



IBIS Open Forum Minutes

Meeting Date: **November 4, 2019**

Meeting Location: **Taipei, Taiwan**

VOTING MEMBERS AND 2019 PARTICIPANTS

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IO Methodology

[Lance Wang]

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Xpeedic	Cunhui Gui
Zhaoxin (Shanghai Zhaoxin Semiconductor)	Zhen (Caffrey) Fu, Chuanyu (Liam) Li

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
November 8, 2019	Asian IBIS Summit (Tokyo) – no teleconference	
November 22, 2019	624 227 121	IBISfriday11

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

<http://tinyurl.com/IBISfriday>

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.

NOTE: "AR" = Action Required.

OFFICIAL OPENING

The Asian IBIS Summit took place on Monday, November 4, 2019 at the Sherwood Hotel in Taipei. About 67 people representing 27 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/nov19b/>

Randy Wolff opened the summit by welcoming everyone and thanking the sponsors ANSYS, Cadence Design Systems, and Synopsys. He noted that minutes of the meeting would be posted. There would be two breaks for refreshments and vendor interaction, and free lunch. The Summit would be followed by a vendor presentation session led by Lance Wang of Zuken as moderator.

IBIS CHAIR'S REPORT

Randy Wolff (Micron Technology, USA)

Randy described the status and activities of the IBIS Open Forum. There are 26 member companies of IBIS in 2019. The 2019-2020 officers have changed significantly from the previous year. Many IBIS meetings occur weekly to yearly from task groups to Summits around the world. SAE ITC is the parent organization of IBIS, providing financial and legal services. IBIS has four task groups meeting weekly to discuss technical topics, IBIS quality, and the

Editorial task group, which meets only as needed to produce new IBIS specification documents. The latest IBIS milestone is the release of IBIS 7.0 and the ibishchk7 parser to support it.

Beyond IBIS 7.0, there are currently 5 BIRDS in discussion. The interconnect task group is working on an important update to EBD to support IBIS-ISS and Touchstone models. BIRD200 is already approved, and it improves die capacitance modeling. BIRD195.1 is also approved, and it simplifies some AML input models.

Randy encouraged new contributions to IBIS from the meeting participants to ensure that IBIS continues to meet the needs of new technology, including improving power delivery design. He also described the BIRD process, and he noted that ideas do not need to be written in formal BIRD templates, but first can be presented in task groups for discussion before a BIRD is proposed.

Randy noted that there was interest expressed in the Shanghai Summit for a regular task group meeting in Asia. He encouraged meeting attendees to think about participating in such a meeting in the future.

INTRODUCING IBIS VERSION 7.0

Michael Mirmak*, Randy Wolff** (*Intel Corporation, **Micron Technology, USA)
[Presented by Randy Wolff (Micron Technology, USA)]

Randy introduced IBIS 7.0, ratified on March 15, 2019 and available for download from the IBIS website. The specification is now 331 pages. Randy reviewed that 17 BIRDS are addressed in IBIS 7.0.

The Interconnect BIRD brings IBIS up-to-date for package modeling, and there are several related smaller BIRDS. The interconnect package modeling adds support to directly connect Touchstone and IBIS-ISS into the IBIS model. The BIRD also gives explicit buffer and die pad locations, which gives the ability to define better on-die power delivery networks.

IBIS 7.0 adds backchannel support for Tx and Rx equalizers to interact. IBIS now supports connecting 4-port Touchstone files for analog buffer characteristics. The Special_Param_Names parameter has been added to allow EDA functions beyond current IBIS limitations. Parameters can be passed to instances of [External Circuit]. Randy noted that supporting files could now be in directory structures.

IBIS 7.0 has additional editorial changes for readability, and there are now subsections with numbering. The document now contains hyperlinks to sections, tables and figures. Randy listed the BIRDS that were excluded from IBIS 7.0. There is also a list of known editorial issues already started. An ibishchk7 version 7.0.0 parser for IBIS 7.0 has recently been released. Randy noted he expects to see support for IBIS 7.0 in new releases of EDA tools now that the parser is available.

A question was asked about how to choose the version of IBIS necessary for correctly modeling a device operating at higher data rates. Randy responded that the answer depends on several factors. For example, at the package level, you need to look at the required bandwidth of the

package model based on factors of data frequency, frequency content of the signal from rise/fall time of the buffer, as well as the electrical length of the package. In many cases, the RLC models available in versions of IBIS before IBIS 7.0 are adequate. If you determine that you need a multi-section SPICE package model or S-parameter model, then you should choose IBIS 7.0 to support the new interconnect syntax. Lance Wang responded that the characteristics of the buffer would also be a factor. Support for more data points in V-T curves may be necessary. Randy added that IBIS version 5.1 should be used for modeling power delivery effects, such as simulating SSN.

HOW TO OBTAIN BUFFER IMPEDANCE FROM IBIS

Lance Wang (Zuken, USA)

Lance explained that matching output buffer impedance to interconnect impedance is a necessary task for the SI engineer. Impedance is represented as a complex quantity Z . He showed how to measure input and output impedance of an I/O buffer. Example I-V curves for input and output buffers were shown, including inputs with ODT. Obtaining impedance from an IBIS model starts with overlaying a load line on the Pullup or Pulldown I-V curves. Operating point impedance is the intersection of the load line and the I-V curve. I/O impedance may vary for different loads.

IBIS-AMI AND COM CO-DESIGN FOR 25G SERDES

Nan Hou*, Amy Zhang*, Guohua Wang*, David Zhang**, Anders Ekholm** (Ericsson, *PRC, **Sweden)

[Presented by Anders Ekholm (Ericsson, Sweden)]

Anders started with an overview of the IBIS-AMI flow. Channel operating margin (COM) is related to the ratio of a calculated signal amplitude to a calculated noise amplitude. He described the COM flow, the channel transfer function, and the method for determining the optimal EQ settings. He noted that the channel transfer function combines frequency domain calculations with a time domain calculation to include DFE.

Two cases were shown of simulating COM results, followed by IBIS-AMI simulation with the recommended COM parameter settings. He stressed that COM is only useful for optimizing signal to noise ratio, if other types of optimization are needed, then other methods must be used. In a co-design simulation flow, COM is used for channel optimization followed by IBIS-AMI simulation.

Question page 24, if passed COM simulation, why do we do AMI? Anders: more detailed modeling of simulation in IBIS-AMI, so AMI is necessary to verify with AMI. AMI will always be more accurate, so is necessary to follow COM. Also asked on page 16, is FEC used in the simulation configuration? Anders responded that FEC is not used.

Randy noted that COM was adopted by three standards as shown on slide 7. Is COM useful for more applications? Anders noted that he is trying to understand all the applications for COM. It is possible that COM could be the only metric needed to evaluate certain systems, but that is not proven. Also, COM is only frequency domain, not time domain analysis.

INNOVATIONS IN DDR MEMORY SIMULATION

Stephen Slater (Keysight Technologies, USA)

[Presented by Nash Tu (Keysight Technologies, Taiwan)]

Nash defined the measure of success for a DDR5 design, as no system failures under stress testing with satisfactory product quality risk. Ensuring success with DDR5 requires complicated methodology. Challenges for DDR5 include managing crosstalk and jitter and using BER specifications. Closed eyes need equalization and training. Innovations are required in LPDDR5 and DDR5 modeling and simulations. The signal return path design becomes very important for reducing crosstalk.

Key insights are that jitter and crosstalk are very significant. Simulation must predict eye closure due to random jitter down to the system BER ($1e-16$) in a practical time. EM simulation must capture crosstalk accurately.

DDR5 and LPDDR5 are the first DRAM technologies to include DFE in the receiver. DDR5 Rx specifications are inside the die, so virtual probing inside the die is needed. DDR5 Rx testing now includes a loopback test feature. Skew adjustment is also performed with Write-leveling by the controller.

IBIS-AMI has been widely adopted by IC, system and EDA companies for SerDes signals, but this is the first application to DDR single-ended signals. IBIS-AMI flows for DDR5 must be able to support passing the DC common mode voltage to the Rx model, modeling of asymmetric eyes due to driver rise/fall mismatch, and inclusion of external clocking to track uncorrelated jitter between DQ and DQS. A backchannel interface for training could also be an improvement.

CHANNEL SIMULATION OVER DDR4/5 AND ABOVE

Kumar Keshavan*, Ambrish Varma*, Ken Willis*, Skipper Liang** (Cadence Design Systems, *USA, **Taiwan)

[Presented by Skipper Liang (Cadence Design Systems, Taiwan)]

Skipper noted that as the transmission rate of a memory bus goes beyond 5Gbps, besides the well-known timing and overshoot/undershoot analysis, it requires BER prediction analysis and channel analysis. Two additional concerns we need to face while using a channel engine to deal with a memory bus include asymmetric rising/falling edges and strobes as a timing reference.

As channel simulation and IBIS-AMI modeling methods are adapted from serial link to DDR interface analysis, we encounter IBIS I/O models with asymmetric rising and falling edges. This is different from the highly symmetric drivers we typically encounter with serial link analysis. Traditional single-step response methods for impulse response generation may not reproduce circuit simulation results accurately enough. An EDA tool can handle this without changes to the IBIS specification. Characterization methods using rising and falling edges captured the rising/falling asymmetry behavior very well for channel simulation.

As channel simulation and IBIS-AMI modeling methods are adapted from serial link to DDR interface analysis, serial link CDR algorithms are often used for analysis. Using a default CDR instead of the actual strobe to get clock ticks will miss important impairments/jitter for a parallel bus topology. Analysis results show false optimism using the CDR approach as compared to a true strobe timing methodology. It is necessary to model delay accurately between data and strobe.

IBIS FILE FORMAT LINKS

Bob Ross (Teraspeed Labs, USA)

[Presented by Randy Wolff (Micron Technology, USA)]

Randy presented an overview of the evolution in the number and types of file formats supported by IBIS. IBIS now directly or indirectly supports over 17 formats ranging from IBIS defined formats (ebd, ibs, pkg, ami, Touchstone, etc.) to formats managed by other standards bodies (VHDL_AMS, Berkley SPICE, etc.). Electrical Module Description (EMD) is a future format that is under development in the Interconnect task group.

CLOSING REMARKS

Randy Wolff closed the Summit, thanking the sponsors, the authors and presenters, and all participants. He encouraged all to consider participation in future IBIS meetings in Asia and proposing their ideas for IBIS through the BIRD process. The summit was adjourned.

NEXT MEETING

The next IBIS Open Forum teleconference meeting will be held on November 22, 2019. The following IBIS Open Forum teleconference meeting is tentatively scheduled on December 13, 2019.

The Asian IBIS Summit in Tokyo will be held November 8, 2019. No teleconference will be available for the Summit meeting.

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NOTES

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This meeting was conducted in accordance with ANSI guidance.

All inquiries may be sent to info@ibis.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 and/or ibis-users@freelists.org email lists (formerly ibis@eda.org and ibis-users@eda.org).
- To subscribe to one of the task group email lists: ibis-macro@freelists.org, ibis-interconn@freelists.org, or 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 `s2ipt`.

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

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 for more information on previous discussions and results:

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

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SAE STANDARDS BALLOT VOTING STATUS

Organization	Interest Category	Standards Ballot Voting Status	September	October	November	November
			27, 2019	18, 2019	1, 2019	4, 2019
ANSYS	User	Active	X	X	X	X
Applied Simulation Technology	User	Inactive	-	-	-	-
Broadcom Ltd.	Producer	Inactive	-	-	-	-
Cadence Design Systems	User	Active	-	-	X	X
Cisco Systems	User	Inactive	-	-	X	-
Dassault Systemes	User	Inactive	-	-	-	-
Ericsson	Producer	Active	-	-	X	X
GLOBALFOUNDRIES	Producer	Active	-	X	-	-
Google	User	Inactive	X	-	-	-
Huawei Technologies	Producer	Inactive	-	-	X	-
Infineon Technologies AG	Producer	Inactive	X	-	-	-
Instituto de Telecomunicações	User	Inactive	-	-	-	-
IBM	Producer	Inactive	X	X	-	-
Intel Corp.	Producer	Active	X	X	X	X
Keysight Technologies	User	Active	X	-	X	X
Maxim Integrated	Producer	Inactive	-	-	-	-
Mentor, A Siemens Business	User	Inactive	X	X	-	-
Micron Technology	Producer	Active	X	X	X	X
NXP	Producer	Inactive	-	-	-	-
SiSoft	User	Inactive	X	X	-	-
SPISim	User	Inactive	X	X	-	-
Synopsys	User	Active	X	X	X	-
Teraspeed Labs	General Interest	Inactive	X	X	-	-
Xilinx	Producer	Inactive	-	-	-	-
ZTE Corp.	User	Inactive	-	-	X	-
Zuken	User	Active	X	X	X	X

Criteria for SAE 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 standards 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.