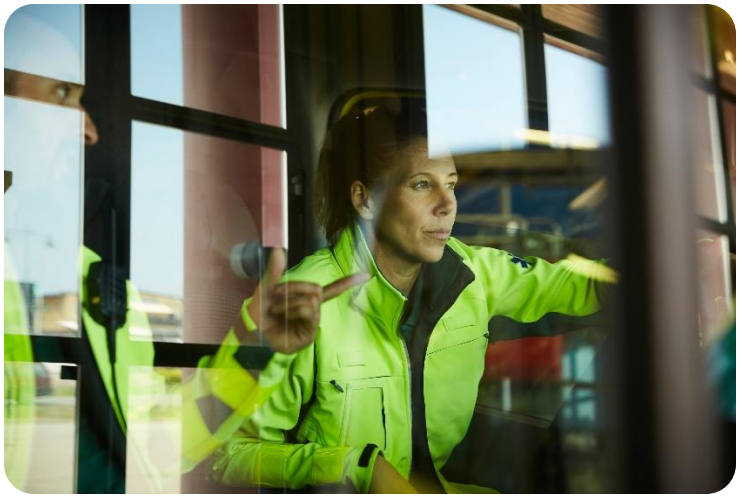
What's in it for the Emergency Services?



Traffic Safety



Shorter Response Times

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Traffic Safety for Emergency Services

- **88 000 Traffic Accidents Yearly**

  It can be estimated that European emergency vehicles are involved in 88 000 traffic accidents yearly.

- **43% of Traffic Accidents Happen in Intersections**

  Knowing that 43% of ambulance crashes happen in intersections and assuming a similar distribution for fire and police vehicles, 37 900 Emergency vehicle accidents happen in intersections yearly in Europe.

- **164 deaths related to EV Traffic Accidents in Intersections**

  Based on US Statistics it can be estimated that the 37 900 Emergency vehicle accidents in intersections account for 164 deaths.

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Shorter Response Times

- **Traffic Signal Priority may reduce the average trip time by 10%**

  Traffic flow simulations showed that if emergency vehicles where given green phase at signalized intersections the average trip time would be reduced by 10%.

- **Traffic light pre-emption has the potential of saving the European society €45bn yearly**

  In Europe, 151 million emergency trips occur annually. With an 8-minute average ambulance response time, potential savings of €375 per minute, and extrapolating similar benefits for police and fire, implementing traffic light pre-emption could save €45 billion yearly, enhancing traffic safety.

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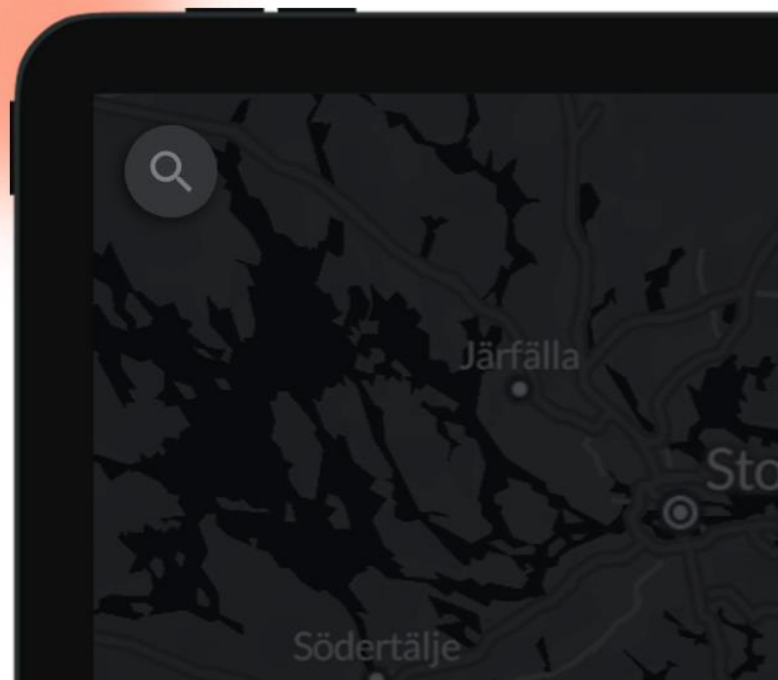
In NW3 we fully incorporated TSP into the Evam Platform

- TSP was demonstrated as a integrated part of the Evam Platform
- The solution is ready for large scale deployment when the infrastructure is in place



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SWARCO Multimodal Traffic Light Prioritisation Service

Multimodal, fully customisable solution

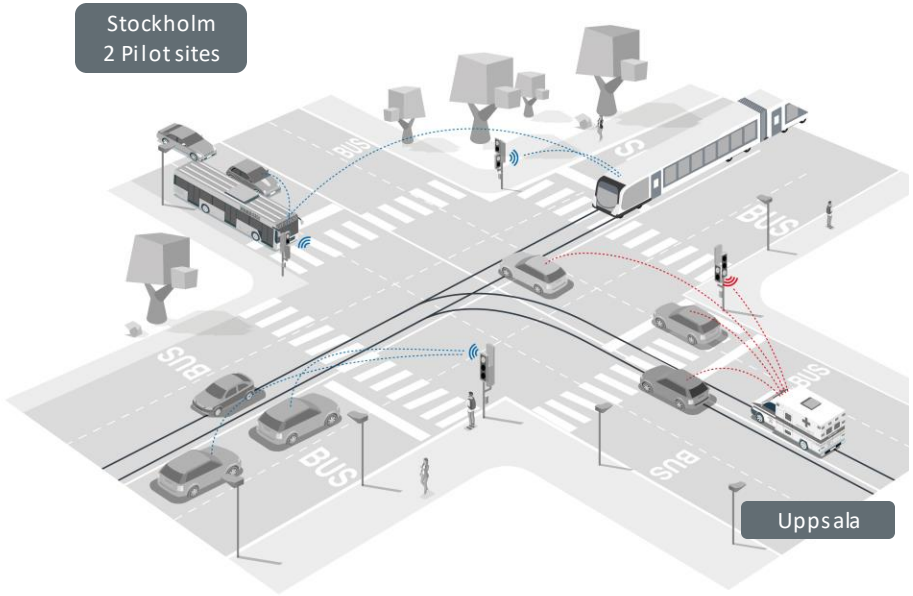
- Different levels of priority can be applied according to city needs and policies. The priority depends on vehicle characteristics such as status (e.g. public transport vehicle on time or behind schedule) or type (e.g. heavy goods, electric vehicle, cyclist etc.).

Savings and improvements

- Saves fuel, helps reduce pollution, makes public transportation more attractive to the citizens.

Advantages

- The vehicle request priority for the intersection, the traffic light logic determines in real time how to respond in order to keep most efficient traffic flow.
- Economy-of scale effect – many use cases with the same technology, widespread and future-proof solution.
- Easily scalable – from city to nationwide deployment (x-vehicles / x-cities / x-service providers).



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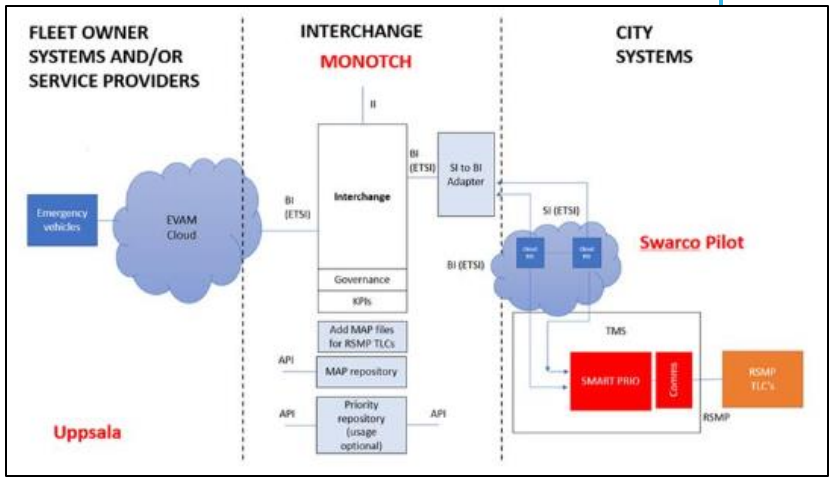

- **Technology is ready for scale-up: 6 different, standard deployment scenarios**
- **Compliance to open international standards (C-Roads, ETSI SRM usage)**

BENEFITS

CENTRAL FUNCTIONS for Use Cases requiring:

- **Quicker response time of the "blue lights" vehicles, with safe passage through intersections** (pre-emption = green for early responders, red for conflicting traffic, every second counts)
- **More reliable public transport operations while improving the fleet operations** (reduction of the travel time by 10% up to 35% and improvement of the public transport punctuality by 4 - 9%).
- **Processing capabilities** (remote data centers provide unlimited virtual processing capabilities on-demand)
- **Reduced costs** (license fees are lower than the cost of the on-premise equipment and its continuous maintenance)
- **Integration** of various sources of data/information or systems
- **Scalability** in storage, processing power, bandwidth

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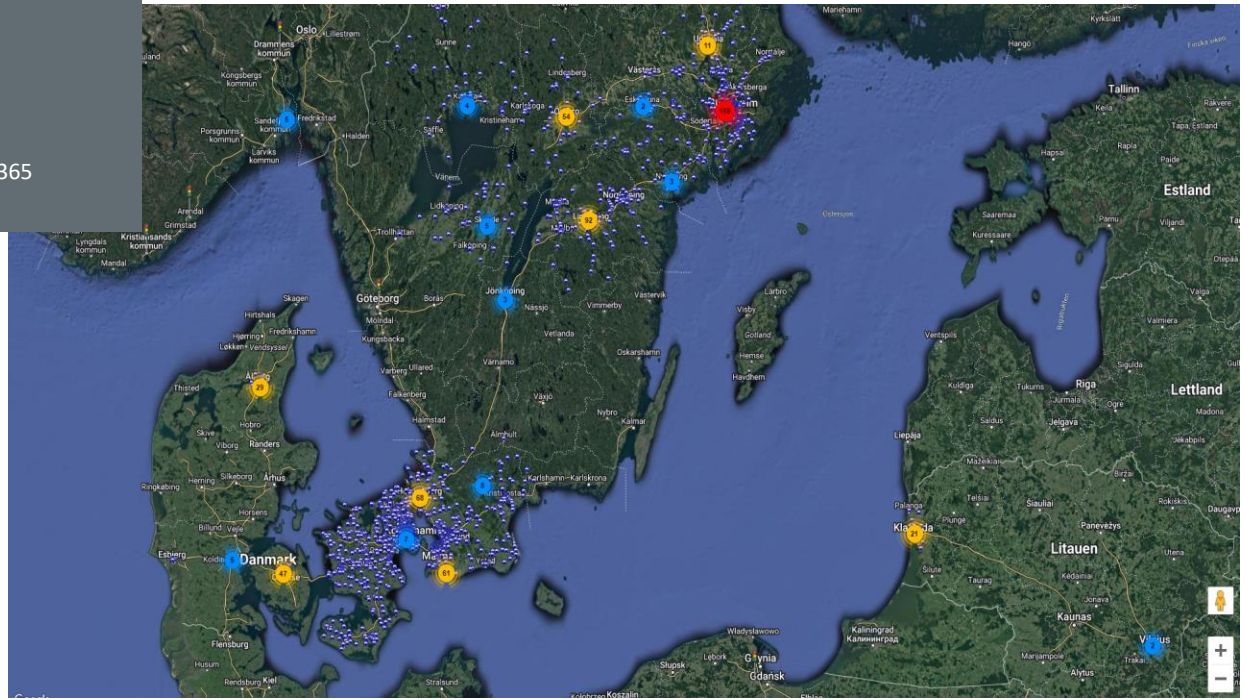
SWARCO after NordicWay III

Lesson learned?

We are ready for further expansion and evolution of the Multimodal Traffic Light Prioritisation Services

- More than 8 500 prioritized vehicles
- Over 750 registered intersections
- Over 2 700 virtual detector zones
- Over 11 000 messages sent every second 24/7/365



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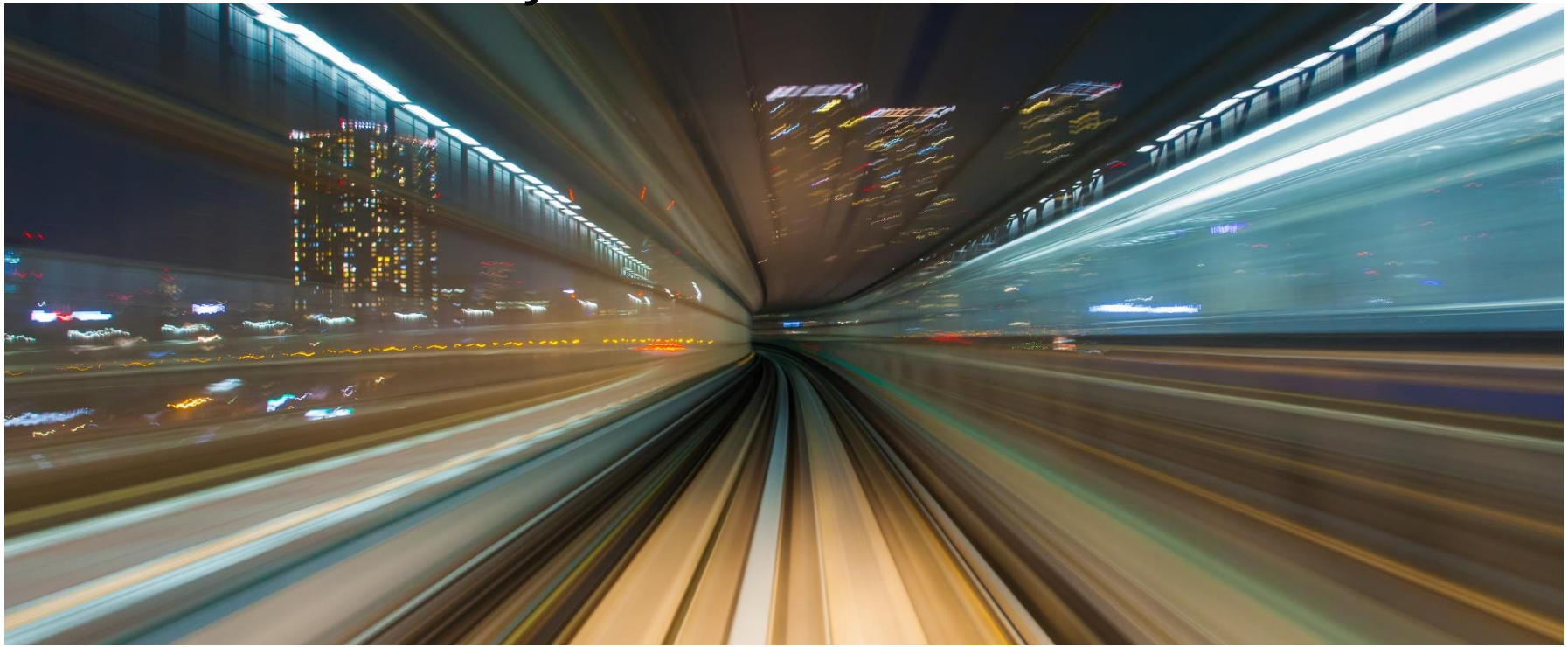
Technolution's hybrid TSP Solution



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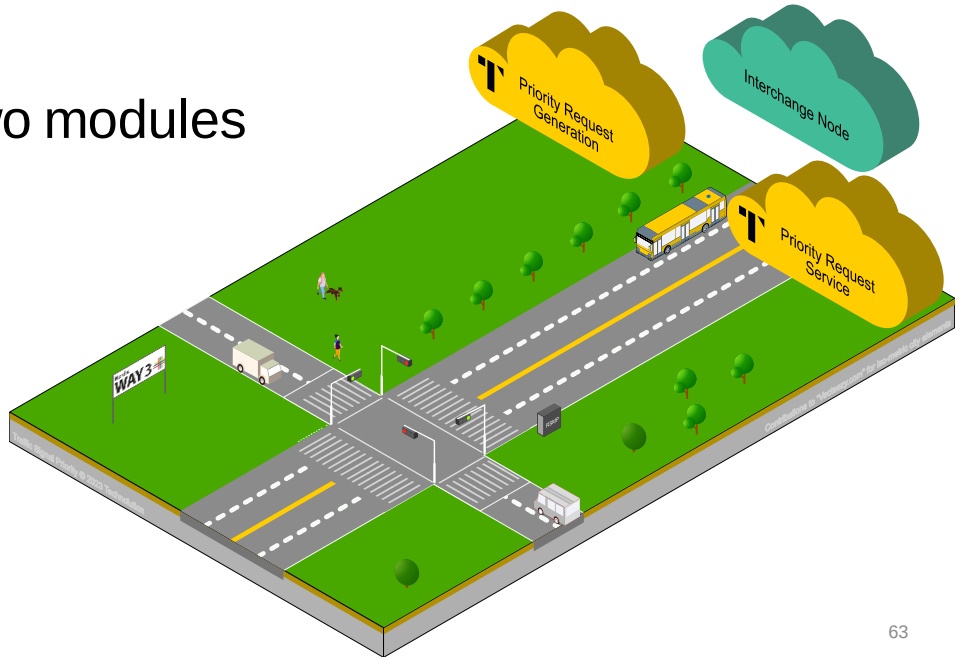
Technolution's hybrid TSP Solution

- Our goal was to extend the concept to existing, legacy equipment using standardized protocols, i.e. RSMP and ETSI;
- For this purpose, we extended two modules for Priority Request Generation and Priority Request Service;
- These new modules are connected through the NW3 Interchange Node.



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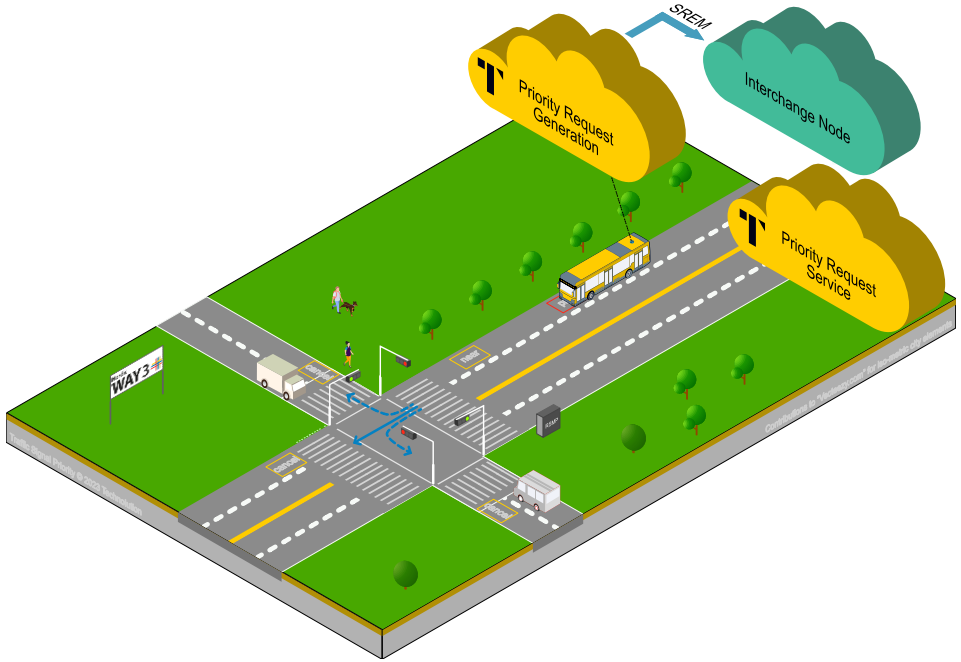
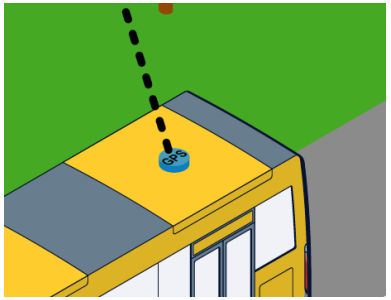
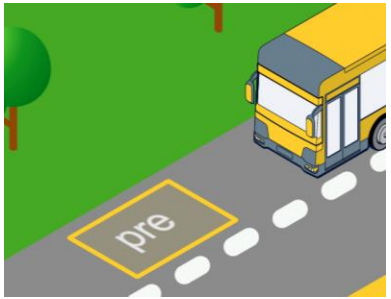
Technolution's hybrid TSP Solution



- Using real-time bus GPS information from Trafiklab we know the buses' locations;
- Virtual reporting points tell us what priority is required by configuration;
- Once a bus 'hits' a reporting point, we create the priority request message as an SREM.





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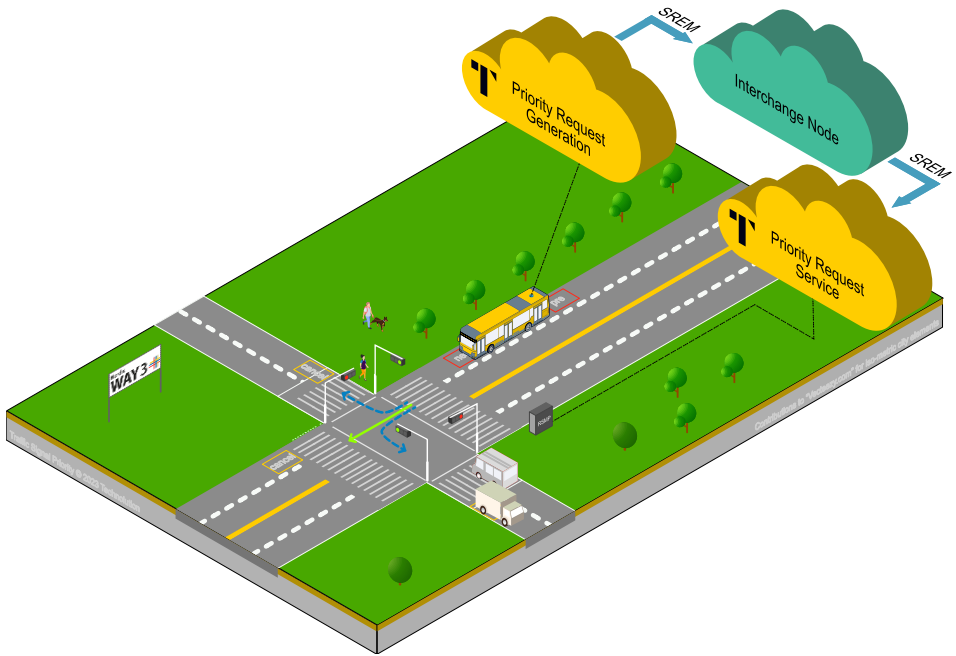
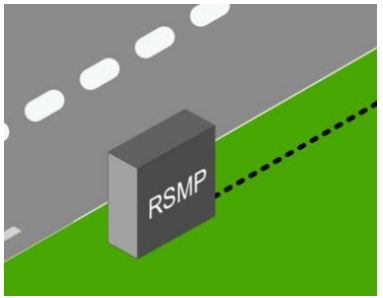
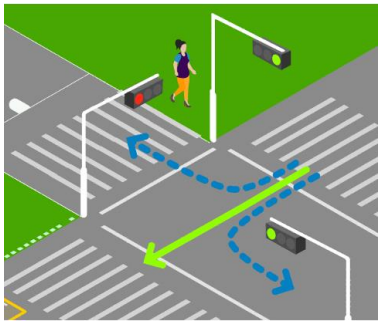
Technolution's hybrid TSP Solution



- We convert the priority request into a RSMP command;



- The RSMP traffic light controller responds by prioritizing the bus for the requested movement.



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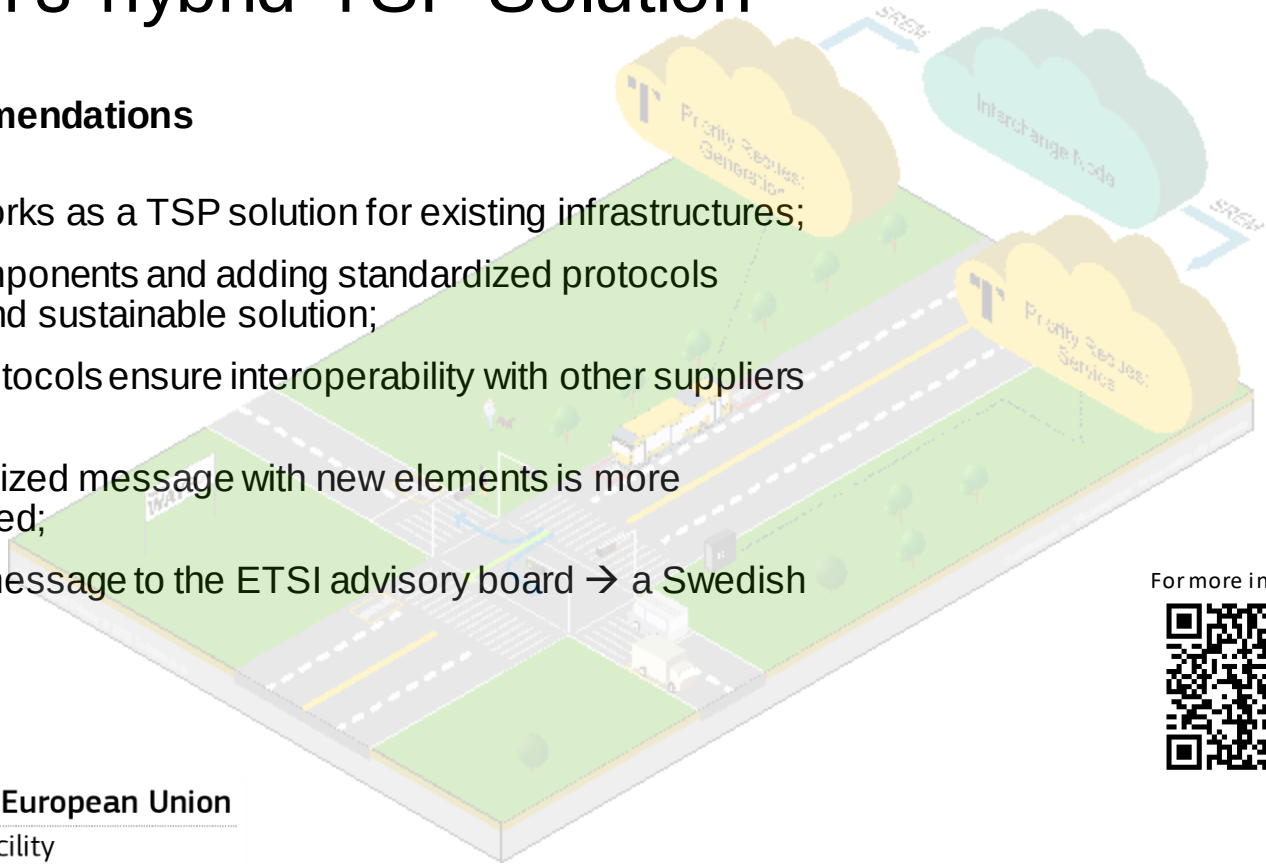
Technolution's hybrid TSP Solution

Findings and Recommendations

- A hybrid approach works as a TSP solution for existing infrastructures;
- Reusing existing components and adding standardized protocols result in a scalable and sustainable solution;
- The standardized protocols ensure interoperability with other suppliers and stakeholders;
- Extending a standardized message with new elements is more complex than expected;
- Bring the extended message to the ETSI advisory board → a Swedish profile!



For more information:

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Traffic Signal Priority: Monotch

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Our role in the TSP use-case

- Providing the software/services for data exchange and aggregation, equipment connections and quality control, security, governance…

monotch
SMART MOBILITY PLATFORMS

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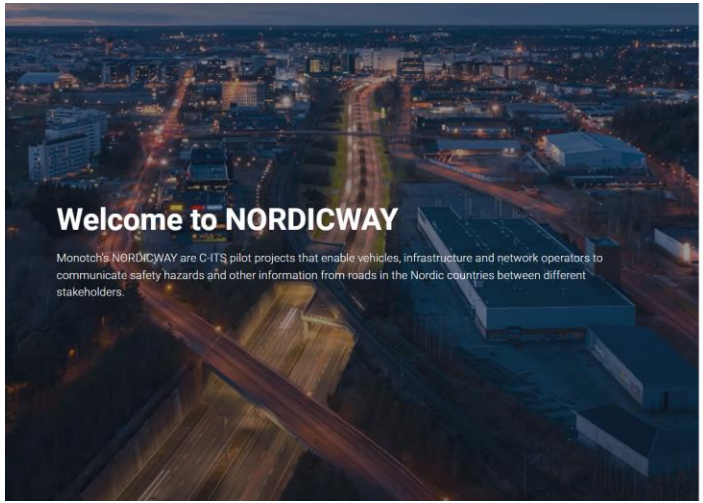
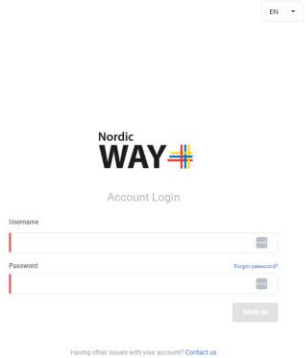
Our solution: the Interchange





- Fast & secured bi-directional data gateway following the C-ROADS standards
- Connecting the TLC's with the C-ITS Subject Interface

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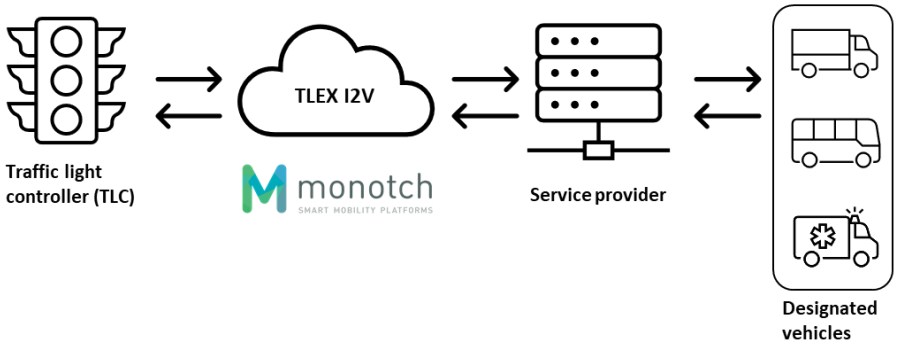
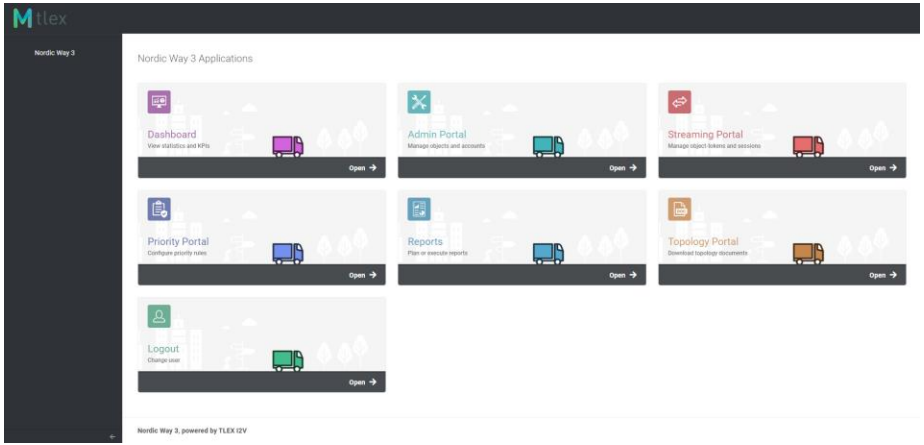
Lesson Learned

- Necessity of the Interchange as a hub that connects and manages all parties following the EU standards

- Requirements for dashboarding and analytics features made available by our product TLEX





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Traffic Signal Priority: Findings and conclusions

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Findings and conclusions

- Interchange necessary for C-ITS enabled TSP
- C-ITS TSP is easy to scale up to new intersections once key infrastructure is in place
- C-Roads specifications don't offer a full "manual" for architecture
  - Much is needed to be defined on a national level
- In order to deploy, local adaptations were done. This made it possible to integrate to legacy equipment. (Traffic Light Controllers). Less investment in new hardware.
- Complicated architecture and different interpretations of standards
  - More testing needed
- C-ITS is defined by many standards and specifications, hard to comprehend
  - Some "reading guide" would be nice.
- Extra data in ETSI messages was used, can be taken to C-Roads for amendment in message profiles

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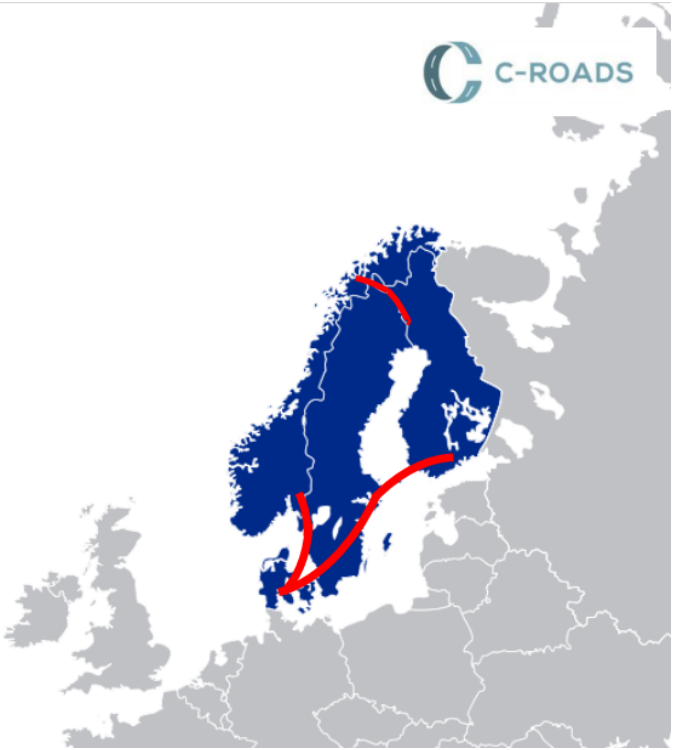
Traffic Signal Priority Solution

Nordic WAY 3

Thanks for listening!
Any Questions?



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