

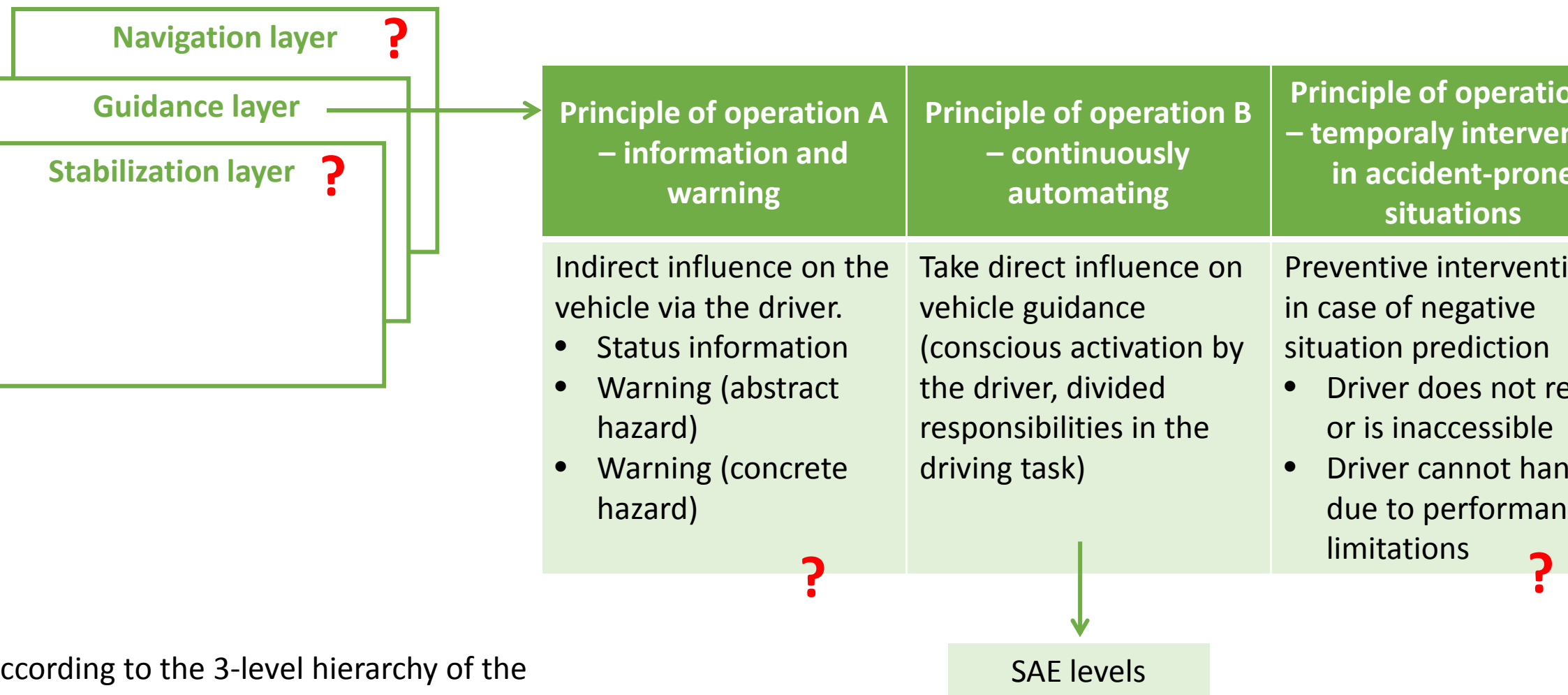
VALIDATION SCENARIOS FOR VRU – RESULTS OF THE PROSPECT PROJECT

Andrés Aparicio

Applus IDIADA, on behalf of the PROSPECT project consortium

Session SIS45 – Challenges on Testing and Validation of Automated Driving

PRINCIPLES OF OPERATION



According to the 3-level hierarchy of the driving task (Donges, 1982)

SAFETY EVALUATION FOR CONSUMERS



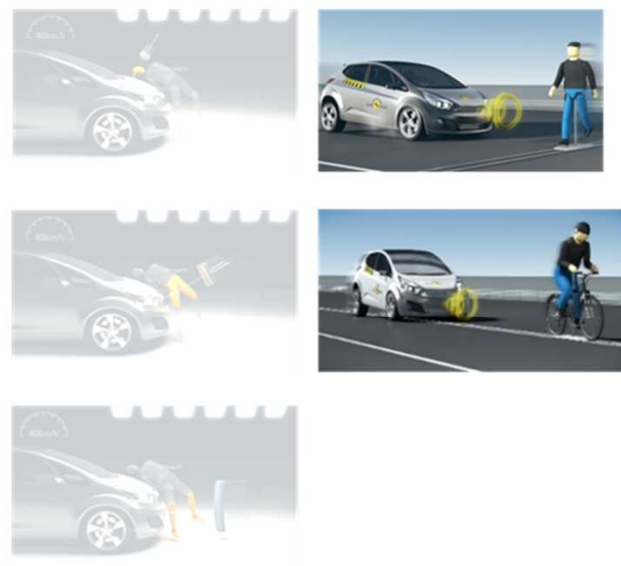
About Euro NCAP

- To eliminate road trauma by encouraging safer vehicle choices




SAFETY EVALUATION FOR CONSUMERS

Euro NCAP Rating Scheme Update




D EVALUATION FOR CONSUMERS


Automated Driving Test Matrix (under discussion)



| Longitudinal Control | | Test Speed | |
|----------------------|-----------------|--------------------|--------------------|
| Scenario | Distance | VUT | Target |
| Stationary | > sensor range | 50-130 km/h | 0 km/h |
| Moving | > sensor range | 80-130 km/h | 20, 60 km/h |
| Braking | closest setting | 50, 80, [130] km/h | 50, 80, [130] km/h |
| Cut-in | closest setting | 50, 130 km/h | 10, 80 km/h |
| Cut-out | closest setting | 70, 100 km/h | 50, 80 km/h |



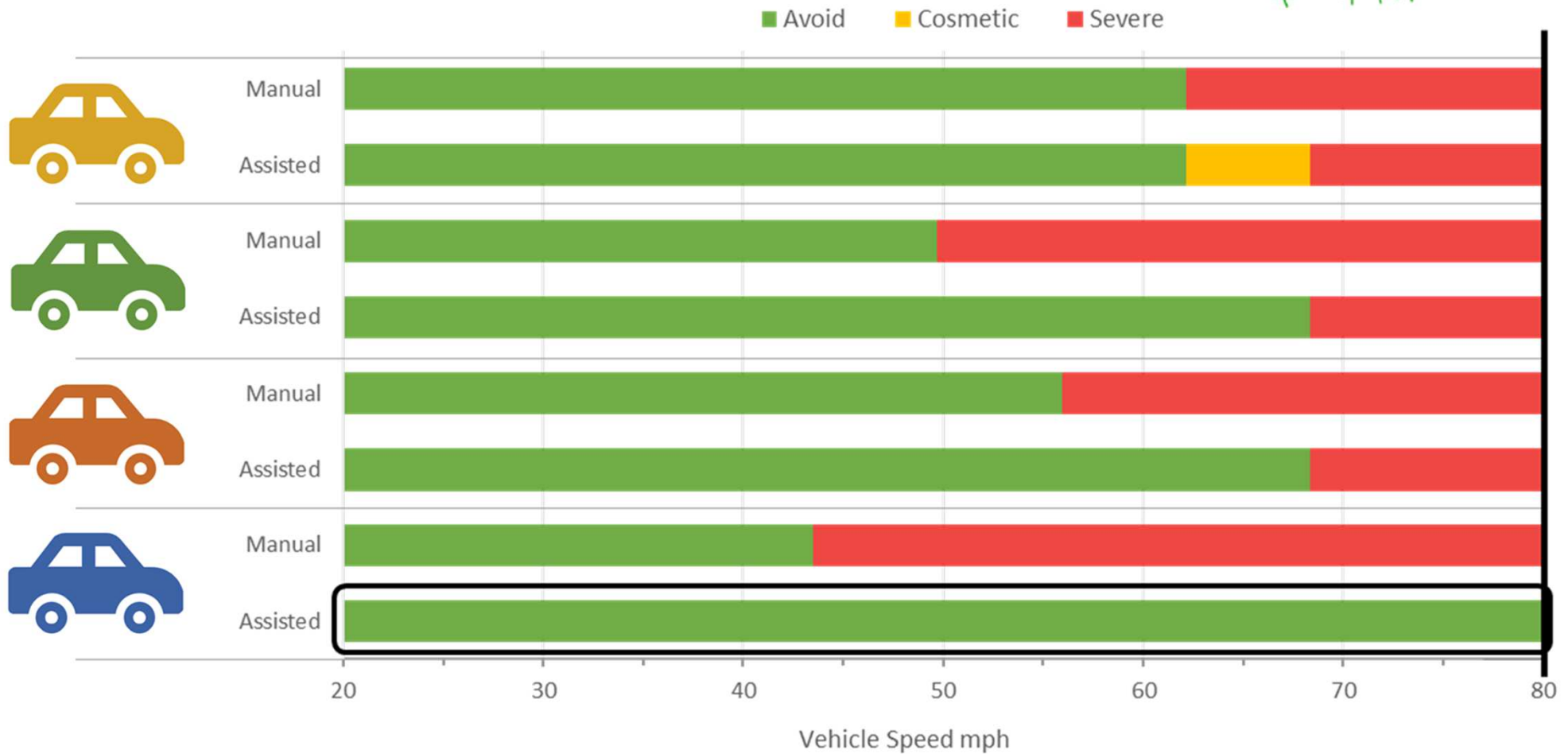
| Lateral Control | Distance | Test Speed | |
|---|-----------------|--------------------|--------------------|
| Scenario | | VUT | Target |
| Steering capabilities (highway radius) | | 90-130 km/h | - |
| Lane change (ELK) | closest setting | 72 km/h 80 km/h | 72 km/h 72 km/h |
| Override effort | | | |



| Speed Control | Test Conditions |
|---------------------------------|--|
| Speed Limit Detection | Weather Time, Distance, Arrows, Vehicle Category, Implicit Speed Limits, Dynamic Speed Limits, [Advisory Speed Limits] |
| Speed Control Test | Speed Limit Detection Test |
| Traffic Sign Recognition | Lane closure, Warning signs, Traffic lights etc. |



D EVALUATION FOR CONSUMERS



VRU EVALUATION FOR CONSUMERS



HOW DO WE DEFINE SCENARIOS?



Project title PROactive Safety for Pedestrians and Cyclists

Acronym PROSPECT

Objective To significantly improve the effectiveness of active VRU safety systems compared to those currently on the market

- by expanding scope of scenarios addressed by the systems
- and improving overall system performance

GA number 634149

Coordinator IDIADA Automotive Technology, SA

Starting date 1st May 2015

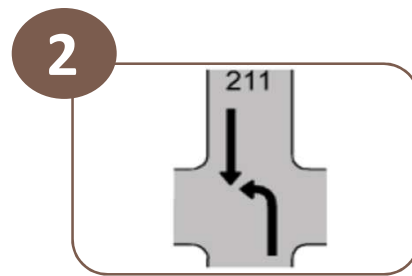
Ending date 31st October 2018



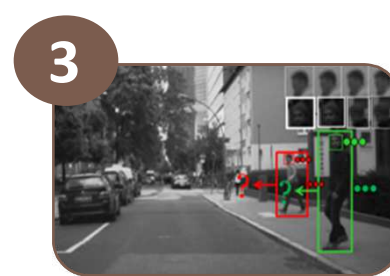
WHAT TO TAKE INTO ACCOUNT?



Study



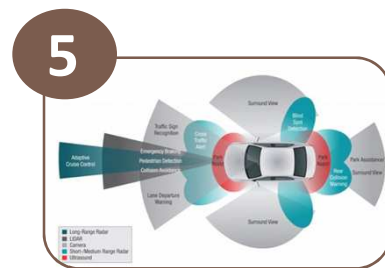
Specification



Advanced
VRU sensing



Actuation
and control
strategies



Integration



Validation

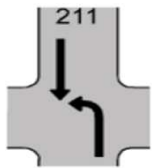
PROCESS

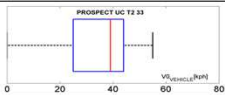
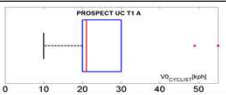
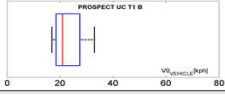
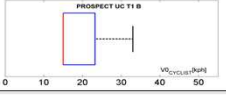
- Macro-statistical accident research
- In-depth accident research
- Field Operational Tests

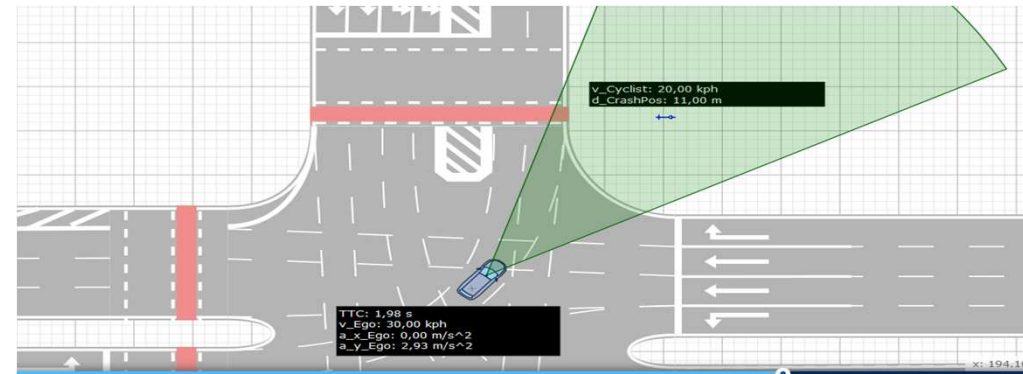


Car-to-VRU Use Cases:

- Crossing scenarios
- Longitudinal scenarios
- Turning scenarios



| Distribution in % | Part IPVERL 4&5 VO Vehicle [kph] | Part IPVERL 4&5 VO Cyclist [kph] | Part IPVERL 4&5 Time of Day | Part IPVERL 4&5 Obstruction |
|-------------------|--|---|--|--|
| 4.4% | PROSPECT UC T2 33  | PROSPECT UC T1 A  | Time of Day Day Dawn Night T1_A 63% 19% 19% | Obstruction Yes No T1-A 13% 88% |
| 1.4% | PROSPECT UC T1 B  | PROSPECT UC T1 B  | Time of Day Day Dawn Night T1_B 100% | Obstruction Yes No T1-B 100% |



RESULTS

- Detailed scenarios
- Reference data for advanced perception
- Testing tools
- Evaluation protocols

| ID | VUT Track | VUT Speed profile (km/h) | VRU Track | VRU Speed (km/h) | Signs / Clutter | Test runs | Pictogram |
|-------|---------------------|--------------------------------|---|------------------|------------------------------|---|-----------|
| CAI01 | Large road, Track E | Turning left (20-30), Track G | Crossing small road (from left, Track H) | 5 – 10 | Priority signs on large road | 1. $v_{VUT} = 20\text{ kph}$; 2. $v_{VUT} = 30\text{ kph}$; 3. $v_{VUT} = x5\text{ kph}$ (optional) | |
| CAI02 | Large road, Track E | Turning left (20-30), Track G | Crossing small road (from right, Track G) | 5 – 10 | Priority signs on large road | 1. $v_{VUT} = 20\text{ kph}$; 2. $v_{VUT} = 30\text{ kph}$; 3. $v_{VUT} = x5\text{ kph}$ (optional) | |
| CAI03 | Large road, Track A | Turning right (15-30), Track G | Crossing small road (from right, Track G) | 5 – 10 | Priority signs on large road | 1. $v_{VUT} = 15\text{ kph}$; 2. $v_{VUT} = 20\text{ kph}$; 3. $v_{VUT} = 30\text{ kph}$; 4. $v_{VUT} = x5\text{ kph}$ (optional) | |
| CAI04 | Large road, Track A | Turning right (15-30), Track G | Crossing small road (from left, Track H) | 5 – 10 | Priority signs on large road | 1. $v_{VUT} = 15\text{ kph}$; 2. $v_{VUT} = 20\text{ kph}$; 3. $v_{VUT} = 30\text{ kph}$; 4. $v_{VUT} = x5\text{ kph}$ (optional) | |



CONCLUSIONS



- A wholistic approach is needed for the definition of validation scenarios for ADAS and AD
- Special emphasis is needed for safety critical scenarios (accidentology)
- PROSPECT has compiled a relevant database of scenarios for VRUs

PROSPECT FINAL EVENT



FINAL EVENT

*of the European projects on
Traffic Safety of Vulnerable Road Users*

 12th October 2018 at Applus IDIADA



These projects are co-funded by the European Union's Horizon 2020 Research and Innovation Programme under the following Grant Agreements: No. 634149, No. 635895 and No. 635975

HANK YOU VERY MUCH FOR YOUR KIND ATTENTIO

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