

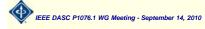
Working Group Meeting September 14, 2010

Agenda

- Call to order
- ◆ Approval of agenda
- **♦** Administrative issues
 - Minutes of last meeting
 - Publicity
 - Review of IEEE patent policy
 - 1076.1.1 and 1076.1 updates
- ♦ Project overview and status
- Next meeting
- **♦ AOB**
- ◆ Adjourn

Administrative Issues 1

- ♦ Approval of minutes of WG meeting held August 10, 2010
- **♦ Publicity**
 - Publication in Simulation News in Europe
 - Missed deadline August 2010
 - · Looking for next available slot
 - DASC column in IEEE Design and Test magazine expected to start late 2010 or early 2011
 - · WG chairs will be asked to contribute
- ◆ Review of IEEE patent policy
 - http://standards.ieee.org/board/pat/pat-slideset.pdf



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Administrative Issues 2: Standard Revisions

- ♦ 1076.1.1 revision
 - Before ballot, LRM must go through Mandatory Editorial Coordination
 - · May require some updates to LRM
 - Plan is to get this done before the end of this month
- **◆ 1076.1 revision**
 - 1076.1 PAR draft
 - · PAR held up by questions regarding copyrights
 - Do we have to get Copyright permission from organizations that gave it to 1076?
 - · Issue is being debated between IEEE and DASC

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Revision of IEEE Std 1076.1

◆ Scope

- Synchronize with IEEE Std 1076-2008. This will bring, among other features:
 - VHPI-AMS
 - · IP protection, encryption
 - Genericity, i.e. the ability to write a model that is independent of the energy domain (e.g. a generic resistance model)
- Integration of IEEE Std 1076.1.1 Packages for Multiple Energy Domain Support
- Selected language enhancements prioritized by survey among users and other interested parties
 - · Frequency domain modeling
 - Package supporting table-driven modeling
 - Package supporting vector/matrix operations
 - Other projects not yet started
 - Mixed Netlists
 - PDE Support
 - Uniform use of SPICE Models

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VHPI-AMS: Overview

- ◆ The VHDL Procedural Interface is a application programming interface to VHDL tools.
- VHPI allows an external application to access information about a VHDL model during analysis, elaboration and execution.
- This enables:
 - · the creation of tools such as debuggers or profilers for VHDL models
 - support foreign models, which are models written in part (foreign subprograms) or in their entirety using a standard programming language like C.

VHPI-AMS: Scope

- ◆ The VHPI-AMS is an extension of the VHPI defined in IEEE 1076-2008.
 - Extension will include modification/addition to machine readable package.
- ◆ The VHPI-AMS will not extend the digital information model to IEEE 1076-2008.
- ◆ Derived requirements that will be supported:
 - Standard utilities provided in VHPI extended for VHDL-AMS objects. Examples include printing, comparing values, error handling.
 - Static design data provided in VHPI extended for VHDL-AMS objects.
 - Object access to query new objects such as free quantities and through/across quantities on branches.
 - Extend VHPI foreign interface to support VHDL-AMS objects.
 - Simulation interaction and control for stop/start
 - Extension of VHPI Tool Execution specification (Section 20 in IEEE 1076-2008) to consider the analog/mixed-signal simulation cycle



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VHPI-AMS: Scope Restrictions

- ◆ Derived requirements that will be considered
 - Modifications of the value of a quantity values (setting values but not forcing) may be supported in this version. This is similar to Section 22.5 Updating object values in IEEE 1076-2008.
- Derived requirements that will not be supported:
 - Modification of generics on elaborated design (which may cause reelaboration) during restart. This could be done by a tool in an implementation specific fashion and does not require support in VHPI.
 - Modification of topology during simulation (forcing values, shorting and opening nodes) and adding/deleting elements.
 - No special semantics for meta simulation (monte carlo, worst case, etc...) will be added. These may still be implementable with the core VHPI and above extensions.





VHPI-AMS: Resources

Resources

- M. Vlach: Programming Interface Requirements for an AMS Simulator, ISCAS'2004
 - This paper provides an overview of requirements for VHDL-AMS VHPI.



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VHPI-AMS: Status

♦ Status

- Review of Verilog-AMS VPI extensions
- · Initial analysis of extensions to information model
- Investigating possible donation

Next Steps

- Review existing VHPI-AMS functions and identify modifications or additions
- Investigating technical feasibility of writing to quantities and related use cases
- Define detailed requirements based on these investigations

1076.1.1 Integration: Overview

Purpose

- IEEE Std 1076.1.1 is a companion to IEEE Std 1076.1 that provides a collection of standard definitions to support the creation of models in multiple energy domains: electrical, translational, rotational, thermal, and others.
- Just as IEEE 1076-2008 integrated the previously separate standards defining the packages std_logic_1164, math_real, math_complex, numeric_bit, numeric_std, the plan is to make the 8 packages defined by IEEE Std 1076.1.1 an integral part of IEEE Std 1076.1.
- Existing 1076.1.1 will then be discontinued.



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1076.1.1 Integration: Scope

- ◆ Integrate 1076.1.1 text into new 1076.1 LRM
- ◆ Add 1076.1 packages to machine readable packages (library IEEE)
 - FUNDAMENTAL_CONSTANTS, MATERIAL_CONSTANTS
 - ENERGY_SYSTEMS, ELECTRICAL_SYSTEMS, MECHANICAL_SYSTEMS, RADIANT_SYSTEMS, THERMAL_SYSTEMS, FLUIDIC_SYSTEMS
- ◆ Review all descriptions/definitions against IEEE SI 10-2002 and IEEE PSI-10/D1.May 2010.
- Investigate adding support for dimensions and consistency of dimensions on connections. This could provide support for external dimensional consistency but not part of standard.
 - A dimension refers to the physical value being modeled and not the unit used to represent it. Example of length being a dimension but foot or meter being a unit.





1076.1.1 Integration: Status

Status

- Waiting on new LRM creation to integrate existing 1076.1.1 text and packages and to do the SI review.
- Investigated early white papers on dimensional analysis for 1076.1.1.
- Reviewed Modelica to understand its use of units and dimensions.
- Defined Scope and Rational for Dimension support.

Next Steps

- Complete existing 1076.1.1 integration when new LRM format is reworked.
- Define detailed requirements for Dimension support.



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Frequency Domain Modeling: Overview

♦ Purpose

- Allow a user to write a model whose frequency domain behavior depends on the simulation frequency
- · Scope is support for small-signal behavior
 - No intent to support harmonic balance or other algorithms that are sometimes called large signal AC.

Restrictions

 A large signal model for DC and time domain must still be defined, as there is no closed form transformation of a frequency domain model into time domain.

Resources

- J. Haase, E. Hessel, H.-T. Mammen: <u>Proposal to Extend Frequency</u> Domain Analysis in VHDL-AMS, FDL'09
 - This paper provides some of the mathematical background.
 Emphasis is on frequency domain behavior described by a table.

Frequency Domain Modeling: Status

♦ Status

- · Properties/limitations small-signal algorithms understood
 - · Mathematical background
 - Implications of changing equations for frequency domain
 - · Algorithmic changes in an implementation are minor
- Changes to LRM minor
- Guidelines for writing models with frequency-dependent behavior understood
 - How to write a model to get the expected behavior
 - · Modeling style is imposed by small-signal algorithms
- Findings documented mostly in meeting slides

Next steps

- Write-up of all aspects of frequency domain modeling support
- Expose to WG for approval



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Table Driven Modeling

Subcommittee members

- Ernst Christen
- · Joachim Haase
- Arpad Muranyi
- Alain Vachoux

◆ Purpose

- Measured and simulated data are gathered into tables.
- · Tables include, possibly multidimensional, data points.
- They are indexed by a number of independent variables and all necessary information to properly interpret and use these data points.
- · Table using may be mandatory in the following cases:
 - · No analytical model exists
 - · To achieve faster simulation

♦ Scope

- Definition of VHDL-AMS data structures and functions that support this functionality
- Development of VHDL-AMS package(s) that will serve as reference implementation
- The development of an optimized implementation is out of the scope.

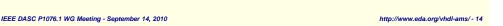


Table Driven Modeling: Plan of Activities

♦ Schedule

- Phase 1: Establish the "Requirements for Table Look-Up Modeling with VHDL-AMS"
- · Phase 2: Discussion of VHDL(-AMS) implementation aspects
- Phase 3: Definition of VHDL(-AMS) function and package headers
- Phase 4: Reference implementation of functions
- Phase 5: Test of the reference implementation
- Phase 6: Finishing of documentation proposal for the standard revision

◆ Timeline

- Begin in June 2010
- Expected end in summer 2011

State of affairs

- · Phase 1 finished
- Requirement document to be submitted to the WG for discussion and vote by the end of the week



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Table Driven Modeling: Requirements (1)

♦ Description of functions that shall be supported

- Multidimensional real-valued functions $f: \mathbb{R}^n \to \mathbb{R}, y = f(x_1, x_2, ..., x_n)$
 - n ≤ 4 shall be supported.
 - n > 4 should be supported.
 - · Data points are given on a grid.
 - · It is not required that the grid is fully populated.
 - · It is not required that the data points are ordered.
- One-dimensional complex-valued functions $f: R \to C, y = f(x)$

Interpolation of given data points

- Interpolation methods: closest data point, piecewise constant, piecewise linear, quadratic spline, cubic spline
- · Extrapolation methods:
 - · same (as interpolation), constant, linear, periodic
 - · none (failure if data point outside table is accessed)

Table Driven Modeling: Requirements (2)

Table Data Sources

- Storage of data points using arrays shall be supported.
- Storage of data points using files shall be supported.
- The following file formats should/may be supported
 - Verilog-AMS
 - Touchstone
 - IBIS
 - Excel CSV



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Vector/Matrix Support: Plan

- Call for participation to form the subcommittee
 - 4 5 people joined
- ◆ Develop requirements (work-in-progress)
 - Cooperated with other related subcommittees to define the basic requirements
 - Develop detailed requirements based on the basic requirements (will ready in September-October)
- Present detailed requirements to working group for approval (October 2010)
- Develop Technical solution from detailed requirements (3-4 months)
- ◆ Present the solution to working group for approval (Jan-Feb 2011)
- Review LRM changes implemented from LCS for accuracy and clarity (2 months)
- ◆ Completion of work (May 2011)

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Vector/Matrix Support: Requirements

 Matrix/vector operations are defined as reference in standard package [required]

 Implementation should produce the same result as definition but does not need to exactly follow the definition.

♦ Matrix definition

 Real and complex type [required] Non-floating data type [required] Block matrix notation [required]



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Vector/Matrix Support: Requirements (2)

♦ Matrix/vector construction

· Identity matrix [required] Zero matrix [required]

♦ Matrix/vector slicing

[required]

- v(i:j) -- a vector of ith to jth element in vector v
- A(:, j) -- a vector of jth column in matrix A
- A(r, i:j) -- a vector of ith to jth element in rth row in matrix A

Supported mathematical operations:

• +, -, *, /, ^ for matrix element [required] · Dot product for matrix/vector [required]

• Transpose, conjugate transpose (complex), complex conjugate (complex) for matrix/vector [required]

· Determinant for matrix/vector [required]

Vector/Matrix Support: Requirements (3)

 Matrix power [required] Matrix exponential [required] Norms (1, 2, infinite) for matrix/vector [required] Trace for matrix [recommended] Kronecker Product for matrix [recommended] Dimension check in all ops. [recommended] Inverse [optional]

♦ Annotation of matrix/vector

[recommended]

· Supply additional information such as matrix property (triangular, banded) or other user-defined property to be used along with the matrix.



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Vector/Matrix Support: Requirements (4)

- Matrix definition
 - Supports matrix of (real and complex) [required]
 - Supports matrix of (non-floating data type) [recommended]
 - Supports block matrix notation (matrix in matrix)
- ◆ Type checking for quantity vector/matrix [recommended]
- ♦ Matrix/vector operator definition in standard package [required]
 - Implementation should produce the same result as definition but not exactly follow it.





Next Meeting

◆ Meeting schedule

- Meeting schedule once per month, mostly web
- Always announced at www.eda.org/vhdl-ams
- Next meetings:
 Tuesday, October 12, 2010, 8am PDT
 Tuesday, November 9, 2010, 8am PDT (tentative)



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