Add Support of Power Delivery (PD) Analysis in IBIS

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Add Support of Power Delivery (PD) Analysis in IBIS

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Background

- Platform electrical design challenges increases, because of
  - Different optimization points of perf., cost, Form Factor, Power & Battery life, etc.
  - Multiple physical attributes permutations of stackups, single/double-sided, FF & shape
  - System design components supply chain shortage

- IBIS model has kept evolving since 1990s, supporting platform SI design.
  - IBIS (1.0) was initialized in 1990s.
  - IBIS (5.0) was ratified with AMI in 2008
  - IBIS (6.1) was ratified with PAM4 in 2015.
  - …

- No standard PI model defined, supporting platform PI design, until
  - BIRD223.1: Add support for SPIM in IBIS was approved by IBIS Open Forum in Nov. 2023
    - Tree Structure of *.spim File and the relevant syntax were defined and supported by FastPI
  - BIRD226: PSIJ Sensitivity was approved by IBIS Open Forum in Dec. 2023

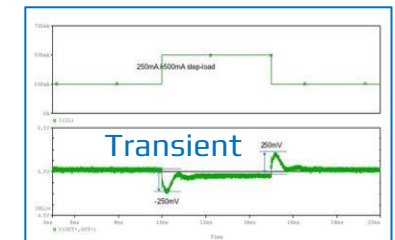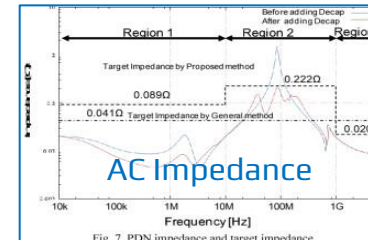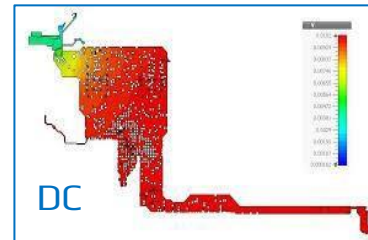Other names and brands may be claimed as the property of others. All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice.
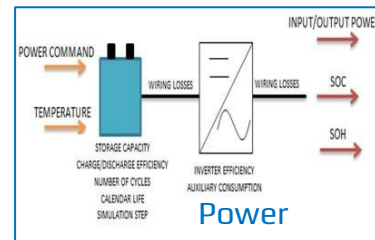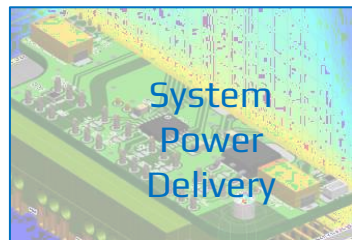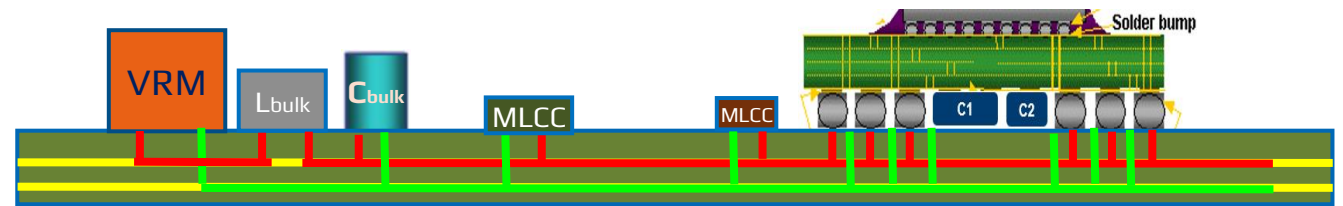
Objective

❑ Add Support in **IBIS**, for the analysis of system Power Delivery, including Power Consumption, Power Integrity of AC, DC & Transient, and the Co-simulation of SI & PI.

- Leverage & enhance the existing **IBIS** keywords at most
- Focus on the coverage beyond modeling accuracy

❑ Domains:

- The power consumption & loss
  - o from charger to on-die loading
- The AC impedance, DC
- The Transient,
 - o From buck/booster to on-die loading, with decoupling capacitances on-BRD/in-PKG/on-die

System Power Delivery

Power

DC

AC Impedance

Transient

* Courtesy to the authors of the pictures from internet.

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Importance of Modeling and Analysis of Power Consumption & Loss

- Power modeling is critical for (1) Battery Life of a mobile devices, and (2) user experiences of an Electrical Vehicles.

- The power becomes one the main limiting factors for the AI/ML data center hardware.

- About 2/3 area of a Graphic Card is occupied by power components of MOSFET, Bulk L/C.

* Courtesy to the authors of the pictures from internet.

This figure is from Zhiping Yang.
nVidia TDP Power Trend

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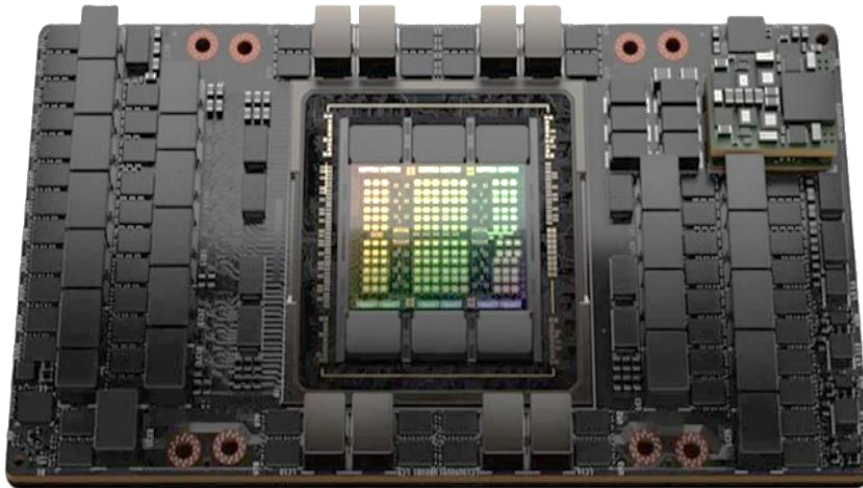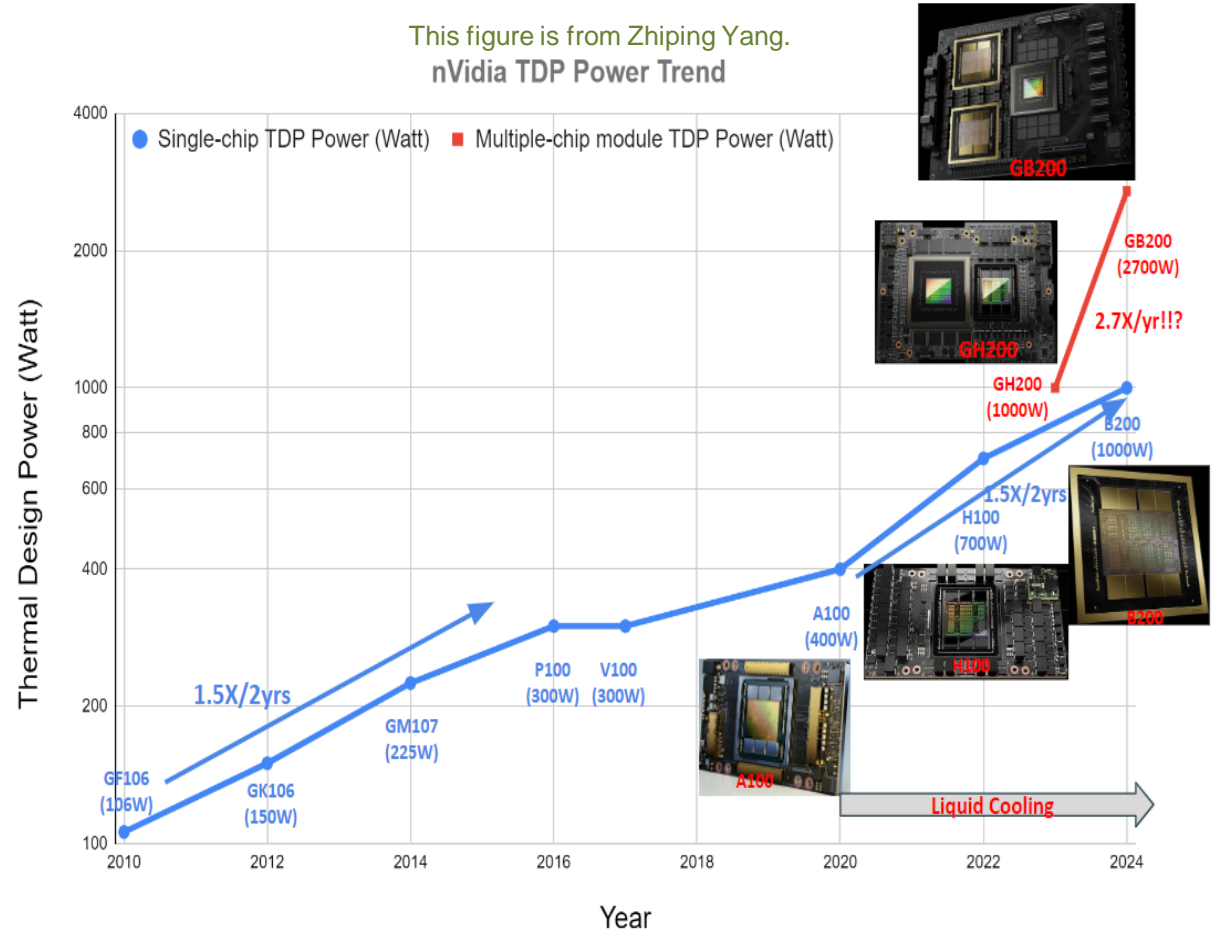
Power Components in system PD

- Passive components
  - Resistor - current sensing or stitching two power nets.
  - Capacitor - noise decoupling, R/L/C or s-parameter model.
  - Inductor - critical for switching power suppliers. (Yimajian Yan)
  - Transformer and/or coupled inductor – more popular
  - Ferrite Bead – noise isolation in power rails consolidation
  - Connector/socket – additional resistance and inductance

- Active components
  - Power Diode – charger circuit.
  - Transistor - Power MOSFET (V-drive)/ BJT (sP/HV) (I-drive)
  - Diode/Transistor - Diode incorporated MOSFET

- More components
  - PMIC Controller - Power management IC (Yimajian Yan)
  - DC/DC Converter – With/without integrated Power MOSFET
  - LDO - Low Dropout Regulator, integrated/discrete
  - Charger - Wired USB-C / Simple charging port /Wireless charging
  - Battery / Battery pack
 - Chip --- SPIM at PKG level, CPM at Silicon level

* Courtesy to the authors of the pictures from internet.

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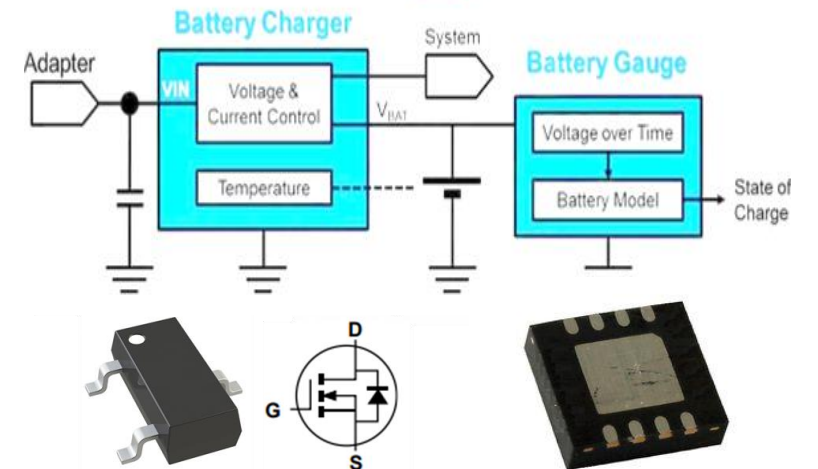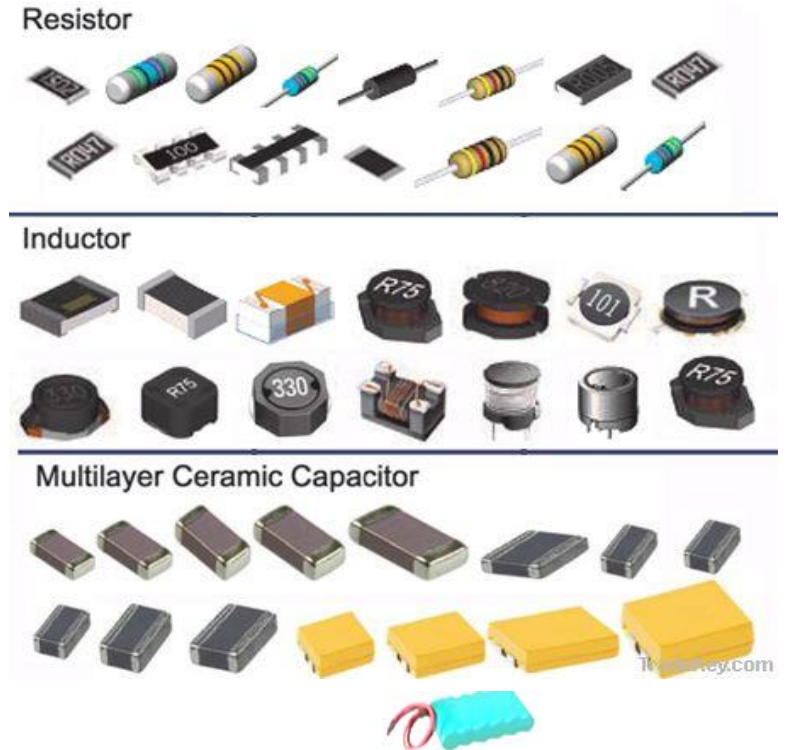
What has been done

- Expand IBIS for system-level PD initialized, presented by Zhiping Yang etc. in 2019 & 2022.
  - https://ibis.org/summits/feb19/yang.pdf
  - https://ibis.org/summits/aug22/yang.pdf

- IBIS Based Buck Converter DC Modeling, presented by Zhiping Yang etc. in 2020.
  - https://ibis.org/summits/aug20/yang.pdf
  - https://ibis.org/summits/jan20/yang.pdf

- Inductor loss model in system PI analysis & opt., presented by Yimajian Yan etc. in 2020
  - https://ibis.org/summits/aug20/yan.pdf

- IBIS Based Behavior Modeling CCM Buck Converter, presented by Zhiping Yang etc. in 2020
  - https://ibis.org/summits/aug20/huang.pdf

- Add Support for SPIM in IBIS, by Kinger Cai etc. in 2023, approved in November 2023
  - https://ibis.org/birds/bird223.1.docx

- PSIJ Sensitivity, by Kinger Cai etc. in 2023, approved in December 2023,
  - https://ibis.org/birds/bird226.docx

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What are the next steps:

- Call to action of all experts in the domains of PI/PD & Battery in the industry

- Figure out and agree on all components, passive or active, in system PDN path

- Each expert assumes the ownership of modeling of one (or two) PD component(s)

- For each relevant PD component, revisit/improve the existing model in IBIS Spec, or develop a new model, of those without existing models in IBIS Spec.

- Develop and submit BIRDs for (1) improving insufficient models, or (2) a new model.

- Present your PD model improvement and development in IBIS Summit

- Attend weekly IBIS ATM meetings to get feedbacks for your proposed BIRD(s), till official submission

- Attend monthly IBIS Open forum get your BIRD approved or concluded.
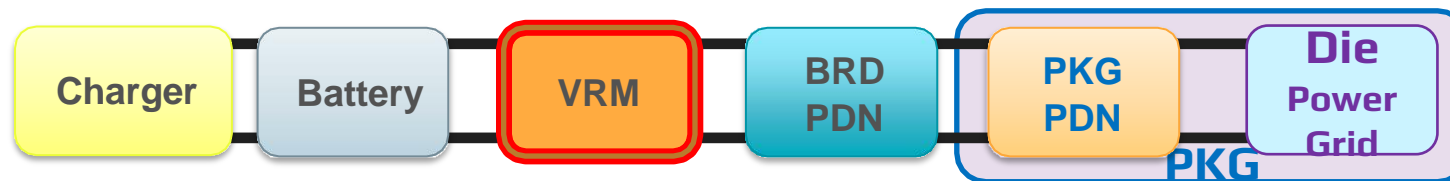
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