



IBIS Open Forum Minutes

Meeting Date: **August 12, 2021**

Meeting Location: **IBIS Summit at 2021 IEEE Virtual Symposium on EMC+SIPI**

VOTING MEMBERS AND 2021 PARTICIPANTS

ANSYS	Curtis Clark*, Wei-hsing Huang
Applied Simulation Technology	(Fred Balistreri)
Broadcom	(Yunong Gan)
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Celestica	(Sophia Feng)
Cisco Systems	(Stephen Searce)
Dassault Systemes (CST)	Stefan Paret, David Duque, Longfei Bai
Ericsson	(Guohua Wang)
Google	Zhiping Yang*, Songping Wu*
Huawei Technologies	(Hang (Paul) Yan)
Infineon Technologies AG	(Christian Sporrer)
Instituto de Telecomunicações	(Abdelgader Abdalla)
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Luminous Computing	David Banas
Marvell	Steve Parker
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Maxim Integrated	Tushar Pandey
Micron Technology	Randy Wolff*, Justin Butterfield, Aniello Viscardi
MST EMC Lab	Chulsoon Hwang*, Anfeng Huang*, Yifan Ding*
NXP	(John Burnett)
SerDesDesign.com	(John Baprawski)
Siemens EDA (Mentor)	Arpad Muranyi*, Weston Beal
Siemens AG	Franz Pflieger, Sebastien Kollinger
Synopsys	Ted Mido, Andy Tai
Teraspeed Labs	Bob Ross*
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ZTE Corporation	Bowen Shen, Changgang Yin, Dongdong Ye Liqiang Meng, Xiaoxuan Liu
Zuken	Michael Schäder
Zuken USA	Lance Wang*

OTHER PARTICIPANTS IN 2021

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Analog Devices	Patrick DeRoy*

ATE Service Corporation	Yutaka Honda*
AVL Software and Functions	Wolfgang Röhrner
Ciena	Taha Kheyar*
Continental Automotive	Julnar Musmar, Stefanie Schatt
De Montfort University (IEEE EMC)	Alistair Duffy
Hamburg University of Technology	Cheng Yang*
IT-Beratung-Maurer	Manfred Maurer
Kandou Bus	Sherman Chen
KEI Systems	Shinichi Maeda
Microchip Norway	Lars Snith
Politecnico di Torino	Stefano Grivet-Talocia, Paolo Manfredi Alessandro Zanco, Felipe Treviso Marco Destefano, Riccardo Trincherro Tomasso Bradde
RTC	Ken Whigham
Simberian	Yuriy Shlepnev*
Teradyne	Tao Wang*
University of Illinois, Urbana	Jose Shutt-Ainé, Xinying Wang

In the list above, attendees at the meeting are indicated by *. Those submitting an email ballot for their member organization for a scheduled vote 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 connection information for future IBIS teleconferences is as follows:

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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 IBIS Summit at 2021 IEEE Virtual Symposium on EMC+SIPI took place on Thursday, August 12, 2021, as an online virtual meeting. About 19 people representing 15 organizations attended.

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

<https://ibis.org/summits/aug21a/>

Start times and durations listed in these minutes refer to the meeting recording linked at:

https://ibis.org/summits/aug21a/summit_recording.mp4

(Start time: 0:00, Duration: 2:45)

Randy Wolff opened the summit by welcoming everyone and thanking them for joining. He thanked the organizers of IEEE EMC+SIPI 2021, the IEEE EMC Society, for working with the IBIS Open Forum to organize the summit.

IBIS CHAIR'S REPORT

Randy Wolff (Micron Technology, USA)

(Start time: 3:05, Duration: 13:15)

Randy Wolff provided a report on ongoing activities of the IBIS Open Forum. He shared a list of the new features (BIRDS) expected in the upcoming IBIS 7.1. Looking to the future, Randy mentioned possible new directions for IBIS, including the modeling of new signaling technologies and power delivery networks. He encouraged everyone to consider working with an IBIS task group and or drafting a BIRD if they had ideas for enhancements to IBIS.

CHECKING AND CONVERTING TOUCHSTONE FILES WITH TSCHK2

Mike LaBonte (The MathWorks, USA)

(Start time: 17:25, Duration: 26:10)

Mike LaBonte gave a brief historical overview of the Touchstone specification and the TSCHK2 parser, which had recently been updated. He showed examples of using TSCHK2 to check syntax, inspect the contents, and convert Touchstone files between version 1 and version 2 formats. New options for controlling numerical precision and whitespace allowed converted files to be either compact or easy to read. Mike showed the TSCHK web pages and described the bugs fixed in the recent version 2.0.1 release.

Zhiping Yang asked how popular the Touchstone 2 specification had become. Mike said there had been some polling on the topic, and it seemed adoption of Touchstone 2 was going slowly. Lance Wang said most but not all EDA tools were able to work with Touchstone 2 files. Randy Wolff expected Touchstone 2 to be a topic of discussion for the IBIS Interconnect Task Group, once they resumed meeting. Zhiping also suggested working with the IEEE P370 group to see about means to assess quality metrics for Touchstone files. He would provide contact information.

EXPECTATIONS FOR IBIS 7.1

Michael Mirmak (Intel Corp.)

(Start time: 45:00, Duration: 14:40)

Michael Mirmak described the process of producing the IBIS 7.1 specification draft, which the IBIS Editorial Task Group had been working on since February. There were new technical features as well as significant work on clarification. Michael described changes in the areas of C_comp modeling, on-die power distribution networks, Electrical Descriptions of Modules (EMD), a more powerful successor to Electrical Board Description (EBD), and a few other new IBIS-AMI developments related to DC offset, back-channel, eye centering, and clock forwarding. A more detailed presentation could be expected in a future IBIS Summit, after ratification of IBIS 7.1.

Arpad Muranyi asked where the documents could be found. Michael said it was on the IBIS Editorial Task Group web page.

ANALYSIS TO MEASUREMENT VALIDATION WITH S-PARAMETERS SIMILARITY METRIC

Yuriy Shlepnev (Simberian, USA)

(Start time: 1:00:25, Duration: 32:15)

Yuriy Shlepnev compared digital data rates against the ability to measure, finding that the Nyquist frequency for data rates around 128 Gb/s exceeded measurement bandwidth for available equipment. Approaches for comparing the simulation results against measurement results typically required visual assessment. Yuriy had tried using the Feature Selective Validation (FSV) approach described by Alistair Duffy¹. He found that to be simple, but the results could be affected by certain details. He introduced 3D Real-Imaginary-Frequency (RIF) plots as a means to view S-parameter data. An advantage of 3D representation was that it avoided the complication of intersecting curves as seen in 2D polar plots. Yuriy showed 3D plots of pairs of S-parameters, one from field solution and one from measurement. He defined Drif as the closest distance between a given point on one to the other, which varied along the length of the spirals. That analysis was done for both S11 and S12 S-parameters. An S-Parameters Similarity (SPS) metric was defined, ranging from 0 to 100, in which 100 was completely identical. It was necessary to resample the frequency points, and an adaptive algorithm placed more points near resonances. Yuriy found that a 10% delay resulted in significant Drif values. Numerical ranges had been established for Good, Acceptable, Inconclusive, and Bad SPS values. Given two unrelated S-parameters, the SPS would always be less than 80 (Bad). It was also possible to determine the port mapping by finding the best SPS.

Zhiping Yang asked how much difference adaptive sampling made in the similarity metric results. Yuriy said equidistant sampling had been used for the measurements, and that using adaptive sampling to add more points in certain regions did make the metric more sensitive. Zhiping asked if the method could identify outliers. Yuriy said it could compare any S-parameter to another, and the outliers would appear.

1. A.P. Duffy, G. Zhang, "FSV: State of the Art and Current Research Fronts", *IEEE Electromagnetic Compatibility Magazine*, Volume 9, #3, 2020, p. 55-62

NEW WAY TO IMPROVE POWER SUPPLY INDUCED JITTER SIMULATION ACCURACY FOR IBIS MODEL

Yifan Ding*, Yin Sun**, Zhiping Yang***, Chulsoon Hwang*

(*Missouri S&T, USA; **Zhejiang University, China, ***Google (Waymo), USA)

(Start time: 1:33:15, Duration: 27:45)

Yifan Ding said the current power-aware IBIS model was unable to account for the delay effects of power supply noise. To address that, their approach was to use time-averaged supply voltage to alter the Kd(t) and Ku(t) curves that control switching behavior. They had modified their initial proposal after the IBIS Advanced Technology Modeling Group (ATM) provided feedback. It was found that some existing IBIS tools differed significantly in the Ku(t) and Kd(t) curves extracted from IBIS waveforms. A correction had been made to adjust the initial and steady state voltages, to produce a more accurate model. Power supply-induced jitter was modeled as a jitter sensitivity in ps/V, which would become a new PSIJ IBIS-AMI reserved parameter. In the overclocking case where the propagation delay was greater than the switching time, it would be necessary to use delay elements that would store the switching times and set the Ku/Kd adjustments to take place in the correct time frames. It was found that accuracy relative to full transistor SPICE simulation had been improved.

Arpad Muranyi asked if there would be a BIRD for the proposed new IBIS-AMI parameter, and if any other new keywords or parameters were needed. Yifan said only the PSIJ keyword is needed. Chulsoon Hwang said they would like to present the proposal one more time to a working group and then write a BIRD. Zhiping Yang asked if the BIRD should be written first, or if it should be discussed in ATM first, or if both could be done in parallel. Arpad said a BIRD could be submitted by anyone at any time, and that ATM group review was not required. It could be discussed in ATM concurrently. Chulsoon said they appreciated the feedback from the ATM group. Randy Wolff thanked the authors for addressing the ATM feedback.

FAST PDN IMPEDANCE PREDICTION USING DEEP LEARNING

Ling Zhang*, Jack Juang*, Zurab Kiguradze*, Bo Pu*, Shuai Jin**, Songping Wu**, Zhiping Yang**, Jun Fan*, Chulsoon Hwang*

(*Missouri S&T, USA; **Google, USA)

Randy Wolff played a video pre-recorded by Ling Zhang. In the video presentation Ling Zhang said described the limitations of models used for calculation power delivery network plane impedances. The cavity impedance model could handle only rectangular shapes. The plane pair PEEC model could handle irregular shapes, but it was slow. They explored the use of deep

learning models to predict impedance quickly, with sufficient accuracy. Doing so required producing a significant amount of training data. A Boundary Element Method (BEM) solver was chosen because it was much faster than full wave, running in less than 5 seconds versus greater than 20 minutes. Training cases with random shapes, decoupling capacitors and stackups were generated and solved with BEM, and these were used to train a convolutional neural network. That required about 80 hours of compute time. The neural network model was then able to solve the training cases much more quickly than BEM, and the accuracy was tolerable.

Arpad Muranyi asked how often the 80-hour training would need to be run. Chulsoon Hwang said no retraining would be needed as long as the training cases had a wide enough range to encompass the designs to be analyzed. Randy Wolff asked how the GPU hardware used for training would compare to other available hardware such as multicore systems. Chulsoon said only 8 layers had been used for training, but it could be expanded to 20 or more layers. They had not tried the training on other platforms. Lance Wang asked how many training cases had been used. Chulsoon said about a half million designs had been generated, over 2 million with different decoupling capacitor arrangements. Zhiping Yang encouraged people to look at the open-source code and data, available on GitHub.

(Start time: 2:03:50, Duration: 21:55)

GDDR6X IBIS MODELING

Wolff, Randy*, Muranyi, Arpad**

(*Micron Technology, USA; **Siemens EDA, USA)

(Start time: 2:26:20, Duration: 36:50)

Randy Wolff said the GDDR6X changed DDR signaling from NRZ to single ended PAM4. It had been found that NRZ was not useful even at 28 Gb/s. SPICE simulation was slow, and the IBIS behavioral model was not well suited for transient simulation of PAM4, because a fundamental assumption of IBIS was that devices have two states. The IBIS-AMI PAM4 flow required characterizing full swing behavior to derive impulse responses, but for better accuracy an approach with four states and separate characterization of the different edge transitions between them was desirable. Arpad Muranyi said he had revisited VHDL-AMS and Verilog-A models produced for the IBIS Macromodel Task Group in 2005 and 2006, to produce four-state models. An integer vector parameter was used to describe the sequence of four logic states, using the D_drive port as a clock. This model could still have jitter. Two sets of I-V curves were used, for 60ohm and 120ohm behavior. Arpad wrote a MATLAB script to derive K-t from V-t. Verilog-A did not encounter discontinuities going from state to state, an initial concern. Randy said that for testing they converted S-parameters to SPICE, so that all tools would get the same results for the channels. An IBIS-AMI model with an ideal Tx did not match SPICE results as well as the Verilog-A model did. Adding non-ideal IBIS behavior, and then separate IBIS behavior for each edge helped further. Randy proposed that IBIS could have new PAM4 model types based on the idea.

Bob Ross asked if 40 ohm buffers would be used to drive a 20 ohm t-line. Randy said they would not. Bob asked if Rfixture=40 had been used to extract models. Randy said Rfixture=50 had worked well enough. Bob asked if the Kt tables accounted for C_comp. Arpad said they did. Bob asked how the separate C_comp values for different states were accounted for. Arpad

said the C_{comp} value used could be averaged, but it would not affect the Kt table because that used the total C_{comp} . Bob asked if open drain/source buffer models had been used. Arpad said a standard pullup/pulldown output buffer was effectively implemented. Arpad commented that he had a concern that [Composite Current] and [ISSO] may worsen the correlation using their approach.

NEXT GENERATION IBIS-AMI MODELING

Katz, Walter (The MathWorks, USA)

(Start time: 3:03:40, Duration: 36:50)

Walter Katz described an implementation of crosstalk cancelation technology, which would cancel only far end crosstalk (FEXT), defined using the strict IEEE 802.3 definition of FEXT. Crosstalk cancellation used a scaled and delayed filter output. Implementation of this would require a new IBIS BIRD. Zhiping Yang asked if the requirement that the aggressor and victim impulse responses had to be the same meant that the channels had to be identical. Walter said he had done what the standard allowed, which was a single impulse response input.

Walter then described an IBIS-AMI test fixture for testing 65 different channel models downloaded from the IEEE 802.3ck website. The serdes models had FFE, CTLE, AGC, and DFE elements, with various controls. Walter had found optimum control settings for each channel, using maximized Channel Operating Margin (COM) as the goal criterion. Two genetic algorithms had provided the best results, although only one of those was suitable for firmware implementation. An adaptive FFE algorithm provided good results with much faster execution. Walter discussed some challenges related to using IBIS-AMI back-channel modeling, noting for example that the back-channel training flow did not allow for changing impulse response during training.

Walter discussed BIRD205, "New AMI Reserved Parameter for Sampling Position in AMI_Init Flow", which introduced the Rx_Decision_Time IBIS-AMI parameter. He said hardware used various methods for eye centering, and IBIS did not specify how to model that. He showed that a DFE would distort the left side of an eye opening, causing the maximum eye height to not appear at the center of the eye.

Discussing BIRD213, "Extending IBIS-AMI for PAMn Analysis", Walter noted that it had not yet been approved by the IBIS Open Forum. He showed an example of a PAM3 eye diagram.

Moving on to BIRD204, "Clock Forwarding Modeling", Walter said using the clock from a DQS signal would include all of its impairments. He showed an example circuit and results, noting that clock forwarding only affected time domain analysis.

Walter then showed an example of using IBIS-AMI to model a 112 Gb/s PAM4 model set in which the Rx used an analog to digital convertor (ADC), leaving much of the signal processing to be handled by digital logic. Since the ADC cannot operate at 112 Gb/s, it was necessary to interleave four of them. The CDR was a challenge because only one point was sampled per unit interval. Walter said it was important to verify that the hardware implementation would match the model. The histogram that normally would show an eye looked very different because there were not enough samples to produce an eye. Walter said that posed challenges evaluating performance, suggesting that it would be possible to report the Signal-to-Noise Ratio

(SNR) using new IBIS-AMI Out parameters.

Randy Wolff asked if serdes designers were using ADCs at 128 Gb/s, noting that doing so handed the problem off to the digital people, who had a different skill set. Arpad Muranyi asked about the benefits of using an ADC. Walter said the processing can be all digital, for example running 64 processes in parallel. He noted that the output signal was not analog, unlike that of a full analog serdes model. He said it would be possible to use a 30 tap FFE to implement the ADC. The training could be done completely in firmware. He suggested using global optimization methods to avoid local minima. Arpad asked if anyone was doing that. Walter said some were.

CLOSING REMARKS

(Start time: 3:38:45, Duration: 1:50)

Randy Wolff said the next IBIS Summit meeting would be held Thursday, August 19, associated with DesignCon. Those interested should email Lance Wang (lance.wang@ibis.org) to register. The next IBIS Open Forum meeting would be held August 27. Randy thanked the IEEE EMC Society for their help, Bob Ross for organizing the Summit, the IBIS board, the presenters, and the attendees.

NEXT MEETING

The next IBIS Open Forum teleconference meeting would be held on August 27, 2021. The following teleconference meeting was tentatively scheduled for September 17, 2021.

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NOTES

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This meeting was conducted in accordance with SAE ITC guidelines.

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 `s2iplt`.

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

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

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SAE STANDARDS BALLOT VOTING STATUS

Organization	Interest Category	Standards Ballot Voting Status	Standards Ballot Voting Status			
			June 25, 2021	July 16, 2021	August 6, 2021	August 12, 2021
ANSYS	User	Active	X	X	-	X
Applied Simulation Technology	User	Inactive	-	-	-	-
Broadcom Ltd.	Producer	Inactive	-	-	-	-
Cadence Design Systems	User	Active	X	X	X	-
Celestica	User	Inactive	-	-	-	-
Cisco Systems	User	Inactive	-	-	-	-
Dassault Systemes	User	Inactive	-	-	-	-
Ericsson	Producer	Inactive	-	-	-	-
Google	User	Active	X	X	X	X
Huawei Technologies	Producer	Inactive	-	-	-	-
Infineon Technologies AG	Producer	Inactive	-	-	-	-
Instituto de Telecomunicações	User	Inactive	-	-	-	-
Intel Corp.	Producer	Active	X	X	X	X
Keysight Technologies	User	Active	X	X	X	-
Luminous Computing	General Interest	Inactive	X	X	-	-
Marvell	Producer	Active	-	-	X	-
MathWorks (SiSoft)	User	Active	X	X	X	X
Maxim Integrated	Producer	Inactive	-	-	-	-
Micron Technology	Producer	Active	X	X	X	X
MST EMC Lab	User	Inactive	-	-	-	X
NXP	Producer	Inactive	-	-	-	-
SerDesDesign.com	User	Inactive	-	-	-	-
Siemens EDA (Mentor)	User	Active	X	X	X	X
Synopsys	User	Active	X	-	X	-
Teraspeed Labs	General Interest	Active	X	X	X	X
Xilinx	Producer	Inactive	-	-	-	-
ZTE Corp.	User	Inactive	-	-	-	-
Zuken	User	Active	X	X	-	X

Criteria for SAE member in good standing:

- Must attend two consecutive meetings to establish voting membership
- Membership dues current
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