SerDes Modeling:
IBIS-AMI Correlation

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SiSoft
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Agenda

- IBIS-AMI milestones
- IBIS-AMI simulation correlation
- SPICE-based correlation
- IBIS-AMI simulator correlation
- Dedicated SerDes tool correlation
- Closing Thoughts

IBIS-AMI Milestones

- Feb 2007 – IBIS-AMI BIRD development begins
- June 2007 – Draft BIRD approved for prototyping
- Aug 2007 – SiSoft toolkit released
- Sep 2007 – Cadence toolkit released
- Nov 2007 – BIRD 104.1 approved
- Feb 2008 – Interoperability documented
- Mar 2008 – Vendor IBIS-AMI models released
- May 2008 – BIRD 107.2 approved

IBIS-AMI Simulation Correlation

- What does “correlation” mean?
  - Nominally, reproducing time-domain waveform behavior
  - Ideally, reproducing Bit Error Rate (BER) & other metrics
- What types of simulations need to be correlated?
  - IBIS-AMI to SPICE-based analysis
  - IBIS-AMI to IBIS-AMI
  - IBIS-AMI to dedicated SerDes tools
- How is correlation measured?
  - Visually, with waveform overlay
  - Analytically, comparing dynamic and steady-state voltage matches

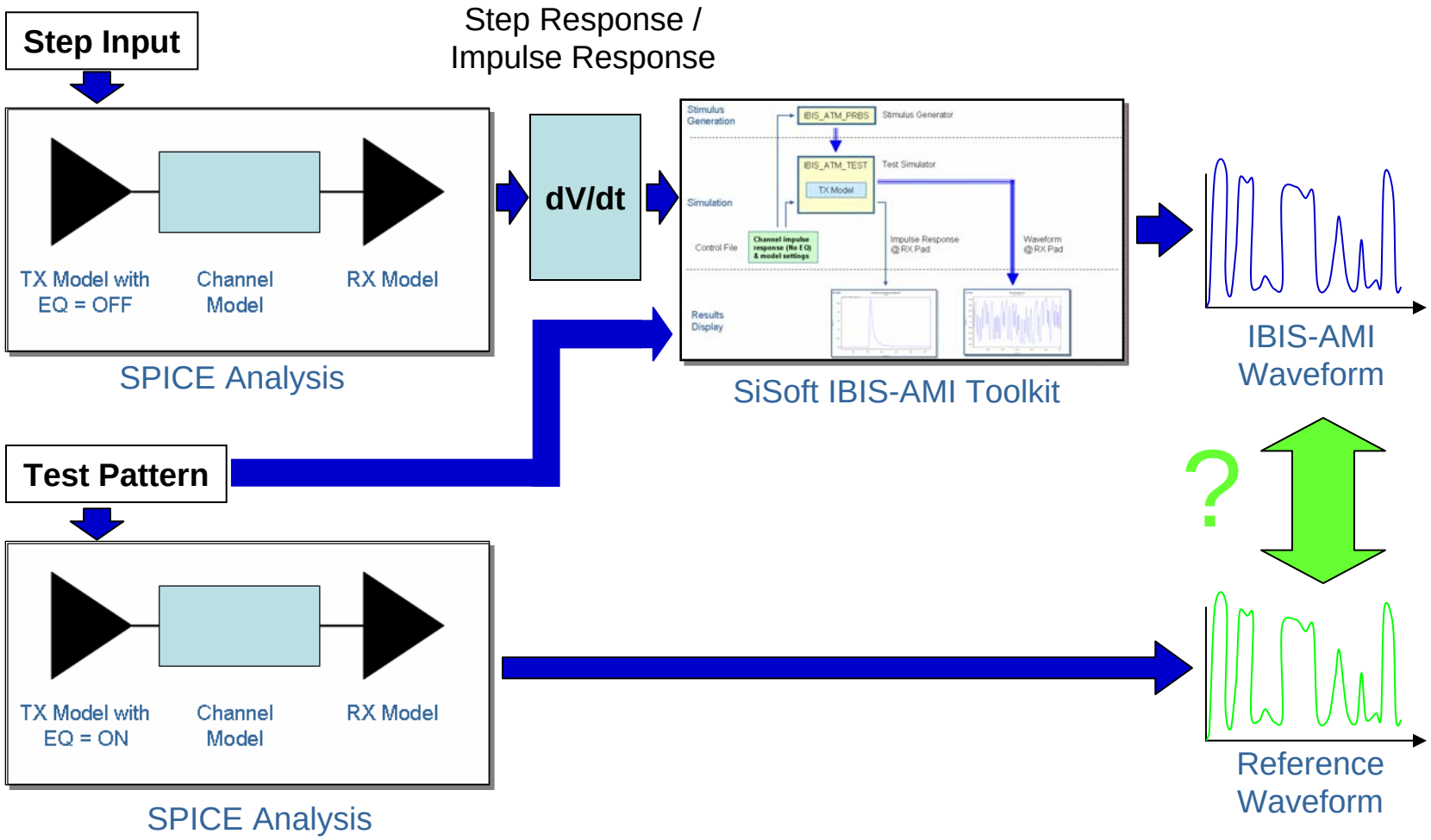
IBIS-AMI to SPICE-based Correlation

- Technologies with simple TX equalization and no / simple RX equalization
  - PCI Gen 1
  - PCI Gen 2
  - XAUI
  - SATA
- SPICE-based analysis of these technologies is common since SPICE TX equalization models are possible along with simulations of 1000's of bits
- These are ideal "crossover" applications for IBIS-AMI, since simulations using either method are possible

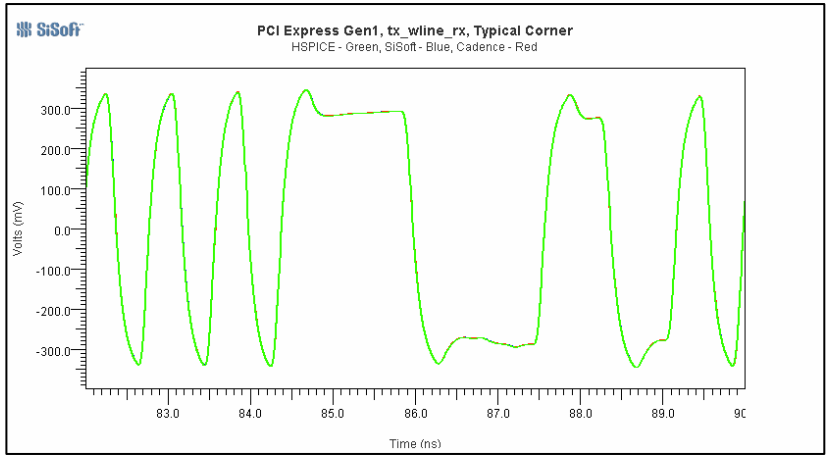
SPICE Correlation (Algorithmic Model)

- Algorithmic (communications) analysis requires the analog channel impulse response as an input
- The analog channel impulse response can be derived from either:
  - Analog simulation of the unequalized TX / channel / RX using a conventional analog IBIS model
  - Analog simulation of the unequalized TX / channel / RX using the SPICE transmitter and receiver model
  - We'll start with the latter, as it allows the simulation and correlation to be performed only using the published IBIS-AMI toolkit and SPICE

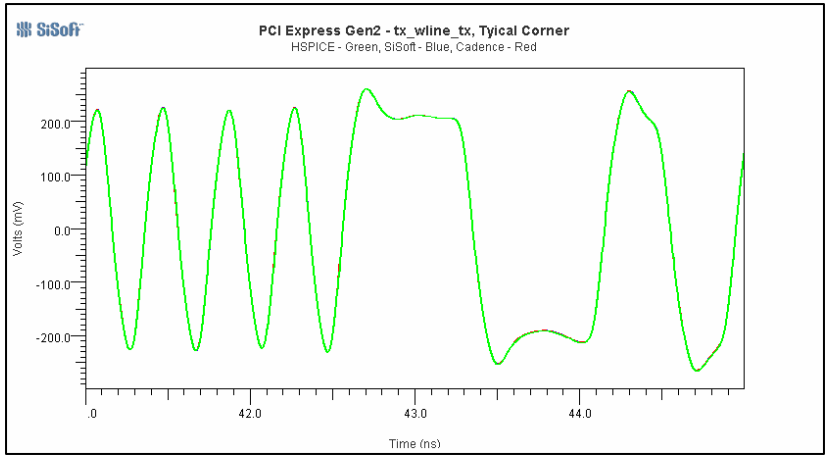
SPICE/Toolkit Correlation Process



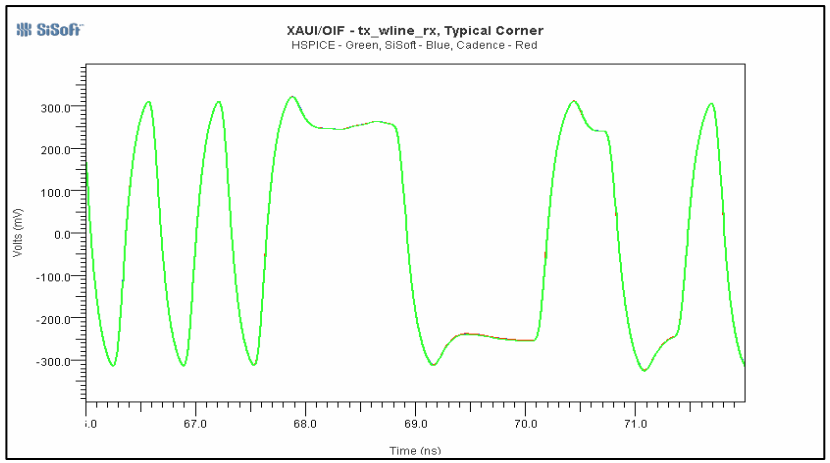
PCIe Gen 1 / Gen 2 / XAUI Results



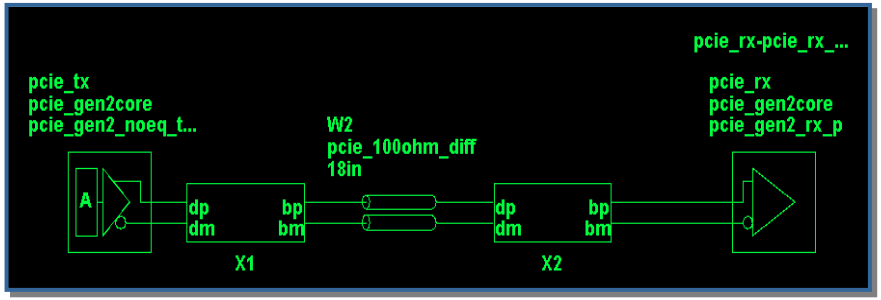
PCI Gen 1



PCI Gen 2



XAUI

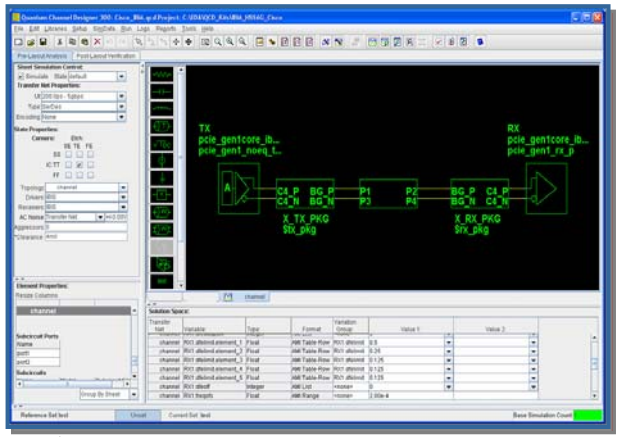


Green = SPICE, Blue = IBIS-AMI
Where waveform is green, simulations match

IBIS-AMI and SPICE models provided by IBM

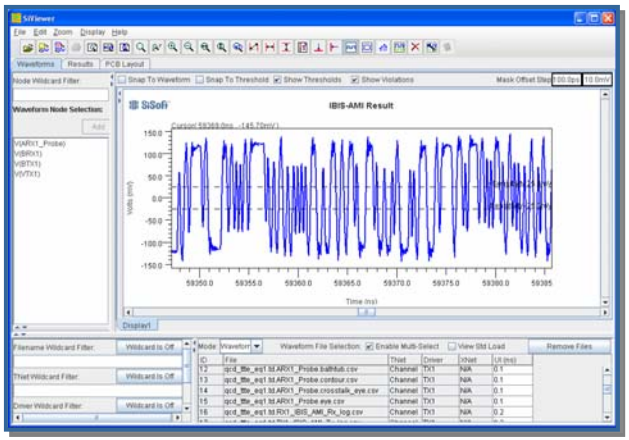
SPICE/EDA Tool Correlation Process

IBIS Analog, IBIS-AMI Models

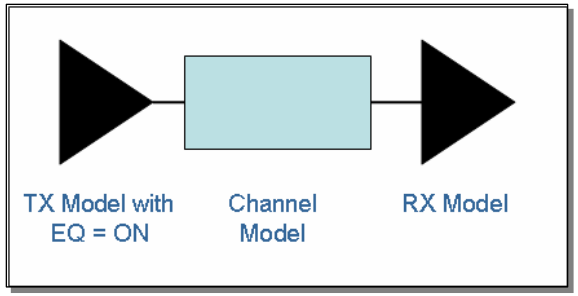


EDA Tool

IBIS-AMI Waveform



Test Pattern

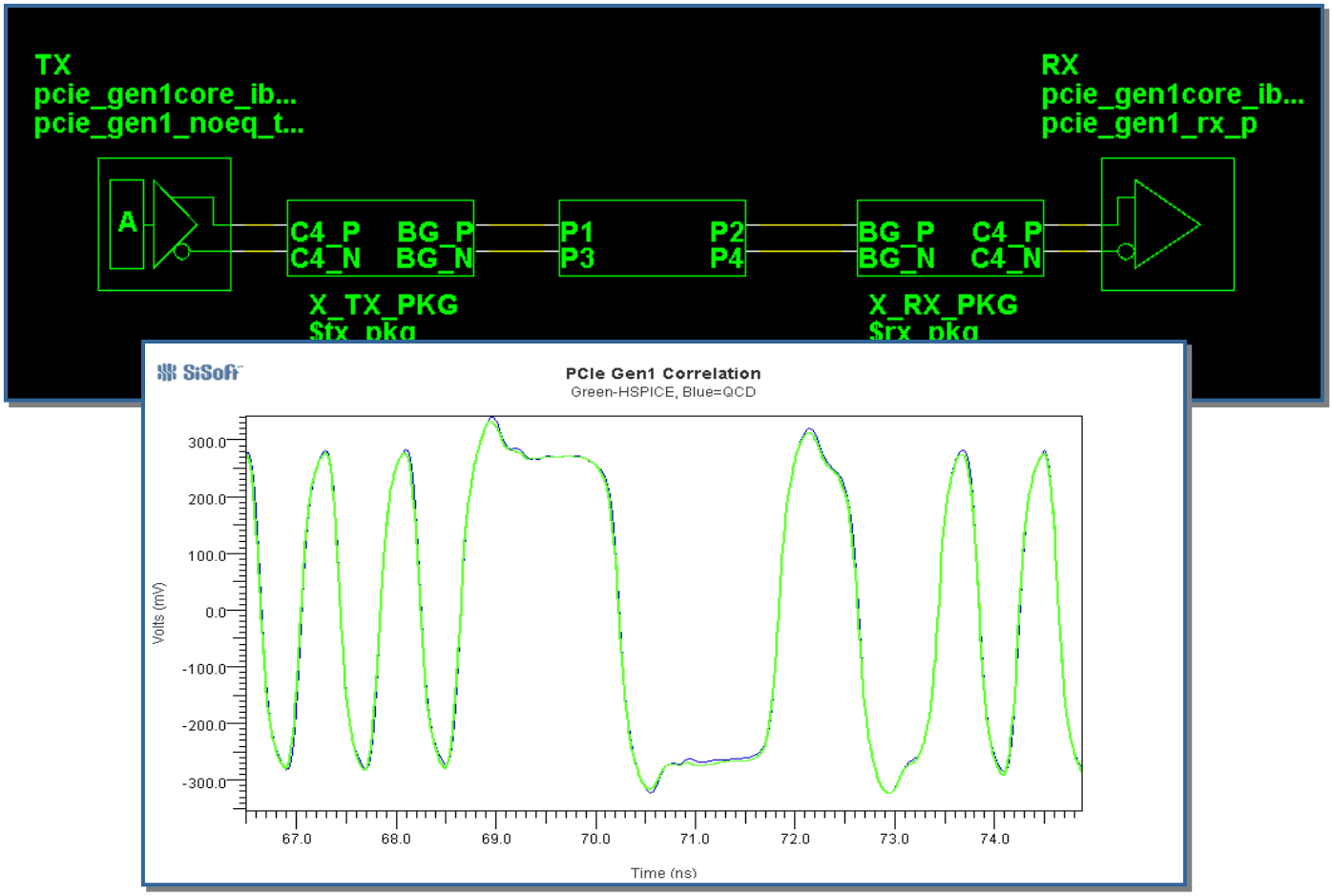


SPICE Analysis

?

Reference Waveform

PCIe Gen 1 Results



Green = SPICE results, Blue = IBIS-AMI results

Where waveform is green, results are identical

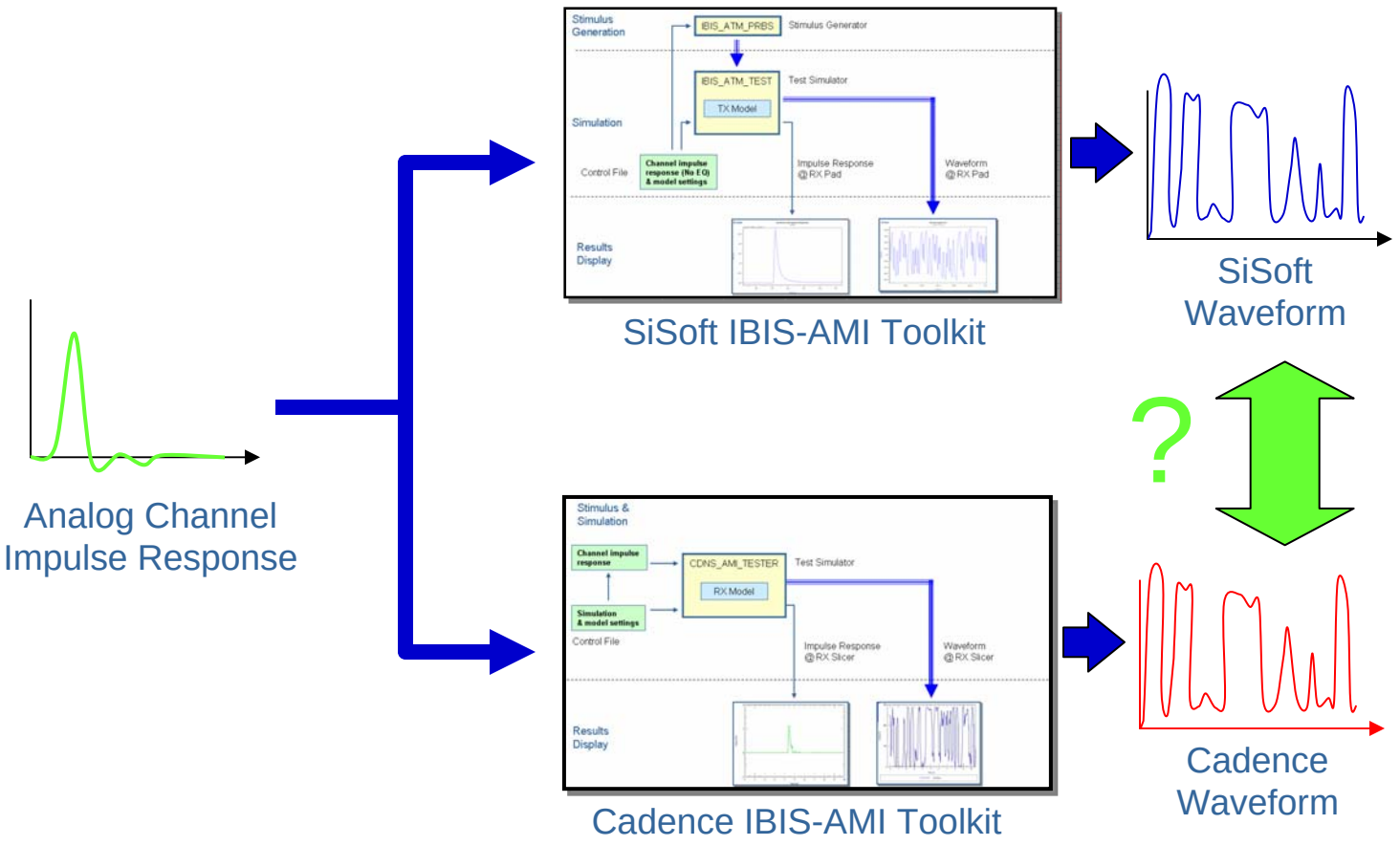
PCIe Gen 1 Simulation Performance

- SPICE – 2ps timestep, 200 ps data unit interval
  - 10,000 bits, 500 sec: 1.2K bits/min
- IBIS-AMI
  - Time-Domain Analysis – 1M bits
    - Single run, 150 sec: 400K bits / min
    - Dual run / dual core, 160 sec: 750K bits / min
- Relative performance: ~ 300 – 600X
- Relative performance will typically be higher:
  - SPICE models optimized for simulation performance
  - S-parameter fit not included in run-time

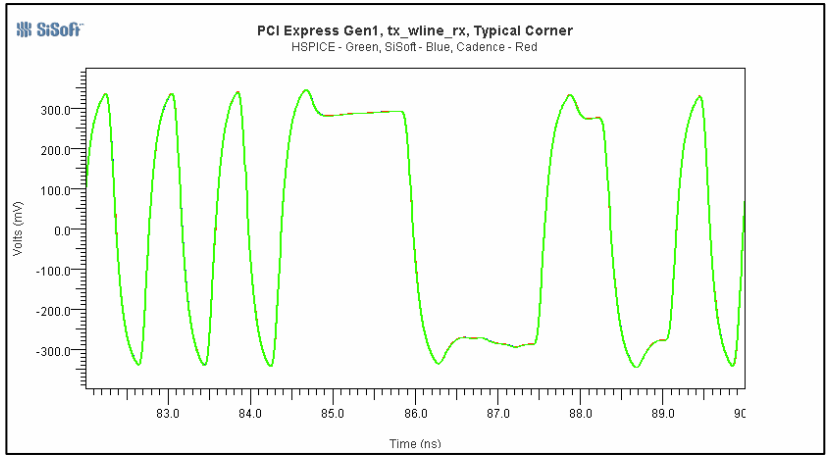
IBIS-AMI to IBIS-AMI Correlation

- Work done with IBIS-AMI toolkits and IBM models to test consistency between EDA vendors
- EDA vendors responsible for consistency between toolkits and their commercial tools
- This effort drove clarifications to the IBIS-AMI spec
  - BIRD 107.2 / IBIS-AMI reference flow
  - IBIS-AMI terminology
- Resulted in updates to existing toolkits and models
  - SiSoft toolkit 2.10
  - Updates to Cadence kit

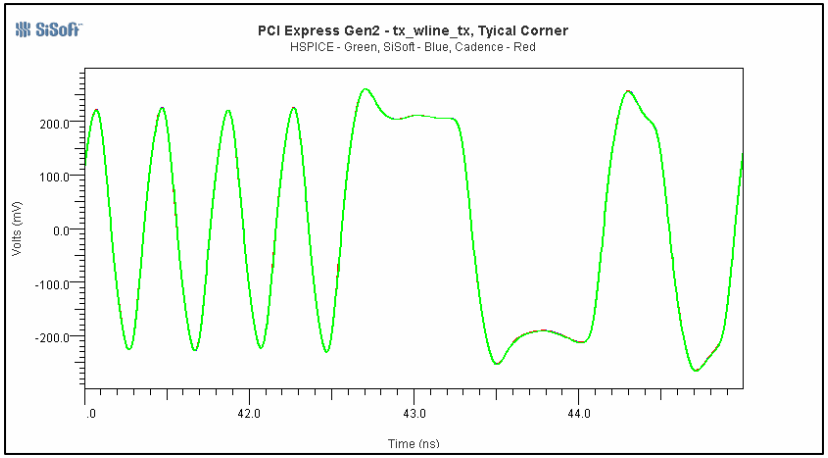
IBIS-AMI to IBIS-AMI Correlation



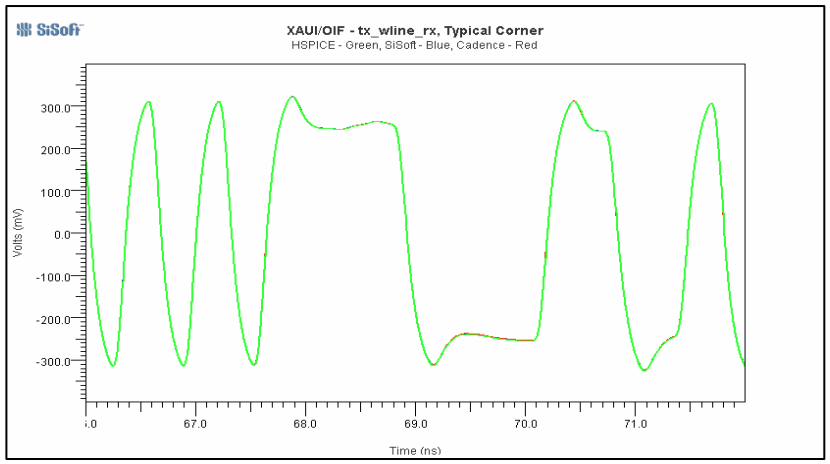
PCIe Gen 1 / Gen 2 / XAUI Results



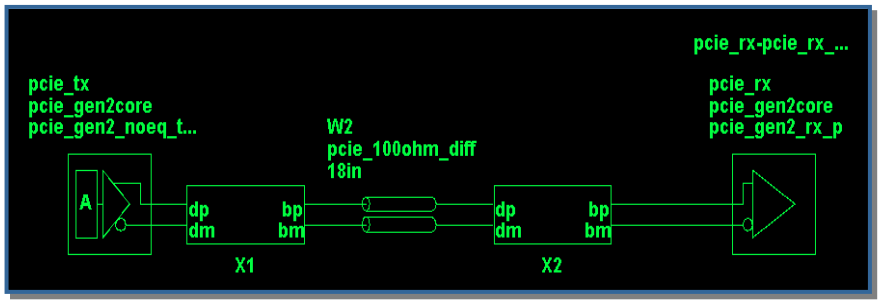
PCI Gen 1



PCI Gen 2



XAUI



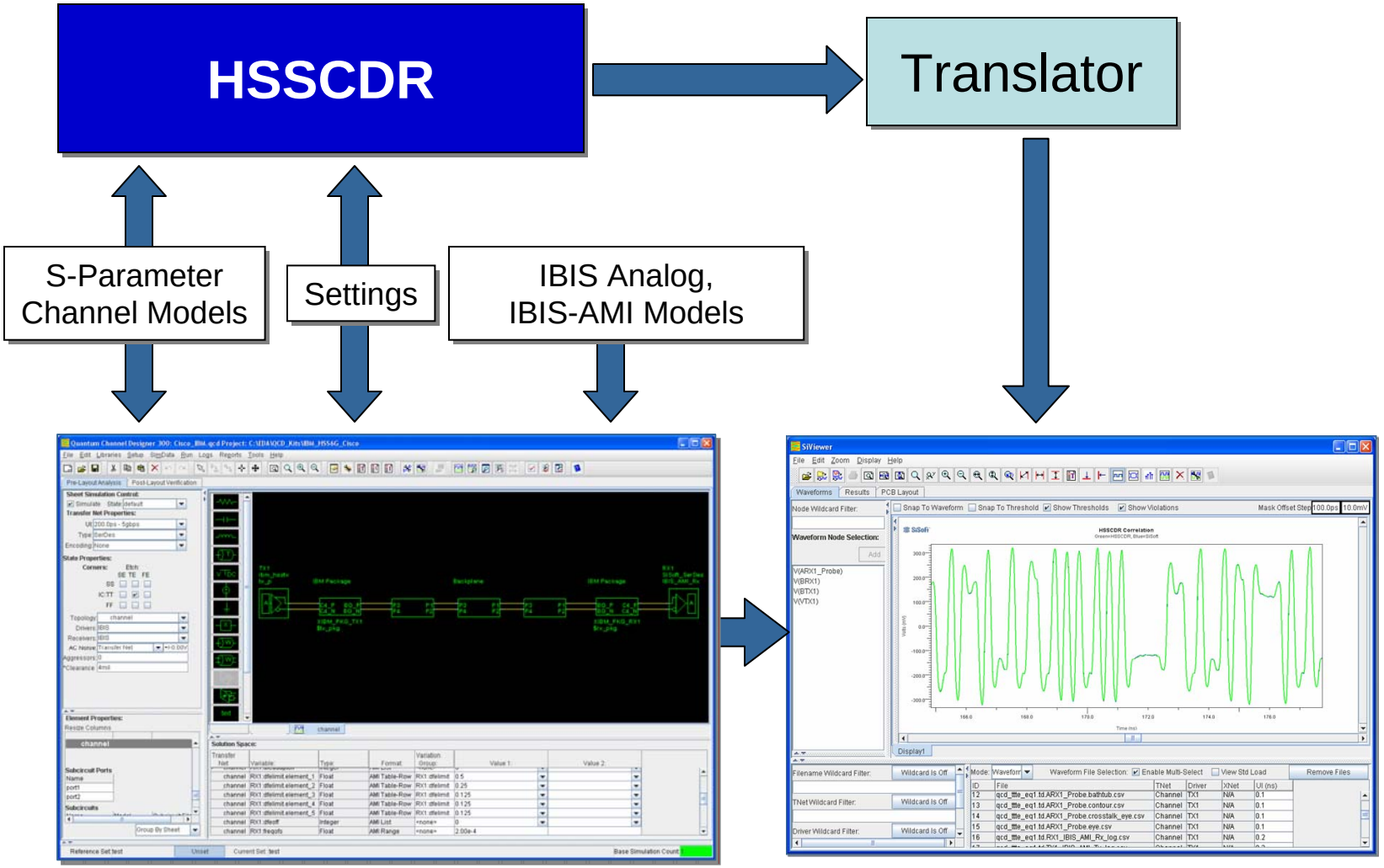
Green = SPICE, Blue = SiSoft, Red = Cadence

Where waveform is green, all 3 simulations match

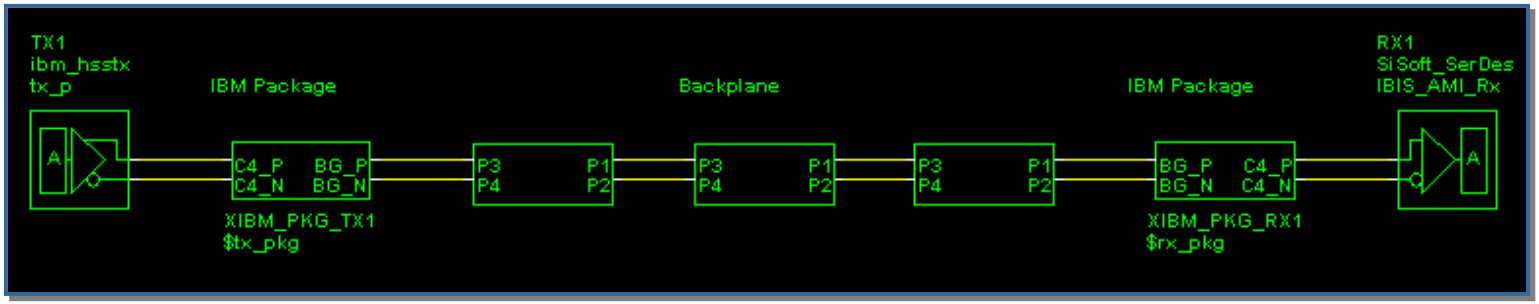
IBIS-AMI to SerDes Tool Correlation

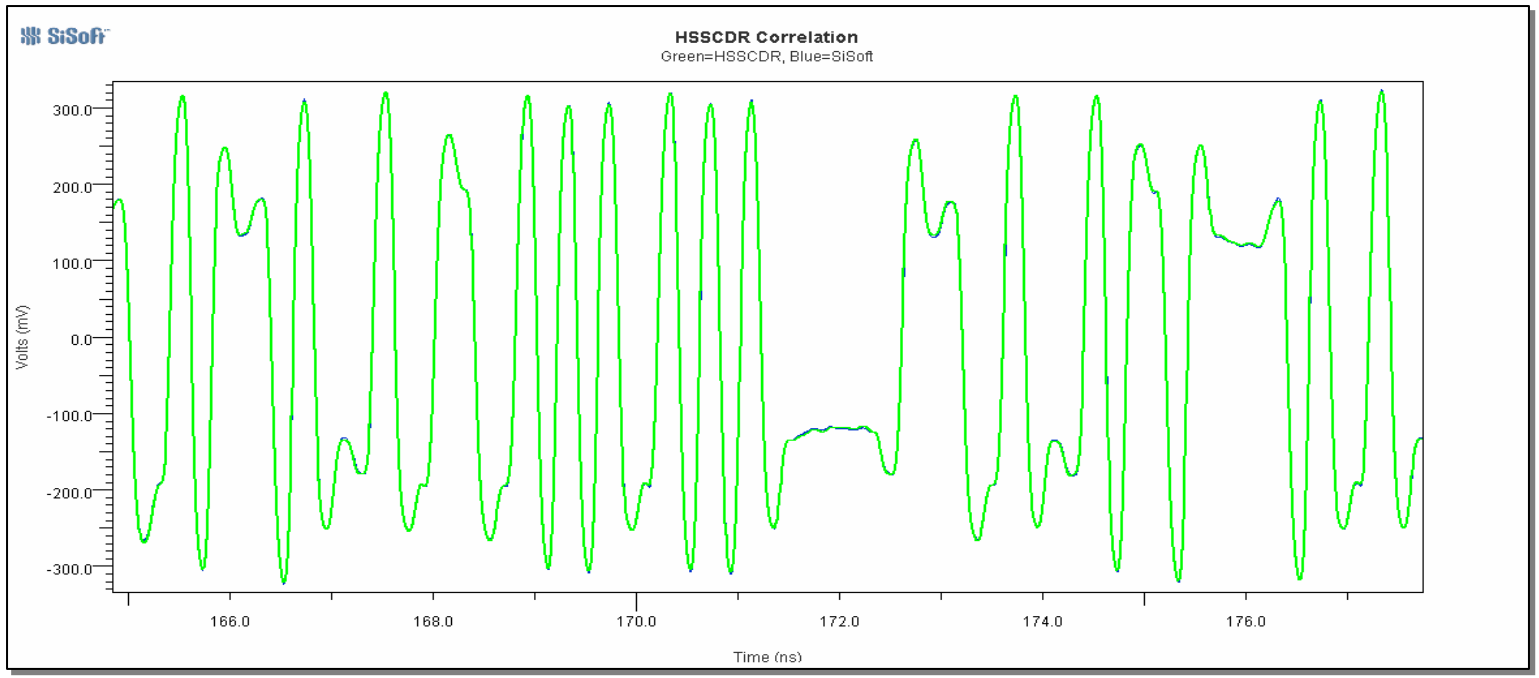
- Many semiconductor vendors have dedicated simulation environments for their SerDes IP
- Simulation functionality and outputs vary from vendor to vendor, so correlation plans must be built around the specific models and simulation capabilities
- Most tools allow customers to input their own channel models via S-parameters
- These results show current correlation results for IBM's HSS6G technology simulated in HSSCDR with a realistic channel model

HSSCDR Correlation Methodology



HSSCDR Correlation Results





Green = HSSCDR results, Blue = EDA Tool results using IBIS-AMI models
Where waveform is green, results are identical

Closing Thoughts

- This stuff really works!
- We expect to see continued correlation activity as more users and vendors adopt IBIS-AMI modeling
- Three common IBIS-AMI correlation activities
  - IBIS-AMI vs. SPICE
  - Between IBIS-AMI tools
  - IBIS-AMI vs. SerDes vendor tools
- Levels of correlation
  - (1st level) Time-domain waveforms
  - (2nd level) Metrics (BER, etc.) for single channels
  - (3rd level) Metrics (BER, etc.) for coupled channels