

Delivering Performant and Precise AI-Enabled Wafer Inspection

The Prodrive Zeus cabinet with 3rd Gen Intel® Xeon® Scalable processors takes on challenging semiconductor inspection use cases with nanometer precision



"3rd Gen Intel® Xeon® Scalable processors are at the core of the solution. We add capability and seamless operation on top of the Intel® architecture, so everything's turnkey and customers can get the most value out of their investment."

—Bas van Bree, Program Manager at Prodrive Technologies

Semiconductor manufacturing is potentially the most challenging form of industrial production globally. The creation and inspection of semiconductor wafers, integrated circuits, and chips requires extreme accuracy down to the nanometer scale. The system of measurements required for this process, also known as metrology, targets even smaller and more-precise ranges as integrated circuits for all manner of computers become more condensed and powerful. Driven by the demand for more output and to support IoT implementations of growing intricacy, the market for wafer inspection tools is projected to grow to USD 1.2 billion by 2025.¹

Challenge: Smaller size equals more data

The combination of optical tools and electron beam—or e-beam—technology allows chipmakers to scan wafers for defects. Optical processes first check for alignment in the many layers of integrated circuit that make up the wafer and generate a map of hotspots for closer inspection. Then e-beam tools check the hotspots for defects in individual features, such as short circuits, open circuits, or traces that are thicker or thinner than expected. Most wafer features or nodes are 7 to 10 nanometers, and as features decrease in size, they generate a larger data footprint of up to 100 Gb/s in some cases.² Semiconductor fabrication plants, informally known as semicon fabs or fabs, need metrology and inspection tools that can handle more-data-intensive workloads and more complex AI inspection algorithms to ensure a high quality of output.

Solution: Fully integrated, powerful AI-enabled wafer inspection

Prodrive Technologies, a global company with over two decades of experience in industrial technology, now offers the Zeus High Performance Cabinet (ZHPC) solution based on 3rd Gen Intel Xeon Scalable processors. As an OEM, Prodrive develops their own building blocks all the way down to the server board level, allowing for deep customization and integration with existing infrastructure. The ZHPC also uses key 3rd Gen Intel Xeon Scalable processor enhancements, such as gen-over-gen increases in performance,³ to manage data growth in wafer inspection. Bas van Bree, Program Manager at Prodrive Technologies, says, "3rd Gen Intel Xeon Scalable processors are at the core of the solution. We add capability and seamless operation on top of the Intel® architecture, so everything's turnkey and customers can get the most value out of their investment." Hardware-enabled AI acceleration technologies such as Intel® Advanced Vector Extensions 512 (Intel® AVX-512) are also available to help customers supercharge their AI inference for e-beam inspection, allowing for fast training and more-data-intensive scans.



Figure 1. The Prodrive ZHPC solution can scale beyond three cabinets with 100 rack servers or more depending on the customer's network architecture.

How it works

Customers will deploy the ZHPC solution near optical and e-beam inspection devices. The ZHPC solution provides the computing power for AI-enabled inspection tools at the point where data is generated. This setup is common for closed and isolated fab environments, which are locked down and not connected to external data centers or the internet for security reasons. Based on customer needs, a single deployment can scale from one cabinet with 10 rack servers to three cabinets with 100 rack servers, or even more depending on the customer's network architecture.

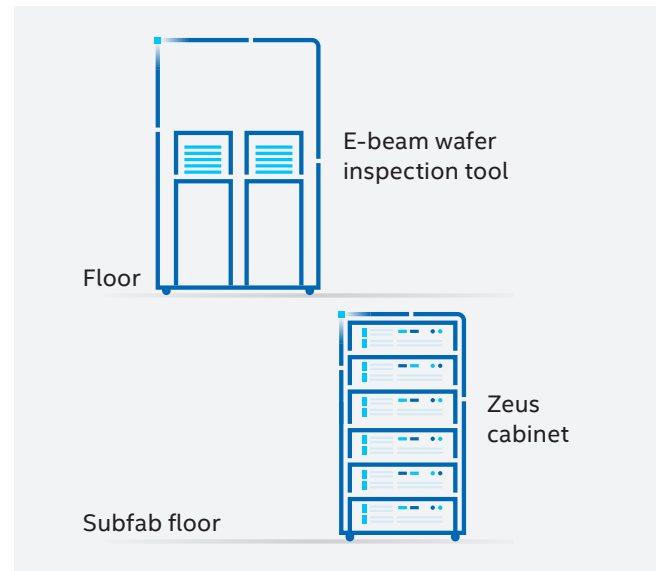


Figure 2. The ZHPC solution deploys to the subfab floor to support inspection equipment on the floor above.

3rd Gen Intel Xeon Scalable processors

Prodrive Technologies was already using previous-generation Intel Xeon Scalable processors and served a customer base that was familiar with the portfolio. Transitioning to 3rd Gen Intel Xeon Scalable processors brought the potential for gen-over-gen performance gains and accelerated AI inference. “The most important part is

crunching more data and increasing throughput,” van Bree states. PCIe 4 support and high memory capacity allow for greater expandability and flexibility, which is a priority for semicon fab customers that use add-in GPU cards to enhance AI inference even further.

3rd Gen Intel[®]
Xeon[®] Scalable
processors

Better performance
1.46x
average performance gains
over the prior generation³

More cores
Up to **28**
cores/socket in IoT SKUs⁴

Hardware-enabled AI acceleration

Wafer inspection is an automated process with little to no human intervention, except to manage the inspection equipment, so nearly all semicon fabs rely on AI technology to drive the inspection process. Intel AVX-512 and Intel® Deep Learning Boost (Intel® DL Boost), features of the Intel Xeon Scalable processor family, help accelerate AI with new instructions that reduce the computational requirement for complex model training and inference. This optimization results in up to 1.56x improvement in AI inference for image classification gen over gen.⁵ Improved performance and higher memory bandwidth in the processor family also helps accelerate precision image scanning with high accuracy.

Long life availability

Prodrive Technologies commits to 10+ year availability for the ZHPC solution to help support “copy exact” deployments that some customers require to manage the complexity of the semiconductor device manufacturing process. Semicon fabs rely on copy-exact to minimize variables in the inspection environment, which contributes to smoother operation and a lower potential for variation, and also to support root-cause analysis anytime an issue does occur. 3rd Gen Intel Xeon Scalable processors also support long life availability in IoT SKUs⁶ that make the product family a reliable choice for manufacturers.

Kubernetes-based orchestration increases density

One of the key differentiators of the ZHPC solution is that compute resources across all the cabinets are abstracted into a software-defined environment. In a bare metal environment, individual nodes would have dedicated functions such as inference, training, or dashboarding. In a virtualized environment, any node can perform any function, which helps eliminate bottlenecks and increases system availability for the most-compute-intensive tasks. The performance gains³ of 3rd Gen Intel Xeon Scalable processors enable condensation and abstraction of more compute resources into fewer physical racks. The ZHPC solution has a number of cost-efficiency benefits, including up to 20 percent hardware cost savings, downtime reduced by up to 25 percent, and up to USD 100K less in development and maintenance costs.⁷

The ZHPC solution uses a Kubernetes-based orchestration platform, Prodrive Kubernetes Services (PKS), developed in-house by Prodrive Technologies to deploy containerized workloads to the system. This platform allows semicon fab engineers to manage, deploy, and balance workloads from a single interface. PKS is part of a larger software platform, the Prodrive Equipment Management Platform, that gives fab engineers granular-level visibility and control over system monitoring and diagnostics.

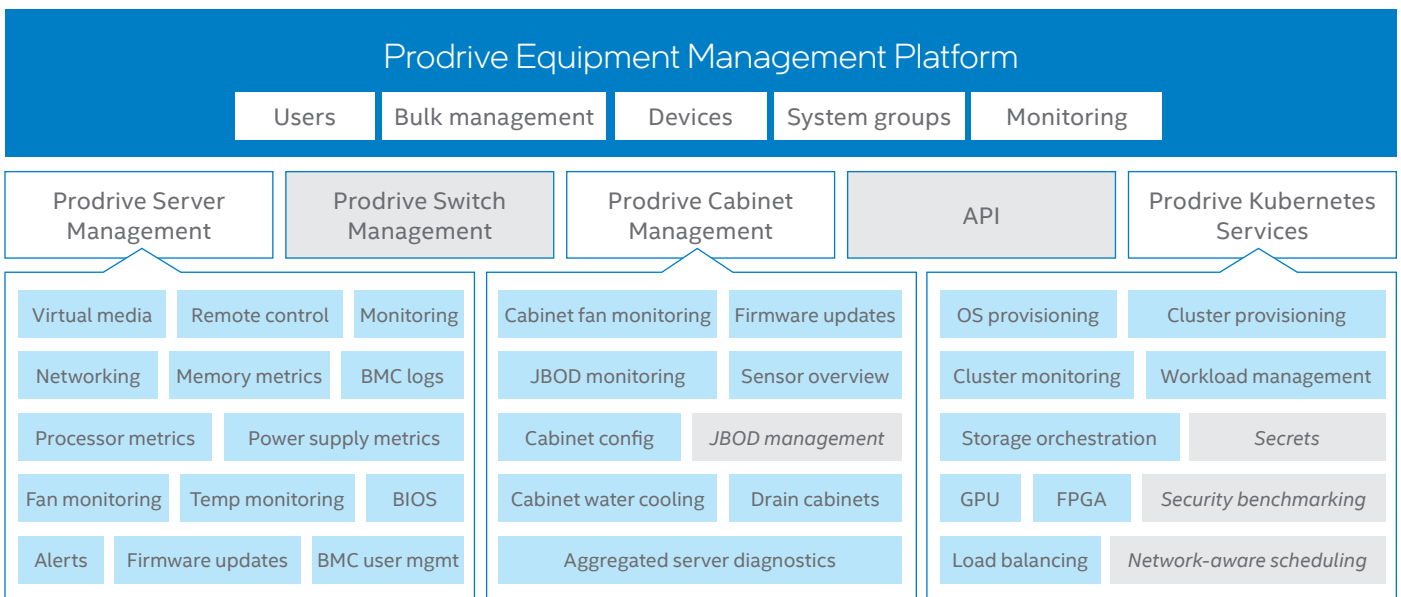


Figure 3. The Prodrive Equipment Management Platform is a catchall interface for hardware monitoring, workload allocation, and more.

Prodrive Zeus High Performance Cabinet⁷

Up to **20%** savings
on hardware costs vs. bare-metal environments

Downtime reduced by
Up to **25%**
vs. nonvirtualized environments

Up to **100K** less
USD in development and maintenance costs vs. in-house

Solving problems through collaboration

Four years into their collaboration with Intel, Prodrive Technologies finds extreme value in the technical guidance that Intel provides. “Intel helped us troubleshoot critical issues with imaging systems. Their support was invaluable,” van Bree says. Intel’s longevity of supply, brand recognition with the customer base, and a bulk of select SKUs making up the core of Prodrive Technologies’ industrial portfolio are all factors that contribute to ongoing success. Prodrive Technologies’ leadership feels confident building on top of Intel® technology. “It’s been a great experience working with Intel,” van Bree says, “We’ve built image processing systems before with other chipmakers, but we switched to Intel architecture because we saw there was more future in the Intel road map.”

Full-service deployments with deep customization

A key differentiator that Prodrive Technologies offers with the ZHPC is a consultation-based approach to implementation. Prodrive Technologies helps customize the ZHPC solution to customer needs and offers arm’s-length direction on how to integrate cabinets into the fab environment, respecting the need for security and isolation. “We build a turnkey solution but we’re available through the complete life cycle,” van Bree says. The implementation process is different for each customer but follows a few common steps:

- **Planning:** During this initial phase, consultants collaborate with customers to map pain points, investigate how to integrate ZHPC systems with existing infrastructure, propose scale in terms of how many servers, and explore possibilities for customization.
- **Prototyping:** In addition to building a prototype, Prodrive Technologies also qualifies electromagnetic compatibility and thermal requirements and certifies each build to SEMI standards.
- **Software integration:** Developers help customers integrate their APIs with the Prodrive Equipment Management software.
- **Field training:** Customers receive field service engineering training, so they’re equipped to solve any issues that arise on the shop floor.

About Prodrive Technologies

Founded in 1993, Netherlands-based Prodrive Technologies provides electronic and mechatronic solutions to customers in manufacturing, medical, and automotive industries. Prodrive’s embedded computing systems power motion control and image processing applications across the globe

prodrive-technologies.com

Learn more

Prodrive ZHPC

Built with 3rd Gen Intel Xeon Scalable processors, the Prodrive ZHPC offers high density for data-intensive, AI-enabled wafer inspection workloads.

[Learn more >](#)

3rd Gen Intel Xeon Scalable processors

Get greater performance, more memory bandwidth, and hardware-enabled security features to enable and enhance your AI and IoT deployments.

[Learn more >](#)



1. "Global E-Beam Wafer Inspection Systems Market Report 2020-2025 - Growing Sophistication of Semiconductor Wafer Designs Stimulates Demand," GlobeNewswire, March 2021.
2. Interview with Bas van Bree, March 2021.
3. See [125] at www.intel.com/3gen-xeon-config. Results may vary.
4. A maximum of 40 cores/socket are available on the DPG road map.
5. See [121] at www.intel.com/3gen-xeon-config. Results may vary.
6. Intel does not commit or guarantee product availability or software support by way of road map guidance. Intel reserves the right to change road maps or discontinue products, software, and software support services through standard EOL/PDN processes. Please contact your Intel account rep for additional information.
7. <https://prodrive-technologies.com/products/embedded-computing-systems/software/prodrive-kubernetes-services/>

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