

Mercury Pushes the Envelope of the ATCA Standard to Solve State-of-the Art Beamforming Challenges

Redesign Using FPGAs Cuts Hardware Cost by Almost Half, Accelerates Application Speed, and Increases Overall Performance

Situation: Fixed Schedule to Design Next-Generation Technology

Mercury's customer is a systems integration specialist in the telecommunications industry. This customer sub-contracts subsystems from technology suppliers – choosing the best-in-class components available – and integrates them into their high-end telecommunications solutions as part of even larger systems.

The company obtained a contract to design a state-of-the-art ground-based beamforming system, which also involved placing some critical components on a satellite. The satellite launch date was fixed and immovable, providing the company with a hard, aggressive deadline to work against. If the company missed the satellite launch, they would not get into the program.

Critical Issue: Smaller, Faster, More Efficient Beamforming Solution

Before this company approached Mercury, they had already started their design of the beamforming application. They sought our help because of our expertise in digital signal processing for streaming applications. Mercury studied the system they had on the drawing board and proposed a re-architecture using field-programmable gate arrays (FPGAs), which would increase performance dramatically, while cutting close to half the amount of hardware needed to do the job.

Reason: High Risks with High Stakes

The customer was under enormous pressure to deliver a cutting-edge solution. Mercury accepted part of this risk by investing money and engineering resources to ensure the success of the customer. The timeline was so short that they could not afford multiple iterations. The designs had to be close to perfect the first time around. While pushing ourselves to the limit, we also challenged our own suppliers to enhance their products and achieve, in turn, new heights of performance in record time.



What Mercury Provided

The system jointly designed by Mercury and the customer had two sub-systems. One was pure digital technology, and the second was a mix of analog and digital. The team divided responsibilities, with Mercury designing all digital portions of the boards and the customer designing the analog side. Mercury was also tasked with system integration within a full-blown AdvancedTCA® (ATCA) infrastructure.

The schedule was extremely aggressive and, from the start, the team had to overcome challenges from all sides. Nonetheless, the Mercury engineering team applied our iterative design approach, all the while meeting almost daily with the customer and our suppliers. Using concurrent engineering techniques, the team initiated three efforts in parallel to develop the algorithms, the boards, and the chassis.

Cutting-Edge Beamforming Algorithms

The customer created the beamforming algorithms, which required a staggering number of mathematical operations to be executed in real time. Mercury developed and tested the overarching data-movement and system-level components of the application, and designed the hardware to execute the algorithms on FPGAs.

Sophisticated Board Design

In a parallel effort, Mercury engineers began designing the first board, which was all digital technology. The Ensemble™ BCE-100 board was designed with 10 FPGAs in a sophisticated hierarchical architecture that provided the optimal performance necessary for digital beamforming. This complex 28-layer board was tested and manufactured in record time.

The second board was designed in close collaboration with the customer. Because this unique module was specific to the customer's application, their analog engineer sat with the Mercury engineering team to speed up the design process.

Exploiting Advanced ATCA Chassis Features

Other Mercury engineers were working with suppliers of the ATCA chassis. Using two boards in an extreme performance application presented the engineers with a huge integration challenge. Mercury engineers soon realized that this application would push the ATCA chassis to the limits of the specifications described in the standard. The Ensemble system they were designing needed to take full advantage of every single ATCA feature.

Capabilities of the Mercury Solution

The project had many challenging requirements that needed to be met within a high-performance solution:

- Mercury worked closely with the chassis supplier to push the thermal limits beyond the usual 200W per slot to accommodate using over 200 FPGAs in two ATCA chassis.
- This high-density FPGA solution requires 300 Gbps of continuous I/O capacity in each direction, which translates to 25 Gbps in each direction per FPGA board with 12 boards in each shelf.
- The integration of these complex components was accomplished at significantly lower cost and time than is usually needed for traditional development cycles.

Results

Seamless Integration and Delivery on Schedule

After the system was delivered and integrated into the customer's larger solution, Mercury software engineers assisted the customer in moving to the next stage, because the complexity of the system necessitated creating, integrating, and debugging the sophisticated management and run-time software as a team effort. The entire cycle from design review to production took place within the aggressive 14-month window for on-time delivery in the satellite program.

Collaborative Approach to Solving Difficult Challenges

The customer came to Mercury to leverage our talent and commitment to solving difficult challenges. As a result of our unique problem-solving approach, we recommended a re-design that cut costs, saved space, and accelerated the application – all at the same time. The final system is about half the size and, therefore, about half the cost, of what was originally projected. This collaboration has allowed the customer to realize numerous benefits and will create many new business opportunities for them based on this remarkable technology.

ATCA Versatility

AdvancedTCA is a complex and versatile standard that can serve as an umbrella for many divergent needs. Mercury helped this customer to not just meet, but exceed expectations for its beamforming application. This project demonstrates that ATCA can provide a firm foundation for the most demanding applications in the industry.

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