IBIS Connector Modeling Specification

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June 2000

What is IBIS?

IBIS = Input / Output Buffer Information Specification

What is this IBIS stuff anyhow ?

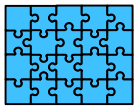
IBIS is a method of providing the Input/Output device characteristics through V/I data without disclosing any circuit/process information. It can be thought of as a behavioral modeling specification suitable for transmission line simulation of Digital Systems and applicable to most digital components.

Further Information:

IBIS Website: http://www.eia.org/eig/ibis/ibis.htm
IBIS Connector Website: http://www.eda.org/pub/ibis/connector/

Compare IBIS Connector Models to SPICE

SPICE: Parametric Representations
IBISCnn: Matrix Representation: Parametrics defined by tool



What does IBIS Have to do with Connectors???

What has the Committee been up too?

Goals:

- Make Sure that Syntax will work
- Ensure syntax is not ambiguous
- Release the specification for vote near DAC 2000 time frame.

IBIS: An opportunity to Optimize Connector Models

Present methods do not address problems encountered in automatically attaching connector models to SI and Timing simulators.

Model Size / Complexity / Ease of Use
Present methods do not allow "on the fly" model size scaling (SWATH mechanism)

Problem Construction and Reconstruction Time
Addressed by incorporating SLM, MLM, and CMLM in a single file (with a single pin mapping). As a side benefit, this should allow simulators to select the most appropriate model based on "level of accuracy" required. (Solution time addressed by hardware and model selection tradeoffs.)

Number of Models required.
Many different models can be required if a connector is to be used with different PCB mounting configurations (i.e. edgecard stack height).

Common Definition of Transmission Line Parameters

Further, consistency is NEEDED...
We have focused on Standard Measurements (EIA); Empirically Analytical and Empirical Measurement and Methods…. Etc.

Should we also have a similar model format / definition between connector vendors??

Compete on Designs, NOT on ability to manipulate a model

As an Example..

Types of Models

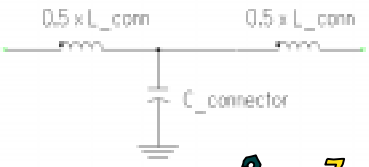
SLM: Single Line Model

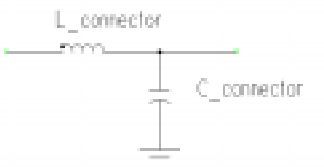
MLM: Multiline Model

CMLM: Cascaded Multiline Model

SLM: Single Line Models

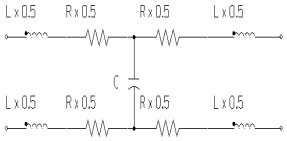
Which one is correct???

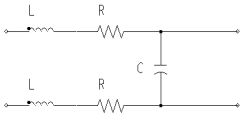




Be VERY careful with SLMs

MLM: Multiline Models





Note: Inductive coupling components removed for clarity.

Which one is correct???

Model extraction tools generate different models.

Some simulations would show similar results others would show significant differences!!

There is efficiency in allowing the end user to decide (or change their mind).

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Introducing... ICM !!!

The goal of the IBIS connector specification...

Facilitate faster simulations, smaller file sizes, and make the creation of connector model families easier. Further enough keywords are defined such that the resulting model can be more user friendly if implemented correctly by the simulator.

Create a common connector model format !

IBISCnn Team

Simulation Vendors
- Ansoft
- Cadence
- HyperLynx
- ViewLogic

Connector Companies
- AMP
- Berg / FCI
- Molex
- Teradyne

End Users
- EMC
- IBM
- Other?

ICM Terms

- Matrix
- Sections
- Cascaded Model
- Swath

IBIS – Matrix Based
SPICE – Parameter Based

Further...

Create a format that can use existing modeling techniques that are in place today.

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IBISCnn supports many different types of connector modeling methods and all types of connectors.

For Example

- Differential and unbalanced signaling
  - and/or to use both signaling methods at the same time
  - and / or with the same model.
- Single Line Models (uncoupled)
- Multiline Models (coupled)
- Cascaded models (Coupled or Uncoupled)
- "Angled" connectors (Right Angle, 30 degree, 45 degree, other)
- "Cross Connected" pins (i.e. modjacks, other)
- Board to board (i.e. Pin and Socket / Backplane, Edgecard)
- Board to Cable
- Other??

There isn't a model that I have made that can't be done with the IBISCnn Specification!

What is a Matrix??

A: A matrix section is a set of tables of numerical values that represent the electrical relationships between all conductors of a given geometry. Further, the matrices used in this specification closely follow the concepts used in the IBIS IC specification.

For example:

[Begin_Section] NameA
[Derivation Method] Lumped
[Inductance Matrix] Full_matrix
.
[Capacitance Matrix] Full_matrix
.
[Resistance Matrix] Full_matrix
.
[End_Section] NameA

	pin1	pin2	pin3	pin4	pin5	pin6
pin1	7.5633E-012	-4.0262E-012	-1.8509E-012	-2.5406E-013	-1.7069E-013	-2.0524E-013
pin2	-4.0262E-012	7.9504E-012	-1.8143E-012	-3.4267E-013	-1.6113E-013	-1.8401E-013
pin3	-1.8509E-012	-1.8143E-012	7.5923E-012	-2.4971E-012	-5.409E-013	-3.51E-013
pin4	-2.5406E-013	-3.4267E-013	-2.4971E-012	6.9155E-012	-2.4288E-012	-4.5406E-013
pin5	-1.7069E-013	-1.6113E-013	-5.409E-013	-2.4288E-012	6.5892E-012	-2.1168E-012
pin6	-2.0524E-013	-1.8401E-013	-3.51E-013	-4.5406E-013	-2.1168E-012	5.6204E-012

Cascaded Matrices

Q: What are cascaded matrices?
A: Cascaded matrices are a series of matrix slices that walk down the connector from one side to the other. The matrices are defined the same as in the IBIS .pkg specification and may be full, spares, banded, or diagonal.

For example:

```
[Begin_Cn_Model] Hdi20 Hdi20Pin Hdi20Phy MLM
Cn_Section NameA Mult=1.0
Cn_Section NameB Mult=1.0
[End_Cn_Model] Hdi20
```

Stub Matrices

Q: What is a stub matrix?
A: A matrix that is connected to the cascaded matrix sections by a tee.

For example:

```
[Begin_Cn_Model] Hdi100 Hdi100Pin Hdi100Phy MLM
Cn_Section NameA Mult=1.0
Cn_Section NameB Mult=1.0
Cn_Stub     StubNameA Mult=1.0 StubNameB Mult=1.0
Cn_Section NameC Mult=1.0
[End_Cn_Model] Hdi100
```

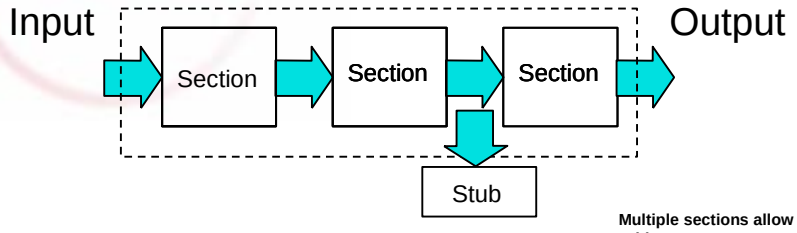
What do we mean when we talk about a Section?

A: A section is made up of a set of matrices. Each matrix is a table of numerical values that defines one of the electrical parameters of a connector or transmission line. Specifically, the matrix represents the electrical relationships between all conductors of a given geometry.

As represented in the Connector specification:

[Begin_Section] NameA
[Inductance Matrix] Full_matrix
.
.
[Capacitance Matrix] Full_matrix
.
.
[Resistance Matrix] Full_matrix
.
.
[End_Section] NameA

What is a cascaded model?



Each section is made up of a SLM or MLM

Multiple sections allow us to Address:

Multiple connector options
and or
multiple model types

…in a single file.

Could also include a "stub" matrices.

A "swath" Operator is also an option…

What Is A “Swath”?

A: It is a method of using a small matrix section to define a much larger and variable size section of a connector. This facilitates faster simulations, smaller file sizes, and makes the creation of a family of connectors much easier.

For example:

```
|                  SwathRows SwathCols RightEdge LeftEdge TopEdge BottomEdge
[Begin_Cn_Swath]        4         6         1        1        0         0
[Cn_Z] 50
[End_Cn_Swath]
```

This example defines a small matrix section of 4 rows and 6 columns. The right- and left-most columns are used only for the right and left edges of the connector. This might be used to define a connector with 4 rows and 6 to 1000 columns. The edges of the small swath matrix are to be connected to 50 ohms to ground when not used at the edge of the connector.

Addresses Model pin count

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Anatomy of a Swath

50 Columns

6 Rows | Really High Pin Count Connector

6 x 50 = 300 pins!! = 300 x 300 matrix = 90,000 points

Assume symmetrical matrix: 90,000 / 2 = 45,000 matrix values = too many

45,000 matrix values x 3 matrices (R,L,C) = 135,000... WAY TOO MANY

135,000 x multiple cascaded sections = ...

Also, difficult / impossible for field solvers in a single simulation

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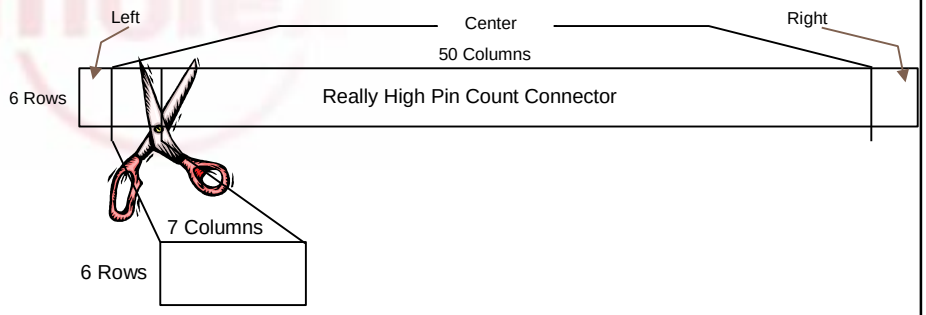
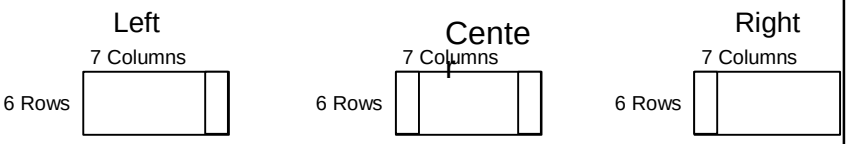
Anatomy of a Swath (cont.)



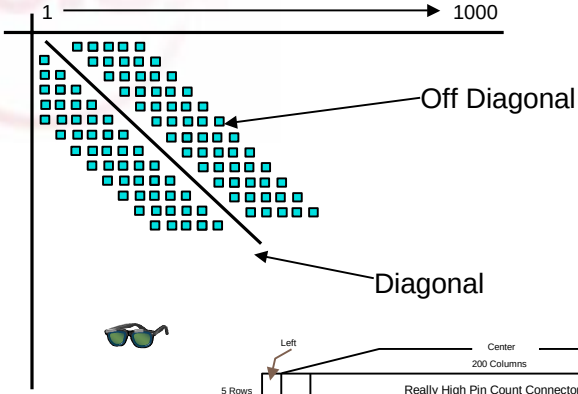


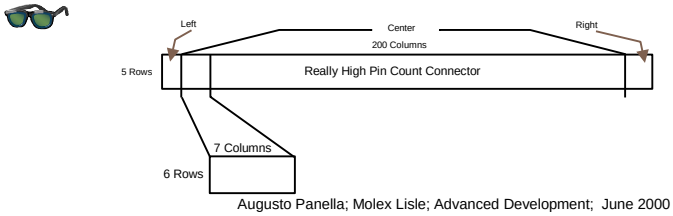
Automatic creation of banded matrices!!

"Do Not Use" locations

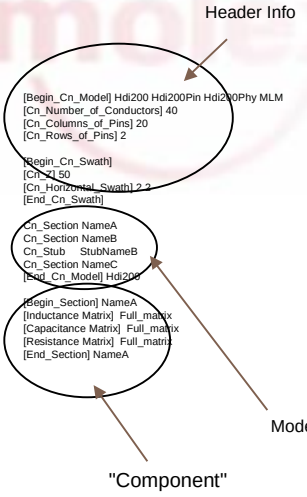
Anatomy of a Swath (cont.)

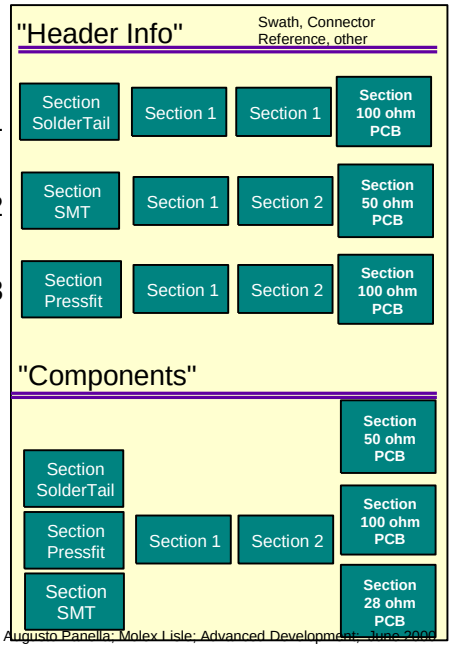
Automatic creation of banded matrices!!





Anatomy of an ICM





- Menu Driven Modeling
- Decrease new model creation time

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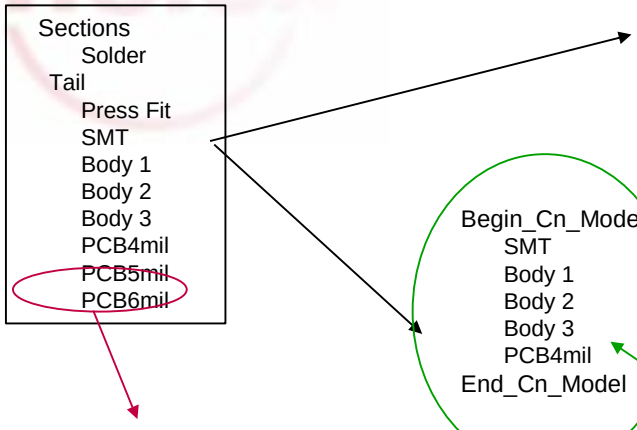
With a few lines of descriptors text, more than one model can be described




```
Begin_Cn_Model
    Solder Tail
    Body 1
    Body 2
    Body 3
    PCB5mil
End_Cn_Model
```

```
Begin_Cn_Model
    SMT
    Body 1
    Body 2
    Body 3
    PCB4mil
End_Cn_Model
```

Each model only references the **NAME** of each section

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Putting the Pieces Together

```
[Begin_Cn_Model] Hdi200 Hdi200Pin Hdi200Phy MLM
[Cn_Number_of_Conductors] 40
[Cn_Columns_of_Pins] 20
[Cn_Rows_of_Pins] 2
|                SwathRows SwathCols RightEdge LeftEdge TopEdge BottomEdge
[Begin_Cn_Swath]  2          4           1         1        0         0
[Cn_Z] 50
[Cn_Horizontal_Swath]
[End_Cn_Swath]

Cn_Section NameA Mult=1.0
Cn_Section NameB Mult=1.0
Cn_Stub    StubNameB  Mult=1.0
Cn_Section NameA  Mult=1.5
[End_Cn_Model] Hdi200

[Begin_Section] NameA
[Derivation Method] Distributed
[Inductance Matrix]  Full_matrix
[Capacitance Matrix]  Full_matrix
[Resistance Matrix]  Full_matrix
[End_Section] NameA
.
.
.
```

What is the Main Disadvantages to a Matrix Approach?

Results from using .ICM models could be Simulation Tool Dependent!

- Before, we had Berkeley SPICE to relate model performance results to empirical data.

Potential Solutions:

"Golden Models": SPICE and IBISCnn models created from the same matrices

User Caution and Understanding

Simulator Vendor Understanding

What is needed for Industry Acceptance of IBISCnn...

Golden Parser

Golden Models

Accuracy methodology documentation for Models
- Levels of comparison (i.e. information only or other?)
- Differential / Unbalanced simulations

Accuracy validation requirements:
- Define Model Types (Ground, no ground)
- Define which tests

Define tests that use different signaling Schemes (Differential / Unbalanced)
- Run golden models in SPICE Analysis (LC, TDR, Crosstalk, TDR, other)
- Run golden models with example non-SPICE simulator (LC, TDR, Crosstalk, TDR, etc.)
- Compare results
- Define test setup (source, sink, connections)
- Which domains? (Time, Frequency, both?)

Further publicly announced support from connector companies.

NOTE: Purposely NOT confirming to empirical measurements!

Bottom Line…

In order to promote consistency, model format standardization is required.

The model format needs to be implemented correctly by the simulator!!!

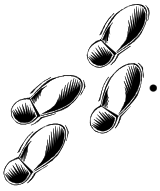
Simulator operation will need to be verified.

Hopefully, IBISCnn will increase our level of customer support while reducing our overall workload.

Questions ???...

What is Next?

- Short Term Goals:
  - Finalize the sub-committee changes
  - Vote to adopt the version 1.0 “ICM” specification.
  - Ask for funds to create the golden parser to be used for syntax checking connector models.
  - Update the examples to support the final syntax and keywords
  - Additional accuracy confirmation of .icm model
    - compare to SPICE model
    - compare to IBIS Package model



- Version 2.x Goals:
  - Add TRUE lossy modeling

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