

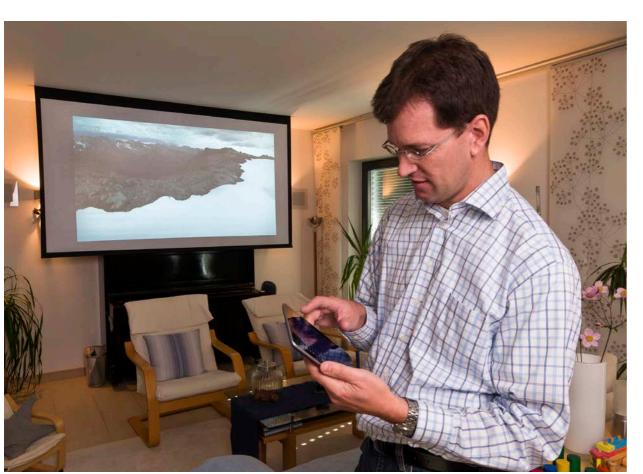
openHAB's Kai Kreuzer (left) and Thomas Eichstädt-Engelen in front of the electrical cabinet at Kreuzer's home SMARTEST HOUSE ai Kreuzer is not an easy man to sneak up on. As you approach the front door of his highly automated house, you will trigger ON THE STREET a sensor that activates a webcam mounted above the front door. Ring the doorbell and he will be alerted to The Internet of Things meets home automation with openHAB, your presence, via either loudspeakers throughout the property or a video a Java-based software environment that integrates devices and display on his iPhone. He may choose applications into a cohesive network. BY DAVID BAUM to let you in by remotely unlatching the door. With a few more taps on his

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Kreuzer controls his home entertainment system through HABDroid, one of the native clients for openHAB.

# **SNAPSHOT**

### openHAB

openhab.org

# **Headquarters:**

Darmstadt, Germany

## **Industry**:

Home automation, open source software

# **Contributors:**

Java technology used:

]ava SE 1.7

phone he can adjust the lights, turn on the music, and adjust the temperature of the home's central heating system. If he is in the garden, you may hear his voice coming over a PA system, directing you outside.

What's unique about this scenario is not the individual systems that automate every aspect of Kreuzer's modern home, but the way these systems work together to improve the convenience, security, and efficiency of dozens of routine tasks.

Home automation is a prime example of the Internet of Things, a phenomenon that is exploding across the domains of healthcare, manufacturing, transportation, and communications as billions of intelligent devices flood into our personal and professional lives. ]ava plays a starring role as a central integration point in this machine-to-machine world by making our cars more efficient and dependable, our homes more comfortable and secure,

and our healthcare less costly and more patient friendly—to name a few prominent examples.

Kreuzer studied mathematics and computer science at the

Technical University of Darmstadt, where he took a particular interest in Java. He has used the language extensively in his professional life as well as in his home automation systems. This lifelong hobby culminated with the founding of open Home Automation

Bus (openHAB) in 2010, a Java-based software environment that integrates devices and applications throughout his home.

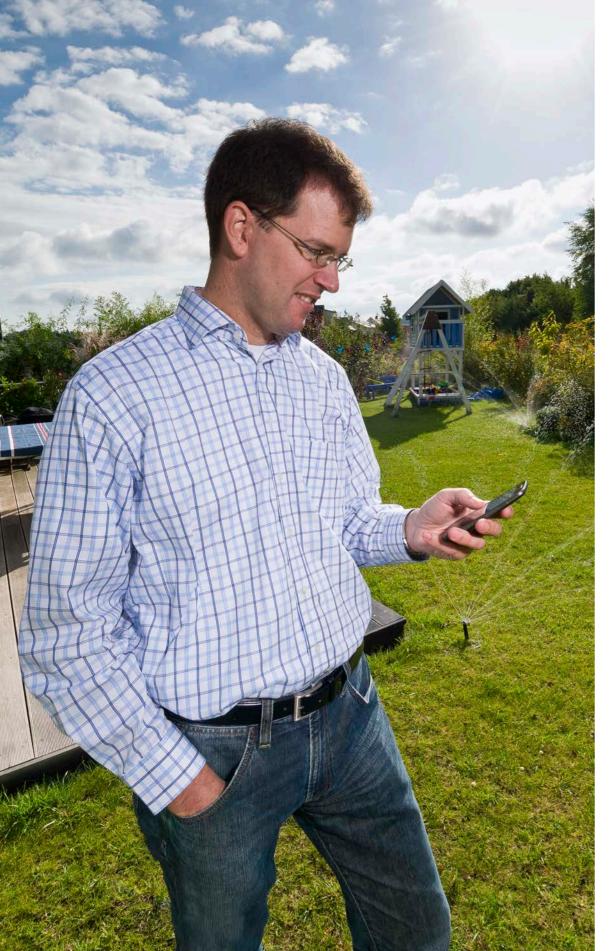
With openHAB as the controller, all of a home's comfort systems, security systems, and energy systems work in concert and can be triggered in unison—through a smartphone interface, via Google Calendar events, or through many other hardware and software interfaces.

Kreuzer's brainchild quickly gained traction in the open source community. Today there are 37 contributors and between 2,000 and 3,000 open-HAB installations worldwide.

**COMMUNITY ROLE** Contributors help to expand the openHAB ecosystem by creating connections to various devices, applications, and interfaces.

Engelen is a fellow home automation enthusiast who now serves as a project leader at openHAB. With a degree in computer science from the University of Hagen and full-time work in the IT field, he is well versed in the software industry

Thomas Eichstädt-



Kreuzer uses his smartphone to manually trigger his sprinkler system.

and has an affinity for the open source movement. He joined Kreuzer a few months after the openHAB environment was launched.

"My own home automation project began with the physical infrastructure and soon progressed to software," Eichstädt-Engelen recalls. "It is not enough to have the hardware in your flat. You have to have something to control it. I liked openHAB because it was free and open source. It was a perfect fit to my skills because it is based on Java and OSGi."

Eichstädt-Engelen has used open-HAB at home to connect many different devices and applications into a cohesive fabric. "In every room I have a loudspeaker, centrally operated by openHAB, along with the lights, the appliances, and the heating and ventilation systems," he explains. "All of the doors and windows have electric contacts that signal the security system. Most of the electric appliances can be controlled remotely, and the various systems work in unison. For example,

the heating system will shut off if the windows are left open. The door won't lock behind you if you go out on the balcony to get some fresh air."

# DESIGN GOALS: BETTING ON JAVA AND OPEN SOURCE

Kreuzer and Eichstädt-Engelen both have day jobs in the IT field and pursue openHAB in their spare time. Eichstädt-Engelen is a software developer at innoQ, a midsize software consulting company. Kreuzer works at Deutsche Telecom as an IT engineer and architect, with previous jobs in the media and banking industries. "Java was always my language of choice, personally and professionally," he says.

In 2008 Kreuzer built a house from scratch and decided to include advanced automation systems that could be interconnected. He worked closely with an electrical engineer to plan and wire the house. Like Eichstädt-Engelen, he was leery of proprietary solutions that would tie his automation systems to a vendor that



Top: A weather station in Kreuzer's garden detects brightness, rain, wind, and temperature, and sensors control window blinds, sprinklers, and the HVAC system. Right: A GIRA system monitors windows and lights, shows missed calls or visitors, and communicates via text-to-speech.



#### **WORKING TOGETHER**

OpenHAB enables discrete automation with centralized control: individual systems can be automated, yet each one is aware of the others through a common controller.

might not exist in 10 or 20 years.

"Since I planned to live in this home indefinitely, I didn't want to bet on a horse that wouldn't win in the long run," he says. "I knew that if I invested in an open source solution I could always extend it as technology evolved. It could be developed and maintained by myself and by others in the open source community. As a professional Java developer, I was not really satisfied with existing open source solutions so I decided to create something completely from scratch and build it for my own use, yet make it flexible and extensible so that it would also be useful for others."

Fast-forward five years and you can see the results of Kreuzer's suburban automation efforts. In addition to a webcam near the front door, he installed a Near Fields Communications (NFC) reader that can control the lock based on signals from inexpensive RFID tags that he issues to his guests. This method is particularly useful for service people, who he may want to let in on

a one-time or periodic basis. "Rather than giving a key to my cleaning service, I can issue an RFID tag. This lets me control when the lock will open for them," he says.

A weather station in Kreuzer's garden detects brightness, rain, wind, and temperature, along with moisture sensors in the soil. Because the sprinkler system is attached to openHAB, the watering system comes on only when the plants need it. A pump is activated with a float switch, which also registers its activities, so there is always enough water in the tank for the garden. This level of integration is what makes openHAB so useful in comparison to standalone or "siloed" automation solutions.

"If you buy a security solution from one vendor and a comfort solution from another, it is generally very difficult to combine them into one smart house," Eichstädt-Engelen explains. "In addition, many of today's home automation systems were designed for very high-end homes.







Kreuzer and Eichstädt-Engelen discuss openHAB with Java Magazine's Caroline Kvitka during JavaOne 2013.

With openHAB, we are bringing this same level of sophistication to average homes and apartments."

Home automation use cases can be divided into three basic categories: comfort, security, and energy management. Some features of a home, such as draperies and shutters, span multiple categories: automatically opening them in the morning and closing them in the evening keeps the house comfortable; saves energy; and improves security, because it makes it appear as if the resident is home even when the house is empty. These activities can occur automatically based on the time of day or can be triggered by sensors that detect when people are home. Lighting, heating, cooling systems, and appliances can also be activated automatically or can trigger other systems. For example, when Kreuzer's washing machine finishes a load it broadcasts its status over the loudspeaker.

### WORKING WITH THE **JAVA COMMUNITY**

The first binary build of openHAB was available for download in the fall of 2010. Since then, Eichstädt-Engelen and Kreuzer have presented the solution at Java user groups and Java conferences such as EclipseCon, Devoxx, JAXconf, and GeeCON. Their growing community now includes a loyal base of contributors that help to expand the openHAB ecosystem by creating bindings, or connections to various devices, applications, and interfaces.

'Bindings are the pieces of code that allow us to connect openHAB to other systems and also to integrate it all together," says Eichstädt-Engelen.

There are currently about 50 bindings to commercial automation systems including Z-Wave, Plugwise, SONOS, Bluetooth, Modbus, EnOcean, and KNX. openHAB also provides consoles such as XMPP, OSGi, and Google

Calendar. Thanks to these consoles and bindings, along with the steady evolution of home automation technologies, homeowners no longer need physical buttons to switch on lights and other electric devices. Pointing a smartphone at an NFC tag hidden behind the wallpaper will do the

**NO LOCK-IN** One of the fundamental design goals is modularity: it is easy to replace one technology with another so that homeowners aren't locked in to particular types of applications and devices.

job—or they can program openHAB so that the phone will signal these devices automatically whenever their owner walks into the room.

"Soon, presence detection technology will allow openHAB to identify you as you move around the home," Kreuzer says. "This will allow open-HAB to adjust the lights or shutters or music to your preferences, based on the time of day or any other variables you choose."

End users simply download open-HAB and unpack it in a Java runtime environment on the target system. "It's more or less a one-click installation," Eichstädt-Engelen notes. "Within five minutes, you can have a running openHAB system."

The project includes the open-HAB Designer, an Eclipse Rich Client Platform application for configuring the openHAB runtime. It comes with editors for the openHAB configura-

> integrated development environment (IDE) support such as syntax checking, autocompletion, highlighting, and content assistance. Kreuzer claims that this mature development environment makes it easier to implement and deploy rules for automatic actions.

tion files, with full

**WHAT JAVA BRINGS** 

"Java is very useful because it has a huge ecosystem of libraries, great debugging tools, and lots of support available on the web."

—Kai Kreuzer, Founder, openHAB

openHAB also includes a scripting language so that developers can easily define new types of automation logic.

"OSGi is an important aspect for openHAB because it brings modularity to our systems," Kreuzer explains. "This makes it easy for contributors to build modules and bindings independently of the core development. Users can pick relevant modules and add them to their openHAB system at runtime."

"Java is very useful because it has a huge ecosystem of libraries, great debugging tools, and lots of support available on the web," Kreuzer continues. "It's easy to find a solution for a specific problem. Java is also platform independent, so you can run it on Linux, Windows, Mac, or an embedded platform."

Eichstädt-Engelen agrees. "The best JVM []ava Virtual Machine] available for embedded systems is Oracle ]ava SE Embedded." Using Java also makes it easier to collaborate with other developers. "There would be fewer contributors if we had chosen another language," Kreuzer adds. "We are part of a big ecosystem, so we can almost always find the solutions we need."

Neither Eichstädt-Engelen nor Kreuzer plans to commercialize openHAB. However, they recently proposed the Eclipse SmartHome project, which will make central parts of openHAB available under the Eclipse license. This move paves the way for the integration into commercial products and ensures sustainability.

But no matter where the openHAB technology goes and how the open source community evolves, the two partners plan to keep the system

closely aligned with Java.

"Java is future proof and platform independent," Kreuzer sums up. "The Java APIs are very stable and consistent from one version to another. Java's diversity makes it easy for other contributors to get involved, all over the world." </article>

Based in Santa Barbara, California, **David Baum** writes about innovative businesses, emerging technologies, and compelling lifestyles.



Kreuzer and Eichstädt-Engelen program openHAB and test it on a Raspberry Pi with a tablet.