Media and Content Management in an Intelligent Driver Support System

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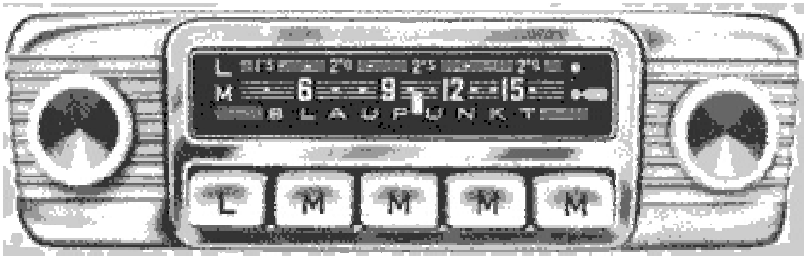
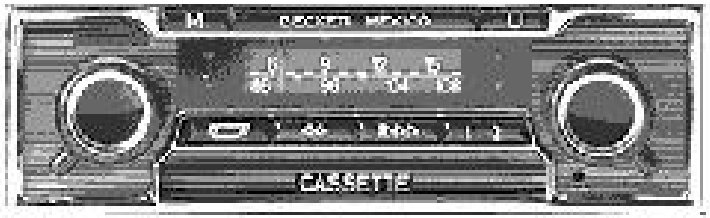
- **Motivation and Scenario**
- **Architecture(s)**
- **Monitoring Tasks**
- **Challenges & Discussion**

From car radios like

1952 “Brezelkäfer”

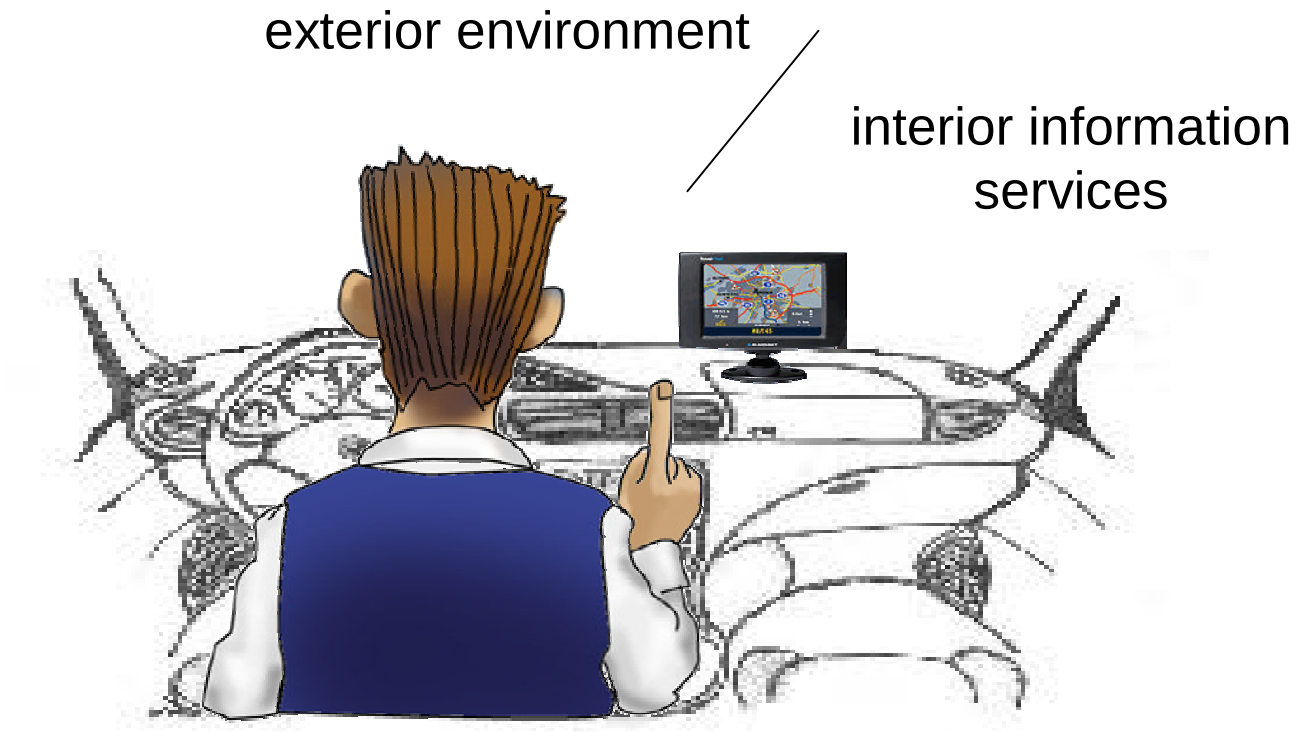


1965 “Model Hamburg”



1970 “Model Mexico Cassette”

… to future intelligent infotainment systems

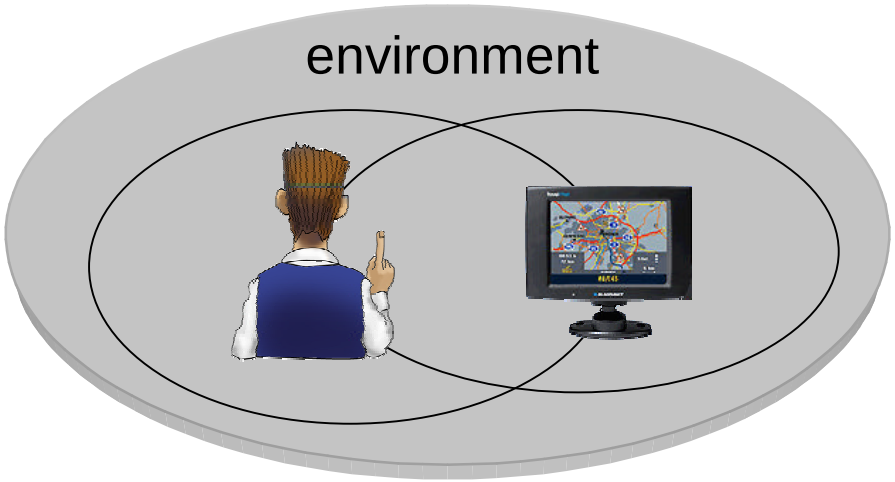


- help the driver to perform driving task safely and efficiently;
- allow the driver to take advantage of online and offline information and entertainment services while driving;

Information sources for the driver

- information sources that can't be influenced directly by the system e.g., the exterior environment perceivable by the driver

- information sources that are under the direct control of an automotive computer system



Some controllable sources

Radio broadcast

- Music/News programs e.g., via DAB (Digital Audio Broadcasting)
- Traffic News, e.g., via TMC (Traffic Message Channel)
- …

Phone & Internet access

- phone / SMS / email / …
- personalized music/news channels
- Traffic News Servers
- ….

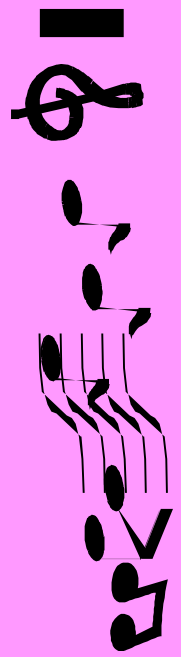
On-board information sources:

- Music repositories (DVD, CD-ROMs)
- Navigation via GPS (Global Positioning System) + angular positioning using a gyroscope + maps on CD ROM
- reports / warnings concerning:
  - car status
  - driving situation

Subtask: coordination of 3 active sources

time

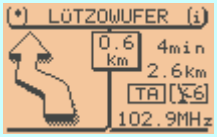
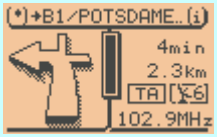
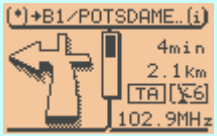
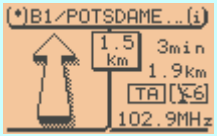
Entertainment

e.g., Music


Traffic News

Text	Speech
Unfall auf der B1, Kreuzung Moltkestrasse. Es kommt zu Behinderungen mit Staugefahr.	*Achtung!* *Staugefahr nach Unfall auf der B1*

Navigation

Graphics	Speech
	*Dem Strassenverlauf folgen*
	*Nach 300 Metern links abbiegen.*
	*Jetzt links abbiegen.*
	*Dem Straßenverlauf weiter folgen.*
....	....

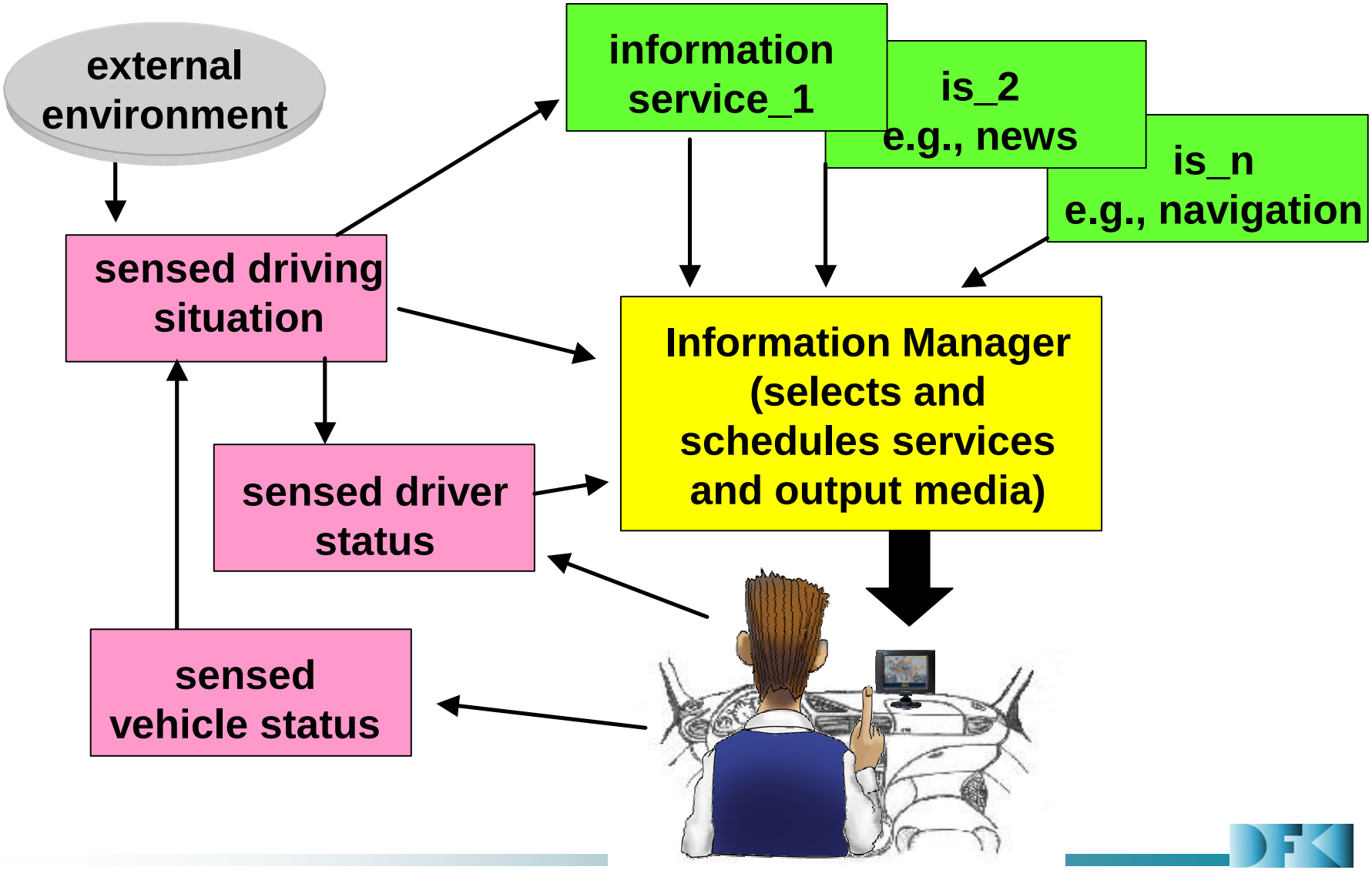
What goals to achieve

- **information presentation goals**
  > traffic news, navigation instructions, etc.
  > warnings and status reports about car and driving situation, etc.
  > personal information requests

- **entertainment goals**
  > meet driver's taste and preferences,
  > keep driver in a positive mood
  > …

- **super-ordinate goals**
  > help the driver to perform driving task safely and efficiently

How to coordinate ? "An engineer's approach"



What can be sensed ?

- **vehicle status**
  > cockpit temperature, humidity, noise, lighting, etc.
  > status of engine, tires, brakes, etc.

- **status of driving situation**
  > speed and rev, centrifugal forces, crosswind, road conditions, sight, etc.
  > distance to other vehicles, traffic density, etc.
  > actions done by the driver, steering, breaking, etc.

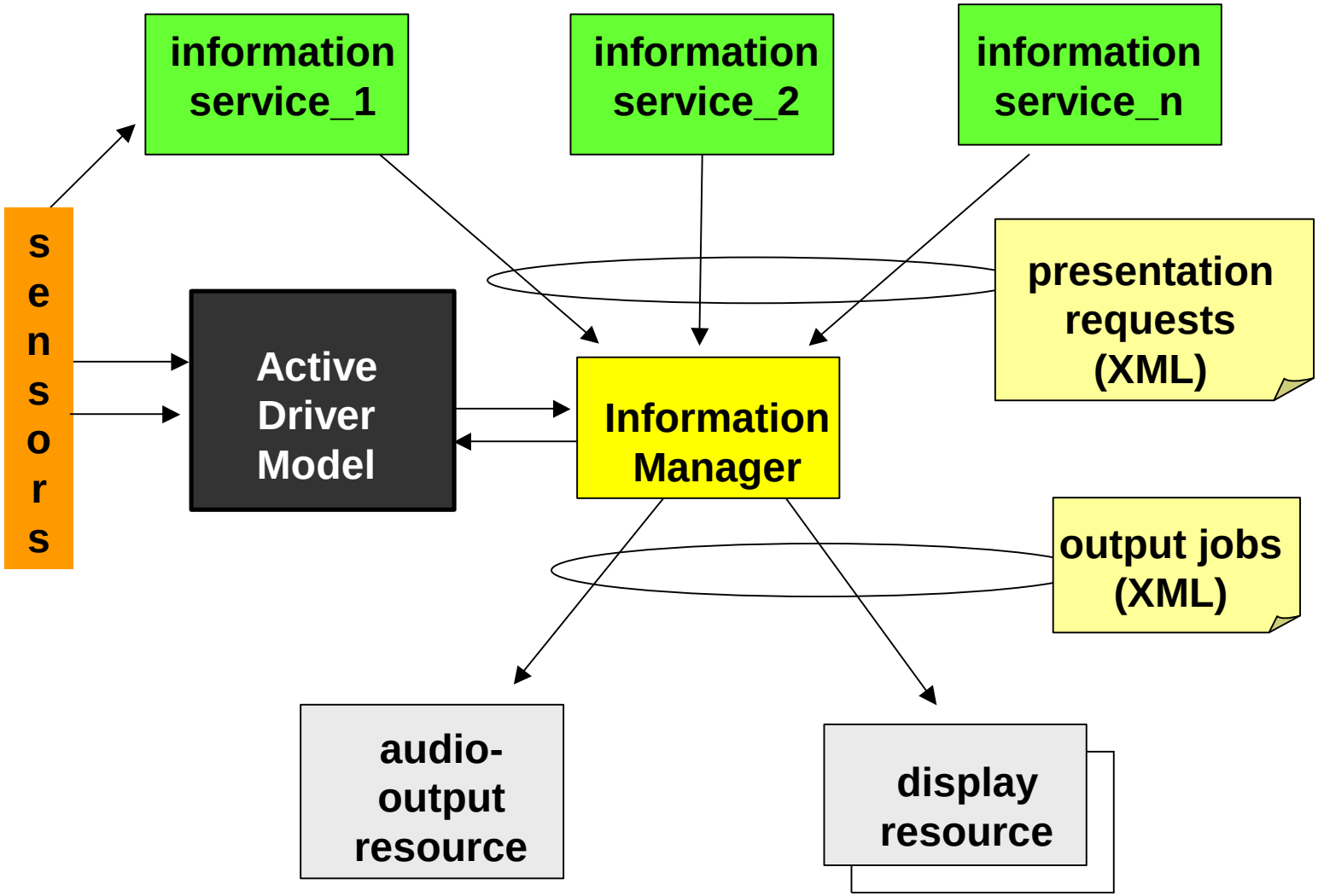
- **driver status**
  > engagement in physical activities: steering, pressing pedals etc.
  > pressure on steering wheel, finger temperature,
  > gaze, heartbeat, ….

How to express relationships between sensor data and content selection ?

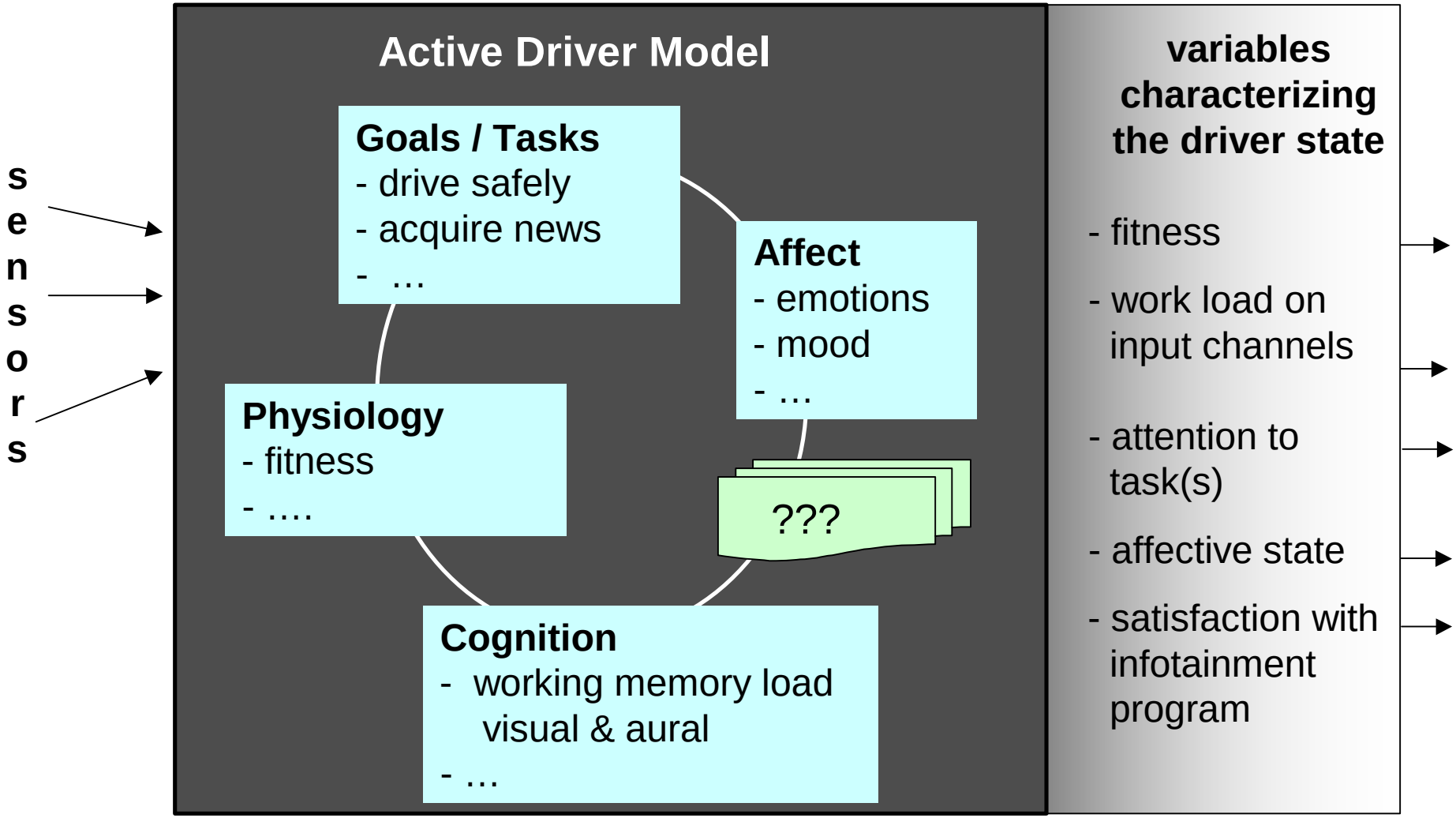
- **avoid rules of the kind**

```
IF  AND
    weather.condition == fog;
    engine.status.rev == high;
    driver.preferred-composers == {Beethoven, Mozart}
THEN
    select ?title with title.composer ==  Mozart
```

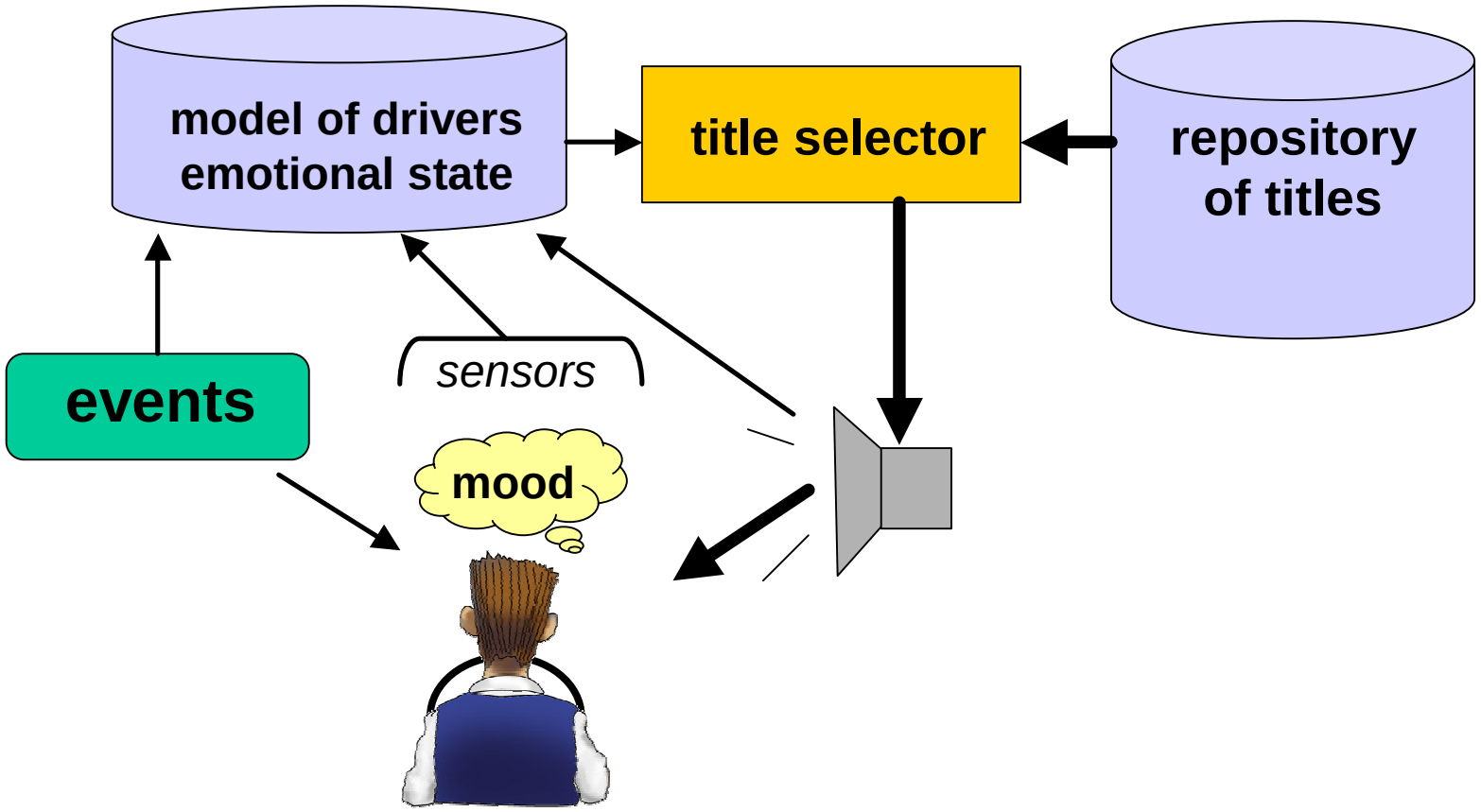
Revised architecture: Incorporate a Driver Model



Granularity of the Driver Model: Which aspects to consider ?



Sample Scenario1: Monitoring the driver's mood



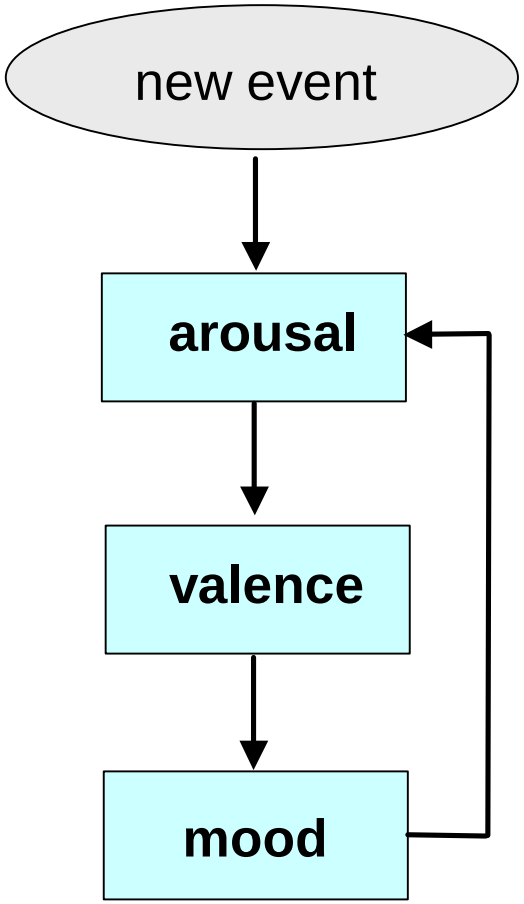
<u>Assumption:</u> playing a certain piece of music elicits emotional responses and this impact can be anticipated to a certain extend

Pointers to related work

- **Research:**
  - Emotion Research Group at Univ. Geneva
    Scherer & Zentner: *Induction of emotional states through music.*
  - C. Krumhansl (1997) *An exploratory study of Musical Emotions and Psychophysiology,* Canadian Jour. of Experimental Psychology.
  - Bruner, G. (1990). *Music, mood, and marketing.*
    Journal of Marketing, 54
  - Adrian et al. (1997) In-store music affects product choice. Nature
  - ...

- **Applications:**
  - techmat AG, search interface for film music titles
  - Youmeus.com, search interface for books

Arousal, valence, and mood

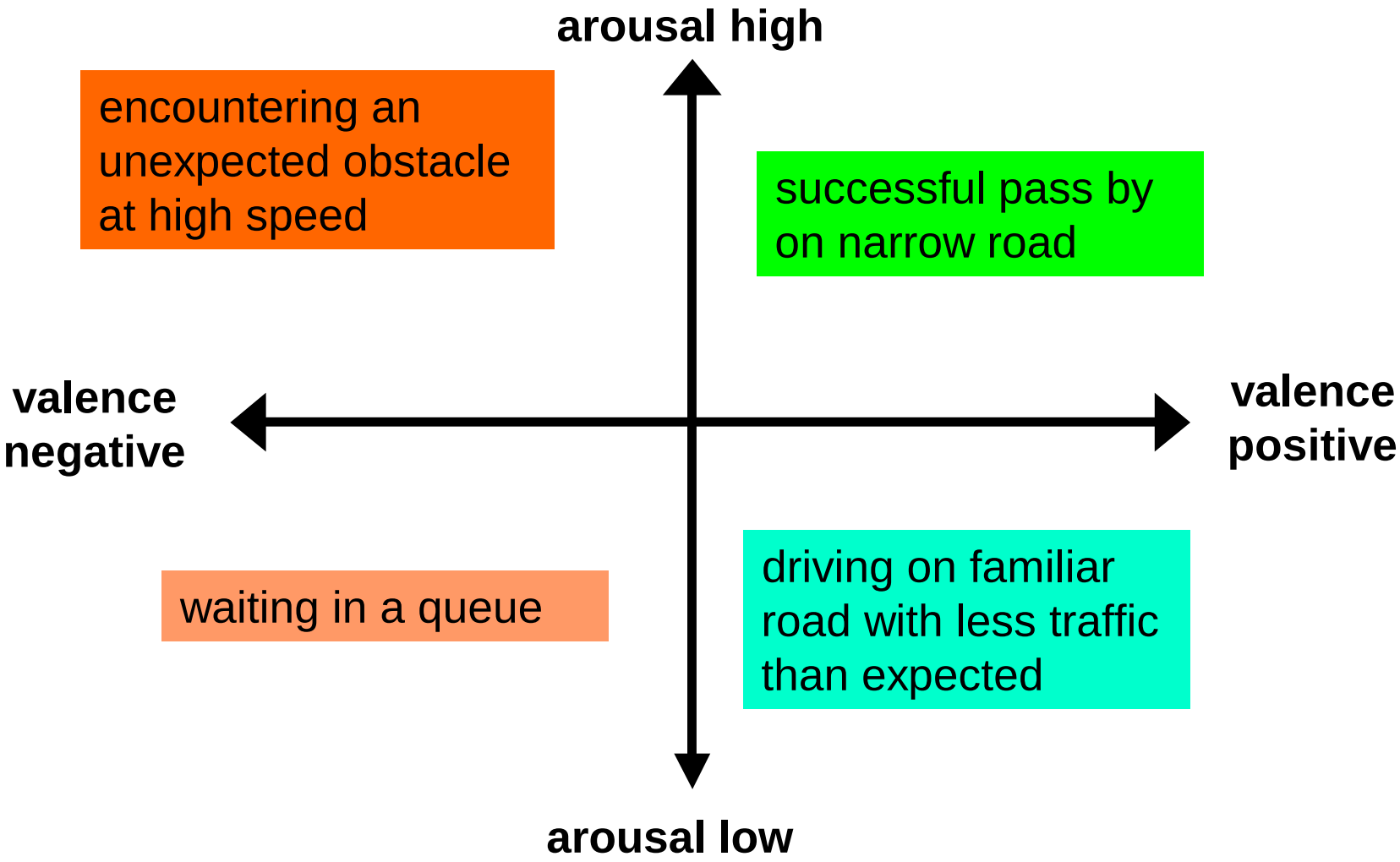


an event generates a certain amount of arousal and will be evaluated relative to one's current sensation - either positive or negative.

In case the resulting state lasts for a longer time, the affective state may stabilise in a certain mood

cf. Scherer, University of Geneva

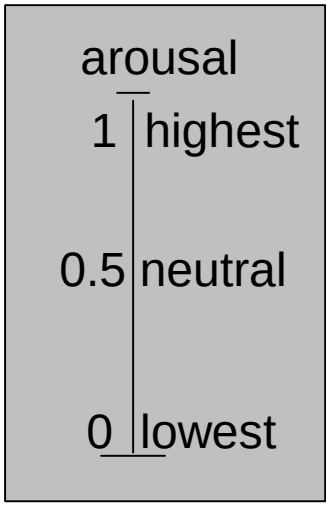
Characterization of events & situations



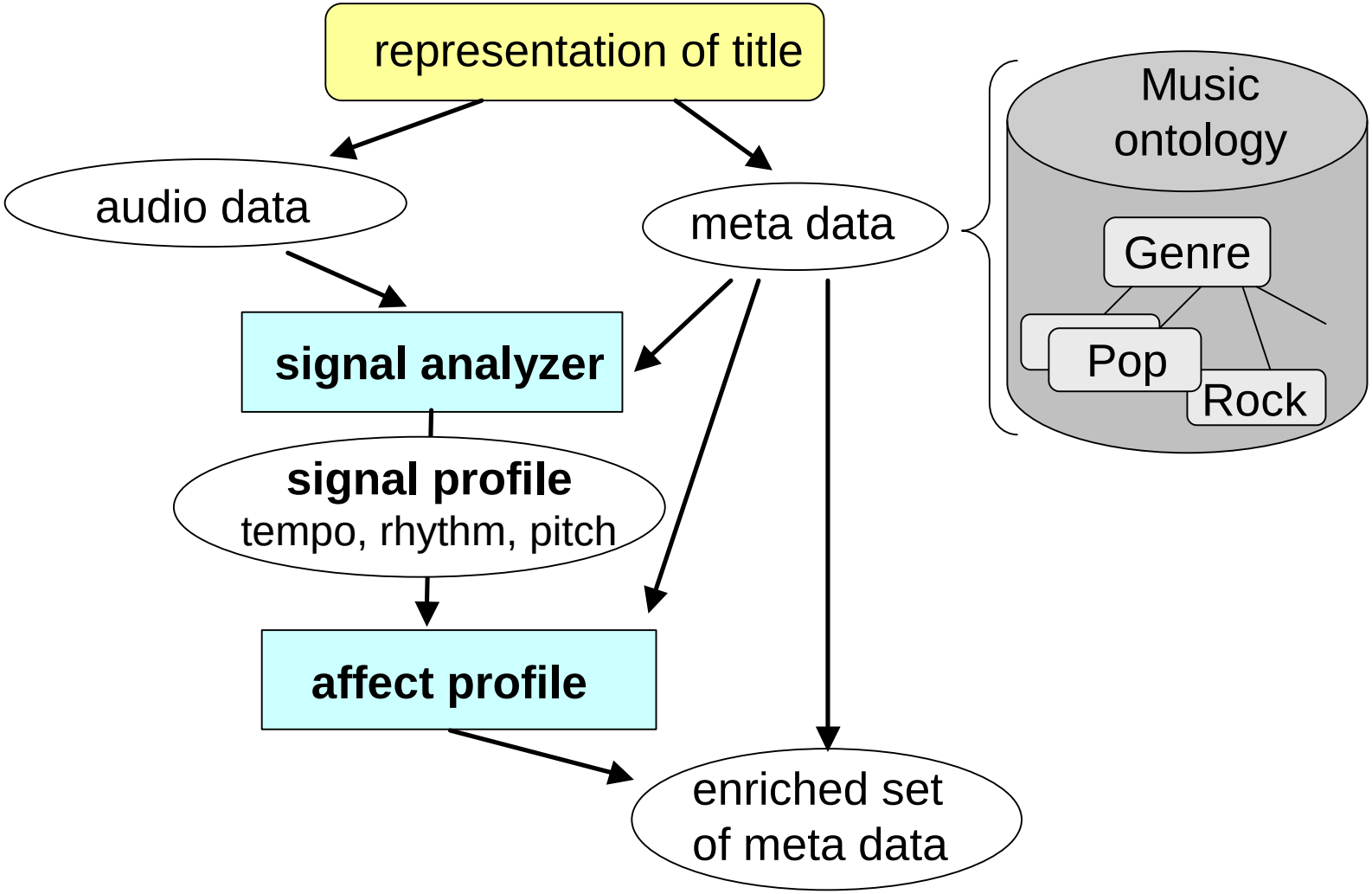
cf. Picard: Affective Computing, MIT Press, 1997

Representing anticipated affect by special annotations – E.g. in XML

```
<playlist xmlns:xsi="http://www.w3.org/2000/10/XMLSchema-instance"
                        type="audio">
<title>HMI-RM Music Compilation 03</title>
<abstract>Selection of MP3 titles</abstract>
  <author>System</author>
          <entry>
                    <author>Third Eye Blind</author>
                    <title>Semi-charmed Life</title>
                    <param name="Genre" value="Punk" />
                    <param name=„arousal" value=„0.7" />
                    <duration value="4:26" />
                    <ref href="Third_Eye_Blind_03_Semicharmed_Life.mp3"/>
          </entry>
          <entry>
                    <author>Cake</author>
                    <title>I Will Survive</title>
                    <param name="Genre" value="Pop" />
                    <param name=„arousal" value=„0.4" />
                    <duration value="5:09" />
                    <ref href="Cake_-_Fashion_Nugget_07_I_Will_Survive.mp3"/>
                    </entry>
          ......
```



Towards an automated characterization of titles



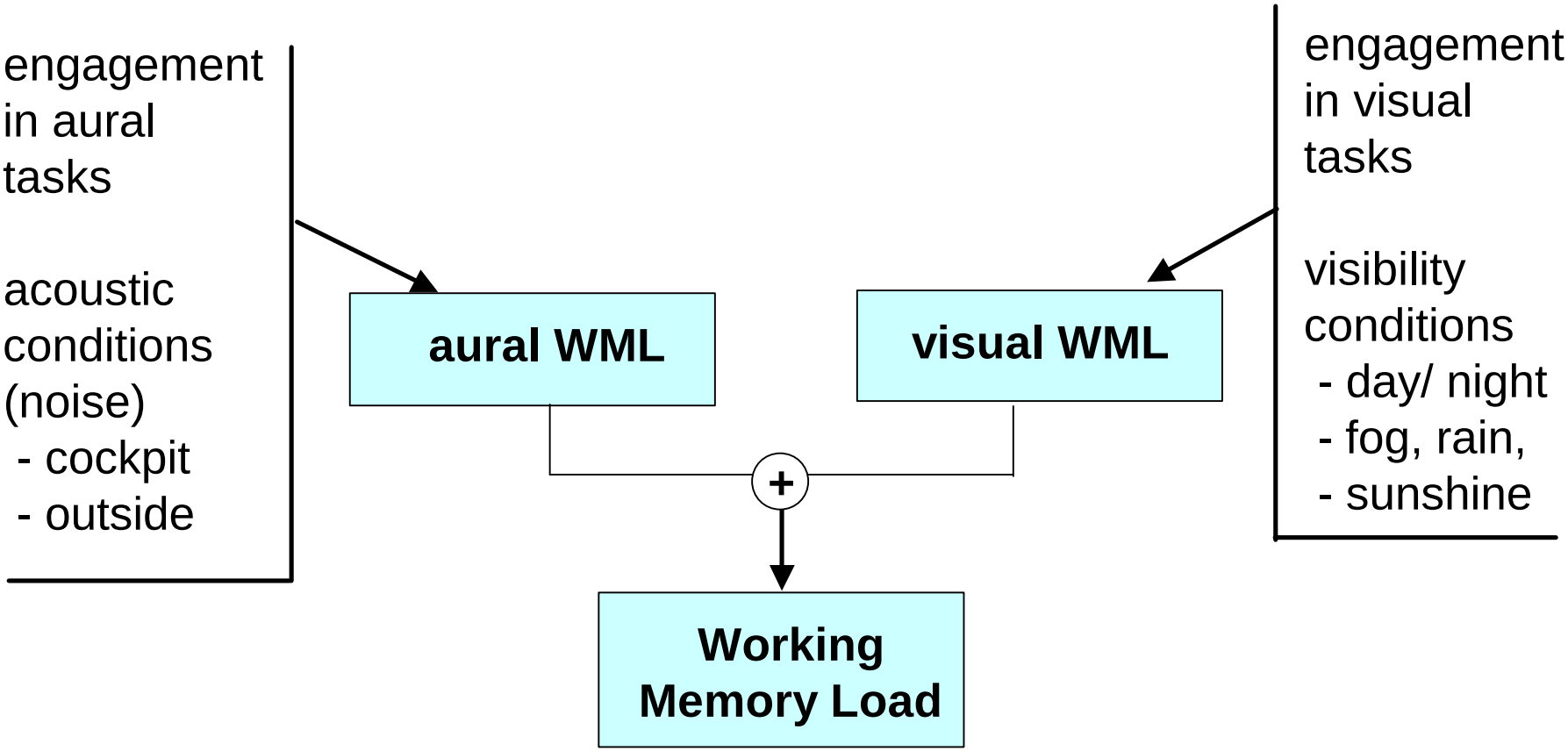
Analysing MPEG-7 audio

- **High-level application tools**
  - musical instrument timbre similarity
  - melody and melodic contour
  - audio matching
  - …

- **Low-level audio description framework**
  -structures: segments and scalable series

- **Descriptors**
  - spectral basis representations
  - timbral spectral: harmonic spectral centroid, deviation, spread, var.
  - timbral temporal: log attack time, temporal centroid
  - signal parameters: fundamental frequency, harmonicity
  - basic spectral: spectral envelope, centroid
  - basic: instantaneous waveform and power

Deducing an Estimate for Working Memory Load



<u>Assumption:</u> different kinds of music pieces require different cognitive resources and an estimate for the required efforts can be derived from the signal profile.

What other factors to consider ?

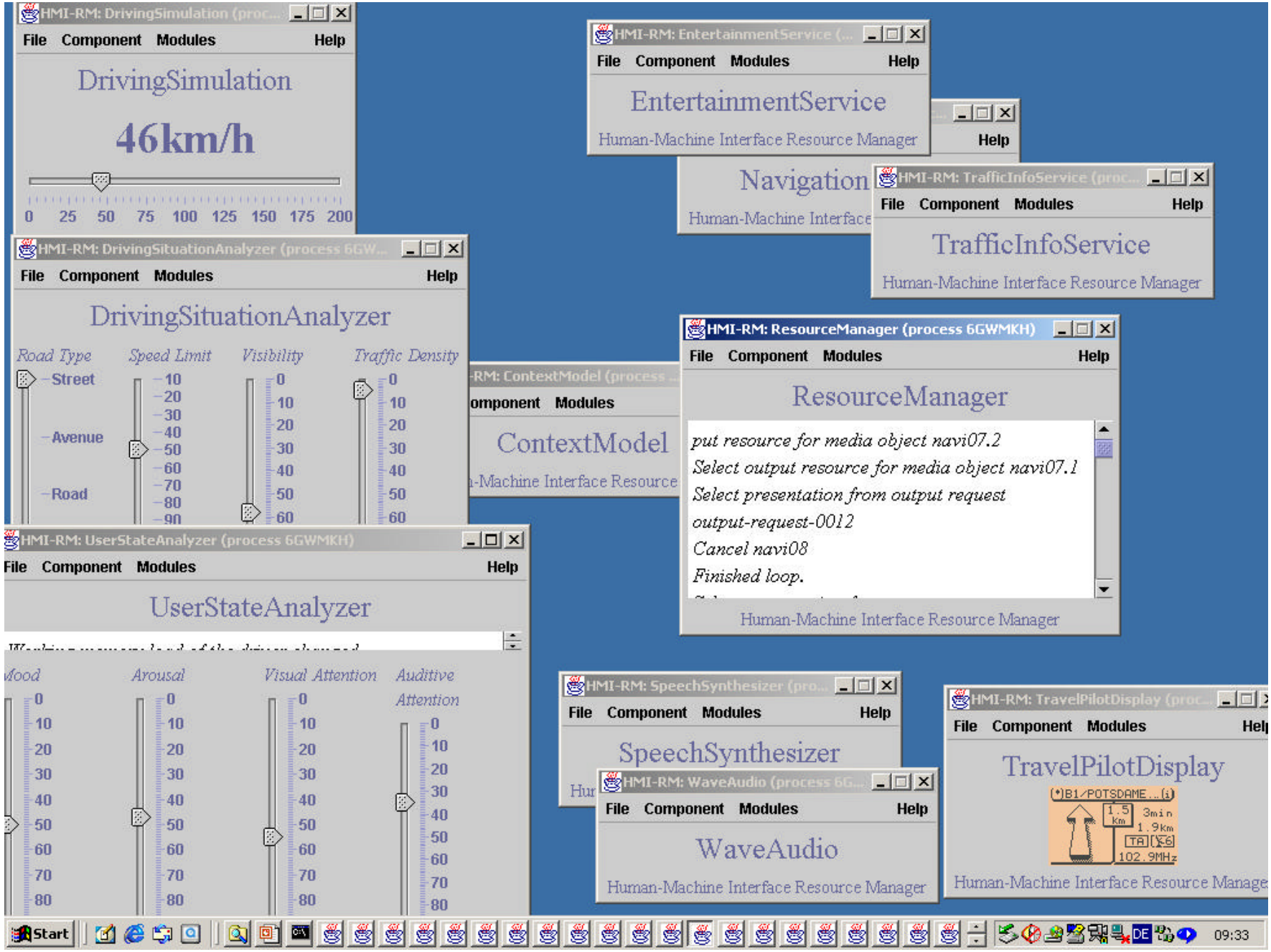
- novelty of a music title
- play context e.g.: [classic1, … classic7], pop
- personal memory associations with a certain title
- …..

Sample rules for content selection

```
;;; select title with potential to reduce arousal
IF  AND
    driver.arousal > 0.8
THEN
   select ?title with title.arousal < 0.5
```

```
;;; select title with potential to reduce arousal
IF AND
   driver.WML == high
THEN
   select ?title with title.WML == low
```

Our Current test environment



Sample scenario for active driver support

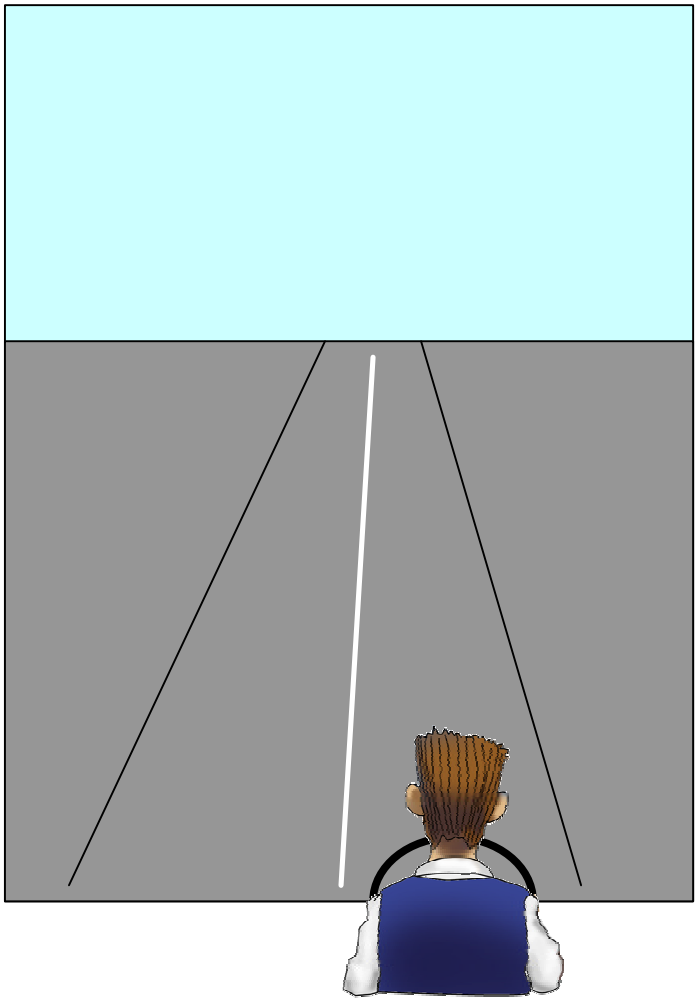
- while driving on a boring autobahn ...

- driving imposes low cognitive load

- two possibilities:

  > competition from other cognitive demands

  > reduction in overall state of arousal



Experimental simulation

- **‘Sustained Attention to Response Task’ (SART)**
  (cf. Robertson et al. 97)

- **Involves withheld key presses to rare (1 in 9) targets**
  - Instruction: “Press button for all stimuli except a square”

successive stimuli over time

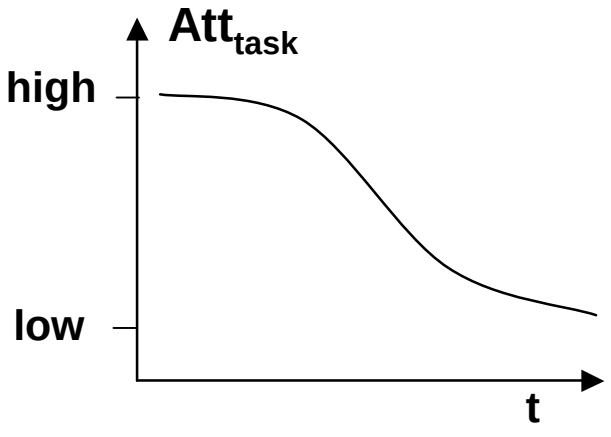
Experimental simulation

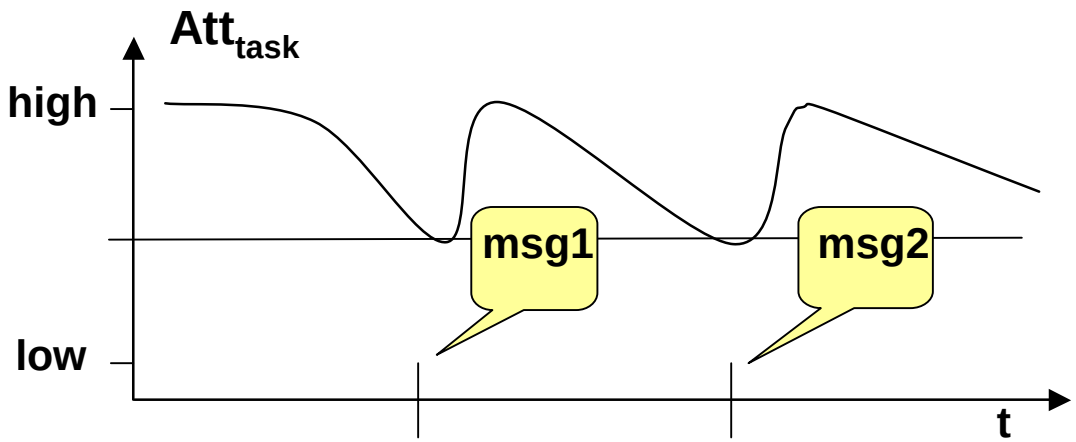
- Irrelevant changes in non-targets increase RT
- Reliance on automatic processing reduced
- Less likelihood of error

Change to small circle reorients attention

Strategy: Reorient driver periodically using (task-) irrelevant attention eliciting stimuli

- monitor driver attention using messages from vehicle information systems - an illustration:





Assessing the driver's attention to driving task based on sensor input

IF AND

FACT "driver not engaged in other (observable) tasks than driving since t"

FACT "almost no change in velocity since t"

FACT "minimal steering input since t"

FACT "almost constant environmental conditions (light, noise) since t"

THEN

Decrease driver.attention-to-driving-task

Related work on driver cognition

- **Tends to be motivated by**

  (a) technology

  - Liu (2001) – unimodal and multimodal displays
  - Haigney & Westerman (2001) – mobile phones
  - Srinivasan (1997) – route guidance

  (b) assessment of driver 'risk taking'

  - Trimpop (1996)
  - Ward & Wilde (1996)

Bruner, G. (1990). Music, mood, and marketing. Journal of Marketing, 54, 94-104.

Conclusions

- **Building an active driver support system is a complex and challenging task:**
  - requires real-time sensing and decision making;
  - need to model a user who is engaged in concurrent tasks and activities some of which require continuous engagement;
  - need for models
  - Model should allow to identify proper resume points after task suspension and to assess suspension costs e.g., in terms of deviation from optimal continuous task execution.

- **Many open issues:**

Challenges

Multi-Modal Input

comprises a conscious activity of the user to express intent:

- articulate a request,
- specify constraints,
- provide feedback,
- …

Multi-Sensor Input

generalization of mm input to infer user state & intent.

May comprise:
- physiological measures;
- measures to capture relevant aspects of the environment

user not necessarily aware of what is sensed.

Implications:

- fusion of multiple modalities AND multiple sensors
- awareness, transparency

Challenges

Information Presentation Tasks

communicative goals like:
- *Inform* "system wants user to know fact X"
- *Warn*
- *Persuade*
- …

Positive Engagement & Entertainment Tasks

monitor (condition) user's cognitive / affective / physiological state (cf. affective / ambient / persuasive computing)

- mood
- attention
- well being
- …

Implications:

- need to explicitly model cognitive / affective / physiological states and processes
- how to evaluate ?

Challenges

support users in performing single tasks one after the other

- sequences and hierarchies of subtasks,
- shared context

support users who engage in concurrent tasks and activities

- some of them require continuous engagement like driving

Implications:

- need to model user engagement in concurrent tasks/activities
- identify proper resume points after task suspension and to assess suspension costs e.g., in terms of deviation from optimal continuous task execution.

Discussion