



## A Middleware Platform Enabling Cooperation in the Object Community

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POBICOS — Platform for Opportunistic Behaviour in Incompletely Specified, Heterogeneous Object Communities

### Project Overview

#### **POBICOS – Platform for Opportunistic Behaviour in Incompletely Specified, Heterogeneous Object Communities**

- Regular objects (e.g., lamps, chairs, cups, refrigerators, watches) equipped with sense-compute-actuate embedded nodes
- Nodes are tightly coupled with the basic functionality of the physical objects
- Number and type of objects unknown to the application programmer
- Exploit whatever “opportunities”, i.e. sensor, actuator and computing resources, happen to be available at any given setting
- Middleware platform

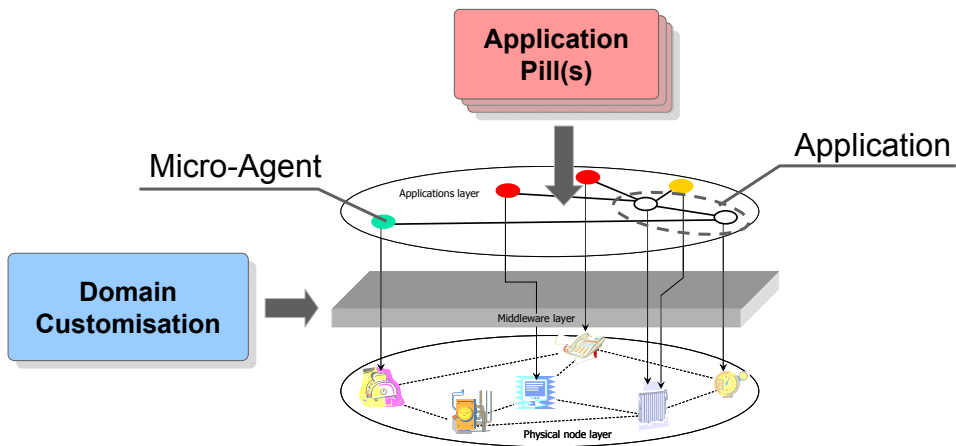


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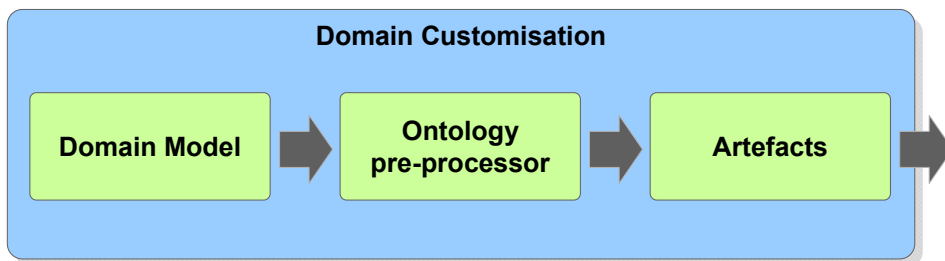
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### Architecture



### Architecture – Domain Customisation



## Architecture – Application Pill

- The process used to add, activate, deactivate and remove an application in/from an object community
- Full deployment cycle
  - Get/acquire application code
  - Check application (non-tampered, trusted, etc.)
  - Deploy application
  - Activate (resume) application
  - Passivate (suspend) application
  - Collect application
- Simplicity is key
  - Simple deployment model, understandable by everybody
  - Simple user interaction, no hidden/irreversible actions



## Architecture – Micro-Agents

- Logical units of POBICOS applications; concurrently running and interacting
- Simplify application programming
- System and application requirements
  - Load balancing and power management
  - Reduction of communication between micro-agents
  - Implicit discovery and selection of sensor/actuator resources
  - Replication for data aggregation and fault-tolerance
- Virtual machine approach



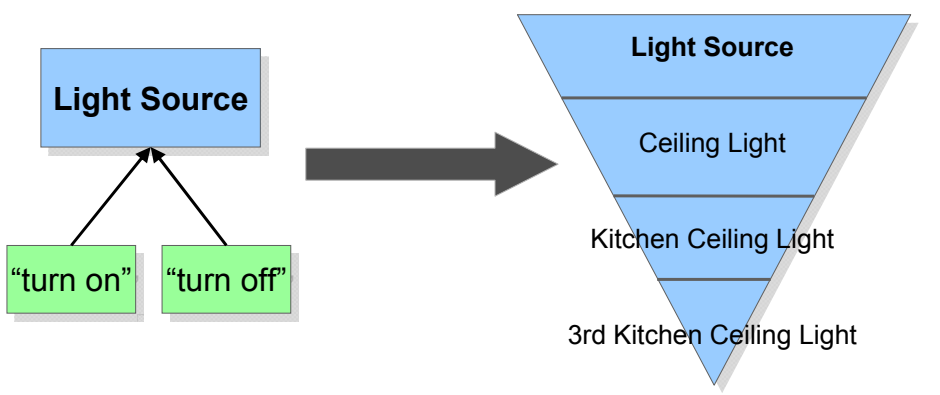
## Opportunistic Behaviour – Classification

- Application level
  - Opportunistic behaviour is explicitly implemented in the application
- Middleware level
  - Load balancing
  - Abstract resource access
    - Type-based
    - Event-based



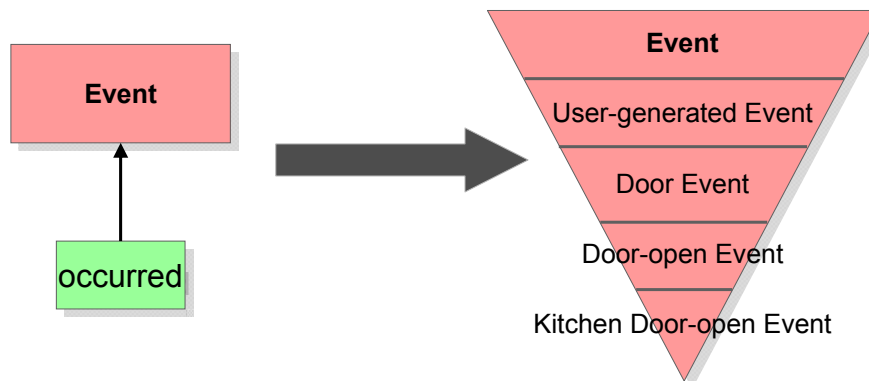
## Opportunistic Behaviour – Example (1/2)

### Type-based abstract resource access



## Opportunistic Behaviour – Example (2/2)

### Event-based abstract resource access



## Cooperation in POBICOS

- Spontaneous cooperation of objects to provide anticipated data for applications
- Enabling the cooperation (interaction) between objects equipped with embedded nodes. The guidelines and goals to be achieved through this cooperation are given (implicitly or explicitly) by the application (code). The middleware is in itself application-neutral, i.e. provides the mechanisms but not the high-level logic for the object cooperation.



## Summary

- Straightforward application deployment
  - Reduced user intervention through application pills
  - Monitor, suspend and resume the operation of applications
- Simplified design of opportunistic applications
  - Applications can be deployed in various settings featuring different types of resources without forcing the programmer to explicitly handle all possible (unknown) cases and without having to modify or recompile code.
  - Mobile-agent technologies
    - Seamlessly interacting distinct units
    - Mapping on physical nodes
    - Load balancing



## Additional Information

### Project Website

[www.ICT-POBICOS.eu](http://www.ICT-POBICOS.eu)

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