IBIS Interconnect Specification (ICM): Status and Proposed Changes

By

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Agenda

- ICM Review
  - Purpose
  - History
  - Structure
- Need for Changes in Draft 1.0
- Proposed Changes
- Parser Overview & Status
- Next Steps
  - IBIS Futures Sub-committee Review
  - Open Forum Review
- Future Updates
  - Potential technical improvements?
- Backup: Example Model Text
What is ICM?

- ICM = IBIS Interconnect Specification
- Purpose: to establish a human-readable standard format for exchanging interconnect modeling data
- “Interconnect” can be connector, cable, PCB traces or even an IC package
- Format is designed to be:
  - Consistent & easily parsed by software
  - Compatible with current means of representing data
    - S-parameters
    - R, L, G & C matrices
    - “Swaths,” trees, node lists
  - IBIS-like (keyword-driven)
ICM History

- Initial concept developed from 1995 - 1997
  - Kellee Crisafulli, Hyperlynx
  - Augusto (Gus) Panella, Molex
  - Others through IBIS Connector Sub-committee

- Revision 0.31 issued in Jan. 1999
  - Outlined in Jan. 1999 IBIS Summit
  - Shift from connectors to interconnects began

- Revision 0.92 issued in Nov. 1999

- Revisions 0.93 - 0.99901 issued 2000 - 2002
  - Added “Argument,” Even & Odd Modes, etc.
  - Revised Swath treatments
  - Editorial changes

- Draft 1.0 released Sept. 19, 2002
ICM Structure

- Header Information
  - [Begin Header] & [End Header] keywords
  - Spec. Version
  - Filename & Revision
  - Date
  - Source, Notes, Disclaimer & Copyright

- ICM Family
  - Description of model “family” or group
  - List of models in the “family”
ICM Structure (continued)

- **ICM Model Description**
  - Type (SLM, S-parameter, MLM_*, etc.)
  - Signal-to-ground ratio & (optionally) reference Z
  - **Tree Path Description**
    - Links groups of signals through cascaded “sections” of model data
    - Intended to describe one-to-one connections between sections and ports or endpoints of the interconnect
    - Allows “forks” with same number of conductors

- **Nodal Path Description**
  - Links sections of model data through input & output nodes per section
  - Connections need not be one-to-one
    - Allows internal “dangling nodes”

- **Note that Nodal and Tree Path Descriptions are mutually exclusive**
ICM Structure (continued)

- Additional ICM Constructs
  - ICM Pin Map
    - Maps connector pins to Tree Path Descriptions
  - ICM Node Map
    - Maps connector pins to Nodal Path Descriptions
  - ICM Section
    - Data block for model sections
    - Data is in RLGC matrix or s-parameter format
      - Matrices include self-inductance, capacitance, conductance, loss, etc.
      - Similar format to IBIS package models
    - Each section is referenced by at least one Tree or Nodal Path Description
ICM Structure (continued)

- **ICM Swath**
  - Allows minimal, economical description to be used for larger connectors or interconnects
    - Smaller electrical parameter matrices can be repeatedly mapped over a larger structure
  - Includes the [ICM Swath Description] and [ICM Swath Pin Numbers] keywords

- **Sample ICM model is included in Backup**
  - *Data is taken from ICM specification examples*
Need for Changes in Draft 1.0

- Draft 1.0 text needs improvement
  - To increase readability & understanding
    - Some small errors have survived revision process
    - The writing style of several sections may produce confusion in readers
  - To ease software parsing
    - Several structures are defined in an ambiguous way and create a risk of conflicting “interpretations” by individual vendor software tools
    - Some structures are not compliant with the Lex/YACC format used as the standard for creating compilers and parsers
Summary of Proposed Changes

- 42 Proposed Changes in All
  - 18 Editorial Changes
    - No impact to functionality of specification
    - Examples
      - Grammatical and spelling corrections
      - Correction of keyword misuse in examples
      - Inconsistent spelling: "Un-ordered" vs. Un_ordered"
  - 24 Clarifications
    - Provide stricter interpretation of content
    - Examples
      - Enforce consistent use of white space & tabs
      - Enforce consistent use of “=“ with subparameters
      - Allow use of non-one denominator in SGR
- Technical changes to be considered only after Draft 1.0 approved by Open Forum
Parser Overview & Status

- ANSI C prototype in development
  - Find issues with 1.0 specification EARLY
- Exploiting widely available tools
  - Lexical processor (FLEX) – COMPLETED
  - Grammar (YACC/BISON) – IN PROGRESS
  - Semantic analysis – NOT STARTED
- Already operational at level of grammar
- Schedule pending approval of proposed changes, but expect golden code by May
- Unencumbered Open Source delivery
- Realistic Test Models available?
Short-Term Future

- Changes to be presented to IBIS Futures Sub-committee
  - Each change is numbered and can be considered and voted upon independently
  - Next meeting likely in early February (shortly before IBIS Open Forum teleconference)

- IBIS Open Forum Review
  - New document, with changes, is presented
  - Open Forum votes to approve or disapprove
  - Next meetings: Feb. 14, March 7
Future Improvements

- Several technical issues may be considered after Draft 1.0 is approved
  - Allow multiple types of data within a single [Begin ICM Model]/[End ICM Model] pair
    - Example: Include S-parameter AND matrix data
  - Include frequency-dependence in matrix data
    - Example: Matrix parameters for 1 MHz, 100 MHz, etc.
  - Allow mixed-mode S-parameters
    - Example: SDC12 vs. S12 – coupled pair insertion loss is described in terms of common-mode excitation and differential response

- Discussion point: on-die interconnect?
Questions & Free Discussion
BACKUP
ICM Example

[Begin Header]

[IBIS ICM Model Ver] 1.0

[File Name] iconm_hdi_202.icm

[File Rev] 1.0

>Date] January 20, 2003

[Source] Results from field simulation

[Notes] This is a test model only.

[Disclaimer] This information is for modeling purposes only, and is not guaranteed.

[Copyright] Copyright 2003, XYZ Corp.,

All Rights Reserved


[Redistribution] Yes

[Redistribution Text] This file is freely redistributable.

[End Header]
ICM Example (2)

[Begin ICM Family] High_Speed_Interconnect
[Manufacturer] XYZ Incorporated

[ICM Family Description]
High Density square pin connector for use on IEEE 99999 buses.

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>HDI_202</td>
</tr>
<tr>
<td>HDI_202_UnMatedA</td>
</tr>
<tr>
<td>HDI_202_SMT_to_Cable</td>
</tr>
<tr>
<td>HDI_202_SMT_to_ThruHole</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
</tbody>
</table>
ICM Example (3)

[Begin ICM Model Description]
High Density 0.1 center square pin with PCB effects

[Begin ICM Model] MyModelExample3

  ICM_Model_Type MLM

[Tree Path Description]
  Model_PinMap MyModelPinMapA
  Section Mult=1 SectionA
  Fork
    Section Mult=1 StubSection1
    End_fork
  Section Mult=1 SectionB
  Model_PinMap MyModelPinMapB

[End ICM Model]
ICM Example (4)

[ICM Pin Map] Baseboard_side

Pin_order = row_ordered

Num_of_columns = 4

Num_of_rows = 2

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<thead>
<tr>
<th>Pin</th>
<th>Type</th>
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<tbody>
<tr>
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<td>SIG</td>
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<td>A2</td>
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<tr>
<td>A3</td>
<td>SIG</td>
</tr>
<tr>
<td>A4</td>
<td>SIG</td>
</tr>
<tr>
<td>B1</td>
<td>SIG</td>
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</tr>
<tr>
<td>B3</td>
<td>SIG</td>
</tr>
<tr>
<td>B4</td>
<td>SIG</td>
</tr>
</tbody>
</table>

[End ICM Family]
ICM Example (5)

[Derivation Method] Lumped

<table>
<thead>
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<th></th>
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<tbody>
<tr>
<td>[Begin ICM Section] ExampleMatrix01</td>
</tr>
<tr>
<td>[Inductance Matrix] Full_matrix</td>
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</table>

<table>
<thead>
<tr>
<th>[Row] 1</th>
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<th></th>
<th></th>
</tr>
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<td>1.3428e-08</td>
<td>6.12191e-09</td>
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<tr>
<td>1.74022e-07</td>
<td>7.35469e-08</td>
<td>2.73201e-08</td>
<td>1.33807e-08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[Row] 2</th>
<th></th>
<th></th>
<th></th>
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<tbody>
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<td>1.3428e-08</td>
<td>7.35469e-08</td>
</tr>
<tr>
<td>1.74022e-07</td>
<td>7.35469e-08</td>
<td>2.73201e-08</td>
<td></td>
</tr>
</tbody>
</table>
ICM Example (6)

The capacitance matrix has sparse coupling:

<table>
<thead>
<tr>
<th>Capacitance Matrix</th>
<th>Sparse_matrix</th>
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</thead>
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<tr>
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</tr>
<tr>
<td>1</td>
<td>2.48227e-10</td>
</tr>
<tr>
<td>2</td>
<td>-1.56651e-11</td>
</tr>
<tr>
<td>5</td>
<td>-9.54158e-11</td>
</tr>
<tr>
<td>6</td>
<td>-7.15684e-12</td>
</tr>
<tr>
<td><strong>Row</strong></td>
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</tr>
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<td>2.51798e-10</td>
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<tr>
<td>3</td>
<td>-1.56552e-11</td>
</tr>
<tr>
<td>5</td>
<td>-6.85199e-12</td>
</tr>
<tr>
<td>6</td>
<td>-9.0486e-11</td>
</tr>
</tbody>
</table>

[End ICM Section] ExampleMatrix01
[End]