



## IBIS Open Forum Minutes

Meeting Date: **January 22, 2016**

Meeting Location: **DesignCon 2016 IBIS Summit, Santa Clara, CA, USA**

### VOTING MEMBERS AND 2016 PARTICIPANTS

ANSYS	Curtis Clark, Toru Watanabe*
Applied Simulation Technology	(Fred Balistreri)
Avago Technologies	Bob Miller*
Cadence Design Systems	Ken Willis*
Cisco Systems	Giuseppi Selli*, Brian Baek*
CST	Stefan Paret*
Ericsson	Anders Ekholm*, David Zhang*, Zilwan Mahmood*
Huawei Technologies	(Jinjun Li)
Infineon Technologies AG	(Christian Sporrer)
Intel Corporation	Hsinho Wu*, Mohammad Bapi*, Michael Mirmak*, Masahi Shimanouchi*, Todd Bermensolo*, Zao Liu*, Gong Ouyang*, Udy Shrivastava*
IBM	Adge Hawes*, Luis Armenta*
IO Methodology	Lance Wang*
Keysight Technologies	Radek Biernacki*, Heidi Barnes*, Jian Yang*, Fangyi Rao*, Stephen Slater*, Pegah Alavi*, Edwin Young*
Maxim Integrated Products	Yan Liang*, Don Greer*, Thinkh Nguyen*, Joe Engert*, Hock Seon*
Mentor Graphics	Arpad Muranyi*, Vladimir Dmitriev-Zdorov*, John Angulo*
Micron Technology	Randy Wolff
Signal Integrity Software	Mike LaBonte*, Walter Katz*, Todd Westerhoff*
Synopsys	Ted Mido*, Kevin Li*
Teraspeed Labs	Bob Ross*
Toshiba	(Yasumasa Kondo)
Xilinx	(Raymond Anderson)
ZTE Corporation	(Shunlin Zhu)
Zuken	Michael Schaefer*, Amir Wallrabenstein*

### OTHER PARTICIPANTS IN 2016

Fujitsu Advanced Technologies	Shogo Fujimori*
GLOBALFOUNDRIES	Steve Parker*
H3C	Bin Cheng*, Mao Jun*
Independent	Carl Gabrielson*
JEITA	Yosuke Kanamaru*
John Baprawski, Inc.	John Baprawski*
KEI Systems	Shinichi Maeda*
Lattice Semiconductor	Dinh Tran*, Maryam Shahbazi*
MathWorks	Mike Mulligan*, Corey Mathis*

Northrup Grumman	Alex Golian*
NXP	Jon Burnett*
Rambus	John Yan*
Raytheon	Joseph Aday*
SAE International	(Logen Johnson)
SILABTECH	Biman Chattopadhyary*
Signal Metrics	Ron Olisar*
SPISim	Wei-hsing Huang*

In the list above, attendees at the meeting are indicated by \*. Principal members or other active members who have not attended are in parentheses. Participants who no longer are in the organization are in square brackets.

## UPCOMING MEETINGS

The bridge numbers for future IBIS teleconferences are as follows:

Date	Meeting Number	Meeting Password
February 5, 2016	205 475 958	IBIS

For teleconference dial-in information, use the password at the following website:

<https://ciscosales.webex.com/ciscosales/j.php?J=205475958>

All teleconference meetings are 8:00 a.m. to 9:55 a.m. US Pacific Time. Meeting agendas are typically distributed seven days before each Open Forum. Minutes are typically distributed within seven days of the corresponding meeting. When calling into the meeting, follow the prompts to enter the meeting ID. For new, local international dial-in numbers, please reference the bridge numbers provided by Cisco Systems at the following link:

[http://www.cisco.com/web/about/doing\\_business/conferencing/index.html](http://www.cisco.com/web/about/doing_business/conferencing/index.html)

NOTE: "AR" = Action Required.

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## OFFICIAL OPENING

The IBIS Open Forum Summit was held in Santa Clara, California at the Hyatt Regency Santa Clara hotel adjoining the Santa Clara Convention Center, during the week of the 2016 DesignCon conference. About 62 people representing 32 organizations attended.

The notes below capture some of the content and discussions. The meeting presentations and other documents are available at:

<http://www.ibis.org/summits/jan16/>

Mike LaBonte welcomed everyone to the Summit, opening the meeting at 8:30 a.m. He thanked the sponsors Keysight Technologies, Mentor Graphics Corporation and Synopsys for offsetting the cost of food and audio-visual equipment. Mike asked all the participants to introduce themselves. There was a large cross section of model users and developers.

### **CHAIR'S STATUS REPORT**

Mike LaBonte, Signal Integrity Software (SiSoft)

Mike LaBonte gave an overview of the organizational status of the IBIS Open Forum. He thanked previous Open Forum chair Michael Mirmak for a total of 11 years of service and gave Michael a custom 3D printed business card holder as a gift. Mike described recent IBIS progress and current work. He noted that while some BIRDs have been pending for a long time most current work involves other matters. To improve IBIS workflow Mike proposed that we add separate Buffer Issue Definition Documents (BIDD) to our process, so that problem definition and solution requirements would be formally discussed and approved before considering solutions in the form of BIRDs. Also our new website will be updated with wiki pages and an online calendar to be more informative and so that designated people will be able to upload and edit content using a web browser.

### **JEITA IBIS PROMOTION WORKING GROUP REPORT**

Shogo Fujimori, Fujitsu

Shogo Fujimori introduced JEITA vice-chair Toru Watanabe from ANSYS. Shogo reported on the status of the JEITA IBIS Promotion Working Group, part of the Supply Chain Management Committee. The group has provided useful summaries of IBIS keywords and guidelines for the use of advanced IBIS technologies. An IBIS workshop had been conducted the same day as the November 2015 IBIS summit meeting in Tokyo. The training offered is geared toward beginner and potential IBIS model users, and is delivered in Japanese. A second seminar will be expanded to four hours by user request.

### **IBIS-ATM TASK GROUP REPORT**

Arpad Muranyi, Mentor Graphics Corporation

Arpad Muranyi showed the list of BIRDs under consideration by the IBIS Advanced Technology Modeling Task Group. Thirteen BIRDs discussed and developed by the task group have been passed by the Open Forum and incorporated into IBIS 6.1. One BIRD (179) was passed but is not yet incorporated. Arpad described the topics currently under discussion, noting that a number of pending BIRDs depend on the resolution of other BIRDs and proposals. Current work focuses mostly on cleaning up language related to ground and reference nodes and is expected to result in an IBIS 6.2 release.

### **SIMULATE IBIS DATA WITH FREE SPICE**

Wei-hsing Huang, SPISim

Wei-hsing Huang explained the details of an IBIS buffer simulation model implemented entirely as circuit elements supported by a SPICE3f5 simulator. Template circuits have been created for

both ramp-only and waveform models. Data is extracted from an IBIS [Model] and set as circuit element parameters. A future enhancement will involve replacing a time delay implemented as a transmission line with an E element delay parameter. Mike LaBonte noted that this tool is available from the IBIS Free Tools website, alongside the IBIS parsers and other free tools. Someone asked if IBIS modeling is supported in any of the free versions of SPICE. Wei-hsing stated that IBIS is not supported directly, but simulation models could be supported using the standard SPICE behavioral element (Bxxxx element).

## REFERENCES IN IBIS

Bob Ross, Teraspeed Labs

Bob Ross said that fixing references in IBIS is a current project in the ATM committee. References can apply to voltages used in extracting IBIS models, specification parameters, terminals, capacitance references in package models, and for simulation. A voltage (loosely defined) is the potential difference between two points or nodes, but IBIS usually designates only the potential value at one node in its keyword and subparameter syntax. Unless stated otherwise, the other reference is an implied "ground" or external "ground". Bob reviewed the keyword history, which started with [Voltage Range] and a stated GND reference. This got expanded to [Pullup Reference], [Power Clamp Reference], etc. for specific rails that could be different than the default [Voltage Range] keyword and support other technologies and configurations.

Bob concluded that references are used differently in several places within IBIS and terminology may differ, therefore a complete page-by-page review is needed to clean up the specification.

Michael Mirmak asked if measurement based extraction can still be supported. Bob stated that it theoretically is more difficult to strip out the package models to get at the core buffer models, but IBIS models can still be extracted from SPICE models with the package information removed.

## FIXING [PIN MAPPING]

Walter Katz, SiSoft

Walter Katz described the [Pin] and [Pin Mapping] IBIS keywords. He noted that the signal\_name column in [Pin] should have the signal names given in IC data books. Walter explained the difference between signal\_names used in [Pin] and bus\_labels used in [Pin Mapping]. He showed an example in which power and ground terminology seemed to be swapped, yet IBISCHK6 would find no errors because the IBIS specification does not require certain conditions. Walter proposed that all pins with the same bus\_label should have the same signal\_name, and that all pins with the same signal\_name should have the same model\_name. He described a new Signal\_names\_are\_bus\_labels subparameter for [Pin Mapping] that would eliminate the need to redundantly include POWER and GND pins in both [Pin] and [Pin Mapping]. Walter said he had not seen existing IBIS models with [Pin Mapping] used in a way that would violate these proposals.

## IBIS INTERCONNECT BIRD UPDATE

Walter Katz, SiSoft

Walter Katz gave an overview of the draft BIRD currently under consideration by the IBIS Interconnect Task Group, chaired by Michael Mirmak. The new [Begin Interconnect Model] keyword will allow package and on-die models in IBIS-ISS and Touchstone® formats to be assigned to IBIS [Component]s and [Model]s. Eventually this will be extended to boards, MCMs and DIMMs. Walter gave an overview of the syntax and showed examples of how a variety of model configurations would be implemented.

Arpad Muranyi noted that bus\_labels describe on-die groupings of signals and IBIS currently assumes that the bus defined by [Pin Mapping] is used to short the pads. He asked if the new on-die interconnect syntax will have the capability to define the location of these busses (shorts), such as being at the buffer terminals or at the die pads, since with the new on-die interconnect modeling syntax these may not be one and the same node as it used to be up to now. Walter said that this is supported in the proposed syntax.

### **A PRACTICAL DOE APPLICATION IN STATISTICAL SI ANALYSIS: USING IBIS & HOW CAN WE MAKE IBIS WORK BEYOND BEST CASE/WORST CASE?**

Feng Shi, Anders Ekholm, Zilwan Mahmud and David Zhang, Ericsson

Zilwan Mahmud said that data for the slow and fast corners supported by IBIS assumes 100% confidence that devices will always operate between those corners, while a statistical approach to signal integrity would allow defect rates to be estimated for any given confidence interval. The Design of Experiments (DOE) methodology involves producing a Response Surface Model (RSM) from a limited number of parameter sweep simulations to allow for very fast evaluation of a much larger set of possible parameter settings. The combination of statistical confidence models and the RSM supports a methodology in which the most sensitive parameters are isolated for more detailed simulation and optimum settings are determined. Zilwan showed an example where ranges of settings to produce good eye openings could be found much more quickly than would be possible by sweeping all combinations. He proposed that IBIS should adopt a means for expressed parameter values as a distribution with known confidence, instead of three process corners. Walter Katz commented that best case/worst case could support five sigma variations.

### **EFFECTIVE METHODOLOGY FOR CORRELATING MEASUREMENT TO SIMULATION FOR IBIS-AMI MODELS**

Seunyoung (Brian) Baek, Amendra Koul and Mike Sapozhnikov, Cisco Systems

Brian Baek showed examples of correlation between measurements and IBIS-AMI simulation results over ranges of parameter settings, noting that eye width and height correlation would generally follow similar trends even if the absolute values were not identical. He showed a process flow for refining TX and then RX trend correlation, discussing the tools and scripts needed to do so. ICs with built in RX decision point eye capture are helpful. Brian showed examples of measured and simulated eye dimensions for actual buffers at different speeds, in which the trends were accurately followed although the absolute values did not match perfectly.

Anders Ekholm asked if trend analysis is enough. Brian stated that hardware correlation is

needed. Anders also noted that the optimal settings were used in correlation. Jitter was one of the correlated parameters. Todd Westerhoff commented that only a single (optimal) setting was used. Bob Miller commented that correlation based on dominant taps was ok. The other taps might lack correlation and could be outliers. Someone asked how long it would take to get the required data. Brian stated that it might take a day to get all the data. Steve Parker commented that cross-correlation and covariance statistical calculations could also be reported.

## **IBIS-AMI MODELLING OF HIGH-SPEED MEMORY INTERFACES**

John Yan and Arash Zargaran-Yazd, Rambus

John Yan gave an overview of how IBIS-AMI models are constructed and how equalization helps to improve eye openings at the RX decision point. He recommended using this technology for memory interfaces to overcome the problem of stagnant channel performance. There was some discussion of whether an IBIS-AMI model could be used for single-ended signals, and some said that it could.

Bob Miller commented that DC aware dual rail models are needed, and that unbalanced channels can cause mode conversion from differential signals and can lead to single-ended DC offsets. Walter Katz commented that the impulse response characterization of a channel was a single-ended input, and AMI is based on such an assumption.

## **TWO FOR ONE: SERDES FLOWS FOR AMI MODEL DEVELOPMENT**

Corey Mathis\*, Ren Sang Nah\*, Richard Allred\*\* and Todd Westerhoff\*\*, \*MathWorks, \*SiSoft

Todd Westerhoff said that SerDes buffers are usually designed by first building architectural models, followed by more detailed implementation models. IBIS-AMI simulation models are usually created separately by different people. Todd gave a brief overview of the AMI development process, proposing that development of the analog channel model is best handled using a channel simulation tool. Corey Mathis presented slides showing that the algorithmic model can be easily produced by the architectural simulator from the architectural model. Todd showed examples of TX and RX IBIS-AMI models produced directly from architectural models that showed excellent correlation to architectural simulation results, and also worked at any samples-per-bit and AMI block size.

## **LICENSED AMI MODELS**

Ken Willis, Cadence Design Systems

Ken Willis listed various restrictions imposed for obtaining and using many IBIS-AMI models, noting that in some cases this would be due to the presence of vendor proprietary features that would make models incompatible with other tools. Ken said that the addition of run-time license checking within the algorithmic model files of IBIS-AMI models would allow those models to function as expected in a target EDA tool while preventing them from running in tools that would not properly support them. Ken proposed that in this case the model maker should be required to also make a standard, portable IBIS-AMI model available, even if it is unable to support all features the licensed model supports.

Several people asked for clarification regarding the purpose of licensing, asking if it was to protect IP, to use vendor-specific features, to get money for time invested in developing executable code, to encourage support of the vendor EDA tool, etc. Todd Westerhoff said that recovering the cost of developing IBIS-AMI models was a valid reason for this approach. Pegah Alavi and others commented that a licensed model should not be called an IBIS-AMI model because it would not be portable among tools.

Ken reiterated that it is preferable that model developers provide non-licensed models. If a user receives a licensed model, they must be able to go back to the model provider to get the unlicensed version.

### **WHAT CAN'T IBIS DO?**

Michael Mirmak, Intel Corporation

Michael Mirmak began by summarizing what IBIS models can do, then moving on to four areas in which IBIS is lacking: advanced packages, complex pad impedances, support for feedback paths inside buffers, and description of special evaluation criteria. He also proposed that IBISCHK should check the executable algorithmic files associated with IBIS-AMI models.

### **OPEN DISCUSSION**

Some of the topics posed in the last presentation were discussed at length. Various proposals for complex impedance models were discussed, including macro-model based approaches. Mike LaBonte expressed an interest in the Ericsson proposal to describe some parameters using statistical distributions.

A poll of people in the room showed that most were at least working with IBIS-AMI models and many were developers of IBIS-AMI models.

### **CONCLUDING ITEMS**

Mike LaBonte again thanked the sponsors Keysight Technologies, Mentor Graphics Corporation, Synopsys, the presenters, organizers and attendees.

The meeting concluded at approximately 4:40 PM.

### **NEXT MEETING**

The next IBIS Open Forum teleconference meeting will be held February 5, 2016. The following IBIS Open Forum teleconference meeting will be held February 26, 2016.

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### **NOTES**

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This meeting was conducted in accordance with ANSI guidance.

All inquiries may be sent to [ibis-info@freelists.org](mailto:ibis-info@freelists.org). Examples of inquiries are:

- To obtain general information about IBIS.
- To ask specific questions for individual response.



- To subscribe to the official [ibis@freelists.org](mailto:ibis@freelists.org) and/or [ibis-users@freelists.org](mailto:ibis-users@freelists.org) email lists (formerly [ibis@eda.org](mailto:ibis@eda.org) and [ibis-users@eda.org](mailto:ibis-users@eda.org)).
- To subscribe to one of the task group email lists: [ibis-macro@freelists.org](mailto:ibis-macro@freelists.org), [ibis-interconn@freelists.org](mailto:ibis-interconn@freelists.org), or [ibis-quality@freelists.org](mailto:ibis-quality@freelists.org).
- To inquire about joining the IBIS Open Forum as a voting Member.
- To purchase a license for the IBIS parser source code.
- To report bugs or request enhancements to the free software tools: ibischk6, tschk2, icmchk1, s2ibis, s2ibis2 and s2iplt.

The BUG Report Form for ibischk resides along with reported BUGs at:

<http://www.ibis.org/bugs/ibischk/>  
<http://www.ibis.org/bugs/ibischk/bugform.txt>

The BUG Report Form for tschk2 resides along with reported BUGs at:

<http://www.ibis.org/bugs/tschk/>  
<http://www.ibis.org/bugs/tschk/bugform.txt>

The BUG Report Form for icmchk resides along with reported BUGs at:

<http://www.ibis.org/bugs/icmchk/>  
[http://www.ibis.org/bugs/icmchk/icm\\_bugform.txt](http://www.ibis.org/bugs/icmchk/icm_bugform.txt)

To report s2ibis, s2ibis2 and s2iplt bugs, use the Bug Report Forms which reside at:

<http://www.ibis.org/bugs/s2ibis/bugs2i.txt>  
<http://www.ibis.org/bugs/s2ibis2/bugs2i2.txt>  
<http://www.ibis.org/bugs/s2iplt/bugspl.txt>

Information on IBIS technical contents, IBIS participants and actual IBIS models are available on the IBIS Home page:

<http://www.ibis.org/>

Check the IBIS file directory on [ibis.org](http://www.ibis.org) for more information on previous discussions and results:

<http://www.ibis.org/directory.html>

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## IBIS – SAE STANDARDS BALLOT VOTING STATUS

Organization	Interest Category	Standards Ballot Voting Status	November	December	January 8,	January 22,
			20, 2015	18, 2015	2016	2016
ANSYS	User	Active	X	X	X	X
Applied Simulation Technology	User	Inactive	-	-	-	-
Avago Technologies	Producer	Inactive	-	-	-	X
Cadence Design Systems	User	Active	X	X	-	X
Cisco Systems	User	Inactive	-	-	-	-
CST	User	Inactive	-	-	-	X
Ericsson	Producer	Inactive	-	-	-	X
Huawei Technologies	Producer	Inactive	-	-	-	-
Infineon Technologies AG	Producer	Inactive	-	-	-	-
IBM	Producer	Active	X	X	X	X
Intel Corp.	Producer	Active	-	X	X	X
IO Methodology	User	Active	X	X	X	X
Keysight Technologies	User	Active	X	X	X	X
Maxim Integrated Products	Producer	Active	X	-	X	X
Mentor Graphics	User	Active	X	X	X	X
Micron Technology	Producer	Active	X	X	X	-
Signal Integrity Software	User	Active	X	X	X	X
Synopsys	User	Inactive	X	-	-	X
Teraspeed Labs	General Interest	Active	X	X	X	X
Toshiba	Producer	Inactive	-	-	-	-
Xilinx	Producer	Inactive	-	-	-	-
ZTE	User	Inactive	-	-	-	-
Zuken	User	Inactive	-	-	-	X

### I/O Buffer Information Specification Committee (IBIS)

#### CRITERIA FOR MEMBER IN GOOD STANDING:

- MUST ATTEND TWO CONSECUTIVE MEETINGS TO ESTABLISH VOTING MEMBERSHIP
- MEMBERSHIP DUES CURRENT
- MUST NOT MISS TWO CONSECUTIVE MEETINGS

#### INTEREST CATEGORIES ASSOCIATED WITH SAE BALLOT VOTING ARE:

- USERS - MEMBERS THAT UTILIZE ELECTRONIC EQUIPMENT TO PROVIDE SERVICES TO AN END USER.
- PRODUCERS - MEMBERS THAT SUPPLY ELECTRONIC EQUIPMENT.
- GENERAL INTEREST - MEMBERS ARE NEITHER PRODUCERS NOR USERS. THIS CATEGORY INCLUDES, BUT IS NOT LIMITED TO, GOVERNMENT, REGULATORY AGENCIES (STATE AND FEDERAL), RESEARCHERS, OTHER ORGANIZATIONS AND ASSOCIATIONS, AND/OR CONSUMERS.