Xilinx IBIS Model Quality Update

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Xilinx IBIS Model Quality Update

- Correlation to Spice models
  - Correlation to bench measurements
  - Virtex-5™ model IQS conformance
  - New activities
Xilinx IBIS Model Quality Update
Correlation to Spice models

• Improved s2ibis extraction procedure

Finer granularity yields smoother curves and better correlation.
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Correlation to Spice models

• Automation of correlation testing
  – do_sims.pl – Perl script that governs the process of fetching, patching, and running the standard I/O Spice models, for a given set of standards, in order to make automated “IBIS vs. Spice” comparison measurements.
    • do_patch – Bash shell script that does the actual patching of the Spice decks.
  – get_results.pl – Perl script that fetches the results of the Spice simulations run by do_sims.pl, and reformats them into *.CSV format for import into MSExcel.

Automation has saved much time and prevented many errors.
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Correlation to Spice models for *virtex5.ibs* v1.9

Histogram of Errors by Metric for Different Error Thresholds
63 tests performed. (21 standards w/ 3 PVT corners ea.)

<table>
<thead>
<tr>
<th>Waveform Metric</th>
<th># of Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>fall</td>
<td>10</td>
</tr>
<tr>
<td>rise</td>
<td>15</td>
</tr>
<tr>
<td>hi</td>
<td>30</td>
</tr>
<tr>
<td>lo</td>
<td>25</td>
</tr>
<tr>
<td>duty</td>
<td>20</td>
</tr>
</tbody>
</table>

Error Threshold:
- 5%
- 6%
- 7%
- 8%
- 9%
- 10%
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Correlation to Spice models for virtex5.ibs v2.6

Histogram of Errors by Metric for Different Error Thresholds
63 tests performed. (21 standards w/ 3 PVT corners ea.)

Showing improved correlation to Spice models. Questions?
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- Correlation to Spice models
- Correlation to bench measurements
- V5 model IQS conformance
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Correlation to bench measurements - Methodology

• IBIS-to-Spice:

  IBIS Value
  \[\downarrow\]
  \[\uparrow\]
  \[<\text{metric}>\]
  \[\rightarrow\]
  \[\rightarrow\]

  Spice Value

  Report the discrepancy.

• IBIS-to-Bench:

  IBIS “Window”
  \[\downarrow\]
  \[\rightarrow\]
  \[<\text{metric}>\]
  \[\rightarrow\]
  \[\rightarrow\]

  Bench Range

  \[\uparrow\]
  \[\uparrow\]
  \[\uparrow\]
  \[\uparrow\]
  \[\uparrow\]

  Check that bench range falls within IBIS window.

Two fundamentally different methodologies are used.
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Correlation to bench measurements - Results

With the exception of the large positive outliers, this histogram is ideal.
Negative LOW margins indicate that silicon is FASTER than the model.
Negative HIGH margins indicate that silicon is SLOWER than the model.
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Correlation to bench measurements - Results

Histogram of High Margins for Rise-time

Again, none of the offenders are high speed standards.
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Correlation to bench measurements - Results

Questions?
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• Correlation to Spice models
• Correlation to bench measurements
• V5 model IQS conformance
• New activities
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IQS conformance

• The new standard ("v1.1") defines 5 levels:
  – IQ0 - No checking at all.
  – IQ1 - Passes IBISCHK without errors or unexplained warnings.
  – IQ2 - IQ1 + data for basic simulation checked.
  – IQ3 - IQ2 + data for timing analysis checked
  – IQ4 - IQ3 + data for power analysis checked

• and 4 modifiers:
  – M - correlated against hardware measurements
  – S - correlated against Spice simulation
  – G - Has “golden” waveforms.
  – X - Has exceptions, commented in file.
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IQS conformance

• According to IQS v1.1ah, our current Virtex-5™ IBIS models file qualifies as IQ3SM:
  – IQ3) We pass all requirements, up to and including the new level 3 checks.
  – ‘S’) We have correlated against Spice.
  – ‘M’) We have correlated against bench measurements.
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IQS conformance

Questions?
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- Correlation to Spice models
- Correlation to bench measurements
- V5 model IQS conformance
- New activities
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New activities – *release report automation*

Xilinx IBIS models file release report for: *virtex5.ibs v2.6*

Produced by: /virtex5_ibis/gen_report.pl v1.6 (Rel_2008-07-10-01)
Produced on: Tue Sep 9 12:36:07 PDT 2008

**Contents:**

- IBIS Parser Results
- Spice Correlation Results
- Bench Correlation Results

**IBIS Parser Results:**

`IBISCHK4 V4.2.0`

Checking `virtex5.ibs` for IBIS 3.2 Compatibility...

Errors : 0
File Passed

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New activities – *release report automation*

**Spice Correlation Results:**

Produced by: `/V5_IBIS_Spice_Correlation/OUTPUTS_ONLY/SINGLE-ENDED/spice_tools/get_results.pl v1.2 (Rel.2008-07-10-01)`

The following effective schematic was used to perform the simulations that generate the results in this section:

![Schematic diagram](image)

The numbers in the following table give the error in the IBIS model predictions, relative to the Spice model predictions, for certain *features* or *metrics* of the test waveform.

Errors are normalized to the Spice prediction, and expressed as a percentage of that value. In cases where the low settling values were below 1 mV, no meaningful error calculations could be made. These cases are indicated by "(n/a)".

<table>
<thead>
<tr>
<th>Standard/Cornor</th>
<th>High Level</th>
<th>Low Level</th>
<th>Rise Time</th>
<th>Fall Time</th>
<th>Duty Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tt</td>
<td>+00.00%</td>
<td>+00.02%</td>
<td>-00.80%</td>
<td>+03.19%</td>
<td>+00.17%</td>
</tr>
<tr>
<td>ss</td>
<td>+00.00%</td>
<td>-00.00%</td>
<td>-05.97%</td>
<td><em>-13.60%</em></td>
<td>-00.04%</td>
</tr>
<tr>
<td>ff</td>
<td>+00.00%</td>
<td>+00.10%</td>
<td>-02.67%</td>
<td>+05.09%</td>
<td>+00.27%</td>
</tr>
</tbody>
</table>

*** Error reading data ***

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New activities – release report automation

Bench Correlation Results:

Produced by: /V5_IBIS_Bench_Correlation/OUTPUTS_ONLY/SINGLE-ENDED/spice_tools/get_results.pl v1.2
(Rev.2008-07-10-01)

The following effective schematics were used to perform the simulations that generate the results in this section:

IBIS-to-Bench Correlation Default Topology

Simulation models shown, with relevant standards identified.
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New activities – release report automation

The numbers in the following table give the min/max IBIS model predictions, and bench measurements, for 4 waveform metrics:

- High settling level
- Low settling level
- Rise-time
- Fall-time

Additionally, the margins between the IBIS model predictions and the bench measurements are also given.

A positive margin indicates that the IBIS model prediction successfully encompassed the bench measurements, while a negative margin indicates that the bench measurements fell outside the IBIS window.

Finally, where available in the bench data, the predictions of the IBIS model, when run in HyperLynx, are compared to those, when run in HSpice. This provides some check on how differently the IBIS models behave when interpreted by two different IBIS simulators (i.e. – HyperLynx and HSpice’s R element). The errors between the two are calculated as:

\[ \text{Error} = \frac{(\text{HyperLynx} - \text{HSpice})}{\text{HSpice}} \]

Note: voltages in Volts, and times in ns, throughout.

<table>
<thead>
<tr>
<th>Standard/Metric</th>
<th>Low Margin</th>
<th>IBIS Low</th>
<th>Bench Low</th>
<th>Bench High</th>
<th>IBIS High</th>
<th>High Margin</th>
<th>Low Error</th>
<th>High Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTL</td>
<td>(-0.039)</td>
<td>(+0.191)</td>
<td>(+0.152)</td>
<td>(+0.241)</td>
<td>(+0.314)</td>
<td>(+0.073)</td>
<td>(-22.0%)</td>
<td>(-7.3%)</td>
</tr>
<tr>
<td>Vol:</td>
<td>(-0.109)</td>
<td>(+0.147)</td>
<td>(+0.259)</td>
<td>(+0.202)</td>
<td>(+0.194)</td>
<td>(-0.009)</td>
<td>[n/a]</td>
<td>[n/a]</td>
</tr>
<tr>
<td>Voh:</td>
<td>No bench data available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trise:</td>
<td>(+0.139)</td>
<td>(+0.152)</td>
<td>(+0.351)</td>
<td>(+0.399)</td>
<td>(+0.246)</td>
<td>(-0.151)</td>
<td>[n/a]</td>
<td>[n/a]</td>
</tr>
<tr>
<td>Tfall:</td>
<td>(+0.139)</td>
<td>(+0.152)</td>
<td>(+0.351)</td>
<td>(+0.399)</td>
<td>(+0.246)</td>
<td>(-0.151)</td>
<td>[n/a]</td>
<td>[n/a]</td>
</tr>
</tbody>
</table>

*** Error reading data ***

Meaning of tabulated data is explained.

Per-standard data, with negative margins highlighted in red.

End of Report.
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New Activities

Questions?