Solution Brief

Robotics/5G/AI
Healthcare, Medical Devices

Powering Data-Intensive Architectures for the Future of Ultrasound

Intel® FPGAs and software solutions are powering a new generation of ultrasound systems and applications designed to leverage AI, 5G, robotics, and other data-intensive technologies at the edge.

Since the invention of the microprocessor in the early 1970s, Intel® hardware has been at the forefront of ultrasound technology development. Today, Intel FPGAs and Intel® software solutions continue to drive advances in the technology, powering increasingly complex ultrasound solutions from the world's top healthcare equipment manufacturers.

From beamforming and image preprocessing to signal processing, control, and output, many workloads are required to support modern ultrasound imaging today. Having the right hardware and software solutions is essential to ensuring ultrasound systems and applications deliver the image quality, operational performance, and longevity the healthcare industry requires.

While ultrasound technology has been widely used for decades, the demand for these critically important systems has never been higher. Technological advances continue to enable new medical use cases, such as surgical, gastro, and vascular applications. An increasingly diverse range of form factors is now available that can support greater mobility, from premium cart-based solutions to portable and even handheld ultrasound devices. Today's solutions are also leveraging 5G and other advanced connectivity technologies for faster image processing and remote deployments. And increasingly, AI is being embedded in ultrasound applications to help clinicians guide diagnostic processes, inform treatments, and aid in decision-making.

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Challenge: Processing data-intensive ultrasound applications at the edge

Ultrasound technology is foundational to myriad medical diagnostic and treatment use cases, providing the highly precise near-real-time imaging needed at the edge in a wide range of clinical settings. At the development level, medical equipment manufacturers and their vendor partners must keep pace with an expansive range of advanced technologies that hospitals and other healthcare providers deploy, including AI, robotics, and 5G. Diverse computing power, scalability, portability, and connectivity are all essential to driving new, emerging ultrasound systems and devices. And in today's highly competitive marketplace, medical equipment manufacturers must be first to market with their innovations to meet the evolving needs of the ultrasound industry.

For hospitals and other healthcare providers, rapidly expanding patient loads require systems to scale up to meet new operational demands. Accordingly, ultrasound systems today must leverage data-intensive intelligent technologies such as AI to support the use of diagnostic procedures conducted via digital workflows and treatments informed by data. There is also increasing demand for ultrasound processes to be guided remotely by off-site medical teams via high-speed 5G networks.

The COVID-19 pandemic has dramatically impacted the industry as well, as healthcare professionals seek physical distance from patients during procedures such as ultrasounds. To diagnose lung conditions and other issues related to the disease, healthcare providers are exploring how robotic-assisted platforms can allow ultrasounds to be completed with precision at a safe distance.

The solution: Intel® architecture, bringing ultrasound imaging to life

Intel architecture plays a significant role in bringing the ultrasound image to the screen in near-real time. Intel FPGAs power hardware and software beamforming, which is a common signal processing technique used in ultrasound devices, as well as system control, switching, and interconnects. Intel FPGAs enable the latest PCIe interface as well and power digital signal processing (DSP) blocks to help form high-resolution 3D and 4D images at ultrafast speeds.

Supporting data conversion and preprocessing in the analog front end (AFE)

Intel FPGAs have long been a key piece of hardware in ultrasound AFEs. FPGA transceiver technology and programmable fabric allow for multichannel ultrasound transducers to transfer data through analog to digital converters at high speeds using IPs like low-voltage differential signaling (LVDS) and the latest JESD204 protocols. With a full range of Intel FPGAs available, from value lines like Intel® MAX® CPLD and Intel® Cyclone® family FPGAs to midrange and high-end Intel® Arria® 10, Intel® Agilex™, and Intel® Stratix® 10 devices, there is an ideal FPGA for any ultrasound analog front end system.

Intel offers a full line of FPGAs for ultrasound applications.

Support for AI-driven ultrasound applications

Intel FPGAs offer hardware customization with integrated AI to power advanced ultrasound applications. The reprogrammable, reconfigurable nature of Intel FPGAs makes them well suited for today's rapidly evolving AI landscape, allowing developers to test algorithms quickly and get to market fast. A new class of AI-driven ultrasound devices is quickly emerging, promising to leverage speech recognition technology and sensors such as smart cameras to enable remote control of ultrasound systems. For example, new advanced systems may allow a clinician to use hand gestures or verbal cues to operate the system, instead of having to physically reach over a patient to input data.

Intel Agilex FPGAs accelerate ultrasound processing at the edge

Intel's newest FPGA family, Intel Agilex, delivers approximately twice the fabric performance per watt vs. 7nm FPGAs, inherent low latency, reduced power consumption, and the design flexibility required to meet the challenges of the ultrasound industry today. Intel Agilex FPGAs are reconfigurable and offer the computation and high-speed interfacing capabilities needed to create smarter, higher-bandwidth networks. As a result, Agilex FPGAs help deliver near-real-time actionable insights via accelerated AI and other analytics used in ultrasound applications wherever these applications are processed, at the edge, in the cloud, and throughout the network.

For AI and other data-intensive workloads, Intel FPGAs offer several advantages:

Great performance with high throughput and low latency

Intel FPGAs can inherently provide low latency for the near-real-time processing required for ultrasound imaging. Intel FPGAs enable high levels of parallel processing, which is critical for ultrasound devices that have many channels.

Longevity

Intel FPGAs support long product life cycles of 15+ years, so hardware designs based on FPGAs can offer healthcare providers extended product life as well. This characteristic makes FPGAs ideal for use in medical devices such as ultrasound systems, which require lengthy qualification cycles

Low power consumption

With FPGAs, designers can fine-tune the hardware to the application, meeting power requirements. FPGAs can accommodate multiple functions, delivering more energy efficiency from the chip. It's also possible to use a portion of an FPGA for a function, rather than the entire chip, so multiple functions can be hosted in parallel.

Excellent value and cost

Intel FPGAs can be reprogrammed for different functionalities and data types, making them highly cost-effective. By integrating multiple capabilities onto the same chip, designers can save on both costs and board space.

Intel's industry-leading performance-per-watt Agilex FPGAs accelerate AI and analytics to enable near-real-time imaging.

Advanced Intel® developer toolkits enable flexible workload optimization, AI deployment

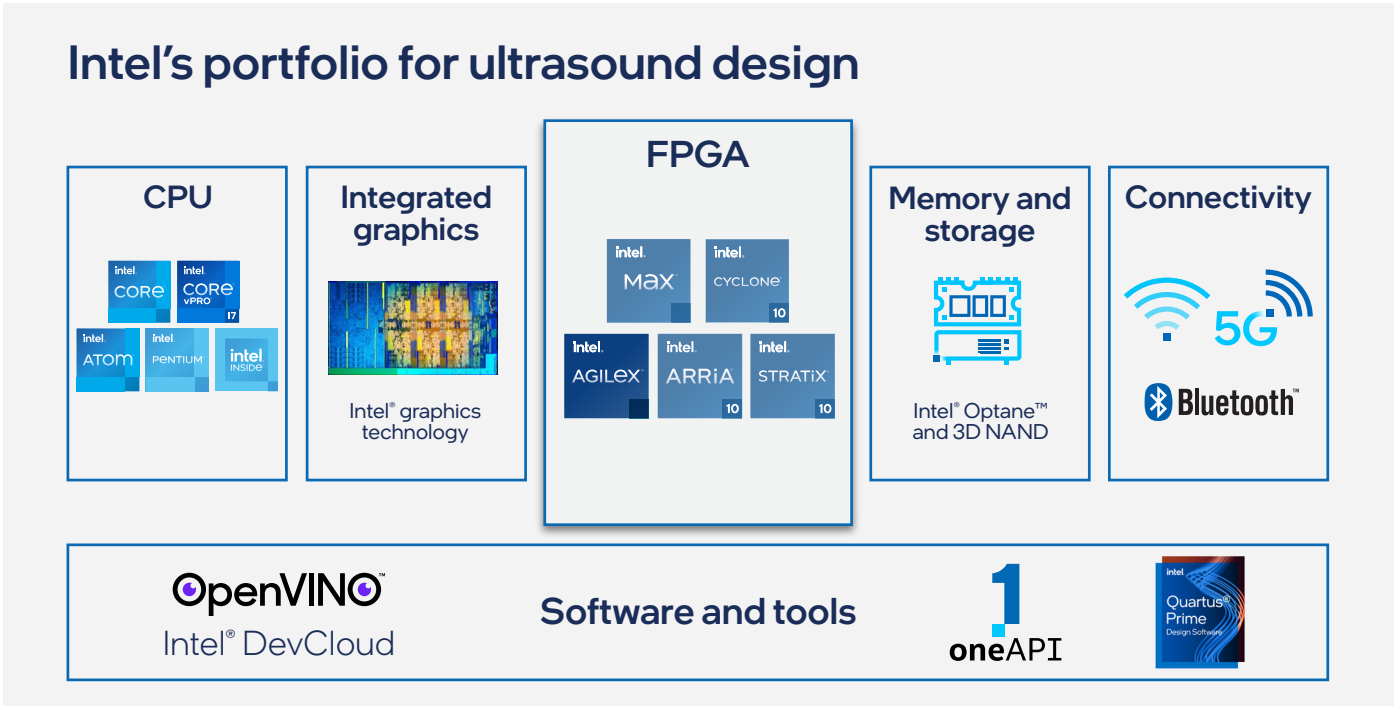
To deliver fast time to market and workload optimization, Intel has created the Intel® oneAPI programming model, enabling a common developer experience across scalar (CPU), vector (GPU), matrix (AI), and spatial (FPGA) architectures. The newest update of Intel oneAPI Toolkits uses the Intel® DevCloud, providing both improved performance and expanded capabilities for data-centric workloads processed for ultrasound applications.

Intel oneAPI Toolkits provide compilers, libraries, analysis tools, and optimized frameworks that implement industry standards—including C++, SYCL, Fortran, MPI, OpenMP, and Python—enabling unique CPU features. Intel® Deep Learning Boost (Intel® DL Boost) further extends Intel AVX-512 with a new instruction set that increases inference performance on lower-precision data types, such as those used in workloads for image classification, speech recognition, and object detection.

The Intel® Distribution of OpenVINO™ toolkit accelerates the development of computer vision and deep learning applications to enable AI-powered ultrasound use cases, without adding hardware cost and complexity.

Securing ultrasound applications and data

Data security is of paramount importance to healthcare providers today. Patient privacy regulations, such as HIPAA, mandate high levels of security around healthcare data. As ultrasound systems and applications increase in their complexity, they generate higher volumes of sensitive patient data that must be protected at the edge. Intel hardware- and software-enabled security extends across all Intel® compute technologies to ensure a zero-trust policy for protecting patient data wherever it is generated.



Intel offers a wide range of hardware and software solutions to power ultrasound systems.

FPGA design services

The Intel® FPGA design services team offers a pool of expertise and a wealth of intellectual property (IP) to solve design challenges in the areas of intelligent video and vision processing. Experienced and skilled Intel designers are motivated to meet clinical design needs with the most efficient and innovative solutions, using a library of highly optimized and proven IP. Partnering with Intel design services often leads to the development of highly effective and efficient designs on Intel FPGAs and programmable SoCs, ideal for data-intensive applications such as medical imaging.

FPGA design services projects are managed as part of an overall program of resource management, risk management, and tracking to ensure that projects are delivered on time and on budget. All project engineers are assigned to projects based on their knowledge, skills, and experience with similar projects or technologies.

Conclusion: The future of ultrasound, built on Intel architecture

Featuring Intel FPGAs, software solutions, and other advanced technologies, the world's top medical equipment manufacturers are deploying new intelligent ultrasound systems that are transforming the healthcare landscape. For healthcare providers and medical equipment manufacturers alike, selecting Intel-powered systems and applications enables integration across their entire technological environment while ensuring seamless upgrades to future Intel technologies as they emerge.

To speed product development cycles and enable fast time to market, Intel offers its healthcare partners a depth of support resources, including expert design services to ensure ultrasound systems are fully optimized for their intended use cases. Ultimately, the Intel® ecosystem of technologies, partners, and support resources enables the performance, scale, design flexibility, connectivity, and security to drive next-generation ultrasound solutions for the fast-advancing needs of the global healthcare industry.

Learn more

View the Intel FPGA offering ›

Explore the industry-leading performance-per-watt Intel Agilex FPGA ›

Discover the value of OpenVINO ›

See the benefits of Intel DevCloud ›

Learn about Intel oneAPI ›

For more information on Intel ultrasound solutions, please reach out to your Intel salesperson.

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