IMPROVING MANUFACTURING PROCESSES AT A SEMICONDUCTOR FABRICATION FACILITY

How Splunk Software Applies Real-Time Analytics to the Internet of Things

CUSTOMER PROFILE

Splunk customer profiles are a collection of innovative, in-depth use cases that highlight the value that Splunk customers gain from collecting, analyzing and visualizing the massive streams of machine data generated by their IT systems and technology infrastructures.

Each “real world” customer profile introduces a unique business challenge and shows how leveraging machine data and Splunk software in new and interesting ways has helped drive powerful business and operational outcomes.
Executive Summary

Over the past decade, the world of global electronics manufacturing has been transformed. The electronics and Internet revolutions, combined with machine intelligence, have yielded results that were once the stuff of science fiction. On factory floors, automated decisions direct material carriers—strategically driving and rerouting high-cost components through dozens of processes, avoiding bottlenecks and maximizing efficiency.

One Splunk customer, a $10 billion APAC electronics manufacturer, was facing some challenges. This customer creates chips for its own products and also contracts with other companies to make integrated circuits for use in automobiles, smartphones, televisions, home appliances, thermostats and medical devices.

To get the operational visibility it required, the customer determined that it needed four solutions, including a Complex Event Processor (CEP) system, a big data platform, a statistical management platform and industrial visualization software. A team of 20 specialists who were in the process of weaving these systems together for a working prototype estimated it would take a full year. Then, one of the operations managers happened to attend a meeting in another part of the semiconductor facility where Splunk software had been rolled out to meet security requirements. Further research revealed that not only could...
Splunk software be applied to the machine data coming in from the manufacturing floor, but it could also handle all four of the major functions required in the prototype.

A four-person team of Splunk experts put together a working proof-of-concept in three months, which they presented on a Friday afternoon. When company decision-makers realized that the Splunk platform would have an immediate, positive, demonstrable impact on yield and profits, they wrote the purchase order the following Monday and began deployment immediately. Splunk software soon proved it had the capabilities of all four solutions in one comprehensive, easy-to-tailor platform. Applying the all-in-one Splunk solution replaced chaos with synergy—optimizing yield, stopping bottlenecks and preventing downtime in the ever-evolving world of semiconductor fabrication, while saving millions of dollars in the process.

With Splunk, the customer has:

- **Complex event processing capability in near real time** due to Splunk software’s ability to correlate data, create meaningful searches and spot anomalies and opportunities on-the-fly
- **A big data platform** for real-time data collection, storing and querying
- **A statistical management platform** that enables access to tools and equations that provide answers
- **Visualizations** that enhance pattern learning and insights for the business, as well as operational staff

**The Journey From Wafer to Chip**

Wafers are typically small, thin, shiny silicon disks, created from highly specialized processes. The disks, which resemble DVDs, are about 1 inch to 18 inches in diameter. Wafers are the canvas on which computer chips are drawn, etched and chemically processed. The larger the wafer, the more chips can be created at one time. A run of wafers can produce chips worth millions of dollars.

Wafers undergo multiple processes on their journey toward becoming chips, including:

- Cleaning
- Texturing
- Etching
- Ion implantation
- Doping
- Deposition of materials
- Photolithographic patterning
- Dicing

At this Splunk customer’s manufacturing plant, a wafer might go through dozens of steps on its path to becoming a series of chips. Several processes take weeks and are so complex that precision is measured in terms of atoms, yet length of etched pathways are measured in kilometers. Automated carriers move the wafers from station to station. While certain processes have to happen in a set order, a set order isn’t critical to all processes. Intelligent decision algorithms enacted in real time change the order of processing depending on bottlenecks, downed machines and related factors. In the past, all of this machine data was critical and important, but it took weeks to get log data and longer to get meaning from it. The manufacturer wanted to decrease downtime to ensure profitability and eliminate delays in its customers’ finely tuned processes as well.

Unfortunately, many things can go wrong in the process of creating wafers. Here are just a few examples:

- Processes can get stuck in an infinite loop, repeating the same steps or series of steps
- A defect can occur on a line or in a process
- A critical process step can be stopped or broken
- A carrier can be stopped, backing up traffic
- A set of wafers can be flawed

Each of these processes can significantly affect yield, which affects profits. Previously, it was difficult for operations management to keep up with automated processes, let alone optimize them. Meanwhile, competition was fierce and demand was high. With each significant improvement there was a substantial risk of unintended consequences.

**Enter Splunk**

Splunk software makes it possible to tune manufacturing systems to create immediate corrective actions and rules, causing issues to be fixed in minutes rather than hours, or hours rather than weeks, depending on the complexity. For example, after team members used Splunk software to understand processes and error conditions with more insight, they created Splunk alerts to interact with manufacturing software to catch problems early. This resulted in immediate return on investment: the Splunk implementation paid for itself soon after it was deployed. Figure 1 shows what happens when an issue occurs between the third and fourth process step. (Note: In the illustration and those that follow, hundreds of steps are condensed into eight in order to make complex scenarios understandable. In actuality, Splunk software has been used to tailor more than 200 rules and corrective actions for hundreds of possible scenarios.)
The customer designed its manufacturing software to respond to conditions, backups and defects in the most efficient way possible, so that when feasible, a wafer might undergo Process 4 prior to undergoing Process 2, for example. And if there is a defect after a process, a wafer might repeat a prior process or the same process, until the defect is fixed. But things can go wrong. For example, a wafer can get into an “infinite loop” and cause bottlenecks or other issues on the manufacturing floor. Figure 2 illustrates “normal” and alternative paths, including some paths that are indicative of defects or problems in the manufacturing process.

Before Splunk software, it was nearly impossible to gain insight into which alternative paths were associated with later defect issues. But when the customer applied the Splunk solution to the problem, it was finally possible to see the big picture and find opportunities to tune the processes even further.

The semiconductor business is built on continual miniaturization and innovation. But before you innovate, you need to know what you have. This Splunk customer realized quickly that Splunk software could help it define and discover the following “silicon-gold” to increase its yield and profits:

- Known Good: The baseline, what they knew worked
- Known Bad: Users predefining search patterns manually—they had to know what they were looking for before they could find it, which was time consuming
- Unknown Bad: They needed to find these and write alerts to prevent them in the future
- Unknown Good: To find this, apply statistical models for process optimizations

Because of conditions on the manufacturing floor, at times the order of processes differed from the “known good.” Statistics predict that if some of these deviations were less profitable, others might be more profitable. With Splunk software, analysts were able to build searches and dashboards to discover “unknown good” and optimize profits in novel, unexpected ways by rerouting the maximum number of wafers through the paths that would maximize profits via significant productivity gains. Splunk software made it possible to follow the clues to higher profits through a maze of data.

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With Splunk, Success Was Clear

In this customer profile, we explored how Splunk software enables Operational Intelligence and business analytics on the manufacturing floor, applying Splunk analytics to the emerging world of Internet of Things. This customer plans to increase its use of Splunk software in the current fabrication facility because the insights gained will pay for themselves tenfold.

This use case demonstrated:

- The ability to collect and index data. Because Splunk software indexes all kinds of data, the customer can finally see how complex manufacturing processes intersect, enabling the customer to find synergies and patterns that were previously invisible.
• **The ability to correlate and analyze.** Because Splunk correlates different types of data, the customer has discovered ways to maximize yield and minimize factory downtime.

• **Flexible analytics powered by a read-time schema.** Because Splunk collects data in full fidelity without filtering, the customer can quickly adapt when the format that a new machine or process outputs changes unexpectedly. The customer doesn’t need to spend months getting disparate systems to make sense.

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**Next Steps**

• To learn about Splunk customer success, ROI stories, customer profiles and more: [www.splunk.com/customers](http://www.splunk.com/customers)

• Splunk software is also available as a free download. Get started today: [www.splunk.com/download](http://www.splunk.com/download)

• If you would like to speak to a salesperson, please use our [online form](http://www.splunk.com/asksales).