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IT@INTEL

Delivering Strategic Business Value with Automated In-House Testing

By partnering with Intel's product development groups to automate the in-house testing of products they create, we deliver substantial strategic value that leads to higher-quality products.

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Executive Overview

Intel IT is transforming our in-house testing environment to deliver better feedback more quickly to Intel's product development groups. Intel employees use Intel's products to do their jobs every day. Intel IT deploys and monitors the performance of these products. By sharing what we learn with the product development groups, we provide them with real-world insights that can lead to higher-quality products.

While we've been monitoring PC client health for years, we previously relied on manual processes to deploy test configurations, gather feedback, and monitor and analyze issues that arose in the field. As our computing environment became more complex, manual testing methods required too much of our time and resources, and made it difficult to connect issues with the appropriate events, causes, and products. We needed more effective tools to support Intel's employees and product development groups.

We partnered with Intel's wireless connectivity solutions (WCS) group and Intel's Internet of Things Group (IOTG) to automate the in-house testing of Intel's wireless products. In doing so, we achieved two important business advantages:

- The product development groups receive timely feedback that can lead to more insights, higher-quality products, and faster time to market.
- IT can improve deployment, monitoring, and analysis of new configurations that we support across the enterprise.

The success of this effort has prompted us to partner with other product development groups, thereby multiplying the business value supplied by IT.

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Acronyms

AP	access point
BSOD	Blue Screen of Death
EMM	enterprise mobile management
IoT	Internet of Things
IOTG	Internet of Things Group
ITIL	Information Technology Infrastructure Library
WCS	wireless connectivity solutions
WEF	Windows Event Forwarding

Business Challenge

Intel IT delivers strategic business value by testing Intel's products and providing insights to product development groups to help improve product quality. Testing and monitoring PC client health is nothing new at Intel, we have been doing that for years.[1] However, as product development cycles accelerated, we realized that we needed a more efficient testing environment to better support product development groups. Manually provisioning products to be tested was time-consuming and limited the level of sophistication we could apply to deployments—our process only allowed for sending the same product configuration to our entire testing population. We also relied on feedback from our users (employee volunteers) to provide context to the data that we collected, which also took time. We needed to update this process in order to expeditiously deliver more comprehensive information to our product development groups so they could improve their products and meet market demands.

In-House Testing Challenges for Wireless Products

The consumerization of wireless computing products is becoming increasingly important in the enterprise environment. Intel's customers—including Intel's own product development groups—expect their wireless infrastructures to support their personal devices across multiple access points (APs) so employees can be more productive and collaborative from anywhere onsite and when working remotely. Moreover, these wireless infrastructures need to be compatible with multiple devices and connectivity protocols. In response to these WLAN market demands, Intel is accelerating development of Intel® wireless products, including the Intel® Dual Band Wireless-AC 7260, Intel® Dual Band Wireless-AC 7265, and Intel® Dual Band Wireless-AC 8260.

Over the last several years, Intel IT has performed in-house testing of Intel wireless products to help identify potential quality issues in WLAN connectivity, monitor performance of Intel wireless products outside of a controlled lab, and collect feedback from users to help developers improve products before they went to market.

The increasing importance of wireless infrastructures and accelerated development of wireless products demand that more products get added to the in-house testing environment and that these products get tested on multiple OS platforms with multiple APs. This increasing complexity expands the number of sources of testing data, which leads to more events and behaviors to monitor and analyze.

[1] See our white paper "Improving Client Stability with Proactive Problem Management," September 2009.

Moreover, the Internet of Things (IoT) vision of seamless connectivity anywhere, through any computing device, introduced a new paradigm of connectivity that is more difficult to test in closed environments. For example, a controlled lab is inadequate for testing how well a smartwatch connect to home, cellular, and corporate networks, or any other available network.

As in-house testing complexity increased with more wireless products, data sources, and events to monitor, the lack of automation made it difficult for us to analyze large volumes of data and produce relevant, meaningful feedback that the wireless connectivity solutions (WCS) product development group[2] could use to make product improvements. Additionally, we could not fix issues for our wireless clients in batches, nor could we fix issues quickly enough to keep up with the increasing complexity of the testing environment. In short, our in-house testing processes were not scalable and were preventing us from providing the feedback that Intel's product development groups needed.

Defining the Need for In-House Testing Automation

To scale testing activities and measure wireless client health in a live in-house testing environment, we realized that we needed to automate the following processes:

- Deploying configurations of hardware, software, and problem fixes to various sizes of test populations (often referred to as "rings").
- Monitoring and collecting data for all products being tested across a variety of real-world conditions: IT-managed and employee-owned PCs; APs in the office, home, or mobile environments; and multiple OS versions.
- Identifying and correlating PC issues across multiple events in the environment to gain a bigger view of problems.

We also realized that by automating our testing in these ways, we could more quickly provide WCS and other product development groups with useful information about product quality.

Solution

In-house testing helps Intel to deliver quality products that better meet customer expectations and requires less IT support. With a goal to use automation to optimize product release cycles, Intel IT partnered with the WCS group and Intel's Internet of Things Group (IOTG). Our initiative is part of Intel IT's Business Solutions Integration, where we use Information Technology Infrastructure Library* (ITIL) processes to align our efforts with our product development groups' priorities.[3] This approach improves our business acumen and allows for more effective collaboration between Intel IT, the IOTG, and WCS group, resulting in a mutually beneficial automation solution.

[2] While in-house testing is available for many Intel products, for this paper, Intel's WCS group is the focus.

[3] For more on aligning IT and line of business (LOB) priorities using Information Technology Infrastructure Library (ITIL) processes, see the Intel IT white paper "Integrating IT Demand Management and Business Relationship Management."

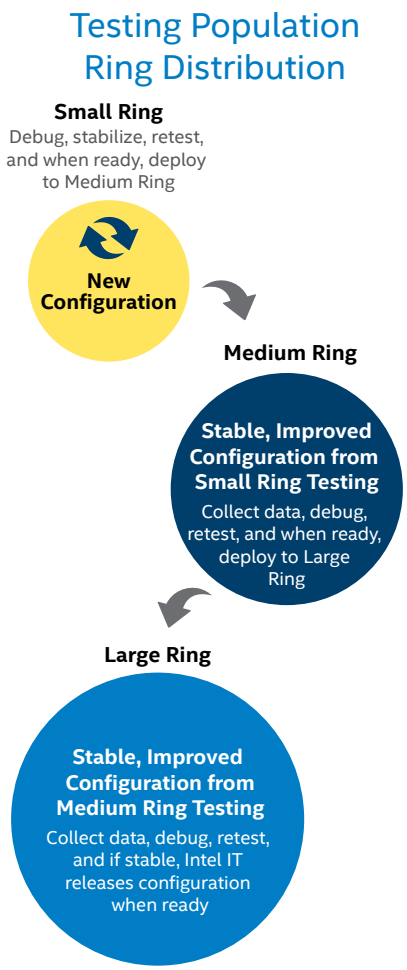

Figure 1. The testing population divided into small, medium, and large rings. Automating the deployment of test configurations enables us to gather more data, increase efficiency, and roll out improved configurations faster than we could prior to automation.

Deployment Methodology

Instead of doing what we used to do—requesting that all users in a testing population install a certain configuration of hardware and software and then relying on their feedback to determine results—we have automated the deployment process with an IoT agent, a third-party enterprise mobile management (EMM) application, and directory service groups.

We stage our deployments across our testing population, starting with a small group, to control the impact of new releases and solve problems faster. We divide our testing population into three rings: small, medium, and large (see Figure 1). Intel employees volunteer to participate as users for in-house testing.

When a new configuration is ready, we deploy it first to the small ring of users. After collecting data and debugging, we either deploy the improved configuration to the medium ring or reconfigure and start over in the small ring. The same process repeats in the medium ring before we deploy the configuration to the large ring. If there are multiple quality issues with the configuration in any given ring, we can delay deployment to the subsequent ring. If the configuration is stable, the deployment can move to the next ring.

To automate configuration deployment, we use existing EMM capabilities, implement dynamic deployments to each of the rings using directory service groups, and host dynamic configuration content on file shares. In addition, the IoT agent complements existing monitoring systems for collecting data on Blue Screens of Death (BSODs) and Windows Event Forwarding (WEF), enabling near-real-time responses to some events and summarizations of long-lasting events such as connectivity.

Automation enables us to gather data from real-world situations when our employee users are working—no separate test environment or effort is necessary. This helps minimize costs and provides higher-value data. We can gather data from as many OEM platforms as are in use by the users.

By dividing the user population into three rings and automating the deployment of configurations to each ring, we can test a configuration three times, each time deploying an improved version of the configuration based on the previous ring's feedback. Our methodology makes it easier for users to participate and creates more opportunities for feedback and improvements. It also enhances tracking of configurations being tested and increases the number and variety of configurations under test. The resulting test information can help our product development group rapidly test and improve products.

Automated In-House Testing Deployment and Monitoring Architectures

Automated deployment enables us to test more hardware and software configurations, but it also increases the volume of data to process. To keep up with this increased velocity and data growth, we automated data collection, packaging, and uploading; data analysis; and reporting. We repurposed existing architectures and processes into new architectures that include automation capabilities.

In-House Testing Deployment Architecture

Intel's product development groups and IT both benefit from automating the deployment of test configurations. The product development groups control the testing flow, deciding what to test, when to test it, and who (which test population) gets each configuration. Intel IT has more control over test configuration contents, defining the test population, and deploying the test configurations. Test configurations can be deployed without interrupting users' workflows, although our system notifies users of what's being deployed.

Figure 2 illustrates the four-step automated deployment process:

1. Through the management portal, administrator determines the testing ring that receives the configuration and defines the configuration to be deployed.
2. The administrator associates each test ring with a directory service group.
3. The administrator prepares drivers, OS version assignments, provisioning parameters, and other configuration details in a file share and deploys it to the testing ring defined by the directory service group, which is dynamic.
4. A third-party endpoint-management application continuously monitors the configuration under test and automatically applies the appropriate changes or configurations to the testing ring.

We also constructed a directory service organization unit and group policy for the deployment architecture, enabling specific settings for each testing ring.

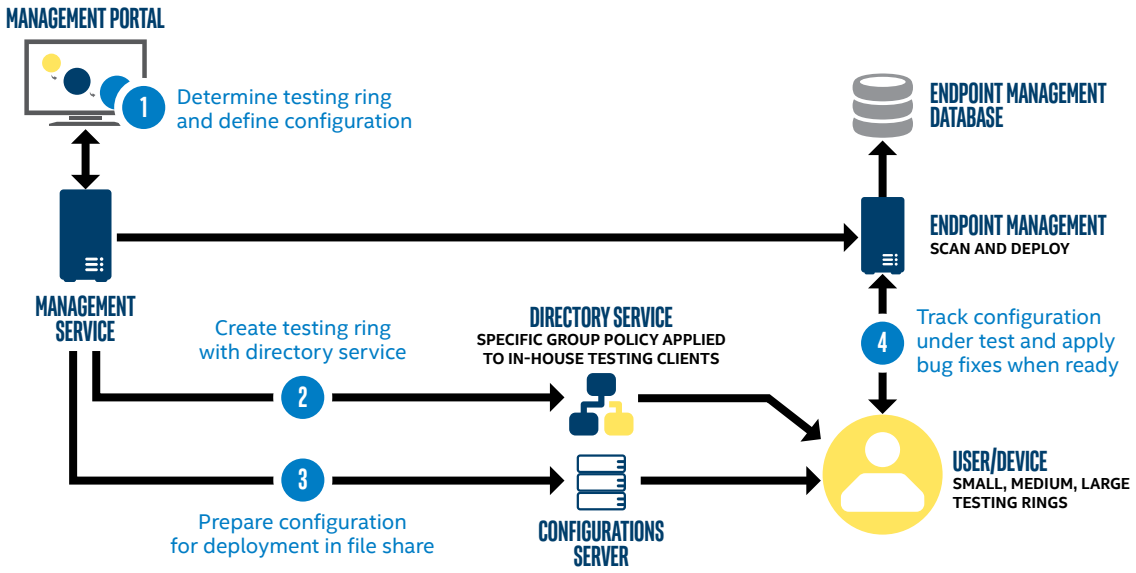

Figure 2. The four-step automated deployment process. Intel product development groups can deploy more tests, and Intel IT has more control over the testing environment to help manage the resulting additional complexity.

In-House Testing Monitoring Architecture

After deploying a test configuration, the automated monitoring architecture (illustrated in Figure 3) collects, analyzes, and reports on event data for that configuration.

Using a combination of EMM and custom services that we created, we automated the monitoring of in-house testing processes, including the following:

- Collection of log and event data
- Analysis and reporting of collected data
- Configuration changes based on insights gained from data analysis
- Device updates of changed configurations using the endpoint management application

A new collection server stores relevant occurrences of BSODs and WEFs and connects the data to the pertinent client details, such as platform name, SKU, and wireless adapter information. The IoT agent complements existing monitoring capabilities by summarizing events of long duration, such as connectivity. It provides insight into complex behaviors composed of several events over time.

We use the EMM's scanning capability to harvest OS and driver data to monitor each user's WLAN devices and configurations. We also have a customized connection between WEF data and BSOD logs. We automate the analysis of this data to obtain a better understanding of all WLAN behaviors.

During analysis, we trace connectivity flows, new and trending issues, issue frequency, and distribution of issues associated with the same function over time. Because this all happens in real time, we do not have to wait for users to provide log data. Private debug symbols help to quickly determine the root cause of a PC crash, so developers can fix issues immediately.

After analysis, third-party reporting services help us view raw data feeds on a dashboard (see Figure 4). Feeds include collected attributes or data, issue priorities, amounts, and normalized figures and trends. This visual display enables us to rapidly identify and respond to problems.

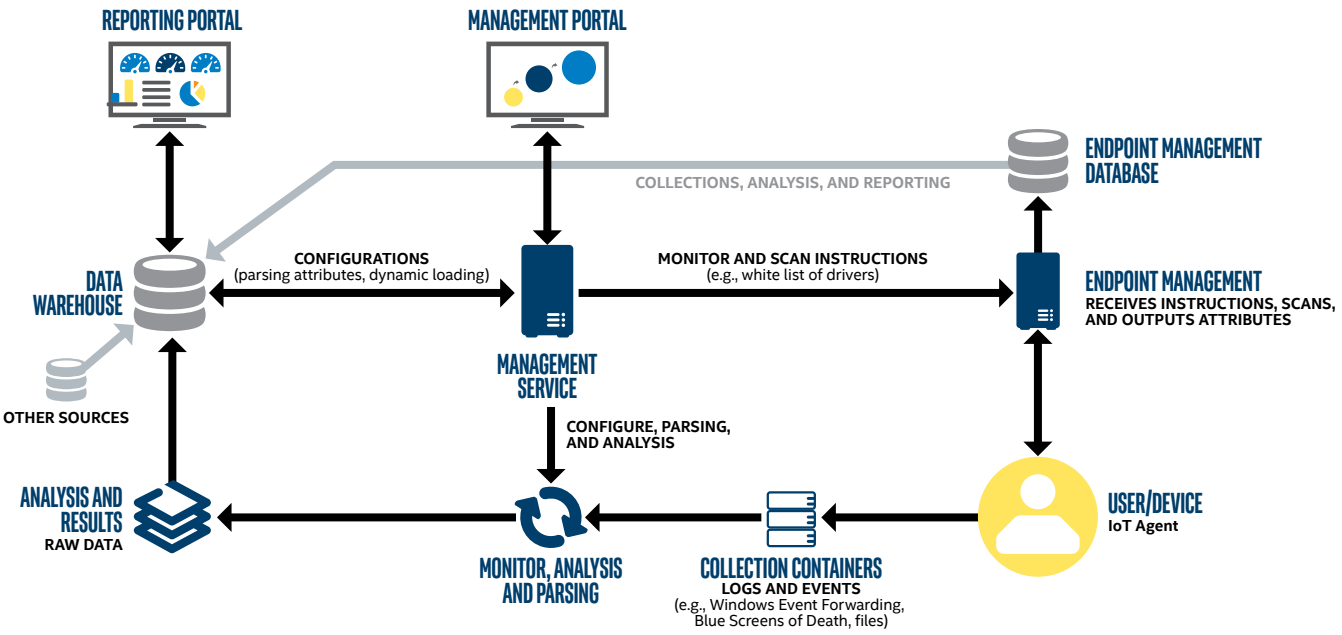

Figure 3. In-House Testing Monitoring Architecture. After a test configuration is deployed, the monitoring architecture automatically collects, analyzes, and reports on data from BSODs and WEF occurrences.

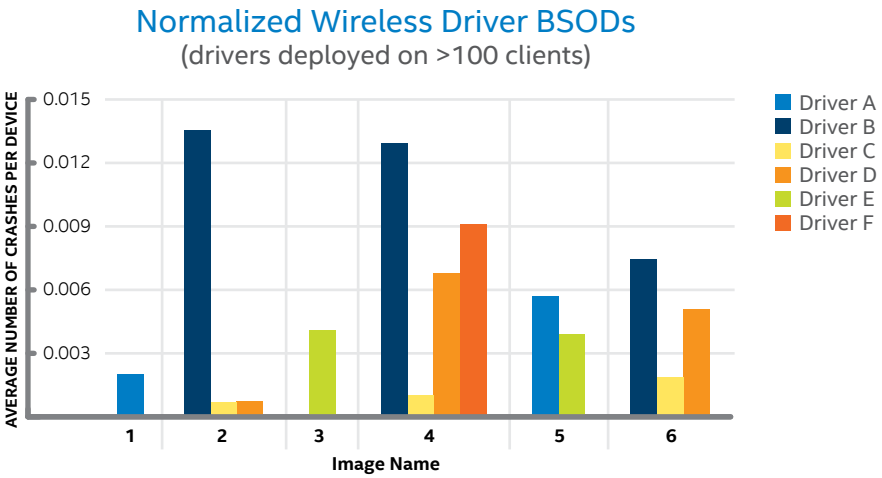

Figure 4. Third-party tool displaying raw data. The data gathered during automated in-house testing shows that driver B crashed more than any other driver.

Results

The automated deployment and monitoring architectures we've put in place deliver significant benefits to the WCS group as well as to Intel IT. We plan to extend these benefits to other groups across Intel.

Strategic Value to Intel Product Development Groups

The product development groups benefit from the following:

- **More comprehensive and rapid feedback about product quality.** Our partnership and automated systems enable product development groups to gain deeper real-world testing insights before they deliver products to OEMs and the marketplace. These insights can lead to higher-quality products and faster product introductions.
- **Reduced time and cost for analysis and validation.** With our manual process, it used to take 60 minutes to identify issues and analyze which issues to fix. Now, with automated in-house testing, it takes only about five minutes, which results in a savings of 37,500 engineer hours per 1,000 users. For one product, releasing debugged configurations to the users using the automated processes eliminated the need to staff QA testers to manually test and release the configurations, saving approximately USD 5,000 per month.
- **Faster, lower-cost problem fixes.** Automation allows us to monitor how each issue evolves as fixes are applied. In the first 6 months of using the automated testing system, we resolved more than 30 issues, which equates to a savings of nearly USD 128,000 that we would have spent on recreating conditions to cause and debug the issues.

4 PRODUCT DEVELOPMENT GROUP BENEFITS

- More comprehensive and rapid feedback about product quality
- Reduced time and cost for analysis and validation
- Faster, low-cost problem fixes
- Better prioritization of high-impact problems

30 ISSUES RESOLVED
in the first 6 months from using the automated testing system.

- **Better prioritization of high-impact problems.** Visualizing information from multiple data sources helps us identify trends. We know how many clients were exhibiting a specific problem, at what frequency, and with what variances. This information helps us determine the impact of issues and prioritize fixes. For example, if a certain issue occurs on 50 percent of the clients while other issues are less common, we focus our efforts on fixing the one with most impact.

The Benefits of In-House Testing

Here are three examples of how automated in-house testing has helped prevent problems from escalating beyond our testing rings:

- **Damage control.** When the WCS group wanted to deploy a driver to OEMs, we used automated in-house testing to determine whether the driver was ready. After spending about an hour defining the testing population and deployment rings, we posted the driver on the file share and deployed it to the small ring. Within minutes we identified two issues: some older adapters caused network disconnections, and we recorded one instance of a BSOD. We immediately advised the product development group not to deploy that version of the driver to OEMs. They created an improved version within a few days, and it passed through all of the testing rings without issue.
- **Methodical testing.** A specific power management registry setting prevented connected standby PCs from waking properly when their covers were opened. We deployed multiple configurations to a small ring until we identified the correct registry change that delivered consistent results. Then we expanded deployment to the larger rings to eliminate the issue.
- **Seeing the bigger picture.** One new driver version showed inconsistent disconnection behaviors that could not be attributed to the deployment. We determined that a local firewall was blocking connectivity, creating issues with the firewall configurations. In this case, in-house automated testing validated the driver and identified issues elsewhere in the network. This example illustrates the value of testing in real-world environments, where we can achieve results not possible in a controlled lab environment.

3 IN-HOUSE TESTING BENEFITS

- Damage control
- Methodical testing
- Seeing the bigger picture

Conclusion

By partnering with Intel's product development groups, Intel IT can provide input on how products perform and how they can be improved. We host a live IT environment where products can be tested before they are delivered to OEMs and the open market. These partnerships result in better products, improved collaboration, and strategic value for future product development—as well as improved IT efficiency.

In a joint effort with the IOTG, Intel IT and the WCS group have automated in-house testing to streamline the maintenance of wireless client health and the product release cycle for Intel wireless products. By eliminating many manual testing processes, automated in-house testing identifies more issues and configurations more quickly. We closed more than 30 issues in the first 6 months as a result of in-house testing, saving approximately USD 128,000 that we would have spent recreating conditions to cause and debug the issues. Our in-house testing has been successful, and we anticipate that it will continue to improve Intel's wireless products and accelerate their time to market.

We plan to extend the benefits of in-house testing across Intel by partnering with more product development groups. As we expand the initiative, we will need to consider complexities such as cross-product impacts on users and multiple configuration subsets. Many challenges lie ahead. From what we've seen so far, we believe that the value of automation to the enterprise outweighs the challenges.

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