SeaMicro is Dazzled with HyperLynx PI Performance

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One trait shared by most engineers is a healthy dose of skepticism. This is particularly true with complex tools, such as HyperLynx PI, that perform a tremendous number of calculations very quickly. The engineers at SeaMicro in Santa Clara, California, are no different. But, after using HyperLynx PI on just one project, they were not only convinced as to the tool's usefulness, they made its use mandatory on future projects.

SeaMicro's Innovative Solution

SeaMicro has a new take on large web page servers. Their first product is a large data center cloud computer appliance. It comprises ten 18-inch rack units and hosts up to 500 processors. It also supports a large number of Ethernet ports and substantial disk storage. Their market is companies that serve hundreds of thousands of web pages.

The primary advantage of the SeaMicro solution is extremely low power consumption. They achieved their low power numbers not with any single large innovation, but by being extremely diligent at minimizing power consumption with every design decision.

Kevin Rowett, Vice President of Engineering, explained it this way: "We achieve minimum power consumption through not any one thing, but many, many system design tradeoffs. We picked a very power-efficient processor. We also went through the design and did everything to scrub out every milliwatt we could. Part of this is, if you take any one of our processors and you're only going to see a few tens-of-milliwatt of savings; if you take 500 of them, or however many we get into any one box, you're going to save a lot of power."

They go in directions other companies won't, as well. For example, they recently took a month to improve the efficiency of their power supply from 88% to 90%. Many companies would see that as moving into a region of marginal returns; SeaMicro saw it as an opportunity.

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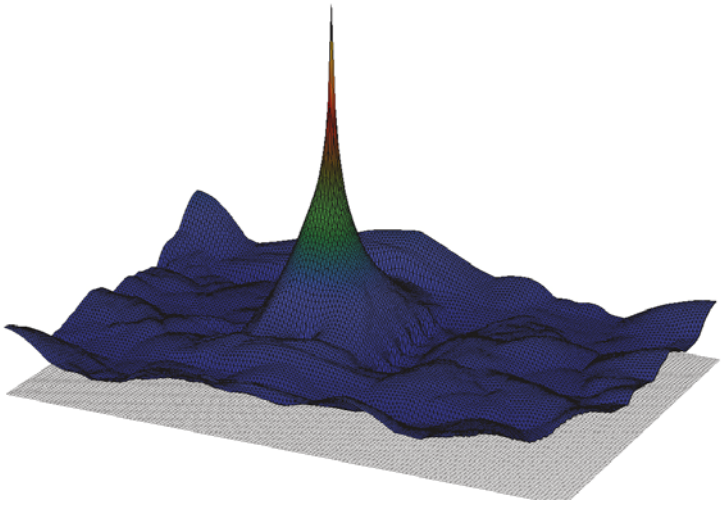
Kevin Rowett
Chief Engineer
SeaMicro



HyperLynx PI presents a 3D representation of current density. This made it easy for SeaMicro to identify problem areas.

SeaMicro

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When it came to system design, they continued their innovative path. Instead of starting with a reference design from the processor supplier and modifying it slightly, they choose to begin with a blank sheet of paper. They picked a processor, added DRAM, and then took a serious look at what else the system required.

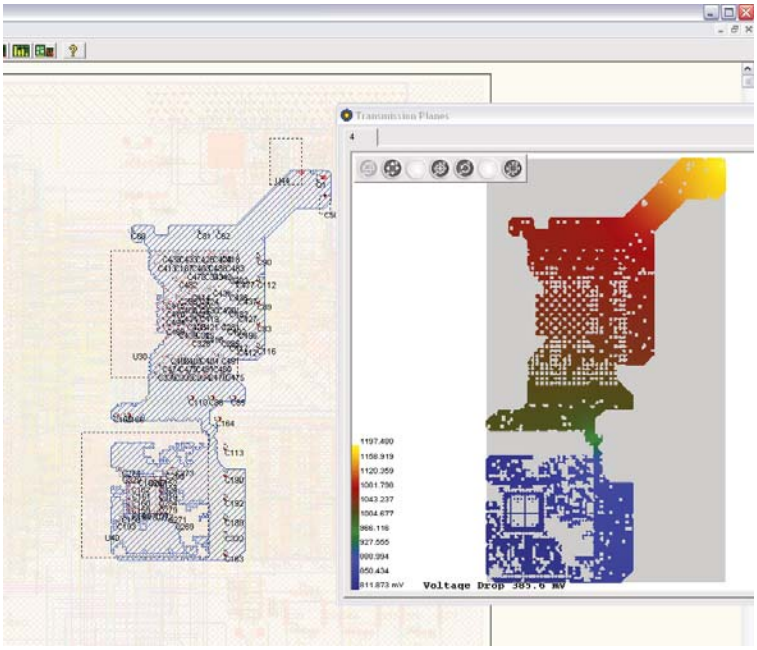
"At the end of the day, we discovered we needed a custom ASIC that allowed us to get that processor booted and let it talk to the disk and Ethernet. So we built that ASIC. And, that's it!" said Rowett. "There's nothing else on our motherboard. There's no SATA controller, no Ethernet controller, no FLASH to boot the BIOS from, no UART, no power supplies that 'somewhat efficient'. That's it, and it got us to extreme efficiency in terms of the power budget. And, throughout the system, we maintained that discipline to get power as low as possible."

An Ugly Problem Surfaces

Another aspect of the SeaMicro system is that it is physically compact. Each of the blades (PCBs) in the system is roughly 8 ½ x 5 ½ inches, yet contains eight independent processors. With the functionality highly integrated into the ASIC, there is room for all eight.

After designing the boards using their in-place rules-of-thumb for power distribution network (PDN) layout, they build a number of boards and began to test them. The quickly began discovering intermittent problems.

Because the eight processors onboard share a single power supply, they compete for power, and had different dynamic loads. "What we found was that from one end of the card to the other, there was a 50 mV drop on one of the rails, so the processors further out on the card were suffering the problems," said Rowett.



HyperLynx PI also provides 2D current density plots that instantly pinpoint current hot spots.

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> SeaMicro

After meeting with the design team, they concluded that the board had insufficient copper to carry enough current to the outlaying processors. However, two of the engineers also had concerns about microvias. The blade is a 12-layer board with microvias. On the negative side, when there are a lot of them, they can measurably disrupt current flow on the power plane. While they were certain they needed more copper, they also wanted to explore the effect of the microvias.

HyperLynx Quickly Analyzes The Complex PCB

"The arithmetic to calculate the resistance in a plan of copper is pretty straight forward. Once you start punching holes in it, it gets to be compute-intensive quite fast!" Rowett continued, "The problem is the location density of those vias."

Almost serendipitously, Chief Engineer Michael Yolkelson had just attended a HyperLynx PI seminar, less than a month before discovering the intermittent problems. "At the time of the seminar," he said, "we thought 'yeah, that's interesting, but we don't have a need for it right now'." Quickly, that had changed. Now, HyperLynx was the only way to analyze the "swiss cheese" power plane, with its many vias.

Once they decided that HyperLynx PI could give them the information needed to solve the problem, it didn't take long to import the schematic to the HyperLynx tool. They began simulation and plotted the voltage drop across the board.

Any skepticism that Rowett had entertained before using the tool had vanished: "Sure enough, the places where we measured the 50 mV drop, HyperLynx said it was 47 mV, which is well within the tolerance of our measurements. And the simulation was just dead-on accurate for what we measured across the board and the effects that we saw. It validated it completely for us. So, for us, that closed the loop. We could have easily spent 6-8 weeks revising the PCB and chasing other things. HyperLynx analytically confirmed what we suspected."

HyperLynx Aids Finding the Optimum Solution

One the team had employed HyperLynx PI to isolate, and visually present a 3-D representation of voltage across the entire board, the task switched to redesigning the board to eliminate the problem.

In addition to fixing the voltage drop problem, the team was cost constrained. It was not possible to add cost to the board to fix the problem. In fact, their goal was to get the board to eight layers instead of twelve, thereby reducing the cost. They quickly found that HyperLynx was easily capable of running "what if" scenarios with a number of different variables.

> *"We expected that it's going to tell us that there are problems, but when the numbers correlated well within the measurement error, we said 'yeah, this tool is really good!'"*
>
> Kevin Rowett
> Chief Engineer
> SeaMicro

They tried increasing the copper density from ½ oz to 2 oz. "You could immediately see the effect in HyperLynx," said Rowett. But HyperLynx also showed that would not be sufficient to solve the problem, because indeed, the density of the microvias was creating problems.

HyperLynx turned out to be a "fantastic simulation tool", as Rowett said. The board was extensively simulated with changes in copper weight and via placement. HyperLynx also was extremely helpful in realizing their goal of getting the stackup down to eight layers.

"So it wasn't it wasn't just one change that we made," said Rowett with a smile. "We had to use different copper weight, a slightly different stackup, and we had to put more copper in one plan and be confident that we weren't stealing from another plane that was going to suffer the same problem."

And, did it work? "We've since built 200 boards with the new design and it's worked perfectly," he concluded.

Is HyperLynx Right for Every Design?

Often, when a skeptic is convinced through proof, the skeptic becomes a "believer." In this case, Kevin Rowett and his team at SeaMicro did indeed become true believers. Not only did using HyperLynx save as much as two months of design time, but it allowed the to cut the board stackup from 12 layers to 8…a 33% reduction.

"We're now into the next version of the card. So our basic policy is that the cards have to go through power analysis before we're willing to sign off the PCB design."

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