Building the Oxide Rack:
Samtec Case Study

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Abstract

“Teamwork makes the dream work,” may be cliché, but in the case of the technology partnership that developed between Oxide Computer and Samtec, it applies. In an Oxide and Friends podcast, Bryan Cantrill, Co-founder and CTO of Oxide Computer Company, sums the experience up this way: “a perfect partnership, a model partnership—innovating together.” But what does it mean to be a great partner in tech, and how did Samtec and Oxide Computer create such a compelling partnership? This case study takes a closer look.

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Designing the Oxide Rack

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Oxide was developing a switch chassis and realized the signal integrity from the switching silicon to the front panel QSFP was going to be a real challenge [1]. Their concern was how to push the ASIC as far back in the chassis as they can, with the cables in the back as short as possible, while still having fans at the back. To complicate this, the boards had to be at a certain height to accommodate those fans. So how could Oxide design this chassis to avoid an “enormous slab of PCB”?

A Blank Sheet of Paper

In a switch like Oxide’s Server Rack, thousands of signals get transmitted through the connectors. It is challenging to make it all fit, as well as be repeatable and manufacturable. Cantrill explained, “We started with a clean sheet of paper at the right moment, and we think that was an advantage.” Adam Leventhal, Engineer at Oxide agreed, “We’ve bumped into designs like this more than once. Without the long chain of legacy, we are able to do ‘a lot less.’” The Oxide team reports that Samtec’s approach of walking with them through the design trade-offs was critical to their success. The clean sheet of paper approach allowed them to innovate in a way that other companies are not able to.

The design team started looking at what was available and discovered the Samtec Flyover® system [2,3], which routes signals using ultra-low skew twinax cable instead of PCB traces (see Figure 1). This would allow Oxide to use a set of connectors and cabling from a QSFP to the ASIC instead of through a PCB trace. “I could go further with the cables because they have better performance than a PCB, but, more importantly, I could basically split the PCB into two and have one board accommodate the fans in the back and at a lower height while the other board could be placed centered vertically in the front. This would allow us to have QSFP ports on both sides of the board.” says Arjen Roodselaar, Engineer at Oxide. “We then used Flyover cable to go back to the main board and land near the ASIC to connect it. There was a specific example on the Samtec website that was exactly what we wanted.”

The Oxide team quickly contacted Samtec, expecting to be engaged in lengthy discussions and NDAs. Instead, Samtec immediately shipped a sample Flyover cable.

What the Oxide team hadn't been aware of was Samtec's Sudden Service® program [4], which includes next-day free samples.

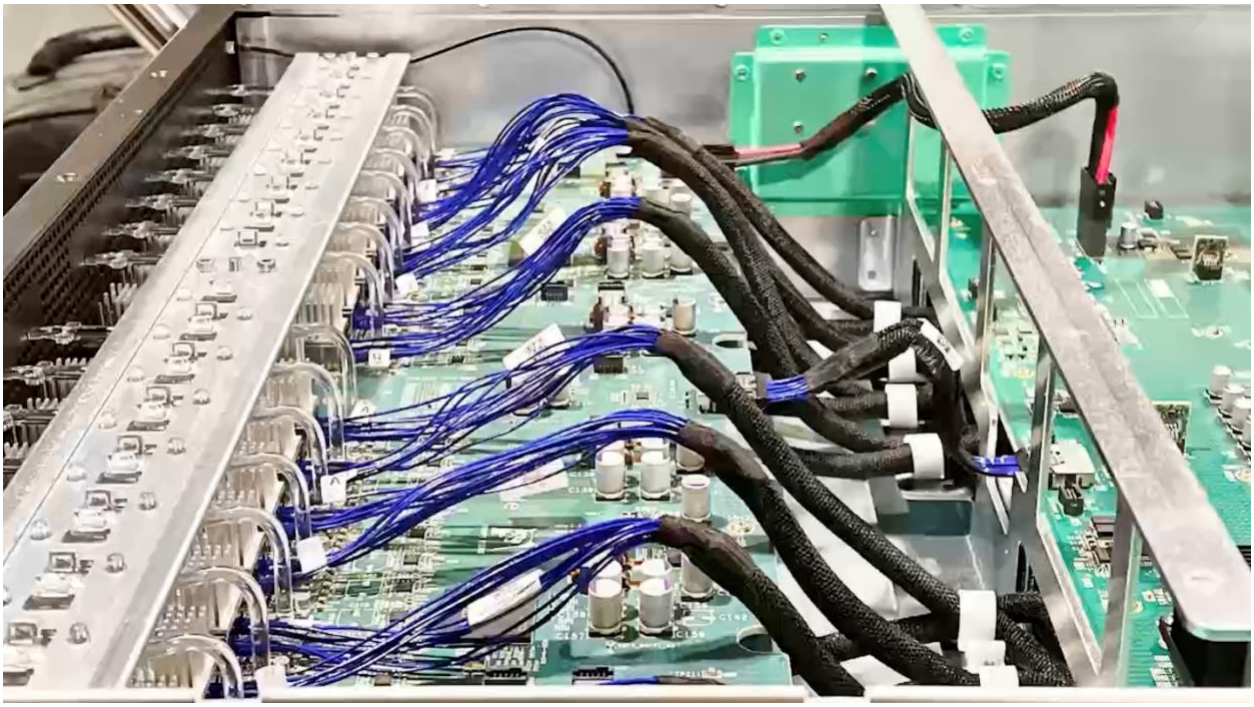

Figure 1: Samtec Flyover cables allow Oxide to mount PCBs at different levels and easily reconfigure the front panel.

Explaining Sudden Service

"We want to understand the problem and get the customer what they need," says Jignesh Shah, Sr Technologist, High Speed Connectivity at Samtec. "Samtec's Sudden Service has evolved beyond samples to providing complimentary cable management mockups, first order fluid dynamics analysis, and signal integrity analysis for the full channel." In fact, Samtec has created multiple support streams because high-speed problems are challenging and the products that support them are complex. "There's a learning curve for our customers. Who better to help them but us?" asks Shah.

The Oxide team agrees, noting that with Flyover cable, you are designing in a 3D space, as compared to 'flatland' on a PCB. This allows you to put boards at different levels, rotate them 90 degrees, etc. For that to happen and to take full advantage of designing in a 3D space, you need to move on from conventional architectures. It's more than just adding a cable, designers need to take care of the signal that rides on the cable in terms of signal integrity, power integrity, and emissions. "When Jignesh talks about complimentary services, it is critical to take advantage of those to understand, adapt, and use these products correctly," says Roodselaar. "As data rates go up, the electrical, mechanical, and manufacturing architects have to work together."

Taking the Heat

Another main draw for Oxide to the Samtec Flyover cable design was its thermal advantage. In a traditional switch, the QSFP interfaces are in the front of the chassis with the ASIC close to them (using as short a trace as possible) to satisfy the loss parameters. For 100G/28G NRZ designs, this can be a fine approach. However, with 56G PAM4, 200-400 Gbps links and beyond, the PCB losses are taking too much of the budget. In addition, all the transceivers have a significant heat load, beginning at around 3-4W and ramping up to 6-8W. As a result, systems are being designed for up to 10W dissipation per transceiver, in addition to the 300-500W ASIC itself. In short, these traditional designs are facing a very large amount of heat in a very small space.

With a Flyover cable approach, the Oxide team was able to put their ASIC in the back of the chassis near the fan to evacuate the hot air. The final design actually separated the PCB into two pieces with an interface. Flyover cabling was used for the high-speed interface from the front panel back to the ASIC, and then there was lots of low-speed signaling between the two boards to manage the power and other components. Another benefit of this approach was that the two boards were designed sequentially, and once the main board was fabbed out in production, the Oxide designers turned their attention to the QSFP board that would attach to it. So, they could sequence the design at a pace that worked for them.

In addition, by using Flyover cables, the Oxide team was able to design the front-panel interface so that they could reconfigure the design with a different QSFP board. Today the design can support thirty-two 200G ports on the front, but they can reconfigure this board with very minimal effort into sixteen 400G ports, using different Flyover cables to connect the 400G ports to the same connectors on the main board. That translates to a huge advantage in that they do not have to redesign the main board. Alternatively, if another standard emerges, they can create a different form factor all together. Already, the design team has developed “special flavors” of the QSFP board for specialized needs without having to redo the main board. This allows them to build several variations of the switch chassis with very minimal engineering effort and very low risk.

Cabling the Backplane

The Oxide team was sold on the Samtec Flyover cables for transmitting signals from the front panel to the ASIC, and it didn’t take long to realize a lot of those same benefits would translate to the backplane. A cabled backplane helps transmits signals greater distances with better signal integrity (see Figure 2). And with no PCB in the way, airflow is improved to help with cooling the rest of the system. The other advantage is that it helps free up time and design resources that can be dedicated to other parts of the system. The terminal base is coined and rounded to increase the solderable surface area of the terminal.

Figure 2: The Oxide Cabled Backplane

A Team Mindset

“With some vendors, part of the frustration is not getting someone at the vendor to treat your design like their system,” said Cantrill, noting that when Samtec entered the scene, they treated it like a system the companies were building together. “We were so impressed with the level of attention to detail and empathy that the Samtec team brought. The degree to which you cared about our problems and solving them was very meaningful, especially because we are doing things that are a little bit odd,” added Cantrill. Jonathan Sprigler, Samtec Product Manager, noted that Samtec gained from

the partnership as well, by having the opportunity to participate in an open discussion about optimized signal maps to layout the cables, discussing cable lengths and sleeving.

Troubleshooting Together

In the early design and test phase, cables in the Oxide rack were having signal integrity issues. Samtec inspected the cables and believed that there was some excessive bending and handling of the cables during the assembly process. Sprigler traveled to Minnesota where he met up with members of the Oxide team at their manufacturing partner, Benchmark. He talked to Oxide and the Benchmark assembly team about the best way to route the cables, where to bend the cables, and when and where to install wire ties. The team tore down and completely re-cabled a full-size rack. Leventhal noted: “It was awesome to see the team roll up their sleeves, elbows deep in the rack, rebundling things, talking about how we could change our design mechanicals to facilitate better bends. Three different companies working together.”

A Model Partnership

Cantrill notes that it’s important to take responsibility for your own ideas all the way from ideation to production. What’s happening in production has a lot to teach you about your next-generation designs. He likes that Samtec has people who work on product design as well as directly with customers deploying those designs, giving them a unique vantage point, “What we have with Samtec is a perfect partnership, a model partnership—innovating together.” That’s what it’s all about.

Resources

[1] Signal Integrity Handbook, 2023

[2] Samtec Flyover Product Information.

[3] Why Use Flyover Cables? Samtec White Paper.

[4] Sudden Service is Essential for Essential Industries - The Samtec Blog