Orthogone

Developers of the
Seemingly Impossible

MEDICAL IMAGING SOLUTION

The Challenge

Develop next generation mammography detection using high-performance image processing algorithms.

CLIENT: ANALOGIC – NASDAQ: ALOG   LOCATION: MONTREAL, QC, CANADA

Design new system architecture to ease integration

Use high-performance imaging algorithms

Integrate sensors with high-speed digital processing

A worldwide leader in direct conversion digital detector technology, **Analogic** develops and manufactures flat-panel, direct conversion digital detectors used by major medical OEMs in mammography systems. To speed development of the next generation of digital mammography detectors, Analogic needed specific technical expertise to use high-performance image processing algorithms with its patented detection technology.

The Solution

Partner with Orthogone to develop a well-engineered solution using FPGA technology for high-speed image processing.

FPGA, EMBEDDED SOFTWARE, AND HARDWARE DESIGN

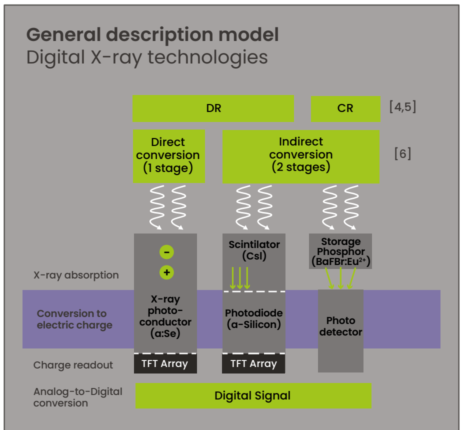

Figure 1

Analogic brought **Orthogone** in as a partner to **provide technical expertise** and **accelerate the development cycle**. With experienced FPGA designers, embedded software designers and hardware designers, the Orthogone team was well-equipped to provide the skills and scalability that the Analogic team needed to achieve their product development goals.

Developing a **state-of-the-art digital X-ray platform** for mammograms, 3D mammography, and other medical imaging applications presented multi-disciplinary technological challenges, including image reconstruction and datapath bandwidth, and flexible architecture to support additional sensor configurations. The team decided to use the Xilinx Zynq UltraScale+ MPSoC for its performance, as well as other Xilinx FPGAs that would provide flexibility and accelerate development time.

> “Our aim is to maintain our lead in the premium market for mammography detectors. In order to do that, we need high-speed communications from the detectors, and that’s definitely an area where we knew that Orthogone could help us… They brought expertise, especially in anything having to do with digital design, memory configuration, and FPGA programming.”

François Boucher, Director of Engineering at Analogic Canada

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System Design & Architecture

System designers had to integrate **extremely sensitive sensors** with **high-speed digital processing capabilities** onto a highly integrated low-profile enclosure. Large-area flat panels often combine multiple sensors to form a larger high-resolution image, with high-speed links used to transfer the raw image data. In this case, the mammography sensors were divided into multiple independent sections that could each use multiple high-speed LVDS differential pairs to transfer their raw acquisition data. Data is sent to independent low-power Xilinx Artix-7 FPGAs installed around an MPSoC located in the center of the PCBA.

In this design, the **Xilinx Zynq UltraScale+ MPSoC** integrates the **Kintex UltraScale+ FPGA** programmable fabric onto a single device with a processing system (PS) that includes a **64-bit dual-core Arm® Cortex®-A53 and a dual-core Arm Cortex-R5**. The architecture was designed to benefit from the FPGA fabric performances and multiple ARM cores flexibility, some of which can be used with operating systems that need to be certified for critical applications required in the healthcare industry.

The design also integrates several high-speed peripheral controllers such as SATA and USB 3.0 into theZynq MPSoC. The architecture is designed to be scalable by easily adapting to different sensor sizes.

Image processing

Capturing high-speed raw data from the sensor is the first step in the image acquisition process. After the custom video DMA (VDMA) **reorganizes the full image** in external memory and **all the pixels of the image** are correctly **reordered**, the FPGA can enhance image quality by performing image processing operations, such as **removing fixed pattern noise** using flat field correction type processing.

Plenty of DSP block resources are provided by the Xilinx Zynq UltraScale+ MPSoC for image processing on the captured data. A ZU7CG MPSoC device that contains 1728 DSP Slices is used on the platform. **Image data can be routed to the DDR**, or directly to the backend interface that will **stream the image/video content on 10G Ethernet port(s)** over a UDP session.

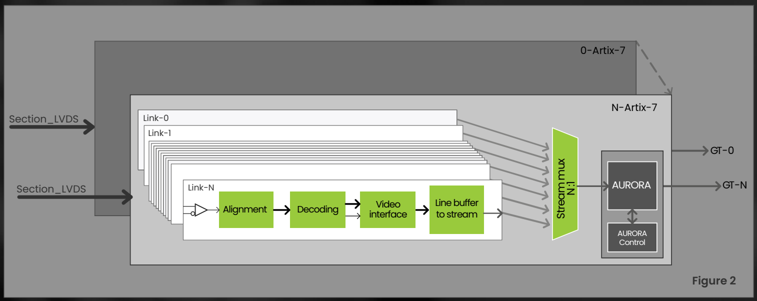

Figure 2

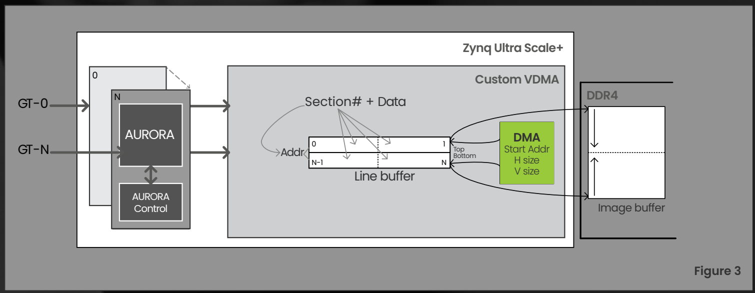

Figure 3

Hardware design

The hardware design had to overcome multiple challenges including **minimizing noise, integrating high-speed digital** with ultra-low noise circuits, physical dimensions constraints, and **safety considerations**. One of the factors in mammography detectors is chest wall constraints: the **sensor** has to be located as close as possible to the patient.

A combination of **voltage regulators and low-noise buck converters** were used to provide low-noise stable DC rails and reduce EMI. The Xilinx Zynq can control and monitor all on-board supplies and disable unnecessary power rails to decrease power consumption when required.

At the center of the system is the Xilinx Zynq UltraScale+ MPSoC, which is responsible for retrieving the image sensing data coming from the Artix-7 FPGAs and creating the final image. For optimal speed and power consumption, DDR4 memory is used to store local frame buffers, and support acquisition at a fast frame rate. The Xilinx MIG (Memory Interface Generator) automatically does the required calibration.

Software design

Analogic's detector software running in the Zynq UltraScale+ hardware platform is **divided into different applications**. These applications manage non-critical background tasks with Linux and **real-time control of the image datapath** on the FPGA side.

Multiple processors that have **access to shared and private memory regions** and peripherals are used by the Zynq MPSoC hardware platform. Based on the Mentor® Embedded Multicore Framework (MEMF) library, most inter processor messaging goes through system shared memory.

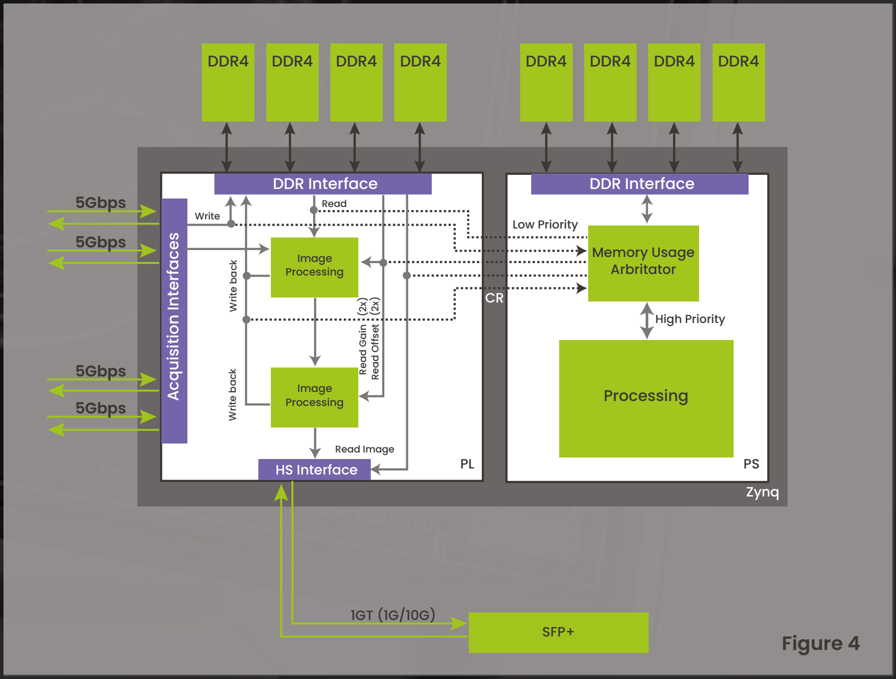

Figure 4

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The Results

Industry-leading advanced detector solution with an extended product life cycle

The team overcame technical challenges with a well-engineered solution.

DETECTING BREAST CANCER EARLY AND MINIMIZING FALSE POSITIVES CAN MAKE A CRITICAL DIFFERENCE IN WOMEN'S HEALTH.

Working in partnership with Analogic, Orthogone used **innovative design and technology implementation** to develop a versatile, easy-to-use solution and deliver the project on time. With the new converter that Analogic and Orthogone developed in collaboration, older x-ray equipment can benefit from the Analogic detector for improved radiology.

The flexibility, versatility, and technical capabilities that the team built in to the new advanced detector solution allows Analogic to **readily meet requirements from various manufacturers** and expand into medical image processing markets beyond mammography detection.

"Orthogone has distinguished themselves helping us anchor our delivery schedule....They helped us meet our development milestones, in spite of changing priorities, changing requirements; they were very flexible in adapting to our needs.... we've had very good success."

François Boucher, Director of Engineering at Analogic Canada

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Orthogone Technologies is a design house that solves tough engineering challenges by providing electronics product development and design services including embedded software development, FPGA / ASIC design & verification and hardware design.

To learn more about partnering with Orthogone to drive innovation, contact us.

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