



Signal Cruncher
[Embedded Realtime Analytics]

Self-learning Smart Home automation

Application and benefits

Lamps that talk to roller shutters, heating systems that learn from the weather, home heating and user behaviour to minimise energy consumption or to maximise comfort, fridges that suggest what to order or even smart advisers to help and entertain – all this is no longer pie in the sky.

Smart Home automation is advancing forward. More and more appliances and services in rooms and buildings are networked with the Internet via a central gateway. Until now all appliances were operated manually, e.g. using a smartphone or had to be laboriously set while keeping to complex rules.

With the lamp in the lounge for example, it was necessary to select each time it was to be switched on and off, as well as choosing the colour value and brightness – possibly also depending on the brightness level outdoors, the number of people in the room and other factors.

Why can't appliances learn to do it themselves? This doesn't just save the occupant bother; a system that learns automatically can take things in statistically with far greater precision than a human being. And also bringing about optimisation, e.g. reducing energy consumption. This very capability is offered by the XONBOT.

Here the XONBOT is connected to the central gateway or even incorporated in it from the start.

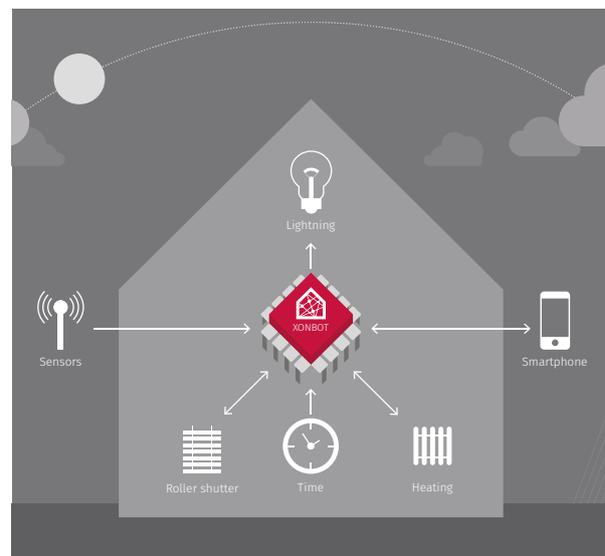


Fig: XONBOT: for self-learning control of home building services.

The XONBOT is then simply put into learning mode for the relevant appliances. It observes their switching behaviour and learns from this. If the XONBOT is to then take control of the appliances, it is simply swapped to application mode. It is of course possible to override its behaviour manually. And the XONBOT learns from this as well. Operation of the Smart Home becomes child's play!

What's more, the XONBOT is able to optimise performance characteristics. It can be told to minimise energy or electricity consumption for

the room temperature selected. If the XONBOT knows current temperatures and power consumption, it will learn to achieve this goal within a matter of weeks.

Entirely automatic – the XONBOT

What does a realtime approach offer the Smart Home? Example of lamp control: XONBOT learns the habits of the occupants in a home: when they switch lamps on and off, their lighting levels and colour. If they are not at home, the lighting can be switched automatically according to the behaviour learned from the occupants to simulate their presence. There are additional options available here: If wished, the system can offer occupants recommendations for lighting control acquired from the behaviour of similar householders or evaluations involving the current occupants.

Example of optimisation of personal consumption: Firstly, an increasing number of sensors are available in the form of thermometers, brightness sensors, smart meters, motion detectors, etc. Secondly, electronic switching is additionally possible for the control variables of the heating circuit such as flow temperature, heating valves, thermal control, etc. And what's more, solar collectors and hot-water tanks can also be incorporated in the decision-making process.

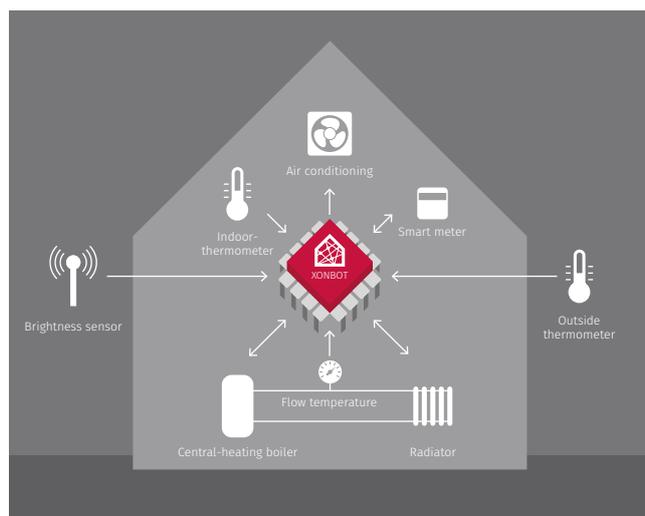


Fig.: Self-learning control of heating systems.

The aim here is now to control appliances as a function of the sensors in terms of time to minimise energy or electricity consumption throughout the day while maintaining a specified temperature profile. The XONBOT continuously learns the thermodynamics of the home, the development of the outside temperatures over the rest of the day and the behaviour of the occupants. In every step it then calculates how the flow temperatures, heating valves or electrical control variables should be selected to minimise energy consumption for the rest of the day.

At each stage it compares the setpoints with the actual values and corrects its model of the environment. This way the XONBOT learns to optimise control of the heating system in a matter of weeks.

Example of marketing: In the context of automated marketing, XONBOT can offer products and services such as lamps, trips, insurance, etc. based on the personal preferences of occupants.

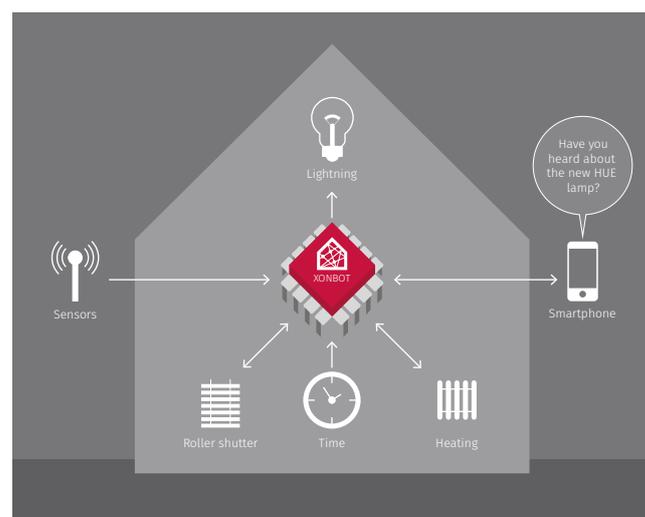


Fig.: The XONBOT as an instrument of marketing automation.

Example of an avatar: XONBOT can be used to create a personal adviser, who gives occupants handy tips and also entertains them. “What's the weather going to be like today? Can I recommend some dream holidays for you? Is the temperature pleasant? Fancy listening to some Deep Purple?”

From this feedback the XONBOT learns when such contact is desired and of what nature. The same principle also applies here: Over time the avatar increasingly adapts to users and their preferences.

How this works

The XONBOT is based in mathematical terms on the approach of reinforcement learning. This is a discipline of artificial intelligence which has explored self-learning control of autonomous systems such as robots or games for many years. The technology of the XONBOT was developed by Signal Cruncher GmbH and its parent company prudsys AG over a period of ten years and has been on the market for a long time.

Reinforcement learning is generally based on incremental learning from the field of regression. Likewise for the XONBOT. While conventional big data methods only store all data in large databases to generate a new analysis model from time to time, the XONBOT updates its internal regression model incrementally with each new transaction. This can be removed afterwards. This approach does away with storage of the transaction data, and the XONBOT is always up to date.

The XONBOT can be used both in pull and push mode, i.e. not only responding to queries but also initiating operations.

Push mode is generally used in the Smart Home sector. Here the XONBOT uses its internal clock to in-

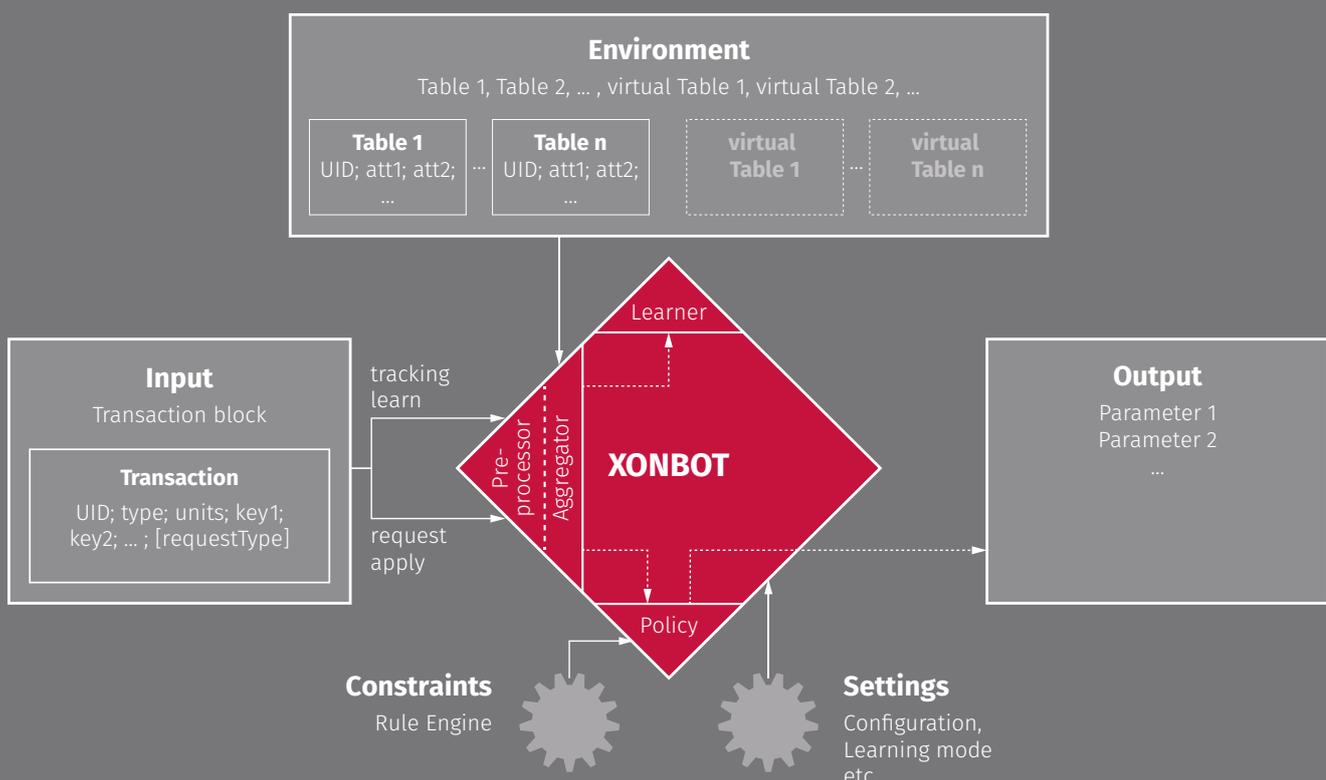
terrogate the measured data at regular intervals (e.g. every 5 minutes) and then decides its next control action which is initiated via the gateway.

Despite its intelligence, the XONBOT is of course not infallible. For this reason, specifications for the XONBOT's work are supported comprehensively by its constraints engine. These specifications take the form of rules, which can be extremely complex (e.g. "always switch light off after midnight if no-one is in the room"). They can be adopted directly from the rule engine of the existing Smart-Home solution and define the framework in which the XONBOT may act.

Besides its clock and constraints engine, the XONBOT includes further components such as connectors, loggers and modules for statistics, evaluations and simulations. It is thus equipped with all infrastructure for swift integration. This is why it has the name "processor".

Being a pure Java application, the XONBOT is therefore platform-independent and can be incorporated in third-party applications within a few days.

Fig.: Setup and operation of the XONBOT



Central issue of data protection Conclusion

It was mentioned above that the XONBOT does not store transaction data due to its incremental method of operation. This has key benefits in terms of data protection.

It is no longer necessary to store the behaviour data of occupants. It is not recorded anywhere whether a radiator or television was switched on or off, and certainly not when or by whom.

And what's more, the data is not transmitted to the Internet or the cloud either. Every XONBOT learns exclusively from the local behaviour of its household. And this is where it should be installed, e.g. in the gateway itself.

Even when faced with complex tasks such as optimising own consumption, the XONBOT is capable of learning optimal control solely from the data of the local household.

The only exception here is marketing automation. This is conditional on learning from multiple households and is supported by XONBOT where the occupants consent to this.

As a result, the XONBOT's primary method of operation differs in every household. No connection to the Internet is necessary here. The local XONBOT can be networked and so exchange data online only as long as the occupants are willing.

The XONBOT makes Smart Home solutions even smarter, not merely because occupants no longer need bother with manual operation, but by also being able to meet specifications and targets more precisely.

The applications of the XONBOT are many in number and can be configured individually. Not every use case is meaningful here, and this is why important cases are already preconfigured.

The XONBOT does not store occupants' data and requires no connection to a central server (only available for special applications). This ensures compliance with the data protection laws, something that is very important in the Smart Home sector, especially where the use of personal data is concerned.

The XONBOT can solve many more other problems via integrated reinforcement learning. We would be pleased to provide you with more information.



Fig.: XONBOT applications in various branches.