IoT Design and Development

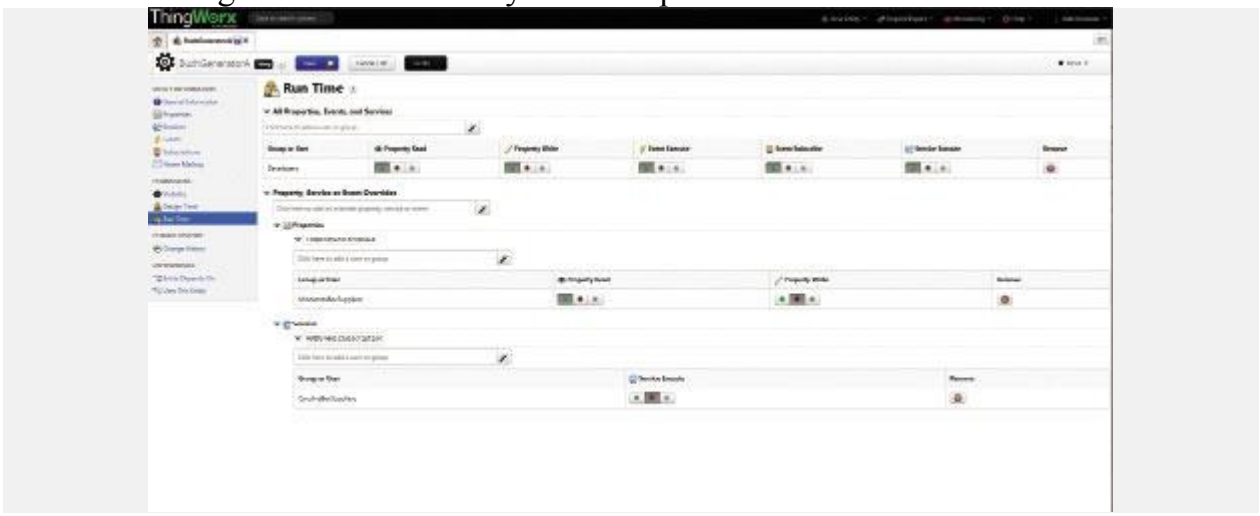
by Brian Albright

The Internet of Things (IoT) was one of the most pervasive tech topics in 2014 as more companies introduced smart, connected products. This included everything from cars and refrigerators to medical devices and even furniture. That growth is only going to continue (research firm Gartner, Inc. expects roughly 26 billion "things" on the network by 2020), and the impact on product design will be widespread.

For designers and engineers, this will mean more than just adding a few sensors and radios to an existing product. IoT connectivity will affect how the software operating within these devices interacts with the hardware, what types of components can be used to gather data and enable communications, and will ultimately affect how the end product functions in the real world. More importantly, the IoT opens up a stream of real-time operational, usage and failure data that will give R&D departments, engineers and quality experts a previously unheard of view into how every component and material decision is playing out at customer sites.

"Design and development are being influenced by real-time feedback, which makes it imperative for designers and developers to be more agile and responsive," says Adi Pendyala, co-founder and head of Business Development at mnubo.

"How do you design a product that requires you to contemplate mechanical hardware, electronics, how to manage software on the product, and software that is in the cloud?" says Kevin Wrenn, division general manager of the ePLM (product lifecycle management) group at PTC. "We could see evergreen products that add features and functions throughout the entire lifecycle of the product."



PTC's ThingWorx IoT platform offers a granular security model to enable data isolation and service execution at any required level, including user and device authentication. Image Courtesy of PTC.

In the IoT model, companies aren't selling products; they are selling services or outcomes. Developers and designers on both the hardware and software side have to work even more closely together to make that model work. Because the connectivity component is outside the domain expertise of many manufacturers, they are increasingly turning to IoT development platforms.

These solutions help companies accelerate development and design by making it easier to integrate sensors, microcontrollers, communications software, security and connectivity functions into products or machines. These tools can also be used to build the onboard and cloud-based applications required to run IoT solutions.

IoT Development Platforms

IoT solutions development has affected software and hardware development by simplifying the development process itself, lowering barriers to entry and increasing efficiency. According to Ilya Kretov, senior technology advisor at DataArt UK, in every IoT system, there is a point where hardware and software converge, blending design team responsibilities. IoT development platforms help speed development time and save costs by making it easier to extract value from the object data that is being generated.

"These systems are rather complex, so there are technical challenges in every part of the system," Kretov says. "That is especially true in the connection points between the systems."

Building computer-like connectivity, processing power and communications into products that have never had such features before will pose a number of challenges for designers and engineers. Smart, connected devices will require more personalization, support for ongoing product upgrades and accommodation of remote or predictive service models. Integration of hardware, electronics, software and connectivity technology will have to be more agile and flexible. There will be more design changes later in the process, as well as post-purchase changes and more rapid iterative work on those designs. Even products that already included some level of embedded intelligence will be configured differently. Designers will need a new menu of boards, sensors, power supplies and actuators, along with a strategy for determining optimal computational load payoff between the local data processing and what happens in the cloud. Security and communications considerations will have even more impact on both the physical design and software development process for a wider range of products.

Designers will also have an entirely new view of how products are actually used. "These are things that designers never got to see before, because once they were finished with a product they didn't really know if it was being used in the way they anticipated, or if it

was performing as expected," says Tom Shoemaker, vice president of the ePLM group at PTC. "That stream of information can now be made available to R&D (research & development) and the engineering team to give them better insight as to how the product is performing."

IoT development platforms make it easier to bake in the required connectivity without a lot of heavy lifting on the software development side. They also provide tools that can help guide hardware decisions at the board and sensor level, and APIs (application programming interfaces) that enable integration with data analytics, simulation, design and other software systems.

PTC entered the IoT market via its acquisition of ThingWorx in 2013 to complement its PLM and SLM (service lifecycle management) portfolios by offering a way to create secure product connections and to develop applications to leverage data generated by those products. "Existing design platforms have to get smarter to incorporate all of these new considerations," Shoemaker says. "We will need new libraries of sensors and other components that can be re-used and embedded in to the design process."

Wind River offers a development environment (Intelligent Device Platform XT), along with an Edge Management solution for connecting devices through a central console. According to Ido Sarig, general manager and vice president of the IoT Solutions Group at Wind River, the company has focused on creating ways to deploy embedded software to different hardware configurations quickly, without eating up lots of memory on the devices themselves.

"The whole paradigm of software development for embedded devices is undergoing a radical change," Sarig says. "It used to be you designed the software with a cross compiler for a particular target board, and then deployed it. That's very cumbersome and doesn't scale if you have more than one type of hardware. Ideally you would write once, and deploy everywhere."

Security Challenges

Securing the data generated by smart objects is a new challenge for developers. Devices that weren't previously connected to the network lack the common security capabilities found on a desktop computer, for example.

Every Samsung Product Will Connect to the IoT

To get an idea of what the Internet of Things might mean for future product designs, look no further than Samsung's recent announcement that by 2020, every product it sells will be connected to the Internet of Things and be able to communicate with each other. The company envisions everything from your phone and headphones to cars, mall maps and furniture interacting and providing feedback to users.

Samsung has opted to follow an open route to ensure device interconnectivity. It acquired a company called SmartThings last year that has created a smart home hub that effectively acts as a translator between different smart objects.

“Without this kind of openness, there won’t be an Internet of Things because the things will not fit together,” said BK Yoon, CEO, during his International Consumer Electronics Show 2015 (CES) keynote.

To make this possible, Yoon said that Samsung would need to develop smart components like sensors that can demonstrate understanding and context while the products are operating. Samsung is also investing more than $100 million in the developer community via accelerator programs worldwide.

Interoperability among what is expected to be billions of connected devices in the next decade will be a key challenge for the expansion of the IoT. In January, the Linux Foundation announced the preview release of IoTivity, an open source software framework that provides IoT connectivity.

“There are new considerations in the design regarding identity and access,” says Sean Lorenz, senior product marketing manager for LogMeIn’s Xively. “You want to know what sensors are able to be read, how they are read, and who is able to access them. All of that information has to be determined in the design phase so that you can better understand the security issues.”

“The type of software being developed in the past did not necessarily take all security issues into consideration, because the device was separated from the outside world,” Sarig says. “They only thought about physical security. With the IoT, that changes. If you want to get data off of that device, how do you do that efficiently and securely? You have to work more closely with the developers working on the cloud side of the application to make sure the two parts interoperate. It’s become a more complex development environment.”

Security is just one area where hardware and software design are converging because of IoT requirements. “You have physical hardware and embedded systems designers, and software designers who build Web apps, and they’ve worked in completely different worlds,” Lorenz says. “Now they are being thrust together in IoT. You not only have to understand the fundamentals of the hardware design, but also best practices for software, connectivity, data allocation and directories.”

Developers that understand both halves of the process will be crucial players in re-organized design teams, and those teams will have to plan for the new ways in which customers use products and machines.

Real-Time Performance Data

The IoT will also lead to another significant change in the design process: closed-loop product lifecycle management. The data coming back from connected products will be more detailed and more granular, and provide a much better view of how customers are using products and how those products are performing.

This is a new concept for companies that have traditionally relied on historical data to determine failure rates and identify design problems. “You can understand how many button presses are occurring, and find out where the flaws are in real-time, and gather that data on a global scale,” Lorenz says. “You then feed that back into analytics or whatever system you have to iterate on product design.”

IoT platforms typically include APIs that make integrating this data into design software, analytics or simulation tools fairly straightforward. “And instead of doing traditional simulations, you now have real field data to show you what the actual fault tolerances are, for instance, in a real product,” Lorenz says.

Currently, much of this smart object data exists in a silo at many companies, and that’s where IoT development platforms also play a role. “What’s going to happen for the next-generation OEMs (original equipment manufacturers) is there is going to be a business federation layer where business rules feed that data into existing processes,” mnubo’s Pendyala says.

Connected failure analysis can greatly accelerate the time it take to uncover and correct design problems, because companies will now have access to real-time performance and failure data.

“When properly instrumented, you can see the combination of environmental and operating conditions that lead to a failure,” PTC’s Shoemaker says. “That enables more rapid resolution of those types of problems and can also reduce costs by avoiding over-engineering certain products or features.”

IoT development platforms can help companies quickly implement direct connectivity with products, and support the type of open communication among different types of products that IoT boosters have always touted. More of these tools are entering the market every month, and they will play a key role in product development as the demand for connected products increases.

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