Creating Broadband Analog Models for SerDes Applications

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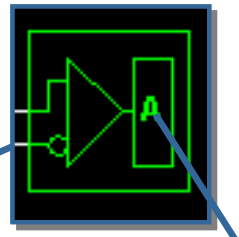
Agenda

- IBIS-AMI Models
- Analog Output Characteristics
- SerDes Reference Platforms
- SerDes Driver Modeling
- Correlation
- Existing Proposals
- The Direct Path
- Summary

IBIS-AMI Models

An IBIS-AMI model has two parts:



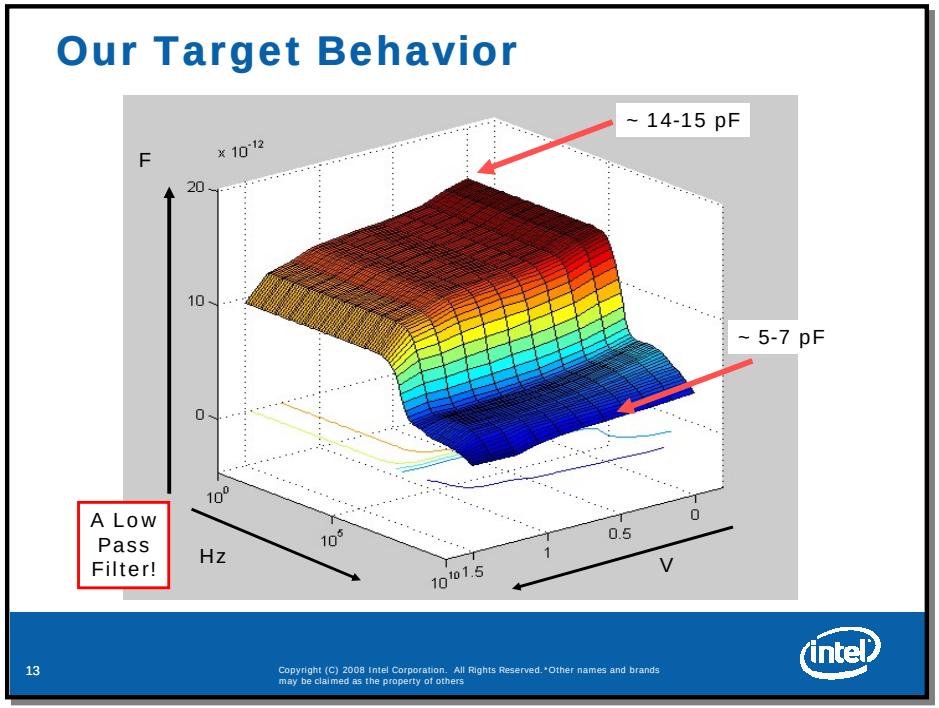
Analog Model

- Models unequalized analog device behavior
- Traditional IBIS table-driven models supplied as text (.IBS) files
- Used to characterize analog network and derive impulse response
- Analog model points to additional algorithmic model

Algorithmic Model

- Models equalization and clock recovery behavior
- Supplied as executable code
- Models can operate at two different levels:
  - INIT: impulse response processing
  - GETWAVE: time-domain waveform processing

Analog Output Characteristics



- Frequency-dependence of buffer behavior has been well documented
  - Arpad Muranyi, 2003
  - Michael Mirmak 2004, 2008
- Both transmission and reflection behaviors are frequency-dependent
- Existing IBIS black-box model doesn't represent broadband behavior

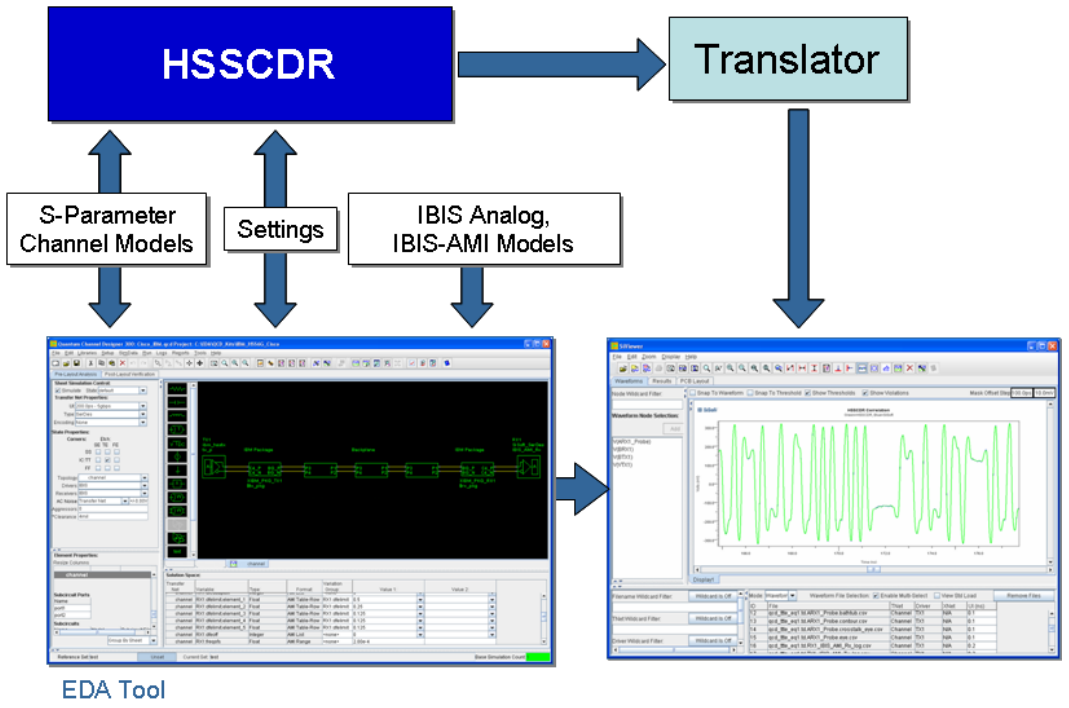
Michael Mirmak
IBIS-ATM Work Archive
1-Oct-2008

SerDes Analog Model Requirements

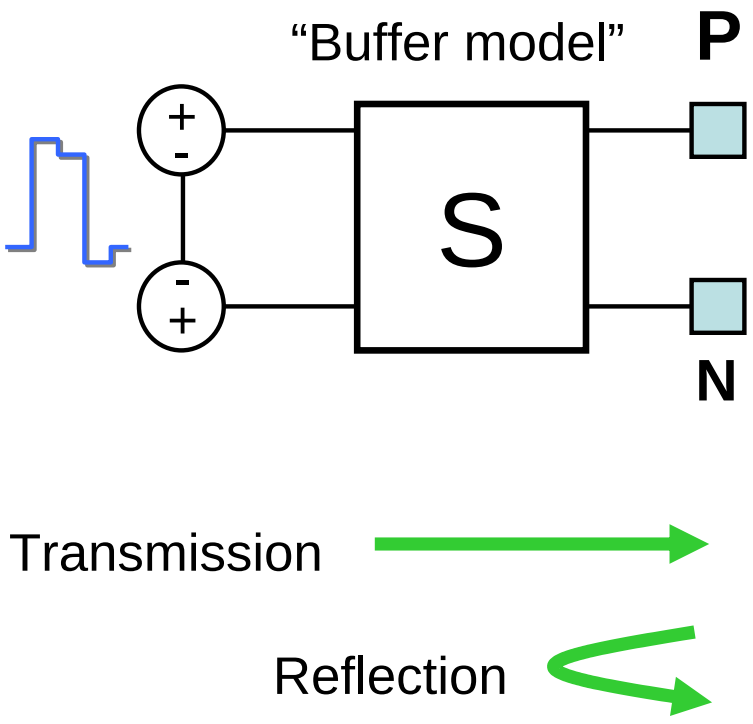
- Accurately model impedance and capacitance (transmission and reflection) characteristics over a wide frequency range
- Leverage existing IBIS format
- Leverage existing vendor data and processes
- Easy to understand and use

SerDes Reference Platforms

- Traditionally, IBIS models have been compared to SPICE simulations and physical measurement
- SerDes models are usually compared to internal vendor tools, which are correlated to measurement

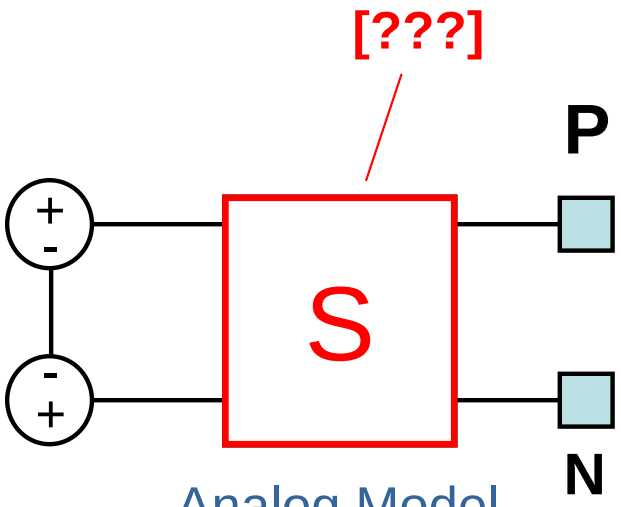


Modeling SerDes Drivers

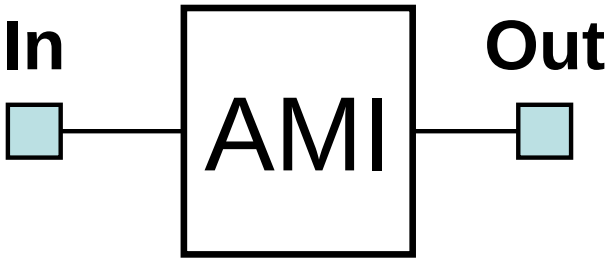


- Since we're comparing to SerDes vendor tools, we should understand how they model analog circuit behavior
- One method is to represent the driver as an ideal source in series with S-parameter data
- This scheme is simple to implement and models transmission / reflection characteristics across a wide frequency range

How Can We Do This in IBIS?



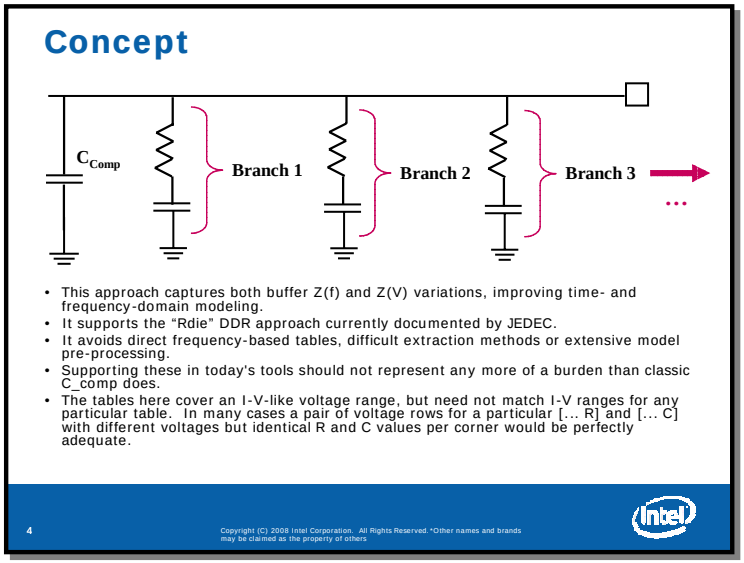
Analog Model



Algorithmic Model

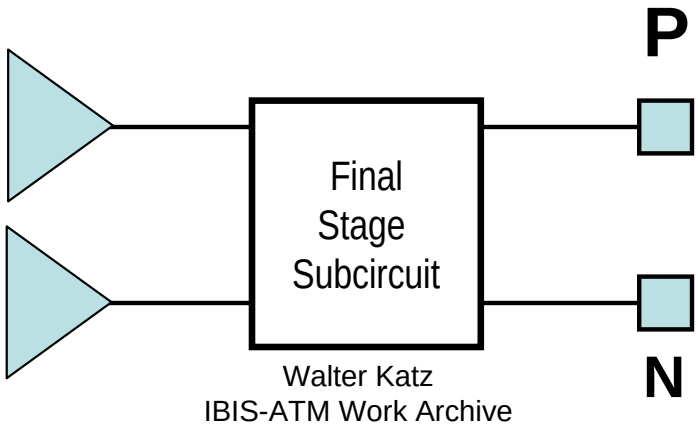
- An ideal source could be approximated with existing IBIS constructs
  - Better method is to just use an ideal source
- Algorithmic models handle the equalization behavior
- How do we include the S-parameter block?

Current IBIS Proposals



Michael Mirmak
IBIS-ATM Work Archive
1-Oct-2008

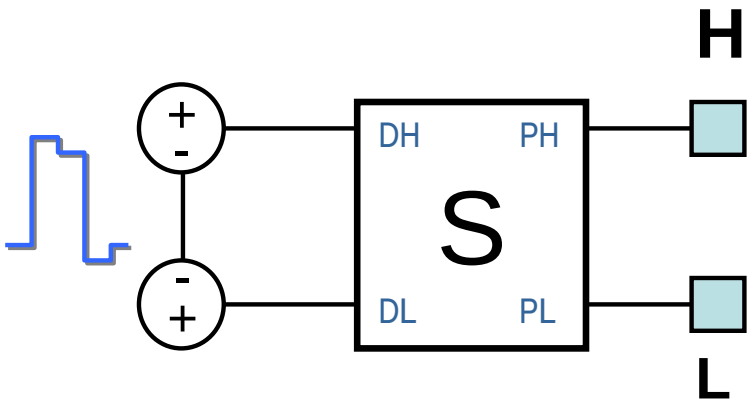
- Michael Mirmak has proposed an N-stage RC ladder network
- Could frequency-dependent behavior be adequately represented in this manner?



Walter Katz
IBIS-ATM Work Archive
Multiple Presentations

- Walter Katz's "IBIS Interconnect SPICE" proposal could be used to encapsulate S-parameter data

The Direct Path



- Point directly to a TOUCHSTONE® file from within the buffer or component model
  - TOUCHSTONE is already an EIA standard
- The S-Parameter element would be inserted between an ideal source and the "pad" nodes

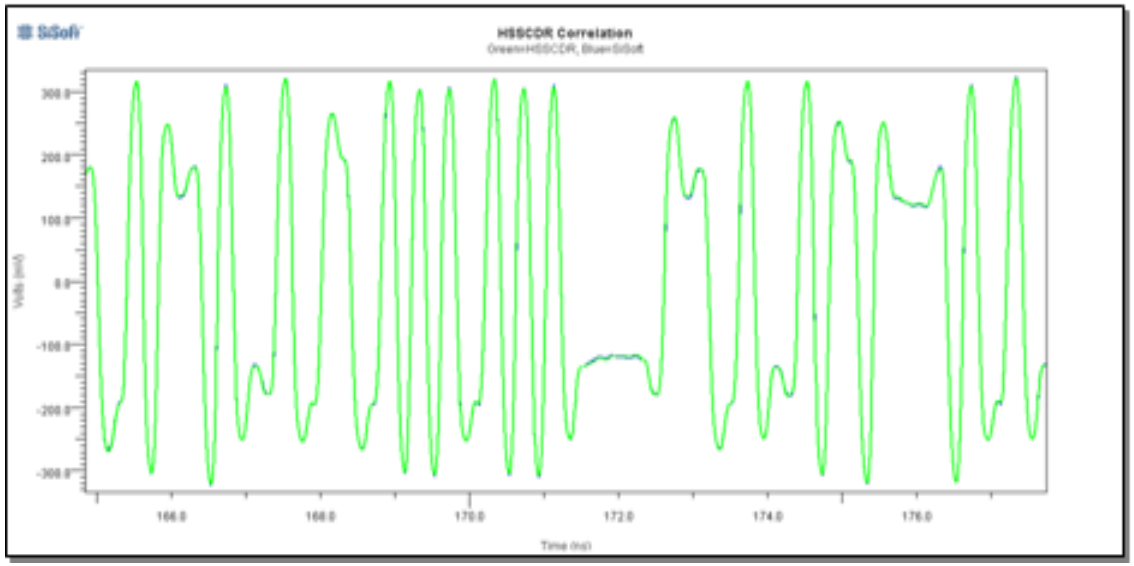
```
TSTONEFILE  max*  drv_bc.s4p    DH PH DL PL
TSTONEFILE  typ*  drv_tc.s4p    DH PH DL PL
TSTONEFILE  min*  drv_wc.s4p    DH PH DL PL
```

* Corners need further discussion

Correlation to Reference Platforms

- How well would the S-parameter scheme work?
  - Commercial tools are already using it
  - Results for one tool were reported at the DAC 2008 Summit

IBIS-AMI Model Results



Correlation to
IBM HSSCDR

Summary

- Analog buffers have frequency-dependent transmission/reflection behaviors that need to be properly represented for SerDes analysis
- An ideal source / S-parameter combination models these behaviors well
  - Results correlate to established vendor tools
- Existing IBIS efforts can be adapted to meet this requirement, or we can point to S-parameter data directly
  - Main issue is expediency: need is NOW
  - Direct method already in production use