DG MOVE Support Study for IA of Cooperative Intelligent Transport Systems

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Stakeholder workshop

9th February 2018

Transport and Environmental Policy Research

Disclaimer: The assumptions presented here are only draft assumptions. In this workshop we are aiming to validate these through your input.

You will be able to submit your feedback through SurveyGizmo, an online survey tool.

http://www.surveygizmo.com/s3/4180603/C-ITS-Stakeholder-Workshop-09-02-18

Alternatively you can reach out to us by email.

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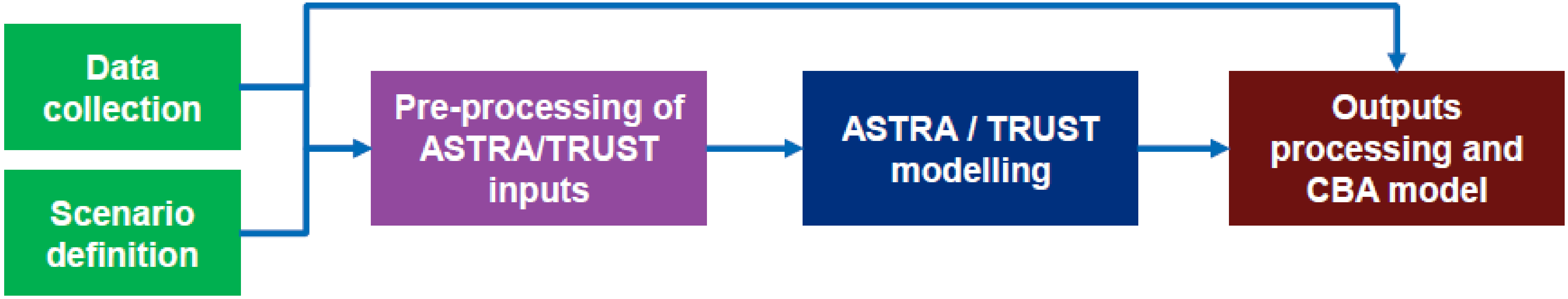
Objectives

- Overview of our modelling approach
- Discuss and obtain feedback on C-ITS cost and impact data gathered to date
- Discuss and obtain feedback on the translation of policy scenarios into modelling assumptions

Agenda

- Overview of modelling approach
- Discussion of modelling input + assumptions
  - Service bundles
  - Cost data
  - Assumptions to define uptake rates
  - Impact data

We re-use the modelling framework developed for the 2016 Deployment study



Changes made to reflect:

- New assessment timeframe: out to 2035
- Service bundles → aligned with EC C-ITS Strategy
- Specific policy options, rather than wider scenarios

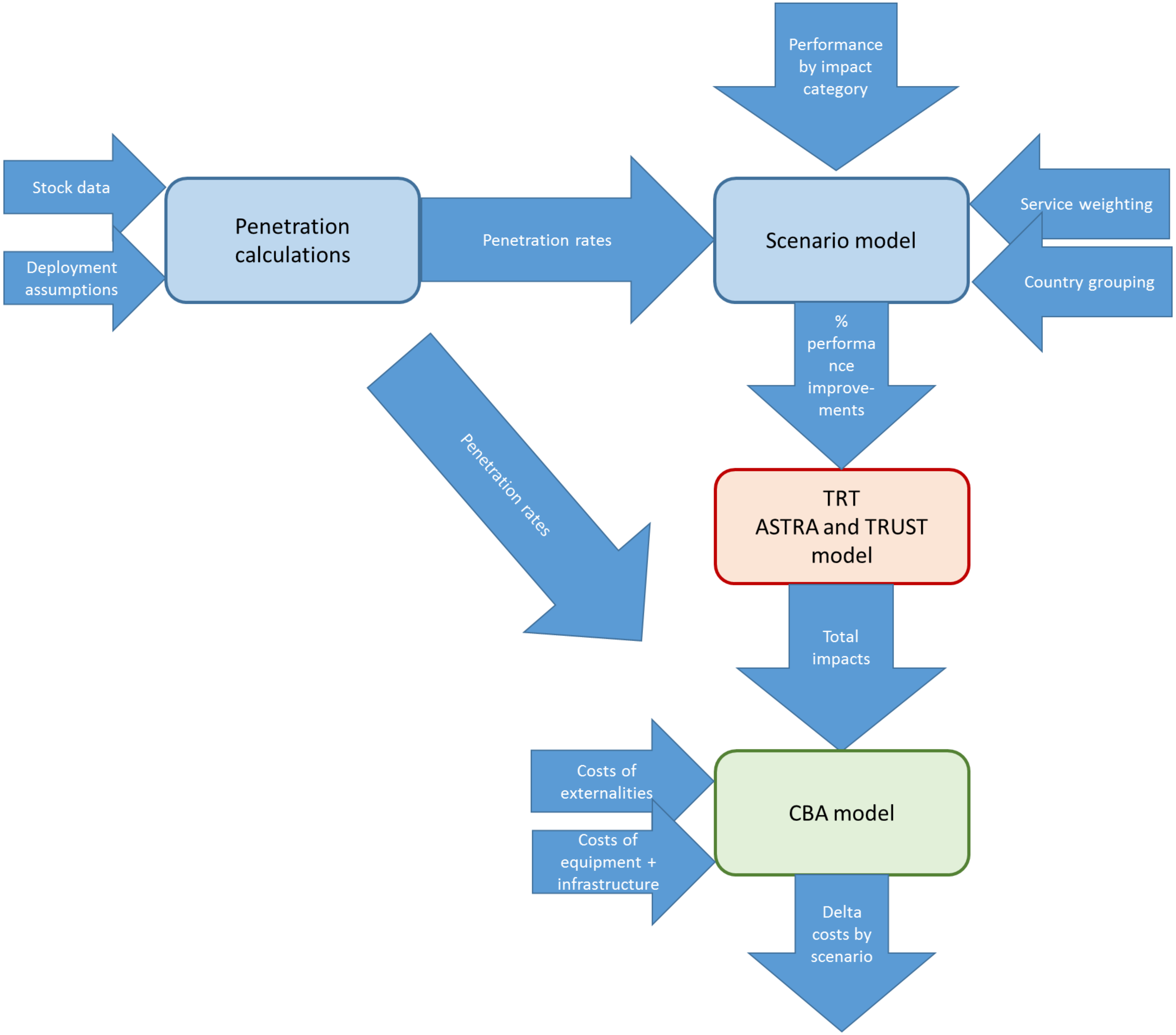
→ Input data and modelling assumptions are being updated based on newer available data and input from stakeholders

A range of quantified and semi-quantified economic, environmental and social impacts will be assessed

Economic, environmental, and social impact assessment

- **Economic impacts covered:**
  - Investment costs
  - Operating costs
  - Financial burden for the private sector, public authorities and distributional impacts
  - Impacts on congestion and travel time
  - Macro-economic impacts
  - Impacts on job creation and new business opportunities
  - Impacts on SMEs
  - Impacts in research and innovation (R&I)
- Where possible, economic impacts will be assigned to relevant economic operator, including MS, road operators, local authorities, vehicle users, vehicle manufacturers, transport authorities and service providers.
- **Environmental impacts covered:**
  - GHG emission/fuel consumption
  - Air pollutant impacts
  - Modal shift impacts
- **Social Impacts covered:**
  - Road safety impacts
  - Impacts on vulnerable road users
  - Impacts on privacy and protection of personal data
  - Impacts on security of C-ITS communications

We will sequence the input of data and assumptions with model runs



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Service Bundles are aligned with the EC strategy on C-ITS

Service bundle	C-ITS Services	Rationale
Bundle 1 ***Day 1, V2V***	• Emergency brake light. • Emergency vehicle approaching. • Slow or stationary vehicle(s). • Traffic jam ahead warning • Hazardous location notification	Day 1 safety-based V2V services. Applicable to all road types but benefits are most likely to be delivered on motorways.
Bundle 2 ***Day 1, V2I, mainly applicable to motorways***	• In-vehicle signage • In-vehicle speed limits • Probe vehicle data. • Shockwave damping. • Road works warning. • Weather conditions.	Day 1 V2I services that deliver most benefit to motorways. Some services listed here may also be applicable to other road types.
Bundle 3 ***Day 1, V2I, mainly applicable to urban areas***	• Green Light Optimal Speed Advisory • Signal violation/Intersection safety • Traffic signal priority request by designated vehicles	Day 1 V2I services that are expected to only be applicable in urban areas. Therefore, these services are in a separate bundle to those in Bundle 2.
Bundle 4 ***Day 1.5, V2I, Parking Information***	• Off street parking information • On street parking management and information • Park & Ride information • Information on AFV fuelling & charging stations.	C-ITS services intended to provide information regarding parking (and refuelling) to drivers.
Bundle 5 ***Day 1.5, V2I, Traffic and other information***	• Traffic information and smart routing	C-ITS services intended to provide traffic information to drivers.
Bundle 7 ***Day 1.5, V2X, mainly applicable to urban areas***	• Vulnerable road user protection (pedestrians and cyclists)	V2X service expected to be post Day 1. Main benefits are likely to be seen in urban areas.

Note: the numbering of bundles from the C-ITS Deployment study has been retained for consistency.

Agenda

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Cost data is being updated and verified through input from technical experts

Type of cost data considered:

1. **Central ITS sub-systems**
2. **Personal ITS sub-systems**
3. **Vehicle ITS sub-system**
4. **Roadside ITS sub-systems**

Methodology:

- Technology costs based on data collected for 2016 Deployment Study
- Cost data has been sent out to stakeholders for feedback

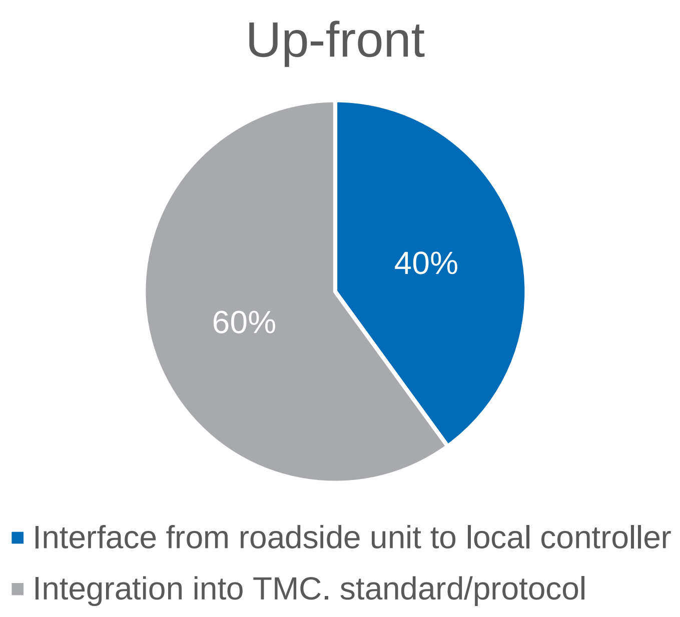
General assumptions:

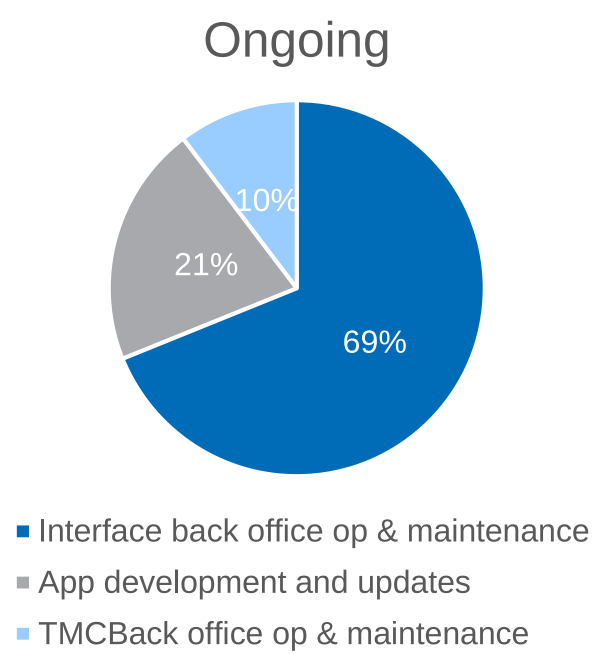
- Technology learning rates:
  - a learning rate of 10% is applied to all up-front costs for personal, in-vehicle and roadside ITS sub-systems

Q1: Is it reasonable to assume a 10% learning rate?
- Yes
- No, it is too high
- No, it is too low
- Don't know

Central ITS sub-systems costs

Total Costs per Member State	2015
Up-front (integration cost)	€ 2,500,000
Ongoing (back office op, maintenance)	€ 551,800

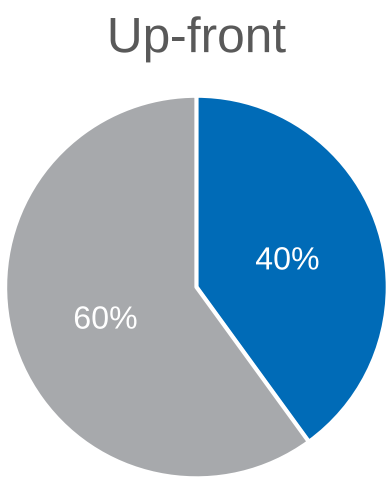


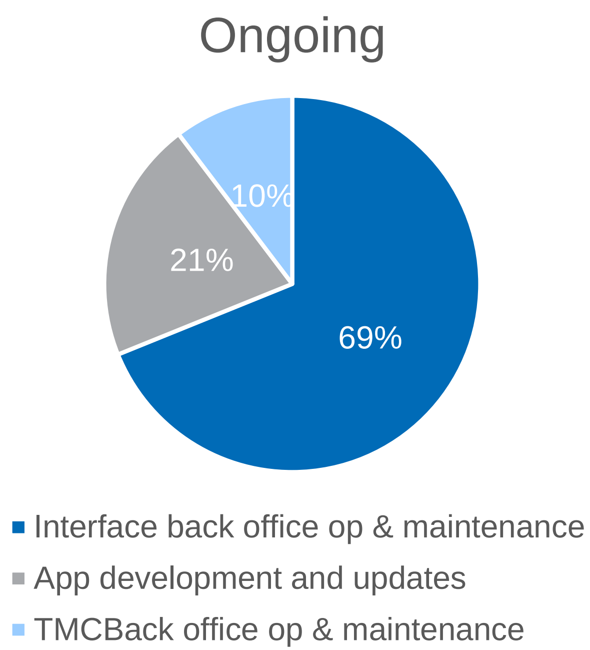


Central ITS sub-systems costs

Total Costs per Member State
Up-front (integration cost)
Ongoing (back office op, maintenance)

Q3: Have we captured all cost elements for central ITS sub-systems?
- Yes
- No, essential ones are missing. Please specify.
- Don't know





Q2: Is it reasonable to assume the above presented central ITS sub-system costs?
- Yes
- No, they are too high
- No, they are too low
- Don't know

Personal ITS sub-systems costs

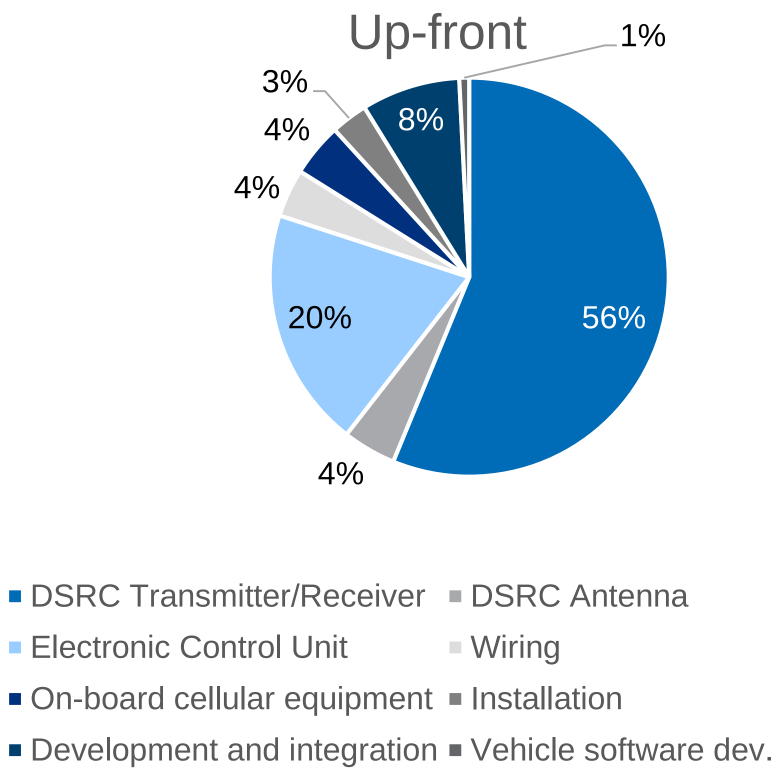
Cellular Total Costs	2015
Up-front	€ 0 (Mobile phones are already owned by the user)
Ongoing (cost for data packages needed for V2X communication)	€ 2.69/ year (for additional data usage)
Personal Navigation Device (PND) Total Costs	**2015**
Up-front	€ 124
Ongoing	€ 0 (C-ITS applications and cellular data will be included in the purchase price of the PND)

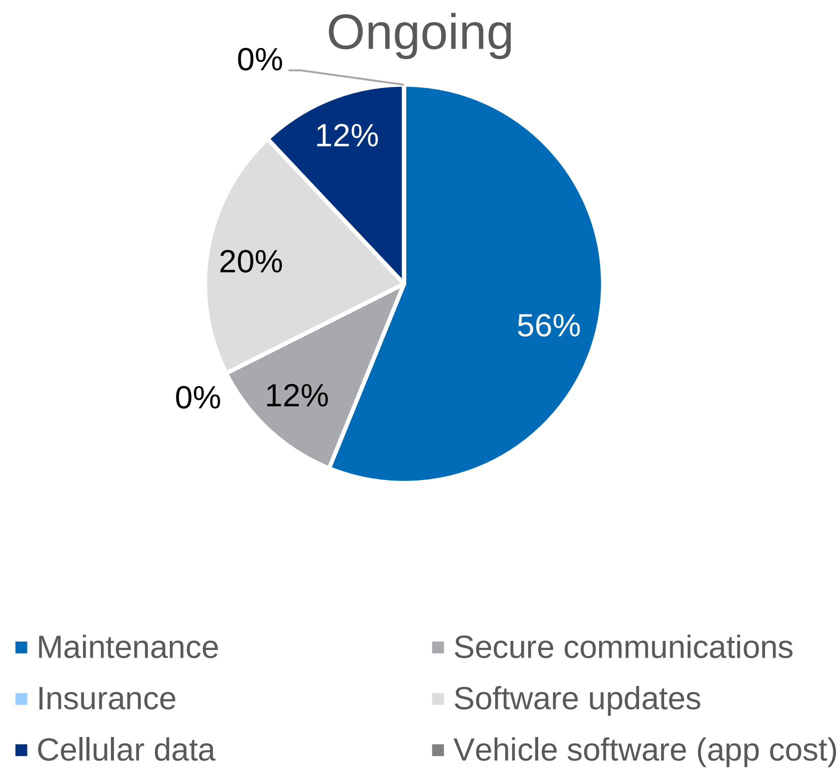
Q4: Is it reasonable to assume the above presented personal ITS sub-system costs?

- Yes
- No, they are too high
- No, they are too low
- Don't know

Vehicle ITS sub-system costs

Total Costs	2015
Up-front	€ 285
Ongoing	€ 22

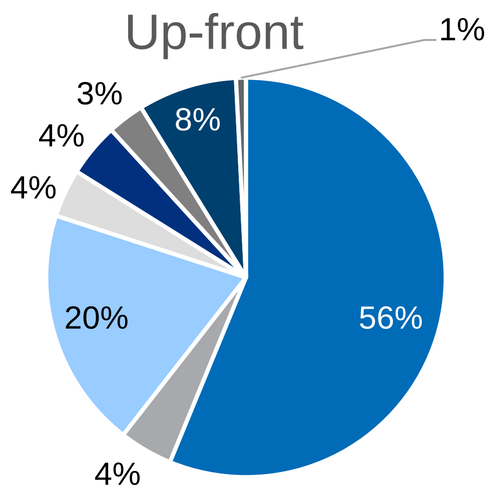




Vehicle ITS sub-system costs

Total Costs
Up-front
Ongoing

Q6: Have we captured all cost elements for vehicle ITS sub-systems?
- Yes
- No, essential ones are missing. Please specify.
- Don’t know



Q7: We are assuming a mark-up of 1.5 between the costs for the OEM and the end-user. Do you agree with this mark-up?
- Yes
- No, it should be slightly lower
- No, it should be significantly lower
- No it should be slightly higher
- No, it should be significantly higher
- Don’t know

Q5: Is it reasonable to assume the above presented vehicle ITS sub-system costs?
- Yes
- No, they are too high
- No, they are too low
- Don’t know

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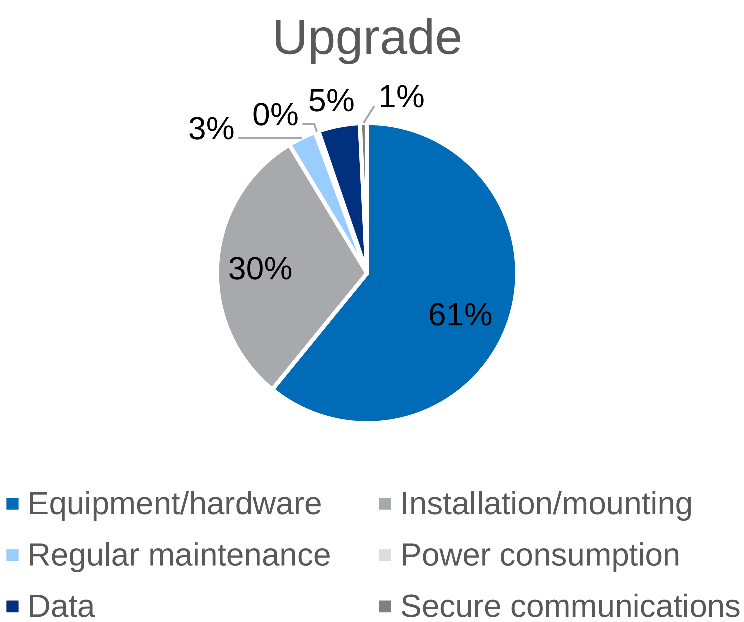
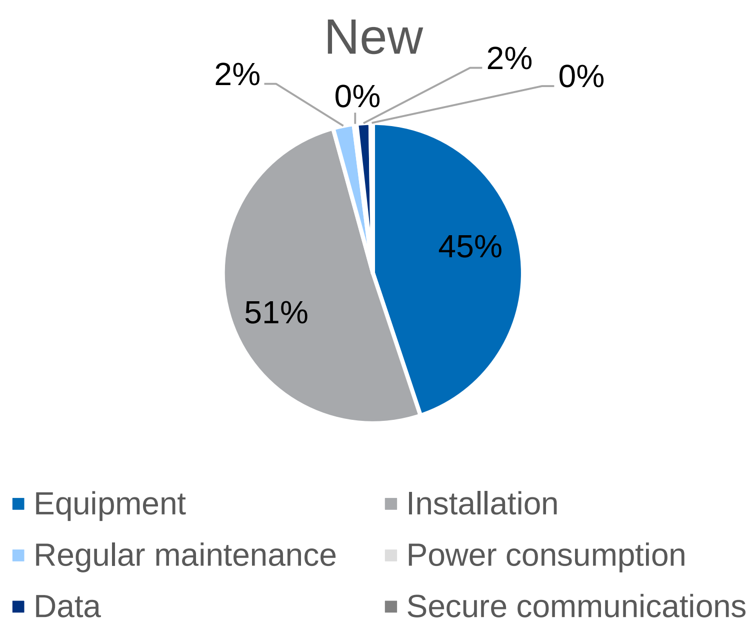
- Maintenance
- Insurance
- Cellular data
- Secure communications
- Software updates
- Vehicle software (app cost)

Roadside ITS sub-systems costs

RSU Upgrade Total Costs (per unit)	2015
Up-front	€ 4,500
Ongoing	€ 427
New RSU Total Costs (per unit)	**2015**
Up-front	€ 14,117
Ongoing	€ 632

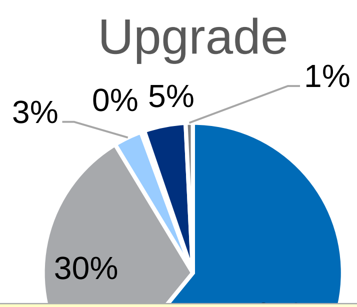


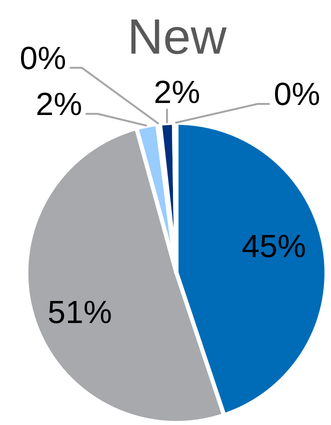


Roadside ITS sub-systems costs

RSU Upgrade Total Costs (per unit)	
Up-front	
Ongoing	
New RSU Total Costs (per unit)	
Up-front	€ 14,117
Ongoing	€ 632

Q9: Have we captured all cost elements for roadside ITS sub-systems?
- Yes
- No, essential ones are missing. Please specify.
- Don't know





Q8: Is it reasonable to assume the above presented roadside ITS sub-system costs?
- Yes
- No, they are too high
- No, they are too low
- Don't know

Agenda

- Overview of modelling approach
- Discussion of modelling input + assumptions
  - Service bundles
  - Cost data
  - Assumptions to define uptake rates
  - Impact data

Deployment assumptions have been developed for all policy options

Headline assumptions

Scenario	Description	Scope: Vehicles	Scope: Infrastructure	Uptake
Baseline	Existing C-ITS activities: •ITS Directive •Regional & national deployment projects •EU funding in the area e.g. under CEF	• Deployment of Bundles 1 and 2 in cars and trucks and Bundle 3 across all vehicles	• Deployment of Bundle 1 across all road types, Bundle 2 across TEN-T Corridor & Core roads, and Bundle 3 on Urban roads	• Slow uptake in new vehicles and Personal ITS devices • Infrastructure uptake based on actual deployment, capped at 2020
PO1	Package of soft policy measures e.g. guidelines, reference to existing standards / definition of services	• Baseline + deployment of Bundles 1 and 2 in public transport	• Same as Baseline	• Based on baseline but with faster vehicle uptake and infrastructure uptake extended after 2020
PO2	PO1 + Package of legal measures limited to specifications e.g. definition of Day 1 services	• Same as PO1	• Same as Baseline	• Faster uptake than PO1 of vehicle and infrastructure uptake
PO3	PO2 + Package of legally binding measures e.g. mandatory deployment of V2V communication	• Same as PO1	• Same as Baseline	• Faster vehicle uptake rates, reflecting mandate • Same infrastructure uptake as PO2

Deployment assumptions – Baseline – New vehicles + Personal ITS devices

<table>
<tr><th></th><th>Vehicle type</th><th>Bundle 1</th><th>Bundle 2</th><th>Bundle 3</th><th>Comments</th></tr>
<tr><td rowspan="3">New Vehicles</td><td>Personal Transport</td><td colspan="3">Uptake across all car categories, reaches 100%in 4 vehicle lifecycles starting 2019. (Based on VW starting with penetration across new vehicles in 2019). Maximum penetration reached in 2047 (28 years = 4 model lifecycles)</td><td rowspan="3">Cars assumed to have model lifecycle of 7 years. Assumed it takes 4 lifecycles until max penetration reached.

Public transport & freight transport assumed to have longer model lifecycle (9 years).</td></tr>
<tr><td>Public Transport</td><td colspan="2">No Uptake</td><td>Same total uptake % as for personal transport, but over 36 years, rather than 28 (4x9 years) to reflect different model lifecycles</td></tr>
<tr><td>Freight</td><td colspan="3">Same bundles and total uptake % as for personal transport, but over 36 (4x9 years) to reflect different model lifecycles</td></tr>
<tr><td rowspan="3">Personal ITS devices</td><td>Personal Transport</td><td colspan="3">Uptake in mobile phones will start when vehicle penetration in new vehicles reaches 25%. It progresses linearly, in line with uptake in new vehicles, following trajectory whereby maximum uptake (95%) in Personal ITS devices would be reached when penetration in new vehicles reaches 100%.</td><td rowspan="3">Due to population age distribution, there will always be a percentage that will not have a smartphone[1].

Maximum penetration for Personal ITS devices linked to maximum penetration in new vehicles and maximum smartphone penetration.</td></tr>
<tr><td>Public Transport</td><td colspan="2">No Uptake</td><td>Same assumption as for personal transport, but following uptake in new public transport vehicles, rather than passenger cars</td></tr>
<tr><td>Freight</td><td colspan="3">Same assumption as for personal transport, but following uptake in new freight vehicles, rather than passenger cars</td></tr>
</table>

[1] Based on previous Ricardo work on C-ITS.

Deployment assumptions – Baseline – New vehicles + Personal ITS devices

	Vehicle type	Bundle 1	Bundle 2	Bundle 3	Comments
		gori … ratio … del l		(Based … reached	Cars assumed to have model lifecycle of 7 years. Assumed it takes 4 lifecycles until max penetration reached.
		ptal		sonal … ther than … nt model	
	Freight	Same bundles and total uptake % as for personal transport, but over 36 (4x9 years) to reflect different model lifecycles			Public transport & freight transport assumed to have longer model lifecycle (9 years).
		will … wit … ITS		25%. It … maximum … hicles	Due to population age distribution, there will always be a percentage that will not have a smartphone[1].
		Uptal		nal … in new … ather than passenger cars	Maximum penetration for Personal ITS devices linked to maximum penetration in new vehicles and maximum smartphone penetration.
	Freight	Same assumption as for personal transport, but following uptake in new freight vehicles, rather than passenger cars			

Q10: Is it reasonable to assume a model life cycle of 7 years for cars?
- Yes
- No, it is too high
- No, it is too low
- Don't know

Q11: Do you think C-ITS technology could be introduced mid lifecycle?
- Yes
- No
- Don't know

Q12: Is it a reasonable approach to link personal ITS devices uptake to uptake in new vehicles?
- Yes
- No
- Don't know

Q13: Is it reasonable to assume a 25% threshold for personal ITS devices uptake?
- Yes
- No, it is too high
- No, it is too low
- Don't know

[1] Based on previous Ricardo work on C-ITS.

Assumptions – Baseline – Infrastructure

Road type	Baseline	Comment
TEN-T Corridor	RSU: Use actual data on average deployment levels expected by 2020, assumed constant thereafter. Cap uptake in the year C-Roads runs out (2020). Cellular: assume 84% coverage	Data from projects used to assess % equipment of road network with RSUs to 2020. Cellular coverage based on overall geographical coverage. Assessment of existing deployment projects has revealed an approximate 50:50 split between countries planning to deploy RSUs vs. cellular networks & weighted average infrastructure penetration based on this split.
TEN-T Core		
TEN-T Comprehensive	RSU: No uptake Cellular: assume 84% coverage	
Non-Urban Non-Motorway	RSU: No uptake Cellular: assume 84% coverage	
Urban	RSU: 8% x 25% per year from 2020	In urban areas, assumed 25% of new traffic lights equipped with ITS-G5 transmitters beyond 2020, Urban infrastructure deployment based on a 12.5 year traffic light lifetime, based on consultation with stakeholders in C-ITS Deployment study.

- Weighted average of RSU and Cellular infrastructure uptake calculated by country grouping to account for the mix of cellular and RSU.

Assumptions – Baseline – Infrastructure

Road type	Baseline	Comment
TEN-T Corridor	RSU: Use actual data on average deployment levels expected by 2020, assumed constant thereafter. Cap uptake in the year C-Roads runs out (2020). Cellular: assume 84% coverage	Data from projects used to assess % equipment of road network with RSUs to 2020. Cellular coverage based on overall geographical coverage. Assessment of existing deployment projects has revealed an approximate 50:50 split between countries planning to deploy RSUs vs. cellular networks & weighted average infrastructure penetration based on this split.
TEN-T Core		
TEN-T Comprehensive	RSU: No uptake	
Non-Urban Non-Motorway		
Urban	RSU: [illegible]% x 25% per year from 2020	In urban areas, assumed 25% of new traffic lights equipped with ITS-G5 transmitters beyond 2020, Urban infrastructure deployment based on a 12.5 year traffic light lifetime, based on consultation with stakeholders in C-ITS Deployment study.

Q14: Literature suggests that the geographical coverage of 4G is on average 84% across the EU. Do you think this is a reasonable assumption?

- Yes
- No, it is too high
- No, it is too low
- Don't know

- Weighted average of RSU and Cellular infrastructure uptake calculated by country grouping to account for the mix of cellular and RSU.

Assumptions – Scenarios – New vehicles + Personal ITS devices

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<table>
<tr><th>Vehicle type</th><th>PO1</th><th>PO2</th><th>PO3</th><th>Comment</th></tr>
<tr><td>Personal Transport</td><td>Same assumptions as baseline but with faster uptake. Maximum penetration reached after 2.5 model life cycles instead of 4 life cycles as in the baseline.</td><td>Uptake as per Visiongain / IHS forecasts</td><td>Uptake rates reflect mandate, reaching all cars by 2026, starting 2019 (one model life cycle).</td><td rowspan="3">Cars assumed to have model life cycle of 7 years

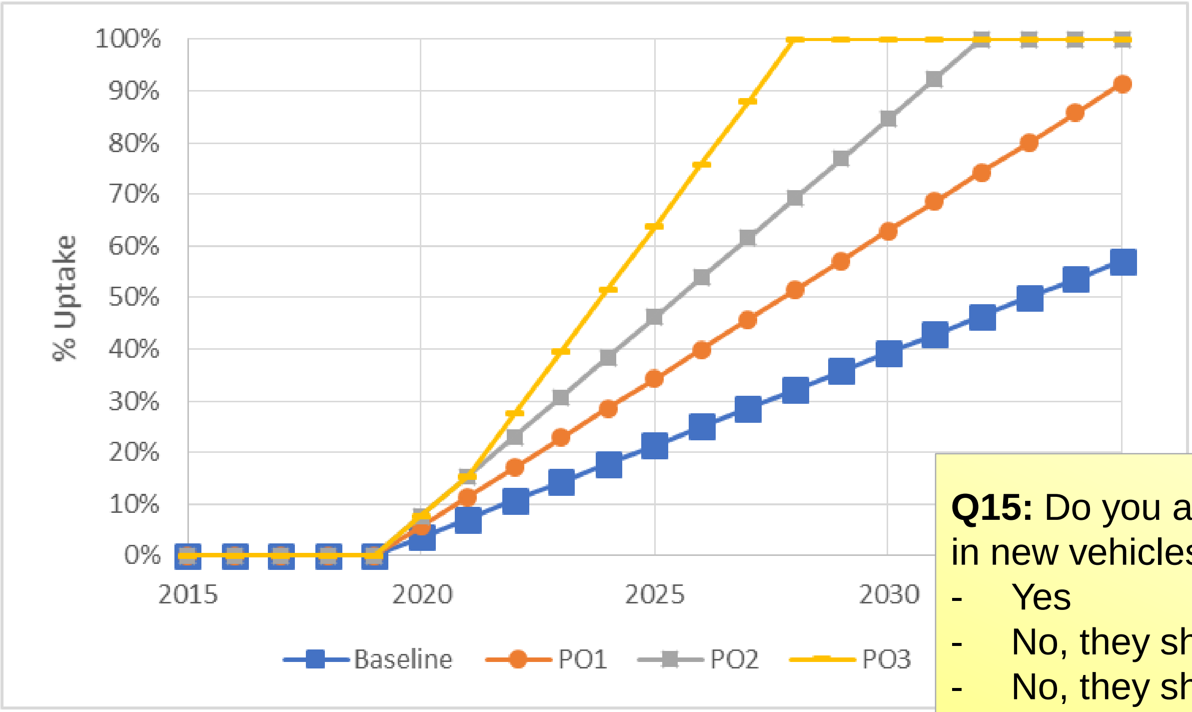
Public transport & freight transport assumed to have longer model life cycle of 9 years.</td></tr>
<tr><td>Public Transport</td><td colspan="2">Same uptake as personal transport but with longer model life cycles (9 years)</td><td>All vehicles covered by 2028, starting 2019.</td></tr>
<tr><td>Freight</td><td colspan="2">Same uptake as personal transport but with longer model life cycles (9 years)</td><td>All vehicles covered by 2028, starting 2019.</td></tr>
</table>

- For **Personal ITS devices**, as per the baseline, uptake in mobile phones will start when vehicle penetration in new vehicles reaches 25%. Once threshold is met, the Personal ITS devices uptake increases linearly, to the max uptake (95%) when in-vehicle systems reach 100%.

Uptake rates – Scenarios – New vehicles

- Compared to the baseline, all three Policy Options lead to increased uptake of C-ITS systems in new cars.
- The quickest uptake in Policy Option 3 reflects the use of a mandate.

Uptake in new personal vehicles - Policy Options vs the Baseline



Q15: Do you agree with the uptake rates in new vehicles overall?
- Yes
- No, they should be higher
- No, they should be lower
- Don't know

Assumptions – Scenarios – Infrastructure

<table>
<tr><th>Road type</th><th>PO1</th><th>PO2</th><th>PO3</th><th>Comments</th></tr>
<tr><td>TEN-T Corridor</td><td rowspan="2">RSU: Use actual data on average deployment levels expected to be achieved by 2020 to calculate trajectory. No cap.

Cellular: assume 84% coverage</td><td colspan="2" rowspan="2">RSU: Same as PO1 but 1.5x trajectory

Cellular: assume 84% coverage</td><td rowspan="2">-</td></tr>
<tr><td>TEN-T Core</td></tr>
<tr><td>TEN-T Comprehensive</td><td rowspan="2">RSU: No uptake

Cellular: assume a 84% coverage</td><td colspan="2">RSU: From 2020, 50% uptake rate of TEN-T Corridor and Core

Cellular: assume a 84% coverage</td><td rowspan="2">From PO2, RSU uptake applied to wider network at reduced rates relative to TEN-T Corridor/Core uptake.</td></tr>
<tr><td>Non-Urban Non-Motorway</td><td colspan="2">RSU: From 2020, 25% uptake rate of TEN-T Corridor and Core

Cellular: assume a 84% coverage</td></tr>
<tr><td>Urban</td><td>RSU & Cellular: 8% (traffic light stock that is replaced each year) x 50% (new traffic lights equipped) per year from 2020</td><td colspan="2">RSU: 8% x 75% per year from 2020</td><td>In urban areas, % of new traffic lights equipped with C-ITS transmitters beyond 2020 increases across the policy options. Urban infrastructure deployment based on 12.5 year traffic light lifetime.</td></tr>
</table>

- Weighted average of RSU and Cellular infrastructure uptake calculated by country grouping to account for the mix of cellular and RSU.

Assumptions – Scenarios – Infrastructure

Road type	PO1	PO2	PO3	Comments
TEN-T Corridor	RSU: Use actual data on average deployment levels	U: Same as PO1 Cellular: assume		
TEN-T Cor				
TEN-T Comprehensive	RSU: No uptake Cellular: assume a 84% coverage	From 2020, 50% Corridor a Cellular: assume a 84% coverage		at reduced rates relative to TEN-T Corridor/Core uptake.
Non-Urban Non-Motorway		RSU: From 2020, 25% uptake rate of TEN-T Corridor a Cellular: assume		
Urban	RSU & Cellular: 8% (traffic light stock that is replaced each year) x 50% (new traffic lights equipped) per year from 2020	RSU: 8% x 75% p		C- t based on 12.5 year traffic light lifetime.

Q16: In the 2016 deployment study we Assumed a distance between RSU units of 1 km. Is this a reasonable assumption?
- Yes
- No, it should be higher
- No, it should be lower
- Don’t know

Q17: Do you agree with the approach to link urban RSU uptake to traffic light lifetimes?
- Yes
- No
- Don’t know

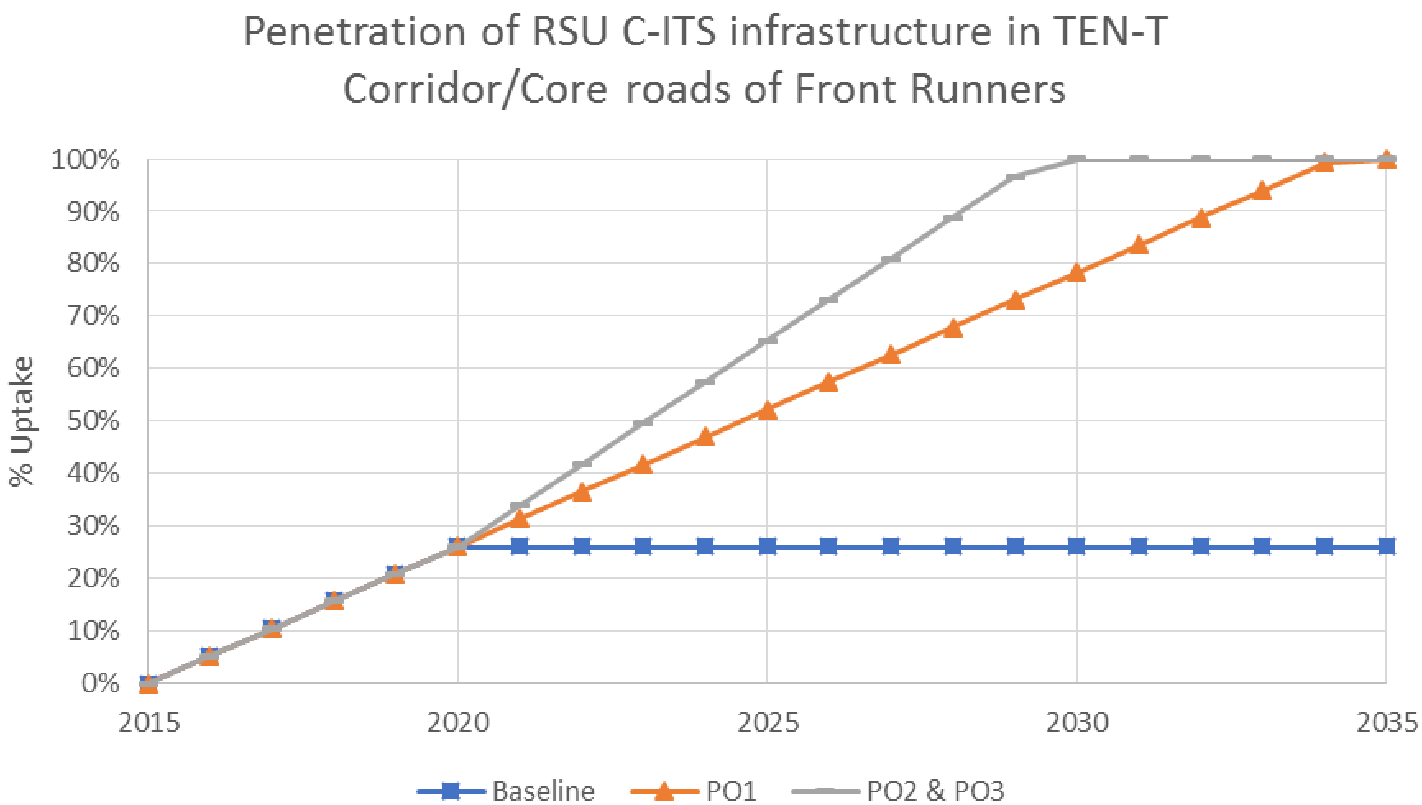
Q18: Is it reasonable to assume that 50% of new traffic lights will be equipped with C-ITS technology?
- Yes
- No, it should be higher
- No, it should be lower
- Don’t know

- Weighted average of RSU and Cellular infrastructure uptake calculated by country grouping to account for the mix of cellular and RSU.

Uptake rates – Scenarios – Infrastructure

- All scenarios begin in 2020 and so the baseline is followed until then.
- PO1 linearly extrapolates the baseline from 2020.
- PO2+PO3 increases the uptake rate of PO1 by 50%.

Q19: Do you agree with the uptake rates in infrastructure overall?
- Yes
- No, they should be higher
- No, they should be lower
- Don't know



Agenda

- Overview of modelling approach
- Discussion of modelling input + assumptions
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  - Cost data
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  - Impact data

Impact data builds on assessment from 2016 Deployment study and is being further refined through stakeholder input

Type of impacts considered:

- Fuel consumption
- Pollutant emissions
- Accidents
- Average speed reductions

Methodology:

- Impact data based on data collected for 2016 Deployment Study
- Impact data has been sent out to stakeholders for feedback
- Focus of the verification of the data on C-ITS services that were not covered through literature last time.

C-ITS services of particular interest:

- Information on fuelling & charging stations for alternative fuel vehicles
- Park & Ride information
- Traffic information & Smart routing
- Vulnerable Road User protection

Focus of impact data verification exercise on data gaps from last 2016 deployment study

Assumed from source	Not applicable /assumed zero	Only applicable to some services

Maximum expected impact assuming 100% deployment

Impact	Road type	Vehicle type	Information on fuelling & charging stations for alternative fuel vehicles	Park & Ride information	Traffic information & Smart routing	Vulnerable Road user protection
Fuel consumption	Urban roads	Cars	0.0%	-0.8%	-2.0%	0.0%
Pollutant	**Road type**	**Vehicle type**				
CO	Urban roads	Cars	0.0%	-0.3%	-2.3%	0.0%
NOx	Urban roads	Cars	0.0%	-0.8%	-0.5%	0.0%
VOC	Urban roads	Cars	0.0%	-0.8%	-1.7%	0.0%
PM	Urban roads	Cars	0.0%	-0.1%	-0.1%	0.0%
Vehicles	**Road type**	**Seriousness**				
Cars	Urban roads	Fatalities	0.0%	0.0%	0.0%	-1.8%
Cars	Urban roads	Serious injuries	0.0%	0.0%	0.0%	-1.9%
Cars	Urban roads	Light injuries	0.0%	0.0%	0.0%	-1.9%
Cars	Urban roads	Material damages	0.0%	0.0%	0.0%	-1.9%
Input	**Context**	**Impact**				
Cars	Urban roads	Average speed	0.0%	0.0%	-8.0%	0.0%

Focus of impact data verification exercise on data gaps from last 2016 deployment study

Assumed from	Not applicable	Only applicable to

Q20: Is it reasonable to assume the presented impacts for Information on fuelling & charging?
- Yes
- No, they are too high
- No, they are too low
- Don't know

Q21: Is it reasonable to assume the presented impacts for P&R information?
- Yes
- No, they are too high
- No, they are too low
- Don't know

g 100% c

In			Information on fuelling & charging stations for alternative fu vehicles			ble ser on
F c			0.0%			
P						
C			0.0%			
N			0.0%			
V			0.0%			
PM	Urban roads	Cars	0.0%	-0.1%	-0.1%	0.0%

Q22: Is it reasonable to assume the presented impacts for Smart Routing?
- Yes
- No, they are too high
- No, they are too low
- Don't know

Q23: Is it reasonable to assume the presented impacts for VRU protection?
- Yes
- No, they are too high
- No, they are too low
- Don't know

Vehicles	Road type	Seriousness				
Cars	Urban roads	Fa			0.0%	-1.8%
Cars	Urban roads	Se			0.0%	-1.9%
Cars	Urban roads	Li			0.0%	-1.9%
Cars	Urban roads	M da			0.0%	-1.9%
Input	**Context**	**In**				
Cars	Urban roads	Av			-8.0%	0.0%

Q24: For any of these services. Do you think the impact will change significantly?
- Between vehicle types?
- Between road types?
- None of the above
- Please specify your answer

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