



Evaluation and User Acceptance Test Results

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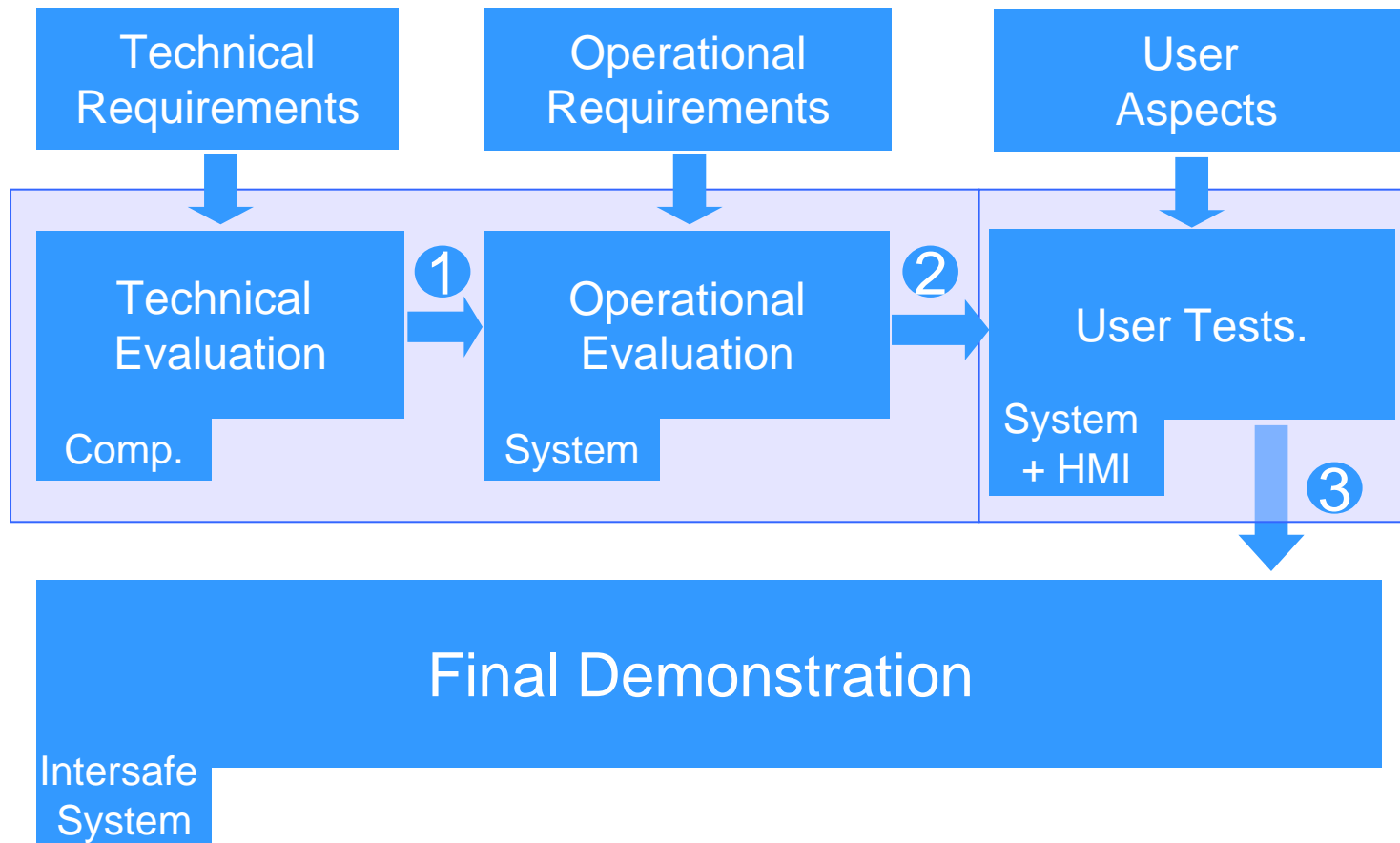
ika – Institut für Kraftfahrwesen Aachen



European Commission
Information Society and Media

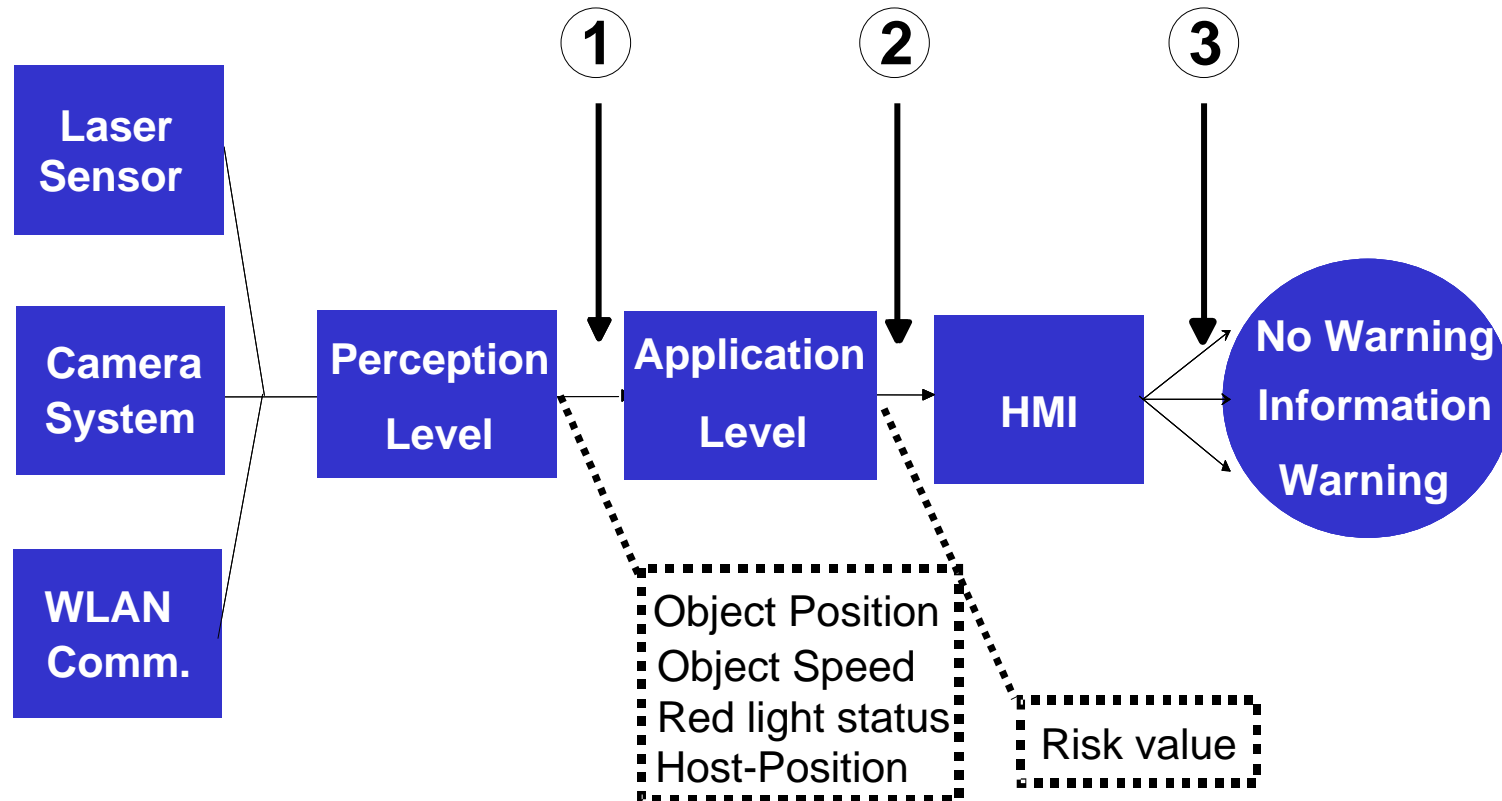


System Testing Concept – based on CONVERGE methodology



General System Description

Phases



Phase 1 – Laserscanner Tests

Test Name	Interface	Criteria	Target Object	Testing Environment
ST-1	1	Range	V1 to V4 and PD	Test track
ST-2	1	Field of view	V1 to V4 and PD	Test track
ST-3	1	Distance resolution	V3	Test track
ST-4	1	Rel. velocity accuracy	V3	Test track
ST-5	1	Object position accuracy	B090	Test track
ST-6	1	Relative localisation position accuracy	LM	Test intersection

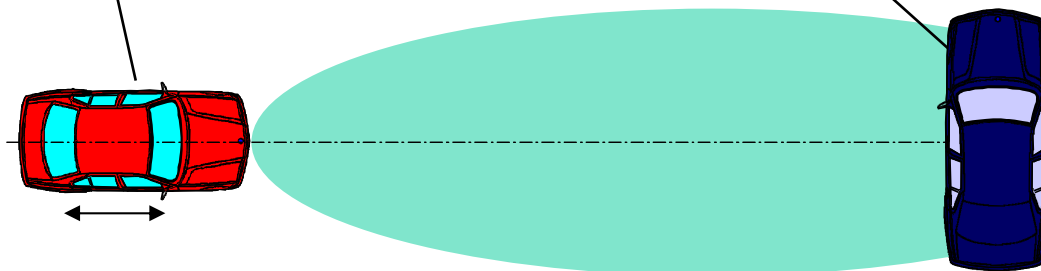
Tab. 6-2: Test Matrix for IBEO Sensor tests

V1 to V4: target vehicles
 PD: pedestrian
 B090: Laser dummy target
 LM: landmarks on test intersection



Demonstrator vehicle

Target vehicle



Phase 1 – Target Vehicles



Honda VFR800



VW Lupo



BMW 325i



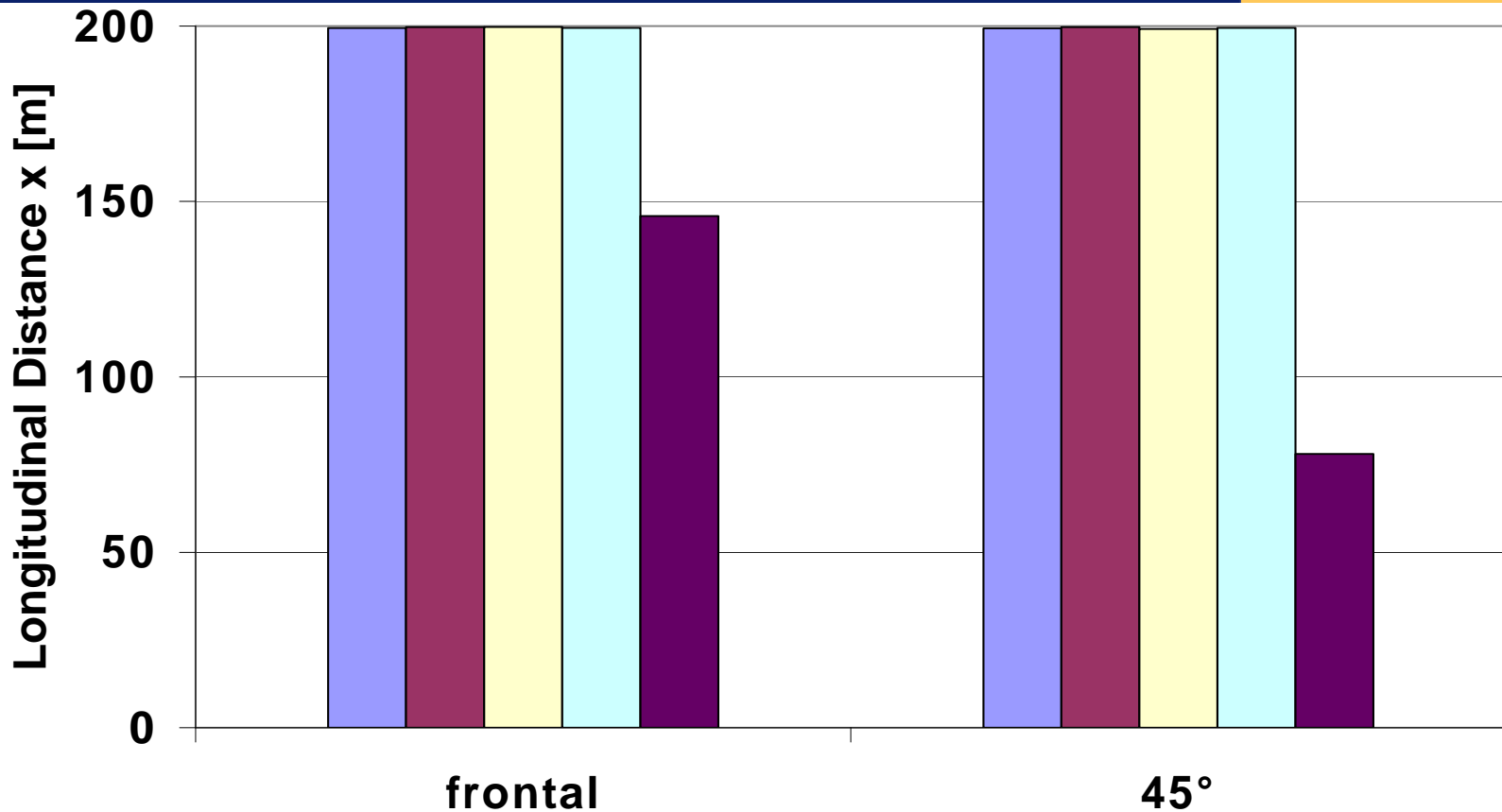
BMW 728i



VW Golf



Phase 1 – Laserscanner Test Results



- CAN specification was limited to 200m
- All vehicles classified correctly immediately after detection
- Pedestrian detected and classified correctly at distances of 110 m



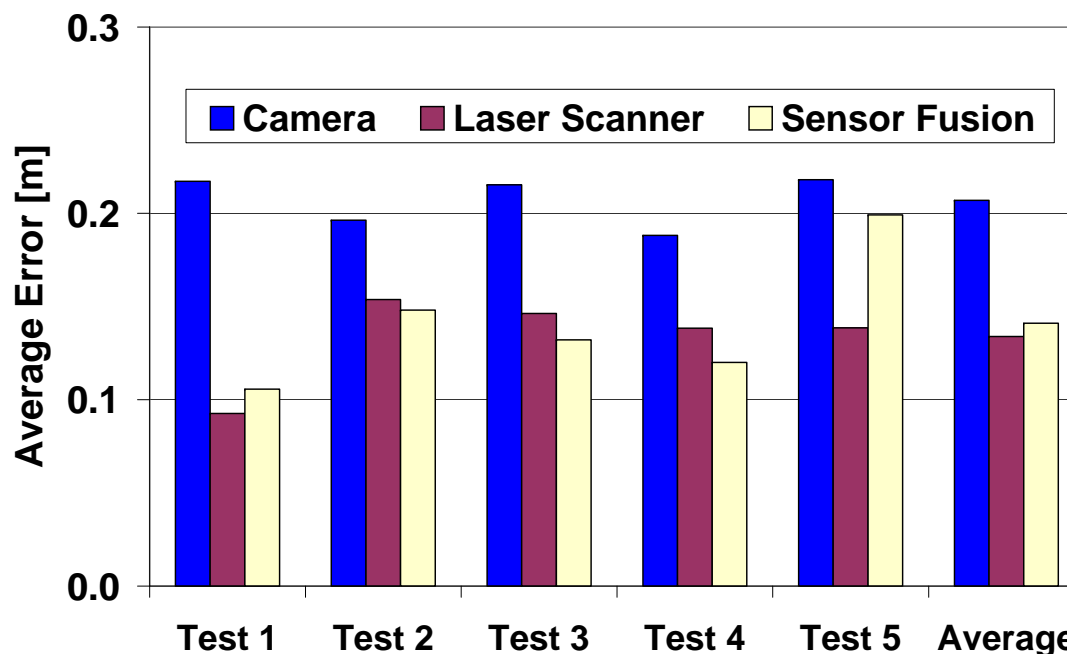
Phase 1 – Localisation Test Results



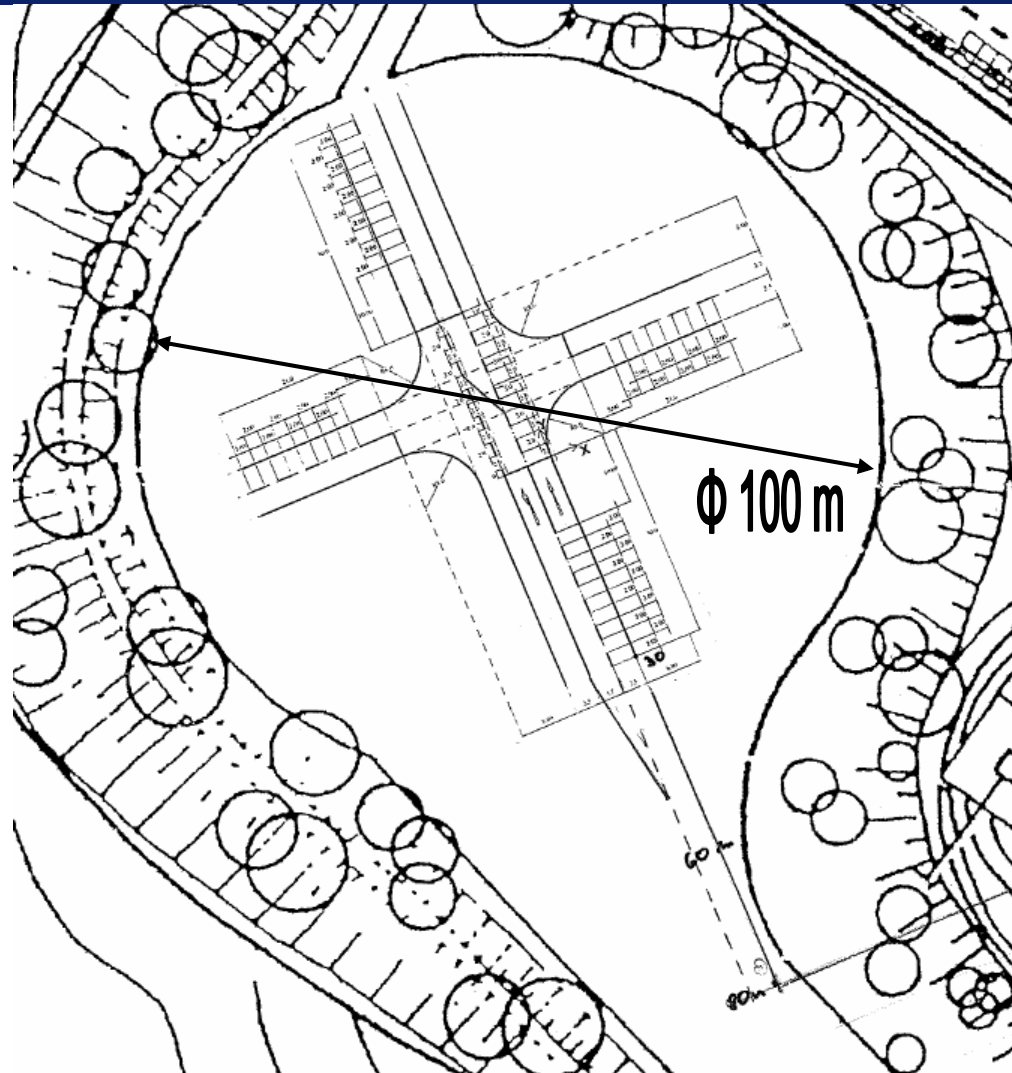
Test Name	Interface	Criteria	Target Object	Testing Environment
ST-10	1	Relative localisation Position accuracy	LM and RM	Test intersection
ST-11	1	DO, DOD, DOR	LM and RM	Test intersection

LM: landmarks
RM: road markings

- Average localisation errors of sensor and fusion system between 10...20 cm
- The outputs of all localisation systems are continuous. No drop-out occurred.



Test Site for System and User Tests



Evaluation of operational requirements (Phase 2) and user aspects (Phase 3)



Methodology → Re-enactment of accident scenario 1 to 3



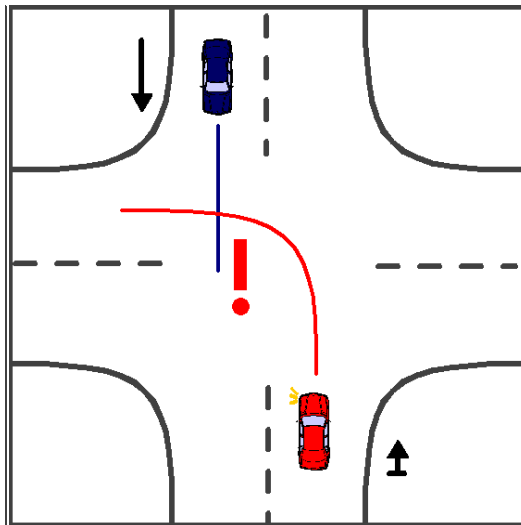
Evaluation of operational requirements (Phase 2) and user aspects (Phase 3)



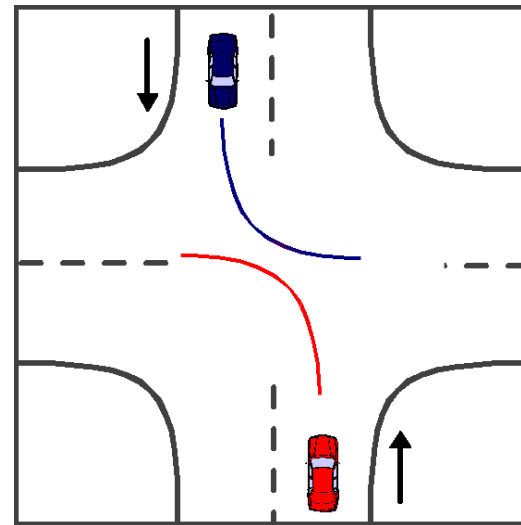
Methodology → Re-enactment of accident scenario 1 to 3

The boundary conditions for reproducible tests in phase 2 and 3:

- Behaviour of the host vehicle (*static, starting up, approaching, braking*)
- Presence/absence and behaviour of adverse traffic participant
- Categorisation of a situation's risk potential acc. to risk assessment module function (*crossing trajectories and presence at same spot at the same time*)



ALARM Situation Scenario 1

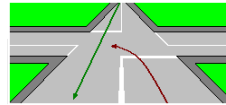


NO ALARM Situation Scenario 2



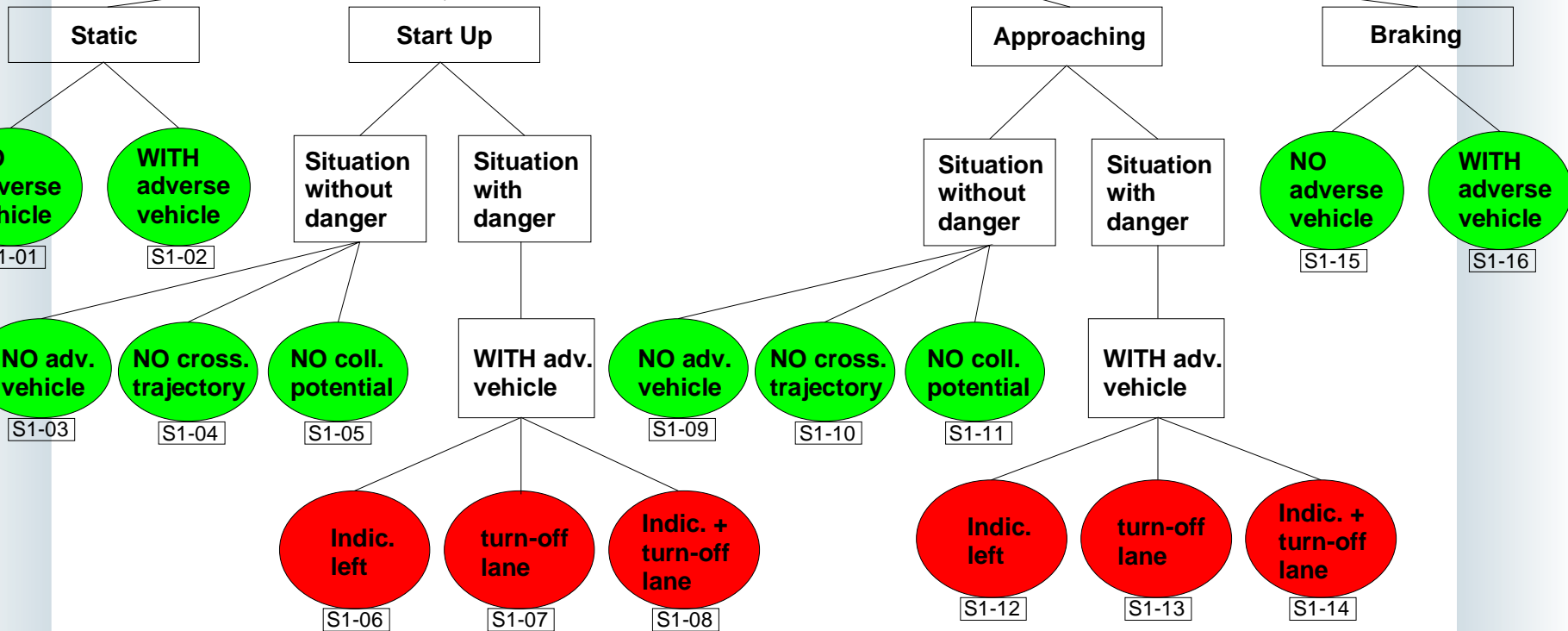
Phase 2 – Example for Test Situations in accident scenario 1:

Scenario 1



 NO Alarm Situation

 Alarm Situation



Phase 2 – Example for Left Turn

Start up with adverse vehicle



- CAR between 90...100 %
- FAR between 0...10%
- NO dangerous Missing Alarms
- TLA and IA systems showed very promising results and
- Large potential to avoiding intersections accidents

System	CAR [%]	FAR [%]	MAR [%]
IA at left turn	93	7	0
IA at lateral traffic	100	0	0
TLA	90	10	0



Requirements for Warning Systems:

- The warning must be noticed
- The warning must be read (or heard)
- The warning must be understood
- The warning must be accepted

[Wickens, et. al., 1998]

Evaluation criteria (by questionnaires):

- Design of HMI
- Design of the system
- Timing of warning

Boundary conditions for user tests

- Same situations from testing phase 2 are used (situations defined after tests of phase 2)
- Two to three ALARM-/NO ALARM situations per accident scenario
- 16 test persons per demonstrator vehicle

Phase 3 – Test Design



gender	Driving experience	Age 18-25	Age 26-35	Age 36-45	Age >45
male	experienced	No. 1	No. 2	No. 3	No. 4
	inexperienced	No. 5	No. 6	No. 7	No. 8
female	experienced	No. 9	No. 10	No. 11	No. 12
	inexperienced	No. 13	No. 14	No. 15	No. 16

Subjects: 16 subjects to achieve a representative result
Boundary of experienced/inexperienced driver: 10,000 km/year

Scenarios: Same scenarios for each subject
Scenario sequence changed to avoid effects of test orders

Duration: 2.5 hours each



User Test Results

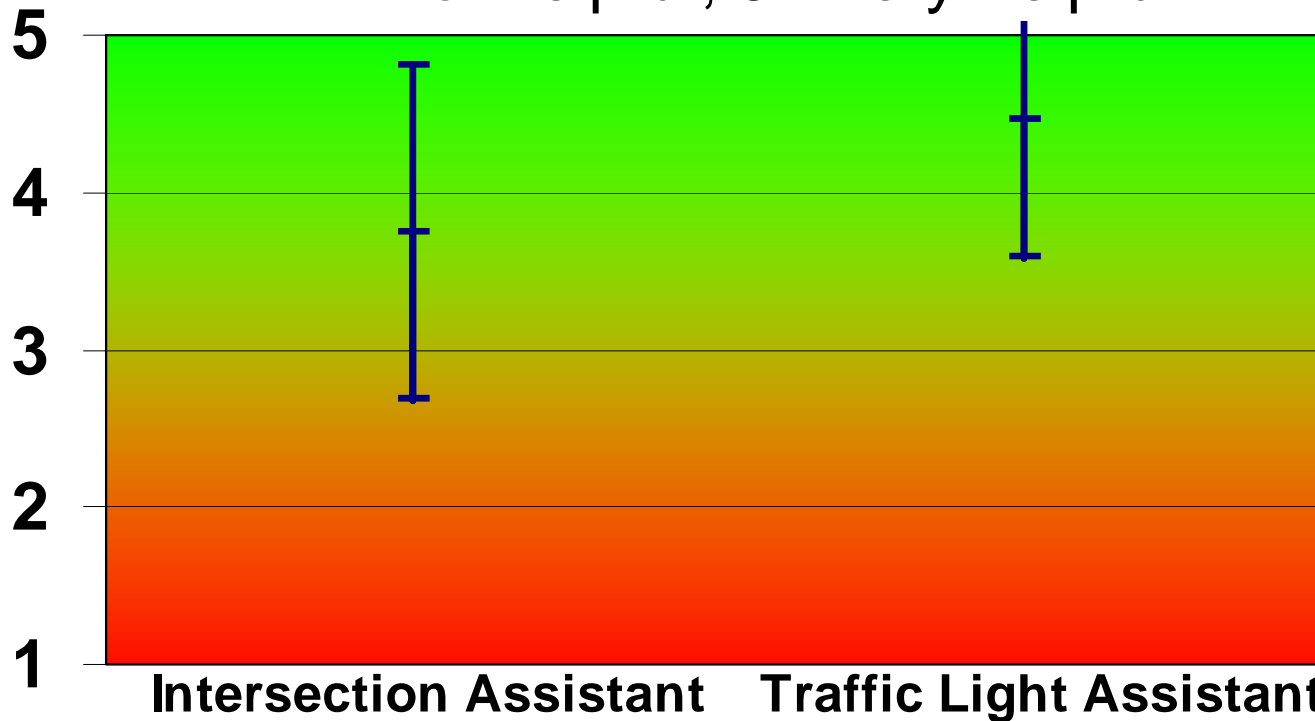
- TLA vs. IA



Examples

How would you evaluate the assistant?

1= not helpful; 5= very helpful



User Test Results

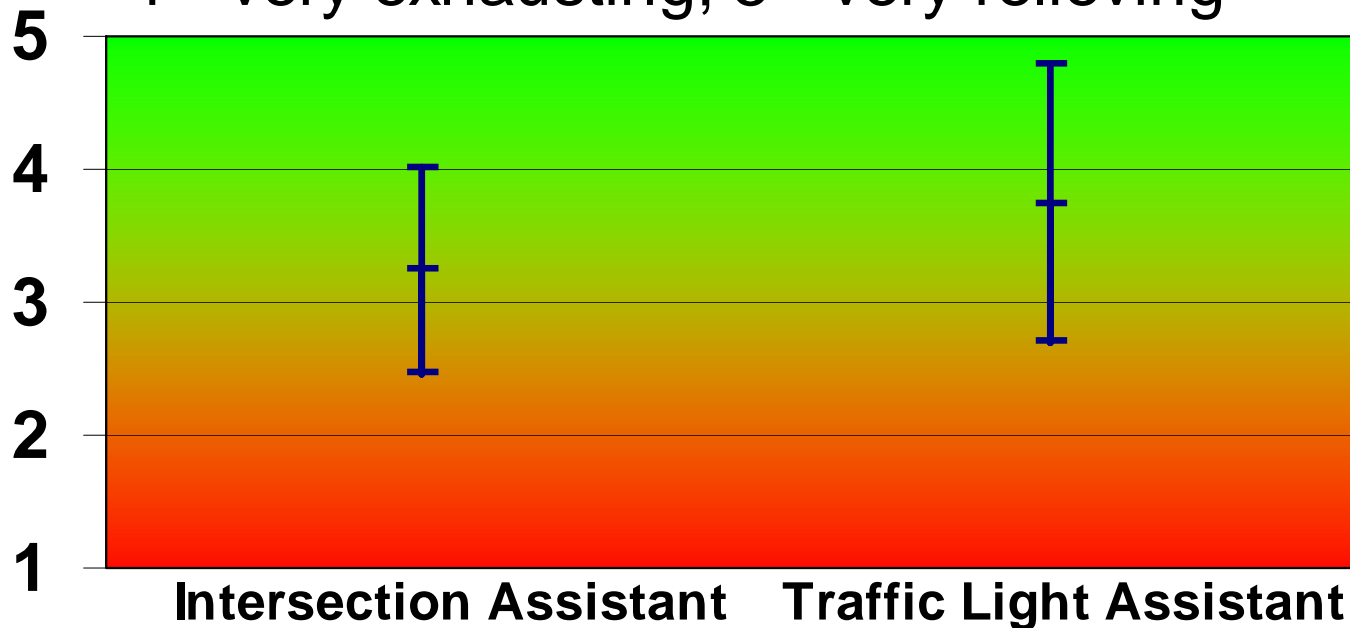
- TLA vs. IA



Examples

How would you judge the usage of this assistant?

1 = very exhausting; 5 = very relieving



User Test Results

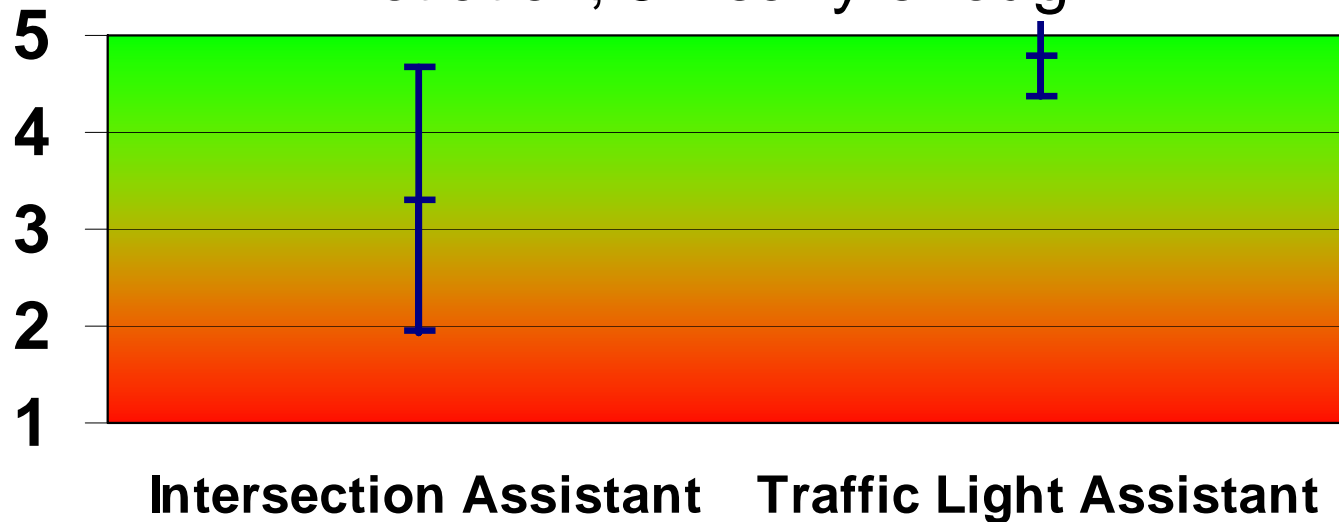
- TLA vs. IA



Examples

How far before a critical situation does the system indicate you a potential danger?

1= not at all; 5= early enough



User Test Results

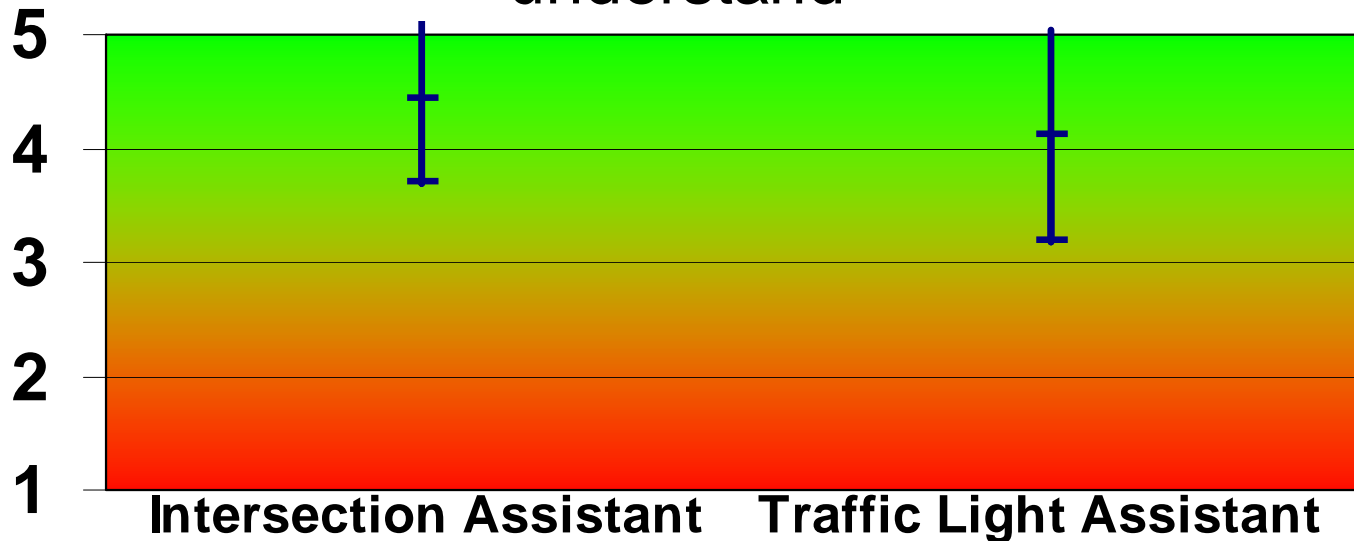
- TLA vs. IA



Examples

How would you evaluate the design of the warning signs in the display?

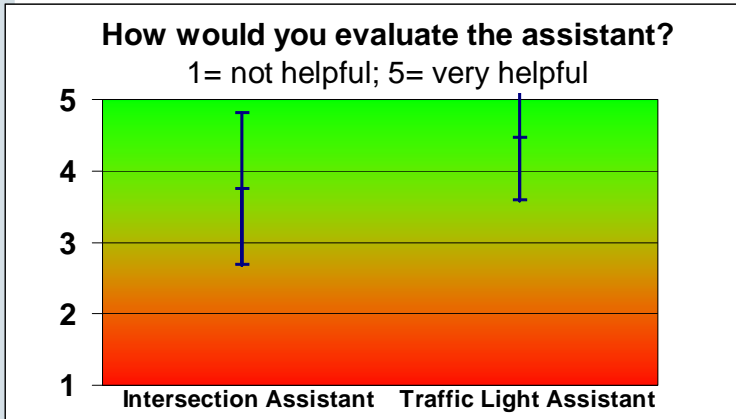
1= difficult to understand; 5= easy to understand



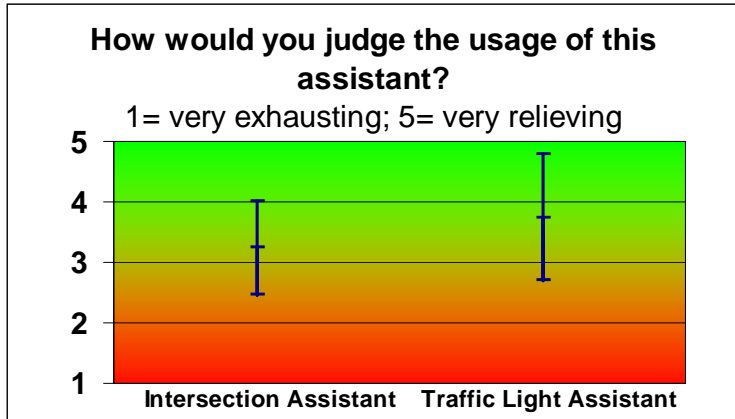
User Test Results

- TLA vs. IA

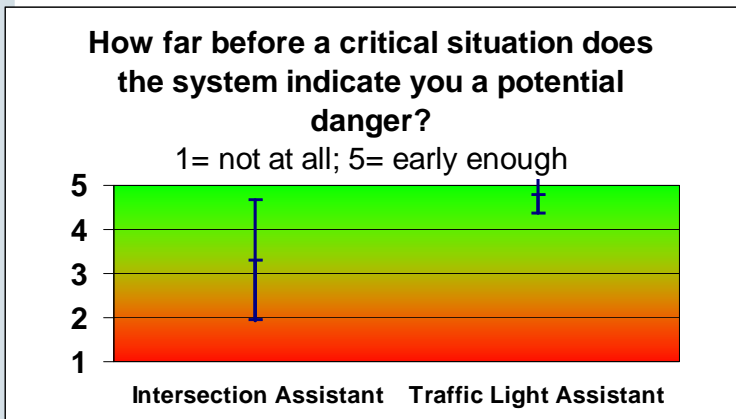
Summary



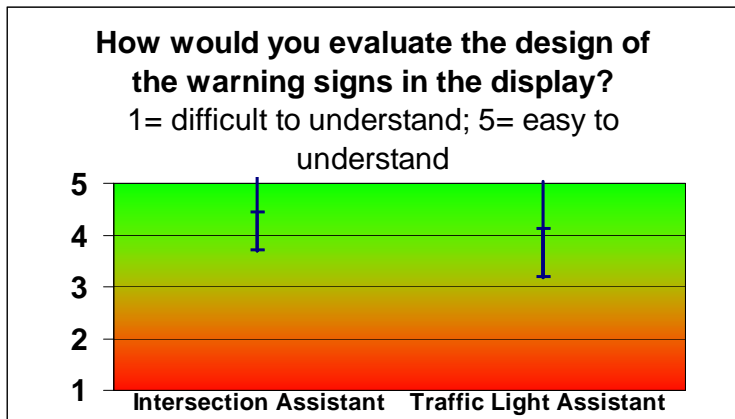
TLA is rated more helpful than IA



TLA is rated more relieving than IA



TLA warnings are early enough
IA warnings are just in time



TLA and IA HMI design are easy to understand



User Test Results

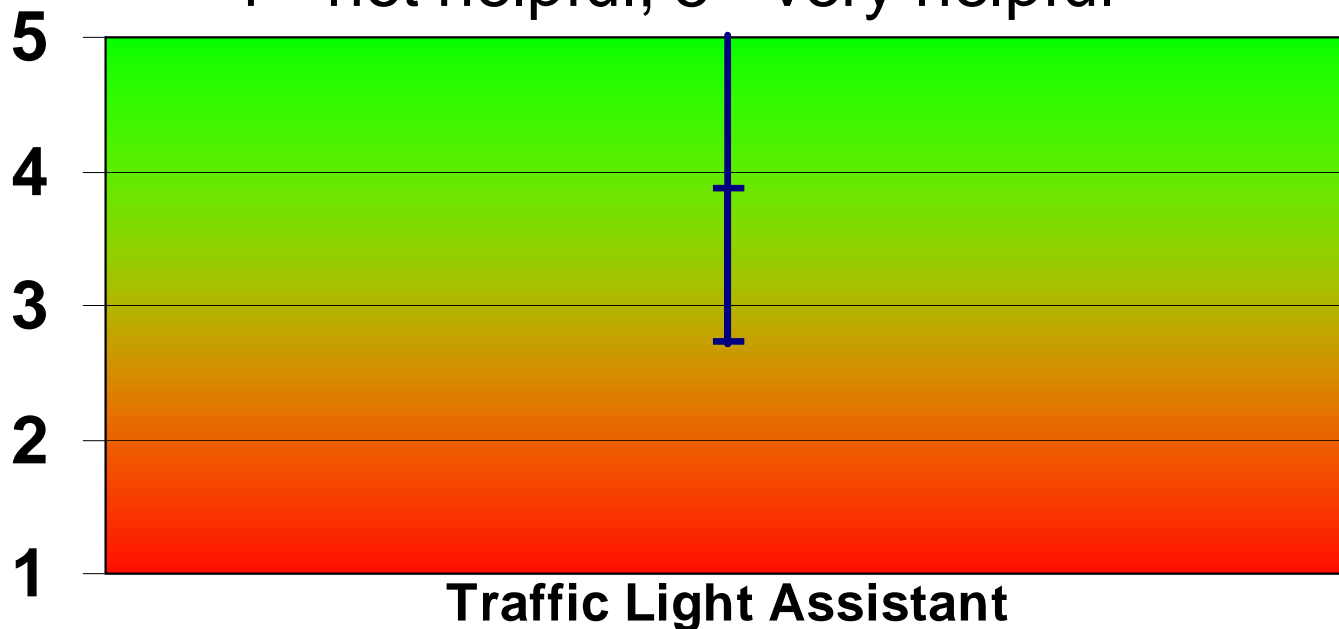
– General Statements



Examples

How would you judge the proposal for
velocity?

1 = not helpful; 5 = very helpful



User Test Results

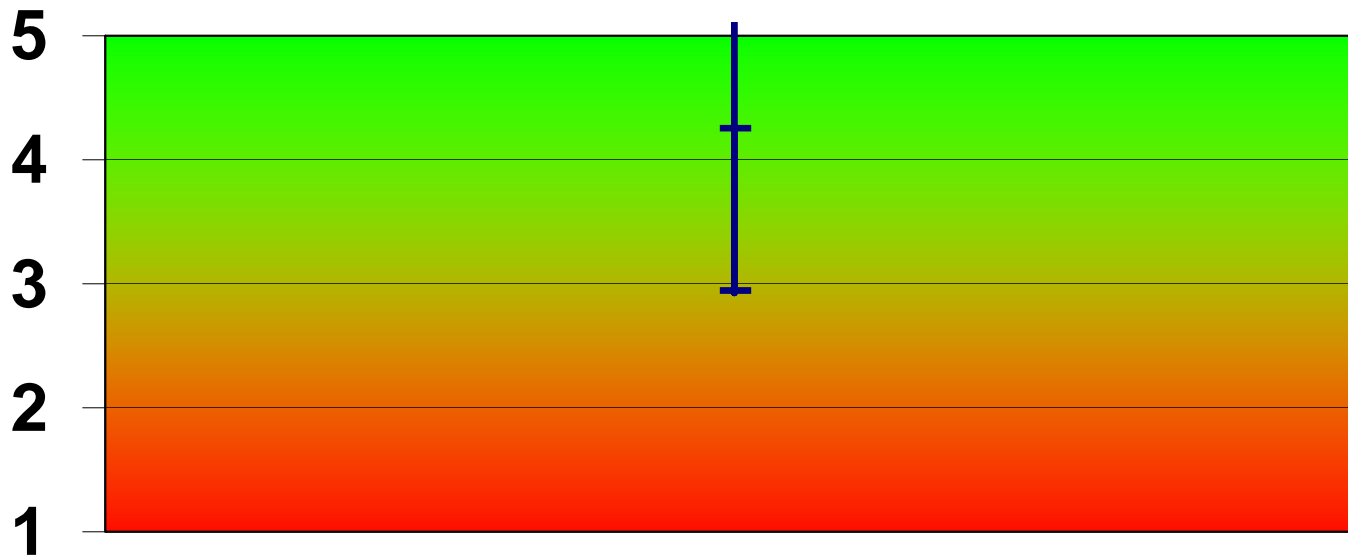
– General Statements



Examples

Do you feel patronised of the display-warning/proposal of velocity?

1 = yes; 5 = no



Traffic Light Assistant



User Test Results

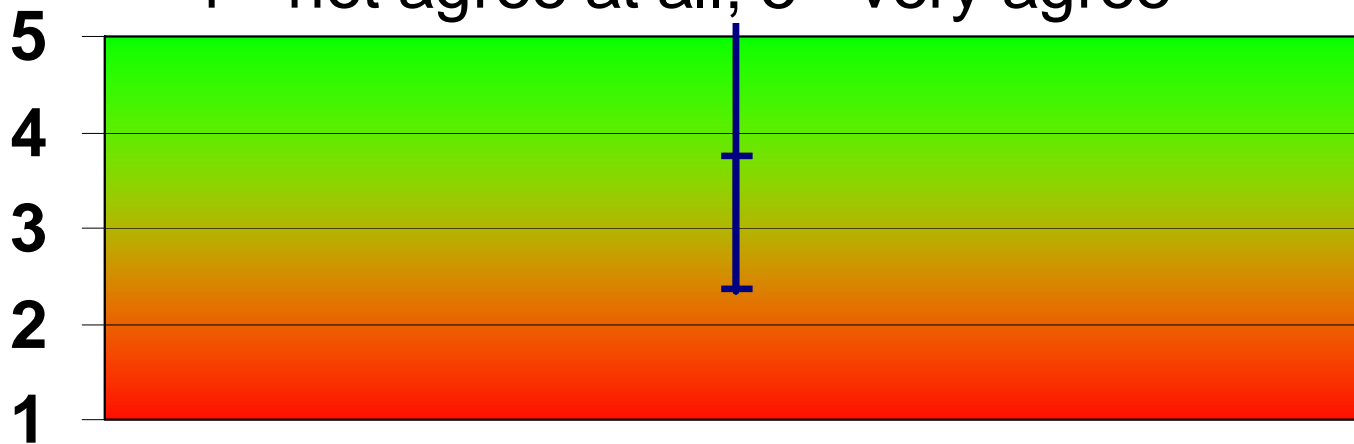
– General Statements



Examples

If all the drivers have such assistants in the car, much fewer accidents will occur. Do you agree with this statement?

1= not agree at all; 5= very agree



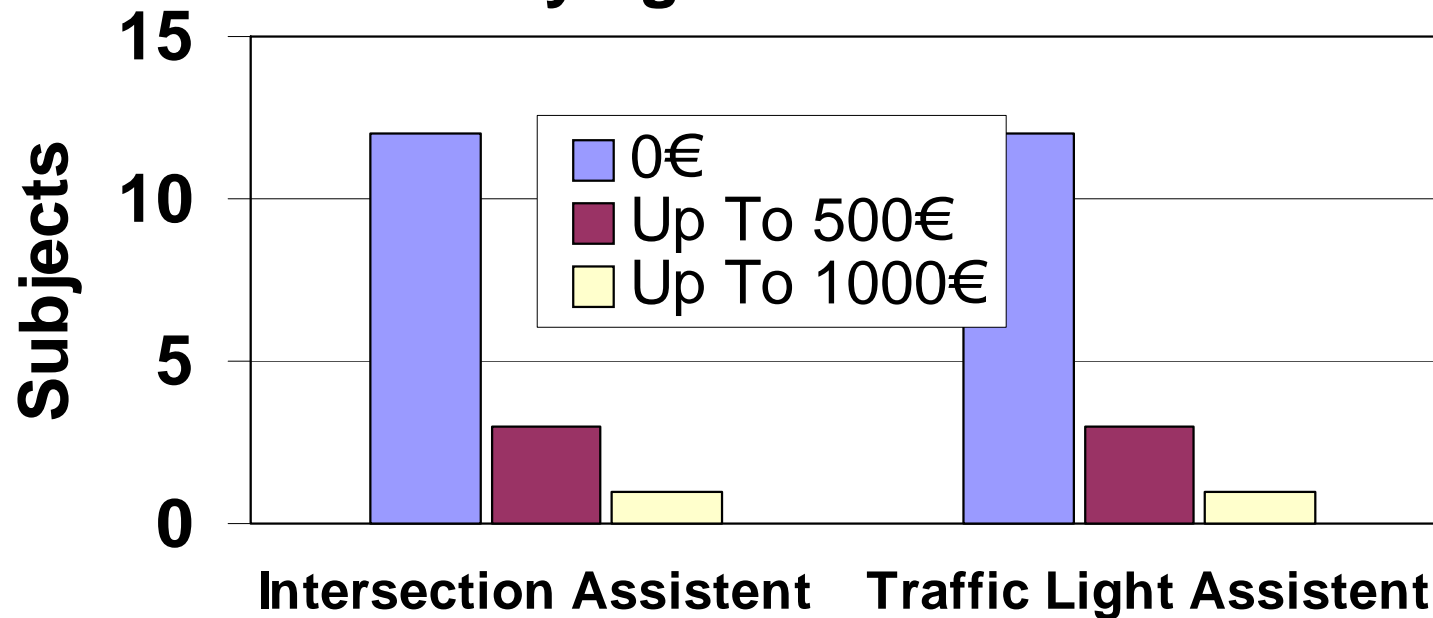
User Test Results

– General Statements



Examples

What is the maximum you would be willing to spend on an assistant when buying a new car?



User Test Results

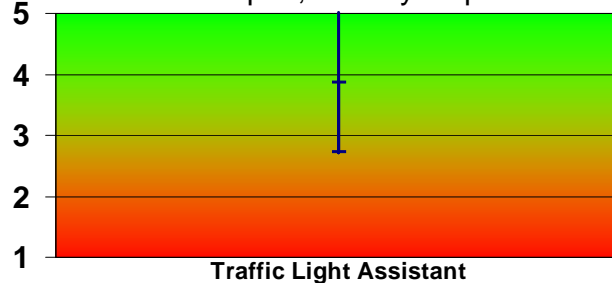
– General Statements

Summary



How would you judge the proposal for velocity?

1= not helpful; 5= very helpful

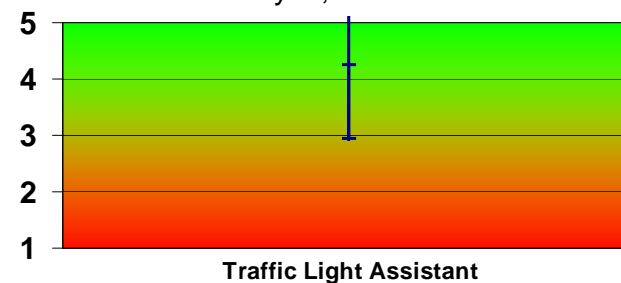


Traffic Light Assistant

Velocity proposal rated very helpful

Do you feel patronised of the display-warning/proposal of velocity?

1= yes; 5= no

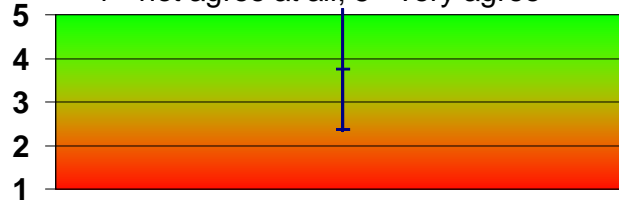


Traffic Light Assistant

Subjects do not feel patronised by the TLA systems.

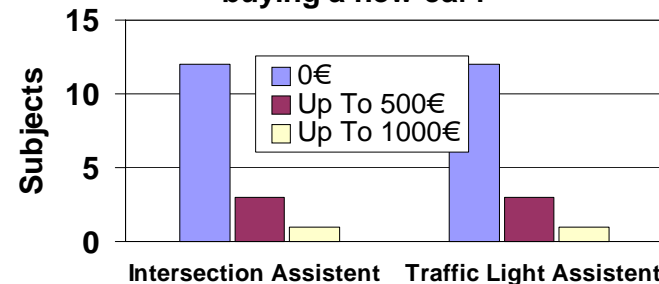
If all the drivers have such assistants in the car, much fewer accidents will occur. Do you agree with this statement?

1= not agree at all; 5= very agree



Subjects think the presented systems contribute to traffic safety

What is the maximum you would be willing to spend on an assistant when buying a new car?



Most subjects do not want to spend extra money on the systems



User Test Results

– Summary



- Perception system (sensors, communication and fusion module) fulfil the technical requirement specification
- TLA and IA systems showed promising results with a very high CAR between 90...100 %, a low FAR between 0...10% and no dangerous Missing Alarms in the system tests
- System tests show a large potential of TLA and IA to avoiding intersections accidents
- User tests show that both INTERSAFE systems (TLA and IA) are rated helpful and relieving,
- Generally TLA is rated more helpful than IA by users
- Users stated that INTERSAFE systems can improve traffic safety and they do not feel patronised by the INTERSAFE system
- Most subjects do not want to pay extra costs for the INTERSAFE system, when buying a new car

