IBIS-AMI Compliance (and what we need in IBIS 5.X)

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Overview

- Just what is “IBIS 5.0 compliant”?
- System Designer concerns
- Experiences with IBIS-AMI models
- Features needed in IBIS 5.X
- Proposed IBIS 5.X features
- What do we do until IBIS 5.X?
- Summary

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Compliance / Compliant

Regulatory compliance

From Wikipedia, the free encyclopedia

In general, **compliance** means conforming to a rule, such as a specification, policy, standard or law. **Regulatory compliance** describes the goal that corporations or public agencies aspire to in their efforts to ensure that personnel are aware of and take steps to comply with relevant laws and regulations.

Dictionary.com

com·pli·ant

[kuh m-**plahy**-uh nt] Show IPA

–adjective

1. complying; obeying, obliging, or yielding, especially in a submissive way: *a man with a compliant nature.*
2. manufactured or produced in accordance with a specified body of rules (usually used in combination): *Energy Star-compliant computers.*

For IBIS:

"conforming to", "in accordance with" ➔ the current IBIS 5.0 specification

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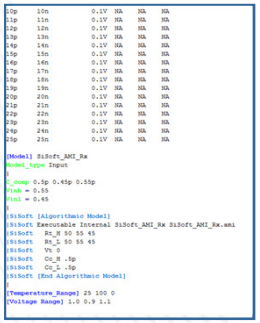
How is Compliance determined?

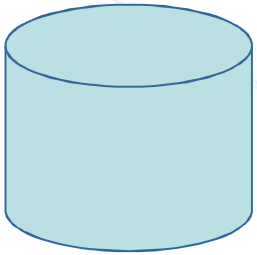
.IBS file



.AMI file

IBIS Parser

.DLL, .SO files



IBIS_AMI_Test

- Syntax compliance
- Some semantic compliance

- IBIS-AMI API compliance
- Input / Output waveforms

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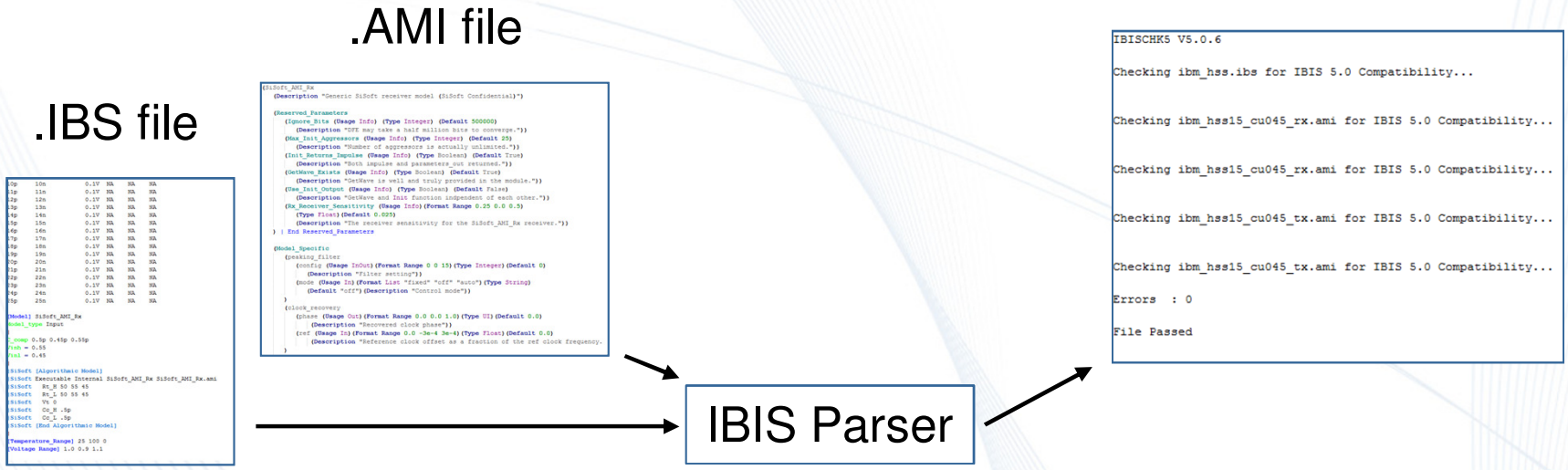
IBIS Parser (IBISCHK5)



- Free tool on IBIS web site; developed and maintained by IBIS
- Checks .ibs and .ami files for syntax, some values and some semantics
- Produces list of errors, warning and line numbers

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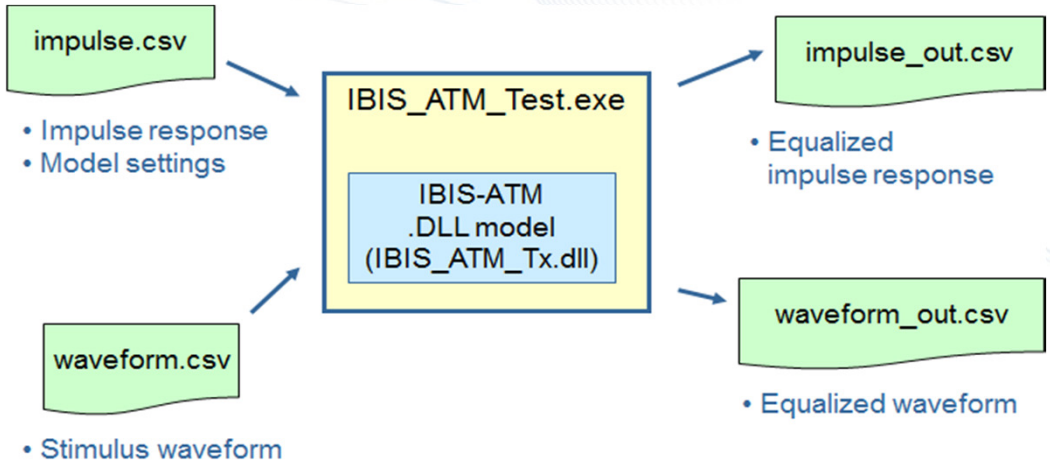
IBIS-AMI Test Benches



- Free tools verify DLLs execute & pass data
- Test benches available from SiSoft & Cadence
- Sample DLL source code included
- Available for Windows & Linux
- They must work, because DLL non-compliance problems have been few & far between!

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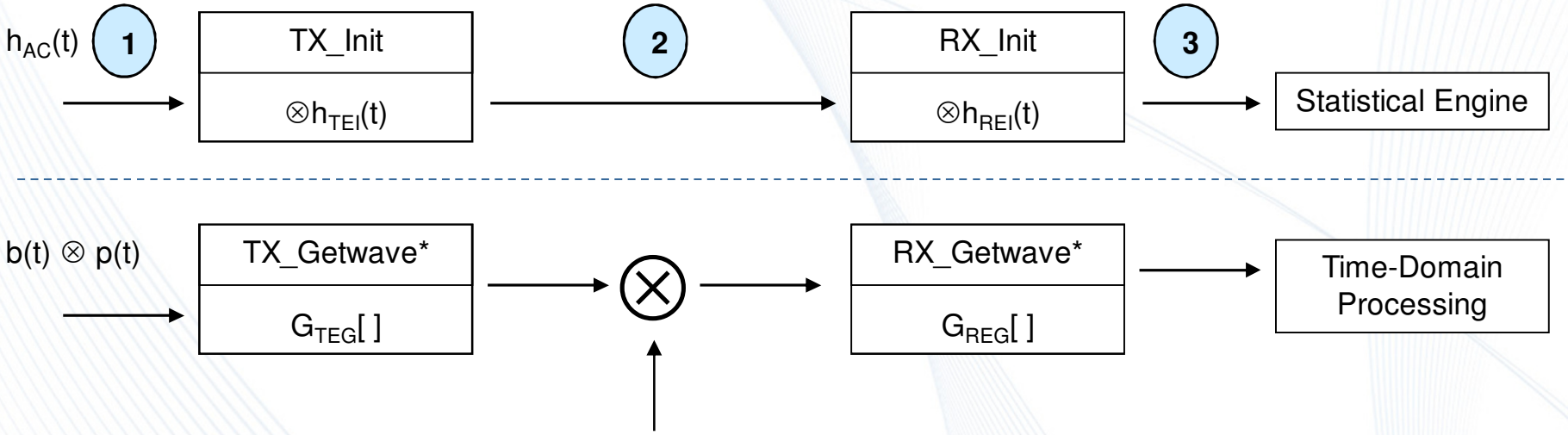
IBIS-AMI Reference Flow (BIRD 120)



Case #	Tx Type**	Rx Type**	Convolution Input
1	FT	FT	**3**
2	FT	TF	**3**
3	FT	TT	**2**
4	TF	FT	**3**
5	TF	TF	**3**
6	TF	TT	**1**
7***	TT	FT	**iFFT(FFT(3)/FFT(2)) ⊗ 1**
8	TT	TF	**1**
9	TT	TT	**1**
** = Getwave_Exists, Init_Returns_Impulse			
*** = If de-convolution is not supported, use Case 1 flow instead			

* If Getwave_Exists = False for a model, the call to that model's Getwave() entry point is skipped.

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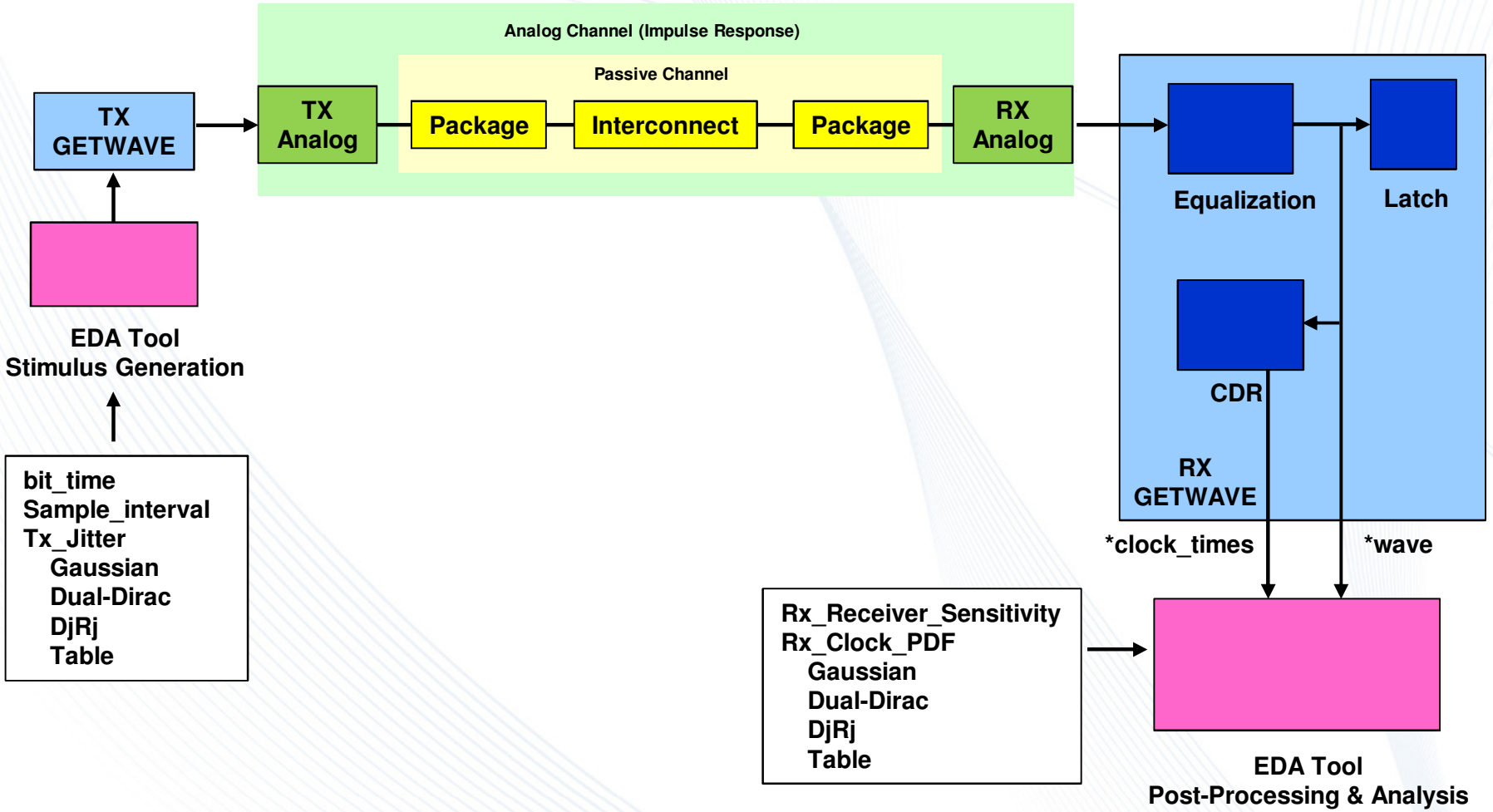
IBIS 5.0 Time-Domain AMI Simulation



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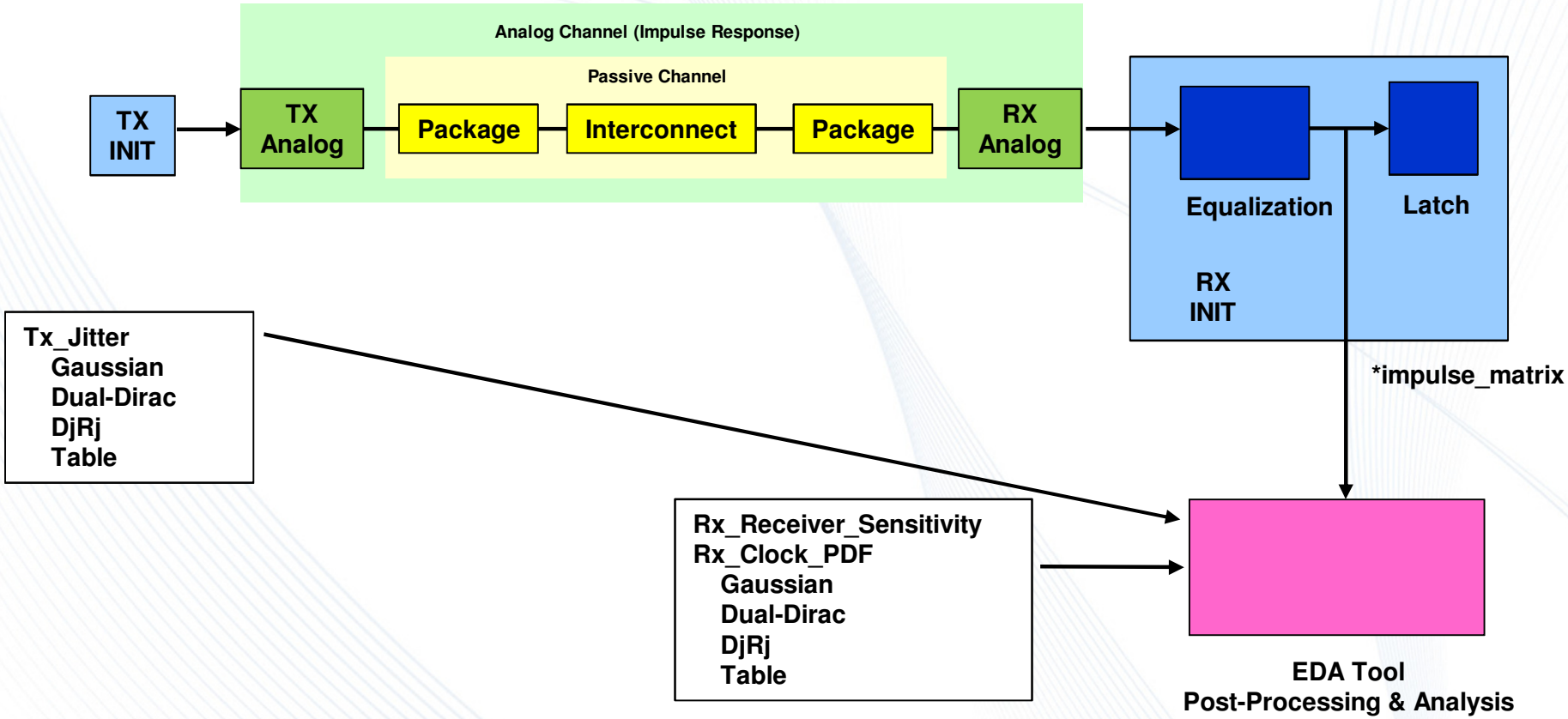
IBIS 5.0 Statistical AMI Simulation



Legend:

Interconnect | Analog | Algorithmic | EDA Tool | IBIS 5.0

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System Designer Concerns

- Model X works in simulator Y (**portability**)
- Model X works with model Z (**interoperability**)
- AMI model correlation (**accuracy**)
  - to hardware
  - to vendor simulation tools
- Model X fully supports simulator Y (**functionality**)
- Model X / simulator Y run fast enough to produce statistically significant results (**speed** / **capacity**)

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Portability Issues

- Incomplete models
  - No .IBS file
  - No analog model in .IBS file
  - No .AMI file
- Non IBIS 5.0 models
  - Non-IBIS models (proprietary syntax)
  - AMI files using features beyond IBIS 5.0
- Differences in assumptions
  - Different interpretations of original [Table] syntax
  - Sensitivity to details in impulse response
  - Differing interpretations of jitter specs

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Portability Issues (cont.)

- DLLs that require external files
  - Additional DLL's required to execute (e.g. Matlab)
  - External data files (e.g. Pole-Zero data)
  - Models that require a directory path as input
- DLLs that output files directly
  - Crosstalk simulations run multiple instances of the same DLL in a single simulation. Files can collide and corrupt results

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Portability vs. Compliance

- IBISCHK5 can't tell if a model is portable or not
  - Checks syntax & some semantics, but doesn't check some "debated" semantic constructs
  - Semantic constructs that affect portability are technically compliant with IBIS 5.0 as specified, but are not supported by multiple simulators
  - Models can pass the parser but not be fully functional in all simulators
- A model's portability is therefore a manual assessment made by an AMI expert
  - And of course, not all experts agree!

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Interoperability Issues

- Models with “samples per bit” restrictions
  - One model with a restriction is OK, but two models with different restrictions are not
- Models that rely on external runtime libraries
  - Different models requiring different versions of the same runtime won’t run together
  - Mainly a model software architecture issue, can be mitigated by incorporating runtime libraries into the compiled .DLL
- Models that pass data via external files
  - TX/RX models that pass state data external to the AMI API

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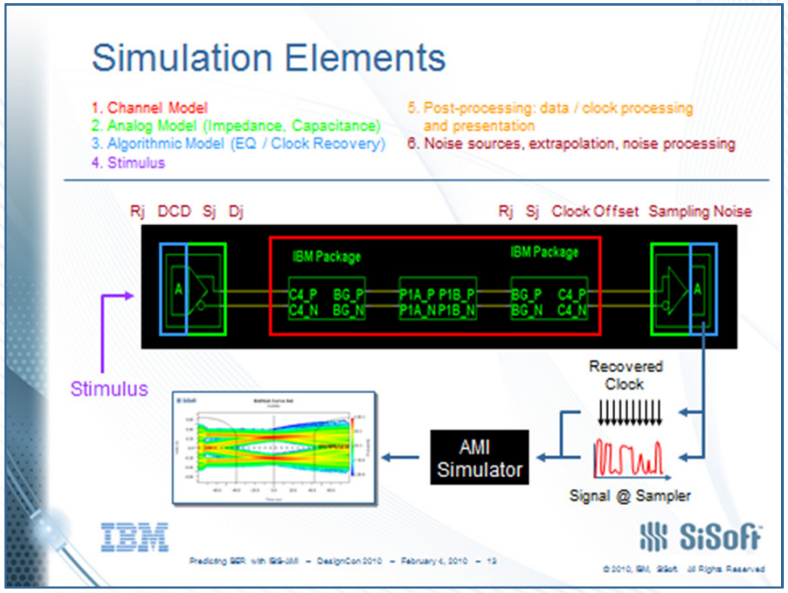
Accuracy Issues

- Correlation usually gets performed between
  - A specific commercial AMI simulator
  - A specific vendor's internal simulator
- Achieving correlation requires the ability to model key features (analog models, jitter budgets) of the vendor's simulator in AMI



"Predicting BER with IBIS-AMI: experiences correlating SerDes simulations and measurement"

DesignCon 2010 and DesignCon 2010 IBIS Summit

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Functionality Issues

- Models that don't provide EQ during INIT (Init_Returns_Impulse = False) don't support Statistical simulation
  - The simulation runs, but model's EQ is missing
- Models with external file I/O can corrupt swept-parameter simulations
  - Files from one simulation run interfere with subsequent simulation runs
- Models with external file I/O can corrupt crosstalk simulations
  - Multiple instances of the model in the same simulation interact and affect results

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Speed Issues

- Baseline user expectations:
  - Statistical simulations take seconds
  - Time-domain simulations run ~ 1M/bits/minute/CPU
- Some models take 30-60 seconds in INIT (Statistical simulation)
  - Limits sweeps, but not a huge problem
- Some models run time-domain simulation up 10-20X slower than baseline expectations
  - Significant impact on analysis time and compute resources required

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Needed features in IBIS 5.X

Feature	Why It's Important
Broadband buffer models	Some vendors only provide S-param data for the analog buffer. Some vendors use S-param data to improve model correlation.
Broadband package models	Most vendors are supplying package models as S-parameter data
Jitter by Corner	IBIS 5.0 doesn't support [slow, typ, fast] jitter budgets
Sinusoidal (Periodic) jitter	Model modulation caused by on-die clocks running at different speeds
>3 Corner Support	Some vendors characterize their silicon at more than 3 corners (BC, NC, WC, EC, …)
Repeater modeling	Needed to support data rates > 10Gb/s and long channels.
Noise budgets	Some vendors provide noise budgets at the sampling latch. Need way to model noise introduced by repeaters.
Data management	Prevent unintentional interactions between models
Reference Clock	Model jitter on reference clock, forwarded clocks, retimers
Analog/Algorithmic Linkage	Improve support for cases where .AMI options determine analog model to be used for Network Characterization
Backchannel support	Support protocols like 802.3ap (kr), PCIe-Gen3, …

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Extending IBIS-AMI

Requirement	Proposed Implementation
Broadband buffer models	Use IBIS-ISS to specify analog buffer subcircuits
Broadband package models	Use IBIS-ISS to specify package subcircuits
Jitter by Corner	Reserved jitter parameters than can use AMI [Corner] format
Sinusoidal (Periodic) jitter	Reserved parameters for sinusoidal jitter and frequency
>3 Corner Support	Leverage Dependency Tables to allow unlimited corners
Repeater modeling	Define mechanisms for channel linkage and noise modeling
Noise budgets	Reserved parameters for induced noise at different nodes
Data management	Provide models unique base names to avoid data file collisions
Reference Clock	Provide *clock_times input to CDR model
Analog/Algorithmic Linkage	Leverage Dependency Tables to link AMI parameter settings to required analog models for Network Characterizaton
Backchannel support	Standard mechanism for RX ➔ TX model communication

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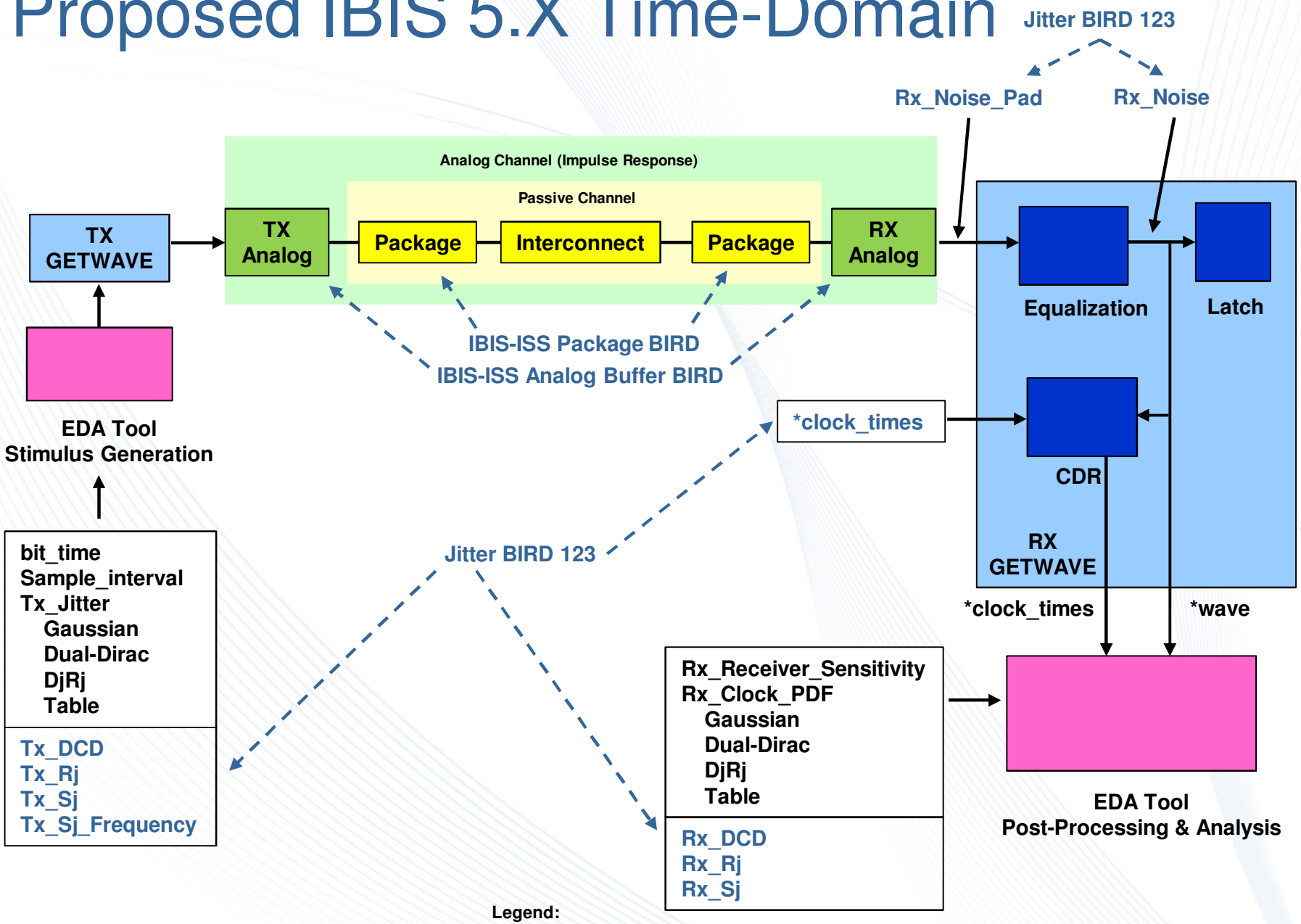
Proposed IBIS 5.X Time-Domain



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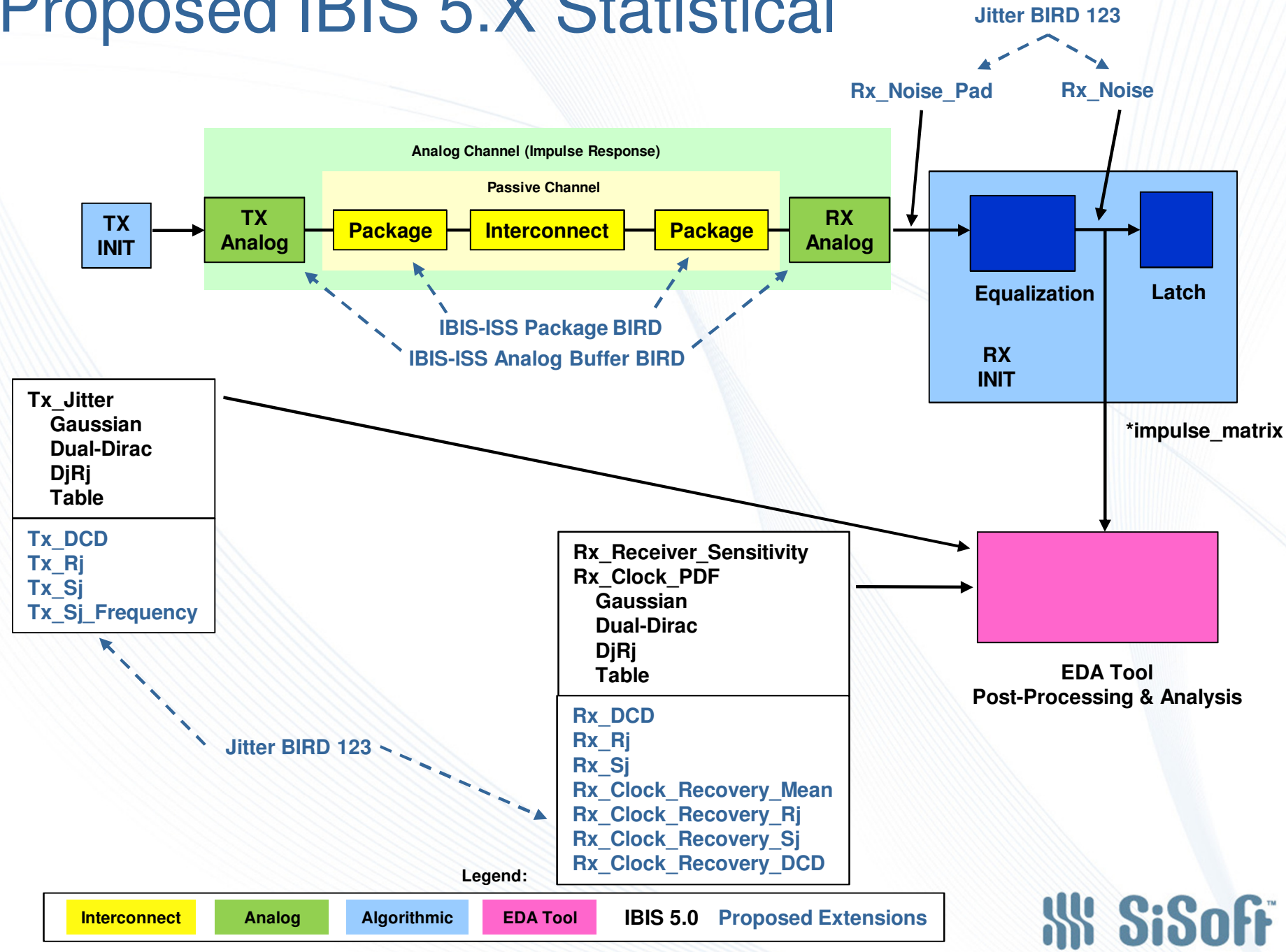
Proposed IBIS 5.X Statistical



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Proposed IBIS 5.X Features

Need	Where Addressed
Broadband buffer models	IBIS-ISS Analog Buffer BIRD
Broadband package models	IBIS-ISS Package BIRD
Jitter by Corner	BIRD 123 (Jitter BIRD)
Sinusoidal (Periodic) jitter	BIRD 123 (Jitter BIRD)
>3 Corner Support	BIRD 124 (Dependency Tables)
Repeater modeling	BIRD 131 (Repeater BIRD)
Noise budgets	BIRD 123 (Jitter BIRD)
Data management	BIRD 121
Reference Clock	BIRD 123 (Jitter BIRD)
Analog/Algorithmic Linkage	BIRD 124 (Dependency Tables)
Backchannel support	Backchannel BIRD

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... So What Do We Do Until 5.X?

- Encourage IBIS BIRDs approved by the IBIS Open Forum be considered for model and EDA tool implementation
- Encourage model makers and EDA vendors to bring innovations to IBIS for standardization
- Openly address the issue of model functionality vs. portability, providing end-users a useful way of determine which model runs in which simulator

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Summary

- Existing tools help verify IBIS 5.0 compliance
- Compliance and portability are different things
- Identified needed features in IBIS 5.X to improve model portability, interoperability, accuracy and functionality
- These features are proposed in BIRDs already under discussion
- Need discussion on when / how BIRD features become legit for model / EDA tool adoption
- Need better mechanisms for assessing model portability

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