Achieving Full System Signal Integrity for High Speed Backplane System

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Outline

• Introduction of backplane system
• Challenge to backplane system simulation
• Components of EM simulation
• Analysis workflow
• Full backplane system SI simulation
• Summary
Backplane System

• Backplane system is used as a backbone to connect several printed circuit boards together to make up a complete system

• There are various configurations
  – Traditional backplane
  – Orthogonal direct
  – Orthogonal mid-plane
  – Coplanar
  – Cable backplane
Backplane System Example -- Server Board

• Complex PCB layout.
• Maybe system has capacitor or repeater, Engineer need to check repeater gain based on channel’s loss.
Backplane Design Consideration

- Copper Roughness
- Dielectric Losses
- Parasitic modes
- Radiation
- Cross talk
- Reflections
- Skin Effect
Challenges to Channel SI Simulation

• Reflection noise due to impedance mismatch, via, connector and other discontinuities.
• Need to capture all physical parasitic effects
  – Reflection, Coupling, Delay, Freq. dependent Losses,…
• Measurements become very difficult,
  – Parasitic values are small but important at high speed.
  – Large number of ports for interconnects.
• EM simulation of the discontinuities is a must. However, the current flow suffers the following problems:
  • Manual process to extract the via, trace, and other discontinuities
  • Manual process to build all the channels
Components of EM Simulation

- Transmitter
  - Transistors
  - Sources
  - Algorithms
  - Passives
  - Memory

- Interconnect
  - Thru Via
  - BB Via
  - Microstrip
  - Stripline
  - Capacitor
  - Repeater
  - Connector
  - Backdrill

- Receiver
  - Transistors
  - Sources
  - Passives
  - Memory
Analysis Workflow

1. Layout Extraction
2. Via/Trace Simulation
3. Pin Mapping
4. Single or Multiple Channel Simulation (Freq and Time)

- Compliance Test
  - Yes: Help Engineers to understand the system
  - No: S-param Exploration
    - Show 3D Structure
    - Show Every Channel Physical Parameter

Done Work
Analysis Workflow

1. Import Layout File
2. Setting Connection
3. Choose Channel
4. Layout Information
5. Auto Pin Mapping
6. Choose Desired Net
7. Setting Via Model

Seamless Integration
Friendly User Interface
Analysis Workflow

Create Channel Table

Create Excel File

Batch Simulation

Create 3D View

Create Schematic

Time and frequency domain solutions
S-parameter, Crosstalk analysis, TDR, Eye diagrams
Post-Layout Extraction

- Import all the boards for the backplane system
- Extract vias and traces from layout

- Layout Files
- Model Template

- Self cleaning process
- Discrete components
- Area/Net selection
- Stackup definition
- Materials definition
- BB, Back drill definition
- Auto port definition
- Parameter/Optimization
- High flexibility
• Via and ground plane will lead to \textit{parasitic capacitance} and \textit{parasitic inductance}.

• \textit{How to deal with a lot of via models?}
Trace Modeling

- For trace, the common approach is to use 2D models for main high speed interconnect.
Connection between Boards through Pin Mapping

1. Import .csv file.
2. Create connection manually.
3. Create connection base on slot ID.
Connector S-parameter from Vendor

- Connector S-parameter file comes from vendor
Auto Cascading to Create Channel

Channelview

- 3D structure of BP system
- Hide/Show board or net in 3D
- Show entire channel path
- Single vs. multiple simulation and cascading

Cascading

- Fast and memory efficient
- Show channel’s structure size in Excel file
- Easily find worst channel
- Easily generate Excel report

Excel File
Full Backplane SI Simulation - Frequency Domain

• Full backplane SI simulation is achieved by sweeping all the channels

Full Net Return Loss

Full Net Insertion Loss

Net Distribution @ 13.67 GHz
Full Backplane SI Simulation - Time Domain

- Support IBIS, IBIS-AMI, Spice model.
- Add proper pattern model.
- Fast modeling and high accuracy.
Full Backplane SI Simulation - Time Domain
Summary

• Passive channel modeling and simulation is essential to high speed channel design.

• Optimal channel design requires user friendly EDA tool to do layout extraction, via optimization, trace simulation, $S$-parameter cascading, $S$-parameter exploration, etc.

• Full backplane system SI simulation is achieved by sweeping all the channels with correct models.