

May 18, 2016

# **needs.nanohub.org**


## **The NEEDS online gateway**

Berkeley, MIT, Purdue, Stanford

Xufeng Wang  
Purdue University



# NEEDS.nanohub.org

 **NEEDS** NANO-ENGINEERED ELECTRONIC  
DEVICE SIMULATION NODE

NEEDS HOME ABOUT US RESOURCES CONTACT US NEEDS TEAM

## Nano-Engineered Electronic Device Simulation Node


NEEDS has a vision for a new era of electronics that couples the power of billion-transistor CMOS technology with the new capabilities of emerging nano-devices and a charter to create high-quality models and a complete development environment that enables a community of compact model developers.

NEEDS Team: Purdue, MIT, U.C. Berkeley, and Stanford.

Join Prof. Ashraf Alam for a free on-line short course: [Principles of Electronic Bio Sensors \(edx\)](#) beginning April 12, 2016, beginning January 2016.


NEWEST COMPACT MODEL RELEASE: Physics-Based Compact Model for Dual-Gate Bilayer Graphene FETs. [See Compact Models Page](#)

NEEDS announces the public BETA testing of VALint, an automatic Verilog-A code quality checker.



COMPACT MODELS


SPICE-compatible Verilog-A format supporting resources



COMPACT MODELS: TOOLS

Tools for developers including MAPP & VALint.


**NEW** VALint now in open BETA



COMPACT MODELS: RESOURCES FOR DEVELOPERS

Seminars and tutorials for developing and publishing compact models


**NEW** Publish your compact model in NEEDS



NANOSCIENCE TO SYSTEMS

Physically-detailed simulations system level tools


**NEW** Stanford script-based toolkit for system analysis



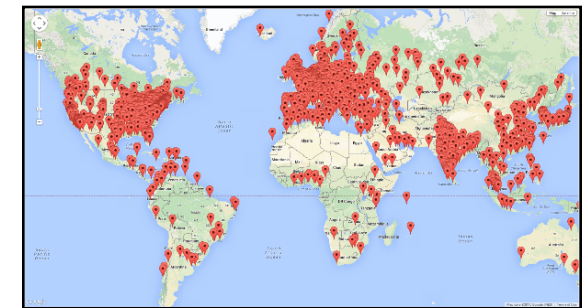
NANOSCIENCE: SEMINARS, COURSES, ETC.

NEEDS Seminars, workshops, nanoHUB-U and more

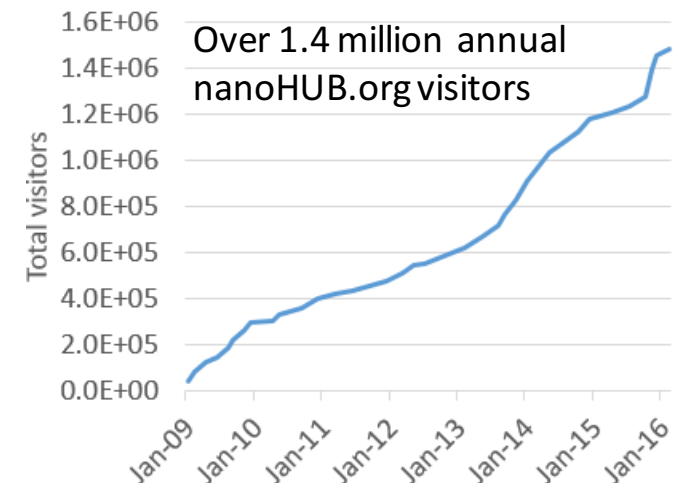
**NEW** Seminar series on devices for 5 nm technology

 NEEDS is a resource for nanoelectronics supported by the [National Science Foundation](#) and by the [Semiconductor Research Corporation](#).

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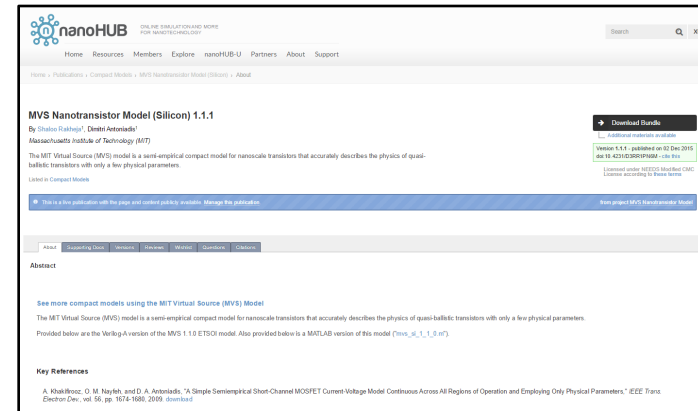
NEEDS > 35,000 users



Leveraging nanoHUB

# Publishing compact model with NEEDS

## Individual compact model page



Description	Content
Title	Source code
Version	Circuit simulation benchmark
Synopsis	Parameter sets/extractor
Abstract	Manual
References	Other files
NEEDS Modified CMC License	
Authors	
Tags	

## NEEDS list of compact models

Name	Created	Latest revision	From
<a href="#">A Verilog-A Compact Model for Negative Capacitance FET</a>	2015-11-29	2015-11-29	Purdue University
<a href="#">The NC-FET compact model is a semi-physical verilog-A model of the negative capacitance transistor. We developed this self-consistent model with SSIM/MVS and Landau theory.</a>			
<a href="#">Ambipolar Virtual Source Compact Model for Graphene FETs</a>	2014-10-22	2014-10-22	MIT
<a href="#">This is a compact physics-based ambipolar-virtual-source (AVS) model that describes carrier transport in both unipolar and ambipolar regimes in quasi-ballistic graphene field-effect transistors (GFETs).</a>			
<a href="#">Berkeley VCSEL Compact Model</a>	2015-5-28	2015-5-28	UC Berkeley
<a href="#">The U.C. Berkeley Vertical Cavity Surface Emitting Laser (VCSEL) Compact Model provides a circuit simulator compatible Verilog A model of VCSEL lasers, primarily for use in designing direct-modulation driver circuits for optical interconnects.</a>			
<a href="#">CCAM Compact Carbon Nanotube Field-Effect Transistor Model</a>	2015-6-15	2015-10-6	Technische Universität Dresden, UCSD
<a href="#">CCAM is a semi-physical carbon nanotube field-effect transistor model applicable for digital, analog and high frequency applications.</a>			
<a href="#">Compact model for Perpendicular Magnetic Anisotropy Magnetic Tunnel Junction</a>	2015-11-09	2015-11-09	Institut Mines-Télécom, et al.
<a href="#">This STT PMA MTJ model integrates the physical models of static, dynamic behaviors and reliability issues, which can be used to perform more accurate and complex reliability analysis of complex hybrid circuits before fabrication.</a>			
<a href="#">FET pH Sensor Model</a>	2014-11-3	2014-11-3	Purdue
<a href="#">The FET pH sensor model is a surface potential compact model for FET based pH sensors that accurately describes the physics of electrolyte and surface charges that respond to pH.</a>			
<a href="#">III-V Tunnel FET Model</a>	2014-10-22	2015-4-20	Penn State University
<a href="#">The III-V Tunnel FET Model is a look-up table based model, where the device current and capacitance characteristics are obtained from calibrated TCAD Sentaurus simulation.</a>			
<a href="#">GCM Model</a>	2014-10-22	2015-1-19	Carnegie


# Publishing compact model with NEEDS

## Version control and access

Versions				
Version	Released	DOI Handle	Status	
1.1.1	Dec 02, 2015	10.4231/D3RR1PN6M	published	<a href="#">view version »</a>
1.1.0	Aug 01, 2015	10.4231/D3QZ22J40	published	<a href="#">view version »</a>
1.0.1	Oct 23, 2014	10.4231/D3H12V82S	published	<a href="#">view version »</a>

## Wishlist


**Wishlist**

 Add a new wish


Recent Wishes ([view all 1](#))

## Questions

**Recent Questions**

 Ask a question

Recent Questions (1)

 [Extracting parameters from MVS model](#)

## Citations

Citations [Non-affiliated \(0\)](#) | [Affiliated \(1\)](#)


Affiliated authors

[S. Eryilmaz; Duygu Kuzum; Shimeng Yu; H.-S.P. Wong \(2015\),  
Volatile-Memory Based Neuromorphic Architectures," \*Electro\*](#)

## Update tracking

**Double-Clamped Silicon NEMS Resonators Model**

This model is built for a silicon-based, double-clamped (soul capacitive modulation with the two gates, piezoresistive mo

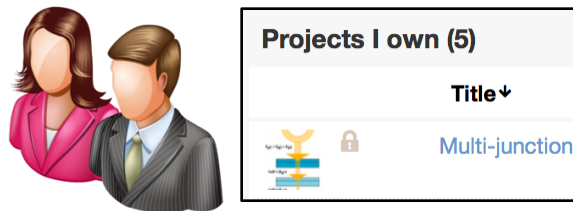
 Subscribe to this compact model update/news

## Upcoming features:

- Bug report
- Detailed user usage

# Compact model publication platform

1. Start by initiating a project.



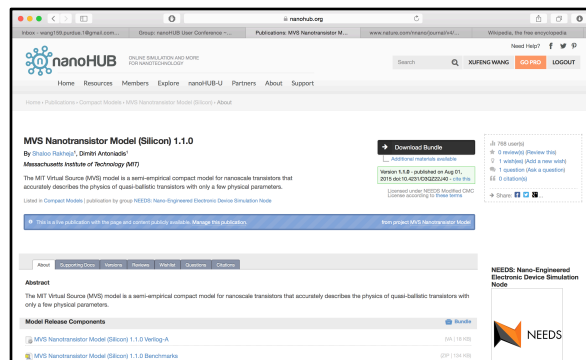
2. Build a CM publication



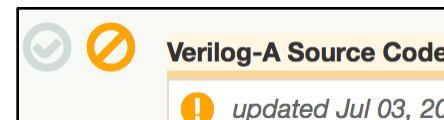
Automatic background VALint check and onscreen feedback to the author

✓Description ✓Content ✓Authors ✓Extras ✓Tags ✓License ✓Notes

4. Publish on nanoHUB



3. Review by NEEDS curator



approve

# VALint

## CMC Recommended Practices

C. McAndrew, et al., "Best Practices for Compact Modeling in Verilog-A", Journal of Electron Device Society (2015)

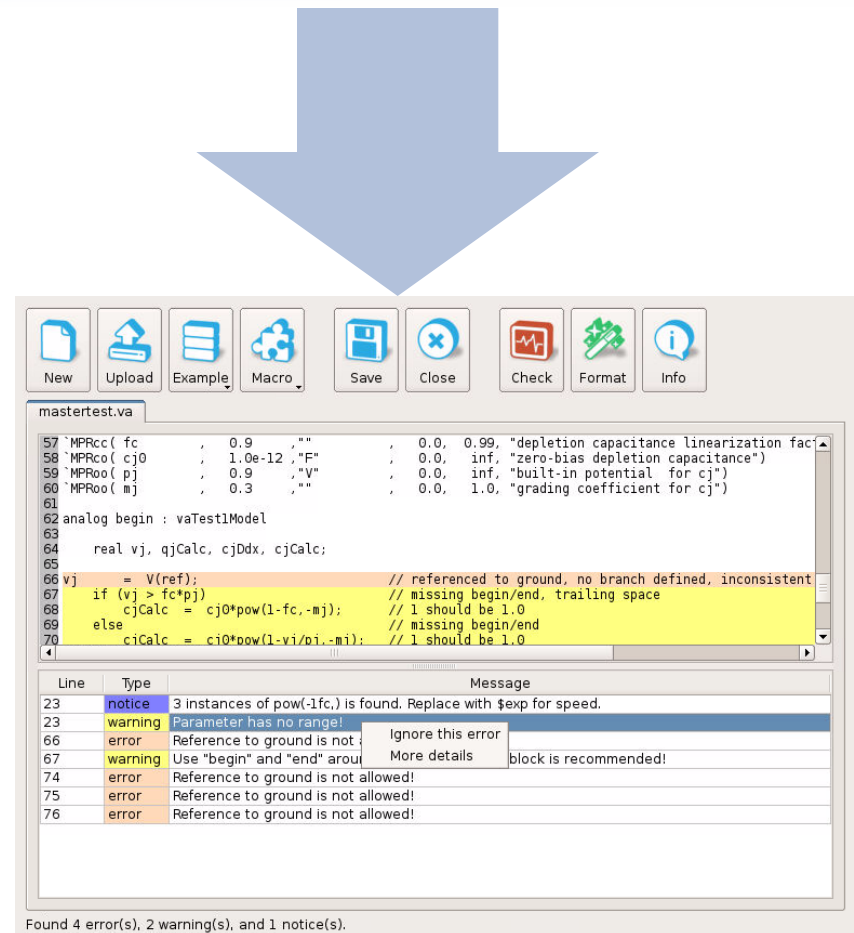
NEEDS  
license  
checking

compiling errors  
checking

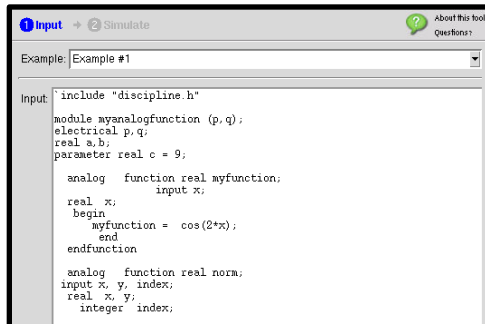
Check

Edit

Pretty  
printing



# VALint development



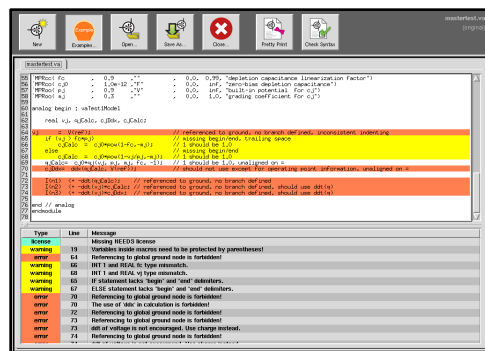
```
Example: Example #1

Input:
#include "discipline.h"

module myanalogfunction (p,q);
  electrical p,q;
  real a,b;
  parameter real c = 9;

  analog function real myfunction;
    input x;
    begin
      myfunction = cos(2*x);
    end
  endfunction

  analog function real norm;
    input x,y, index;
    real x,y;
    integer index;
  endfunction
endmodule
```



Type	Line	Message
Warning	19	Missing IEEE801 license
Warning	64	Variable scope access need to be protected by parentheses
Error	64	Referencing to global ground node is forbidden
Warning	66	BT1 and BT2 is type mismatch
Warning	68	BT1 and BT2 is type mismatch
Warning	68	If statement lacks 'begin' and 'end' delimiters
Warning	67	ELSE statement lacks 'begin' and 'end' delimiters
Error	70	Referencing to global ground node is forbidden
Error	70	The use of 'sin' in calculation is forbidden
Error	72	Referencing to global ground node is forbidden
Error	73	Referencing to global ground node is forbidden
Error	73	del of voltage is not encouraged, this change is not
Error	74	Referencing to global ground node is forbidden

## Prototype: VAChecker0.1 (late 2014)

- Based on ADMS
- Check for single Verilog-A file only.
- Simple text based output

## VALint BETA0.2 (since Sep. 1<sup>st</sup>, 2015)

- Support models with multiple Verilog-A files.
- Text editor interface with VALint integrated.
- To be an integrated part of NEEDS publication curation.

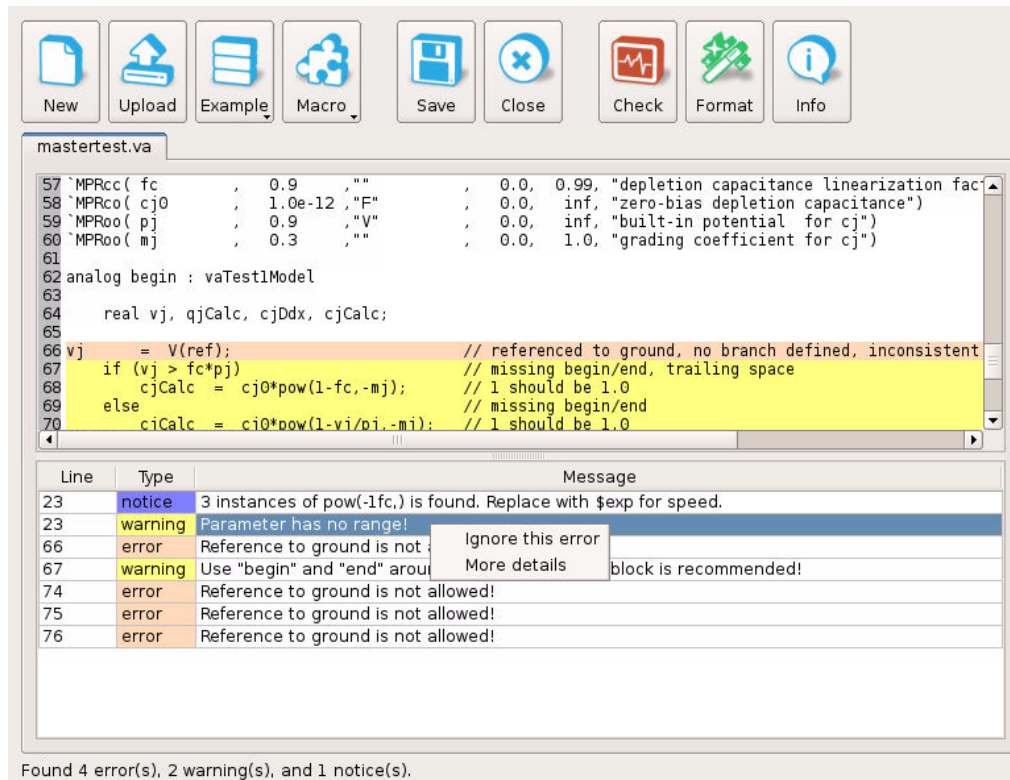
## Feedback:

- Unable to upload proprietary compact models to nanoHUB
- Difficult to install because ADMS depend on legacy software
- Many missing rules/recommended practices that are not supported by ADMS



VALint BETA0.3  
(since April 18<sup>th</sup>, 2016)

# VALint development



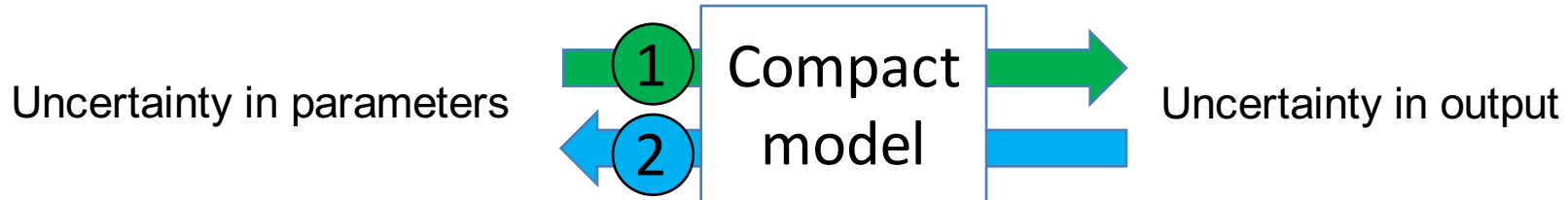
VALint BETA 0.3 (since April 18<sup>th</sup>, 2016)

<https://nanohub.org/tools/vachecker>

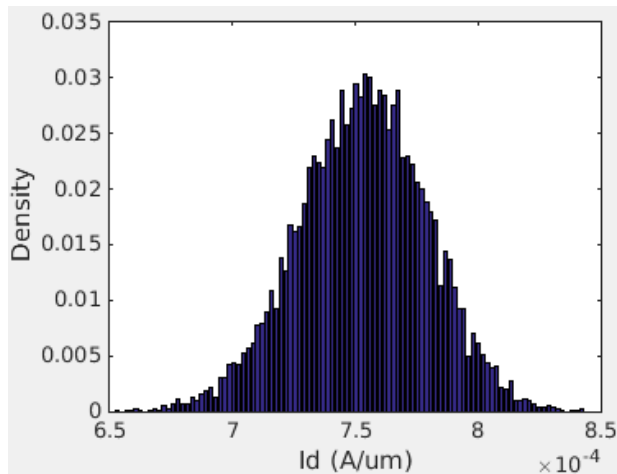
- Complete rewrite based on
  - VAPP engine developed by Berkeley team
  - Qt based interface
- Octave compatible.
- Addressed many issues reported in version 0.2



# Uncertainty quantification with compact models

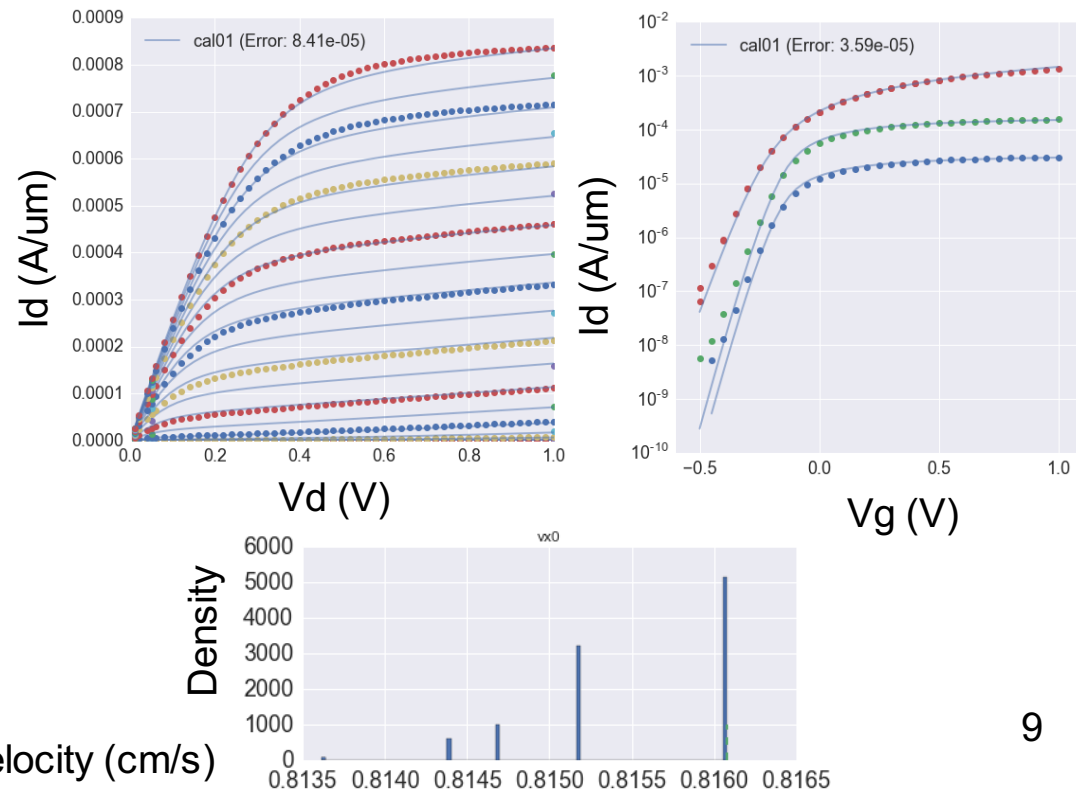


## 1 Uncertainty propagation



Adapting UQ developed by PRISM program at Purdue for compact models

## 2 Parameter fitting with uncertainties



# Summary

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- VALint
  - Industrial strength models
  - Cross platform installation scripts
- Model exerciser
  - MAPP
- Uncertainty quantification
- Model deployment and curation