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Accurate SI/PI Analysis of Differential Interfaces: Addressing Limitations in Power Aware IBIS Modeling Methodology

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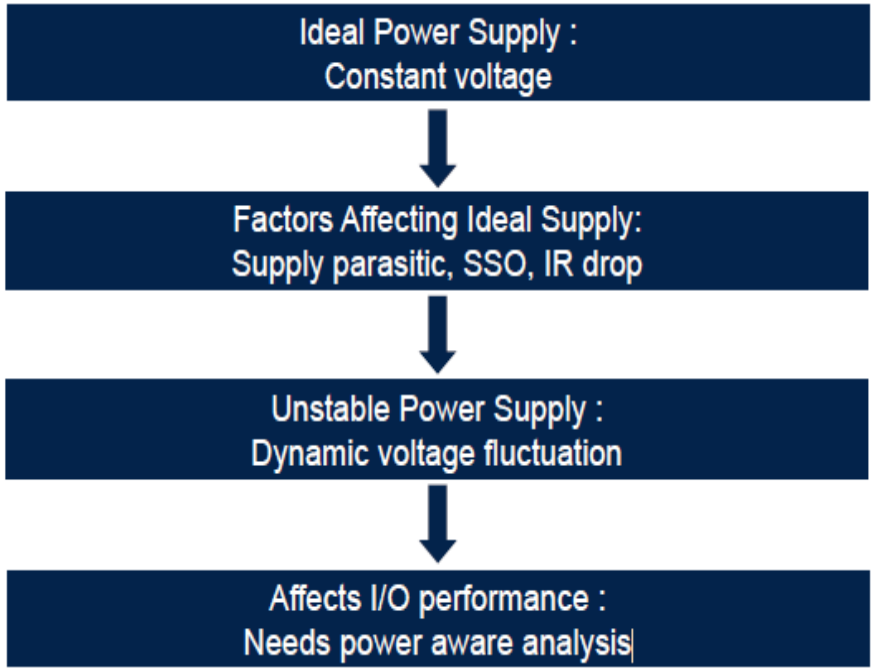
Introduction

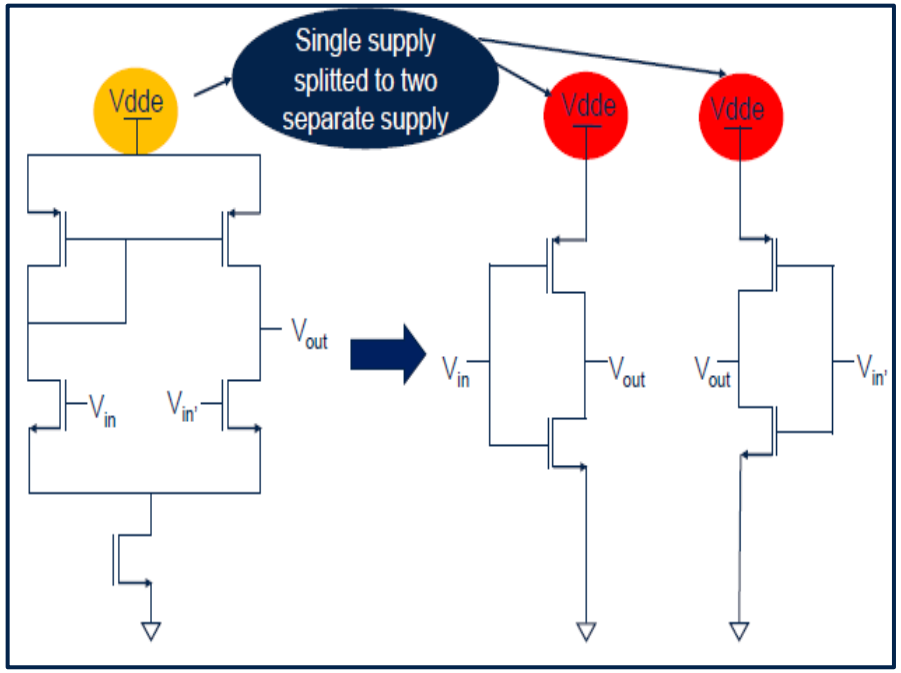
- Various factors on a PCB can introduce fluctuation in power supply
  - These fluctuation affects I/O performance, and may cause functional failure too
- Power aware analysis captures impact of supply fluctuations on I/O behavior
  - It helps identify issues like power droop, ground bounce, etc., before they cause any functional failure
- For power aware analysis IBIS ver.5.0 onward is a widely acceptable solution
  - IBIS captures comprehensive power supply voltage variation in following tables:
    - **[Composite Current]** → Captures total supply current during transition
    - **[ISSO PU/PD]** → Captures dynamic gate modulation from PDN

[Composite Current] and [ISSO PU/PD] table represents realistic buffer current on supply rail and enable models for reliable PI analysis



Challenge

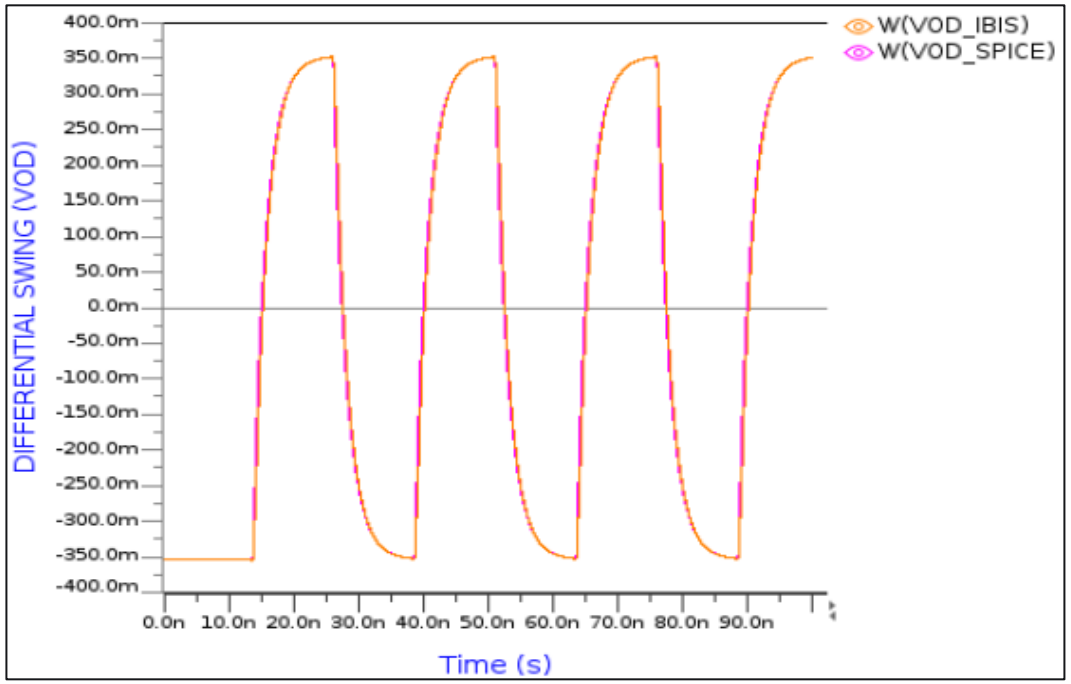
- True differential I/O pads shares a single common power supply
  - Supply current drawn during switching is combined response of the differential pair
- IBIS model of true differential I/Os are approximated using pseudo differential representation
  - Each differential pad are treated as an independent single ended buffer
  - Power supply of each pad is assumed separately (**inaccurate assumption**)
  - Composite current for each pad is calculated separately
- This incorrect assumption leads to:
  - Double counting of total switching current
  - Resulting in overestimation of supply current

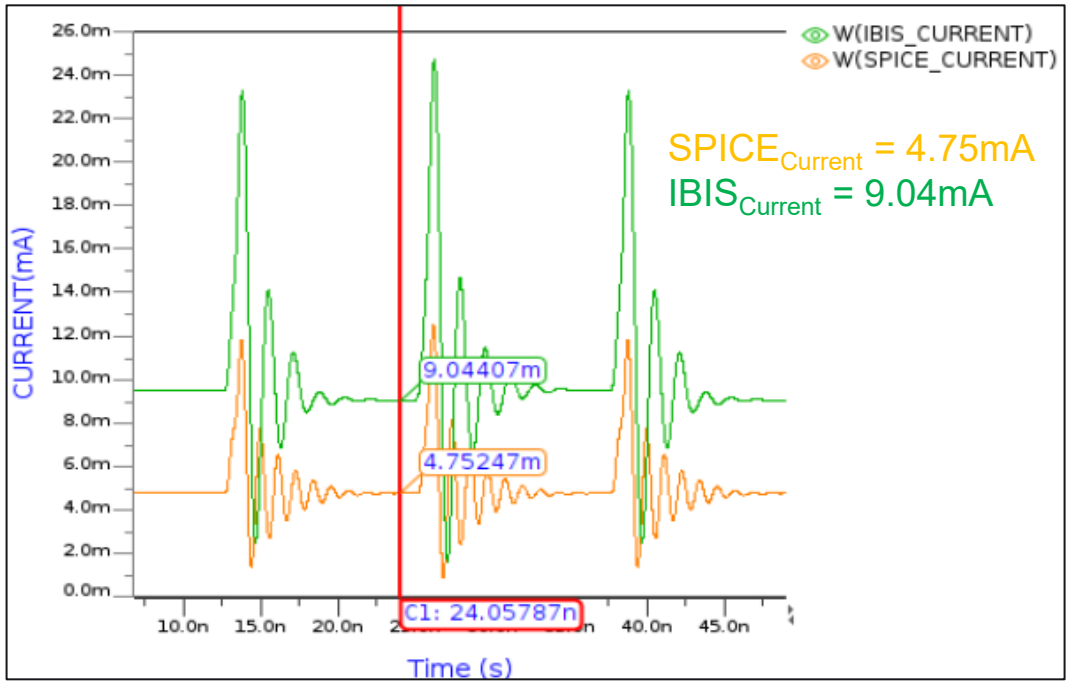


True differential I/O : Pseudo differential representation

❑ **Composite current play's important role in reliable power analysis**

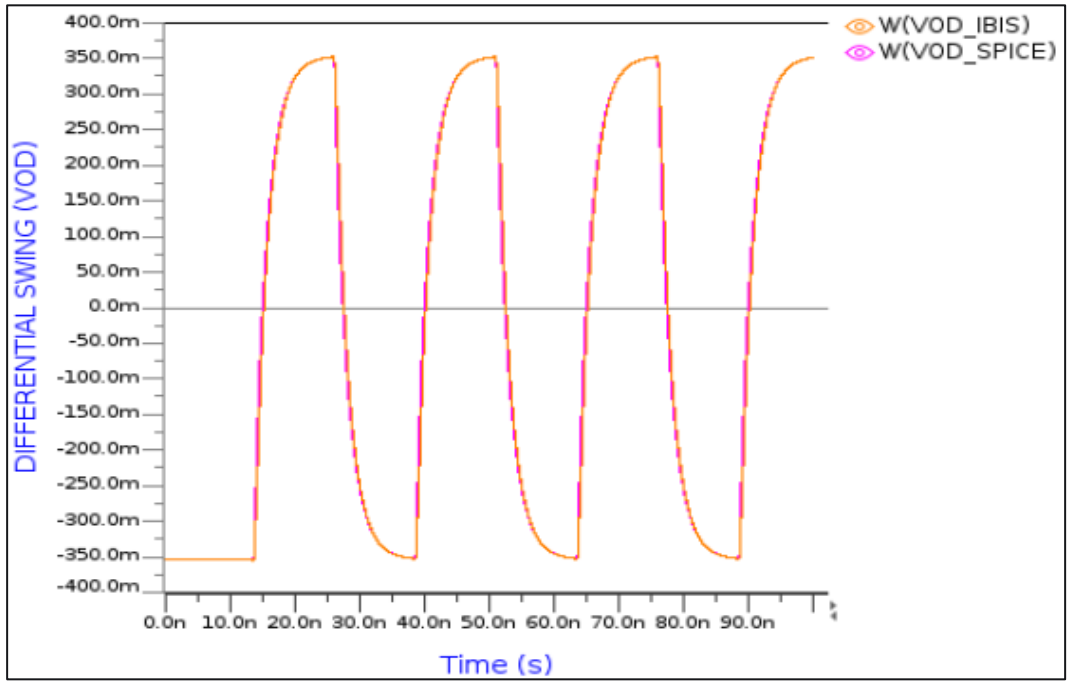
Conventional Modelling

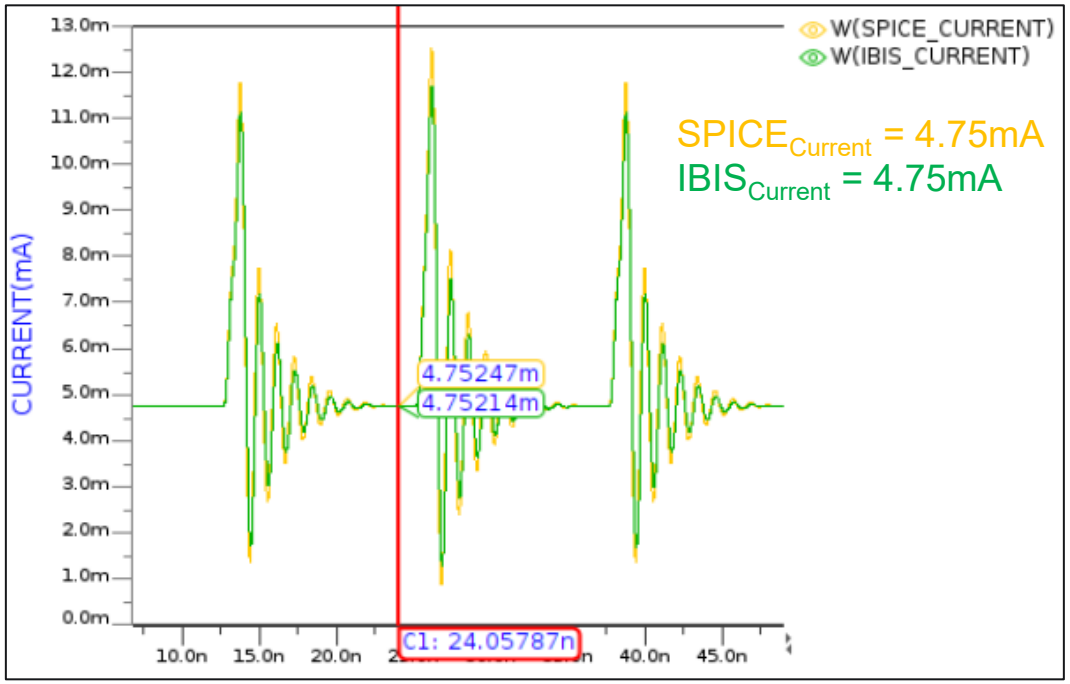




- IBIS accurately replicates differential voltage swing observed in SPICE simulations
- Supply current in IBIS is 2 times compared to reference SPICE
  - Due to duplication of supply current during capturing
- It results in misalignment between IBIS and SPICE supply current
- Affects the accuracy of power aware analysis

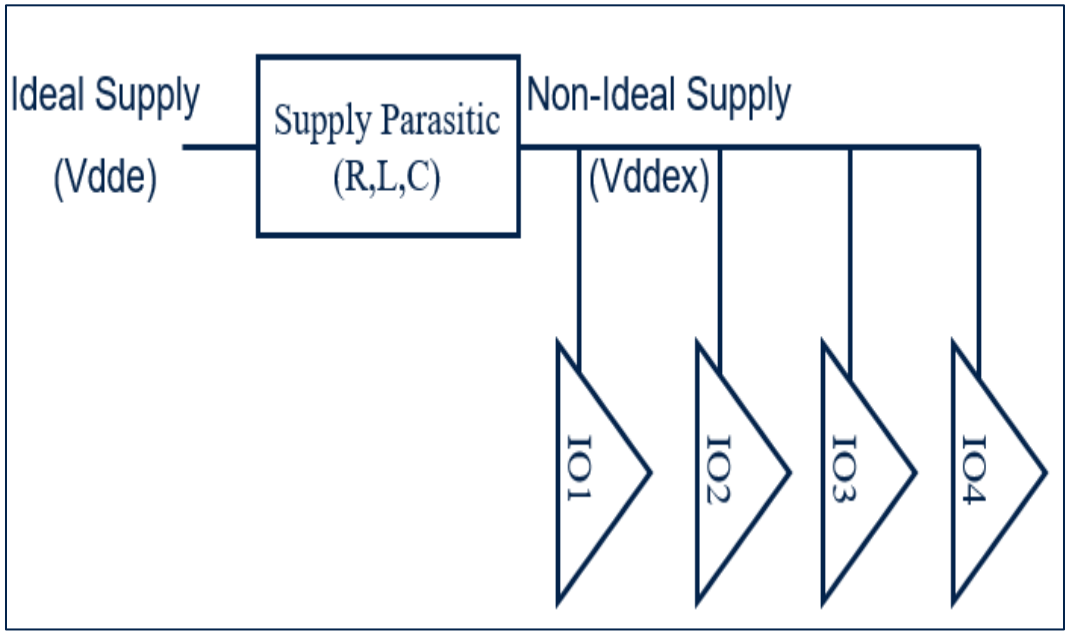
Proposed Solution

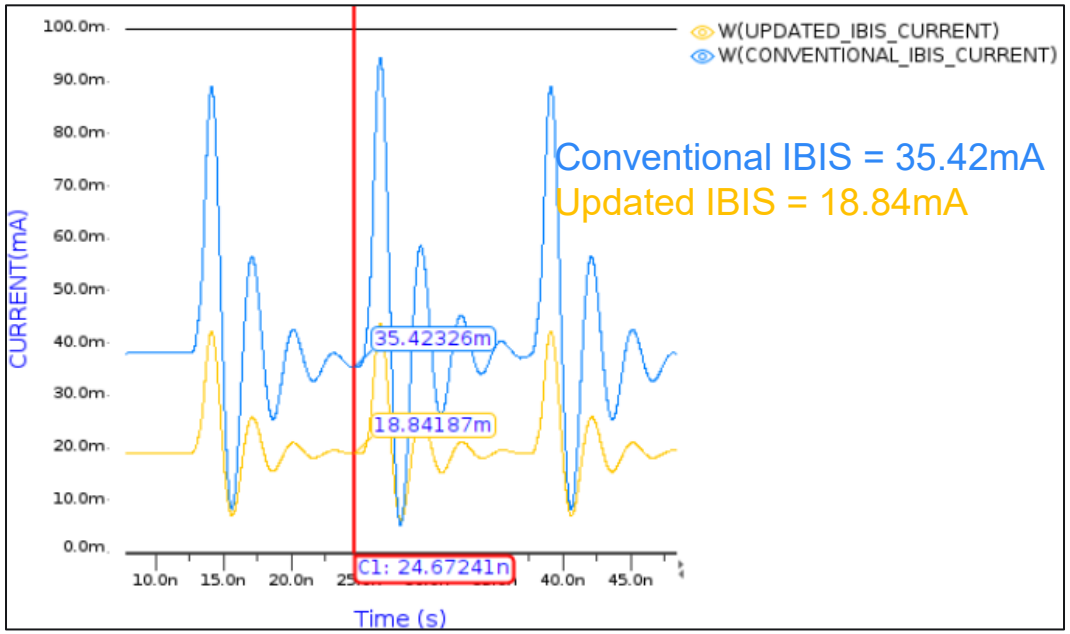




- True differential I/O shares a common supply and pre-driver circuitry for differential pads
- Proposed approach → as composite current is shared between pads
  - **Current per pad ≈ Half of total composite current**
- IBIS modelled using this approach closely matches SPICE supply current as well as differential swing

Conventional vs Proposed Approach Gain





- Considering 4 I/Os are biased from a common supply

  → Supply current from conventional IBIS model is approximately 2 times higher than actual current drawn

- On actual PCBs, multiple I/Os are biased from a common supply

  → Conventional IBIS model will overestimate supply current

- This incorrect representation of switching current results to inaccurate power aware analysis

Conclusion

- Proposed solution accurately represents shared power supply behavior of true differential I/O's
  - Ensures correct composite current representation
- Improves power integrity analysis accuracy:
  - Better prediction of supply noise
  - More reliable signal integrity and power integrity co-simulation under real world switching conditions
- Ensures reliable PDN analysis, with higher simulation confidence

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