CASE STUDY

OPTIMAL+
Manufacturing Intelligence

Marvell Improves Engineering Operations With Optimal+ IIoT Product Analytics

MARVELL®

Founded in 1995, Marvell Technology Group Ltd. has operations worldwide and more than 7,000 employees. A leading fabless semiconductor company, Marvell ships over one billion chips a year.

Marvell's expertise in microprocessor architecture and digital signal processing, drives multiple platforms including high volume storage solutions, mobile and wireless, networking, consumer and green products. World class engineering and mixed-signal design expertise helps Marvell deliver critical building blocks to its customers, giving them the competitive edge to succeed in today's dynamic market.

This case study discusses Marvell's approach using Optimal+ IIoT product analytics software for their semiconductor manufacturing and test operations.

As the semiconductor market continues to grow and mature, many companies are exploring innovative methods that will enable them to appreciably improve product yield. With global supply chains delivering millions of devices every month, any measurable improvement in manufacturing operations can directly translate into significant revenue gains from reclaimed semiconductor yield. With a proven track record, Optimal+ IIoT solutions provide an efficient gateway for technology companies to access these sizeable revenue gains from high-volume manufacturing.

"The data transparency provided by Optimal+ enables our operations team to rigorously analyze every facet of manufacturing to drive yield improvement."

Marc Jacobs,
VP of Engineering Operations, Marvell

For Marvell Semiconductor, the ROI generated through increased production yield is a strong financial justification for the purchase of IIoT solutions from Optimal+. This justification was derived from a comprehensive product analytics pilot project completed by Marvell Operations and Optimal+ engineers. The outcome of that pilot project quantified the yield benefits for financial executives and manufacturing operations teams of both companies.

In addition, Marvell anticipates subsequent benefits from the use of other Optimal+ IIoT solutions in applications beyond manufacturing operations. These benefits were not as straightforward to quantify during the pilot project, yet the impact of these subsequent benefits are even more significant than the yield improvement triggered by Optimal+ solutions.

This case study covers several of these additional long-term ROI benefits that Marvell Semiconductor has realized, in addition to the original manufacturing-related "hard" benefit of increased yield, since the adoption of the Global Ops™ for Semiconductor solution from Optimal+.

Data Transparency Opens the Door

The foundation for all benefits (immediate and long-term) from Optimal+ solutions is based on connecting the manufacturing ata silos and gaining rapid availability of complete and high-integrity productdata. Faster time-to-actionable information enabled Marvell's manufacturing teams to make swift, informed decisions that translated into timely and quantifiable outcomes. For Marvell, the primary benefit of adopting solutions from Optimal+ was an increase of 0.5 percent to one percent in recoverable yield across all product lines – a substantial revenue gain based on monthly IC manufacturing quantities.

Two other benefits that Marvell anticipated early on in the pilot evaluation were better equipment utilization and improved financial tracking. Even though these benefits could not be quantified to the same level of certainty as yield improvement during the pilot, the data transparency provided by the Optimal+ IIoT solutions drove subsequent benefits for Marvell during mass production.

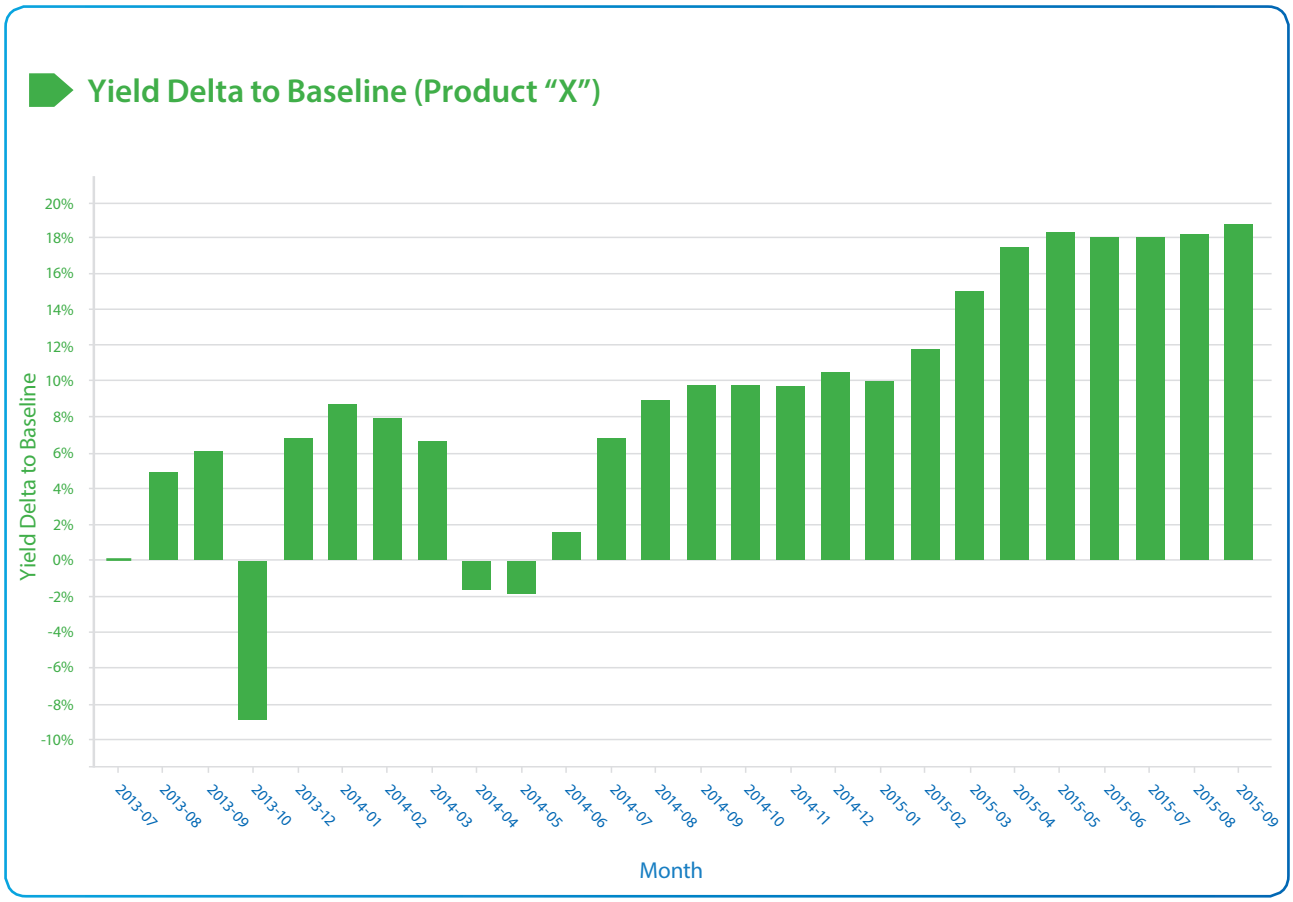

Figure 1: Product Yield Improvement by Month for Product "X"

IIoT Transparency Drives Financial Improvements in Operations

As one of the major fabless semiconductor vendors in the world, Marvell has a global supply chain comprised of multiple foundries and Outsourced Semiconductor Assembly and Test Services (OSAT s) spread out across Asia. To drive this supply chain, Marvell Asia Pte. Ltd. (MAPL) was established to be the regional headquarters and design center in Singapore, chartered with critical responsibilities including manufacturing operations and OSAT management. Marvell Semiconductor U.S. headquarters and MAPL work hand-in-hand to deliver more than 1 billion chips every year targeting high-volume storage solutions, mobile and wireless, networking, consumer and green products. Both organizations search for continuous ways to improve manufacturing operations.

One such area was throughput improvement in manufacturing test operations. As Marvell and

"The manufacturing visibility provided by Optimal+ is enabling MAPL to drive the most efficient supply chain in the semiconductor industry."

Hoo Kuong,
Managing Director
& Vice President, MAPL

MAPL Operations teams started to mine the comprehensive product data made available by Global Ops, they discovered instances where the tester index time for a given device could vary widely, up to a 2x difference in overall time. By analyzing bin data for a given device, the Marvell and MAPL Operations teams were able to streamline many tests and reduce overall test time.

In just one instance, Marvell achieved a 20 percent improvement in overall throughput for a single high-volume product, which was the equivalent of saving the cost of two testers for an entire year.

A second area of savings was the ability to perform better financial tracking and analysis. In 2013, Marvell Operations was investigating the purchase of additional probe cards to support additional test capacity for some high-volume devices. With complete tester and product data now available within Marvell, the finance organization was able to perform a Revenue vs. Expense Analysis by leveraging equipment utilization data.

This analysis showed that additional probe cards were not necessary and would not impact product revenue. When this analysis was

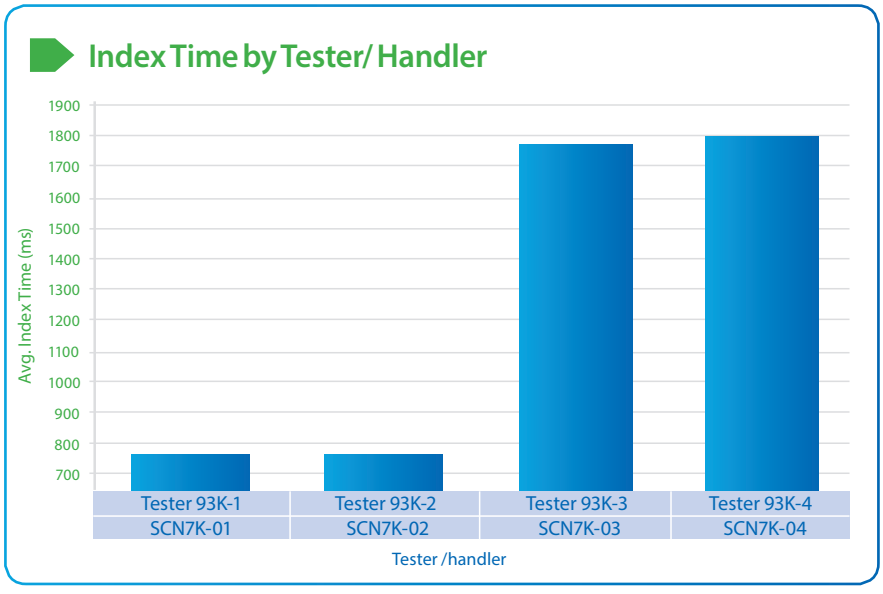

Figure 2: Variation in Index Times by Handler

shared with MAPL, both teams confirmed that the right decision for Marvell was not to invest in additional probe cards, but to look into actionable items to align and optimize existing equipment utilization across large quantity test platforms. Global Ops implemented this strategy which resulted in cost savings with no negative impact on product revenue. This is a key example that showcased how the data transparency provided by Optimal+ product analytics not only enabled Marvell to optimize capital expenditures, but also enabled decisions to improve efficiency and productivity.

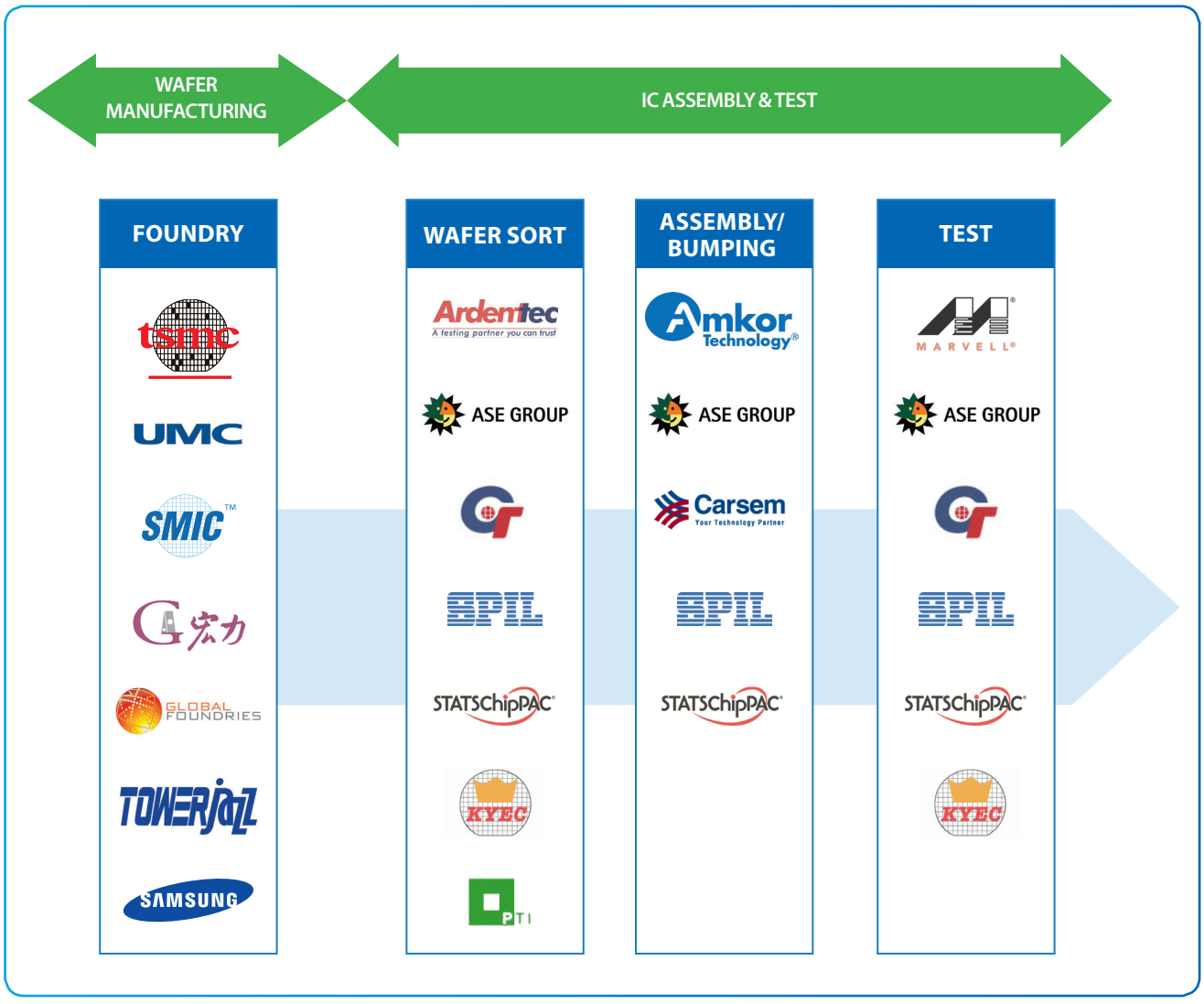

Figure 3: Marvel Supply Chain

Improved Product Forecasting

During the course of 2013, Marvell discovered new benefits from the data transparency provided by Optimal+ IIoT solutions that extended beyond manufacturing operations. One of Marvell's internal groups was tasked with calculating wafer throughput across all their OSATs. Prior to Optimal+, data was provided to Marvell by each OSAT but the data was inconsistent, resulting in rudimentary analysis and overly pessimistic results.

Using the Wafer Sort data provided by Optimal+, the financial planning team developed a new method for tracking wafer throughput by "pulling" wafer sort data directly from their OSATs. This first-hand data resulted in more accurate reports, and also provided the ability to create reports whenever Marvell needed them; such data reports facilitated a more streamlined and accurate flow of information to Marvell product planning teams. This enabled better product forecasting – a mission critical item for success in high-volume semiconductor production.

"We never imagined that manufacturing test data from Optimal+ could help finance do its job better and more efficiently."

Kevin Lu,
Director of Financial Planning & Analysis, Marvell

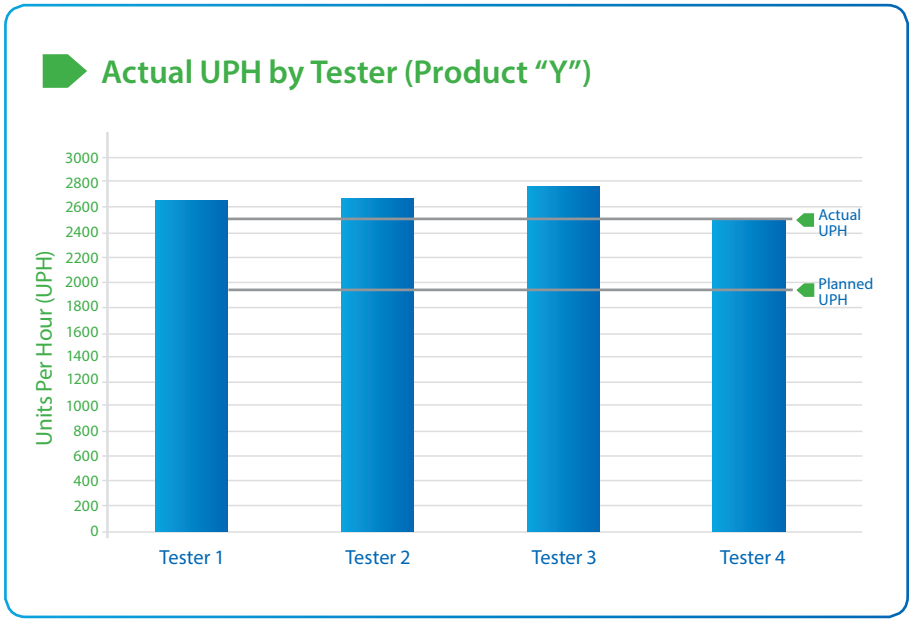

Figure 4: Actual vs Planned Units-Per-Hour for Product "Y"

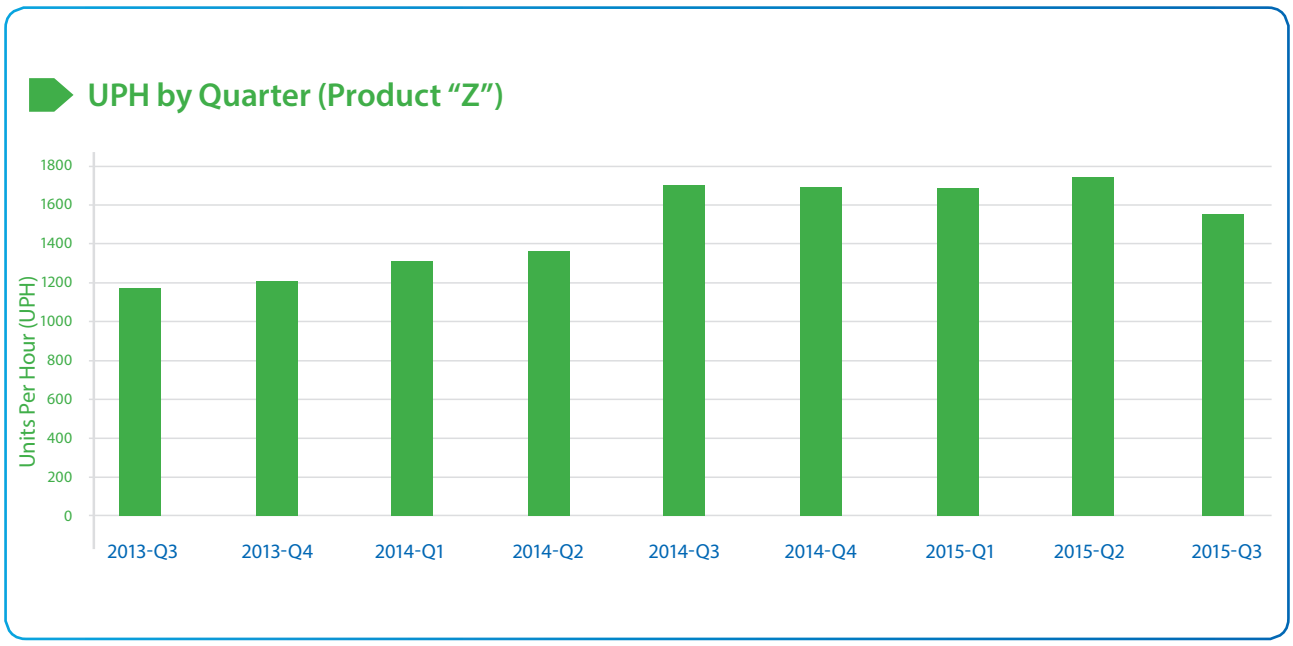

Figure 5: Quarterly UPH Improvement for Product "Z"

Looking Forward

Marvell continues to reap the anticipated benefits of improved yield recovery and is also realizing additional financial and operational benefits since the adoption of IIoT solutions from Optimal+. The concept of multiple business units across Marvell and MAPL using the same data matrix to drive improvements in their own distinct expertise was improbable a few years ago. Optimal+ enables cross-organizational change – starting with the availability of a single, consistent and trusted data source that multiple organizations within Marvell can use to drive positive change across the company. This results in improved overall productivity and efficiency.

Based on the broad usage of the product analytics data from Optimal+ to drive improvements beyond reclaimed yield, Marvell is now planning to use this data to provide better financial reconciliation with their foundries and OSATs. The company plans to build matrices based on Optimal+ data to quantitatively manage vendors on a regular basis. Using these matrices, Marvell intends to cross-correlate manufacturing output to invoices, creating a more accurate financial accounting process across their entire product portfolio.

For more information, please visit: **www.optimalplus.com**

USA OFFICE: Bayshore Plaza,2107 North First Street, Suite 310,
San Jose, CA 95131
Phone: 800-685-2127 | info@optimalplus.com