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LATTICE'S HOLOSCAN SENSOR BRIDGE SOLUTION ACCELERATES DEPLOYMENT OF AUTONOMOUS MACHINES WITH PHYSICAL AI

Overview

Lattice's Holoscan Sensor Bridge (HSB) solution delivers a unified, scalable approach for sensor, video, and data ingestion over Ethernet, addressing the limitations of traditional interfaces in autonomous machines and physical AI systems. Developed with NVIDIA, the solution supports edge AI platforms such as NVIDIA Jetson Orin™ and Thor™ with multiple adaptable sensor or video inputs, programmable I/O, and 1–25 Gb Ethernet connectivity. Lattice FPGAs provide broad sensor compatibility and deterministic near-sensor compute, making the platform well suited for robotics, medical, industrial, automotive, and defense applications. See Figure 1.

Figure 1: Holoscan Sensor Bridge Solution
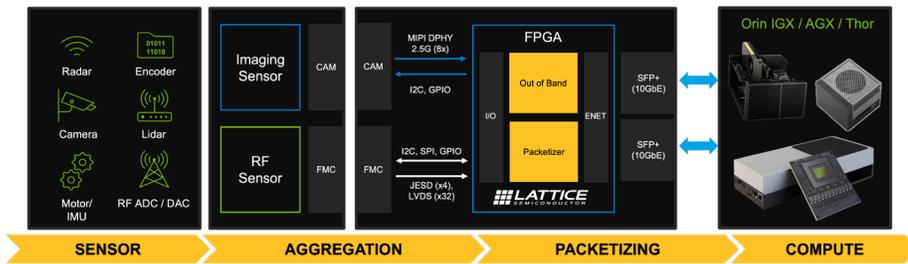
A Unified Sensor Ingestion Platform for Physical AI Systems

Conventional sensor and media interfaces, including LVDS, MIPI, GPIO, GMSL, CAN, HDMI, and USB, impose physical and architectural constraints that limit performance and flexibility on modern edge AI platforms. Porting these legacy interfaces requires new drivers and validation when migrating hardware, increasing cost, complexity, and development time. By unifying sensor connectivity over Ethernet, HSB simplifies system adaptation across applications while improving scalability and long-term maintainability.

Ethernet connectivity also provides system-level advantages such as long cable support, flexible topologies, hot-plug and PoE capability, higher scalability and interoperability, and reduced overall system cost. The solution supports bandwidth scaling from 1–10 Gbps on the Lattice Nexus™ FPGA platform to 1–25 Gbps per port on the Lattice Avant™ FPGA platform, enabling designers to right-size performance for a wide range of edge AI use cases.

Sensors can be configured and added without significant redesign, and multicast streaming enables sensor feeds to be replicated as required. Watermarking, redundancy, and safety features further support secure and reliable operation in demanding environments.

Deterministic, Low-Latency Performance Optimized for Edge Deployment

HSB achieves ultra-low latency and power efficiency through RDMA support. Lattice also enables optimized near-sensor compute and bandwidth reduction, lowering overall system power while freeing compute resources for more advanced algorithms or enabling the use of a lower-performance processor without compromising system capability.

The open-source NVIDIA Holoscan software stack, with standard APIs, accelerates development and deployment. Precision Time Protocol (PTP) provides sub-microsecond synchronization, enabling accurate sensor alignment and improved performance for autonomous operation and advanced sensor fusion workloads.

KEY CHALLENGES

- Wide range of sensors with physical constraints and proprietary interfaces
- Supporting and maintaining interface software and drivers is complex and time-consuming
- High sensor bandwidth requirements and complex joint architectures make interconnect difficult
- Autonomous machines, especially humanoid robots, require massive AI and compute resources
- Edge compute platforms offer limited and costly I/O at advanced process nodes
- Power, latency, and deterministic behavior are critical challenges in autonomous machines
- Security and functional safety requirements add further system complexity

LATTICE SOLUTION

- Scalable sensor connectivity over Ethernet with NVIDIA Holoscan support for Jetson AGX and IGX
- Bridging of legacy and proprietary sensor interfaces with efficient sensor aggregation
- Support for MIPI CSI-2 and other standard interfaces
- Flexible scalability to meet application needs with 1, 10, or 25 Gb Ethernet
- RDMA support for low latency and high-performance sensor streaming
- Precise synchronization using IEEE 1588 PTP
- Flexible I/O expansion via FMCs
- Open-source software stack available through NVIDIA GitHub
- Easily configurable sensor settings and drivers for flexible deployments
- Optional edge sensor processing to reduce power consumption and free compute resources

Lattice Benefits

By leveraging industry-standard technologies such as Ethernet, the Lattice Holoscan Sensor Bridge solution enables low-cost, flexible, and scalable interconnects. Combined with NVIDIA compute platforms and software, the solution delivers high performance while accelerating time to market. Lattice FPGAs go beyond simple bridging, offering a unique combination of small footprint, ultra-low power, and flexible design options that provide significant system-level advantages.

Platform Scalability and Longevity
- Broad platform support across Lattice CrossLink™-NX, Lattice CertusPro™-NX, and Lattice Avant™ FPGA families
- Designed for high-volume, long-lifecycle products that scale to multi-million-unit deployments
- Commercially ready partner sensors and platforms for faster production deployment

Performance, Power, and Determinism
- Ultra-low latency, ultra-low power operation with a small silicon footprint
- Deterministic computer vision, AI, and sensor-fusion processing
- High-performance, deterministic multi-axis motion control
- Up to 10X bandwidth-reduction options, enabling lower system power and lower-cost cabling
- Offloads central compute resources to improve overall system efficiency

Design Flexibility and Ecosystem Support
- Flexible I/O and architecture options with a software- and algorithm-friendly design methodology
- Extensive partner ecosystem providing hardware and software design support
- Industry-leading security solutions and functional safety support
- FuSa-qualified tools with Tool Confidence Levels (TCL) up to TCL3, suitable for IEC 61508 and ISO 26262 workflows targeting SIL 3 and ASIL-D systems

More than just a sensor bridge, Lattice-based solutions give designers a broad range of performance and power options, access to a mature partner ecosystem, optimized CV and AI offload capabilities, and robust security and functional safety support for production-ready systems.

The Lattice Holoscan Ecosystem

The Lattice Holoscan Sensor Bridge solution is part of a robust and expanding ecosystem of Lattice and NVIDIA partners addressing a wide range of applications and use cases. This rapidly growing ecosystem includes a variety of camera modules and sensor solutions optimized for high-performance Edge AI.

For example:

- e-con Systems® offers a Holoscan camera that integrates a Lattice FPGA running e-con's proprietary TintE™ image signal processor (ISP). This design efficiently offloads image processing tasks from the NVIDIA GPU.
- Leopard Imaging provides ready-to-use camera solutions built on the NVIDIA Holoscan Sensor Bridge platform with Lattice FPGAs, enabling high-performance data acquisition and processing for Edge AI applications.
- Sensing Wiki has developed the HSBKITxM (Holoscan Sensor Bridge), an FPGA-based interface designed for low-latency sensor data processing using GPUs and the Lattice Holoscan Sensor Bridge device.
- D3 Embedded's IP69K-rated camera integrates a Lattice Holoscan Sensor Bridge– based solution with the NVIDIA IGX Orin platform for reliable image capture in harsh environments.
- Advantech's Holoscan Sensor Bridge (MIC-FG-HSB) uses the Lattice FPGA solution for its sensor-over-Ethernet board as part of the broader Advantech Holoscan offering.
- Tauro Technologies' NVIDIA Holoscan Sensor Bridges also deliver an FPGA-based sensor-over-Ethernet interface that leverages the Lattice Holoscan Sensor Bridge solution.

Markets and Applications

Holoscan Sensor Bridge technology enables scalable, adaptable physical AI systems that support a wide range of applications. One of the most demanding examples is humanoid robotics, where high-performance sensor processing is required to augment or complement human labor in manufacturing, logistics, healthcare, and, over time, consumer environments. The same capabilities also benefit other markets, including smart agriculture, transportation, and defense. See Figure 2.

Figure 2: Markets and Applications

| MEDICAL	INDUSTRIAL	DEFENSE	AGRICULTURE	TRANSPORTATION
▪ Real-time Scan Analysis ▪ Robotic-assisted Surgeries ▪ Medical Imaging ▪ Rehabilitation Devices	▪ Real-time Analysis ▪ Robotics Precision ▪ Anomaly Detection ▪ Predictive Maintenance ▪ Machine Monitoring	▪ Real-time Sensor Fusion ▪ Intrusion Detection ▪ Pattern Recognition	▪ Real-time Crop Analysis ▪ Machine Monitoring ▪ Remote Robotics	▪ Passenger Detection ▪ Security

Conclusion

The Lattice Holoscan Sensor Bridge solution enables developers to optimize physical AI for demanding autonomous machines, including humanoids and many other applications. Lattice delivers low-latency, low-power, secure, and scalable Edge AI solutions for customers building on NVIDIA Jetson platforms.

By combining NVIDIA's industry-leading compute performance and open-source software stacks with Ethernet scalability and Lattice FPGA-optimized interconnect and processing, customers can address key challenges such as power efficiency, real-time performance, and rapidly evolving market requirements.

In addition, a broad ecosystem of partners offers ready-to-integrate Holoscan platforms with flexible options for cameras, lidar, stereo and depth cameras, and time-of-flight (ToF) sensors, enabling rapid integration and deployment. Lattice also partners with experienced design service providers, offering expertise in FPGA and hardware design, as well as software and system-level development for NVIDIA Jetson-based solutions.

References

Lattice Holoscan Sensor Bridge Solutions

Sensor to Ethernet Streaming | NVIDIA Holoscan Sensor Bridge

e-con Systems Cameras for NVIDIA Platforms with Lattice Holoscan Sensor Bridge Board

Holoscan Sensor Bridge - Leopard Imaging Inc.

Holoscan Sensor Bridge - SENSING

DesignCore® GMSL2 Holoscan Sensor Bridge Bundle for NVIDIA® Jetson AGX Thor | D3 Embedded

Advantech and Lattice Collaborate to Accelerate Next-Generation Humanoid Robotics powered by NVIDIA Holoscan Sensor Bridge

NVIDIA® Holoscan™ - Tauro Technologies
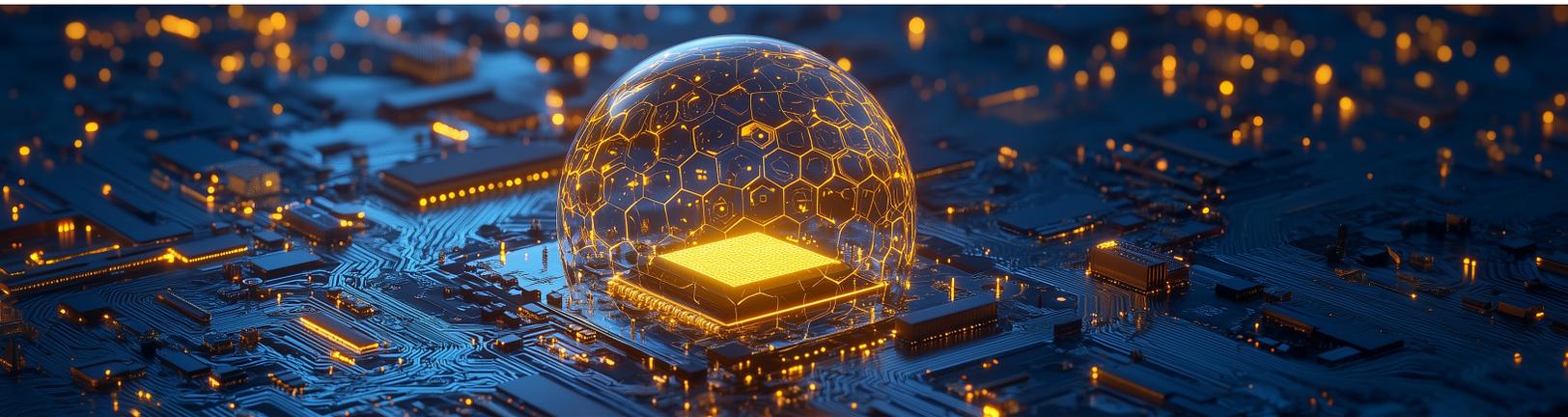
Ready to Learn More?

To learn more about Lattice low power FPGA-based solutions for industrial, automotive, communications, computing, and consumer applications, visit **www.latticesemi.com** or contact us at **sales@latticesemi.com**.