

# Minutes of Compact Model Council Meeting

December 16, 2004 Face-to-Face Meeting in San Francisco

## Companies and Universities in Attendance:

UMC, ASU, AMD, Nassda, NTU-Singapore, Tiburon Design Automation, Cadence, Broadcom, UC-Berkeley, ST Microelectronics, Freescale, Synopsys, TI, STARC, Toshiba, NEC, Hiroshima University, TU-Braunschweg, Intel, Sandia National Laboratory, Silterra Malaysia, RFMD, ADI, Agere, TU-Delft, Renesas, Intersil, Philips

### 1. Membership Review (Joe Watts – IBM/Chair)

Joe reported there were 24 members in 2004 and announced Toshiba will become a member for 2005.

### 2. Treasurer's Report (Robert Lomenick – Intersil/Treasurer)

The council decided to direct its 2004 budget excess to the model support groups at UC-Berkeley (\$7K), UC-San Diego (\$5K), and TU-Delft (\$5K).

Robert reviewed the proposed 2005 budget based on 25 council members. More of the budget will be earmarked for meetings and travel. Also, funds will be directed to support the next generation MOSFET model in 2H05. BJT model support funds will be slightly increased, while BSIM3/BSIM4/BSIMSOI will be slightly decreased in anticipation of fewer expected model updates.

Joe addressed questions regarding GEIA overhead costs. He reported that such charges are typical of a standards organization and provide desirable legal assurances for the CMC.

### 3. Status of Implementations of Standard Models

Joe presented summaries sent in by CMC members Silvaco, Mentor, and Agilent.

Weidong Liu overviewed Synopsys' status.

Pei Yao overviewed Cadence's standard model support status. She also reviewed details of HiCUM implementation in Spectre. See presentation slides for details. She highlighted that lack of complete equation derivatives in the standard HiCUM model code have lead to convergence problems and are likely leading to inconsistencies between simulators.

Action Item:

Joe Watts will send a request to Michael Schroter to address concerns from Cadence about missing HiCUM code, e.g., derivatives.

Keith Green (TI) reported support status summaries for Synopsys, Cadence, and Silvaco are linked to CMC homepage.

Action Item:

Keith Green will ask Mentor and Agilent for web links to their status of standard model support. He will add those to the CMC web site.

#### 4. Bipolar Model Support

HICUM (presentation slides from Michael Schroter - UCSD presented by Joe Watts):

See presentation for details on model support and Michael Schroter's comments regarding implementation quality.

Mextram:

Joachim Burghartz (TU-Delft) overviewed the Mextram Users Group's (MUG) support web site. (There is a link to this from the CMC's BJT standardization web page.) He also reported some of the plans for Mextram improvements including the addition of a temperature dependent thermal resistance and noise due to avalanche current; these will be available mid-December 2004 in version 504.5.0 (simkit 1.4). Code will be available in C and Verilog-a. Also, models for noise of thick IFO transistors and base-emitter Zener breakdown will be implemented and reviewed at the 1Q05 CMC meeting. See presentation for additional details.

Paul Humphries (ADI) reviewed status of CMC member's Mextram "wish list" assembled by Slobodan Mijalkovic (TU-Delft). See presentation slides for details.

Discussion focused on the need for developers to provide example model cards and to aid the testing of model implementations.

Action Item:

Robert Lomenick will set up a subcommittee to define an initial set of model tests to be provided by model developers with each new release. He will call a kick-off meeting in 2005.

#### 5. Resistor Model Subcommittee Update (Colin McAndrew – Freescale)

Colin reviewed the subcommittee's comparisons made between the Agere, tanh, and ADI two-terminal resistor models. Both diffused and poly resistors were used in this work. The subcommittee concluded that the Agere model provided the best solution considering overall accuracy and mathematical behavior across  $V_D=0V$ . See presentations slides for details.

Colin is working on updates to the Verilog-a codes for the Agere R2 model and the R3 model. These will be circulated to all CMC members for evaluation. At the 1Q05 meeting there should be a final decision made on standardizing these models. There will be two versions of the R2 model: with and without self-heating. R3 will have self-heating. Colin will provide a test suite with the model code. These will be posted on the CMC website.

Action Item:

Colin McAndrew will circulate the Verilog-a codes and test suites for the R2 and R3 models to all CMC members for evaluation. Members are asked to complete their testing in time to make a decision about model standardization at the 1Q05 meeting.

6. Proximity Effect Modeling Subcommittee Update (Paul Humphries – ADI)

Paul reviewed a summary of the Dec. 15 subcommittee meeting. That meeting focused on well proximity effect modeling. There was also discussion on how to strategically define a framework for handling layout related effects, i.e., how to partition calculations between LPE tools and SPICE models. This could include defining a standard set geometry “averaging” algorithms (moments) to compute effective dimensions used to be on the model instance statements. See presentation slides for details.

Action Item:

Joe Watts will draft a proposal for a standard set of layout feature moments and circulate it to the Proximity Effect Modeling subcommittee. Paul Humphries will call a teleconference of the subcommittee to review it.

7. Verilog-a Update (Colin McAndrew - Freescale)

Colin reported that LRM2.2 was submitted to the Accelera Board for vote and it was accepted. This version has special extensions for compact modeling. See presentation for details. Now that the language has been accepted the commercial Verilog-a compilers need to be updated.

Action Item:

Keith Green will put a links to the BMAS and the designers guide websites from the CMC website to help direct members to educational information on Verilog-a.

8. Face-to-Face CMC Meetings for 2005 (Joe Watts)

1Q05: March 10-11 in Dallas.

This meeting will include next generation MOSFET model evaluation phase-2 reports; BJT model support group representatives are also asked to attend.

2Q05: June 30-July 1 in Raleigh (after SRC reviews)

This meeting will include next generation MOSFET model evaluation phase-3 reports.

3Q05: October 13 in Santa Barbara (after BCTM)

4Q05: December 15 Washington, DC (after IEDM)

9. BSIM3/BSIM4/BSIMSOI Updates (Jane Xi – UCB & Keith Green - TI)

Jane Xi overviewed numerous update requests for BSIM3, BSIM4, and BSIMSOI. Some of these have been made to UCB-SPICE model code and tested by member companies. See presentation for details.

Keith Green (TI) reviewed a proposal to improve the NOIMOD=1 thermal noise model in BSIM3. The council agreed to include this on UCB's task list. Keith also showed preliminary testing results of the Rsub model in BSIM4.5.0.

Peter Lee (Renesas) presented a proposal to improve the VBS dependence of the Igate model of BSIM4. It was noted this would not be backward compatible, but could be done via the IGCMOD flag. The council agreed to include this on UCB's task list.

Herve Jaoven (ST) reported erroneous behavior of the BSIM4 AC NQS model. The council agreed to put this on UCB's task list as a study item. Herve also requested self-heating be added to BSIM4, however the council maintained its prior decision not to include this on UCB's task list. Harve requested several updates to BSIMSOI that were the same as those presented by Jane Xi. These were added to UCB's task list.

Action Item:

The UCB BSIM team will assemble a list of all model change requests/studies, propose a priority list to CMC members via email, and close on consensus ASAP.

Action Item:

Jane Xi will request Infineon test these new BSIM4.5.0 features they had requested:

- a. New instance parameters XGW and NGCON for the gate resistance model
- b. Additional temperature model equations and parameters (TVOFF and TVFBSDOFF)

10. Next Generation MOSFET Process (Joe Watts)

Joe reviewed the CMC process for evaluation and selection of the next generation MOSFET model standard. See meeting overview slides for details.

## 11. Next Generation MOSFET Model Updates (Developers and Sponsor Teams)

### BSIM5:

Judy An (AMD) reported model parameter extraction for the IBM 90nm CMOS data has begun at AMD. Feedback to UCB produced model updates. IBM and TI have been working on simulator implementations. There will be a new release of BSIM5 in Feb. 2005.

### EKV:

No representation at this meeting.

### HiSIM:

Mitiko Miura-Mattausch (Hiroshima University) reported HiSIM2 was provided to Silvaco in September and that Toshiba will be an additional sponsor. Her group has finished rough extraction for both n- and p-channel MOSFETs of the IBM 90nm data, and UMC and Infineon have joined recently to assist. Required improvements of HiSIM, if necessary, will be done and the code fixed will be finished in the beginning of January.

### PSP:

Dick Khassen (Philips) reported on the status of PSP development: the non-scalable level of the model is ready and the fully-scalable (global) version of the model is under construction. He showed some example model fits to the IBM 90nm CMOS data. Also, the junction diode model is finished and will be included in PSP. There are plans to add the BSIM4 stress model and SP spline-collocation NQS method. He reports that they are on track to meet the March deadline for phase II. See presentation for details.

### Action Item:

All are asked to send Colin McAndrew comments on IBM 90nm CMOS C-V data by the end of next week. Colin will sort through these and send a summary to Joe Watts by Dec. 25. Joe will call a teleconference in January to report on follow up. A similar action will follow for the s-parameter data.

## 12. Membership Matters (All)

It was agreed to increase UCB's portion of the proposed 2005 budget in light of the amount of BSIM work requested. Robert Lomenick will make these adjustments, which will include addition of the dues from RFMD, a company Robert announced had decided to join the CMC after attending this meeting as a guest.

The council developed its goals for 2005. See presentation slide for details.

### 13. Next Meeting Planning (Joe Watts)

1Q05: March 10-11 in Dallas

This meeting will include next generation MOSFET model evaluation phase-2 reports and planning for phase-3; BJT model support group representatives are also asked to attend.

Meeting Adjourned.

This meeting was conducted in accordance with the EIA Legal Guides and EIA Manual of Organization and Procedure.