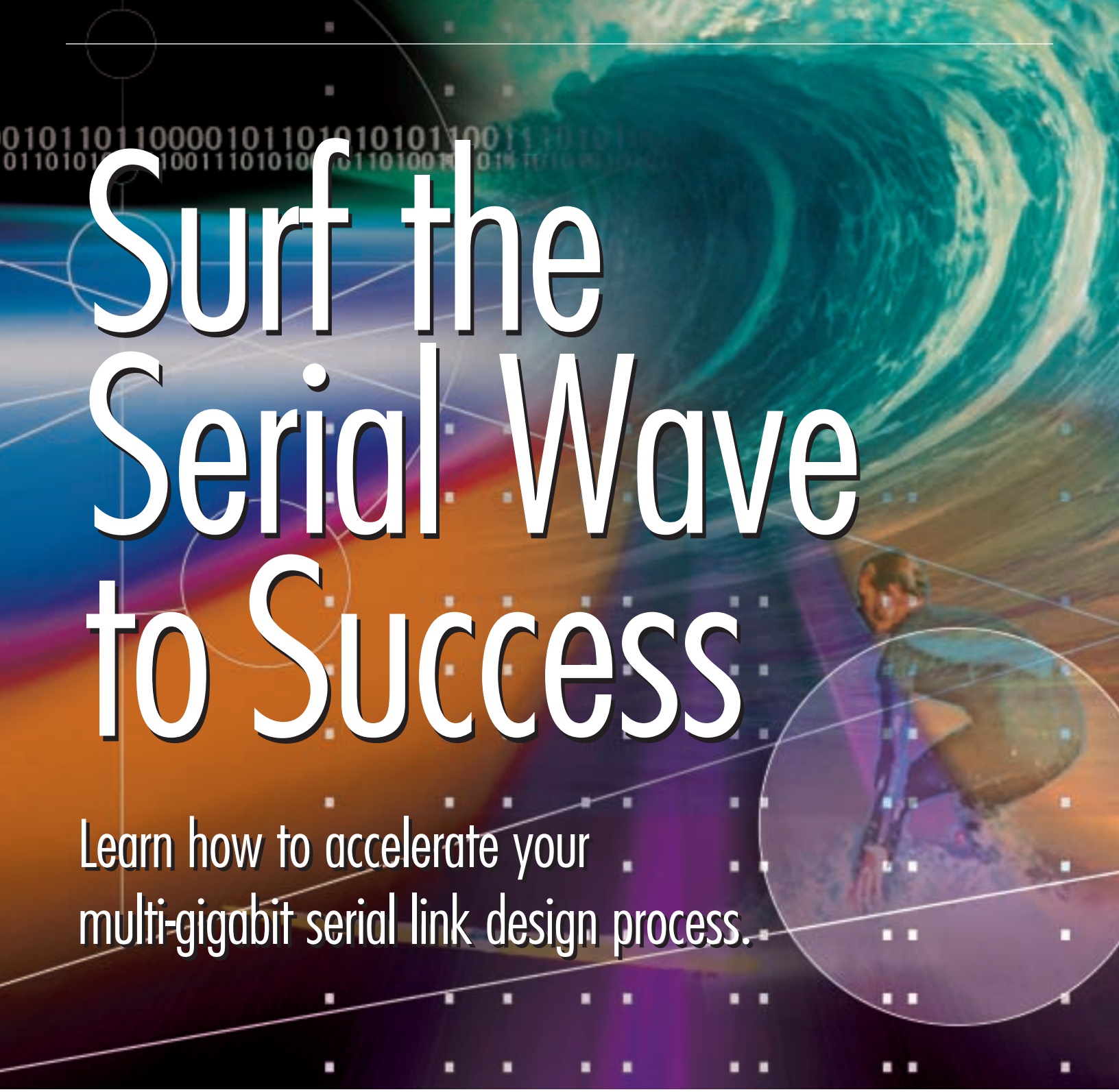

# Surf the Serial Wave to Success

## Learn how to accelerate your multi-gigabit serial link design process.

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The move to multi-gigahertz (MGHz) serial technology represents a sea change of tsunami proportions. A variety of industry forces are revolutionizing product design to accommodate the speed and throughput of serial data transfer.

This article will show you how to harness the power of the Xilinx Serial Tsunami Initiative. We'll look at helpful tools and effective techniques already being used by engineers today.

### Effective Data Transfers

Whether you're moving bits down an MGHz serial link or moving money into your bank account, it's important to make sure all the data is transferred correctly. You simply cannot afford to lose data.

Figure 1 illustrates two types of data transfers relevant in MGHz design. The first row shows the serial link itself. Data is sourced by the transmitter (Tx), transferred through the differential interconnect, and latched onto by the receiver (Rx). If all elements are not tuned to each other, the data is not transferred effectively. The transmission medium must be designed carefully – and all three ele-

ments (Tx, transmission medium, Rx) must be well-matched.

Similarly, the second row of Figure 1 shows the design chain between Xilinx serial technology and your design process. Just as in the case of the serial link, the Xilinx technology must be delivered to you in a medium that matches your design process to ensure a clean data transfer.

In cooperation with Cadence, Xilinx has developed the SPECCTRAQuest Design Kit as a way to effectively communicate the operation of the RocketIO™ MGHz transceivers found in the Xilinx Virtex-II Pro™ FPGAs. Later, we'll examine the Xilinx-Cadence partnership and how you can use it to accelerate your design process and improve your products. But first, let's take a closer look at the MGHz serial link itself.

### How Serial Links Work

Measuring the "opening" on an eye diagram is a common way to judge the effectiveness of serial transmission. Figure 2 superimposes eye diagrams of received signals in three slightly different test cases. In the green signal's circuit, the transmitter, interconnect, and receiver impedances are well-matched. Here, all three elements are working together to produce an acceptably wide eye opening.

The other two waveforms in Figure 2 show what happens when only one of the three elements becomes imbalanced. In the blue signal's circuit, a mismatch in the impedance of the transmission line causes erratic signal behavior and a collapse of the eye opening. Changing the transmitter's impedance, however, causes an even further collapse in the red signal's circuit behavior. Although the red signal appears more deterministic than the blue case, the transmitter in this case is not delivering enough voltage swing to the circuit to meet the thresholds in the receiver to extract the serial data.

Items that make an MGHz serial link work right include:

- Proper sizing of the transmitter for the required voltage swing
- An understanding of the differential impedance of the transmission medium (Z_differential is typically 2*[Z_uncoupled – Z_coupled])
- Matching that impedance with a termination resistor between the two nets at the receiver's inputs
- Thorough characterization and accounting for the interconnect's discontinuities and behaviors (such as vias, connectors, dielectric loss).

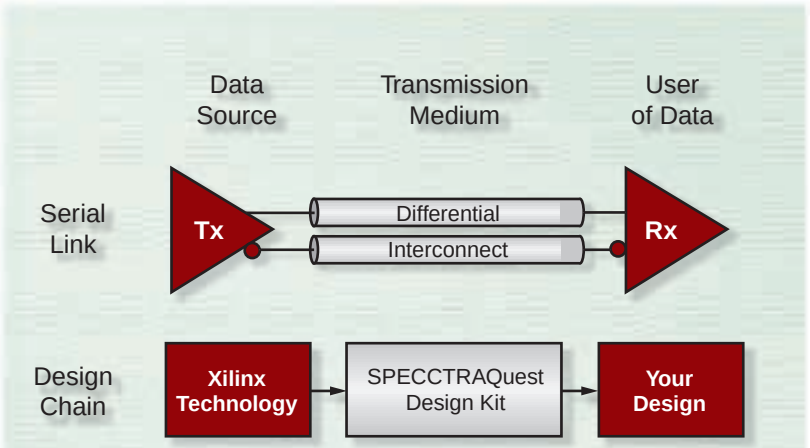


*Figure 1 - How data is effectively transferred in a serial link, and its design chain.*

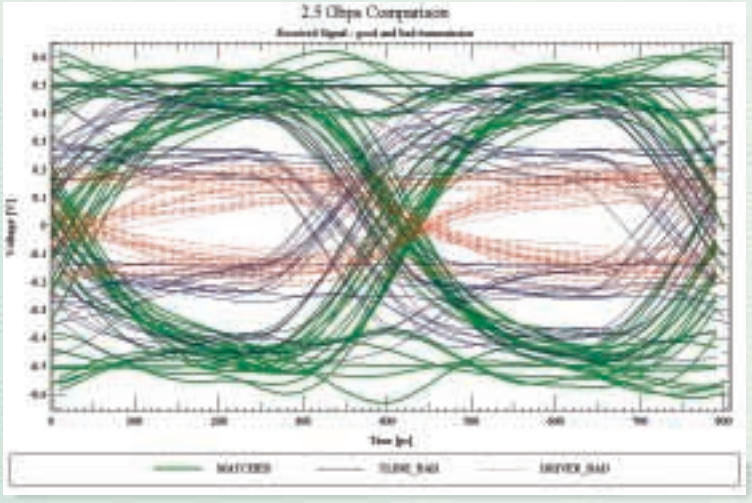

*Figure 2 - Mismatch in any one of the serial link components can adversely affect performance.*

### The SPECCTRAQuest RocketIO Design Kit

Recognizing that the MGHz design process has discontinuities too, Xilinx proactively developed the RocketIO Design Kit for Cadence's SPECCTRAQuest high-speed PCB design tool. This kit was first introduced with the Virtex-II Pro FPGA in March 2002, and was described in an *Xcell Journal* article at that time (see *support.xilinx.com/publications/xcellonline/partners/xc_speckit42.htm*). The kit helps you implement the RocketIO technology by providing the electronic files and models that match and can be inserted directly into your design process. Multimedia tutorials within the kit help you quickly understand the steps involved.

Mohammad W. Ali, Ph.D., a technologist at Tellabs, found the kit to offer significant improvements in both the throughput and quality of his design process. He states, "The new silicon package board solutions in the design kit save me a lot of time, particularly for my multiboard simulations that involve different styles of routed 2.5 GHz differential pairs. With the new interfaces in this SPECCTRAQuest Kit, I can accomplish my simulation task 10 to 20 times faster."

With RocketIO transceivers, signaling throughput has increased an order of magnitude. And with the accompanying design kit, the throughput of the design process has increased similarly as well – even with the challenges of MGHz design.

## Design Chain Optimization

Great technology that is hard to use isn't really all that great. New technologies have failed because they were just too hard to access or too complex to work with. That's why Figure 1 shows the two parallel challenges that must be solved for high-speed serial communication to succeed:

1. Proper transmission of serial data from transmitter to receiver, and
2. Proper transfer of serial technology from Xilinx to you.

Focusing on the second challenge is what "design chain optimization" is all about. Design chain optimization is the only way to achieve the 10X to 20X design task improvement that the RocketIO kit has to offer.

Figure 3 illustrates the design chain. Because the term "design chain" is not as common as "supply chain," both are shown to help you understand their function and relationship to each other. Within the design chain, design kits of "virtual components" (in the form of models, EDA files, and databases) are transferred from the technology deployment group at one company to the engineering group of another.

In our example, the RocketIO kit effectively communicates the nuances of MGHz technology to Xilinx customers. This is done by avoiding the vagaries of textual datasheets, instead providing electronic files that can be easily inserted into your design process. These files are "executable specifications" that can quickly be understood by engineers all over the world, because the tool shows the RocketIO serial transceiver in a context with which they are familiar.

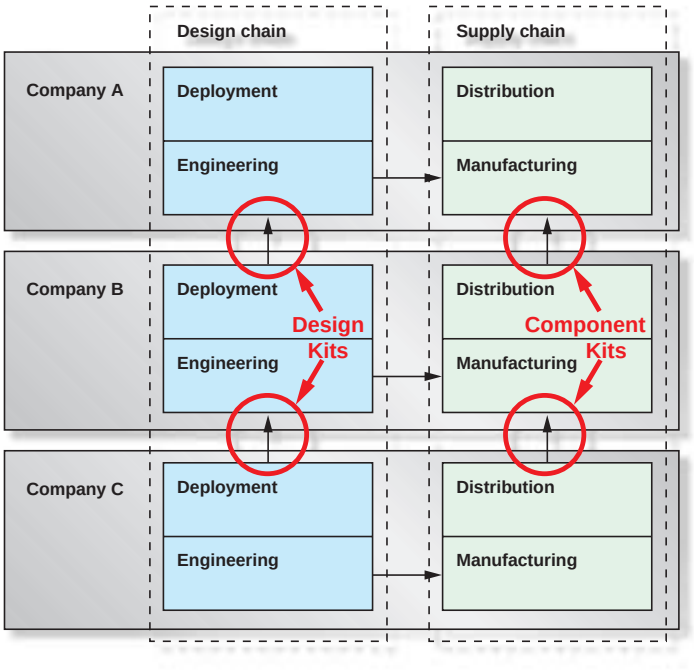


*Figure 3 - Design and supply chains and the role of design kits.*

## Bridging IC to PCB

Just as all elements in a serial link must be matched, so must the elements in the serial design chain. But here Xilinx had a challenge: the model formats commonly used by PCB designers would not work with this new technology. In fact, the only accurate representation of the RocketIO transceiver was the model used to design the silicon – an IC-level model that only worked in IC design tools.

As Figure 1 shows, the SPECCTRAQuest Design Kit answered this challenge and became an efficient "transmission medium" to bridge the worlds of IC and PCB modeling. New technology in the SPECCTRAQuest kit allows you to simulate arbitrary PCB layouts with complex IC models – all from the SPECCTRAQuest user interfaces commonly found in the high-speed PCB design process. If Xilinx had required PCB engineers to learn new IC simulation tools, it would have caused a mismatch in the design chain and hindered the adoption of RocketIO transceivers.

Wenwei Qiao, an engineer at Applied Materials, prefers using the Xilinx and Cadence kit's pre-packaged complex silicon models within the SPECCTRAQuest environment because they can be manipulated much like simpler IBIS-style models. "In only 10 minutes after installation, I was able to begin simulating my multi-gigabit solution," he reports. The user interface helps him focus on the design task and improve his product's quality instead of wading through thousands of lines of text-based models and netlists.

Stéphane Tessier, a hardware engineer at Radical Horizon, a Montreal-based software-defined radio (SDR) solution provider, agrees that the kits are a "must-have" for developing multi-gigabit links. He found that the tutorial information in the kits shortened his learning curve, and he believes use of the kits will "reduce the number of board iterations."

## Conclusion

A survey of engineers currently using the kits revealed that they unanimously find them valuable for serial MGHz design. Already, 75% of the engineers believe that using the combined Xilinx/Cadence kit has helped them improve their product's quality.

During 2002, the integration of the SPECCTRAQuest and RocketIO design kits have become an integral part of the Xilinx Serial Tsunami Initiative – listed among *EDN* magazine's top 100 products for 2002.

The serial tsunami is here and growing. As you join fellow engineers in riding the serial wave, be sure to download your free copy of the SPECCTRAQuest Design Kit. It will help you put the power of MGHz signaling into your next design.

### For More Information

The SPECCTRAQuest RocketIO Design Kit can be downloaded free of charge at: *support.xilinx.com/support/software/spice/spice-request.htm.* Registration and click-license NDA are required.

Information about Cadence SPECCTRAQuest (SQ) and other free SQ design kits is available at *www.specctraquest.com.*

An executive white paper on design chain optimization is available at *http://register.cadence.com/register.nsf/designChain/.* Σ