IBIS在信号完整性分析中的应用
Using IBIS for SI Analysis

Lance Wang, ZhangMin Zhong
Cadence Design Systems, Inc.
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Outline

- What happened on IBIS （IBIS历史）
- Why IBIS （IBIS的好处）
  - Speed and Accuracy （速度和精度）
  - Industrial Examples （工业化例子）
- Advanced IBIS Technologies （加强型IBIS技术）
  - Complex-IO Devices （复杂I/O器件）
  - Macromodeling is a solution （宏模型解决方案）
  - Experiences and Industrial Examples （经验和工业化例子）

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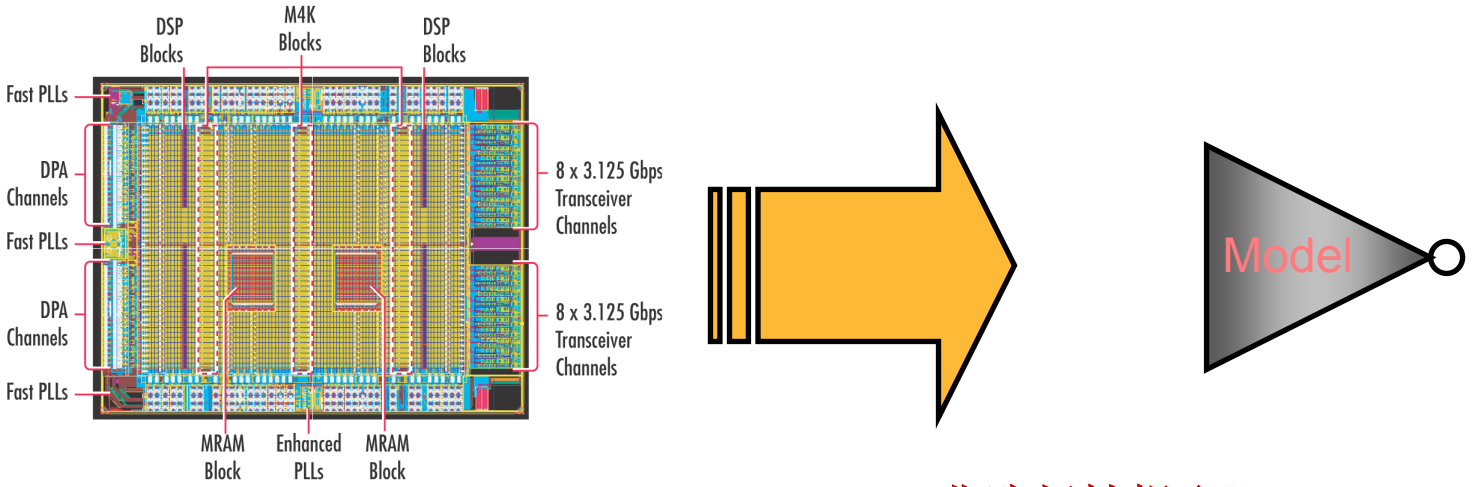
What happened on IBIS
- Spice Transistor Level Models（晶体管级模型建模流程）

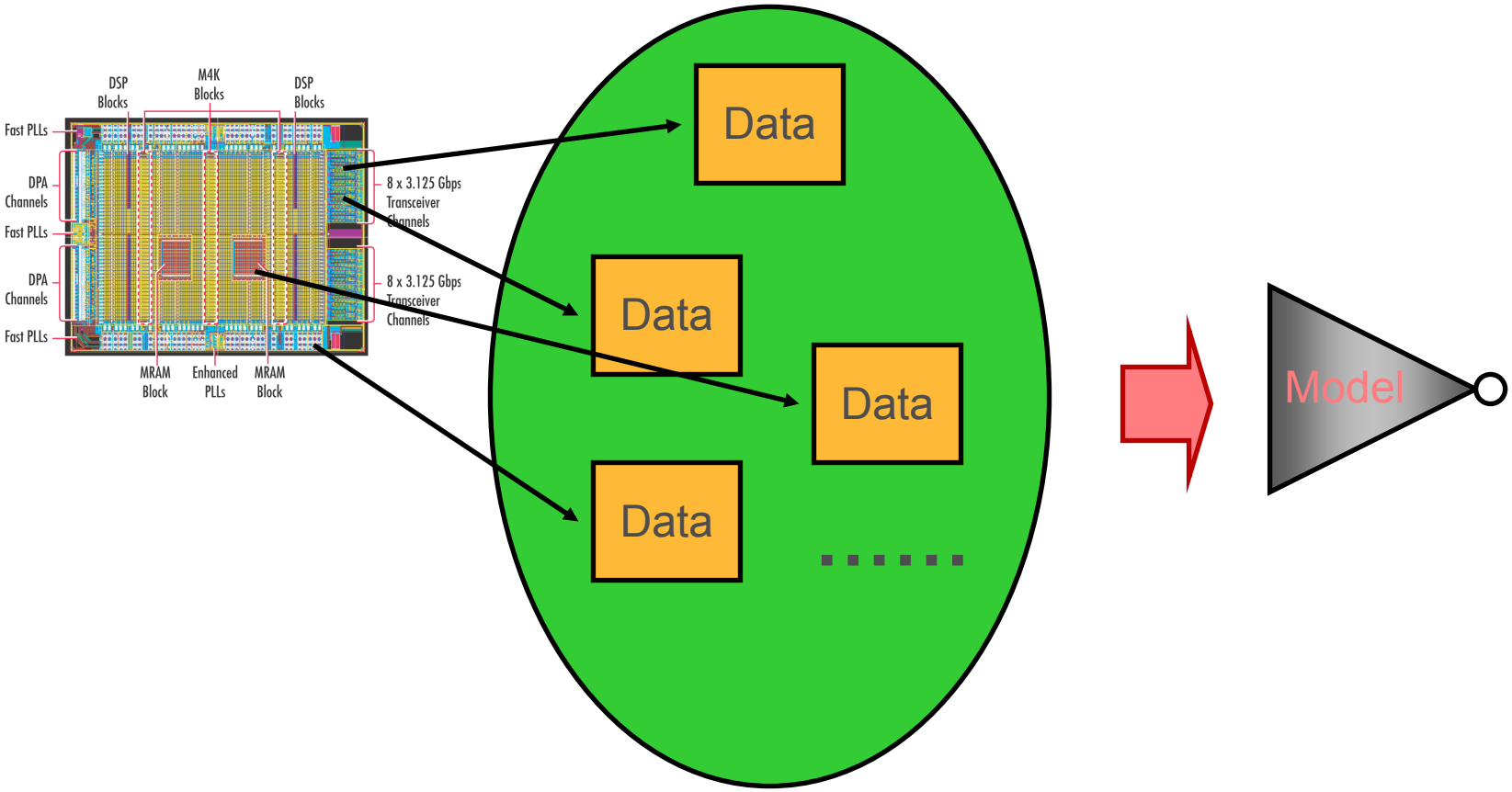


Layout Extractions（非选择性提取）

-Very Complicated
-A lots of unusable stuff
-Too slow in the simulations

What happened on IBIS

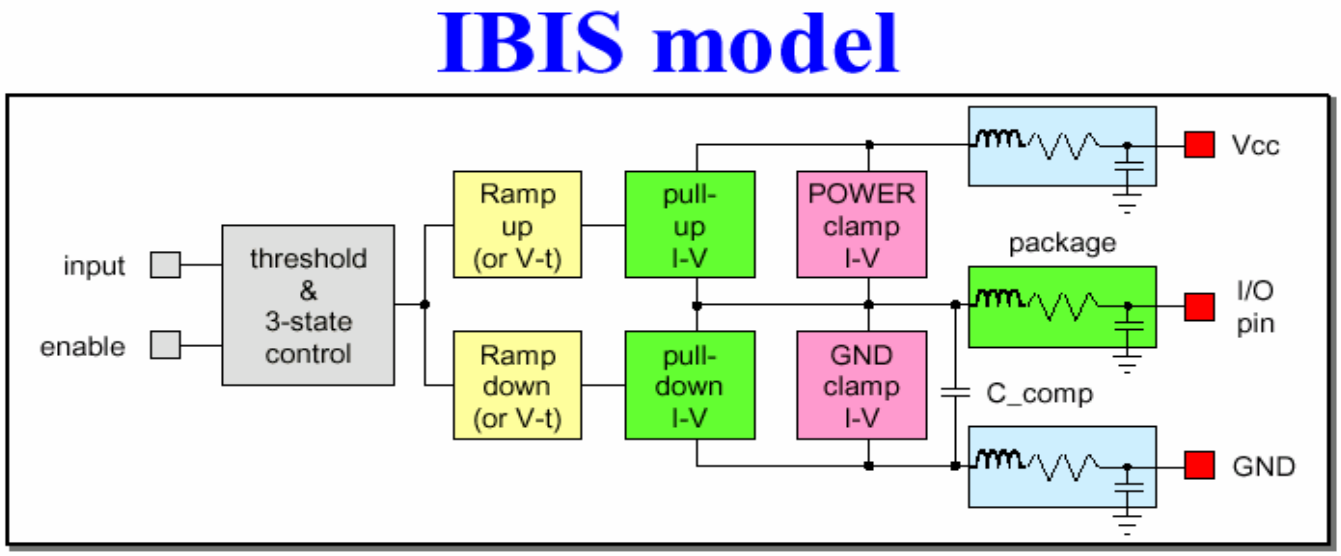
- Behavioral Models （行为级模型建模流程）



Behavioral Extractions 选择性提取

What happened on IBIS

- IBIS is behavioral Model （IBIS是行为级模型）



Block diagram of CMOS buffer

A basic IBIS model consists of:

four I-V curves: - pullup & POWER clamp
- pulldown & GND clamp

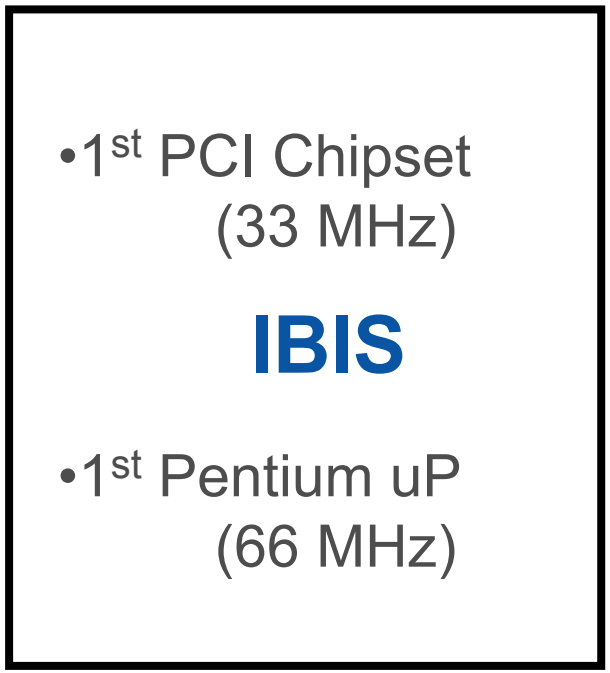
two ramps: - dV/dt_rise
- dV/dt_fall

die capacitance: - C_comp

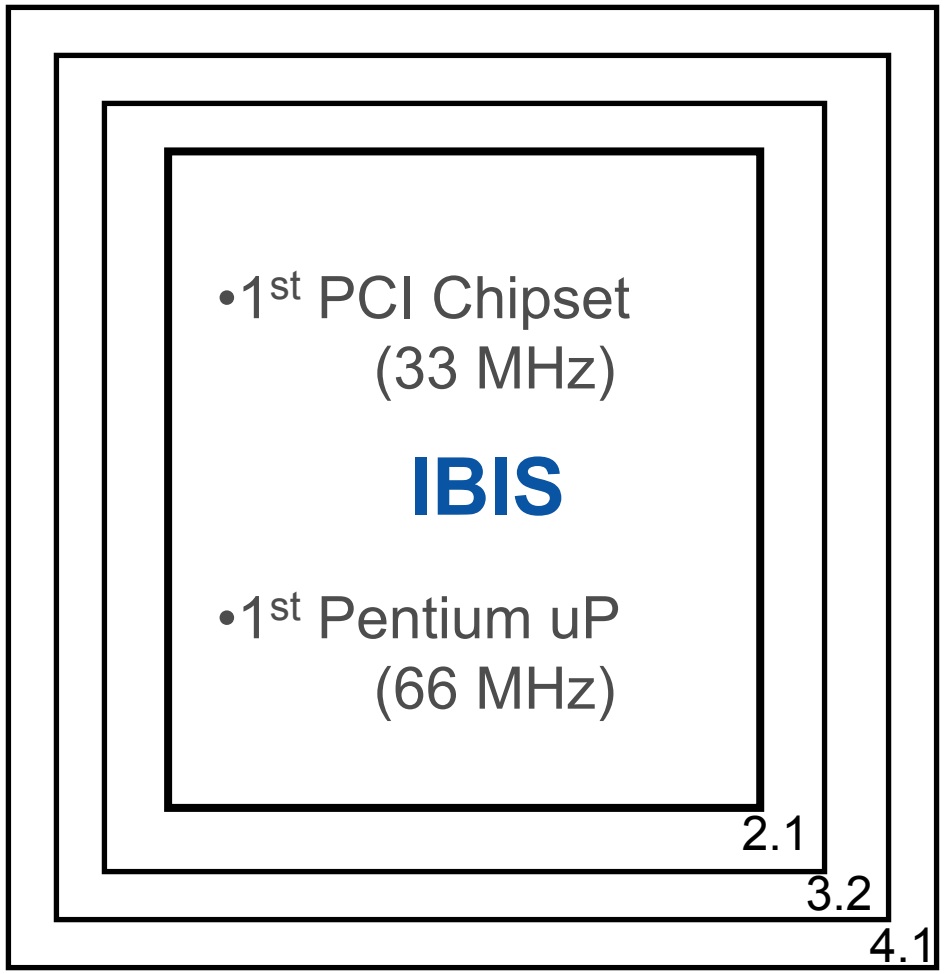
packaging: - RLC values

for each buffer on a chip

What happened on IBIS - The Original "Box"

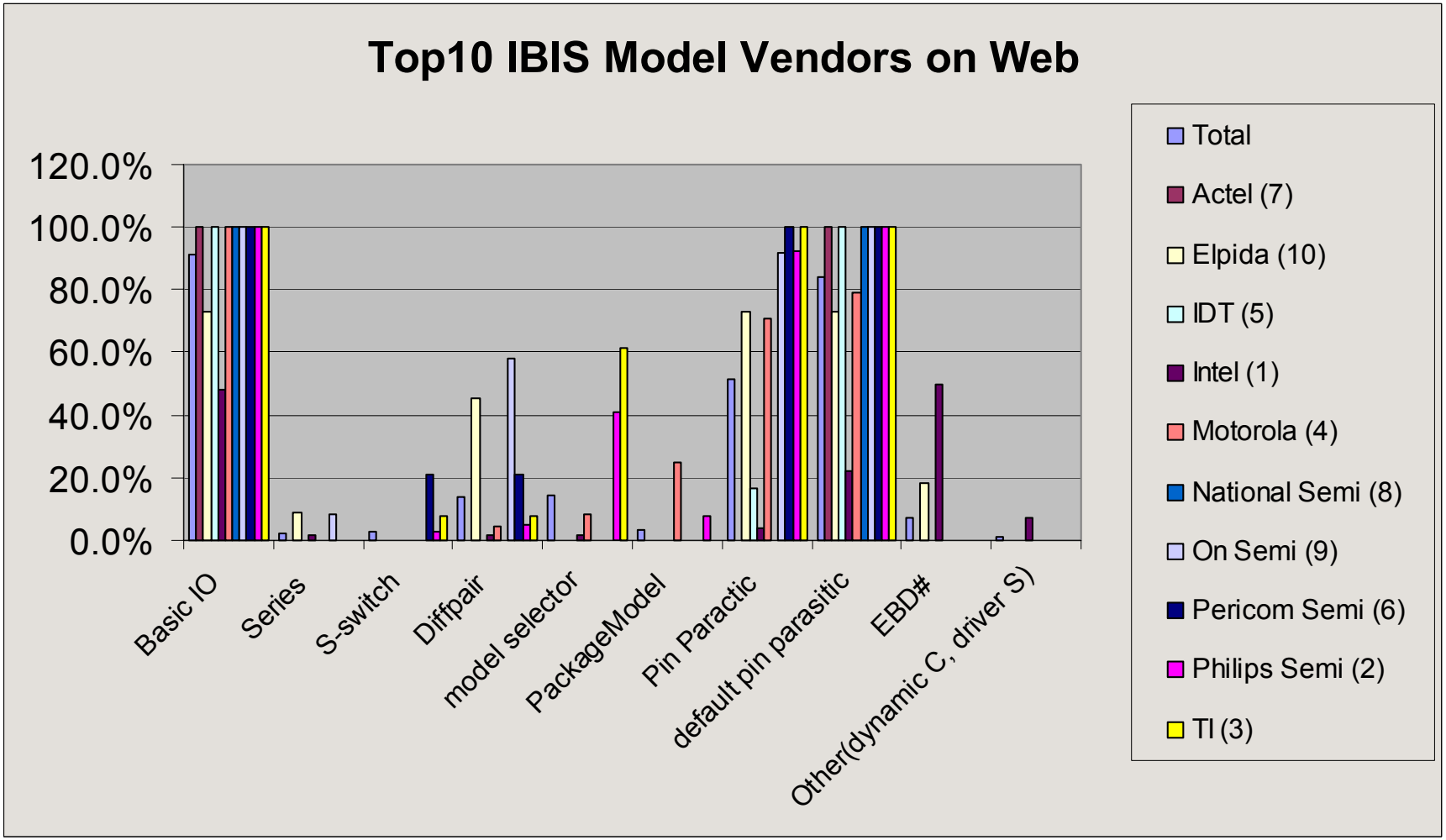


…and the “Box” did grow



An increasing amount of Complex IO models are missing the box

What happened on IBIS
- IBIS Model Vendors（IBIS模型提供者）



What happened on IBIS
- IBIS in EDA Tools（IBIS在EDA工具中的应用）

- Major EDA Simulators are supporting IBIS now
  - Cadence
  - Mentor
  - Synopsys
  - Hyperlynx
  - Agilent

SPICE Simulators are taking IBIS now !!!

And many, many more……

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Why IBIS （IBIS的好处）

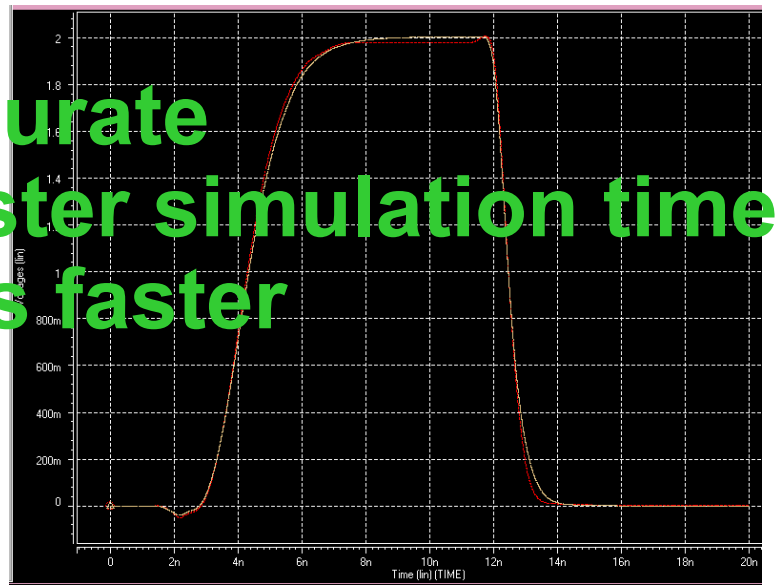
-Speed and Accuracy （速度和精度）

- Behavioral data in Spice simulators

I(pad) = Ipd(V(pad)-V(gnd))*Wd(t) + Icd(V(pad)-V(gnd_c))

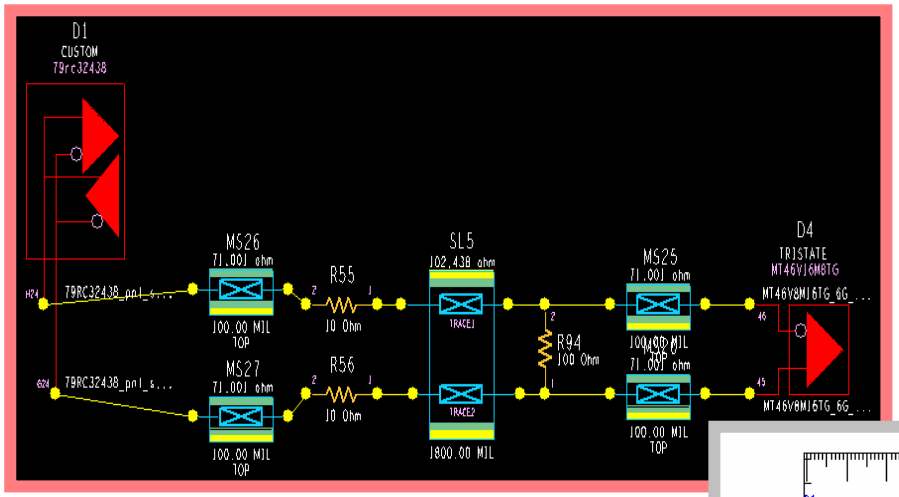
+ Ipu(V(pad)-V(pwr))*Wu(t) + Icu(V(pad)-V(pwr_c))

- **Results are accurate**
- **Much, much faster simulation time**
  - **20-1000 times faster**
- **IP Protected**



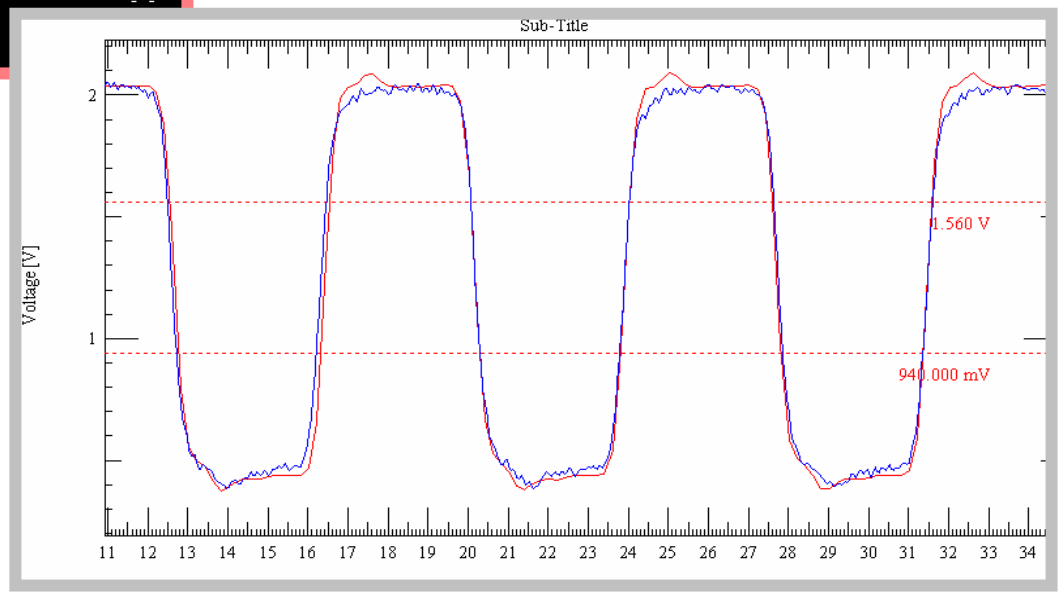
HSpice Transistor Model vs. IBIS Model

Why IBIS （IBIS的好处）
- Industrial Examples（工业化例子） (133MHz)



Driver: IDT 79RC32438

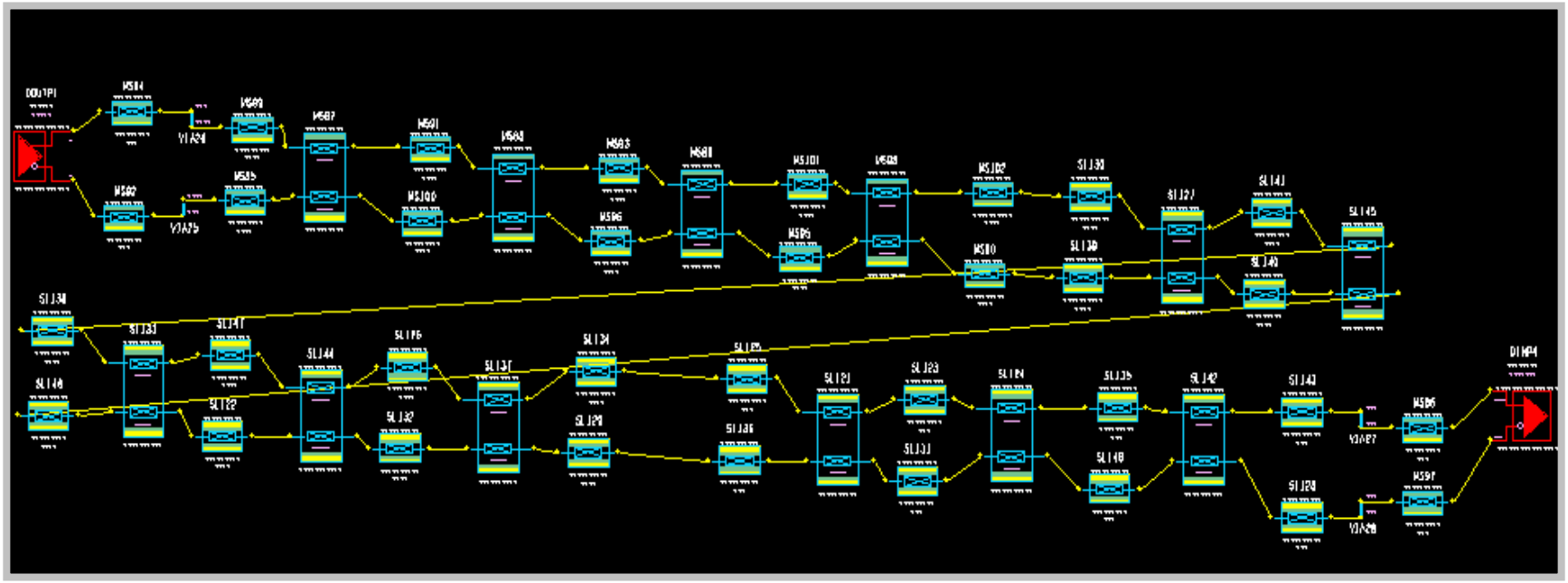
Receiver: Micron MT46V16M8TG

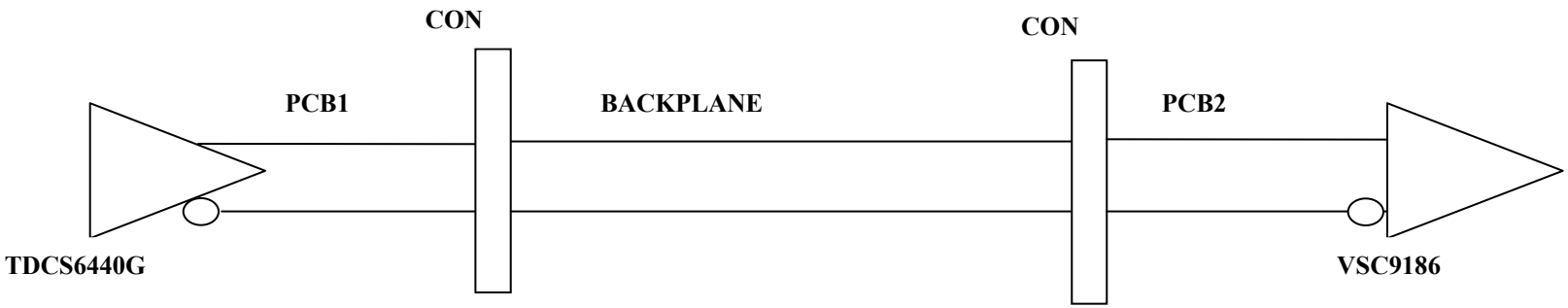


Blue: Measured result

Red: Simulated result

Why IBIS （IBIS的好处）
- Industrial Examples（工业化例子）(622Mbps)





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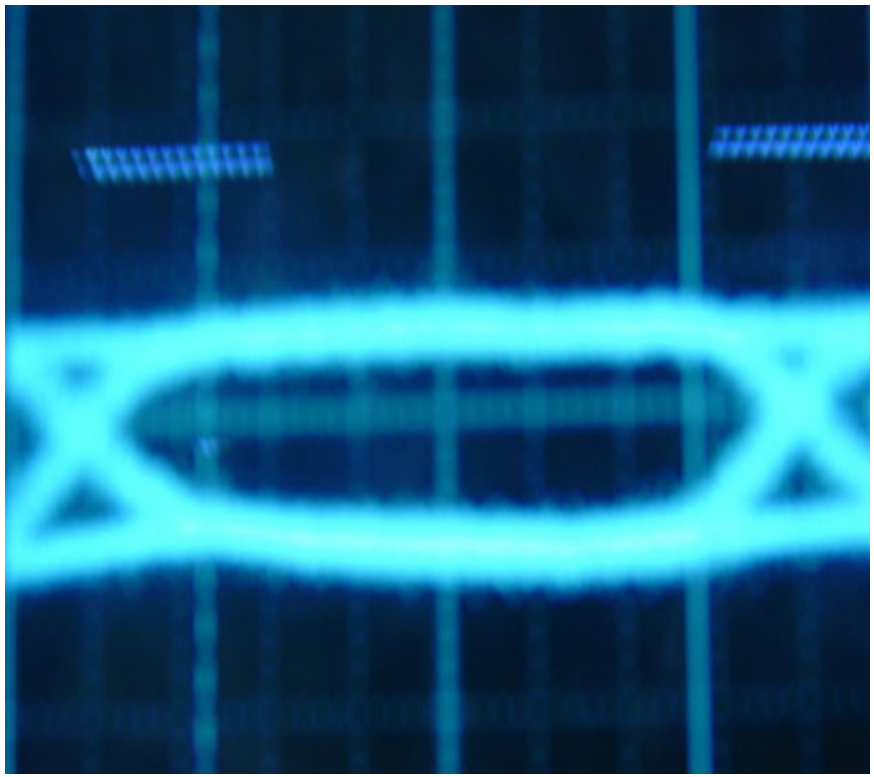

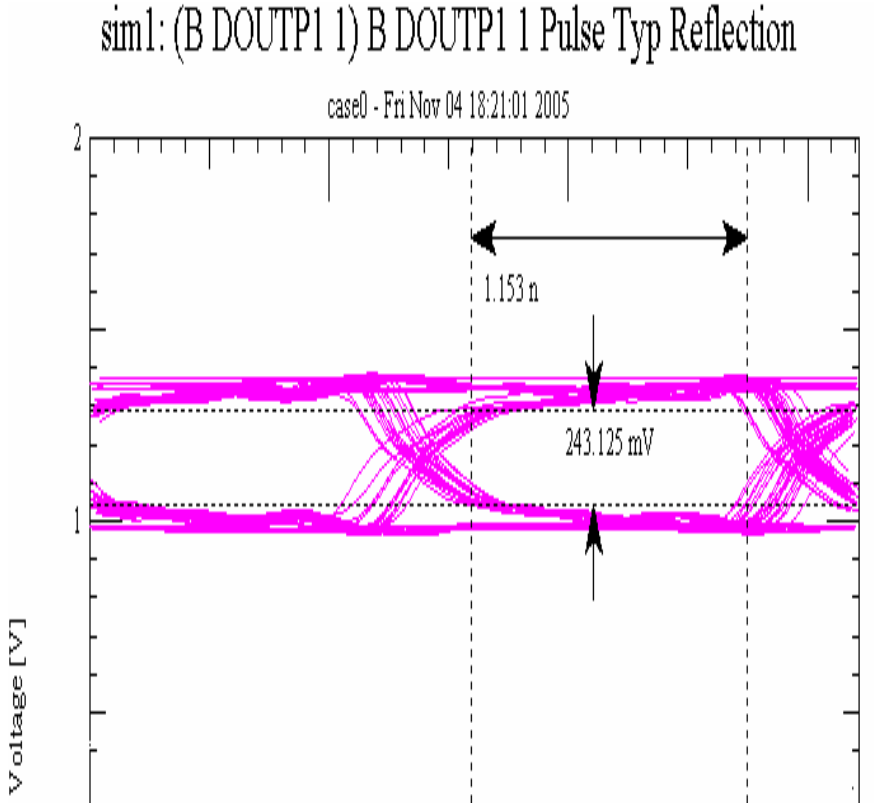

Eye Height: 210mv

Eye Width: 1.1ns

Eye Height: about 240mv

Eye Width: about 1.15ns

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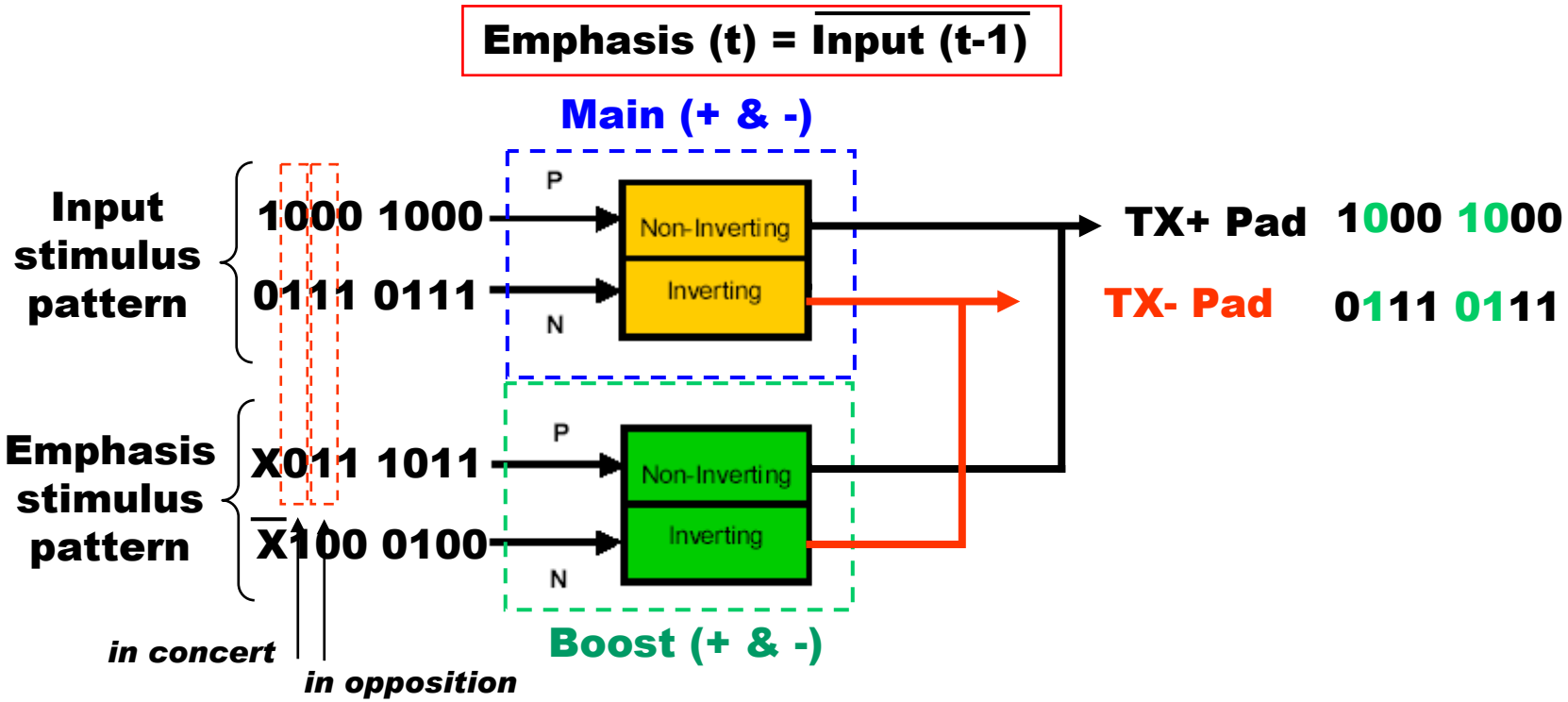
Complex-IO Devices（复杂I/O器件）

Pre-emphasis预加重/De-emphasis去加

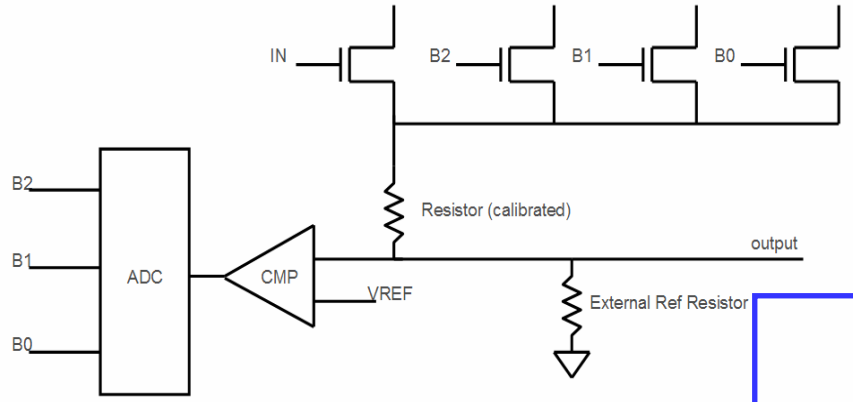


Picture from Michael Mirmak's presentation in DesignCon East IBIS Summit 2004

Complex-IO Devices（复杂I/O器件）

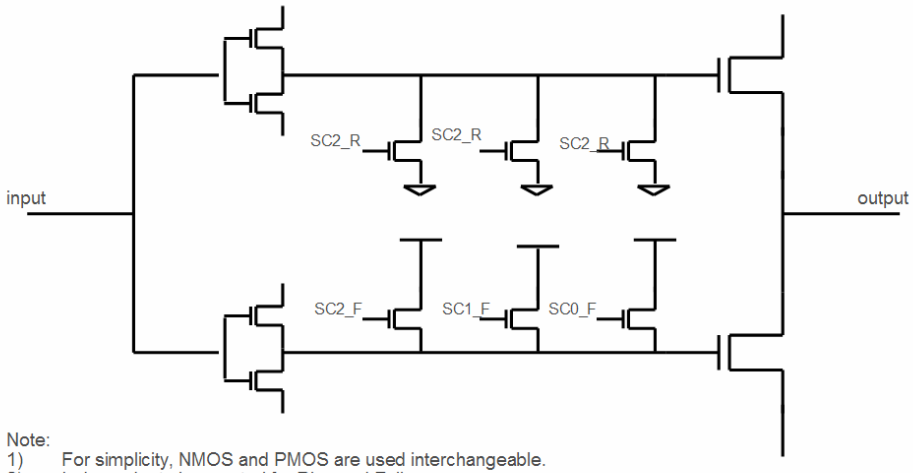
Self calibrating driver

(Calibrating Output Impedance only)
(For DDR2, when controller in a read cycle, the receiver is terminate)
(50 ohms. The resistor also requires to calibrate at run-time)



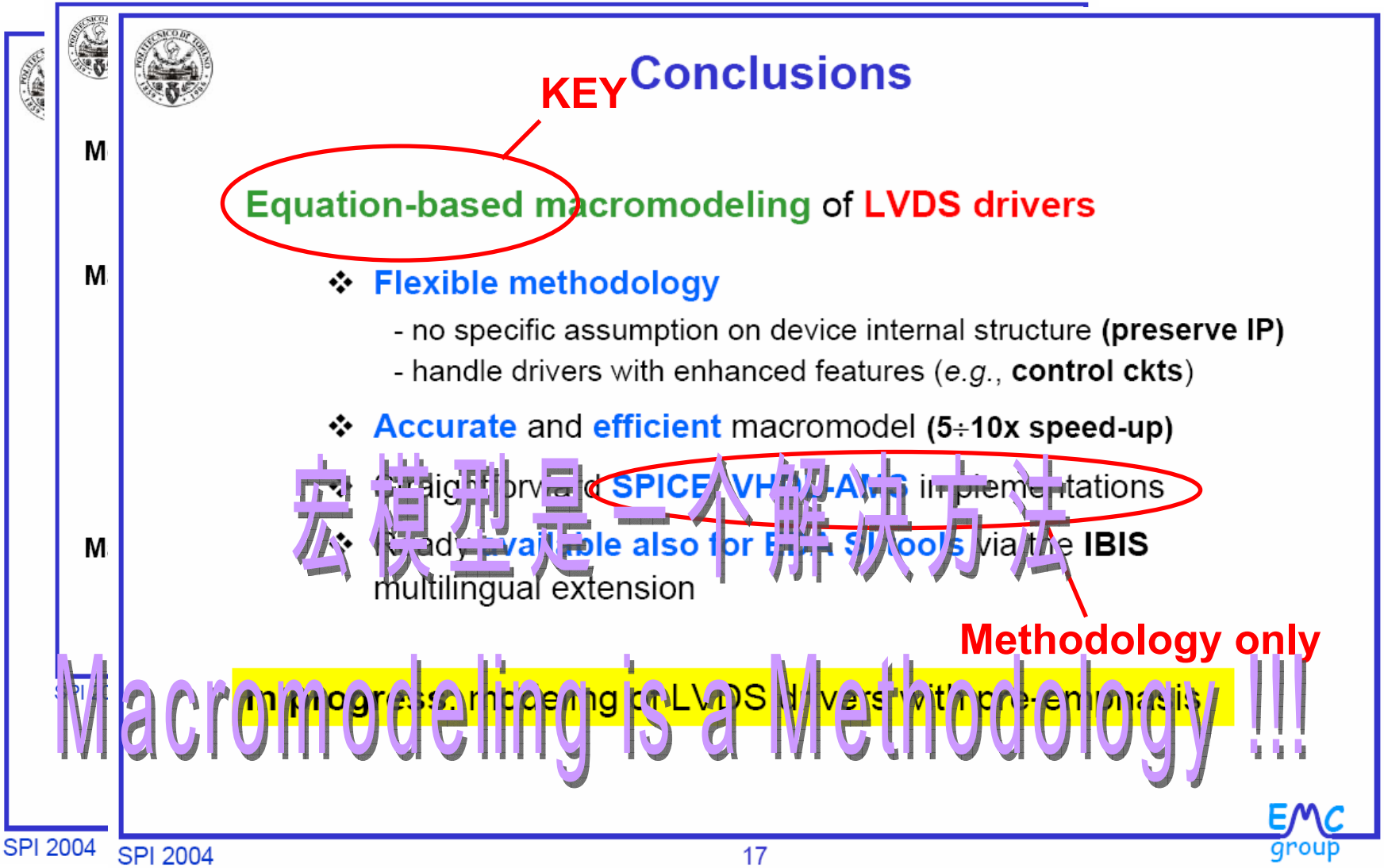
Note:
1) PMOS side is not being shown here.

Driver with Slew Rate Control



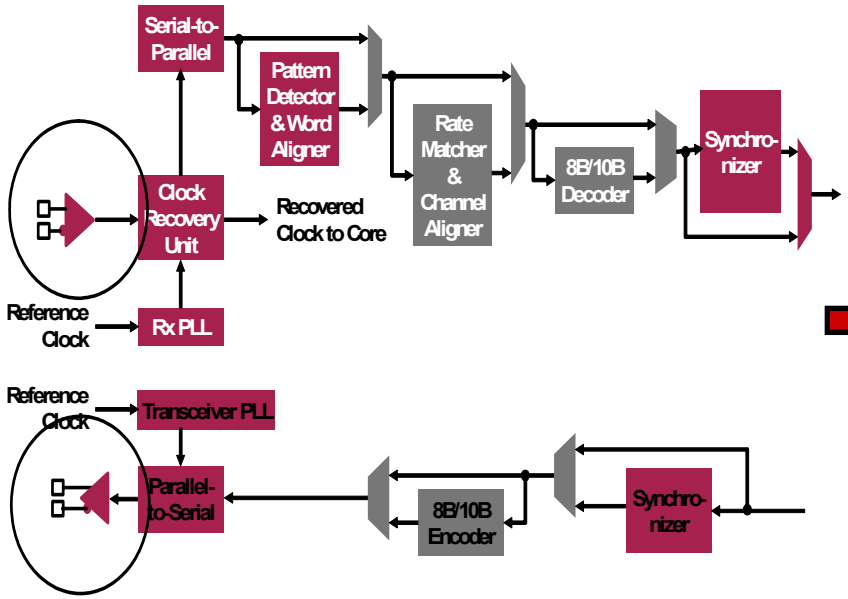
Note:
1) For simplicity, NMOS and PMOS are used interchangeable.
2) Independent slew control for Rise and Fall.

What is MacroModeling and Why?



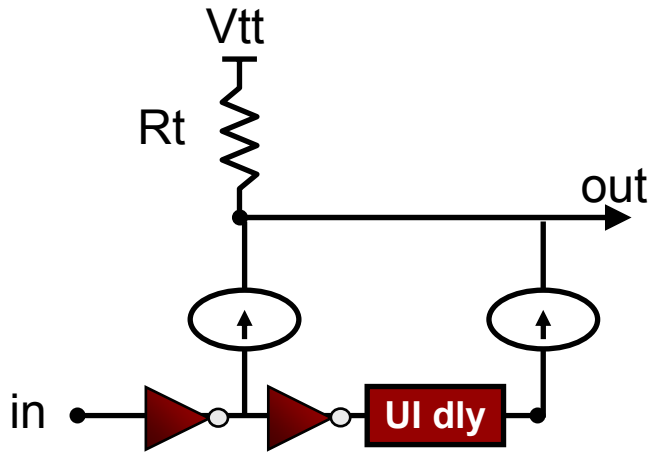
Macromodel from architecture templates
从器件结构中得出宏模型

- Most modern devices are based on known DSP circuit architectures



Known circuit architecture

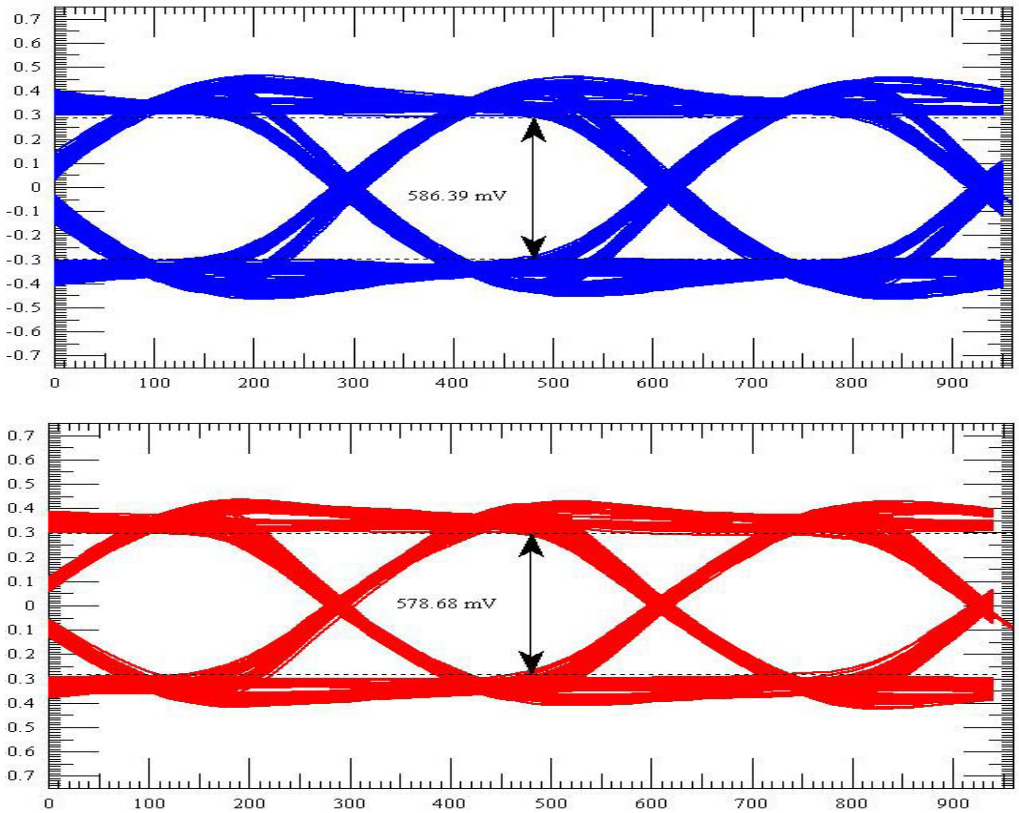
Match template parameters to Layout model to get an accurate macromodel



Macromodel template with parameters

Industry example- Altera Stratix GX

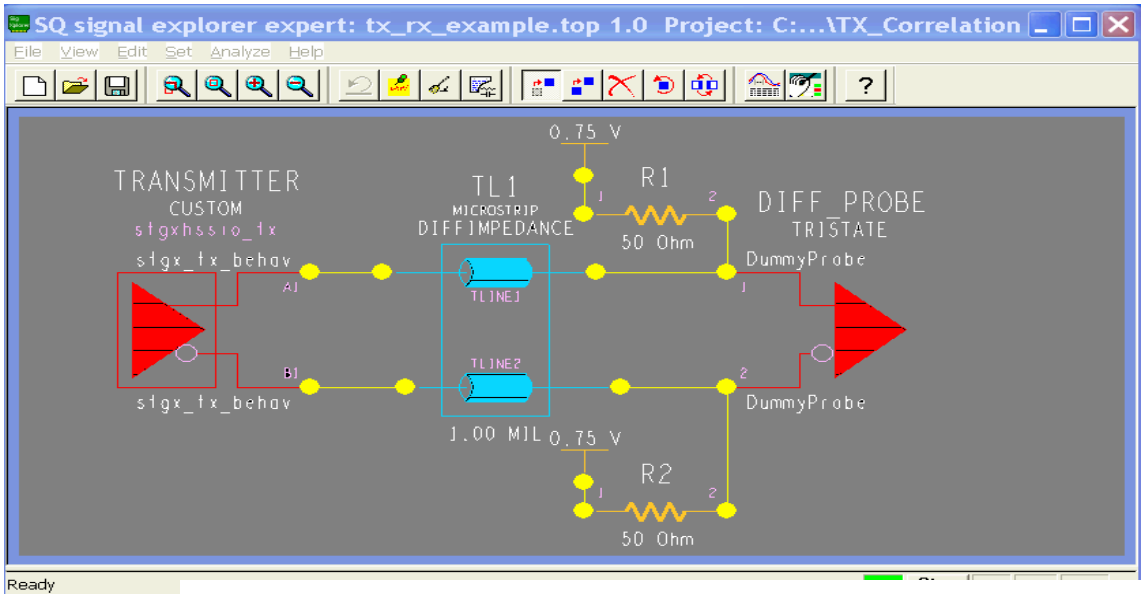
"Altera successfully adapted the MacroModel templates to produce fast and accurate models of our multi-gigabit transceivers. Not only did the resulting model correlate well, it also simulates between 20 to 400 times faster than its transistor-level counterpart. And the model can be easily adjusted to match the behaviors of actual silicon measured in the lab."

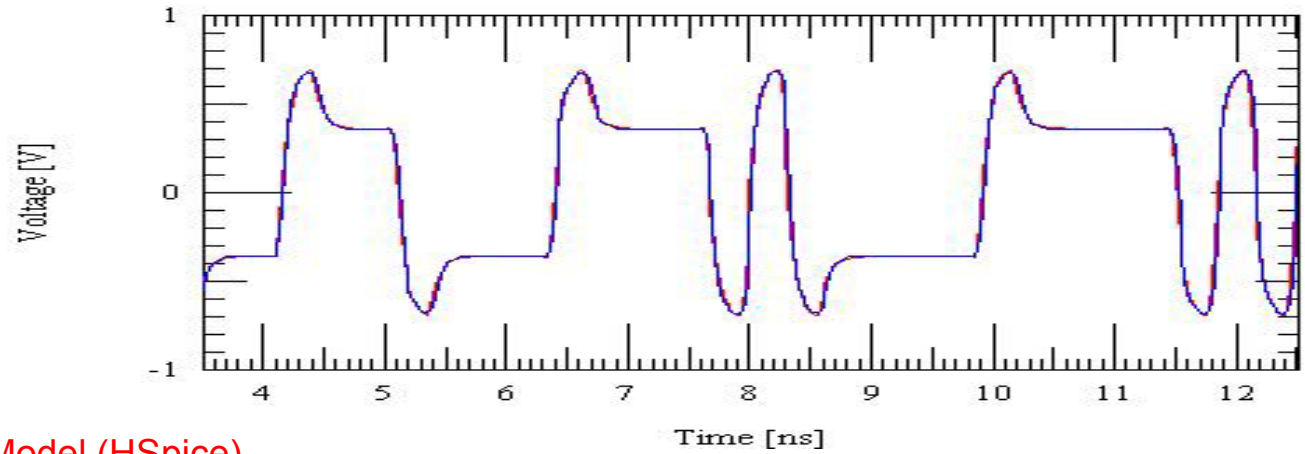


Correlation: MacroModel vs TransistorModel

"Overall, the templates were simple to work with and very valuable amidst the challenges of multi-gigahertz design."

Correlation - Altera Stratix GX

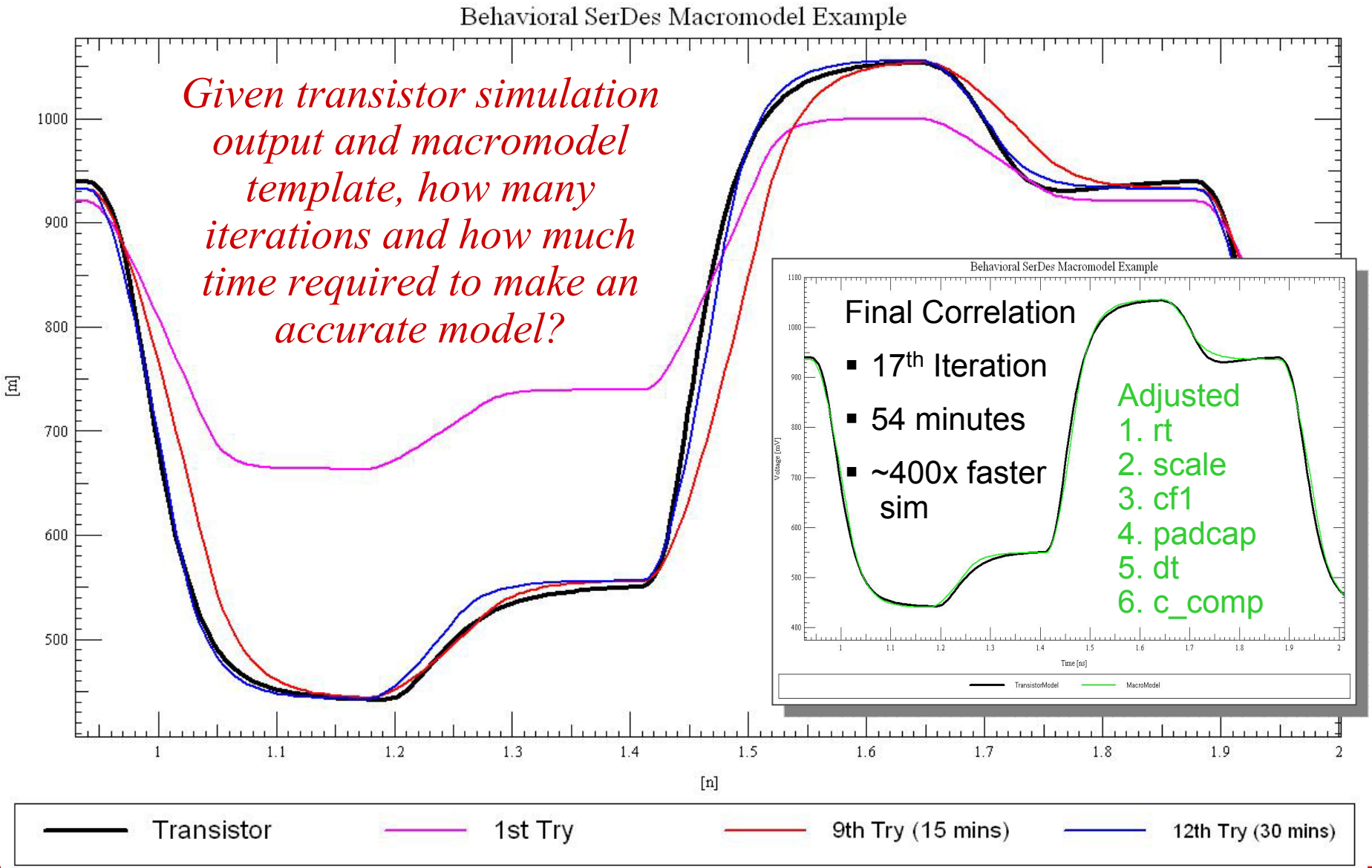




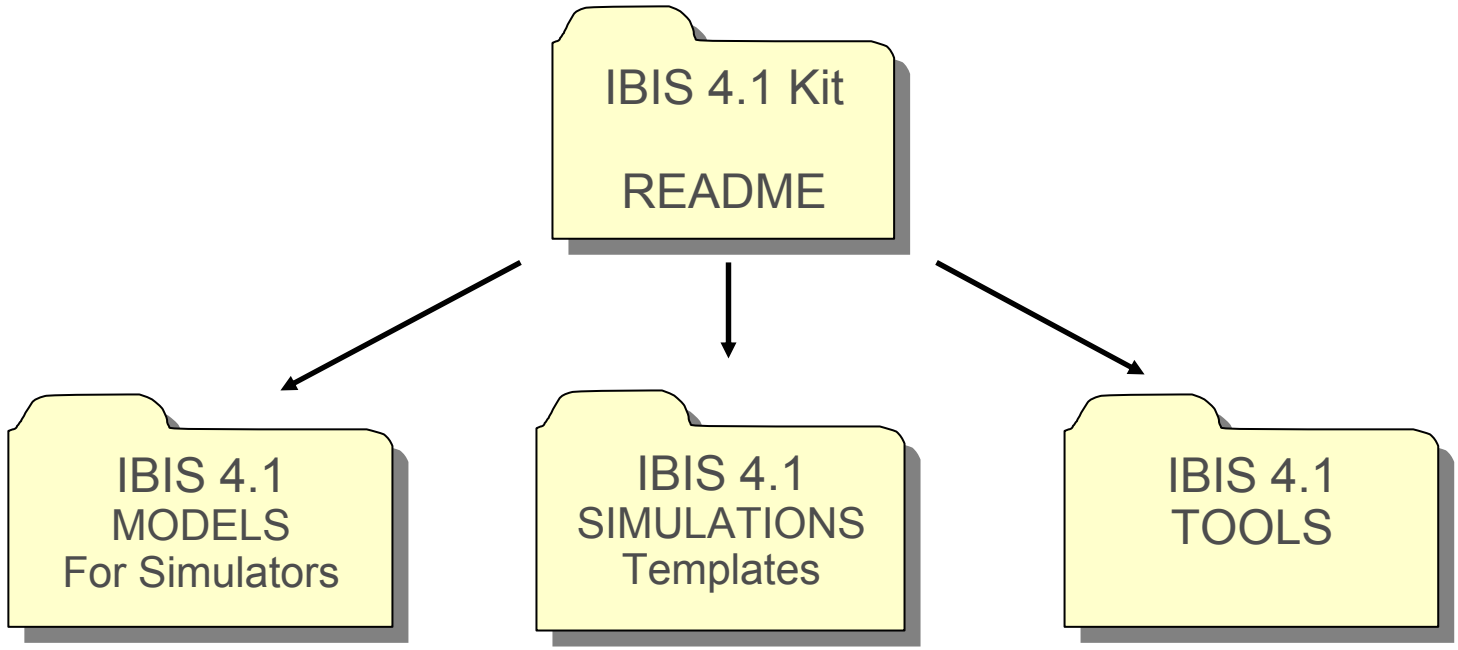
Transmitter output at factor=5

- Transistor Level Model (HSpice)
- Spice Macromodel (Cadence DML)

Case Study: Agere Systems 4 Gbps SerDes



Cadence IBIS 4.1 Kit



- SPICE
- HSpice
- Spectre

- SerDes
- Gate Modulation
- PCI Express IO
- Non-ideal Power
- Pass-thru Rx
- Self-calibrating Tx
- DFE

- Ibis2signoise
- Ibischk4
- SPICE manual

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Thank You

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