A Component-based Middleware Architecture for Sentient Computing

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Goal

- New generation of applications
  - Wide variety of mobile context-aware nodes with different connectivity and different requirements

Infrastructure-based network

Mobile ad hoc network

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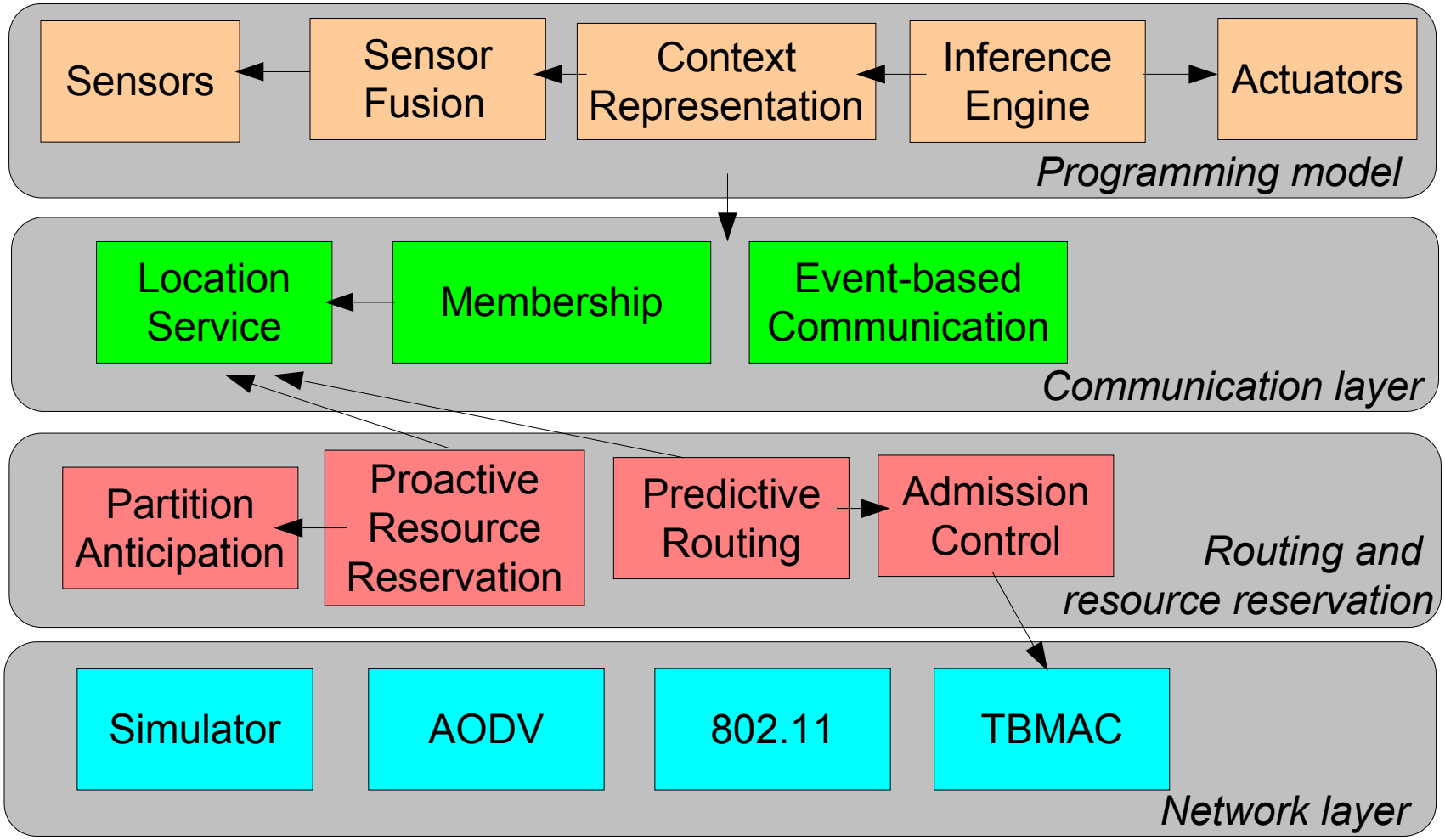
Mobile ad hoc network

→ *Construction of customised middleware*

Approach

- Defining sentient objects
  - Mobile intelligent entities able of sensing their environment and reacting accordingly
- Providing a middleware architecture
  - For non-functional properties (mobility, real-time)
  - For different platforms (embedded systems, simulators...)
  - Based on off-the-shelf components
    - To fit application requirements exactly

Library of components



Programming model: Sentient object model

- Sensors: software entities that produce events
- Sensor capture and fusion
  - Determination of a higher-level context from events of diverse sensors
- Context representation
  - Hierarchy of contexts: actions are limited by the current context
- Inference engine
  - Reasoning mechanisms based on rules that may produce events
- Actuators: software entities that consume events

Communication layer

- Event-based communication
  - Does not depend on any fixed infrastructure
  - Subject, content and proximity filters
- Membership management
  - Classical & proximity group communication
- Location service
  - Fusion of data coming from different sources
  - Convertors of location data format

Routing and resource reservation

- To offer real-time guarantees
  - Key requirement: location-awareness
- Predictive resource reservation
  - Slots allocated in advance by the slot manager
  - Policies applied to reduce the number of participants by admission control
- Proactive routing
  - New path found prior to failures detected by the partition anticipation component

Network layer

- Number of protocols supported
- TBMAC
  - Reduces the probability of collisions by providing time-bounded access to the medium
  - Used to provide predictable access latency for real-time communication

The “sentient sofa”

An instantiation of our middleware architecture

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LPX load sensors

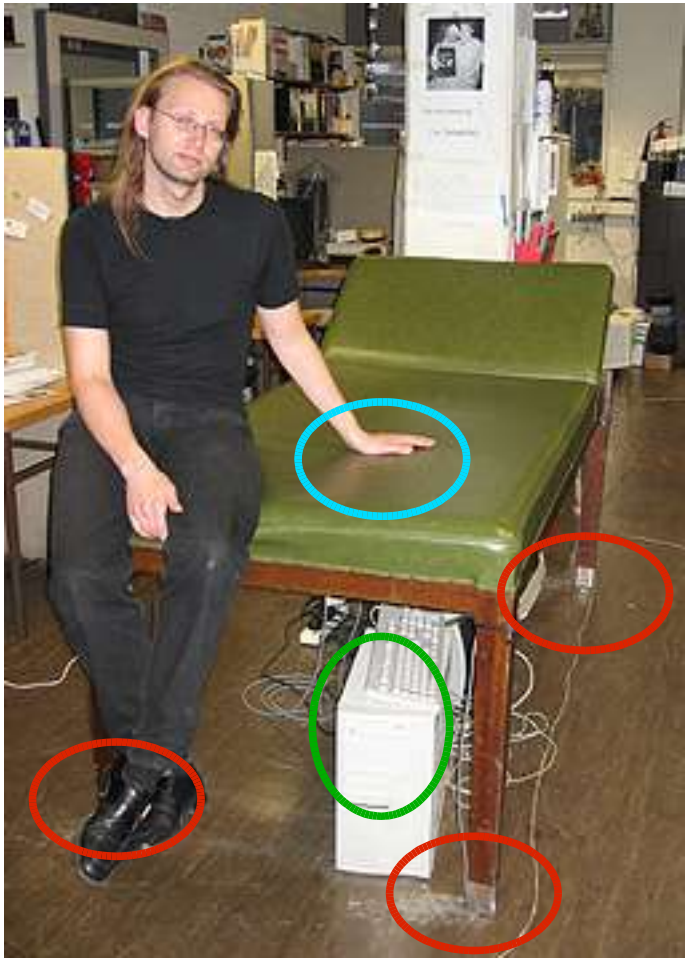
The “sentient sofa”

An instantiation of our middleware architecture

LPX load sensors

CPU connected via serial port

The “sentient sofa”



An instantiation of our middleware architecture

Voice generator

“Hello Maads! You are sitted in the bottom left part of the sofa.”

LPX load sensors

CPU connected via serial port

Components of the “sentient sofa”

- Programming model
  - Fusion of sensor readings
    - Sum of the four readings to determine the user
    - Average of the four readings to determine user location
  - Context representation for location
  - Inference engine activating the voice generator
- Communication layer: STEAM between sensors, “sentient sofa” and voice generator
- No routing and reservation mechanisms
- No components for ad hoc networks
- ➔ *Reduced development time*

Conclusion & future work

- Middleware architecture for context-awareness
  - Customised to various requirements (real-time, mobility, simulation...)
  - Based on components available in a library
- Middleware instantitated for a “sentient sofa”
  - Improvement in development time
- Definition of a formalism to describe the middleware & development of tools
- Development of the component library