BladeCenter Simulation Using IConnect

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Abstract

This paper will describe how IConnect™ software was used during BladeCenter development to do signal integrity simulation. The BladeCenter has Gigabit and Fiber channel interfaces with long lines. The topics of this presentation are simulation goals, possible solutions, an overview of BladeCenter, IConnect setup and comparison of different measurement. IConnect is a tool which can take prototype design data and provides efficient and easy signal integrity analysis for gigabit interconnect links. IConnect can quickly predict eye diagram, jitter, frequency dependent losses, crosstalk, reflections, and ringing.
 This paper will then proceed to show comparisons of IConnect Vs. lab measurements and IConnect vs. Cadence SPECCTRAQuest™ simulation results.

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ITIRC KEYWORDS

SPECCTRAQuest^{TM}
SigWave^{TM}
IConnect^{TM}
Hspice^{TM}

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Introduction:

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We will compare the results of IConnect Vs. lab measurements and IConnect vs. Cadence SPECCTRAQuest simulation. The presentation is concluded by summarizing the benefits of IConnect during design development.

Simulation Goals:
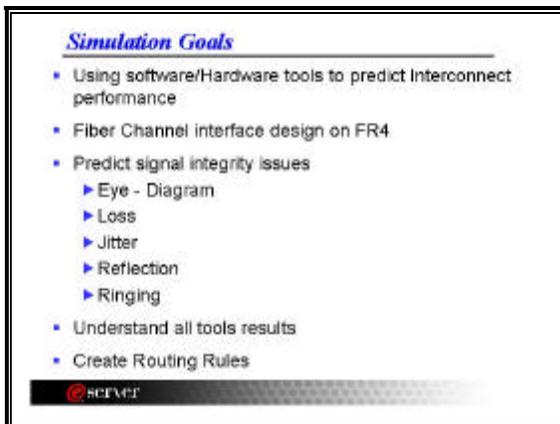
Because of high speed design, the goal was to predict interconnect performance for a longer line length on FR4 material. The data speed was significantly more than had been experienced in the past. We want to make sure that the signal integrity issues have been understood such that the effect of loss, jitter, reflection and ringing does not compromise the eye diagram. The objective was to create design guide lines that can prevent signal quality loss and enhance better eye openings. The intent is to illustrate the IConnect design environment, which can promote the ease of use and enhance simulation accuracy.


Initial debate was that the IBIS model will be accurate at these speed or use some thing else. The IBIS model was available but did not have package model information for a high speed device. There was an Hspice™ model available but it was rated for a 1.25gbs data rate.

Another uncertainty was that the IBIS model and behavioral simulator might not predict AC loss and skin effect accurately for the 2.5Gbs interface signals. The simulation software available was SPECCTRAQuest for behavior simulation and Hspice for detail simulation. The objective was to come up with some design guide line before the first hardware prototype. We had some hardware boxes but not enough to complete the hardware test. The random pattern generator was not available and very expensive to buy.
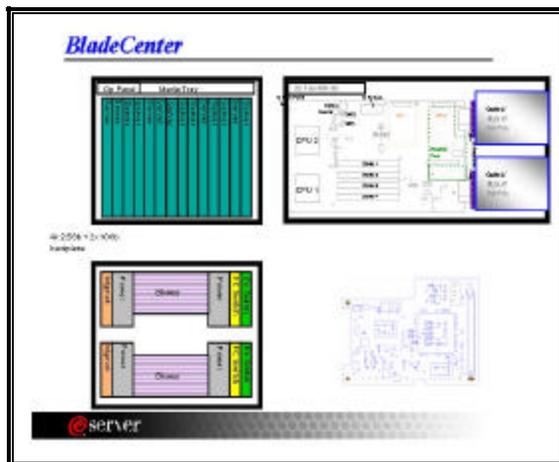
Solution
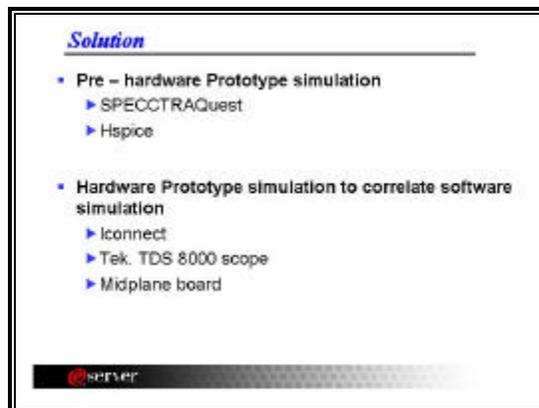
Before a hardware prototype was available some assumptions were made. We used the

pre-route simulation of a 1V voltage source connected to a 100ohm differential and 50ohm single ended transmission line. The simulation in SPECCTRAQuest showed some loss but was limited to a 128bit PRBS pattern. Similar simulation was done using Hspice with large PRBS pattern. Both results show that a 4mil line width would produce more loss than 8mil line width. After several simulations the 8mil line width produced enough eye width at fiber channel speed. The first prototype was developed using an 8mil line width. The transmission line model was created using a SPECCTRAquest tool and also verified with other tool sets. The simulation predicted worst case of 650mv eye opening with 1 volt of output voltage for 18 inch line length. You can see the dielectric loss and skin effect on the eye diagram. The wiring guidelines were submitted to the design engineer to layout on providing proper connection. The stripline structure was simulated and later implemented.

Overview of BladeCenter:

 A quick review of Blade center follows. The BladeCenter consists of several components, such as Blades, Switches, a Management module, and Option card for Ethernet or Fiber Channel. BladeCenter offers the performance and manageability rack-optimized platforms at twice the density of today's 1U servers. The result is a highly managed infrastructure that helps maximize resource productivity and minimize IT administration costs. It has up to 14 blade server bays for extreme performance density. It has four hot-swap and redundant switch modules supporting Giga bit Ethernet and
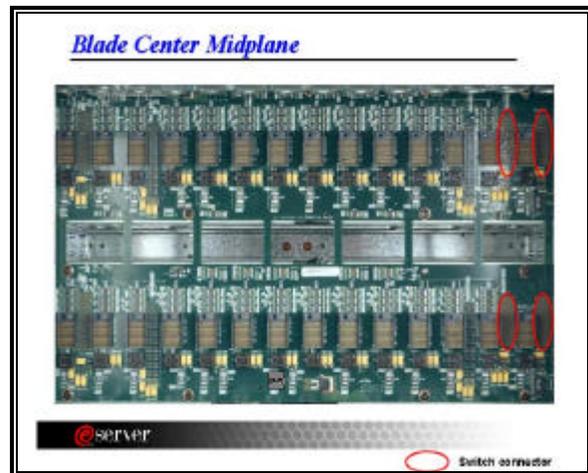
Fiber Channel. It has four hot-swap and redundant load-balancing power supply modules. The RS 485 bus is used for multi-point communications between the Management Module and Processor Blades. The Blade Server RS 485 system uses a Master/Slave architecture, where each slave unit has a unique address and responds only to packets addressed to that unit. Each blade has a 4 SERDES channel connected to the four switches for Ethernet or Fiber Channel Interfaces. Each blade has two processors, four DDR dimms and an independent IDE drive to install any operating system.

     A daughter card provides expansion I/0 or functional capability for a Processor Blade. The daughter card may or may not require a companion Switch Module to offer a complete range of function. The Daughter Card is positioned near the rear of the card adjacent to the mid-plane. It occupies the space where IDE Drive No. 2 would otherwise be placed. However, the Daughter Card does not plug directly into a connector on the mid-plane. The Daughter Card also supports I2C interface on the 200-pin connector. The Daughter Card supports a 64bit PCI-X 1.0 electrical interface via a 200-pin board to board stack connector.


The Mid-plane will provide signals to processor blades, switch modules, power modules, and management modules that identify which slot the component is in. A Mid-Plane is a 6U high single PCB board with HDM connectors for all sub-systems for interfacing among them. Mid-Plane supports a maximum of 14 Processor Blades, 4 Power supplies, 4 Switch Modules, 2 Management Modules, 2 Blowers, 2 Control Panels, and Media Bay in the BladeCenter

chassis. It has connection for four power modules to the Mid-plane of the BladeCenter system, which distributes the power to the system components.

The Midplane has a 2 inch to 18 inch long SERDES interface wired on FR4 material. Midplane has longest traces of transmission line in the whole system. We wanted to verify the dielectric loss and skin effect the signal quality on Midplane lines at 2.5Gbs data rate.

IConnect Setup:
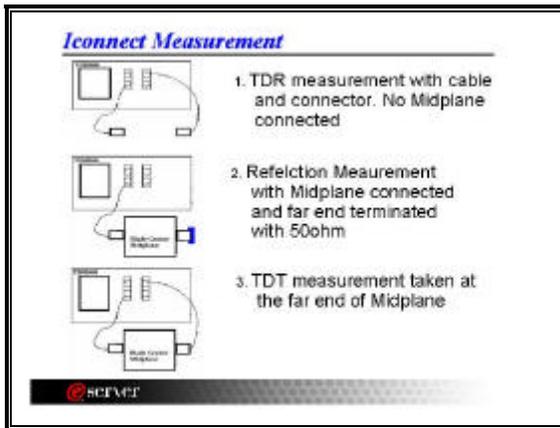
In IConnect setup, the choices are measuring either open-circuit waveforms or measuring matched reflection and matched transmission waveforms. Matched transmission and reflection measurements allow more accurate extraction. In this case we have used a matched waveform setting.

The first step is to create a reference waveform which is a TDR measurement without Midplane. Only a cable and connector are connected to the scope.

The second step is to create a load reflection waveform. In this case the midplane is connected and the far end of the Mid-plane is terminated with 50 ohm resistor.
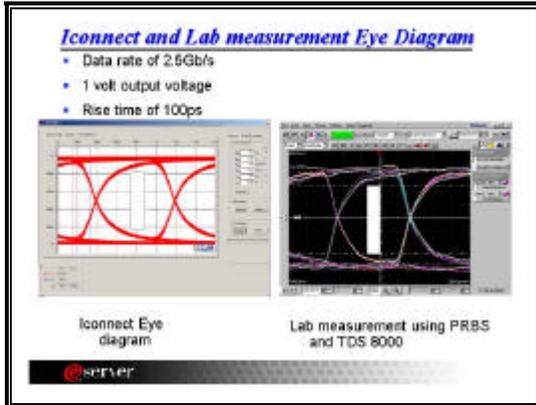
The final waveform is a TDT measurement taken at the far end of the midplane. Once all three waveforms are captured then the user can click the lossy line model button on the IConnect model toolbar to create a lossy line model and eye diagram.
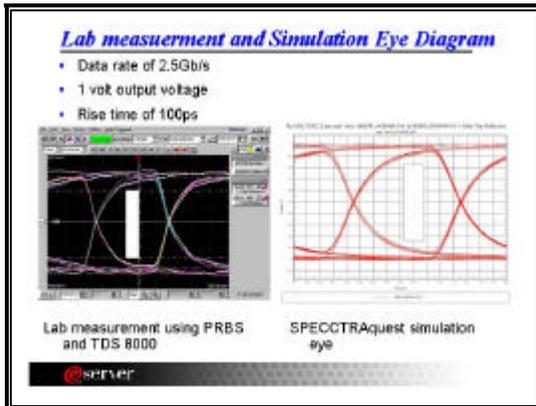
Lossy line:
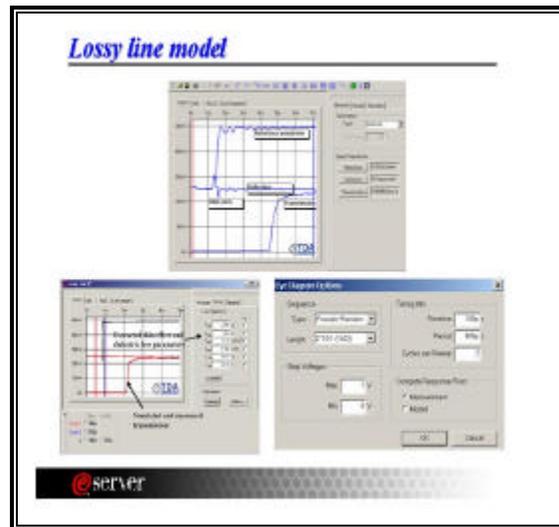
The first step in extracting a lossy line model is to load the waveform to extract the model parameters and an eye diagram. The first step is to select the matched load extraction from the dropdown box labeled Method. On the measure tab, click the button labeled Reference to bring up the waveform selection window. This window allows loading a waveform from the file. Load the reflection and TDT waveform using the same method. Click the Model tab on the right side of the lossy window. Click the compute button and wait to see the lossy line parameters like skin effect and dielectric loss. You can see the time and frequency domain response based on measurements. From model tab in the Eye diagram section, click option to customize the parameters. It was very easy to change parameter like step voltage, rise time and input PRBS pattern. The step voltage of one volt and 100ps of rise time was used during this example. After selecting the proper option click the Display button from the eye diagram section. IConnect computes an eye diagram based on the current eye diagram options.

Compare Results:

Iconnect and Lab measurement Eye Diagram
- Data rate of 2.5Gb/s
- 1 volt output voltage
- Rise time of 100ps

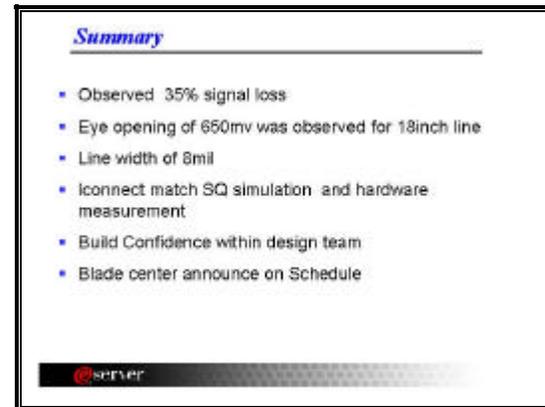Iconnect Eye diagram — Lab measurement using PRBS and TDS 8000

Looking at the accuracy of the tool at 2.5Gbs data rate was the most important factor in this design. Using the same option in the lab, the lab measurements were done using an external random data pattern generator. The external hardware measurements revealed a worst case of 650mv eye opening with 1 volt output voltage in the Random Pattern Generator. IConnect provided similar eye diagram as the lab measurements. This shows us the accuracy of IConnect simulator and lab measurements.

Lab measuerment and Simulation Eye Diagram
- Data rate of 2.5Gb/s
- 1 volt output voltage
- Rise time of 100ps

Lab measurement using PRBS and TDS 8000 — SPECCTRAquest simulation eye

Once the Comparison of lab measurement and IConnect verified, we went back and saw the initial assumption we made before the prototype. The lab measurement was compared with SPECCTRAQuest behavioral simulator. The one volt of the PWL model was created with 100ps rise time. The SPECCTRAQuest simulation matched lab measurement and IConnect. SPECCTRAQuest also provided skin effect

and dielectric loss which were in question before the prototype design. The simulation engine in SPECCTRAQuest (tlsim) did provided a lossy, coupled, frequency-dependent transmission line which was used to predict electrical behavior of PCB traces.

Summary:

Summary
- Observed 35% signal loss
- Eye opening of 650mv was observed for 18inch line
- Line width of 8mil
- Iconnect match SQ simulation and hardware measurement
- Build Confidence within design team
- Blade center announce on Schedule

The signal loss of 35 % was observed with one volt of output voltage. The worst case of 650mv was observed at 100ps of rise time with an 18inch line length on FR4 material. Several lossy simulations showed that 8mil of line width incurred less loss compare to thinner line width. The Mid-Plane was routed with line width constrain successfully without adding any extra layers. The IConnect tool provides good correlation with lab measurement and simulation. The first design success at this speed, provided confidence in signal integrity simulation results and design team. IConnect and SPECCTRAQuest could be use to analyze other hypothetical configurations.