

**RESPONSIVE FLEXIBLE
COLLABORATING AMBIENT**



Pervasive Adaptive Software Challenges

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PerAda
towards pervasive adaptation

REFLECT Goals

Maxim: "The best assistant is the one you do not notice"

- Develop **human-centered pervasive-adaptive applications** by observing
 - *emotional state*
 - *cognitive engagement*
 - *physical conditions/actions*of the involved persons
- Examples
 - **Reflective Music Player** for reinforcing positive feelings
 - **Reflective Vehicle** providing a friendly co-driver for more secure, pleasant and effective driving
 - **Reflective displays** for adaptively tailoring contents to the needs of the actual audience

REFLECT Approach: The Sense-Analyse-React Loop

Reflective Music Player

■ Sensing:

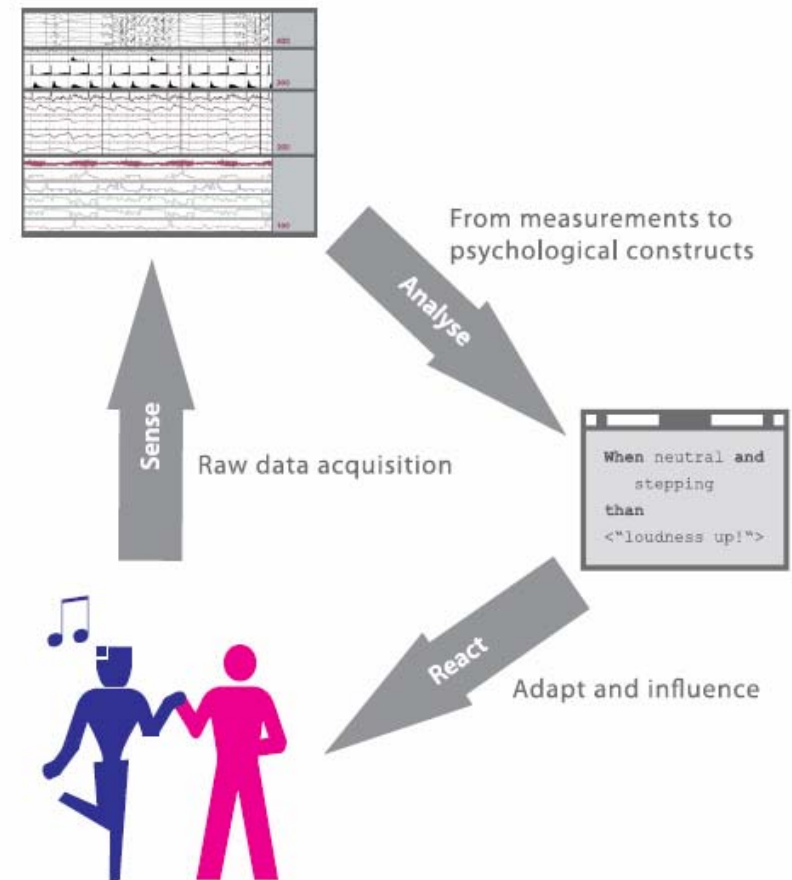
- Person's psycho-physiological characteristics (facial expression, speech and movement detectors)
- Player settings and lighting information

■ Analysing:

- Diagnosing the person's emotional and physical condition (e.g. positive emotion and tapping to the music)

■ Reacting:

- Changing the player settings and ambient light



REFLECT Approach: The Sense-Analyse-React Loop

Reflective Vehicle

■ Sensing:

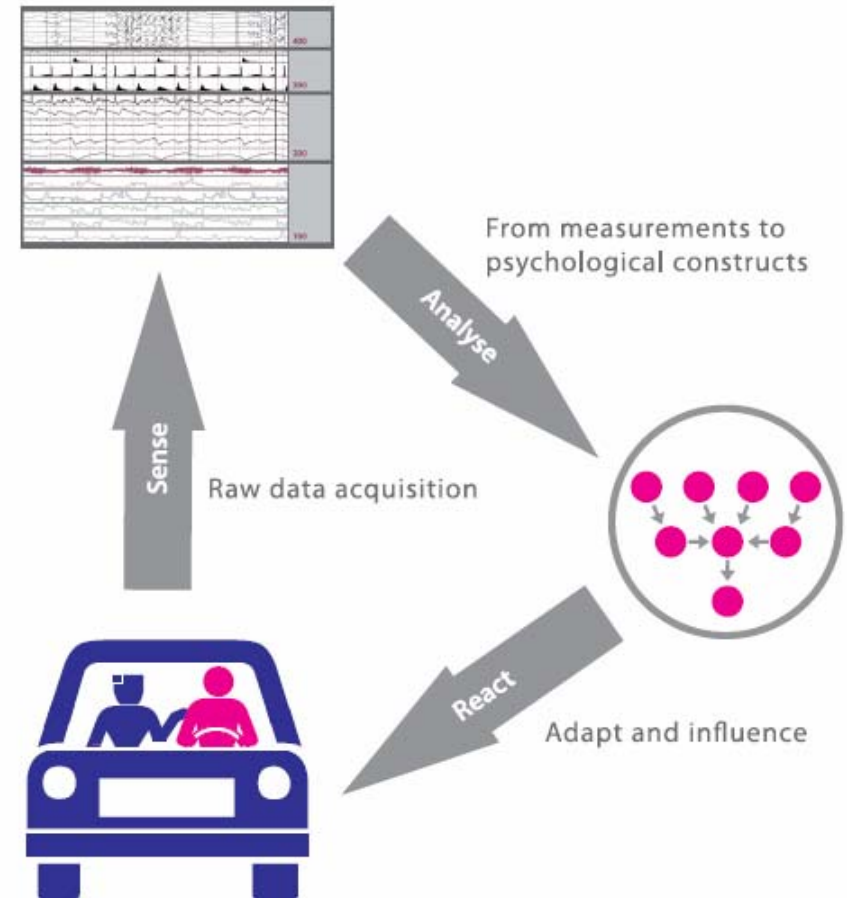
- Driver's psycho-physiological characteristics (skin temperature, heart rate, pupil diameter, etc.)
- Engine parameters (CAN bus parameters)
- Road conditions (external measurements, GPS, etc.)

■ Analysing:

- Diagnosing the driver's emotional cognitive and physical conditions

■ Reacting:

- Changing the engine settings, cabin ambience and seat position



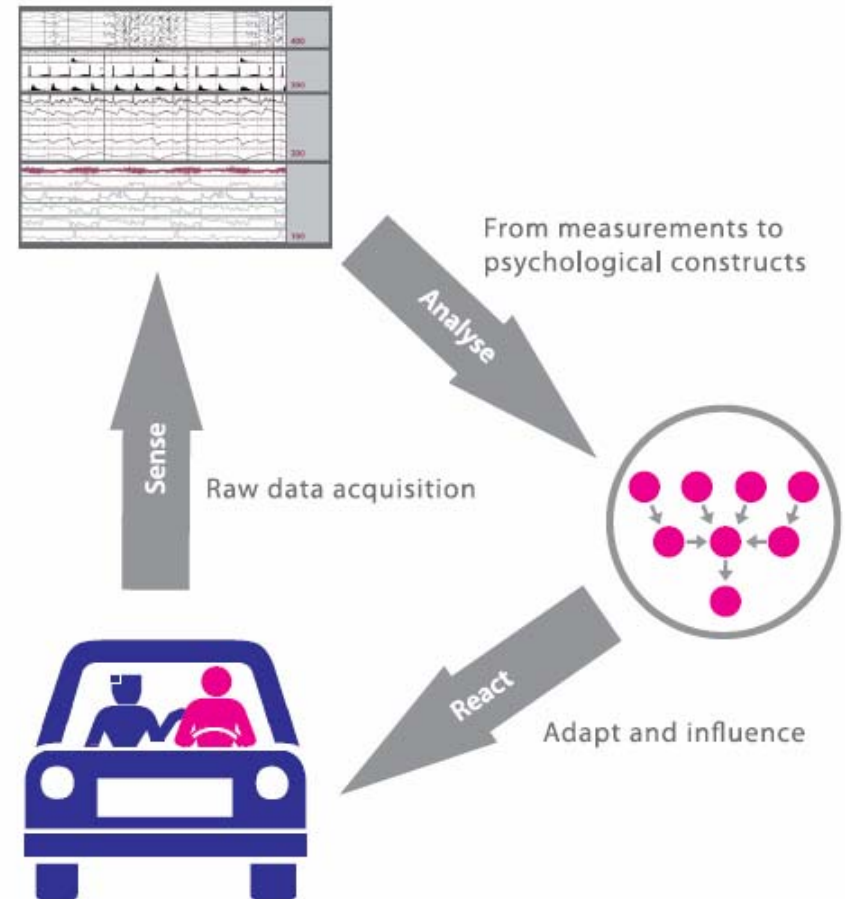
Feedback Loop Control

Context Challenges

- Inter-person variations
- Situational variations
- Missing context knowledge

➤ Sense-Analyze-React needs

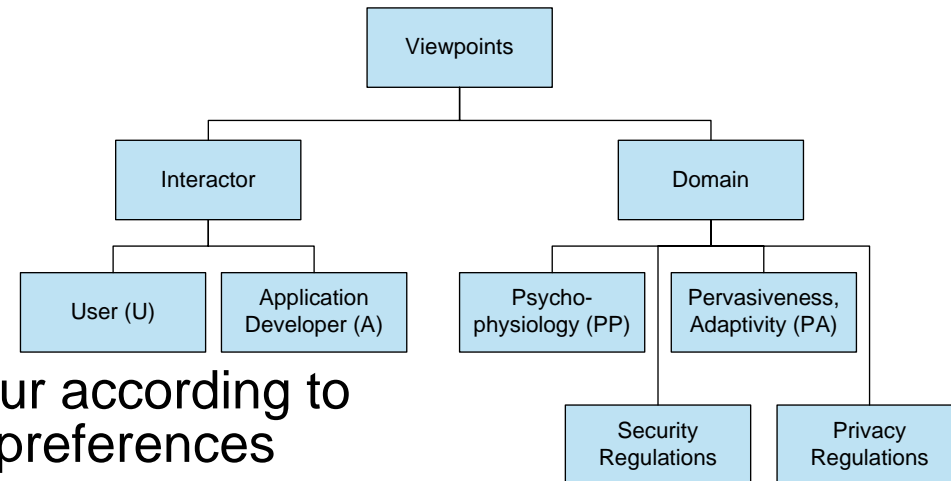
- Supervision
- State abstraction
- On-line validation
- Multiple strategies
- Reflection and adaptivity



Challenges for REFLECTive Systems

- **Viewpoint-Based approach**

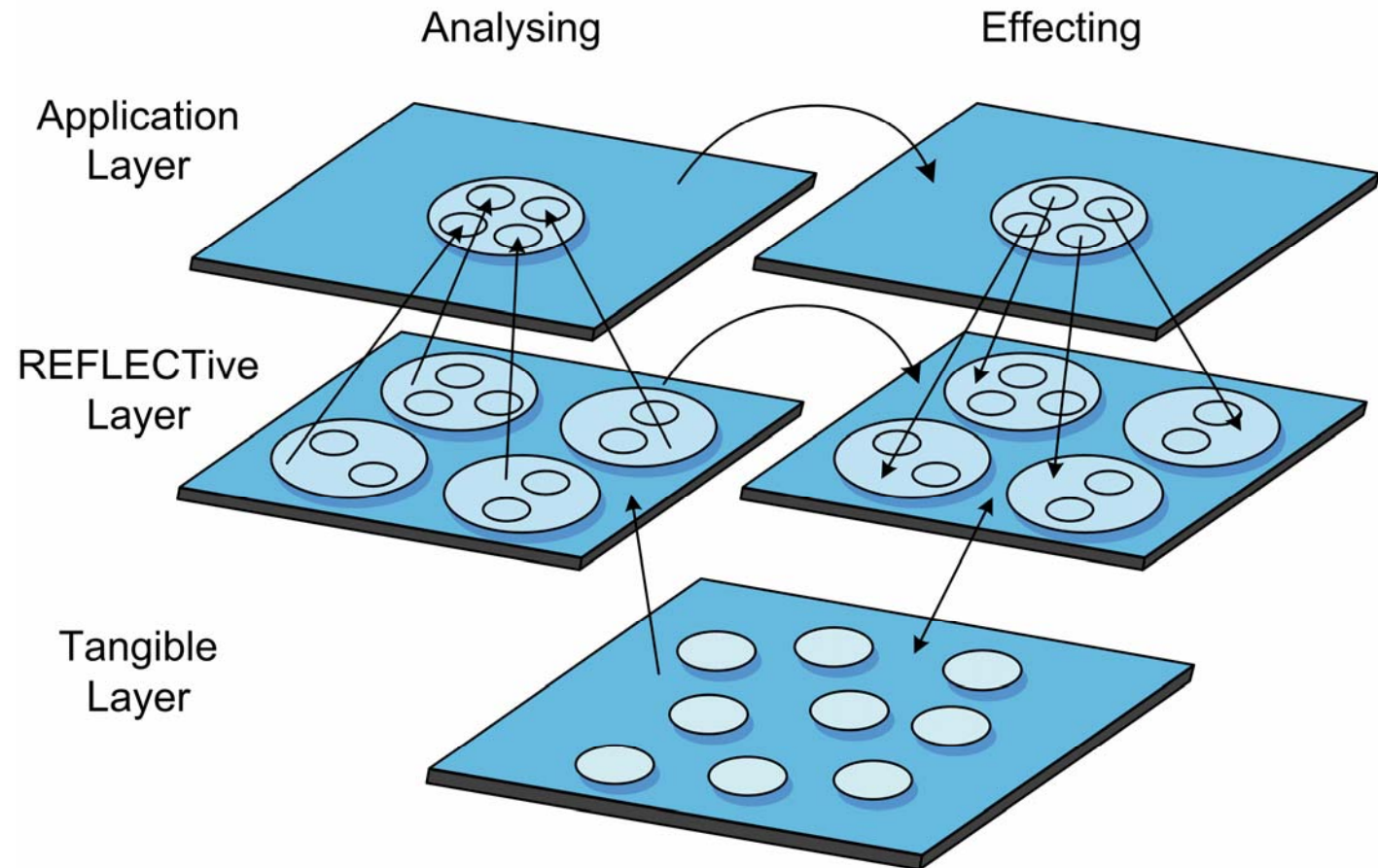
1. The system should adapt its behaviour according to the user's current state, context and preferences
2. The system should be customizable to the user's needs and preferences
3. The system should allow for interactive experimentation and rapid prototyping of applications
4. The system should respect security and privacy regulations and satisfy dependability requirements
5. The system should be easy to extend and maintain



REFLECTive System Architecture

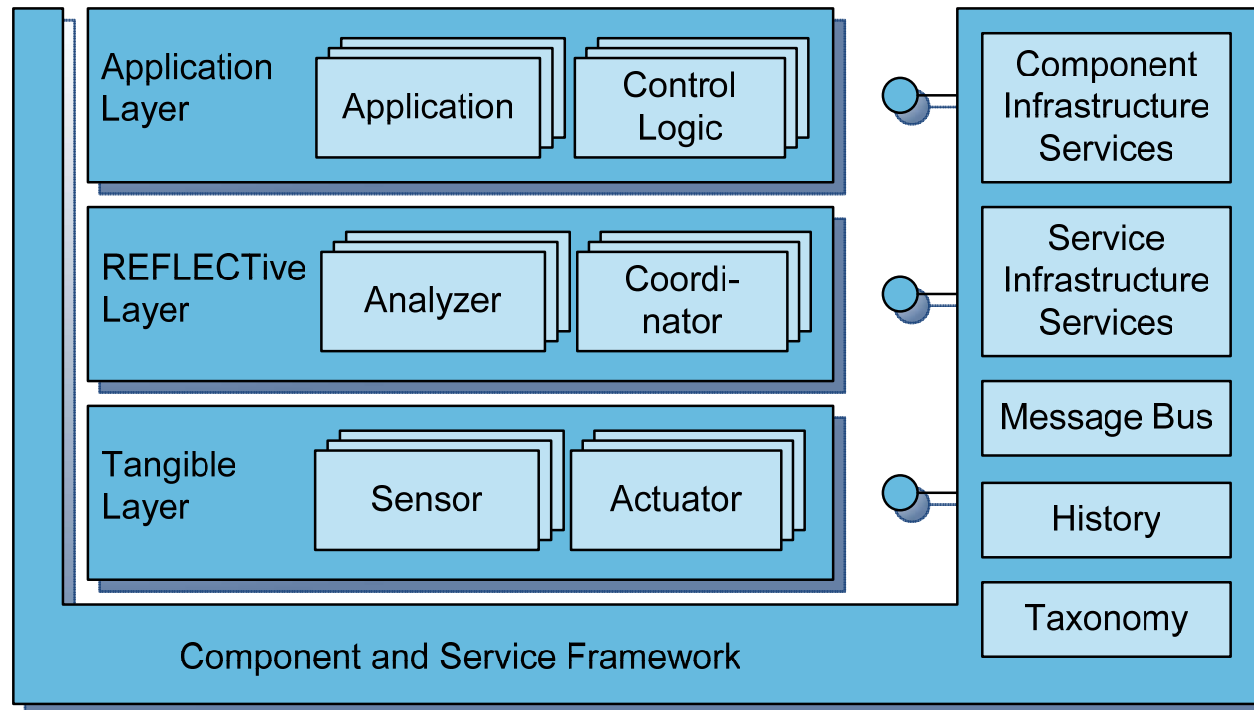
Layered Architecture

- Decision making: application and control
- Abstraction: analysis and coordination
- Linking to physical devices



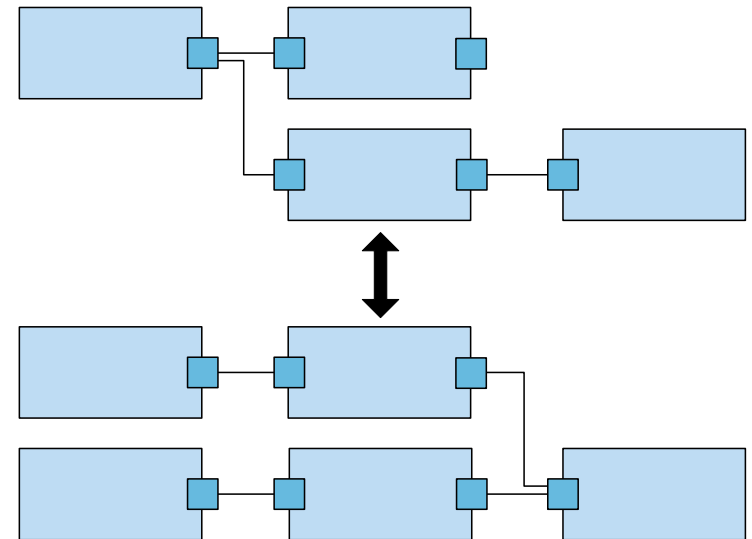
REFLECTive System Architecture (II)

- Component- and service-based approach
 - Easy runtime reconfiguration
 - Hierarchical components and composite services for compositionality, abstraction, and safety
 - Design patterns
 - Fat connectors
 - Membrane
 - ...



REFLECTive Framework and Middleware Prototype

- Realization of adaptivity through
 - Parametric reconfiguration
 - Structural reconfiguration
- Easy experimentation
 - System setup and change facilitated
 - Transparent reconfiguration
 - Separation of concerns



Concluding Remarks

- **REFLECT** provides a **software framework to run and manage human-centered pervasive adaptive applications** by observing
 - emotional state, cognitive engagement, and physical conditions/actions
- **REFLECT software architecture**
 - realizes the **Sense-Analyse-React** loop
 - based on a **layered architecture** and a **service and component framework**
- Main further challenges
 - **Smooth adaptation** taking into account
 - conflicting goals
 - cost and advantage of reconfiguration
 - **Reliable ways for predicting, analyzing, and guaranteeing behaviour** of a system in a pervasive adaptive environment