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Understanding and Using ICM Models

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Topics

- IBIS ICM Model Introduction
  - What's IBIS ICM Model
  - What can we do with ICM model
  - ICM model structure
- ICM model usage scenario
  - Black box model
  - Package model
  - S-parameter support
  - ICM swath model support
- Summary

IBIS ICM

- **IBIS Interconnect Modeling Specification**
  - ICM stands for InterConnect Modeling
- **The goal of the ICM**
  - Provide a better, *more accurate*, non-proprietary interconnect data exchange format
    - Faster & ***accurate*** simulations
    - Smaller file size
- ICM history
  - Final Draft 1.0 released publicly May 16, 2003
    - See IBIS web site under “Connector Info”
  - Version 1.1 “ICM” specification approved in July 2005

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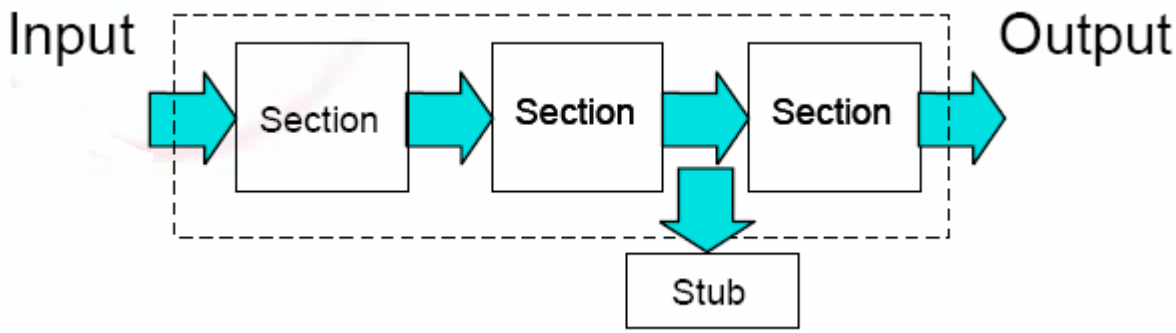
What can we do with ICM model

- ICM supports models for Connectors, PCB traces and IC-Packages

- ICM can include
  - RLGC Matrices
  - Swaths
  - S-parameters

Section of ICM

- Each section is made up of a Single Line Model (SLM) or Multiple Line Model (MLM)
- A matrix section is a set of tables of numerical values that represent the electrical relationships between all conductors of a given geometry



- S-parameter can be used in place of RLGC matrix

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Section: ICM core unit structure

```
/--[Begin ICM Section]
|   |--[Derivation Method]
|   |--[Resistance Matrix]
|   |     /-- [Bandwidth]
|   |     |-- [Frequency]
|   |     \-- [Row]
|   |--[Inductance Matrix]
|   |     /-- [Bandwidth]
|   |     |-- [Frequency]
|   |     \-- [Row]
|   |--[Conductance Matrix]
|   |     /-- [Bandwidth]
|   |     |-- [Frequency]
|   |     \-- [Row]
|   |--[Capacitance Matrix]
|   |     /-- [Bandwidth]
|   |     |-- [Frequency]
|   |     \-- [Row]
|   |
|   |--[ICM S-parameter]
|   |      File_name
|   |      Port_assignment
|   |
\--[End ICM Section]
```

- Sections are basic units and core structure of one ICM model

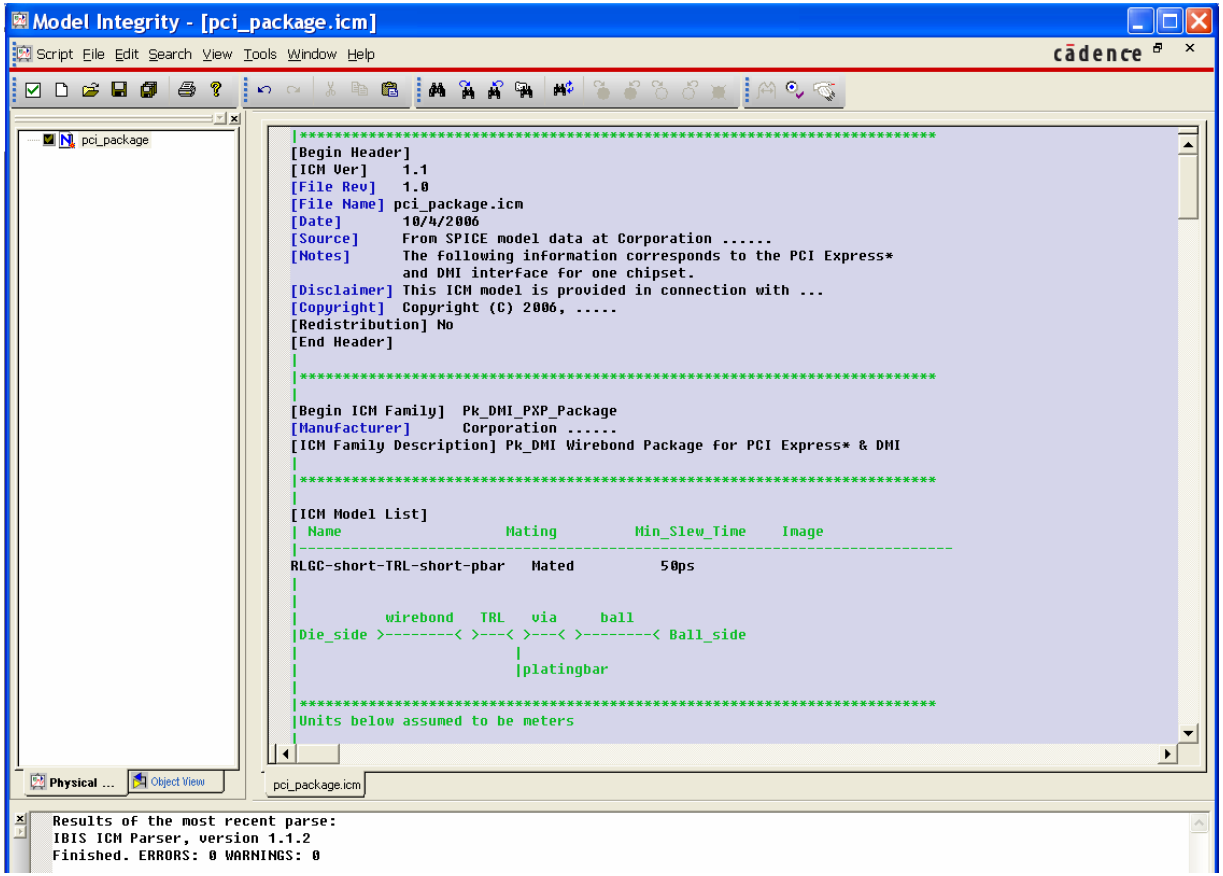
ICM model usage scenario

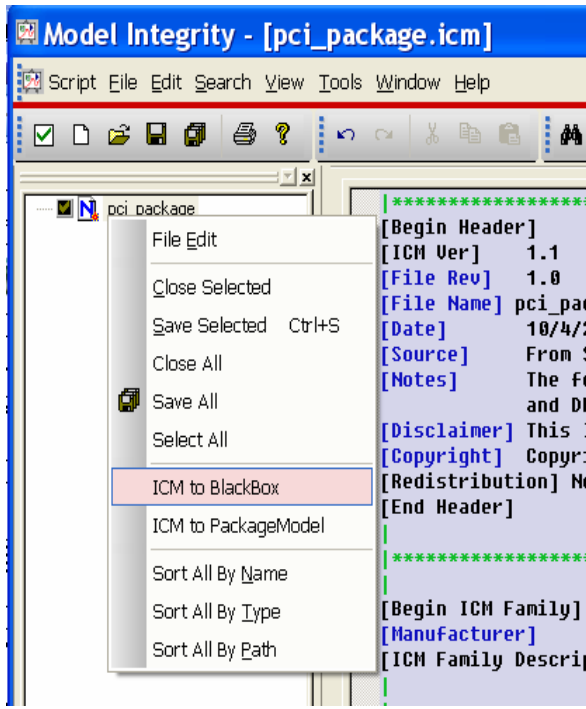
- ICM models can be used during pre-layout and post-layout analysis

- Two cases are presented
  - Case1: In pre-layout simulation, ICM model is used as a Black box model in a topology

  - Case2: In post-layout simulation, ICM package model is assigned to a component IBIS model on the PCB

Example: ICM model of PCI express package





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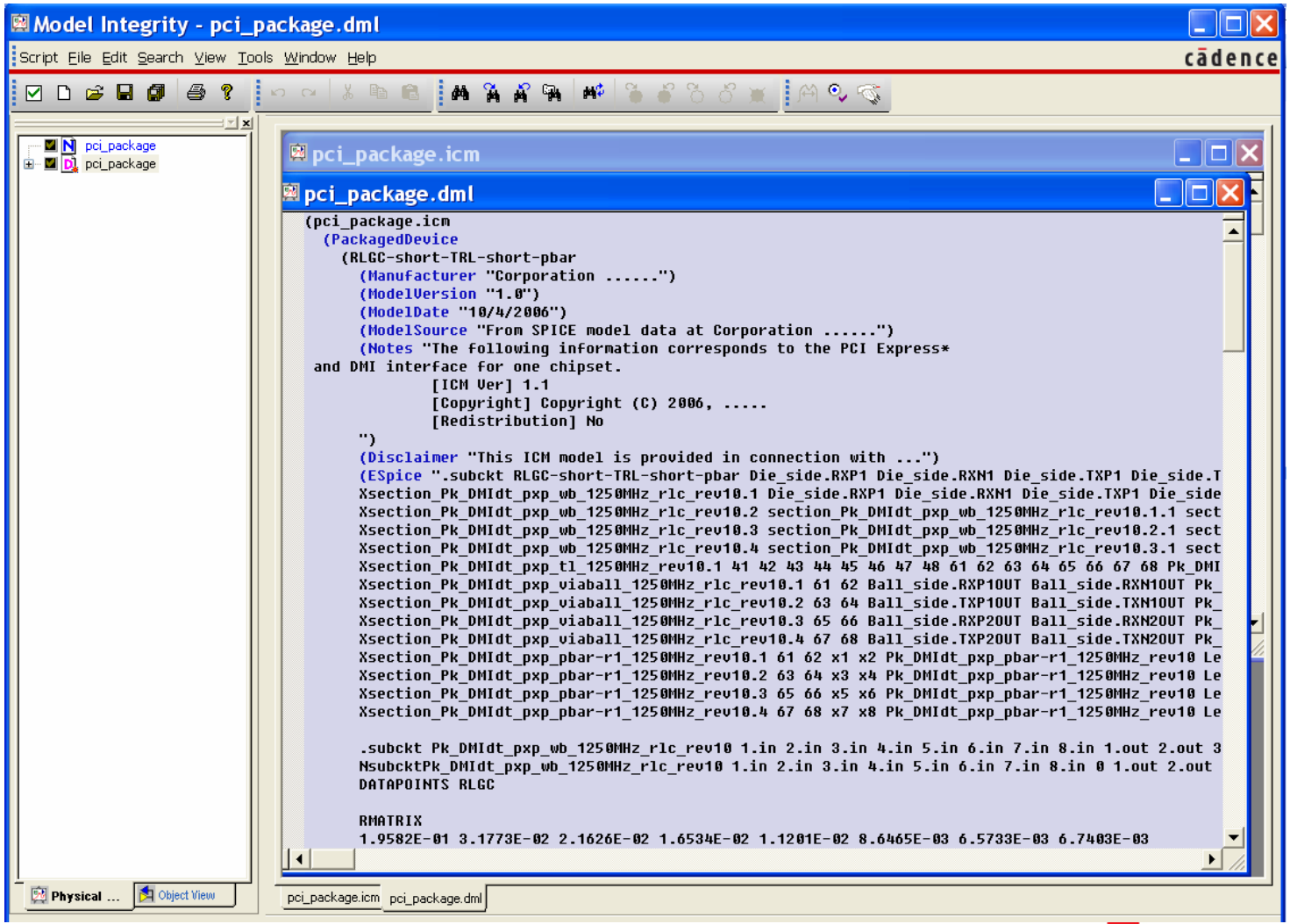
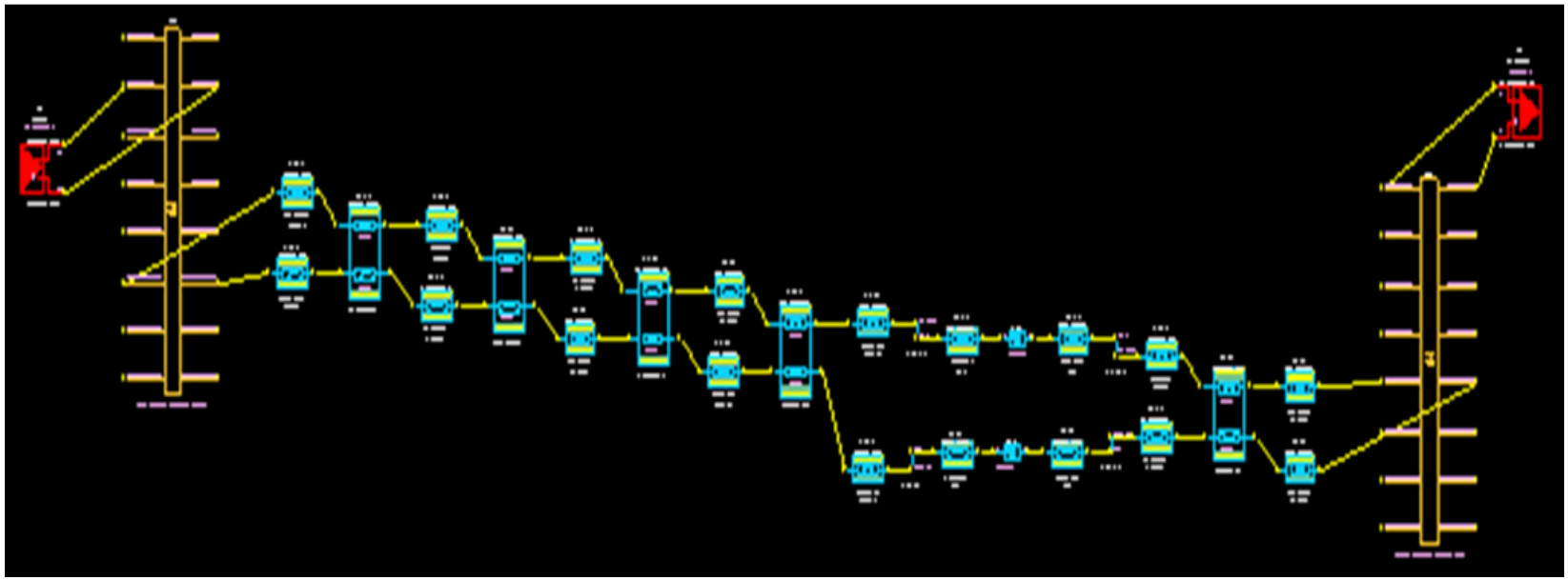
Device model case (Black box model)

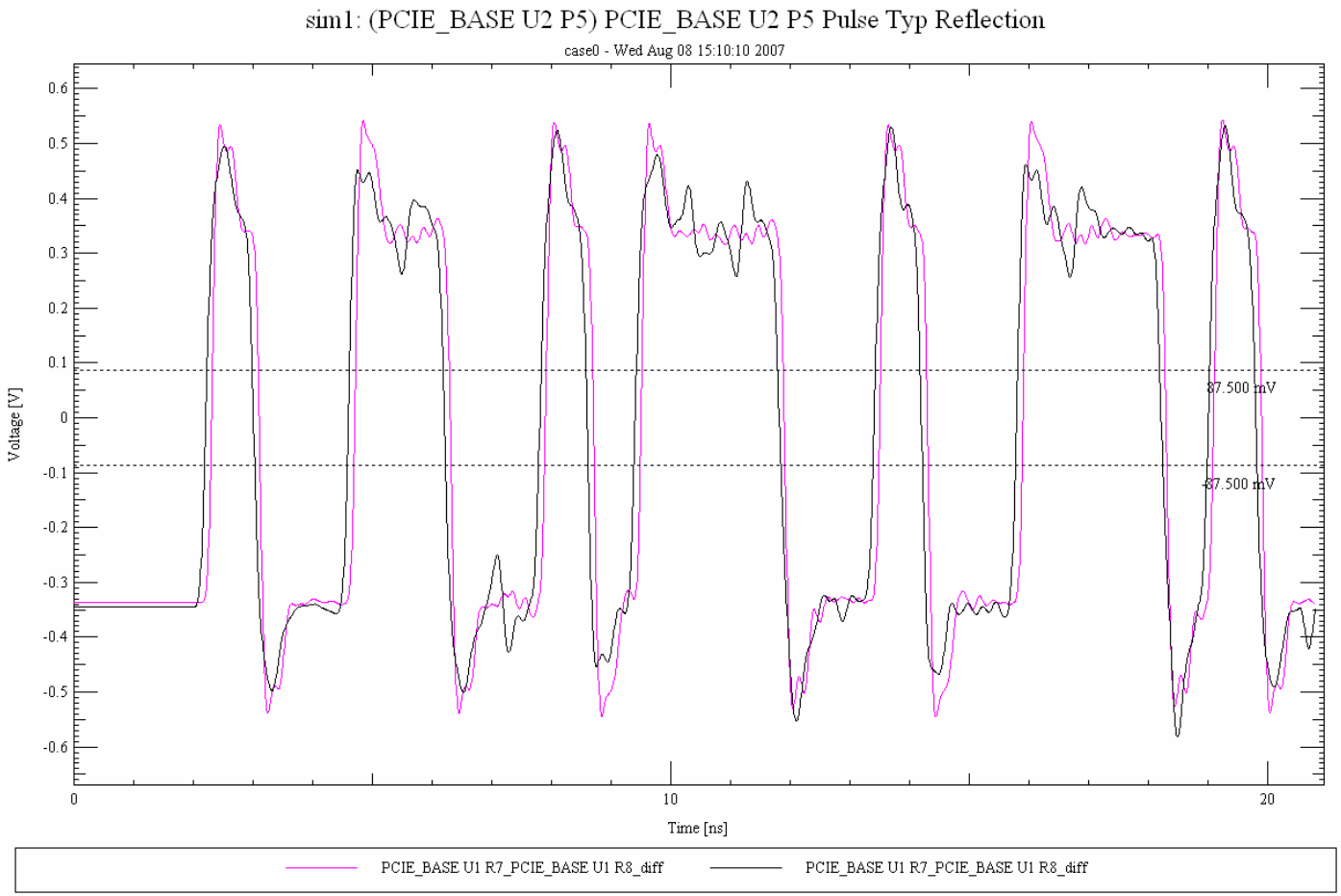


Case 1: ICM acts as device model (Black box model)

- The package ICM model has been wrapped into one black box model, just like one connector



Case 1: Simulation Results comparing (with/o ICM model)



The pink line represents the simulation with ICM model

The black line represents the simulation without ICM model

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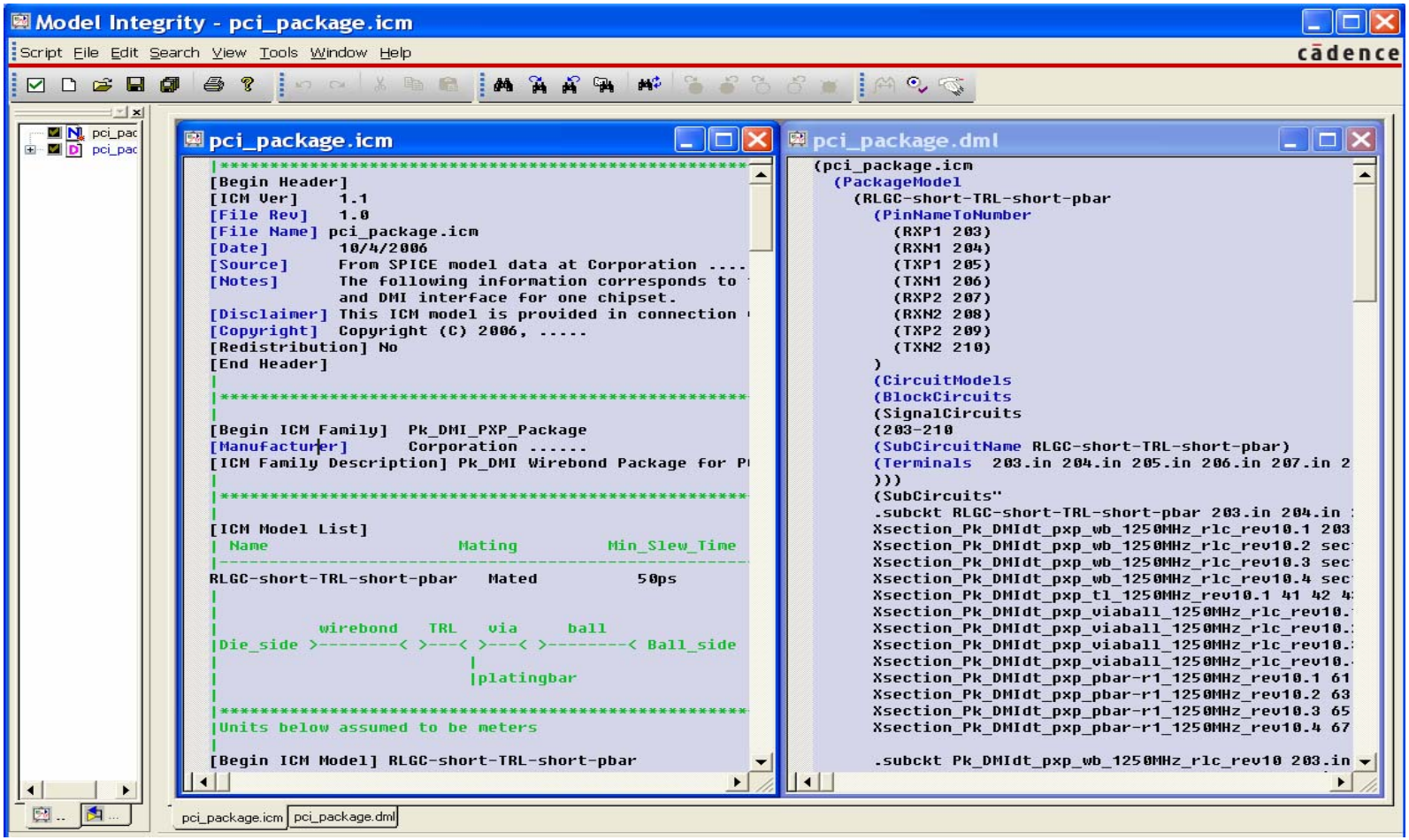
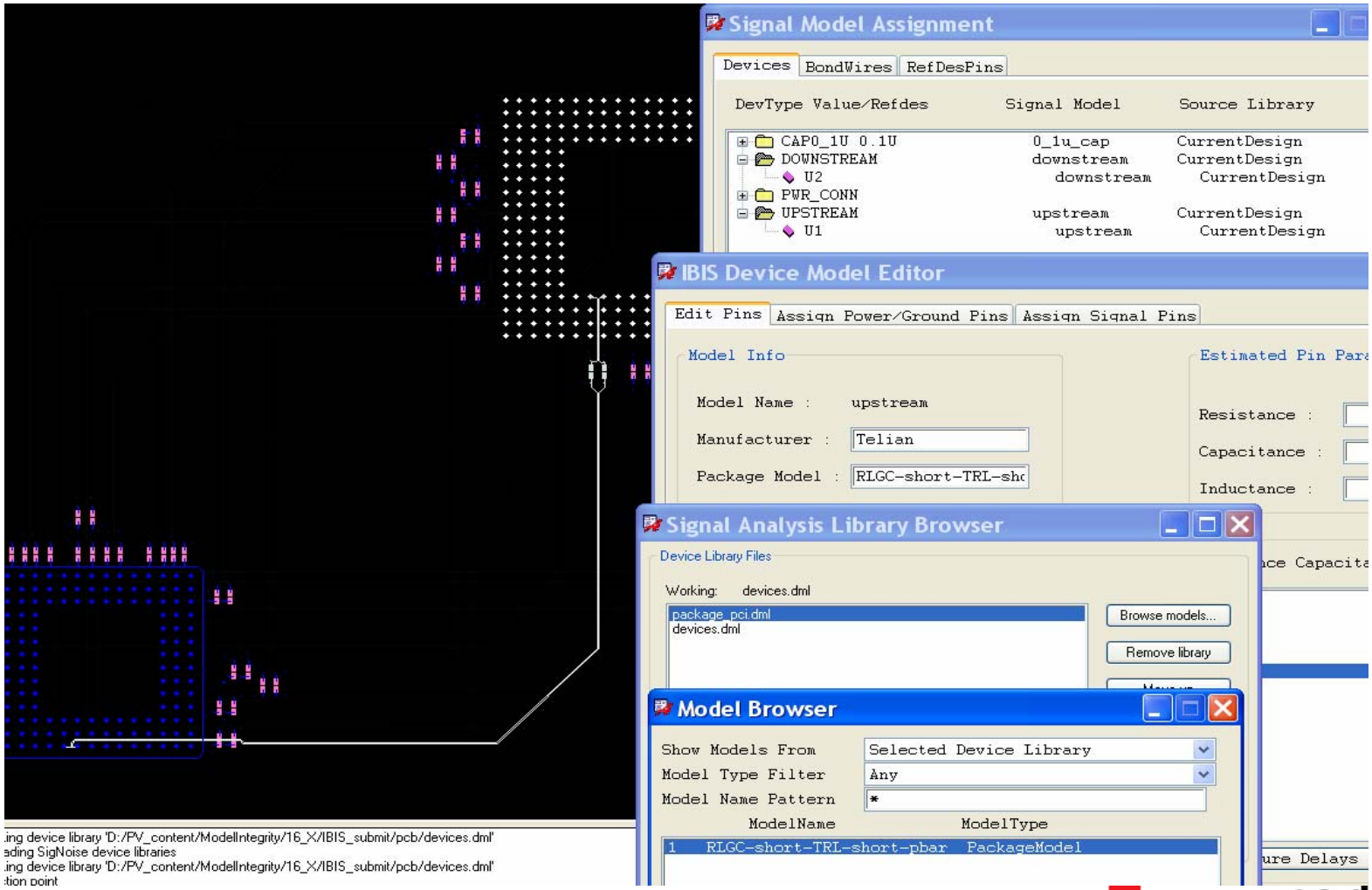
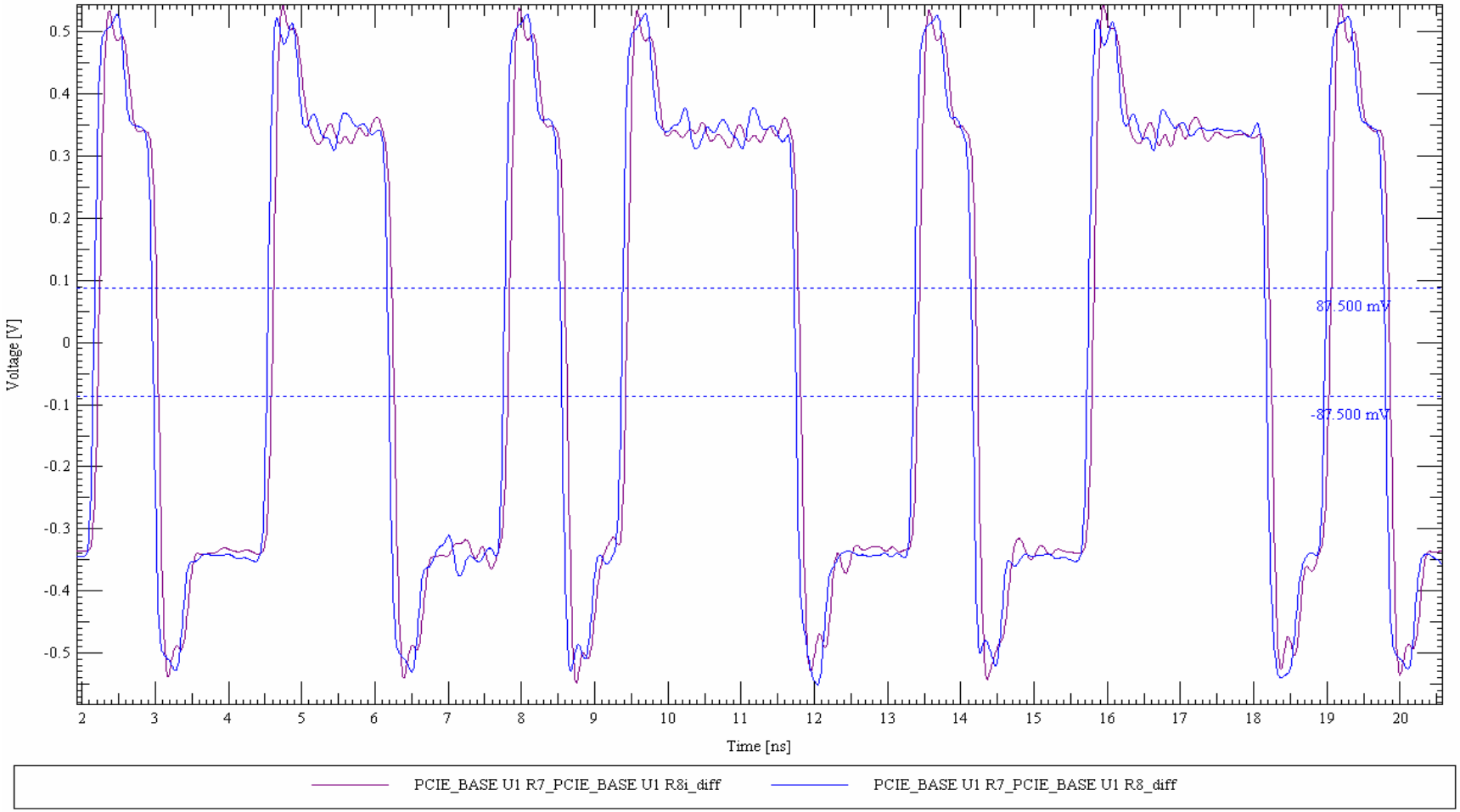
Package model case (associating with its corresponding IBIS model)



Case 2: ICM acts as package model



Case 2: Simulation Results comparing (with/o ICM model)



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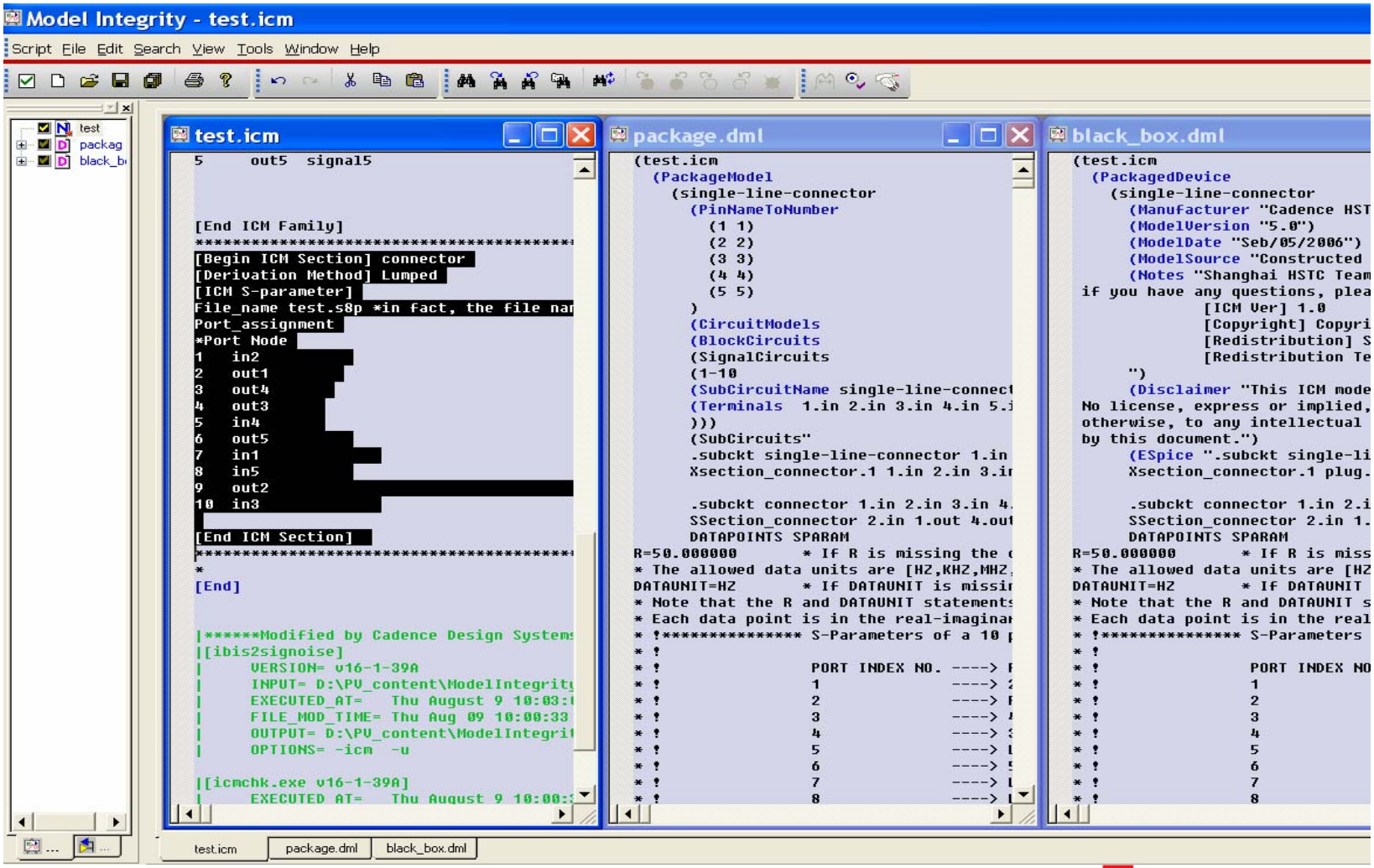
S-parameter support



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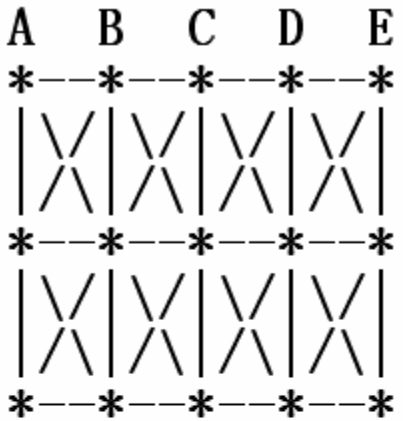
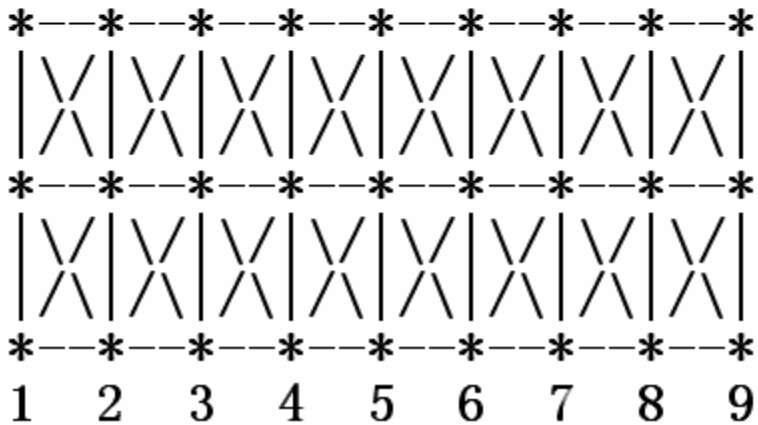
ICM Swath model support



Swath



Full Interconnect

- Swath model
  - Is a method of using a small matrix section to define a much larger and variable size section of a connector
  - This facilitates faster simulation, smaller file size, and makes the creation of a family of connectors much easier

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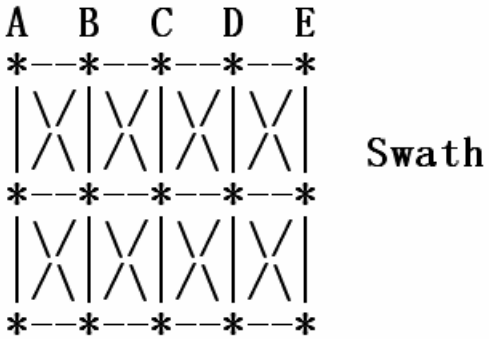
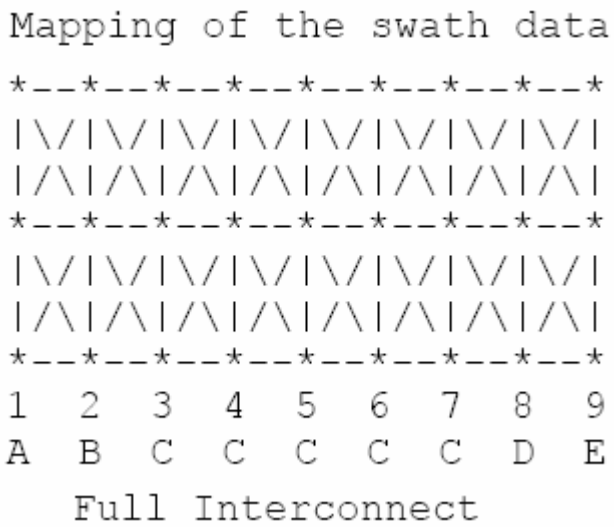
Expanding the swath matrix





- **Three methods can be used to expand a swath matrix into a full-sized interconnect**
  1. Centering the Swath around the pins of interest
  2. Expansion and Centering: Expanding the Swath matrix into a larger sized Swath matrix and centering it about the paths of interest
  3. Expansion to Full Sized Interconnect: Expanding the swath matrix to the full sized interconnect matrix

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Summary

- **ICM models offer open, non-proprietary way for vendors to provide interconnect models to their customers**
- **ICM models can be accurate for simulation at higher frequencies *they can include coupling***

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Thanks!