

## Improving Facility Operations with Intel® Architecture-based Tablets

Technicians using tablets reported an increase in productivity of 3 to 17 percent, based on number of completed work orders.

### Executive Overview

**Intel IT conducted a proof of concept (PoC) that demonstrates the potential productivity and efficiency gains associated with providing facility technicians with Intel® architecture-based tablets. This PoC is one part of our multi-year effort to adopt lean manufacturing processes—maintaining support costs even as our facilities continue to grow.**

Intel's factory sites are extensive—some of them cover over four square miles. Within our factories, Intel facility technicians are responsible for every utility system and piece of ancillary equipment associated with those systems, keeping them running 24x7. During the course of a year, facility technicians complete about 60,000 regular maintenance operations, in addition to emergency repairs.

Typically, facility technicians print a work order and instructions from a desktop PC, and then walk to inspect the system that needs attention. At that point, if the system needs to be shut down, the technician either has to walk back to the desktop to access the master control system, or call a colleague and ask for assistance. This wastes both time and resources. Several years ago, we provided technicians with personal digital assistants but realized that those devices suffer from usability and connectivity issues that prevent them from significantly impacting productivity.

During the four-month PoC using Intel architecture-based tablets, we gave tablets to 12 technicians, enabling them to access

the master control system and real-time instructions from the field. They could also start and close work orders on the tablet without returning to the desktop. Technicians using tablets reported an increase in productivity of 3 to 17 percent, based on number of completed work orders. Management also benefited by gaining greater insight regarding the number of work orders being accomplished and those remaining to be finished.

Benefits from using the tablets include:

- Streamlined technician processes
- Reduced wasted motion by giving technicians necessary controls at work site
- Improved strategic management of maintenance work orders
- Increased completed repair work orders
- Strengthened communication capabilities

This year, we intend to roll out the tablet solution worldwide to approximately 754 facility technicians. Eventually, we intend to extend this solution to all factory workers, aligning similar practices and efficiencies.

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## BACKGROUND

**In our multi-year effort to adopt lean manufacturing processes—maintaining support costs even as our facilities continue to grow—Intel IT began investigating the use of mobile technology to increase facility technician productivity and organizational velocity. Our technicians are responsible for maintaining all the infrastructure and equipment on these sites, keeping Intel’s factories running 24/7.**

As one of the world’s largest makers of silicon chips, Intel’s success depends on the performance of its factories. Facility technicians complete over 60,000 planned maintenance activities each year. Examples of equipment needing regular maintenance include chillers, vacuum pumps, ultrapure water systems, chemical and liquid waste systems, heating and cooling equipment, bulk chemical and gas delivery systems, and electrical systems.

Currently, Intel facility technicians use desktop PCs to manage their workload, print

procedures and work orders, answer email, and perform other office-related tasks. Using automated control and monitoring systems on their PCs, they can remotely turn equipment on and off. However, actually fixing and maintaining equipment requires them to be physically present at one piece of equipment or another for major portions of the day.

As a result, the technicians must print out and carry hard copies of procedures to their work sites and then spend a considerable amount of time walking back and forth between their desktops and whatever pieces of equipment need attention. Intel’s factory sites can be large—some of them covering two to four square miles—so this travel time can significantly reduce technician productivity. Or, instead of walking back to the desktop, a technician in the field needing assistance can call other technicians at their desktops to coordinate equipment monitoring and control; however, this process also involves waiting time, especially if another technician is not immediately available.

Figure 1 illustrates inefficient paper-based facility maintenance processes.

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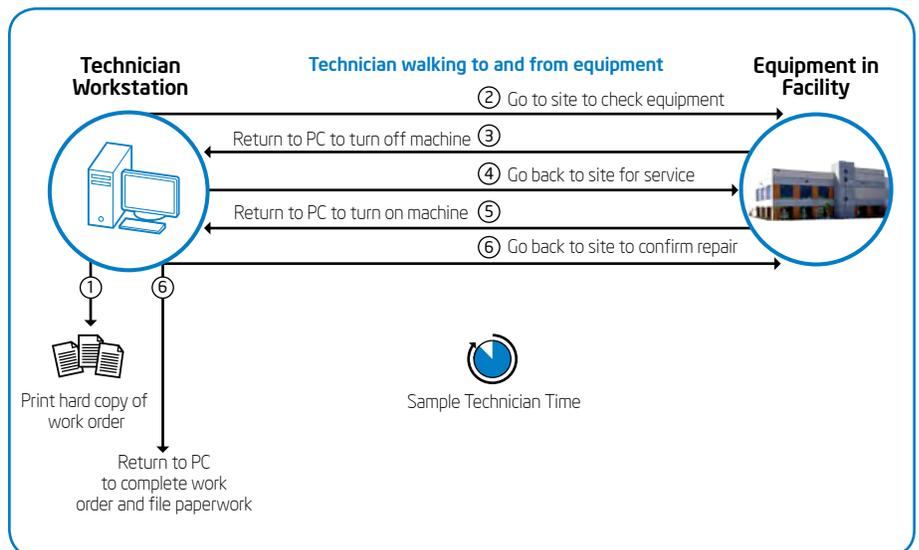


Figure 1. Today, facility technicians’ processes rely heavily on paper.

To boost technician productivity and streamline this manual, paper-based process, Intel IT started investigating mobile technologies. Seven years ago, the only mobile technology that made sense in the factory environment was personal digital assistants (PDAs). However, we experienced limited success with technicians using PDAs, due to several factors:

- Most enterprise applications don't run on these devices.
- The screen size is small, so even those applications that are available are difficult to use.
- Network connectivity is not always available across a facility.
- Recently, PDAs are becoming harder to procure.

Three years ago, we began working with IT Engineering to determine if there was a better way to increase facilities technicians' mobility, and therefore their efficiency. We investigated several options.

We looked at laptop PCs, but felt they were not appropriate for the facility technicians' environment. For example, a technician is usually carrying tools, and rarely has somewhere to put things down, except on the floor. Therefore, the larger, clamshell form factor of a laptop PC proved awkward.

We also investigated smartphones, but the screen size on those devices was too small to adequately display the master system screen, which shows the overall status of equipment within the facility.

A third option we considered was using a non-Intel® architecture-based tablet. However, although the tablets had the right form factor, this approach would have required investing in a virtualization solution to interface with our enterprise Microsoft Windows\*-based applications. The virtualization approach reduced performance

and user experience quality, and would have involved additional licensing costs.

Based on these investigations, we found that a tablet based on Intel architecture was the best solution for us. These tablets allow direct connectivity to our enterprise network and applications, while having an efficient touch screen and suitable processing performance. Typical for tablets, this is a specialized niche application; tablets are companion devices that complement but do not replace PCs for Intel employees.

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## SOLUTION

**Working with IT Engineering, we tested a variety of Intel architecture-based tablets. We tested tablets based on both the Intel® Core™ i5 processor and the Intel® Atom™ processor. In our tests, the performance of the Intel Core i5 processor-based tablets was better, and response time to touch-screen interactions was fast and smooth. In addition, tablets based on the Intel Core i5 processor supported the standard IT client build, which includes many necessary security features.**

Based on these tests, we decided to make resources available to facilities technicians using a familiar user interface—web-based Windows applications—and an Intel Core i5 processor-based tablet. Although we chose tablets based on the Intel i5 Core processor for our proof of concept (PoC), in the production rollout of the solution we anticipate using tablets based on both Intel Core i5 processors and Intel Atom processors.

## Proof of Concept

To illustrate the potential efficiency gains associated with Intel architecture-based

tablet use by facility technicians, we conducted a PoC from November 2011 to March 2012.

For the PoC, we gave tablets to a dozen technicians. We engaged with supervisors and managers to help us find a range of appropriate participants—early adopters as well as those who were less enthusiastic about new technology.

The participating technicians were a representative sample of the entire technician population, although we restricted the PoC to a single site. Half of the participants worked day shifts, and half worked shifts at night. The group worked across all functional areas: mechanical, electrical, instrumentation and control, bulk chemicals, industrial waste, and ancillary equipment such as chillers and vacuum pumps.

Using the tablet, a technician was able to monitor, manage and control any system on the campus, such as a pump on the roof, power distribution, industrial waste systems, or water purification systems. All these systems were controllable from the tablet using a 3G or Wi-Fi\* connection.

A participating technician could walk to the job site, and then use the tablet to log on to the facilities control system. From the tablet screen, the technician could control the system while standing next to it, make system changes, and then return the system to service. The technician could subsequently complete a work order on the tablet to document the work. The technician no longer had to return to the desktop to obtain information about the service order. Using the tablets' communication capabilities, such as instant messaging, enabled a more proactive approach to repair and maintenance issues.

The streamlined tablet-based facility maintenance process is illustrated in Figure 2.

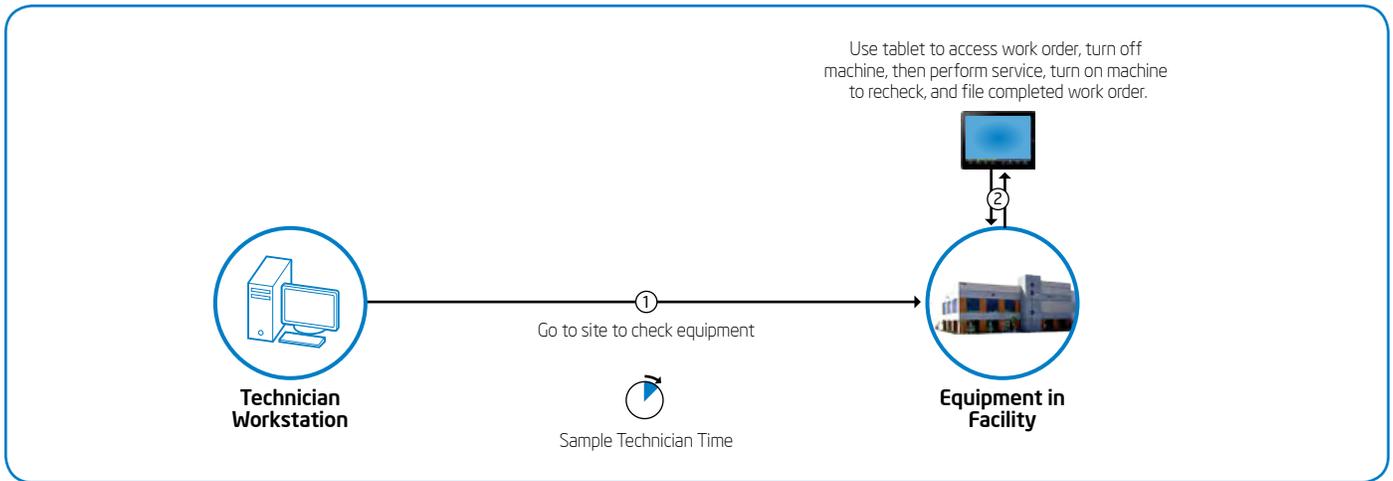


Figure 2. Tablets free technicians to increase job efficiency and business velocity.

## Solving Technical Challenges

The inherent nature of our manufacturing environment, such as very large non-office-like areas and concerns over the security of intellectual property (IP), presents some technical barriers to facility technicians using tablets. Also, tablets are a maturing technology, and design improvements are needed in order to make them an even better tool for factory technicians. We are investigating solutions to these challenges, which include working with industry suppliers.

### CONNECTIVITY

During the PoC, tablets connected to Intel’s network using either a Wi-Fi or 3G connection, whichever was available in a certain location. However, technicians often work outdoors, on roofs, or in basements, where neither type of connectivity may be available, or the connection quality may be less than ideal.

We are investigating improving connectivity in Intel’s factories. Although Wi-Fi is in general faster and more secure than 3G, it is also more expensive to make widely available. We are searching for a low-cost solution to make Wi-Fi available throughout all facilities.

In the meantime, we will continue to use a combination of Wi-Fi and 3G, recognizing 3G limitations of a high service-provider-cost per user, inconsistency across sites, and variable quality of 3G service at the site level due to external factors unrelated to Intel.

### CAMERA DISABLEMENT

Due to IP concerns, we needed to disable the tablets’ cameras. Currently, all consumer devices on the market include built-in cameras. For the short term, we are encouraging manufacturers and OEMs to provide enterprise solutions that do not include a camera. Longer term solutions will hopefully enable managed control over the camera and other device features, such as the USB port.

Our current software solution and monitoring capability provides sufficient IP protection to progress with PoCs and pilot programs for facility technicians’ tablets. We have created a network group policy that by default disables the camera in all tablets used in Intel factories. Further controls, such as the user’s removal from the administrator group, are necessary to avoid any interference with the policy intent. This policy also prevents the user from re-enabling the camera feature. At the moment, this is only

a proposed solution for a specific use case and is not yet approved for general use.

### WHOLE DISK ENCRYPTION

Our existing enterprise-level encryption solutions work well with Intel architecture-based tablets. However, they do require the use of an external keyboard to enter the passphrase every time the tablet boots up or resumes from hibernate. Technicians in the field may not have their keyboards with them. For this reason, we examined other solutions available on the market and found two encryption products that could be used for Windows-based tablets that did not require the use of an external keyboard. However, it was not feasible to integrate these solutions with Intel’s enterprise infrastructure, such as our Active Directory and network group policies.

Instead, we decided to work with a third-party supplier with whom we already had a relationship, and whose encryption product was already integrated with our systems. This supplier agreed to modify the product, enabling a virtual keyboard compatible with the tablets’ touch screen. The solution offers a stronger encryption than the solution available for laptops today.

## BATTERY LIFE

Currently, no tablet on the market features a battery life that can last an entire shift of 8 to 12 hours. Therefore, until the market matures, technicians will have to recharge their devices during their shifts, typically over a meal break.

## ACCESSORIES

We found that the accessory ecosystem for Intel architecture-based tablets is not yet mature, with the availability of only a limited selection of carrying cases and sleeves, ergonomic tools such as keyboards, water-tight cases, and other accessories. However, with some diligence, we were able to purchase suitable supporting accessories, providing PoC participants with waterproof cases for inclement weather conditions; carrying cases that can accommodate larger form-factor tablets; and accessories that make a tablet more ergonomic to use, such as a wireless keyboard and a wide shoulder strap.

## HELPING EMPLOYEES EMBRACE CHANGE

**In reviewing feedback from our PoC, we realized several key learnings that will influence how we move ahead with this project, easing our employees' transition to the new processes and technology.**

Although 30 percent of the PoC participants found the tablet extremely useful and wouldn't give it up, 70 percent of the participants preferred the existing paper-based processes. Interestingly, although younger employees are in general portrayed by the high-tech industry as more likely to be early adopters of technology, we did not experience any age-related correlation between whether a PoC participant liked or disliked using a tablet.

After talking to the PoC participants, we learned there were several reasons for their concerns. First, the overall goal of the PoC was to demonstrate that tablets could increase technician efficiency. However, many employees considered the manual process to already be efficient and were reluctant to admit efficiency could be improved. Also, in many cases, the 3G connection was slow, making the tablets seem less efficient than paper. Wider availability of Wi-Fi will help employees become more comfortable and confident with the new process and technology.

In addition, we initially underestimated the amount of formalized training and support needed to implement the new tablet solution. For the PoC, our training consisted of giving the participants a basic online presentation that featured screenshots. We also implemented an internal blog that enabled employees to ask questions online and obtain answers from other participants who were online at the same time. Our goal for the blog was to create an environment where participants could teach themselves and each other. We found that technicians who were already using their tablets and experiencing efficiency gains tended to inspire other participants to use their tablets more.

As we expand technicians' use of tablets, we will continue the blog, encouraging peer education and support. We will also make available more training options, such as:

- Hands-on training, where users can experiment with the tablet to increase their familiarity with its features before actively using it in the working environment
- Online videos that explain how tablets work and how technicians can successfully use them in job functions

We are confident that increased training and better communication will help us continue employees' successful transition to the new tablet technology.

## RESULTS

**Facility technicians reported that using tablets to accomplish their tasks resulted in much less wasted motion. For example, technicians participating in the PoC could resolve a maintenance issue without having to either walk back to the desktop or involve another employee's time to control the equipment. Overall, technicians participating in the PoC reported a productivity improvement of 3 to 17 percent, as measured by the number of work orders processed per day.**

Other benefits from using the tablets were as follows:

- Participants had better access to timely, up-to-date information. For example, procedures could be accessed from the tablet in real time and from anywhere, instead of having to be printed out several hours in advance.
- Management gained a greater, more timely insight regarding the number of work orders being accomplished and those remaining to be finished. Technicians could use the tablets to open and close work orders in the field, with the device calculating the work order start and stop times and logging this data into our maintenance management system.
- Completed repair work orders increased because technicians could more easily handle and document repair issues identified in the field on a daily basis.
- Intel architecture-based tablets provided better communication capabilities, such as instant messaging. This helped teams work together, enabling them to be more strategic, rather than operating in a reactive mode.

The PoC results helped us understand the global benefits of having facility technicians use tablets in all Intel manufacturing facilities.

## CONCLUSION

**Our PoC demonstrated that providing facility technicians with Intel architecture-based tablets helps increase organizational velocity, enabling employees to accomplish more in less time. In addition, as technicians become more efficient, we anticipate being better able to contain IT support costs while expanding additional facility and maintenance responsibilities.**

Using Intel architecture-based tablets to complete work orders as they maintain Intel's extensive factories—some of them over four square miles in area—frees technicians from an inefficient paper-based process.

With tablets, technicians are able to access the master control system from the field, obtain real-time data and instructions, and start and close a work order without having to return to their desktop. Because the tablets log the work order information directly into the maintenance management system, management immediately gains greater insight into the number of completed and outstanding work orders.

Based on the results from the PoC, in which technicians reported an increase in productivity of 3 to 17 percent, we intend to extend the Intel architecture-based tablet solution this year to all Intel facility technicians worldwide. Eventually, we plan to provide tablets to all factory workers, enabling them to achieve similar efficiency and productivity gains.

## ACRONYMS

IP	intellectual property
PDA	personal digital assistant
PoC	proof of concept

**For more information on Intel IT best practices, visit [www.intel.com/it](http://www.intel.com/it).**

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