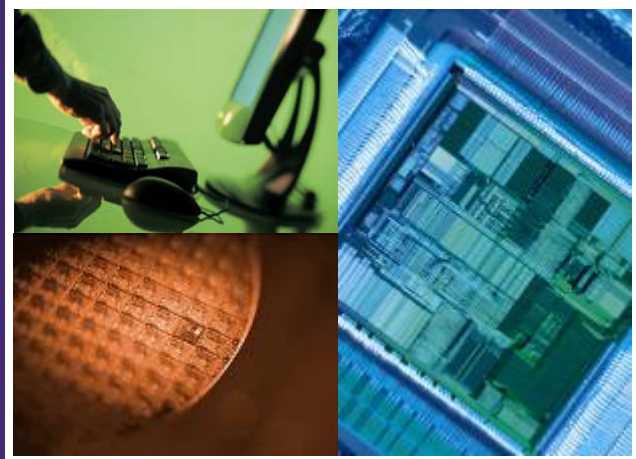
IBIS Algorithm Including Reactive Loads



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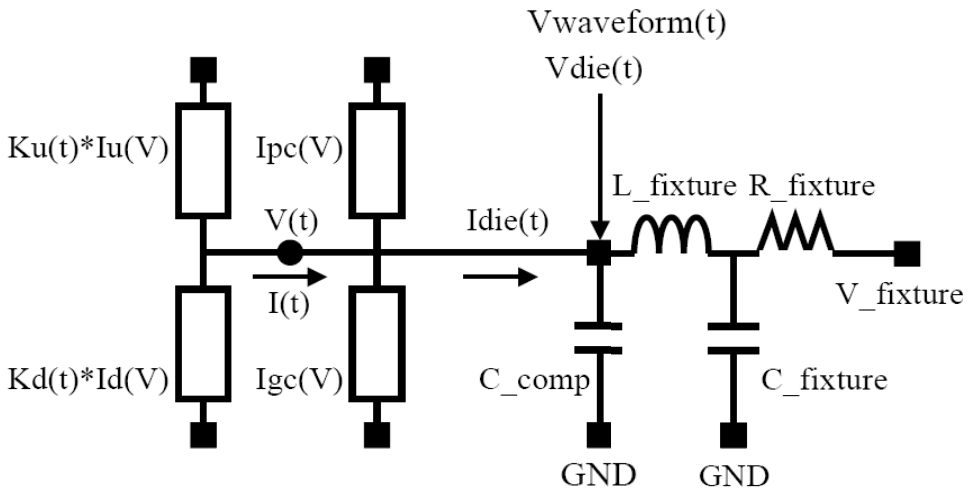
Outline

- Accuracy Issue of Reactive Loads
  - Concept of Reactive Loads
  - Related Presentation Before
  - Example of the Issue
- IBIS Algorithm with R/L/C/V_fixture
  - Algorithm Steps and Equations Involved
  - Recall the Example with Above Algorithm
- Conclusions

Reactive Loads



The general Reactive load in this presentation is the **R/C/L/V_fixture** load shown in the diagram

The presentation does not consider additional components **L/R/C_dut** defined in the IBIS standard (not shown) to mimic the package model of a specific pin

Related Presentation in Past Meetings

- Arpad Muranyi: http://www.vhdl.org/pub/ibis/summits/feb06/muranyi2.pdf
  Deals with a series capacitor (C_load) in series with R_load.
  Found difficulties applying the 2EQ/2UK process.

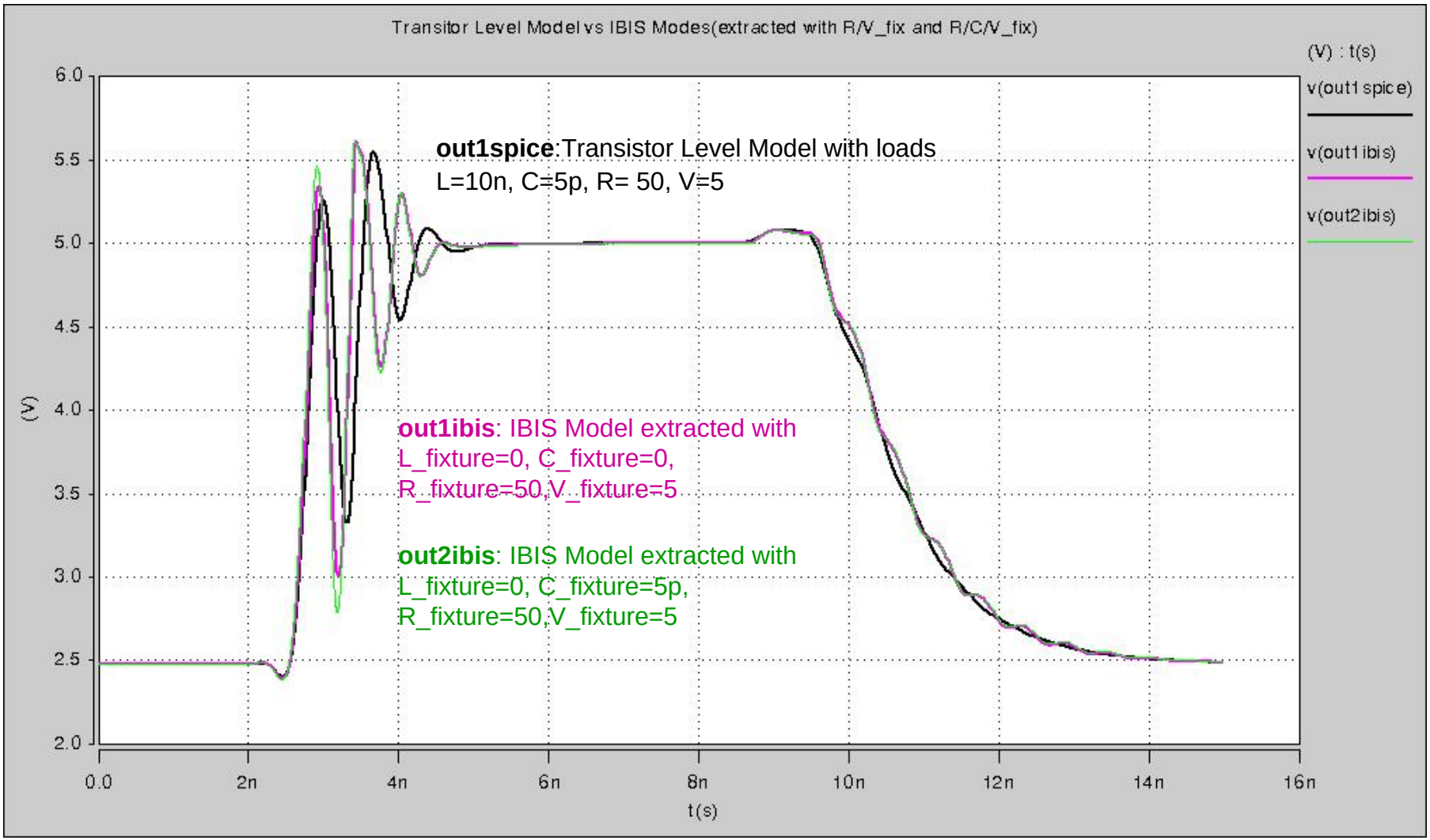
- Manfred Maurer: http://www.vhdl.org/pub/ibis/summits/apr07/maurer.pdf
  Considered using R_fixture, L_fixture, C_fixture by superposition.
  Not yet resolved for series C_load with R_load problem.

- Bob Ross: http://www.vhdl.org/pub/ibis/summits/feb06/ross1.pdf
  Suggested using C_fixture (if handled by IBIS processing algorithm) for buffer peaking to compensate for connected buffers and C_comp loading interactions.

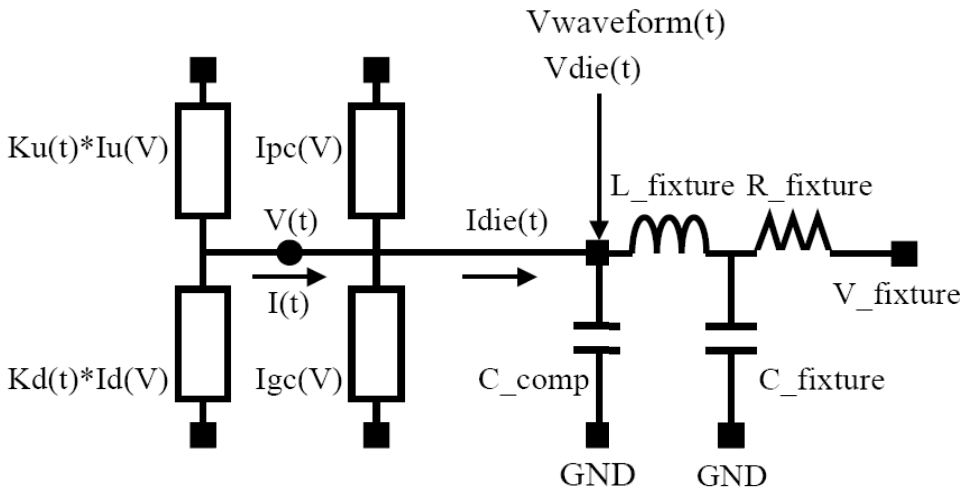
- Michael Mirmak: http://www.vhdl.org/pub/ibis/summits/apr04/mirmak2.pdf
  Considered C_comp extraction issues when buffers are connected and interact.

Example:

Accuracy Issue with L, C, R, V Loads



IBIS Algorithm with R/L/C/V_fixture



Two steps to get scaling coefficients of PU, PD (Ku,Kd)

1. Get $I_{die}(t)$ by VT waveforms, C_comp and *_fixture
2. Use the well known 2EQ/2UK algorithm

$$0 = Ku(t) * Iu(V_{wfm1}(t)) + Ipc(V_{wfm1}(t)) - Kd(t) * Id(V_{wfm1}(t)) - Igc(V_{wfm1}(t)) - Idie(V_{wfm1}(t))$$
$$0 = Ku(t) * Iu(V_{wfm2}(t)) + Ipc(V_{wfm2}(t)) - Kd(t) * Id(V_{wfm2}(t)) - Igc(V_{wfm2}(t)) - Idie(V_{wfm2}(t))$$

IBIS Algorithm with R/L/C/V_fixture (Cont.)

- Compute $I_{die}(t)$ of preceded step 1

$$I_{die}(t) = I_{Ccomp}(t) + I_{Lfix}(t)$$

$C_{comp} * dV_{wfm} / dt$

Differential equations:

$$dI_{Lfix}(t)/dt = (V_{Cfix}(t) - V_{wvf}(t)) / Lfix$$

$$dV_{Cfix}(t)/dt = ((Vfix - V_{Cfix}(t)) / Rfix - I_{Lfix}(t)) / Cfix$$

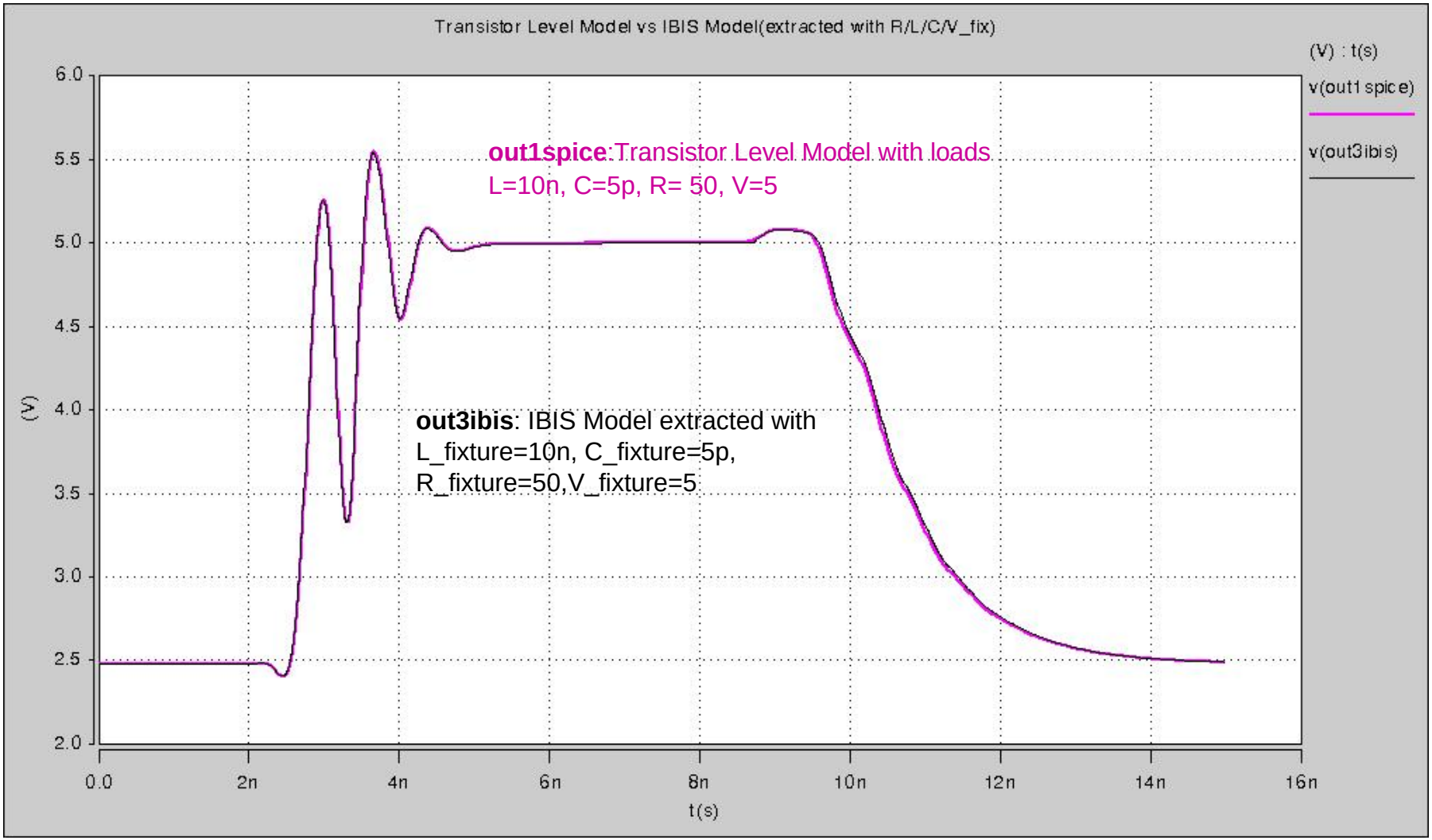
With initial values:

$$V_{Cfix}(0) = V_{wvf}(0)$$

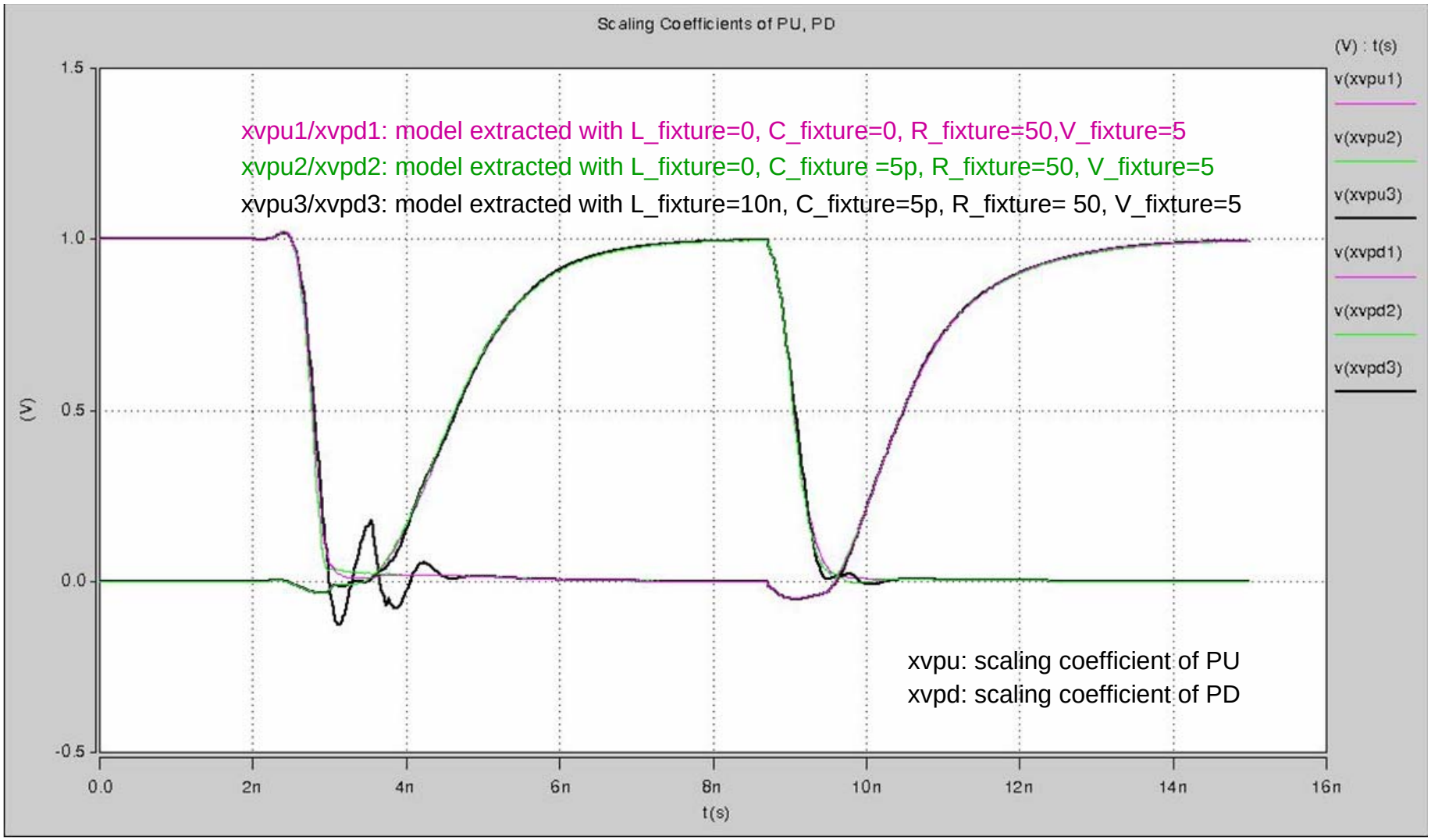
$$I_{Lfix}(0) = (Vfix - V_{wvf}(0)) / Rfix$$

Example:

Fitting Result if Model is Extracted with all L,C,R,V fixtures



Substantial Accuracy Improved



Conclusions

- For reactive loads, IBIS model result can be perfectly fitting with Transistor level model if proper R_fixture , V_fixture, C_fixture , L_fixture are used in model extraction
- The proper values of them are based on practical loads

Special Thanks to Bob Ross

For the help of providing research background, review and good suggestions for this presentation

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