Proposing a Meta-Language for Specifying Presentation Complexity in order to Support System Situation Awareness

dfki iui automotive

Christoph Endres

Michael Feld

Christian Müller

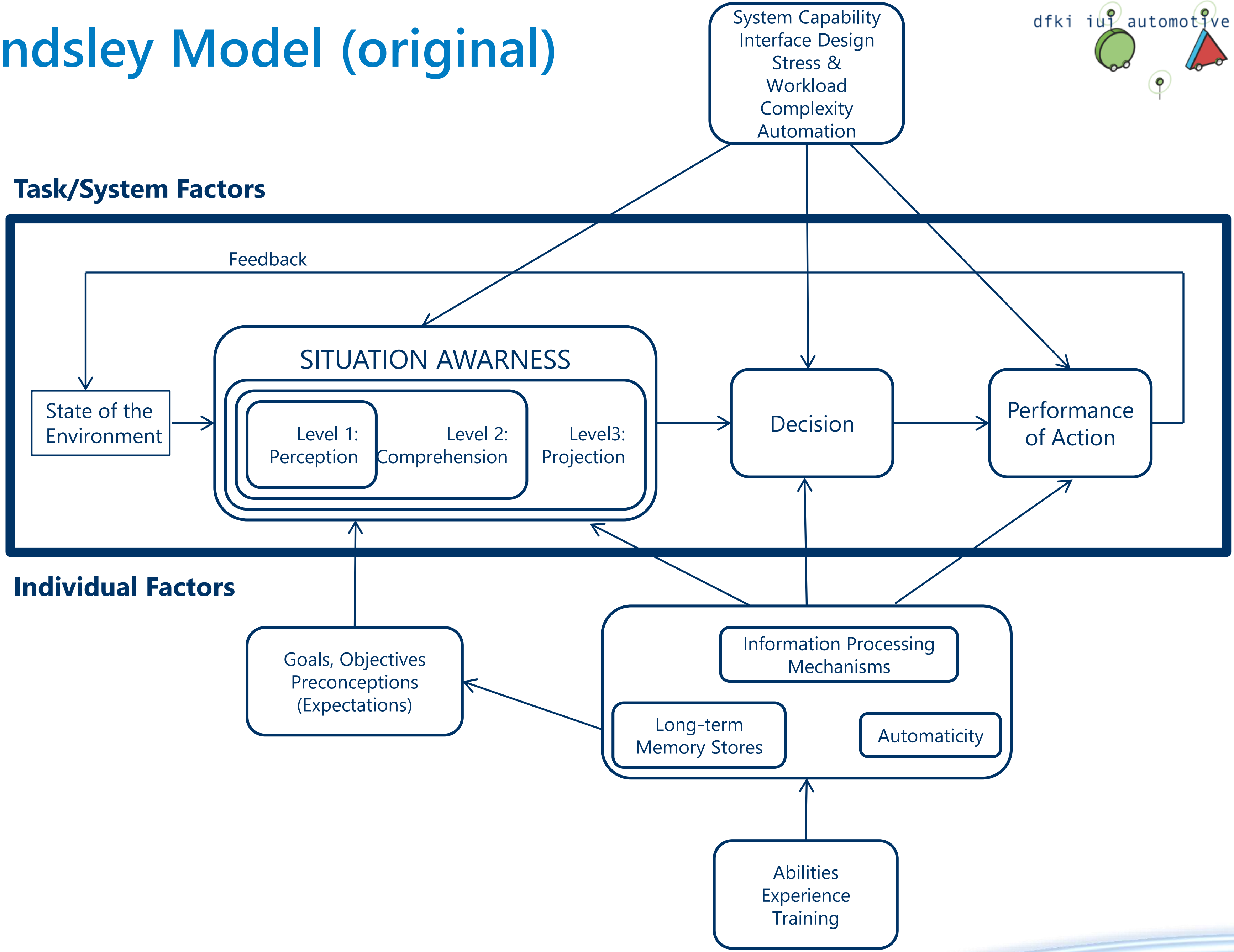
W3C Web & Automotive Workshop

14th-15th November 2012 – Rome, Italy

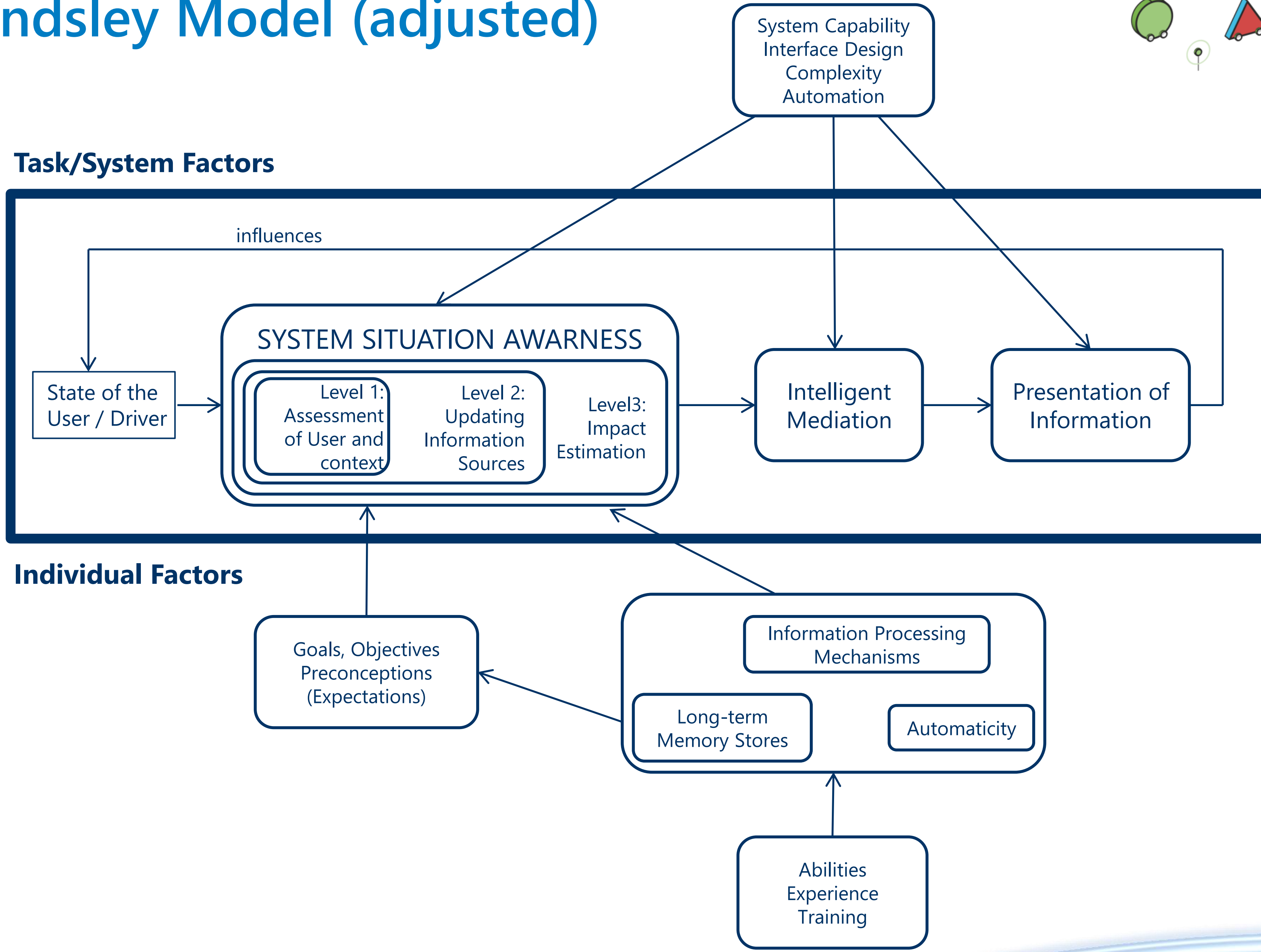
Situation Awareness

- “knowing what is going on around you”
- Automotive Domain: Helps us reduce accidents
- Subgoal: Reducing distraction
- System Situation Awareness
- Endsley Model

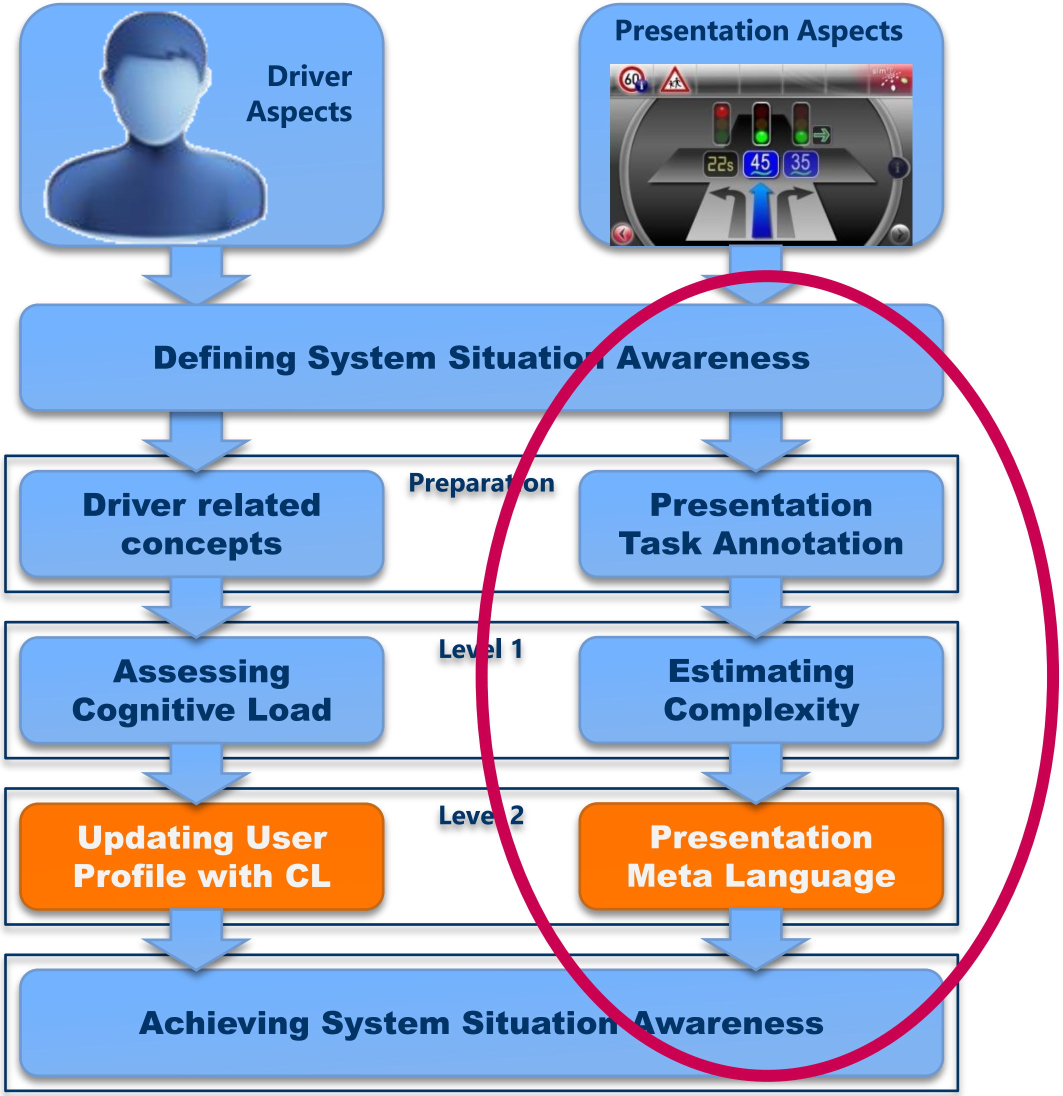
Endsley Model (original)



Endsley Model (adjusted)



Two-fold Research Question

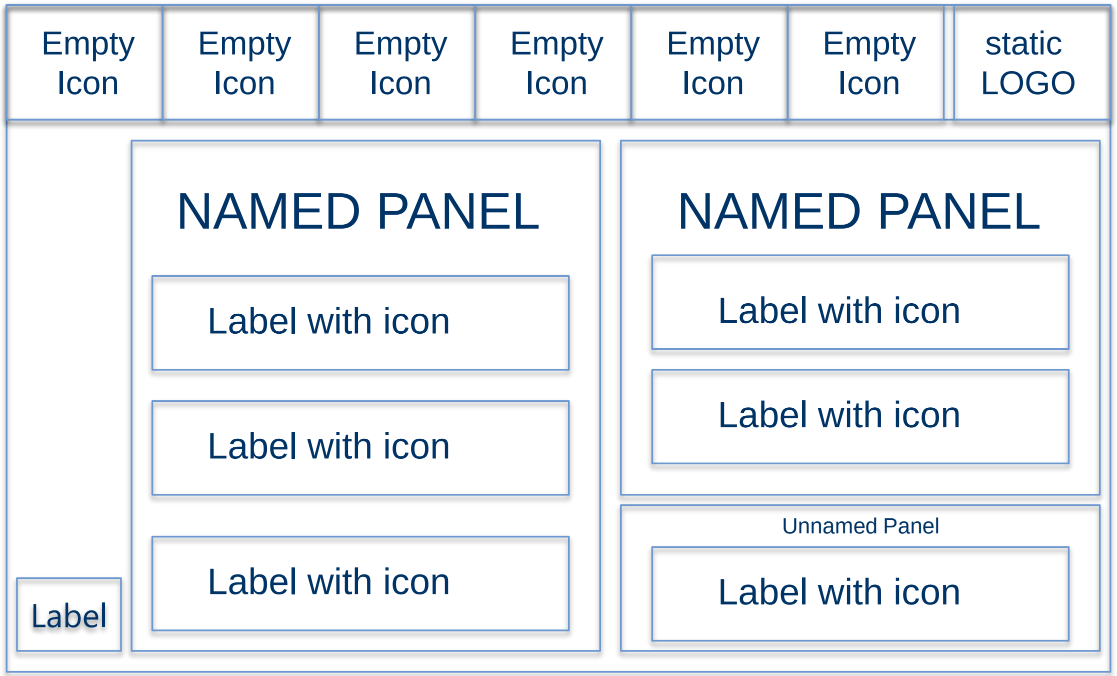


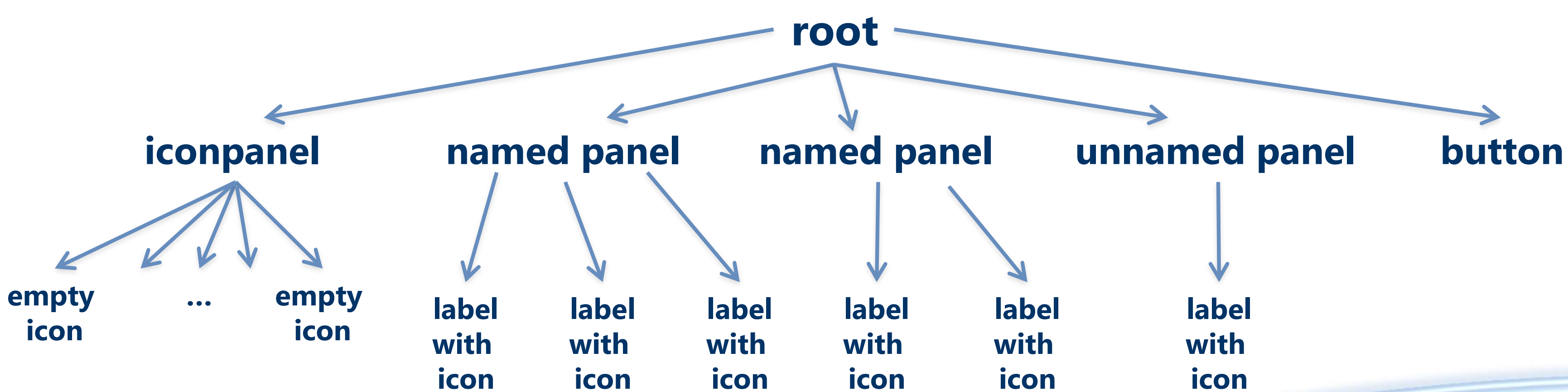
Estimating Presentation Complexity

- Three Options:
  - Complexity specified by designer
    - “Ideal” case → nothing to do
  - Unstructured representation
    - Heuristic approaches → low confidence
  - Structured representation (e.g. HTML5)
    - ACE (Annotated Complexity Estimation)
- Third case:
  - How to annotate complexity automatically?
  - ACE based on visual tree and complexity table

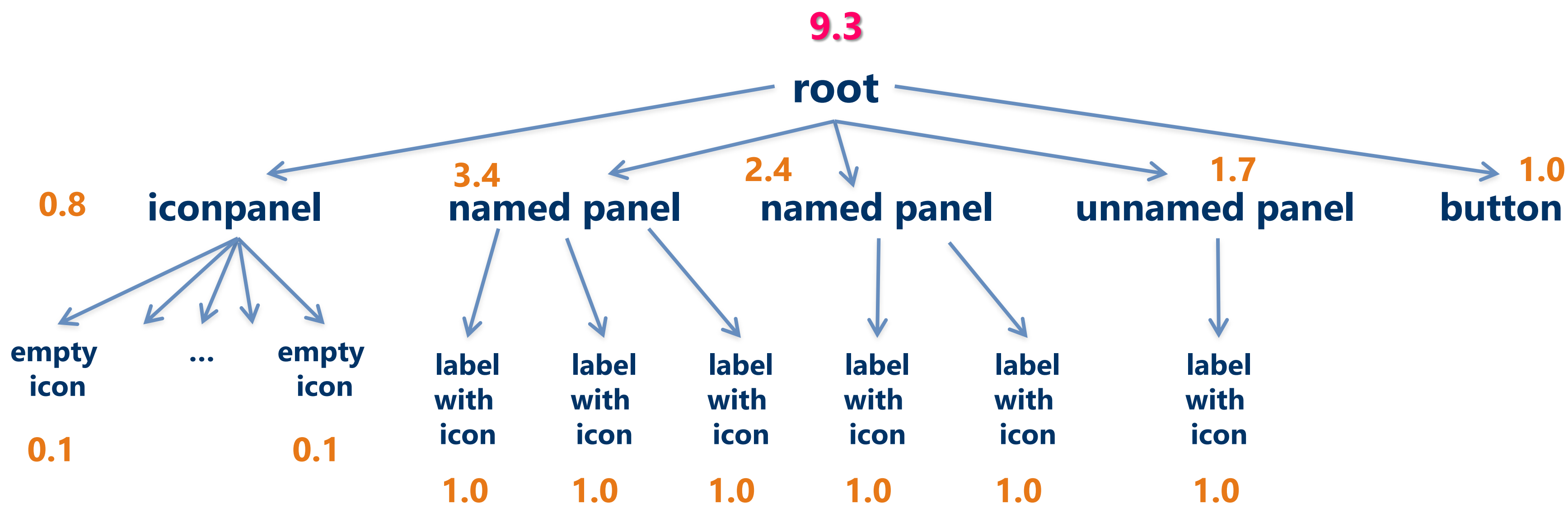
Example Screen Layout (sim^{TD})

GUI Model and Visual Tree





Complexity Computation



component	basic complexity	feature	added
label	0.1	text=true icon=true	+0.5 +0.4
icon	0.1	type=empty type=icon type=static metainfo=text	+0.0 +0.5 +0.2 +0.4
panel	$0 + \sum$ child nodes	decoration=framed decoration=none metainfo=named metainfo=none	+0.2 +0.5 +0.2 +0.5

Presentation Meta Language

- Developer can provides multiple presentation alternatives
- System can choose based on complexity and driver workload
- Goal: No new presentation language
- → Wrapper or **Meta Language**

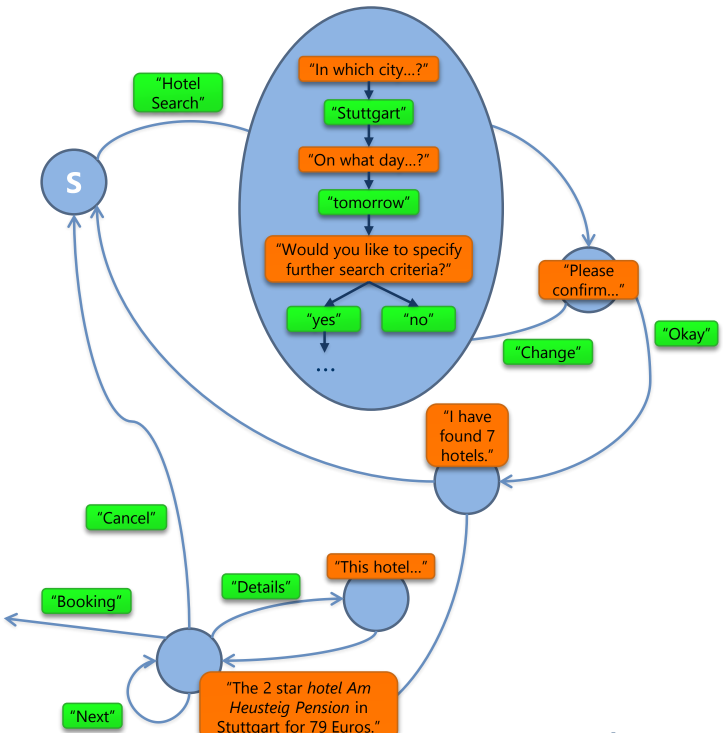
```
<ptcl>
 <meta>
  <overallPriority value=70 metric="percent" />
 </meta>
 <displayStrategies>
  <strategy>
   <preference=1 />
   <demand=0.8 />
   <representation language="XY">
    [first variant of presentation task in language XY]
   </representation>
  </strategy>
  <strategy>
   <preference=2 />
   <demand=0.3 />
   <representation language="XY">
    [second variant of presentation task in language XY]
   </representation>
  </strategy>
 </displayStrategies>
</ptcl>
```

Example

Implementation into a Dialogue Platform

SiAM dp

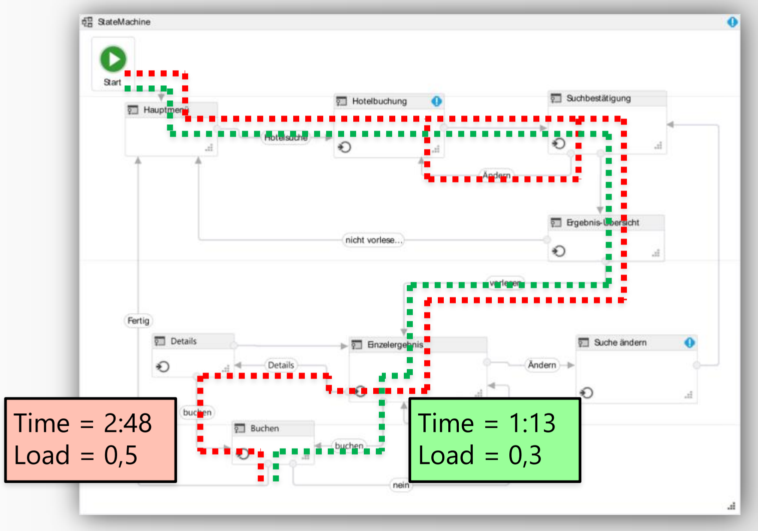
Situation-Adaptive Multimodal Dialogue Platform



SCXML-based

Dialogue Offline Evaluation

- Modeling dialog cost (metrics)
  - Cognitive load
  - Time
  - Usability
  - Money
  - Total cost
- Anticipating the cost of a dialog already at design time (without expensive user study)
  - Expected cost on given path
  - Most costly transitions
  - Shortest / longest path
  - Average path
  - Best modality / modality comparison



Estimating (Input) Interaction Workload

Estimating interaction cost

Analyzing the dialog model and task complexity

Breaking up complex tasks into atomic tasks

Rearrangement | **Text entry** | **Number entry** | **Pan / Zoom** | **List selection** | **Scrolling**

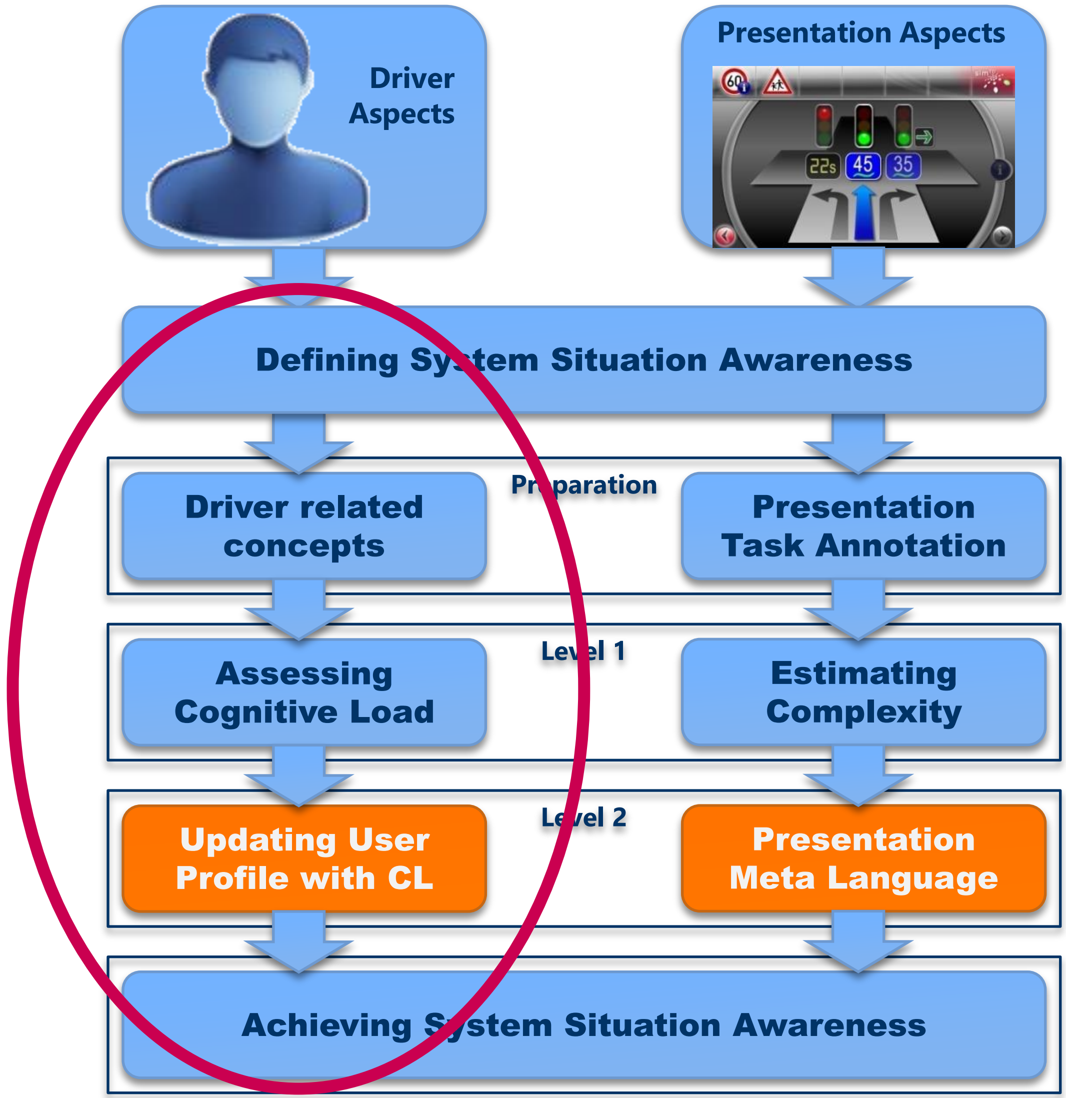
→ Widgets

Touchscreen | Speech | Eyegaze | Micro-gesture

cost

determined in separate studies

Two-fold Research Question

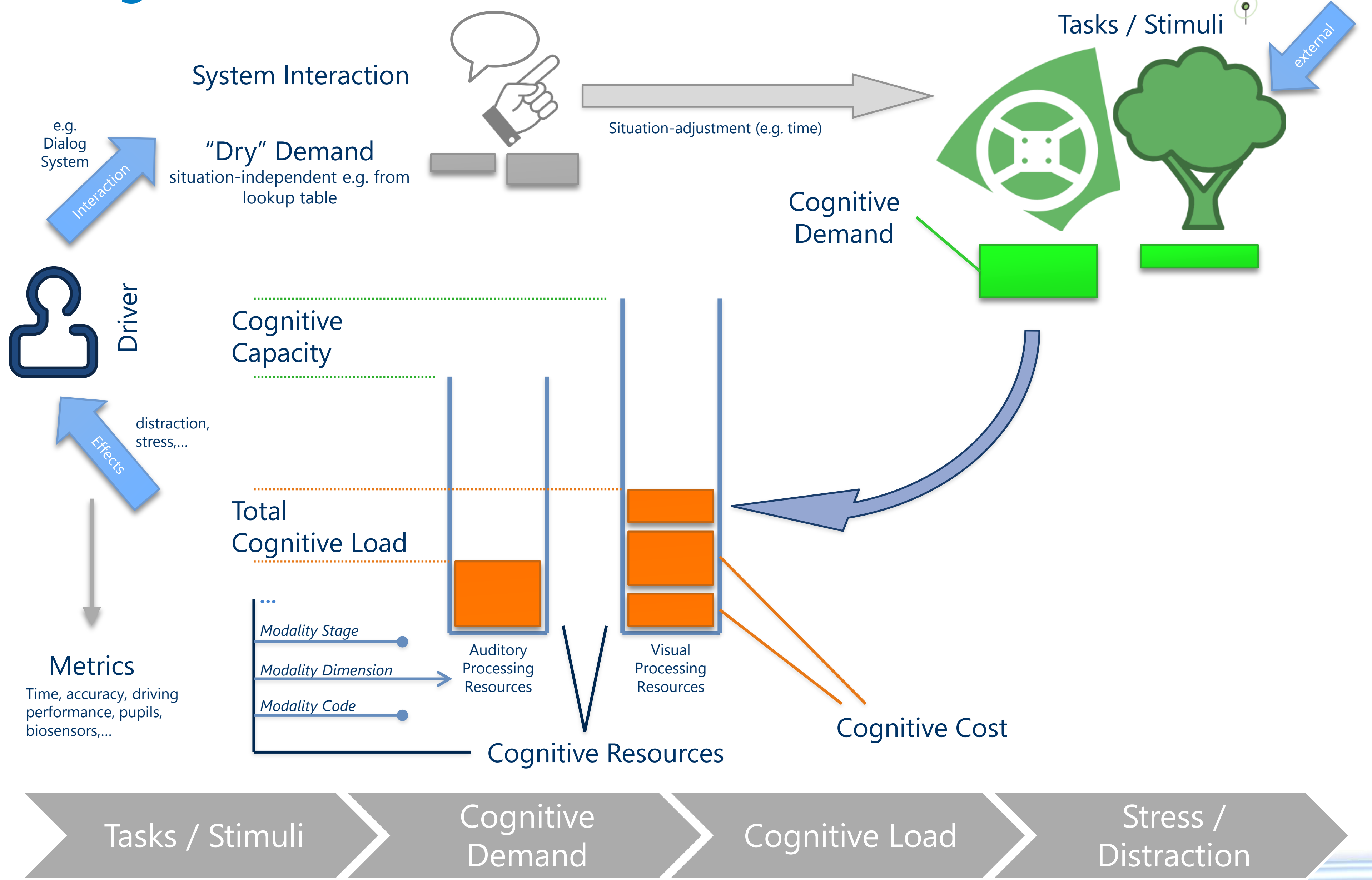


Driver-related Cognitive Load Aspects

Main Questions:

- How to **model** cognitive load?
- How to **quantify** cognitive load?

Cognitive Load Model



Cognitive User Model

- User
  - ProcessingResource (1..n)
    - Dimension
    - CognitiveCapacity
    - CognitiveCost (1..n)
      - Amount
- Dimensions: Wickens (2002)
  - Processing Stage: Perception / Cognition
  - Modality: Visual / Auditive / ...
  - Visual Channel: Focal / Ambient
  - Processing Code: Spatial / Symbolic
- Context
  - Stimuli (1..n) (permanent)
    - GetCurrentCognitiveDemand() : CognitiveDemand
  - Interaction (only temporarily present)

RELATED EFFORTS

Automotive Ontology

On the one hand…

Knowledge in the Modern Car

- Sensors & Controls
  - Inside
  - Outside
- Geographical Knowledge
- Traffic Management
- OEM Uplink
- Car2car
- Roadside Units (car2x)
- Internet Services
- Passenger Profiles
- Driving Habits
  - Roads, times, driving styles…
- Personal Devices
- …

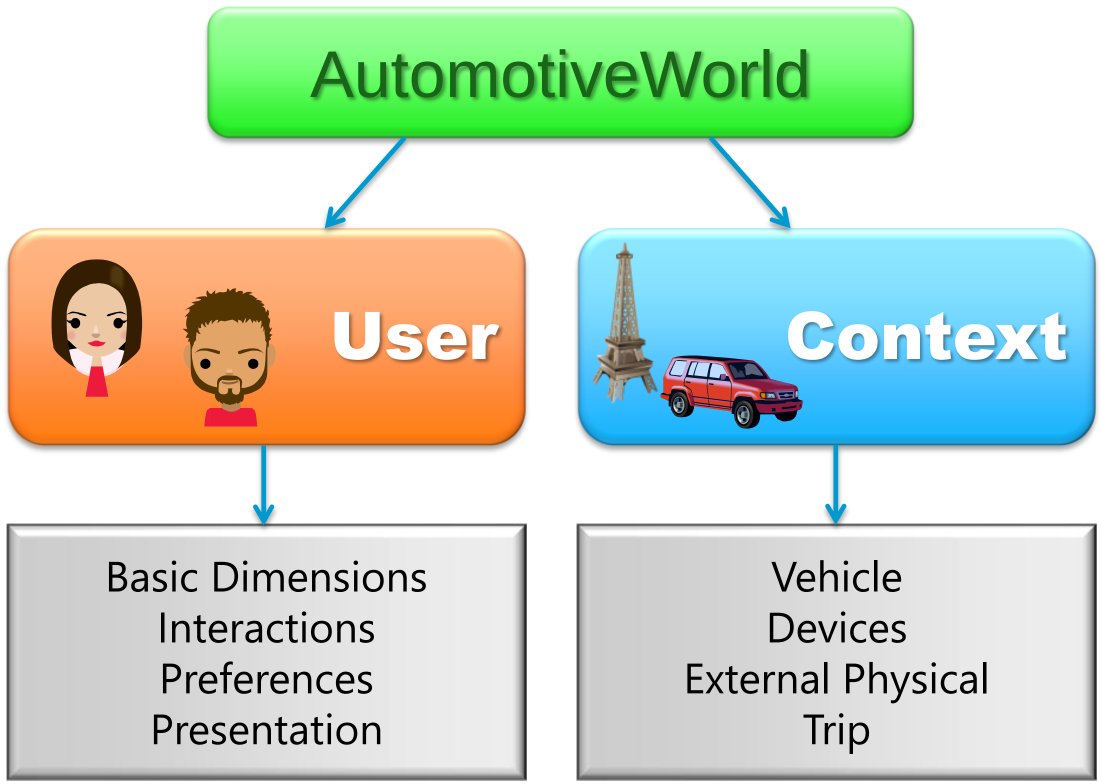
...and on the other hand

Feature-rich In-car Applications

- Driver Assistance
- Navigation
- Parking Assistance
- Comfort Controls
- eMail, SMS
- Twitter, Instant Messaging
- PIM
- News
- Information Search
- Entertainment, Music
- Navitainment
- Local Information
- ...

High-Level Structure

View from the users's perspective



User Model

User — BasicDimensions

GUMO – General User Modeling Ontology

MentalState
- timePressure
- **cognitiveLoad**
- irritation
- trauma

Personality
- extraversion
- agreeableness
- conscientiousness
- neuroticism
- openness

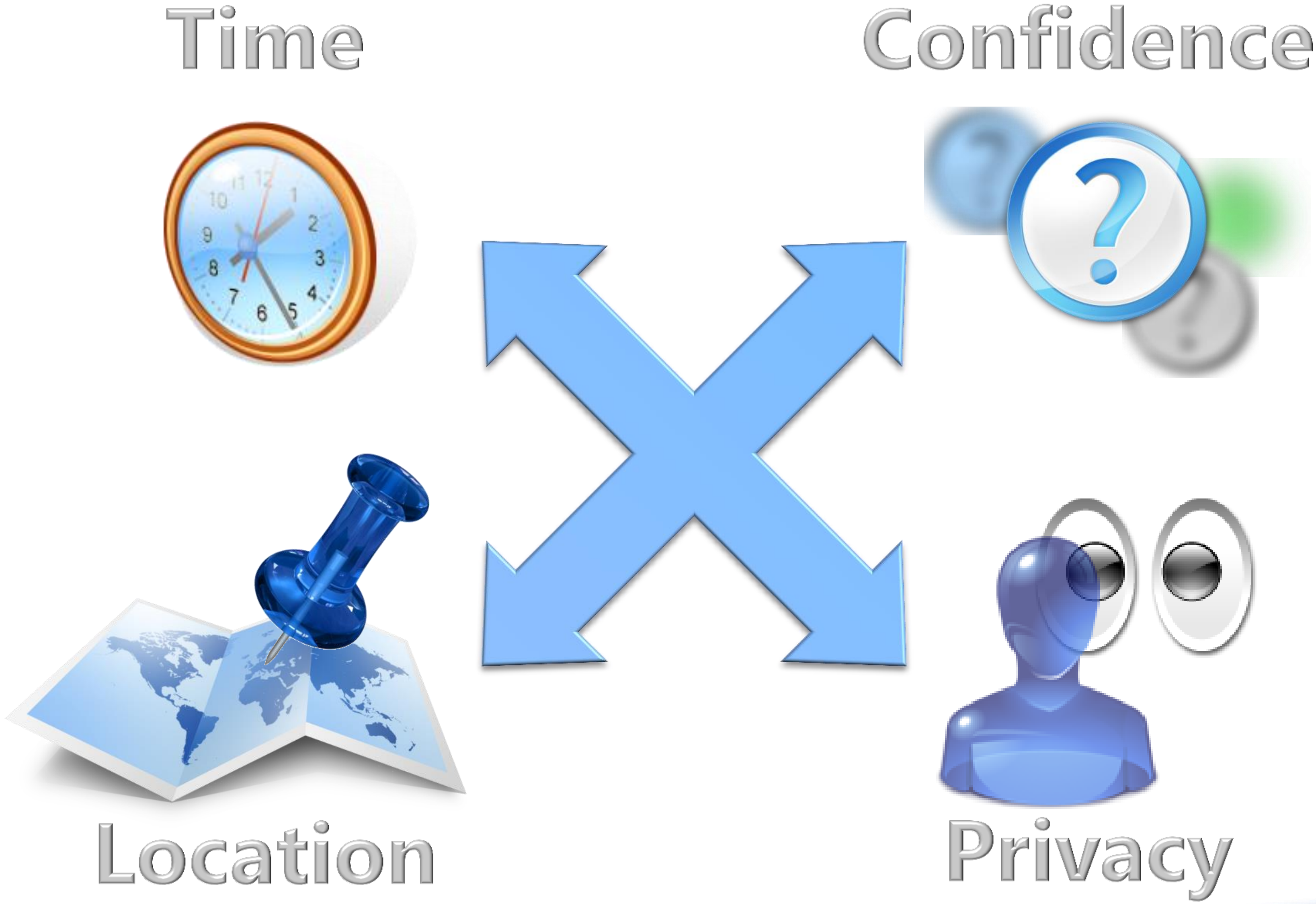
Abilities
- canSee
- canHear
- canSwim
- sight
- hearing

Characteristics
- talkative
- assertive
- dominant
- quiet
- thorough
- helpful

PhysiologicalState
- heartbeat
- bloodPressure
- arousal
- fatigue
- alcoholLevel

EmotionalState
- happiness
- anxiety
- anger
- disgust
- sadness

Meta Information

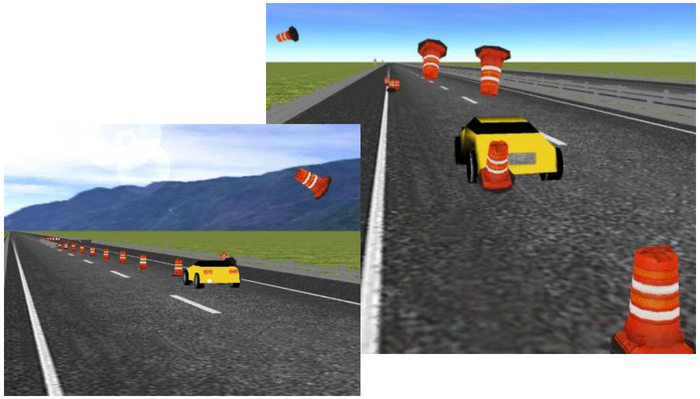


Driving Simulation

- We created a new 3D Driving Simulator in order to measure the driver's distraction in a controlled lab environment
- The simulator is connected via sockets with the HMI that displays important information about the upcoming road segment
- The screens show examples from sim^{TD}

– Road Works Information: a progress bar is shown and the distance counts down until the construction site is reached

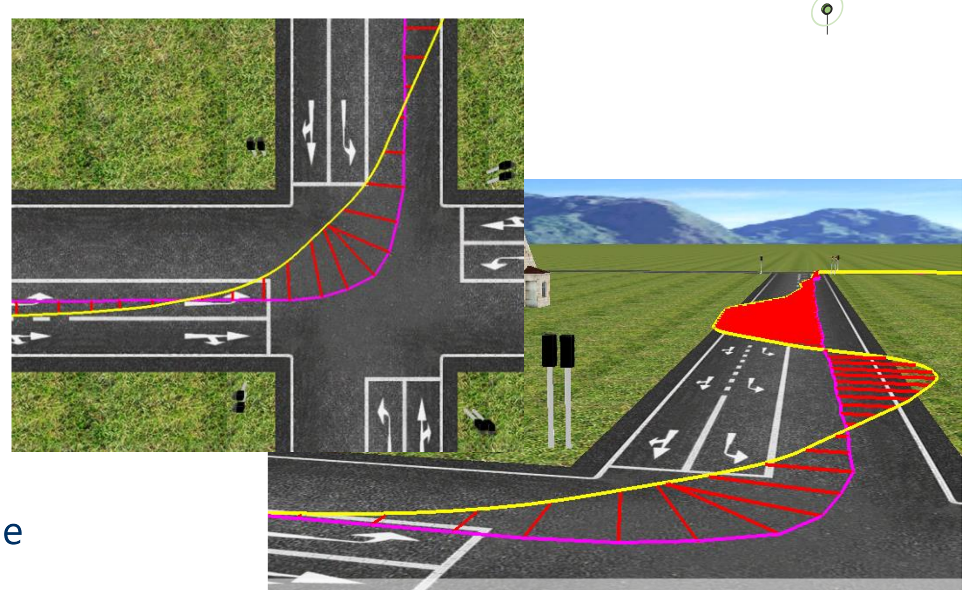
When the construction site is reached, the current position is shown and the time to reach the end elapses



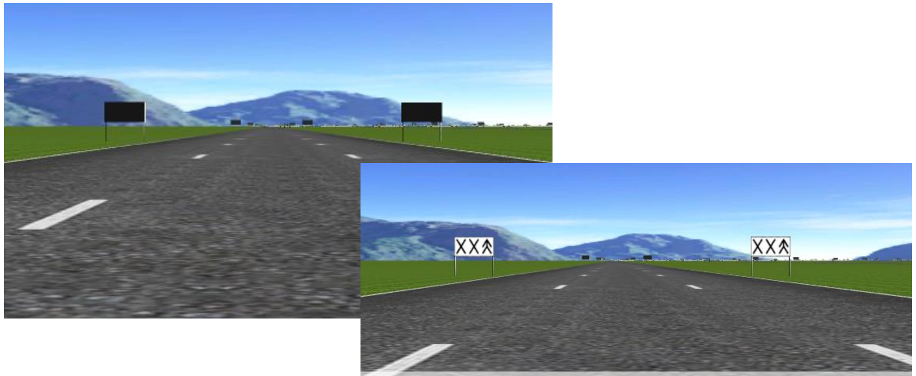
dynamic objects supported!

Driving Performance Measures

- The Simulator can record the driven path as a list of way points
- In the Drive Analyzer this path can be compared to a predefined “ideal line” by computing the average deviation.
- The smaller the area between both lines, the higher the driving quality (c.f. evaluation of Lane Change Test)
- The new 3D Driving Simulator with the shown features is now able to simulate the Lane Change Test from the beginning
- Arbitrary map models can be loaded (as long as they can be processed with Blender)
- The physics simulation is based on a realistic car
- Triggers to hide/show lane signs can be placed
- Evaluation after drive with common “deviation computation” approach
- This approach can be modified and extended to our future needs



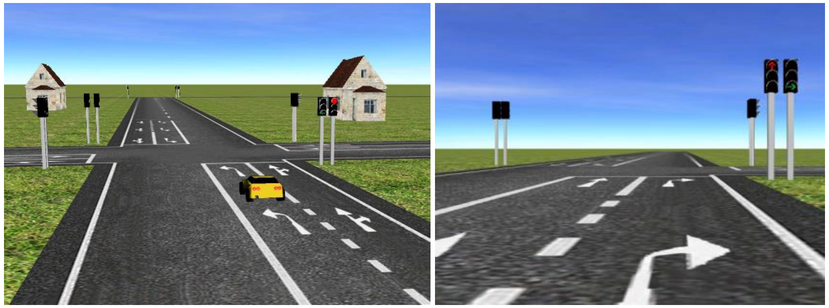
Drive Analyzer in top view and chase camera view. The pink line denotes the ideal path and the yellow line the driven path.



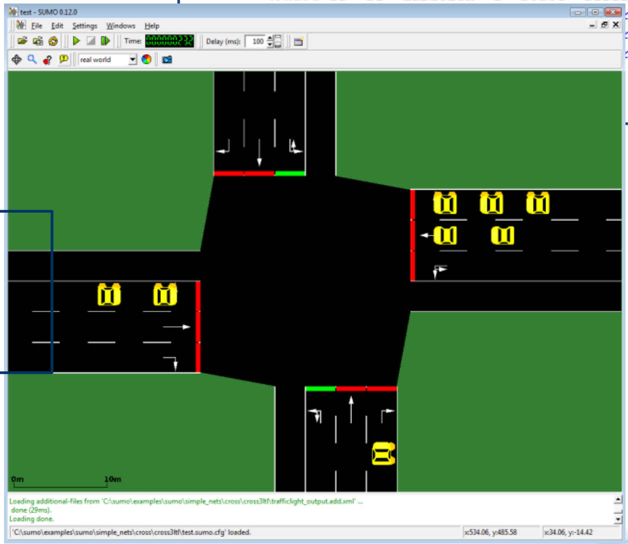
↑ distance more than 40 meters: hidden signs
↓ distance less than 40 meters: visible signs

Traffic Light Control

- Fully controllable traffic lights
- Traffic light programs
  - Triggered traffic light control: only if a car approaches to an intersection the corresponding traffic light will be requested to turn green
  - Internal traffic light control: a given list of traffic light phases will be processed
  - External traffic light control: the simulator waits for external traffic light status inputs (either manually or by a 2D traffic simulator like SUMO)



```
<TrafficLightPhases>
    <Intersection ID="00">
        <Phase ID="01" duration="9" state="ggggrrrrggggrrrr"/>
        <Phase ID="02" duration="1" state="yyggrrrryyggrrrr"/>
        <Phase ID="03" duration="3" state="rrggrrrrrrggrrrr"/>
        <Phase ID="04" duration="1" state="rryyrrrrrryyrrrr"/>
        <Phase ID="05" duration="1" state="rrrrxxrrrrrrxxrr"/>
        <Phase ID="06" duration="3" state="rrrrggrrrrrrggrr"/>
        <Phase ID="07" duration="1" state="rrrrggxxrrrrggxx"/>
        <Phase ID="08" duration="9" state="rrrrggggrrrrgggg"/>
        <Phase ID="09" duration="1" state="rrrryyggrrrryygg"/>
        <Phase ID="10" duration="3" state="rrrrrrggrrrrrrgg"/>
        <Phase ID="11" duration="1" state="rrrrrryyrrrrrryy"/>
        rrrrxxrrrrrr"/>
        rrrrggrrrrrr"/>
        rrrrggxxrrrr"/>
```



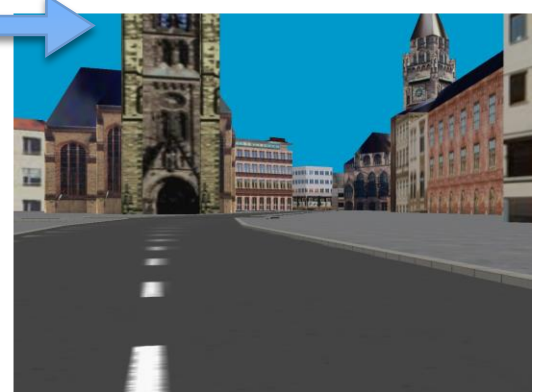
instruction sent by SUMO

```
<TrafficLightControl>
    <tlsstate timeR="178.00" id="0" programID="0"
phase="6" state="grrrgrrr"/>
<TrafficLightControl>
```

External Visualization

- For the new 3D Driving Simulator a special model of Saarbrücken was created as a part of the “Stadtmitte am Fluss” model (by DFKI’s agents and simulated reality group)
- Original map data has been provided by the land registry (Landesamt für Kataster-, Vermessungs- und Kartenwesen)
- Extended by street data extracted from the Open Street Map project
- Simulator computes geo-position to show in Google Maps

traffic light states,
camera position
and orientation



More Information on OpenDS

www.gethomesafe-fp7.eu

THANK YOU!