A Distributed Smart Space Operating System

Challenges | Aims
Smart Spaces are environments that are enriched with sensors and actuators to support us in our daily lives.

We already have Smart Spaces: There are already many devices in our environment that sense presence, luminosity, heat, moisture, power consumption, etc. Today the smart devices often form islands of functionality. An air conditioning system has an exclusively used temperature sensor for instance. This allows the automated orchestration of this specific system: the user programs a desired temperature and the system takes care of reaching and keeping it without further user intervention.

When connecting all the existing and new autonomous systems, sensors, and actuators inside a space it can become much smarter. The environment becomes a cyber-physical system that can be orchestrated via software. In my control system reality gets transformed into a virtual reality in which the software services operate. The goal of my work is making this reality allowing new applications bringing comfort, saving energy, saving time, and other beneficial things for the users.

Abstraction Layers

Monitor Analyze Plan Execute
The MAPE loop is one way to structure the functionality needed for autonomously behaving nodes (Autonomy Proxy on the left).

The monitor gets data from the managed device and passes it to the analyzer that transforms the data into knowledge by adding semantics. The data is then passed to the planner that acts as an administrator of the data. It stores its inside the knowledge store and provides it to other knowledge agents. The planner on the right side of the circle decides what to do according to the data it gets from the knowledge plane as well as its internal logic that might contain artificial intelligence, policies etc. The actions to be performed are handed to the executor that puts them into action.

The MAPE loop runs on every node inside the platform that is controllable. It reflects changes from the real world to the virtual one and vice-versa.

Gateways to Bridge Heterogeneity
Gateways connect heterogeneous devices to the homogeneous information exchange platform.

User Interface
Together with my students I designed a web- and map-based interface for the smart space operating system. As spatial orientation seems intuitive for us we decided to base the interface on a map representation.

We created a software that allows custom overlays like floor plans to get more detailed view. Devices and information is represented based on its real world geo coordinates.

Possible Applications

The interface is device-adapti:

For devices with low resolution the information representation is adopted to show only locally relevant information based on the location of the user.

Due to our data model all information can be displayed.