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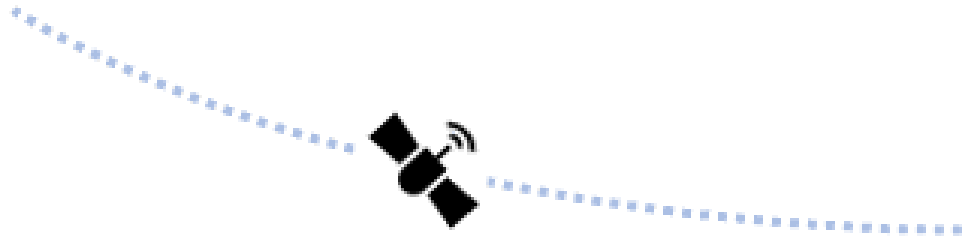
This project has received funding from the European GNSS Agency under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004181.

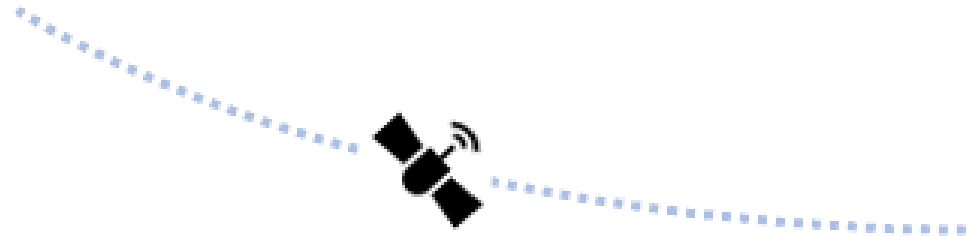


24/09/2021

Workshop on Traffic Infrastructure Mapping and Automated Damage Assessment Systems

Full Name

Company logo



Use Cases and Requirements Analysis

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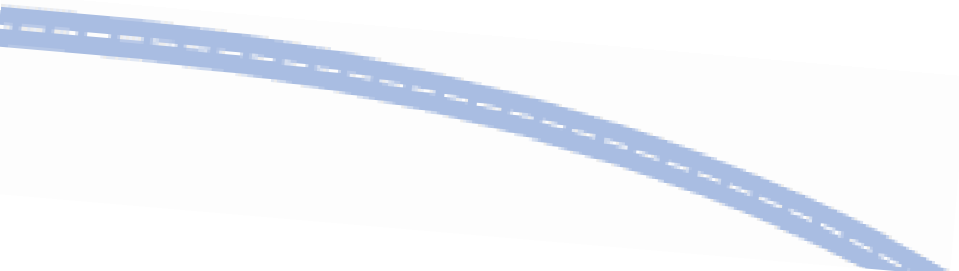
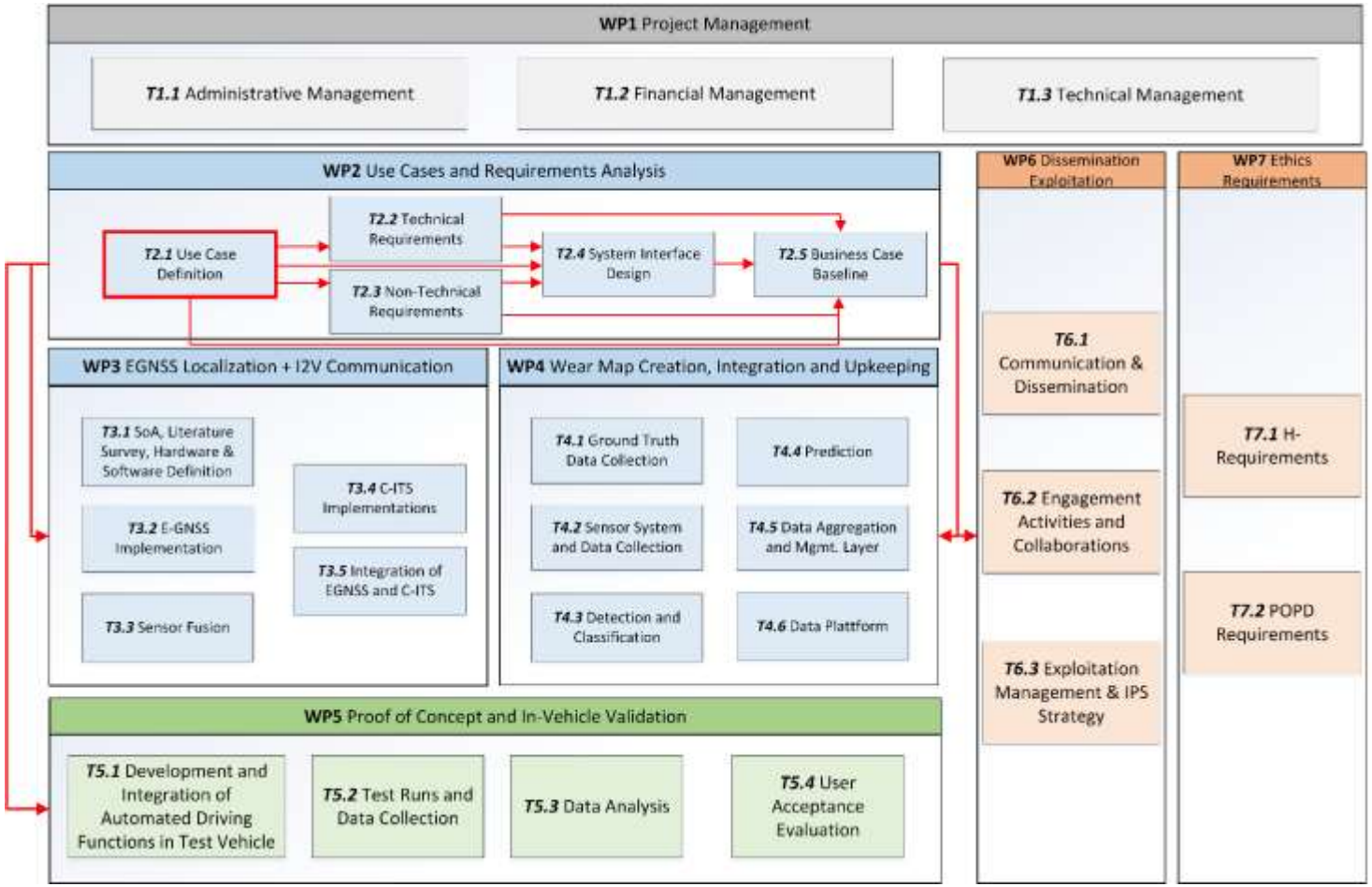


Use Cases – Relation to other WP and Tasks



Methodological approach

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1. Use case analysis based on the DoW: Development of four application scenarios including potential target groups, application prerequisites, challenges.
2. Validation within a bilateral workshop with key customer ASFINAG (road operator)
3. Internal review of updated version with all project partners: Developing consensus within the diverse and multidisciplinary team and taking advantage of multiple perspectives along the value chain
4. External confirmation of relevance of use cases from ASECAP[1]

[1]Also stated in ASECAP's C-ITS Manifesto (cf. ASECAP 2021, p.6, URL: http://www.asecap.com/images/News/PDF/2021_ASECAP_CITS_MANIFESTO_final.pdf)

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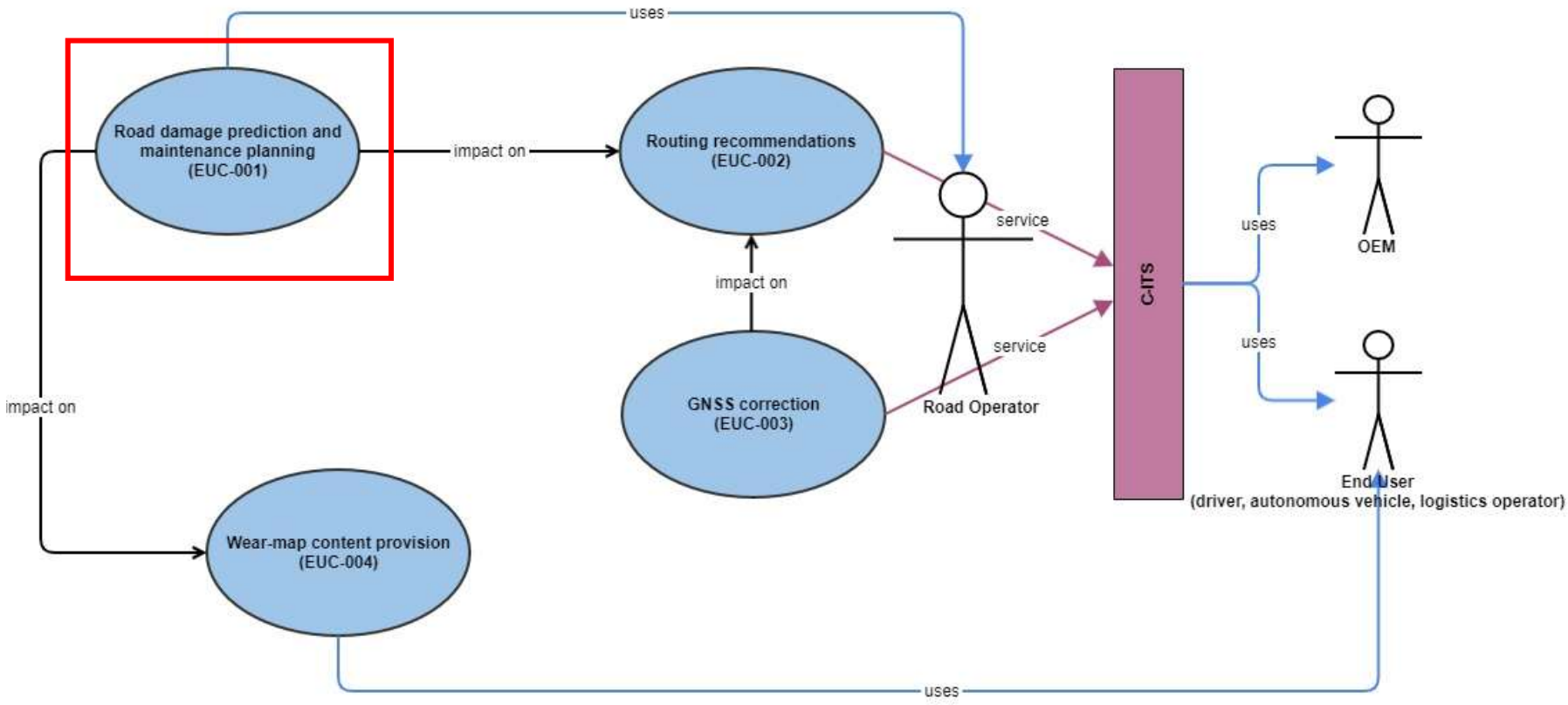
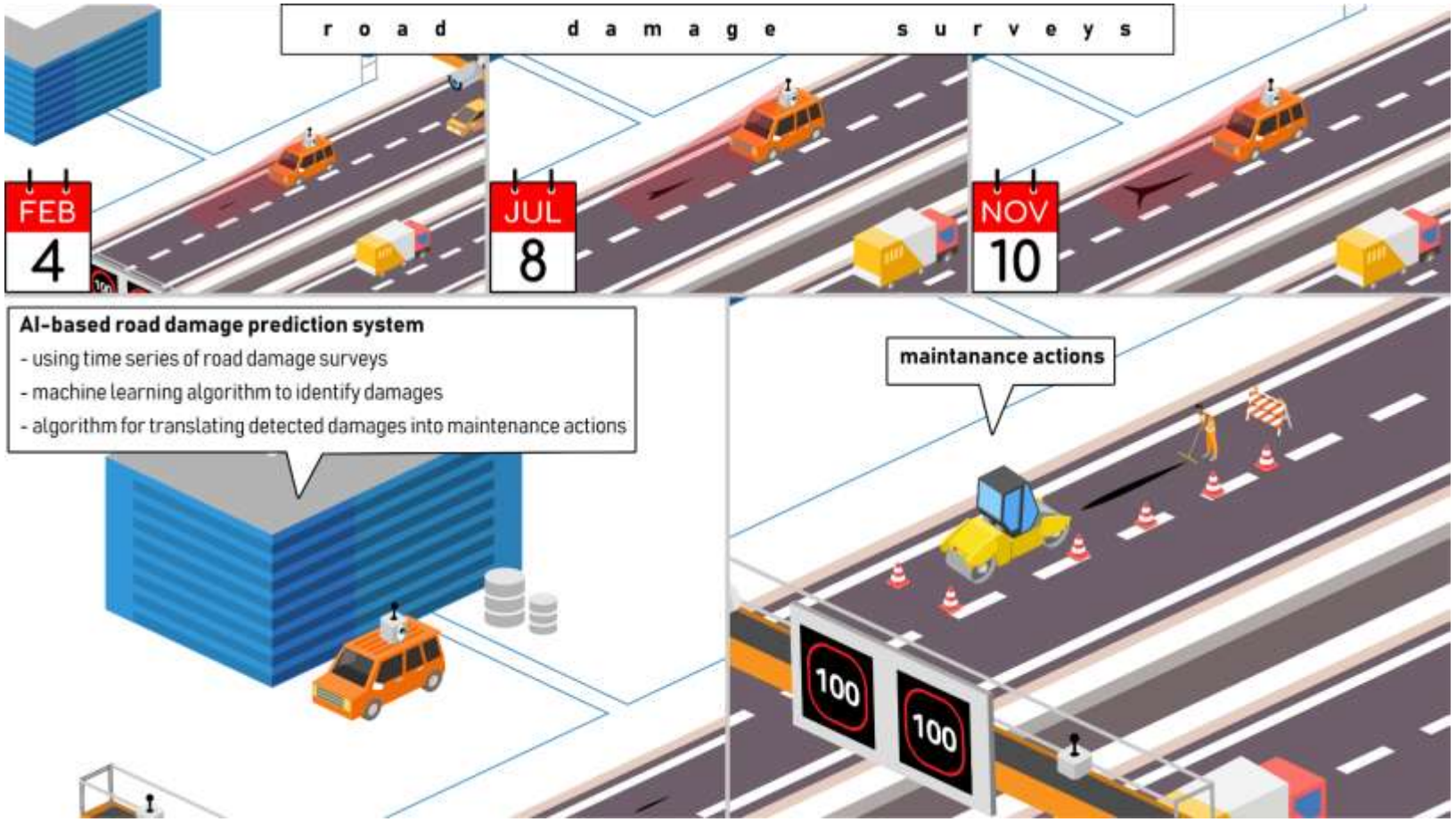


EUC-001: AI-based road damage prediction to support enhanced road maintenance planning (Figure)



EUC-001: AI-based road damage prediction to support enhanced road maintenance planning

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UC Description:

Based on the developed road sensing and damage mapping system, a road wear map layer utilizing AI-based road damage predictions is to be developed and provided to the road operator. Based on the predicted onset of road damages the road operator can set-up a derived predictive road maintenance and action plan to proactively reduce more severe road damages.

Target Group: Road Operators

Preliminary Pain Points

- High costs due to late detection of road damages
- Long-term construction sites (decrease in traffic efficiency and safety, higher CO_2 emissions)
- High costs and impacts due to safety risk and caused incidents
- Traffic jams and related customer complaints

USP

Road maintenance service is

- **safe** (due to high validity of the service)
- **delightful** (due to helping reduce CO_2 emissions)
- and **effective** (due to using the right tools and cost efficient measures when it comes to road maintenance actions)

Expected Benefits

- Enhanced road maintenance planning
- Reduction of overall maintenance activities
- Reduction of CO_2 emissions (avoidance of construction zones and therefore traffic jams)

EUC-001: AI-based road damage prediction to support enhanced road maintenance planning – Additional Information (1/2)

Short description	Based on the developed road sensing and damage mapping system, a road wear map layer utilizing AI-based road damage predictions is to be developed and provided to the road operator. Based on the predicted onset of road damages the road operator can set-up a derived predictive road maintenance and action plan to proactively reduce more severe road damages.
Preliminary Pain points	• High costs due to late detection of road damages • Long-term construction sites are the worst case for all road operators. Negative impact on traffic efficiency, traffic safety and CO2-emissions must be avoided for better planning. • High costs and impacts due to safety risk and caused incidents • Traffic jams and related customer complaints
Preliminary Target group	Road operators (e.g. ASFINAG)
Key assumptions for successful demonstration during the project	• EGNSS supported positioning of the road sensing vehicle available • Road sensing vehicle equipped with EGNSS supporting system available • Machine learning algorithm to quickly identify damages via the road sensing vehicle available • Map-layer with identified damages available • Algorithm for translating detected damages into maintenance actions available • Map-layer with maintenance actions available
Involved stakeholder roles	EGNSS data/service provider, ground truth data system provider, road wear sensor system provider, prediction system provider, data management platform provider, data service platform provider (wear map service provider), road operator (asset management)
Realization Prerequisites (physical infrastructure, digital infrastructure, data availability)	Physical infrastructure: • road sections with visible damages on the road surface • EGNSS supported sensing system • Road sensing vehicle Digital infrastructure: Machine learning software to predict road damages Data availability: Road surface data

EUC-001: AI-based road damage prediction to support enhanced road maintenance planning – Additional Information (2/2)

Challenges/Barriers/Open issues	• Is historical information on traffic density (including mix of traffic, speed, lanes used) available for prediction of surface degradation? Is it planned to be added? • Is road weather related historical information available? • Are road materials and structure information taken into account? • Are framework conditions taken into account that cause impulsive driving manoeuvres such as sudden braking and thus lead to increased road wear (e.g., Speed reductions zone, on- and off-ramps, etc.)?
Target/Evaluation metric	• Quantity and quality of identified damages (type, classification, total percentage distribution) • Precision of the identified damages • Context information regarding road damages (asphalt type, traffic frequency (vehicles/min), weather etc.) • Time and cost / km for operating the sensor vehicle • Saved cost and CO2-emissions due to avoiding construction works • Expected type of maintenance activities for the identified damage including information on e.g. length, duration, time of the day, or time of the year • Expected traffic volumes during the maintenance activity (by vehicle type) • Historic data about accident on this road stretch and for similar construction zones • Travel times on the stretch without road works
Expected benefits	Allows enhanced road maintenance planning which could lead to a reduction of overall maintenance activities and therefore to a possible reduction of CO2 emissions (avoidance of construction zones which lead to traffic jams and increased CO2-emissions). It has to be investigated if an increased number of lane changes leads to more incidents and respective increased travel time.
Preliminary Unique Selling Proposition (USP)	Our road maintenance service is safe (due to high validity of the service), delightful (due to helping to make our world better with regard to CO2-emission reduction) and effective (due to using the right tools and cost efficient measures when it comes to road maintenance actions leading to safer roads).

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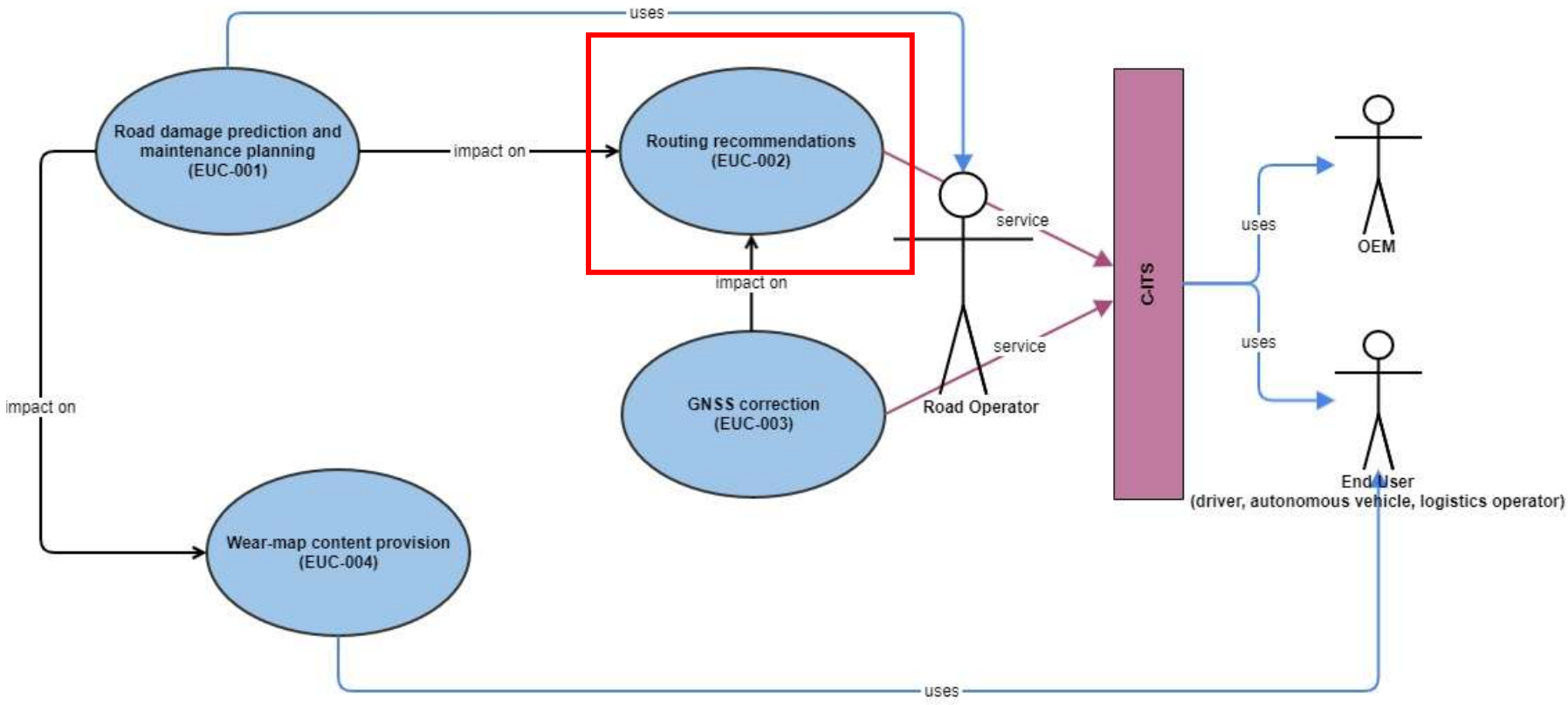
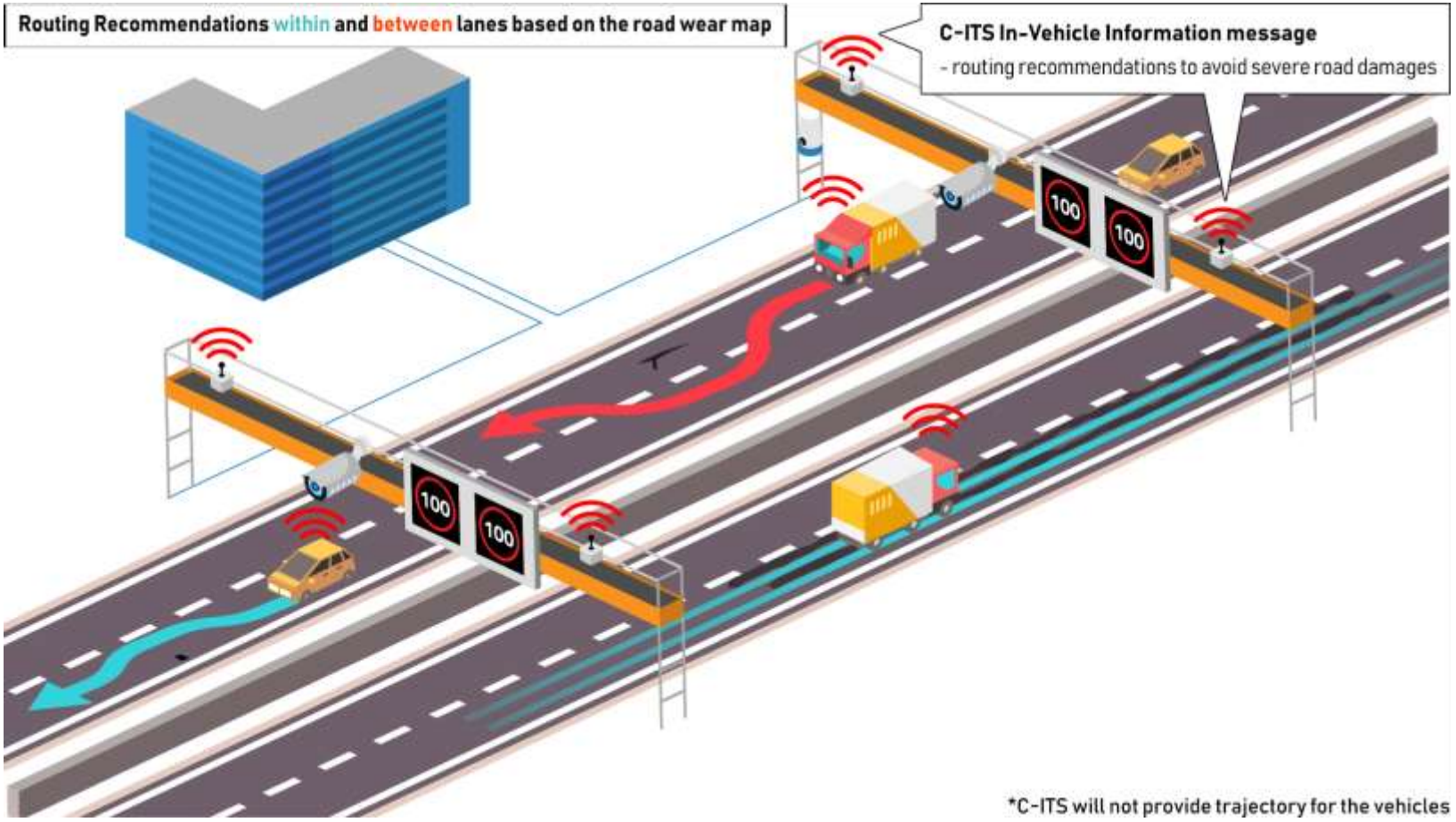


EUC-002: Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages (Figure)



EUC-002: Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages

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UC Description:

Based on very early damage prediction, the road operator can derive an enhanced action plan to proactively avoid severe road damages. One of the actions is to provide EGNSS-based lane change or in-lane offset recommendations for the drivers and end users in general, in order to avoid severe road damages and critical safety-related situations (vehicle side damage avoidance). User compliance-based incentive concepts (e.g. tolling) will be investigated in this scope.

Target Group: End users (drivers of automated trucks and passenger cars), OEMs, logistics operators

Preliminary Pain Points

- Additional costs for on-board units (for receiving C-ITS messages)
- Specific vehicle characteristics are not available for broadcast services - only generic recommendations may be provided
- Safety risk due to road damages
- Safety risk due to driver distraction from complex C-ITS messages

USP

With this service, all the end users feel

- **safe** (due to high validity of the service)
- **relaxed** (due to user-friendly service integration)
- and **effective** (due to getting benefits from complying with road operators' recommendations)

Expected Benefits

- Prevention of severe road damage
- Equal / gradual utilisation of the road to prevent unequal road-surface wear

EUC-002: Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages – Additional Information (1/2)

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Short description	Based on very early damage prediction, the road operator can derive an enhanced action plan to proactively avoid severe road damages. One of the actions is to provide EGNSS-based lane change or in-lane offset recommendations for the drivers and end users in general, in order to avoid severe road damages and critical safety-related situations (vehicle side damage avoidance). User compliance-based incentive concepts (e.g. tolling) will be investigated in this scope.
Preliminary Pain points	• Additional costs for on-board unit (for receiving messages) • Specific vehicle characteristics are not available for broadcast services - only generic recommendations may be provided (meaning that the business logic is on the infrastructure side). • Safety risk due to road damages • Safety risk due to driver distraction from complex C-ITS messages
Preliminary Target group	End users (drivers of automated trucks and passenger cars), OEMs, logistics operators
Key assumptions for successful demonstration during the project	• Map-layer with identified damages available • Algorithm for translating detected damages into maintenance actions and avoidance recommendations available • Map-layer with maintenance actions and avoidance recommendations available (e.g. routing recommendations within and between lanes) • C-ITS messages available for routing recommendations (within and between lanes) • C-ITS infrastructure (road side units available) • Automated demo-car (VIF) available (receiving C-ITS messages, triggering automated vehicle actions) • Trucks (manual driven) with C-ITS on-board units available for assessing user acceptance
Involved stakeholder roles	EGNSS data/service provider, ground truth data system provider, road wear sensor system provider, prediction system provider, data management platform provider, data service platform provider (wear map service provider), road operator (C-ITS provider, traffic management), end user of this service (e.g. logistics provider, truck driver, automated vehicle), OEM
Realization Prerequisites (physical infrastructure, digital infrastructure, data availability)	Physical infrastructure: • C-ITS road side unit and on-board unit • Automated demo-car (VIF) • Trucks (manual driven) with C-ITS on-board units Digital infrastructure: Traffic management center providing C-ITS messages Data availability: Map-layer with road wear ("maintenance actions" are derived from the first use-case)

EUC-002: Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages – Additional Information (2/2)

Challenges/Barriers/Open issues	• How do lane changes based on routing recommendations affect road safety and road efficiency? • How do we inform other road users about potential lane changes, especially those who cannot receive C-ITS messages? • What are the conditions for lane change manoeuvres (e.g. number of lanes, traffic density, weather conditions, etc.)? • How do recommendations within a lane take into consideration the different size of vehicles?
Target/Evaluation metric	• Quantity and quality of C-ITS messages (routing recommendations) received in the VIF demo-car (including accuracy, latency) • Deviation between recommended trajectory and driven trajectory of the VIF demo-car • Quantity and quality of received C-ITS messages (routing recommendations) in fleets during test week (including accuracy, latency) • Monitoring of drivers' behaviour (percentage of vehicles following the recommendations like lane changes). Deviation between recommended trajectory and driven trajectory of the driver (during test week) • Users' acceptance of routing recommendation-related C-ITS messages (qualitative assessment) • Reasons for ignoring C-ITS message: e.g. not enough space for manoeuvre, message unclear, benefit unclear, etc.
Expected benefits	Prevention of severe road damage by proactively set measures in a very early phase of the expected road damage; equal/gradual utilisation of the road to prevent unequal road-surface wear. (e.g. recommended lane changes and randomised lane offsets via C-ITS).
Preliminary Unique Selling Proposition (USP)	With this service, all the end users, particularly the logistics operators and truck drivers feel safe (due to high validity of the service), relaxed (due to user-friendly service integration), and effective (due to getting benefits from complying with road operators' recommendations)

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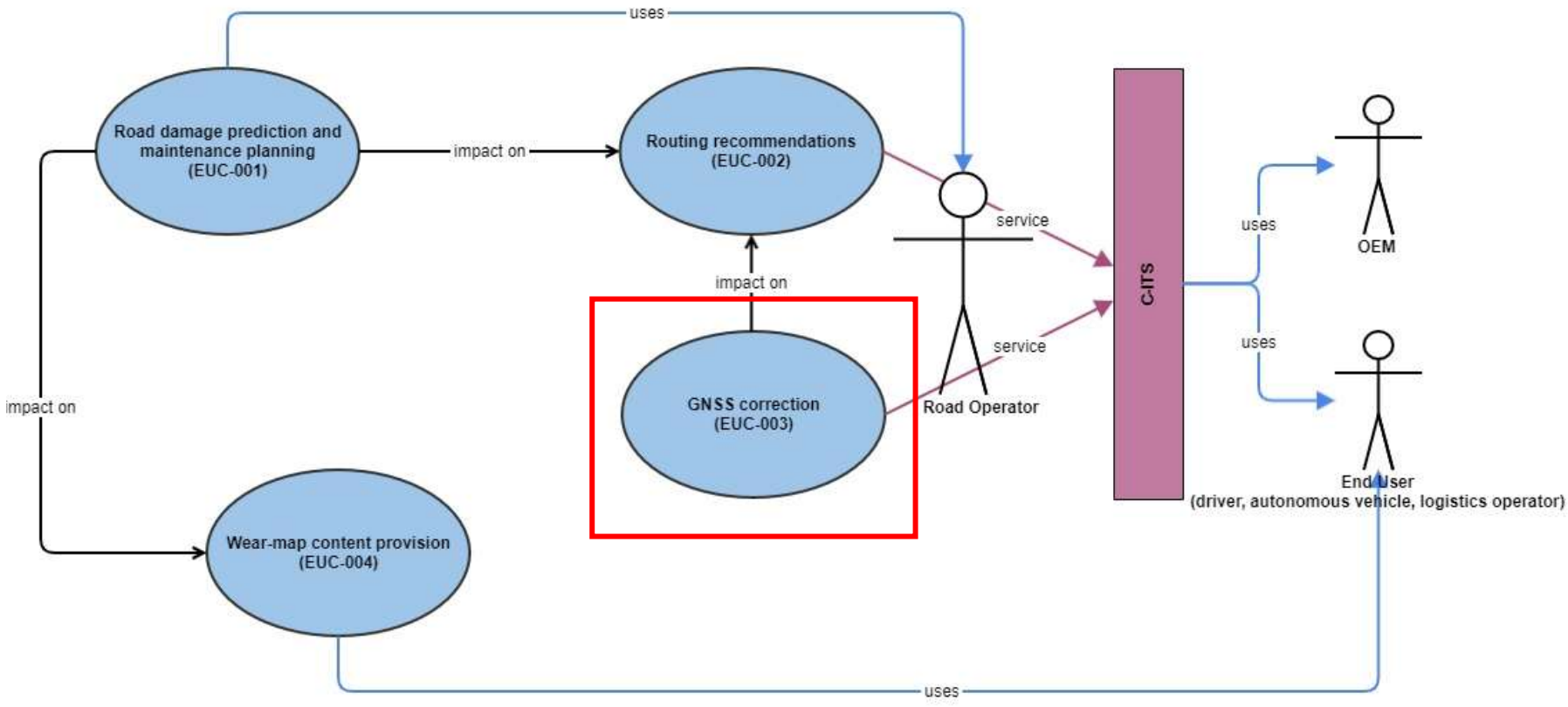
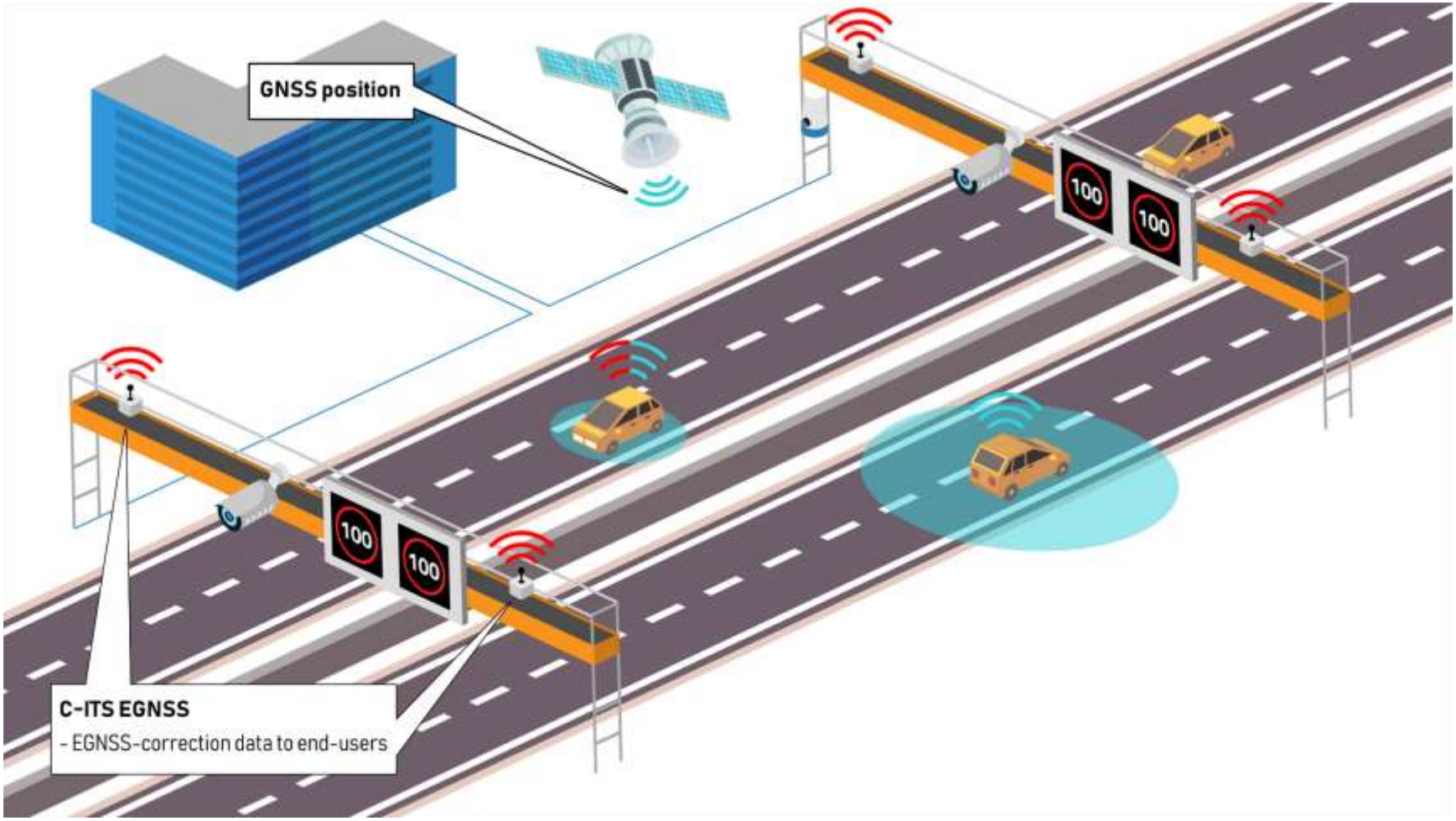


EUC-003: C-ITS Message ‘GNSS-correction data’ provision (Figure)



EUC-003: C-ITS Message ‘GNSS-correction data’ provision

UC Description:

The road operator provides EGNSS-correction data to end users for enhancing the positioning accuracy of end users’ vehicles. Furthermore, vehicles carrying the sensor array uses that service

Target Group: End users (drivers of automated trucks and passenger cars) and vehicle provider (carrying sensor array), OEMs for optimising their ADAS systems (e.g. lane assist, C-ACC)

Preliminary Pain Points

- Loss of high-precision positioning and therefore ADAS systems are not working correctly
- Increased safety risk due to loss of high-precision positioning
- Liability costs in case of accidents

USP

We provide supportive localisation information to your infrastructure operations so that your customers feel **safe** (due to high validity of the service) with high convenience

Expected Benefits

- Precise positioning allows following the lane change or in-lane offset recommendations and therefore avoid road wear
- Providing the EGNSS correction data via C-ITS acts as an additional source of correction information and adds redundancy for requirements of functional safety for automated mobility.

EUC-003: C-ITS Message 'GNSS-correction data' provision – Additional Information

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Short description	The road operator provides EGNSS-correction data to end users for enhancing the positioning accuracy of end users' vehicles. Furthermore, vehicles carrying the sensor array uses that service
Preliminary Pain points	• Loss of high-precision positioning and therefore ADAS systems are not working correctly • Increased safety risk due to loss of high-precision positioning • Liability costs in case of accidents
Preliminary Target group	End users (drivers of automated trucks and passenger cars) and vehicle provider (carrying sensor array), OEMs for optimising their ADAS systems (e.g. lane assist, C-ACC)
Key assumptions for successful demonstration during the project	• GNSS-correction information available for road operator • C-ITS messages available for providing the EGNSS-correction data • C-ITS infrastructure (road side units) available • Automated demo-car (VIF) available (receiving C-ITS messages, triggering automated actions)
Involved stakeholder roles	EGNSS data/service provider, road operator (Traffic Management, C-ITS provider), end user of this service (e.g. logistics provider, truck driver, automated vehicle), OEMs
Realization Prerequisites (physical infrastructure, digital infrastructure, data availability)	Physical infrastructure: • C-ITS road side unit and on-board unit • Automated demo-car (VIF) Digital infrastructure: Traffic management center providing C-ITS messages Data availability: EGNSS-correction data
Challenges/Barriers/Open issues	• What to do in case of failure, i.e. if no correction data can be provided?
Target/Evaluation metric	• Quantity and quality of C-ITS message (EGNSS-correction data) received in the VIF demo-car • Reduction of vehicle position error in meters, compared to uncorrected GNSS position • Better positioning but also better lane level map matching of the ego vehicle.
Expected benefits	• Precise positioning of vehicles allows following the lane change or in-lane offset recommendations issued by the road operator and proactive avoidance of road wear geo-located in the road wear map layer (if available in the vehicle). • Providing the EGNSS correction data via C-ITS acts as an additional source of correction information and adds redundancy for requirements of functional safety for automated mobility.
Preliminary Unique Selling Proposition (USP)	We provide supportive localisation information to your infrastructure operations so that your customers feel safe (due to high validity of the service) with high convenience.

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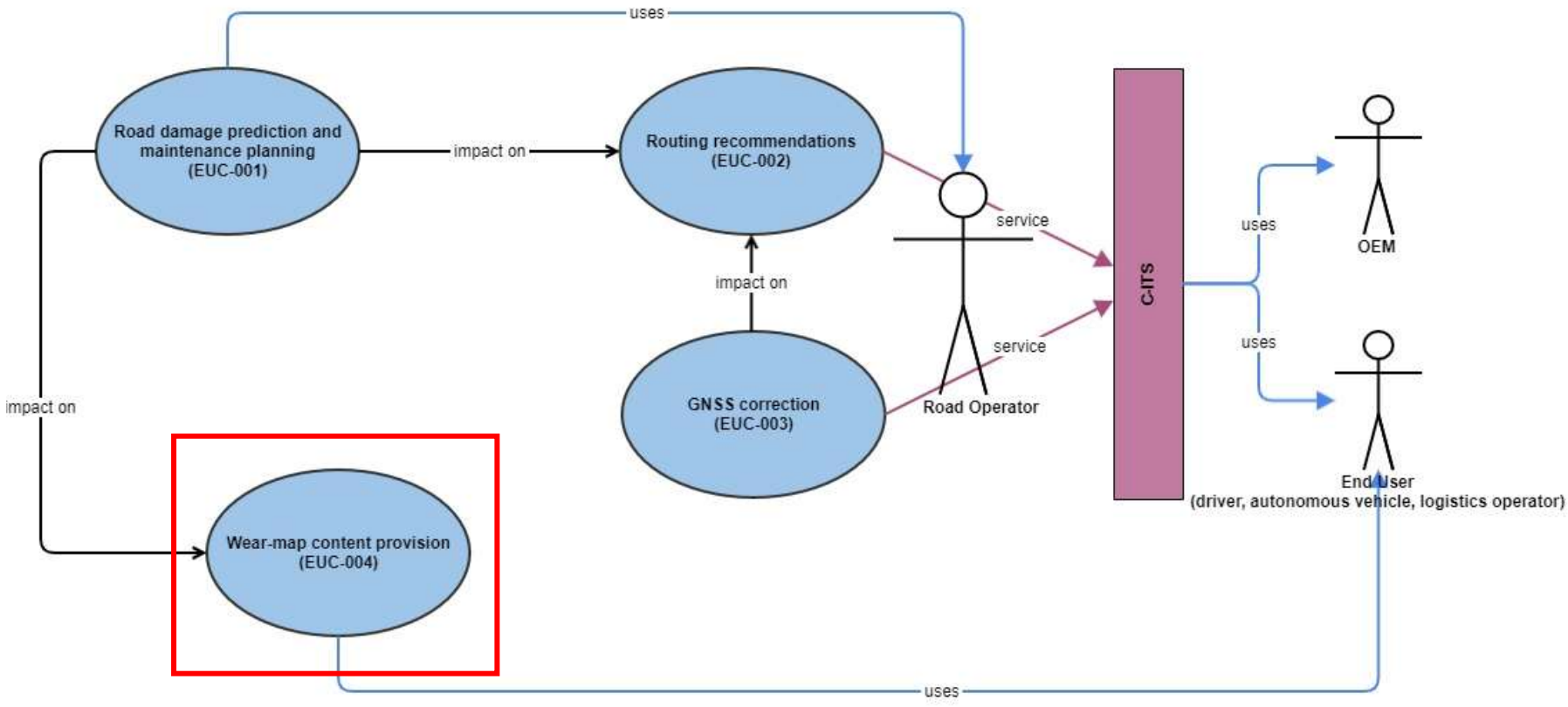
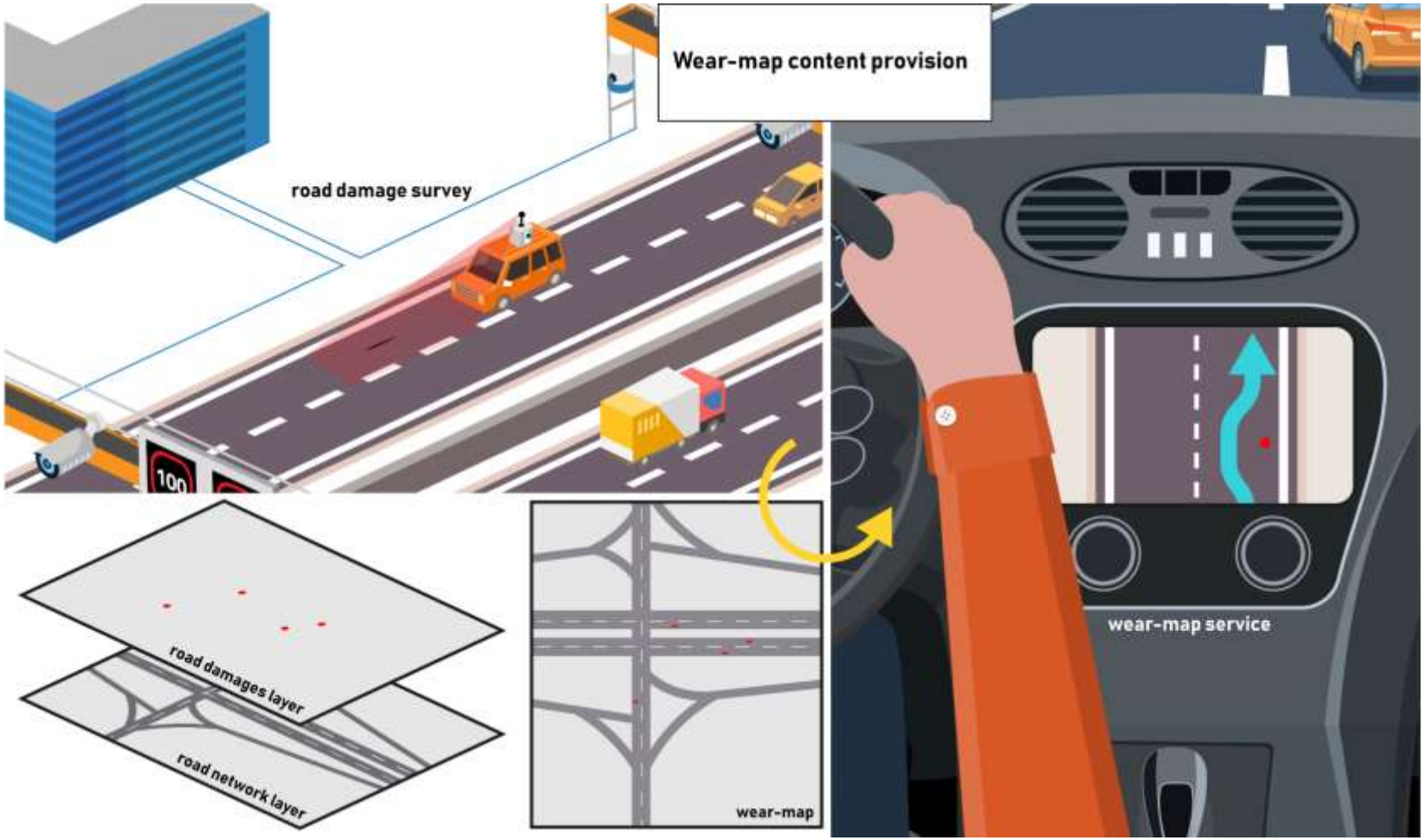


EUC-004: Wear-map content provision (Figure)



EUC-004: Wear-map content provision

UC Description:

Based on the developed road sensing and damage mapping system a road wear map is provided to e.g. navigation service providers, OEMs and road operators to form a basis for convenient routing decisions

Target Group: End users (drivers of automated trucks and passenger cars)

Preliminary Pain Points	USP	Expected Benefits
• Traffic safety risks due to construction works • Traffic safety risks due to damages on the road surface	We support map providers to make the life of drivers safer and more convenient	• Increase driver convenience and traffic safety by proactive avoidance of road wear geo-located in the road wear map layer.

EUC-004: Wear-map content provision – Additional Information

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Short description	Based on the developed road sensing and damage mapping system a road wear map is provided to e.g. navigation service providers, OEMs and road operators to form a basis for convenient routing decisions
Preliminary Pain points	• Traffic safety risks due to construction works • Traffic safety risks due to damages on the road surface
Preliminary Target group	End users (drivers of automated trucks and passenger cars)
Key assumptions for successful demonstration during the project	• Road sensing vehicle equipped with EGNSS supporting system available • Machine learning algorithm to quickly identify damages via the road sensing vehicle available • Map-layer with identified damages available
Involved stakeholder roles	EGNSS data/service provider, ground truth data system provider, road wear sensor system provider, data management platform provider, data service platform provider (wear map service provider), OEMs, MNOs, Navigation service providers
Realization Prerequisites (physical infrastructure, digital infrastructure, data availability)	Physical infrastructure: • Road sections with damages • EGNSS supported sensing system • Road sensing vehicle Digital infrastructure: • Machine learning software • Map software for integrating map-layer with identified damages Data availability: • Road surface data
Challenges/Barriers/Open issues	Format of the data (dynamic map data layer) is questionable: several options of different data types may be suitable for different data services types (C-ITS, TPEG2, DATEX II - for DATEX Light, NDS volatile data, etc.)
Target/Evaluation metric	• Precision of the wear map (including detected damages) • Frequency of map-updates needed for long-term road assessment (including what kind of data needs to be updated) • Integrability of the wear map into target customers' operating systems
Expected benefits	Increase driver convenience and traffic safety by proactive avoidance of road wear geo-located in the road wear map layer.
Preliminary Unique Selling Proposition (USP)	We support map providers to make the life of drivers safer and more convenient.

Poll questions

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1. How would you rate the importance of GNSS-based use cases (like we do in ESRIUM) for the predictive road maintenance?
2. How would you rate the acceptance rate (compliance) of truck drivers to C-ITS messages like “recommended lane” provided by a road operator?
3. How would you rate the importance of benefits (e.g. reducing tolling) for truck drivers’ acceptance of C-ITS messages like “recommended lane” provided by a road operator?

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