Add Support of Transient Analysis in SPIM: Update

SPIM = Streamlined Power Integrity Model

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Kinger is Sr. PE driving platform electrical arch. design & val., and industry Power & Signal Integrity standards & EDA tools evolution, in Solution Engineering Group in Arm.

Kinger was a Principal Engineer/Director, in Client Computing Group in Intel, where he led cross-functional teams in driving AI PC coherent architecture strategies across mobile & client platforms and overseen design & sign-off of numerous SoCs spanning media, mobile, client, discrete GPU, & CPU servers.

Kinger earned his Ph. D from Shanghai Jiao Tong University in 2001 and MBA degree from W.P. Carey business school in ASU in 2008.

Kinger has been focusing on signal & power integrity domains for 20+ years.

Kinger holds 14 granted patents, and published 30+ papers.

SPIM Status Quo & Expansion

- Supports in BIRD223.1, approved in Nov. 2023
  - AC impedance, with [SPIM Touchstone File] and [SPIM Target]
  - DC analysis, with [SPIM Rnetwork File], [SPIM Current] and [SPIM Voltage List]

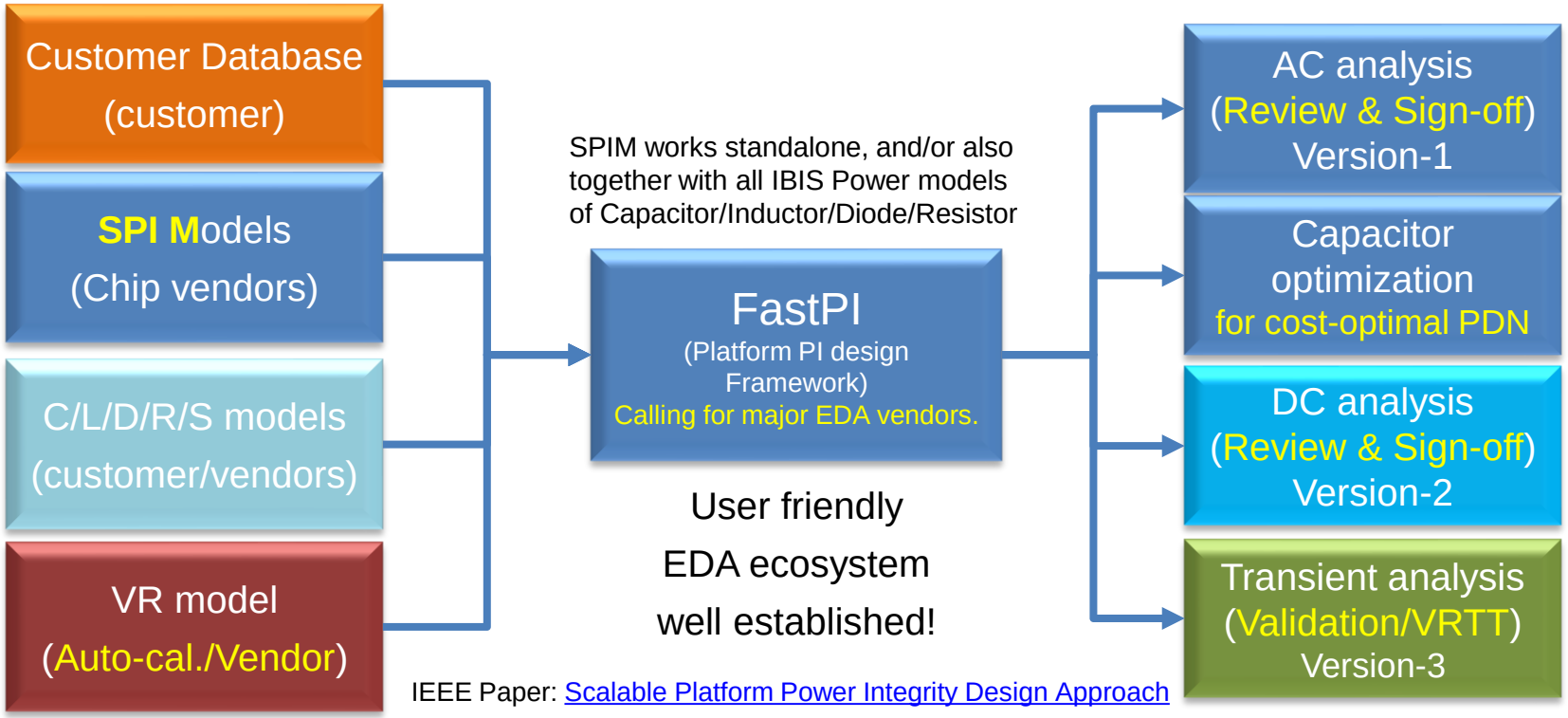
- Add Support for Transient analysis
  - Strongly desired by some PI designers, though it is indeed nice to have
  - "Add [SPIM icct File], and its generation & application', is updated to
  - "Add [SPIM Transient Current File], and its generation & application"
  - The existing [SPIM Current] only refers to DC current, for power DC analysis
  - Add [SPIM Transient Target] for Peak-to-Peak noise Vpp, Vmin and Vmax

SPIM - Streamlined Power Integrity Model, approved by IBIS Open Forum in Nov. 2023 , will be included in IBIS 8.0 in 2025

CVRM - Compact Voltage Regulator Model, published in 2021 IEEE International Joint EMC/SI/PI and EMC Europe Symposium

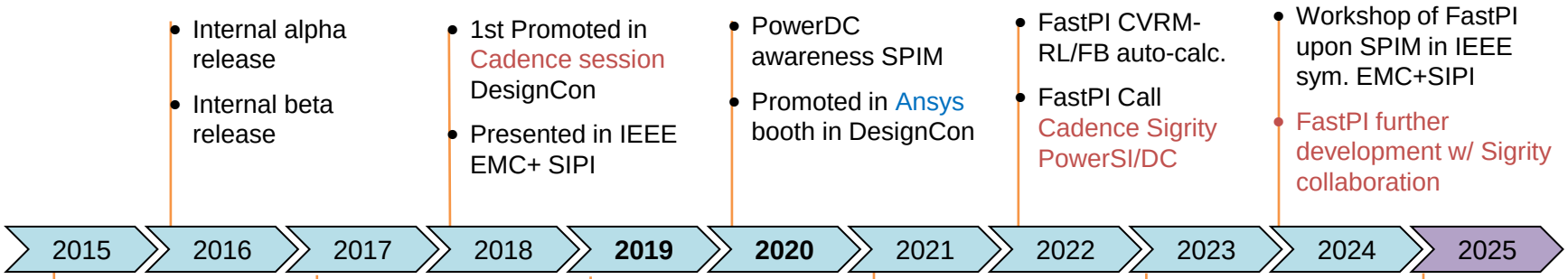
FastPI - Fidelity (AC/DC/Transient) Assessment System-level Technology/Tool of Power Integrity

FastPI (Platform PI Arch. with SPIM) Roadmap



IEEE Paper: [Scalable Platform Power Integrity Design Approach with Standard PI Model (SPIM) and Unified PI Target (UPIT)]

FastPI Roadmap with SPIM



Tree Structure of .spim FILE (Defined in BIRD223.1)

```
.spim FILE
-----------
  |-- File Header Section
  |   -------------------
  |     |-- [IBIS Ver]
  |     |-- [Comment Char]
  |     |-- [File Name]
  |     |-- [File Rev]
  |     |-- [Date]
  |     |-- [Source]
  |     |-- [Notes]
  |     |-- [Disclaimer]
  |     |-- [Copyright]
  |
  |-- [Device SPIM]
  |   -----------------
  |     |-- [Manufacturer]
  |     |-- [Description]
  |     |
  |     |-- [SPIM Rail]
  |     |   ------------
  |     |     |-- [SPIM Pin Cluster]
  |     |     |   -----------------
  |     |     |     |-- [End SPIM Pin Cluster]
  |     |     |     |
  |     |     |-- [SPIM Port List]
  |     |     |   ----------------
  |     |     |     |-- [End SPIM Port List]
  |     |     |     |
  |     |     |-- [SPIM Touchstone File]
  |     |     |   --------------------------
  |     |     |     |-- [SPIM Stimulus]
  |     |     |     |   ---------------
  |     |     |     |     |-- [End SPIM Stimulus]
  |     |     |     |-- [SPIM Target]
  |     |     |     |   ------------
  |     |     |     |     |-- [SPIM Observation Port]
  |     |     |     |     |-- [End SPIM Target]
  |     |     |     |-- [End SPIM Touchstone File]
  |     |     |     |
  |     |     |-- [SPIM Rnetwork File]
  |     |     |   ------------------------
  |     |     |     |-- [SPIM Current]
  |     |     |     |   --------------
  |     |     |     |     |-- [End SPIM Current]
  |     |     |     |-- [SPIM Voltage List]
  |     |     |     |   --------------
  |     |     |     |     |-- [End SPIM Voltage List]
  |     |     |     |-- [End SPIM Rnetwork File]
  |     |     |     |
  |     |     |-- [End SPIM Rail]
  |     |     |
  |     |-- [End Device SPIM]
  |
  |-- [End]
```

Insert new keywords.

.spim FILE Tree Structure Implication & Example

```
|      |      |
|      |      |-- [SPIM Rnetwork File]
|      |      |   -------------------------
|      |      |     |-- [SPIM Current]
|      |      |     |   --------------
|      |      |     |     |-- [End SPIM Current]
|      |      |     |-- [SPIM Voltage List]
|      |      |     |   --------------
|      |      |     |     |-- [End SPIM Voltage List]
|      |      |     |-- [End SPIM Rnetwork File]

|      |      |-- [SPIM Transient Current File]
|      |      |   -------------------------
|      |      |     |-- [SPIM Transient Target]
|      |      |     |   ------------
|      |      |     |     |-- [SPIM Observation Port]
|      |      |     |     |-- [End SPIM Transient Target]
|      |      |     |-- [End SPIM Transient Current File]
|      |      |
|      |      |-- [End SPIM Rail]
|      |
|      |-- [End Device SPIM]
```

```
|*****************************************
|Information for Transient analysis
|*****************************************
|
[SPIM Transient Current File]
| Text file in two columns of time and current amplitude
| File_name              Time_Delay   Repeat_time
SOC_CPU_VCC1_i-t.txt     0.0          0.0
|
[SPIM Transient Target]
[SPIM Observation Port] OB_Sense
| Vpp              Vmin              Vmax
  NA               0.600             1.400
|
[End SPIM Transient Target]
|
[End SPIM Transient Current File]

[End SPIM Rail]
|
|*****************************************
|
[End Device SPIM]
|
[End]
```

Example .spim FILE -Supports Transient Analysis

```
|
|*****************************************
|Information for Transient analysis
|*****************************************
|
[SPIM Transient Current File]
| File_name              Time_Delay    Repeat_time
Intel_CPU_VCC1_i-t.txt 0.0           0.0
|
[SPIM Transient Target]
[SPIM Observation Port] OB_Sense
| Vpp          Vmin          Vmax
  NA           0.600         1.400
|
[End SPIM Transient Target]
|
[End SPIM Transient Current File]
```

Intel_CPU_VCC1_i-t.txt

*time (second)	Current(A)
0.00000E+00	2
100.000E-09	2
105.000E-09	10
1500.00E-09	10
1505.00E-09	2
3000.00E-09	2
… …	

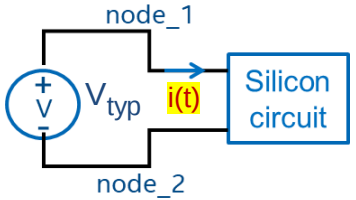
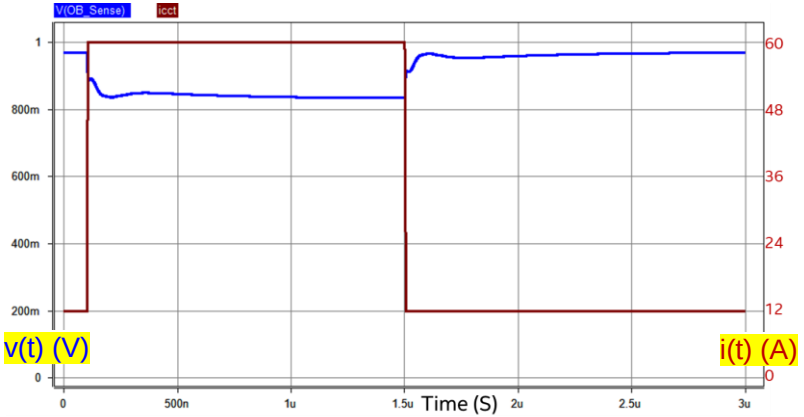


Fig.1 i(t) generation



SPIM Transient Analysis Setup

SOC_CPU_VCC1_i-t.txt

*time (second)	Current(A)
0.00000E+00	2
100.000E-09	2
105.000E-09	10
1500.00E-09	10
1505.00E-09	2
3000.00E-09	2
...	
...	

```
[SPIM Stimulus]
|OB_Stimulus    Weighting
OB_Stimulus_1    0.20
OB_Stimulus_2    0.10
OB_Stimulus_3    0.05
OB_Stimulus_4    0.05
OB_Stimulus_5    0.20
OB_Stimulus_6    0.05
OB_Stimulus_7    0.05
OB_Stimulus_8    0.30
[End SPIM Stimulus]
```

- i(t) profile under typical voltage directly at circuit node is shown in Fig.1.
- i(t) might specify time delay or repeat time, with default values of 0.
- In Power Integrity transient simulation with an actual power delivery network (PDN), the i(t) profile shall be connected as shown by Fig.3 through G element with the 2nd Polynomial function for accuracy, other than the 1st order connection as shown in Fig. 2 for efficient analysis.

* For example,

*.SUBCKT VCC1_i-t node1 node2 V_{typ}='1.0'

*Gpoly node1 node2 POLY(2) node1 node2 p n 0 0 0 0 '1/V_{typ}'

****VCCS i12 = 0+0*V_{12}+0*Vpn+0*V12*V12+'1/V_{typ}'*V_{12}

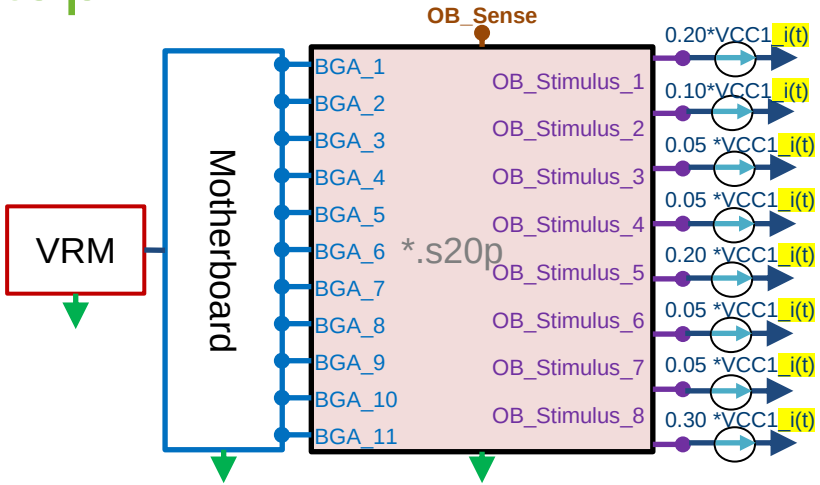


Illustration with the 1st order setup

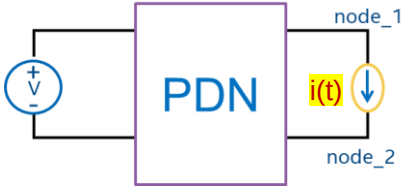


Fig.2 1st order setup

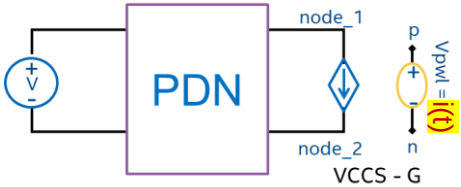


Fig.3 2nd order setup

Next Steps

- Review and revise this proposal through IBIS-ATM
  - Obtain EDA vendors to support Transient Analysis in SPIM
  - Obtain chip vendors to support Transient Analysis in SPIM
  - Obtain platform designers to support Transient Analysis in SPIM
- Submit BIRD of “Add Support of Transient Analysis in SPIM”
- Get approval of the BIRD of the same in IBIS Open Forum
- Integrate the BIRD of the same into upcoming IBIS Version release

Thank you!

QUESTIONS?

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