Subckt Package Model in IBIS

Dr. Wenliang Dai  (wldai@cadence.com)
Cadence Design Systems, Inc.

Asian IBIS Summit,
Shanghai, China,
November 4th 2009
Agenda

• Standard IBIS Package Model Overview

• Requirements on IBIS Package Model in High Speed Circuit Analysis

• Proposed IBIS Subckt Package Model

• Summary
Standard IBIS Package Model Overview

- **Existing Simplified IBIS Package Model**
  - Single RLC value

- **Customized IBIS Package Model**
  - Segmented/Forked RLC value

- **Coupled IBIS Package Model**
  - RLC Matrix value

- **Pin Mapping in Pin Numbers and Model Data Section**
  - 1:1 mapping of die pins to package pins
  - Simple RLC for each signal, power and ground pin
Agenda

• Standard IBIS Package Model Overview

• Requirements on IBIS Package Model in High Speed Circuit Analysis

• Proposed IBIS Subckt Package Model

• Summary
Extracted Package Model by Field Solvers & Measurements

- Current Standard IBIS Package Model Format
  - Very simple RLC value with 1:1 mapping of BGA pins to Die pins
  - It makes little sense for each pwr/gnd pins

- Subckt Model for Coupling Signal, Power and Ground Nets from Field Solvers
  - Complex Spice subckt with high accuracy & efficiency by pwr/gnd pins group process

- Touchstone Format S Parameter Model from Field Solvers or Measurement
  - $S/Y/Z$ parameter model and related Subckt model can be obtained conveniently

- Today’s power & SSN analysis with lower voltage and higher current require high accurate power, ground (including decaps) and signal nets coupling circuit model for higher simulation accuracy and efficiency
  - Subckt or S parameter models are required
  - Pin-Port Mappings are required by full system high speed circuit analysis

Notes: Current IBIS Package Model is NOT ENOUGH for high speed circuit analysis, especially for Power analysis & SSN simulation
How to Use the Extracted Subckt Package Model

• Create the Whole Circuit Netlist by Editing the Connection between the Extracted Spice Package Model and S Parameter Model in **Text File Format**
  – Good

• Create the Connection between the Package Model and other Models in GUI with additional **Pin-Node Mapping file** Manually
  – Better

• Create the Connection between Package Model and other Model automatically through **Enhanced IBIS Package Model**
  – Best and it’s a Standard

**Notes:** Consume complicated/coupled signal & power net subckt in IBIS models
Agenda

• Standard IBIS Package Model Overview

• Requirements on IBIS Package Model in High Speed Circuit Analysis

• Proposed IBIS Subckt Package Model

• Summary
Existing IBIS Package Model in V5.0

- [Define Package Model]
  - ----------------------
  - |     |-- [Manufacturer]
  - |     |-- [OEM]
  - |     |-- [Description]
  - |     |-- [Number Of Sections]
  - |     |-- [Number Of Pins]
  - |     |-- [Pin Numbers] Len, L, R, C, Fork, Endfork
  - |     |-- [Model Data]
  - |     |   ------------
  - |     |     |-- [Resistance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  - |     |     |   -------------------
  - |     |     |     |-- [Bandwidth]
  - |     |     |     |-- [Row]
  - |     |     |-- [Inductance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  - |     |     |   -------------------
  - |     |     |     |-- [Bandwidth]
  - |     |     |     |-- [Row]
  - |     |     |-- [Capacitance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  - |     |     |   -------------------
  - |     |     |     |-- [Bandwidth]
  - |     |     |     |-- [Row]
  - |     |     |-- [End Model Data]
  - |     |   ------------
  - |     |-- [End Package Model]
What’s New in the Enhanced IBIS Package Model

- [Define Package Model]
- [Manufacturer]
- [OEM]
- [Description]
- [Number Of Sections]
- [Number Of Pins]
- [Pin Numbers]
- [Model Data]
- [End Model Data]
- [End Package Model]

[Define Package Model]
[Manufacturer]
[OEM]
[Description]
[Number Of Sections]
[Number Of Pins]
[Pin Numbers]
[Model Data]
[End Model Data]
[Subckt Package Model]
[Pin-Node Mapping]
[End Pin-Node Mapping]
[Subckt Model Data]
[End Subckt Model Data]
[End Subckt Package Model]
[End Package Model]

It also supports multiple Subckt models in one package with its pin node mapping.
Keywords for Proposed IBIS Package Model

- Keywords:
- [Subckt Package Model]
- [Subckt Model Data]
  - Required: Yes
  - Description: Indicates the beginning of the formatted subckt package model data, that can include the spice subckt or s parameter model keywords.
- [End Subckt Model Data]
- [Subckt Model Data]
- [End Subckt Package Model]
- [Pin-Node Mapping]
- [End Pin-Node Mapping]

Notes: The goal is to specify a complicated spice-like subckt package model instead of standard simple RLC package model to be used by the keyword Subckt Package Model.
Keywords for Proposed IBIS Package Model

- Keywords:
- |
- Keyword: [Pin-Node Mapping]
- Required: Yes
- Description: Indicates the beginning of the formatted Pin Node mapping data for subckt package model data.
- |
- [Pin-Node Mapping]
- |
- |
- Keyword: [End Pin-Node Mapping]
- Required: Yes
- Description: Indicates the end of the formatted pin port mapping data.
- Other Notes: In between the [Pin-Node Mapping] and [End Pin-Node Mapping]
  keywords is the pin port mapping data itself. The data is a set of subckt node name like N001, pin name like VDD01 and net name like Net1 as below
  N001 VDD01 Net1
  N002 VDD02 Net1
  N003 VDD03 Net2
  N004 VSS01 Net3
  The net name like Net1 is "OPTIONAL"
- |
- [End Pin-Node Mapping]
Keywords for Proposed IBIS Package Model

- Keywords:
  - [Subckt Model Data]
  - Required: Yes
  - Description: Indicates the beginning of the formatted subckt package model data, that can include the subckt or s parameter model keywords.

- [End Subckt Model Data]
  - Required: Yes
  - Description: Indicates the end of the formatted subckt model data.
  - Other Notes: In between the [Subckt Model Data] and [End Subckt Model Data] keywords is the data itself for subckt package model.
  - The data is a set of spice subckt or S parameter model as below
  - Spice: “.subckt PowerModel N001 N002 N007 N008 ... .ends PowerModel”
  - Or S parameter: “.MODEL name sp [DATA=(npts ...)] [DATAFILE=filename]

- [End Subckt Model Data]
Agenda

• Standard IBIS Package Model Overview

• Requirements on IBIS Package Model in High Speed Circuit Analysis

• Proposed IBIS Subckt Package Model

• Summary
Summary

• Requirements on IBIS Package Model
  – Accurate Power/SSN analysis with a complex package model

• Proposed Subckt Type in IBIS Package Model
  – Spice circuit or S parameter data

• Applications for IBIS Subckt Package Model
  – IC-Package-Board co-design flow and Design Link
Action items

• Add the proposed subckt package model keywords into standard IBIS package part

• IBIS parser parses the subckt package keywords
  – Similar use model to existing lumped package model

• EDA tools consume the subckt package model to create circuit netlist