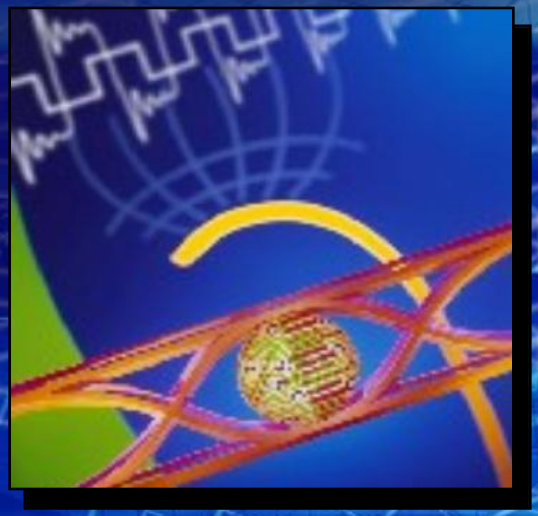
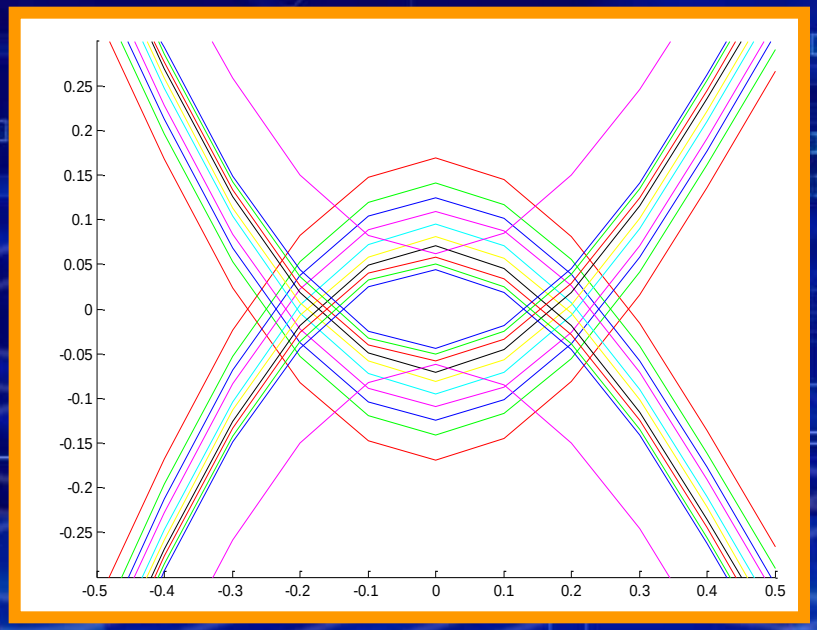
Comparison of the Recent Analog Modeling BIRD Proposals



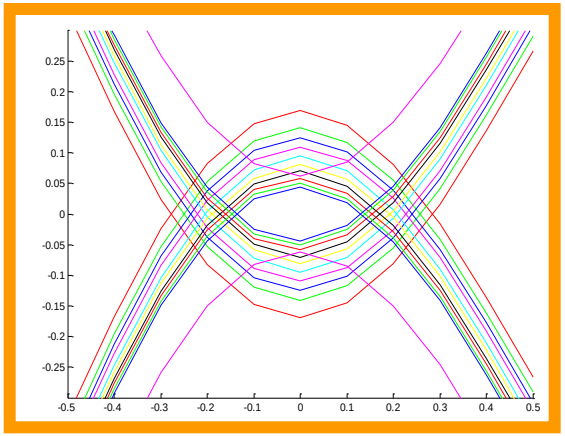
IBIS Summit, DAC,
June 7, 2011
San Diego, CA



Arpad Muranyi

Mentor Graphics®

Comparison of the Recent Analog Modeling BIRD Proposals



IBIS Summit, DAC,
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San Diego, CA

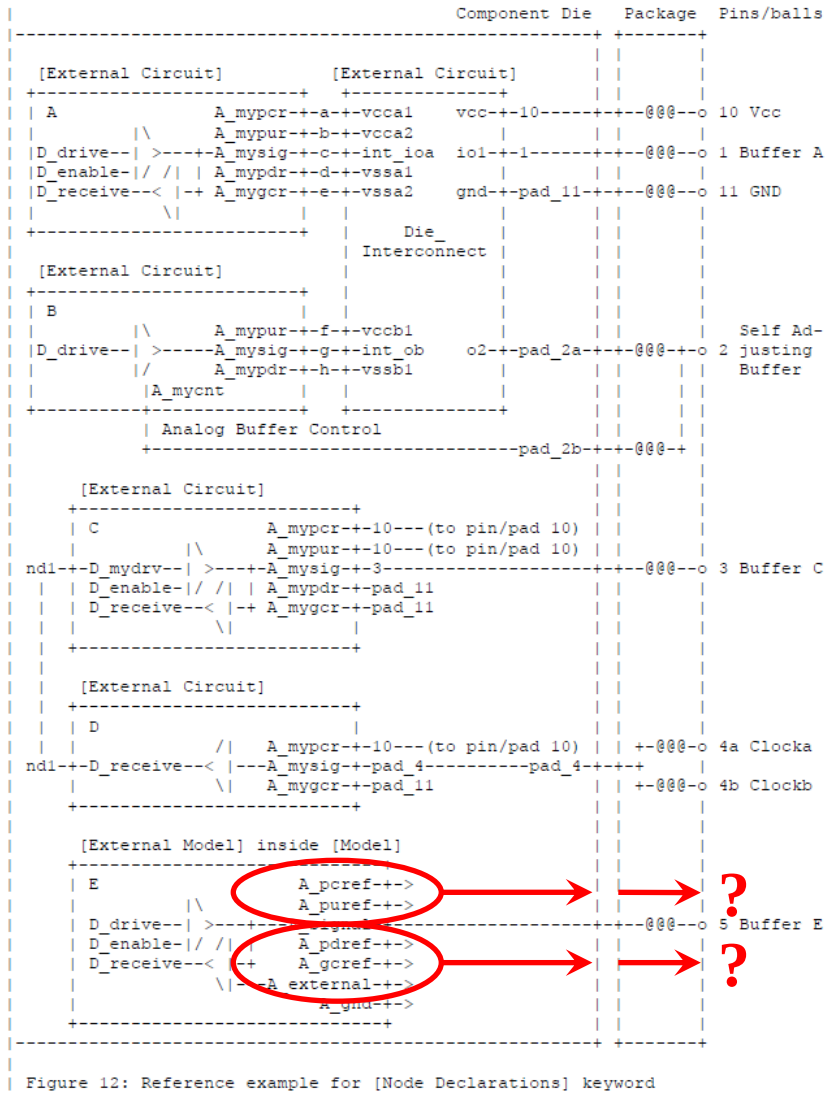
1. **Addendum to my DesignCon 2011 presentation**
2. **Overview of Mentor's analog modeling proposals**
3. **Examples for the Mentor proposals**
4. **Overview of SiSoft's analog modeling proposals**
5. **Call to action**

Addendum to my DesignCon 2011 presentation

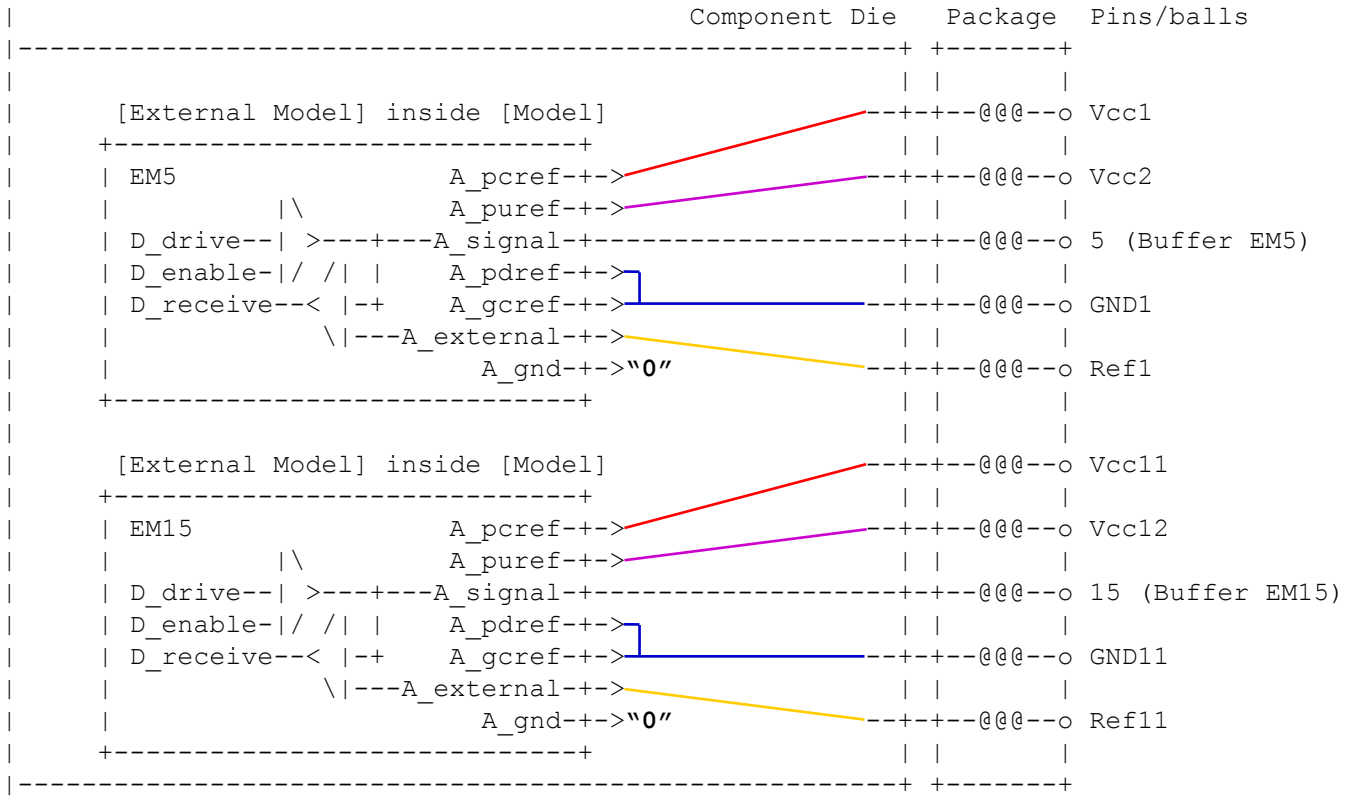
"IBIS-AMI Analog Modeling and Much Needed Improvements for IBIS"
http://www.eda.org/ibis/summits/feb11/muranyi2.pdf

- **The above presentation explained the concepts described in my analog modeling BIRDs with examples**
  - **BIRD 116, 117, 118, 125, (129)**
- **The proposals are based on IBIS-ISS and address the shortcomings of legacy IBIS models as well as the needs of the new analog modeling directions emerging with AMI models**
- **The last example showed a complete implementation of Figure 12 (pg. 136) from the IBIS 5.0 specification**
  - **forgot to explain how the supply nodes of [Model] or [External Model] can be connected to specific pins through a package model**

Figure 12 (pg. 136) in IBIS v5.0



Modified Fig. 12 to illustrate supply connections



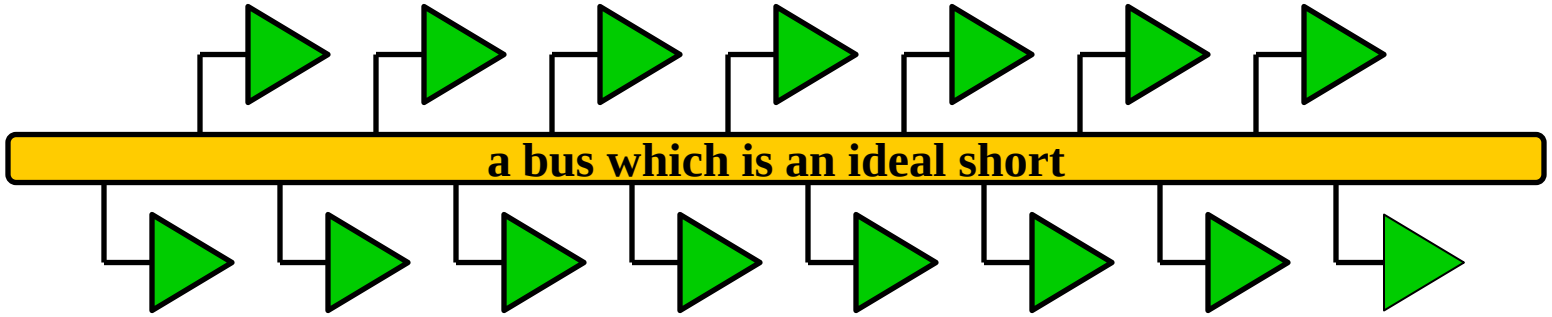
How can we tell the simulator how the supply connections of [Model] or [External Model] are made to specific supply *die pads* so that package parasitics for supply pins can also be included in simulations?

Use [Pin Mapping] to declare supply die pads

```
[Pin]   signal_name   model_name   R_pin   L_pin   C_pin
|
Vcc1    Supply1       POWER
Vcc2    Supply2       POWER
Vcc11   Supply11      POWER
Vcc12   Supply12      POWER
GND1    Ground1       GND
GND11   Ground11      GND
Ref1    Reference1    POWER
Ref11   Reference11   POWER
|
5       Data5         EM5
15      Data15        EM15
|
|
[Pin Mapping] pulldown_ref  pullup_ref  gnd_clamp_ref  power_clamp_ref  ext_ref
|
Vcc1          NC            PCref_EM5
Vcc2          NC            PUref_EM5
Vcc11         NC            PCref_EM15
Vcc12         NC            PUref_EM15
GND1          Ground_EM5    NC
GND11         Ground_EM15   NC
Ref1          NC            EXref_EM5
Ref11         NC            EXref_EM15
|
5             Ground_EM5    PUref_EM5   Ground_EM5    PCref_EM5       EXref_EM5
15            Ground_EM15   PUref_EM15  Ground_EM15   PCref_EM15      EXref_EM15
```

These are called “bus names” by the specification, and are defined to be ideal shorts. Functionally they are the same thing as “die nodes”.

If a bus is an ideal short, it is a node



Since the "bus" is an ideal short, each receiver sees exactly the same signal

An ideal short "bus" = "node", correct?

The number of connections we make to the "bus" doesn't make a difference, if it is ideal, it is till just a "node"…

[Pin Mapping] = [Node Declarations] + Netlisting

- **The [Pin Mapping] keyword serves three functions**
  - **declares die nodes (ideal short die buses)**
  - **associates (i. e. connects) die nodes with the reserved analog supply node names of [Model] or [External Model]**
    - `A_pdref, A_pdref, A_gcref, A_pcref, A_extref`
    - signal nodes are NOT included
  - **associates the named die nodes (pads) with pin names**
    - eliminates the need for implicit die pad names (derived from pin names)
- **This provides a mechanism to connect the supply nodes of [Model] and [External Model] through an accurate package model (IBIS-ISS) to specific pins**
  - **multiple pin to single pad *is* possible (with the 5.0 syntax)**
  - **multiple pad to single pin *not* possible (with the 5.0 syntax)**
- **This works with the existing features of IBIS 5.0!**
  - **slight modifications to [Pin Mapping] could provide more capabilities in the future, such as on die interconnect modeling**

Using the BIRD 125 concepts for this example

Legacy IBIS file:

```
|-------------------------------------------------------------
| Example of an IBIS model using an IBIS-ISS package model.
|-------------------------------------------------------------
|
Vcc1    Supply1       POWER
Vcc2    Supply2       POWER
Vcc11   Supply11      POWER
Vcc12   Supply12      POWER
GND1    Ground1       GND
GND11   Ground11      GND
Ref1    Reference1    POWER
Ref11   Reference11   POWER
|
5       Data5         EM5
15      Data15        EM15
|
[Pin Mapping] pulldown_ref pullup_ref gnd_clamp_ref power_clamp_ref ext_ref
|
Vcc1            NC            PCref_EM5
Vcc2            NC            PUref_EM5
Vcc11           NC            PCref_EM15
Vcc12           NC            PUref_EM15
GND1            Ground_EM5    NC
GND11           Ground_EM15   NC
Ref1            NC            EXref_EM5
Ref11           NC            EXref_EM15
|
5               Ground_EM5    PUref_EM5  Ground_EM5     PCref_EM5       EXref_EM5
15              Ground_EM15   PUref_EM15 Ground_EM15    PCref_EM15      EXref_EM15
|
[Package Model]  QS-SMT-cer-10-pin-pkgs
|…
```

IBIS-ISS subcircuit:

```
*************************************************************
.SUBCKT  S_pkg  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+               P11 P12 P13 P14 P15 P16 P17 P18 P19 P20
+ TSFile="TouchstoneFileName.s20p"
Sdriver  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+        P11 P12 P13 P14 P15 P16 P17 P18 P19 P20
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]
*************************************************************
.ends
```

IBIS .pkg file:

```
|-------------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------------
|
[Define Package Model]  QS-SMT-cer-10-pin-pkgs
[Manufacturer]          Quality Semiconductors Ltd.
[OEM]                   Acme Package Co.
[Description]           10-Pin ceramic SMT package
[Number Of Pins]  10
|
|
[Pin Numbers]
Vcc1    DiePort = PCref_EM5
Vcc2    DiePort = PUref_EM5
Vcc11   DiePort = PCref_EM15
Vcc12   DiePort = PUref_EM15
GND1    DiePort = Ground_EM5
GND11   DiePort = Ground_EM15
Ref1    DiePort = EXref_EM5
Ref11   DiePort = EXref_EM15
|
5       DiePort = IDP_5
15      DiePort = IDP_15
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  PackageModel.spi  S_pkg
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s20p"
|
| Ports are in same order as defined in SPICE
Ports  Vcc1         Vcc2         Vcc11        Vcc12
Ports  PCref_EM5    PUref_EM5    PCref_EM15   PUref_EM15
Ports  GND1         GND11        Ref1         Ref11
Ports  Ground_EM5   Ground_M15   EXref_EM5    EXref_EM15
Ports  5            15
Ports  IDP_5        IDP_15
|
[End Package Circuit]
[End Package Model]
```

Matched by name

Explicit die ports (red) are declared under [Pin Mapping]

Implicit die ports (blue) are declared here

Matched by name

Matched by position

Only a slight modification is needed in BIRD 125

- **This works with the existing [Pin Mapping] keyword of IBIS 5.0**
- **BIRD 125 needs a slight modification to include the "bus names" declared in [Pin Mapping] for this purpose:**

```
|*              DiePort This subparameter declares the name of the connection
|*                      point for use within [Define Package Model] at which
|*                      the package is connected to the die.  The subparameter
|*                      must be followed by an equal sign ("=") and the name
|**                     of a node or bus that was previously declared by the
|**                     [Node Declarations] or the [Pin Mapping] keywords in the
|*                      .ibs file, or a reserved word "IDiePort_" immediately
|*                      followed by the pin name that precedes this reserved word.
```

Overview of Mentor's analog modeling proposals

Overview of the Mentor analog BIRD drafts

- **BIRD 116: Add IBIS-ISS to [External Model] and [External Circuit] as a Supported Language**
- **BIRD 117: Parameterize A_to_D and D_to_A Converters**
  - allows parameters in .ami files to define their amplitude and edge rate
- **BIRD 118: Analog Parameter Assignments**
  - allows values to be assigned to [External ***] parameters
  - for [External Model] we can use parameters from .ami files
- **BIRD 125: Make IBIS-ISS Available for Package Modeling**
  - no changes in the .ibs file
  - one new keyword [Package Circuit] under [Define Package Modeling], following the style of the existing [External Circuit]
- **BIRD 129: Add "Polarity" Argument to D_to_A Converters**
  - simplifies the content of IBIS-ISS buffer models and the construction of differential buffer stimulus parameters in .ami files

Summary of the Mentor analog BIRD drafts

- These BIRDs provide solutions for the analog buffer and package modeling problems for legacy and AMI models
- Analog modeling remains in the .ibs file
  - but parameters can be supplied to them in .ami files
- The concepts and syntax are well documented, the BIRDs are in a "finished" condition, ready to be voted on
  - this is not to say that we can't make any changes if we receive useful suggestions and feedback
- The concepts do not require substantial changes in the existing IBIS specification

What the Mentor BIRDs cannot do

- **The buffer BIRDs did not define IBISfile(ParName)**
  - **good idea, can be added easily**
- **BIRD 125 currently associates the pin names under the .ibs [Pin] and .pkg [Pin Numbers] keywords by name**
  - **this doesn't allow for shifting around a package model along the pins in the .ibs [Pin] keyword**
  - **we can consider to modify BIRD 125 to add this capability to it, but is this really useful in practice?**

```
[Pin] signal_name  model_name
|
  1   Channel_1P   ISS_Diff_Tx
  2   Channel_1N   ISS_Diff_Tx
  3   ground1      GND
  4   Channel_2P   ISS_Diff_Tx
  5   Channel_2N   ISS_Diff_Tx
  6   ground2      GND
  7   supply1      POWER
  8   ground3      GND
  9   Channel_3P   ISS_Diff_Tx
 10   Channel_3N   ISS_Diff_Tx
 11   Channel_4P   ISS_Diff_Tx
 12   Channel_4N   ISS_Diff_Tx
 13   ground4      GND
 14   supply2      POWER
 15   ground5      GND
 16   Channel_5P   ISS_Diff_Tx
 17   Channel_5N   ISS_Diff_Tx
 18   ground6      GND
 19   Channel_6P   ISS_Diff_Tx
 20   Channel_6N   ISS_Diff_Tx
```

How would you slide an 8-port S-parameter file with two differential signal pairs along this pin list automatically?

or

How would you slide an 8-port S-parameter file with one differential signal pair with power and GND along this pin list automatically?

Examples for Mentor's analog modeling proposals

S-parameter Tx model with [External Model] & IBIS-ISS

Legacy IBIS file:

```
|------------------------------------------------------------
| Example of an analog AMI Tx model using [External Model] and
| an IBIS-ISS S-parameter:
|------------------------------------------------------------
[Model] ISS_Diff_Tx
Model_type Output_diff
Rref_diff = 100
|
[Voltage Range] 1.0   NA   NA
|
[Ramp]
dV/dt_r   0.6/40p   NA   NA
dV/dt_f   0.6/40p   NA   NA
|
[External Model]
Language ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner     Typ          AMIdriver.cir    AMI_Sdrv
|
| List of parameters
Parameters  TSFile = AMIfile(Tstonefile)
|
| List of converter parameters
Converter_Parameters  VloP =  AMIfile(Vol)
Converter_Parameters  VhiP =  AMIfile(Voh)
Converter_Parameters  VloN =  AMIfile(Voh)
Converter_Parameters  VhiN =  AMIfile(Vol)
Converter_Parameters  Tfa  =  AMIfile(Trf)
Converter_Parameters  Tri  =  AMIfile(Trf)
|
| Ports List of port names (in same order as in SPICE)
Ports  A_signal_pos  A_signal_neg  my_driveP  my_driveN  A_gnd
|
| D_to_A d_port port1 port2 vlow vhigh trise tfall corner_name
D_to_A  D_drive  my_driveP  my_ref  VloP  VhiP  Tfa  Tri  Typ
D_to_A  D_drive  my_driveN  my_ref  VloN  VhiN  Tfa  Tri  Typ
|
[End External Model]
|
[Algorithmic Model]
Executable  Windows_VisualStudio_32  MentorTx.dll  MentorTx.ami
[End Algorithmic Model]
```

EDA tool GUI lets user select "one of many". Dependency Table may also affect what this GUI does.

Tx.ami file:

```
(Tstonefile (Usage Info)(Type String)
   (Corner "NC.s4p" "WC.s4p" "BC.s4p")
   (Description "Driver on-die S-parameter file")
)
(Voh (Usage Info)(Value 0.9)(Type Float)
   (Description "Output open circuit high voltage")
)
(Vol (Usage Info)(Value 0.0)(Type Float)
   (Description "Output open circuit low voltage")
)
(Trf (Usage Info)(Value 40e-12)(Type Float)
   (Description "20%-80% output rise time")
)
```

IBIS-ISS subcircuit:

```
*******************************************************************************
.SUBCKT  AMI_Sdrv  A_signal_pos  A_signal_neg  my_driveP  my_driveN  my_ref
+ TSFile="TouchstoneFileName.s4p"

Sdriver  my_driveP  A_signal_pos  my_driveN  A_signal_neg  my_ref
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

*******************************************************************************
.ends
```

RC Rx model with [External Model] & IBIS-ISS

Legacy IBIS file:

```
|------------------------------------------------------------
| Example of an analog AMI Rx model using [External Model] and
| an IBIS-ISS circuit:
|------------------------------------------------------------
[Model] ISS_Diff_Rx
Model_type Input_diff
|
[Voltage Range] 1.0   NA   NA
|
[External Model]
Language ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner     Typ          AMIreceiver.cir    AMI_RCrcv
|
| List of parameters
Parameters   Rt_H  Rt_L    = AMIfile(Rt)
Parameters   Rd            = AMIfile(Rd)
Parameters   Cc_H  Cc_L    = AMIfile(Cc)
Parameters   Cd  Vt
|
| List of converter parameters
Converter_Parameters  Vlo = -0.05
Converter_Parameters  Vhi =  0.05
|
| Ports List of port names (in same order as in SPICE)
Ports  A_signal_pos  A_signal_neg  my_rcv_H  my_rcv_L  A_gnd
|
| D_to_A d_port port1 port2 vlow vhigh corner_name
A_to_D  D_receive  my_rcv_H      my_rcv_L      Vlo  Vhi  Typ
|A_to_D  D_receive  A_signal_pos  A_signal_neg  Vlo  Vhi  Typ
|
[End External Model]
|
[Algorithmic Model]
Executable  Windows_VisualStudio_32  MentorTx.dll  MentorRx.ami
[End Algorithmic Model]
|
```

Rx.ami file:

```
(Rt (Usage Info)(Value 47.75)(Type Float)
   (Description "Single-ended termination resistance")
)
(Rd (Usage Info)(Value 99.75)(Type Float)
   (Description "Differential termination resistance")
)
(Cc (Usage Info)(Value 0.5e-12)(Type Float)(Default 0.5e-12)
   (Description "Input Capacitance")
)
```

IBIS-ISS subcircuit:

```
*******************************************************************************
.SUBCKT  AMI_RCrcv  A_signal_pos  A_signal_neg  my_rcv_H  my_rcv_L  my_ref
+ Rt_H   = 1e+6
+ Rt_L   = 1e+6
+ Rd     = 1e+6
+ Cc_H   = 0
+ Cc_L   = 0
+ Cd     = 0
+ Vt     = 0

Cc_H  A_signal_pos  my_ref         C=Cc_H
Cc_L  A_signal_neg  my_ref         C=Cc_L
Cd    A_signal_pos  A_signal_neg   C=Cd
Rt_H  A_signal_pos  my_vtt         R=Rt_H
Rt_L  A_signal_neg  my_vtt         R=Rt_L
Rd    A_signal_pos  A_signal_neg   R=Rd

Vvtt    my_vtt    my_ref  DC=Vt
E_H     my_rcv_H  my_ref  VCVS  A_signal_pos  my_ref  1
E_L     my_rcv_L  my_ref  VCVS  A_signal_neg  my_ref  1
*******************************************************************************
.ends
```

A simple package model with IBIS-ISS

Legacy IBIS file:

```
|------------------------------------------------------------
| Example of an IBIS model using an IBIS-ISS package model
|------------------------------------------------------------
|
[Pin] signal_name  model_name
  1   …            …
  2   …            …
  3   …            …
  4   …            …
  5   Channel_1P   ISS_Diff_Tx
  6   Channel_1N   ISS_Diff_Tx
  7   Channel_2P   ISS_Diff_Tx
  8   Channel_2N   ISS_Diff_Tx
  9   …            …
 10   …            …
|
[Package Model]  A_4_pin_pkg_model
|…
|…
```

Matched by name

IBIS-ISS subcircuit:

```
**************************************************************
.SUBCKT  S_pkg  P1  P2  P3  P4  P5  P6  P7  P8
+ TSFile="TouchstoneFileName.s8p"

Sdriver  P1  P2  P3  P4  P5  P6  P7  P8
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

**************************************************************
.ends
```

Matched by position

IBIS .pkg file:

```
|------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|------------------------------------------------------------
|
[Define Package Model]  A_4_pin_pkg_model
[Manufacturer]          Noname Company, Inc.
[OEM]                   Another Noname Package Company, Inc.
[Description]           4-pin
[Number Of Pins]  4
|
[Pin Numbers]
  5   DiePort = IDP_5
  6   DiePort = IDP_6
  7   DiePort = IDP_7
  8   DiePort = IDP_8
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  PackageModel.spi  S_pkg
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s8p"
|
| Ports are in same order as defined in SPICE
Ports  5      6      7      8
Ports  IDP_8  IDP_7  IDP_6  IDP_5
|
[End Package Circuit]
[End Package Model]
```

Declaration of Implicit die ports

Matched by name

Figure 12 implemented with IBIS-ISS

Legacy IBIS file:

```
|-------------------------------------------------------------
| Example of an IBIS model using an IBIS-ISS package model.
| This example implements a package call for the drawing in
| Fig. 12 on pg. 136 of the IBIS v5.0 specification.
|-------------------------------------------------------------
|
[Pin] signal_name  model_name
 10   Vcc          POWER
  1   A0           CIRCUITCALL
 11   GND          GND
  2   CAS0         CIRCUITCALL
  3   A1           CIRCUITCALL
  4a  Clk_A        CIRCUITCALL
  4b  Clk_B        CIRCUITCALL
  5   A2           Buffer_E
|
[Node Declarations]
| Die nodes:
a  b  c  d  e  f  g  h  nd1    | List of die nodes
|
| Die pads:
pad_2a  pad_2b  pad_4  pad_11  | List of die pads
|
[End Node Declarations]
|
[Package Model]  QS-SMT-cer-8-pin-pkgs
|…
```

IBIS-ISS subcircuit:

```
**************************************************************
.SUBCKT  S_pkg  P1  P2   P3   P4   P5   P6   P7   P8
+               P9  P10  P11  P12  P13  P14  P15  P16
+ TSFile="TouchstoneFileName.s16p"

Sdriver  P1  P2   P3   P4   P5   P6   P7   P8
+        P9  P10  P11  P12  P13  P14  P15  P16
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

**************************************************************
.ends
```

IBIS .pkg file:

```
|-------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit for the drawing in Fig. 12 on pg. 136 of the
| IBIS v5.0 specification.
|-------------------------------------------------------------
|
[Define Package Model]  QS-SMT-cer-8-pin-pkgs
[Manufacturer]          Quality Semiconductors Ltd.
[OEM]                   Acme Package Co.
[Description]           8-Pin ceramic SMT package
[Number Of Pins]  8
|
[Pin Numbers]
 10   DiePort = IDP_10
  1   DiePort = IDP_1
 11   DiePort = pad_11
  2   DiePort = pad_2a
  2   DiePort = pad_2b
  3   DiePort = IDP_3
  4a  DiePort = pad_4
  4b  DiePort = pad_4
  5   DiePort = IDP_5
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  PackageModel.spi  S_pkg
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s16p"
|
| Ports are in same order as defined in SPICE
Ports  10  1  11  2  3  4a  4b  5
Ports  IDP_5  pad_4  IDP_3  pad_2b
Ports  pad_2a  pad_11  IDP_1  IDP_10
|
[End Package Circuit]
[End Package Model]
```

Matched by name

Implicit die ports (in blue)

Explicit die ports (in red) are declared under [Node Declarations]

Matched by position

Matched by name

Modified Fig. 12 Using BIRD 125 syntax

Legacy IBIS file:

```
|-------------------------------------------------------------
| Example of an IBIS model using an IBIS-ISS package model.
|-------------------------------------------------------------
|
Vcc1    Supply1       POWER
Vcc2    Supply2       POWER
Vcc11   Supply11      POWER
Vcc12   Supply12      POWER
GND1    Ground1       GND
GND11   Ground11      GND
Ref1    Reference1    POWER
Ref11   Reference11   POWER
|
5       Data5         EM5
15      Data15        EM15
|
[Pin Mapping] pulldown_ref pullup_ref gnd_clamp_ref power_clamp_ref ext_ref
|
Vcc1            NC            PCref_EM5
Vcc2            NC            PUref_EM5
Vcc11           NC            PCref_EM15
Vcc12           NC            PUref_EM15
GND1            Ground_EM5    NC
GND11           Ground_EM15   NC
Ref1            NC            EXref_EM5
Ref11           NC            EXref_EM15
|
5               Ground_EM5    PUref_EM5  Ground_EM5     PCref_EM5       EXref_EM5
15              Ground_EM15   PUref_EM15 Ground_EM15    PCref_EM15      EXref_EM15
|
[Package Model]  QS-SMT-cer-10-pin-pkgs
|…
```

IBIS-ISS subcircuit:

```
*************************************************************
.SUBCKT  S_pkg  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+               P11 P12 P13 P14 P15 P16 P17 P18 P19 P20
+ TSFile="TouchstoneFileName.s20p"
Sdriver  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+        P11 P12 P13 P14 P15 P16 P17 P18 P19 P20
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]
*************************************************************
.ends
```

IBIS .pkg file:

```
|-------------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------------
|
[Define Package Model]  QS-SMT-cer-10-pin-pkgs
[Manufacturer]          Quality Semiconductors Ltd.
[OEM]                   Acme Package Co.
[Description]           10-Pin ceramic SMT package
[Number Of Pins]  10
|
|
[Pin Numbers]
Vcc1    DiePort = PCref_EM5
Vcc2    DiePort = PUref_EM5
Vcc11   DiePort = PCref_EM15
Vcc12   DiePort = PUref_EM15
GND1    DiePort = Ground_EM5
GND11   DiePort = Ground_EM15
Ref1    DiePort = EXref_EM5
Ref11   DiePort = EXref_EM15
|
5       DiePort = IDP_5
15      DiePort = IDP_15
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  PackageModel.spi  S_pkg
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s20p"
|
| Ports are in same order as defined in SPICE
Ports  Vcc1         Vcc2         Vcc11        Vcc12
Ports  PCref_EM5    PUref_EM5    PCref_EM15   PUref_EM15
Ports  GND1         GND11        Ref1         Ref11
Ports  Ground_EM5   Ground_M15   EXref_EM5    EXref_EM15
Ports  5            15
Ports  IDP_5        IDP_15
|
[End Package Circuit]
[End Package Model]
```

Matched by name

Explicit die ports (red) are declared under [Pin Mapping]

Implicit die ports (blue) are declared here

Matched by name

Matched by position

EBD with IBIS-ISS example

IBIS .ebd file:

```
|-------------------------------------------------------------
| This example implements an EBD model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------
|
[Begin Board Description]  An_EBD_model
[Manufacturer]             Noname Company, Inc.
[Number Of Pins]           4
|
[Pin List]  signal_name
  1         POWER5
  2         MySignal
  3         GND
  4         NC
|
[Path Description]
|
Node  U21.15
|
[EBD Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  EBDModel.spi  S_EBD
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s4p"
|
| Ports are in same order as defined in SPICE
Ports   1   U21.15   3   2
|
[End Package Circuit]
|
[Reference Designator Map]
. . .
. . .
. . .
[End Board Description]
[End]
```

Matched by position

IBIS-ISS subcircuit:

```
**************************************************************
.SUBCKT  S_EBD  P1  P2  P3  P4
+ TSFile="TouchstoneFileName.s4p"

Sdriver  P1  P2  P3  P4
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

**************************************************************
.ends
```

A simple “sliding” package model with IBIS-ISS

Legacy IBIS file:

```
|-------------------------------------------------------------
| Example of an IBIS model using an IBIS-ISS package model
|-------------------------------------------------------------
|
[Pin] signal_name  model_name
  1   Ground_1     GND
  2   Channel_1P   ISS_Diff_Tx
  3   Channel_1N   ISS_Diff_Tx
  4   Supply_1     POWER
  5   Channel_1P   ISS_Diff_Tx
  6   Channel_1N   ISS_Diff_Tx
  7   Supply_2     POWER
  8   Channel_2P   ISS_Diff_Tx
  9   Channel_2N   ISS_Diff_Tx
 10   Ground_2     GND
|
[Package Model]  A_4_pin_pkg_model
|…
|…
```

Matched by name

IBIS-ISS subcircuit:

```
*************************************************************
.SUBCKT  S_pkg   P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+                P11 P12 P13 P14 P15 P16 P17 P18 P19 P20
+ TSFile = “TouchstoneFileName.s4p”
+ SlideSelector = 1

.IF (SlideSelector == 2)
Sdriver  P3  P4  P13  P14
.ELSEIF (SlideSlector == 3)
Sdriver  P5  P6  P15  P16
.ELSEIF (SlideSlector == 4)
Sdriver  P7  P8  P17  P18
.ELSEIF (SlideSlector == 5)
Sdriver  P9  P10  P19  P20
.ELSE
Sdriver  P1  P2  P11  P12
.ENDIF

+ MNAME=TSFile
*************************************************************
.ends
```

Matched by position

Slide an .s4p model along the full pin list

IBIS .pkg file:

```
|-------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------
|
[Define Package Model]  A_10_pin_pkg_model
[Manufacturer]          Noname Company, Inc.
[OEM]                   Another Noname Package Company, Inc.
[Description]           10-pin illustration package model
[Number Of Pins]  10
|
[Pin Numbers]
  1   DiePort = IDP_1
  2   DiePort = IDP_2
  3   DiePort = IDP_3
  4   DiePort = IDP_4
  5   DiePort = IDP_5
  6   DiePort = IDP_6
  7   DiePort = IDP_7
  8   DiePort = IDP_8
  9   DiePort = IDP_9
 10   DiePort = IDP_10
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  PackageModel.spi  S_pkg
|
| Parameters List of parameters
Parameters  TSFile = “My_TstoneFile.s4p”
Parameters  SlideSelector = 1
|
| Ports are in same order as defined in SPICE
Ports  1  2  3  4  5  6  7  8  9  10
Ports  IDP_1  IDP_2  IDP_3  IDP_4  IDP_5
Ports  IDP_6  IDP_7  IDP_8  IDP_9  IDP_10
|
[End Package Circuit]
[End Package Model]
```

Declaration of Implicit die ports

Matched by name

Syntax options for “sliding” mechanism

```
************************************************************
.SUBCKT  S_pkg    P1   P2   P3   P4   P5   P6   P7   P8   P9   P10
+                 P11  P12  P13  P14  P15  P16  P17  P18  P19  P20
+ TSFile = “TouchstoneFileName.s4p”
+ SlideSelector = 1

.IF (SlideSelector == 2)
Sdriver   P3   P4   P13   P14
.ELSEIF (SlideSlector == 3)
Sdriver   P5   P6   P15   P16
.ELSEIF (SlideSlector == 4)
Sdriver   P7   P8   P17   P18
.ELSEIF (SlideSlector == 5)
Sdriver   P9   P10   P19   P20
.ELSE
Sdriver   P1   P2   P11   P12
.ENDIF

+ MNAME=TSFile
************************************************************
.ends
```

.IF/.ELSEIF in IBIS-ISS

Or using duplicate IBIS-ISS subcircuits with parameterized filenames and/or subcircuit names in the “Corner” subparameter

```
| Corner corner_name file_name circuit_name (.subckt name)
Corner   Typ   FileNameStringParameter   SubCktNameStringParameter
```

Examples for SiSoft's package and EBD modeling proposals implemented with BIRD 125 syntax

SiSoft's IBIS-ISS component pkg

Legacy IBIS file:

```
|-------------------------------------------------------------
| SiSoft's IBIS-ISS component package model example
| implemented using BIRD 125 syntax
|-------------------------------------------------------------
|
[Component] my_ibis_component
|
[Pin]  signal_name  model_name  R_pin  L_pin  C_pin
1      rx1_p        rx          NA     NA     NA
2      rx1_n        rx          NA     NA     NA
3      tx1_p        tx          NA     NA     NA
4      tx1_n        tx          NA     NA     NA
5      VDDQ         POWER
6      VSSQ         GND
|
[Package Model]  A_differential_pkg_model
|
[Diff Pin] inv_pin vdiff tdelay_typ tdelay_min tdelay_max
1   2
3   4
|
[Model]  tx
. . .
. . .
```

IBIS-ISS subcircuit (Package.iss):

```
*************************************************************
.subckt  Diff_Pins_1_2  pinH  pinL  padH  padL
+  Td=50ps  Zo=50

T1  pinH  0  padH  0  Td=Td  Zo=Zo
T2  pinL  0  padL  0  Td=Td  Zo=Zo

*************************************************************
.ends Diff_Pins_1_2
```

IBIS .pkg file:

```
|-------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------
|
[Define Package Model]  A_differential_pkg_model
[Manufacturer]          Noname Company, Inc.
[OEM]                   Another Noname Package Company, Inc.
[Description]           Illustration package model
[Number Of Pins]  2
|
[Pin Numbers]
  1   DiePort = IDP_1
  2   DiePort = IDP_2
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  Package.iss  Diff_Pins_1_2
|
| Parameters List of parameters
Parameters  Td = 99ps
Parameters  Zo = 51
|
| Ports are in same order as defined in SPICE
Ports  1  2  IDP_1  IDP_2
|
[End Package Circuit]
[End Package Model]
```

SiSoft's IBIS-ISS coupled component pkg

Legacy IBIS file:

```
|-------------------------------------------------------------
| SiSoft's IBIS-ISS component package model example with
| crosstalk and power implemented using BIRD 125 syntax
|-------------------------------------------------------------
|
[Component] my_ibis_component
|
[Pin]  signal_name  model_name  R_pin  L_pin  C_pin
1      rx1_p        rx          NA     NA     NA
2      rx1_n        rx          NA     NA     NA
3      tx1_p        tx          NA     NA     NA
4      tx1_n        tx          NA     NA     NA
5      VDDQ         POWER
6      VSSQ         GND
|
[Package Model]  A_coupled_pkg_model
|
[Diff Pin] inv_pin vdiff tdelay_typ tdelay_min tdelay_max
1   2
3   4
|
[Model]  tx
. . .
. . .
```

IBIS-ISS subcircuit (Package.iss):

```
**************************************************************
.subckt  Coupled_Power  P1   P2   P3   P4   P5   P6
+                       P7   P8   P9   P10  P11  P12
+ TSFile="TouchstoneFileName.s12p"

Sdriver  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10  P11  P12
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

**************************************************************
.ends Coupled_Power
```

IBIS .pkg file:

```
|-------------------------------------------------------------
| This example implements a package model using an IBIS-ISS
| subcircuit.
|-------------------------------------------------------------
|
[Define Package Model]  A_coupled_pkg_model
[Manufacturer]          Noname Company, Inc.
[OEM]                   Another Noname Package Company, Inc.
[Description]           Illustration package model
[Number Of Pins]  6
|
[Pin Numbers]
  1   DiePort = IDP_1
  2   DiePort = IDP_2
  3   DiePort = IDP_3
  4   DiePort = IDP_4
  5   DiePort = IDP_5
  6   DiePort = IDP_6
|
[Package Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  Package.iss  Coupled_Power
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s12p"
|
| Ports are in same order as defined in SPICE
Ports  1      2      3      4      5      6
Ports  IDP_1  IDP_2  IDP_3  IDP_4  IDP_5  IDP_6
|
[End Package Circuit]
[End Package Model]
```

SiSoft's IBIS-ISS EBD example

IBIS .ebd file:

```
|-----------------------------------------------------------------
| SiSoft's IBIS-ISS EBD example implemented using BIRD 125 syntax
|-----------------------------------------------------------------
[Begin Board Description]  Simple
[Number Of Pins]           2
|
[Pin List]  signal_name
1   DQS0
2   DQS0#
|
[Path Description]
Node  U1.8
Node  U1.9
Node  U2.8
Node  U2.9
Node  U3.8
Node  U3.9
Node  U4.8
Node  U4.9
|
[EBD Circuit]
Language IBIS-ISS
|
| Corner corner_name file_name circuit_name (.subckt name)
Corner  Typ  Simple.iss  Pins_1_2
|
| Parameters List of parameters
Parameters  TSFile = "My_TstoneFile.s10p"
|
| Ports are in same order as defined in SPICE
Ports  1  2  U1.8  U1.9  U2.8  U2.9  U3.8  U3.9  U4.8  U4.9
|
[End Package Circuit]
|
[Reference Designator Map]
| Ref Des File name Component name
U1   simple.ibs   simple
U2   simple.ibs   simple
U3   simple.ibs   simple
U4   simple.ibs   simple
|
[End Board Description]
[End]
```

IBIS-ISS subcircuit:

```
*************************************************************
.SUBCKT  Pins_1_2  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+ TSFile="TouchstoneFileName.s10p"

Sdriver  P1  P2  P3  P4  P5  P6  P7  P8  P9  P10
+ MNAME=TSFile
+ [FBASE = base_frequency] [FMAX=maximum_frequency]

*************************************************************
.ends
```

Overview of SiSoft's analog modeling proposals

Overview of the SiSoft analog BIRD drafts

- They were originally part of BIRD 119
  - the goal of BIRD 119 was to bring the Opal™ features to IBIS
  - BIRD 119 was split into four independent BIRDs on the request of the ATM group
- BIRD 122 became the "Analog Modeling BIRD"
  - up to this point, there was no mention of IBIS-ISS or package modeling in these BIRDs
- A draft for BIRD 122.1 was distributed in March 2011
  - this version included the idea of making use of IBIS-ISS and to address package modeling also
  - this BIRD draft was rather informal, contained mostly examples
- The draft of BIRD 122.1 was split into two (unnumbered) BIRD drafts in May 2011
  - the content is still in an "early stage" condition (mostly examples)
  - there are many undefined rules, ambiguities, inconsistencies

Overview of SiSoft's buffer BIRD draft

- **There are three main features in this BIRD draft**
  - **IBIS-ISS analog buffer subcircuit parameters in .ibs file**
    - this is done with a new keyword: `[External ISS], [End External ISS]`
    - subparameters include: `ISS_Buffer_File, ISS_Buffer_Subckt, ISS_Buffer_Arguments, Tx_Voh, Tx_Vol, Tx_Trf`
    - The ISS_Buffer parameters may be defined in either the .ami file or in the [Model] section of a .ibs file: `IBIS([Voltage Range]), Vref=IBIS(Vref), C_comp=AMI(Cc)`
  - **IBIS-ISS analog buffer subcircuit parameters in .ami file**
    - reserved parameters: `ISS_Buffer_File, ISS_Buffer_Subckt, ISS_Buffer_Arguments, Tx_Voh, Tx_Vol, Tx_Trf`
    - Model_Specific parameters: `C_comp, Impedance,` etc…
  - **intrinsic analog buffer model (defined in .ami file)**
    - this works the same way as IBIS-ISS analog buffer subcircuit in .ami file, except the value for `ISS_Buffer_Subckt` is `(Value "Intrinsic_Tstonefile_Tx")`
    - no IBIS-ISS subcircuit is needed, because the (hard coded, or predefined) circuit is assumed by the simulator
    - Model_Specific parameters are as defined in the Opal™ document

Overview of SiSoft's package BIRD draft

- **There are two main features in this BIRD draft**
  - **IBIS-ISS analog package subcircuit parameters in .ibs file**
    - this is done with several new keywords: `[ISS Packages], [End ISS Packages], [ISS Package], [End ISS Package]`
    - subparameters include: `ISS_Package_File, ISS_Package_Subckt, ISS_Package_Arguments, Pin, PinP, PinN, Pad, PadP, PadN, Td=AMI(Td), Zo=AMI(Zo),` etc…
    - another form of parameter definition appears: `Parameter Zo 50 45 55`
    - a new, special node syntax: `Pin.1, Pin.[Pullup Reference],` etc… is shown in the examples
    - the package can be called from a (new) subparameter of Component:

      ```
      [Component] my_ibis_component
      ISS_Package component_package
      ```

      or from the inside of a [Model]:

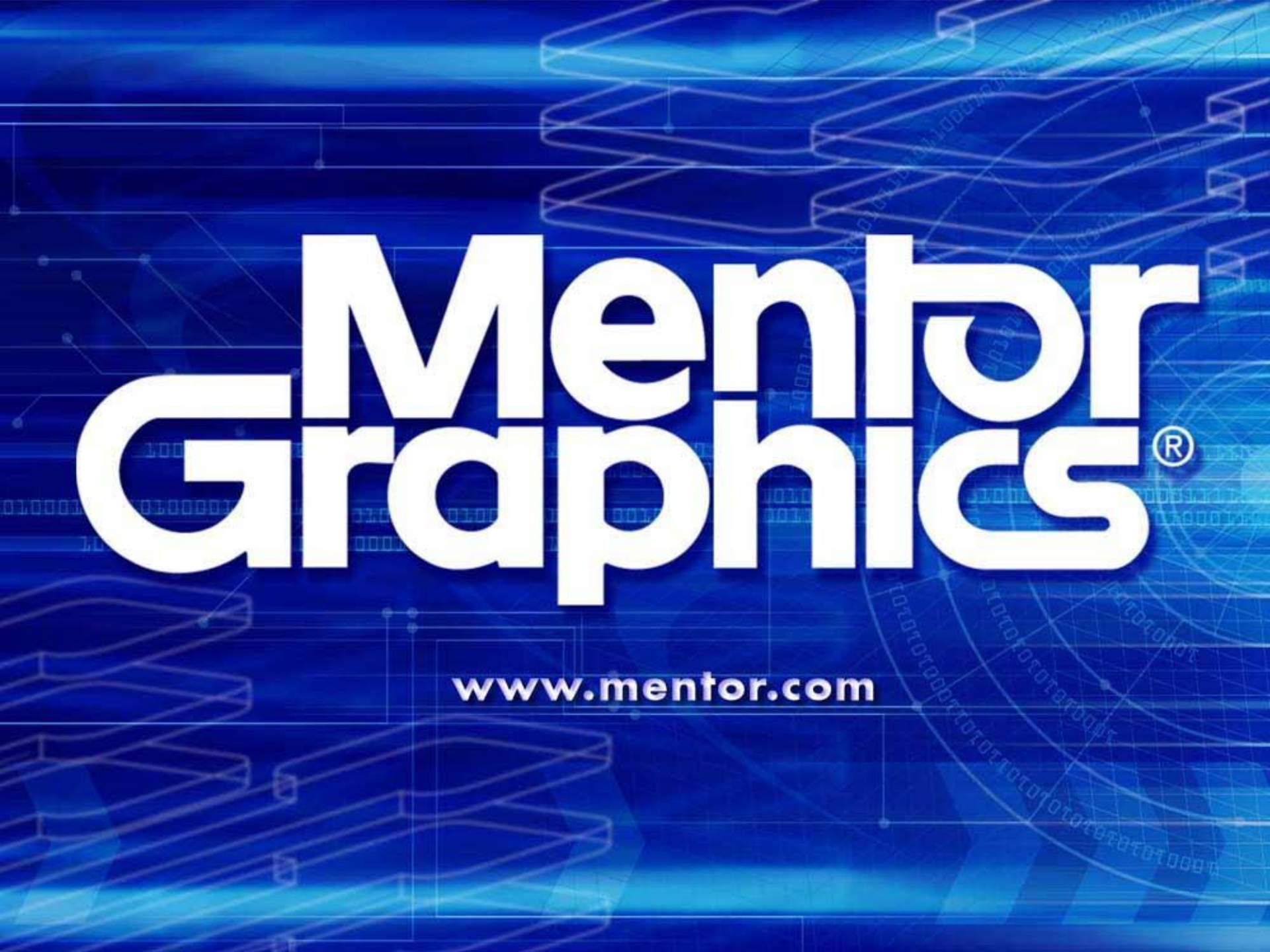
      ```
      [Model]    tx
      Model_type Output
      ...
      ISS_Package tx_package Td=AMI(Length) Zo=AMI(Zo)
      ```
    - there is another "more IBIS like" syntax example in the proposal
  - **IBIS-ISS analog package subcircuit parameters in .ami file**
    - this is missing from this BIRD draft, but it was present in a previous version

General summary of the SiSoft BIRD drafts

- They contain a lot of good ideas, but little attempt is made to implement them with existing keywords
  - new [External ISS] vs. reusing [External Model],
  - new [ISS Packages] vs. reusing [Define Package Model], etc…
  - this may be good from one perspective but bad from another
- These BIRD drafts need a lot of work to get to a finished condition
  - the draft itself contains numerous inconsistencies, the ideas need to be matured
  - there are a lot of completely new ideas to IBIS, like the dot syntax for node names
  - the numerous new syntax ideas need rigorous rules
  - this may take a huge amount of time and effort

Summary of the SiSoft buffer BIRD draft

- **Do we really want to add hard coded "intrinsic" analog models to the specification?**
  - **IBIS-ISS can do the same and more, is this necessary then?**
- **Do we really want to instantiate analog buffer models (IBIS-ISS subcircuits) from .ami files?**
  - **it is somewhat questionable to put analog buffer model parameters into the "digital" .ami files, but we can live with that…**
- **If we decided to eliminate these two features, the only thing that is left is the [External ISS] keyword in the .ibs file**
  - **this capability, however, is already described in BIRD 116, making use of the existing [External Model] keyword**
  - **is it really necessary to introduce a new keyword for a very similar functionality?**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