VICOR

Current Multiplier Technology Advances Enable New AI Processor Power Solutions

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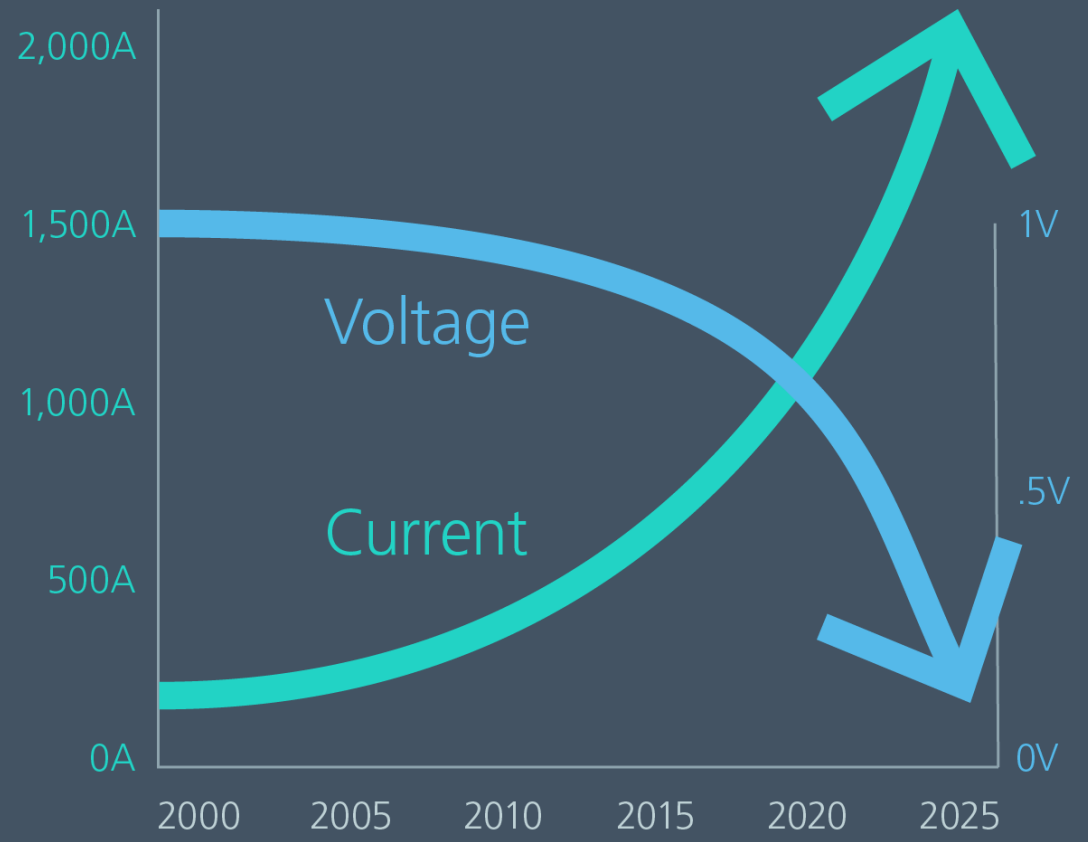
Powering high performance processors

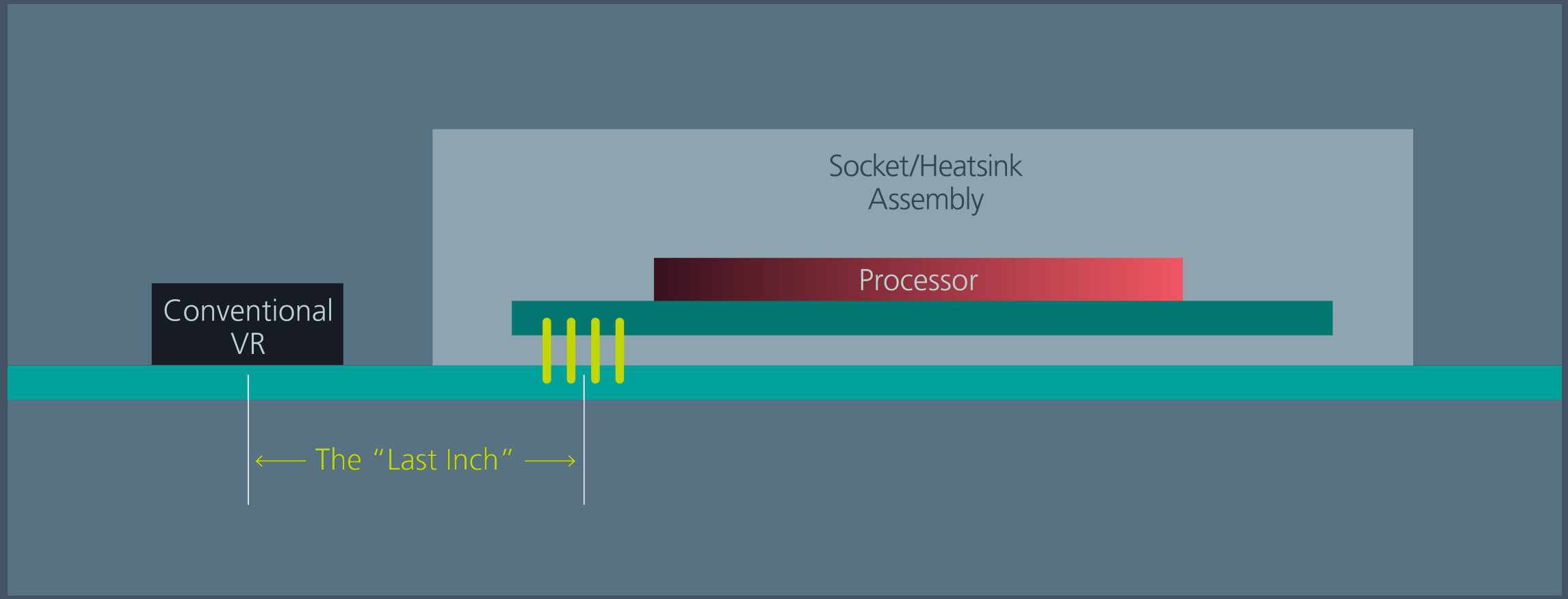
- Modern processors (GPU, CPU, NPU) need a lot of current…
- Decreases in power efficiency
  - Increasing PDN distribution losses
- Significant operating performance reduction if power demands are not met
- Added complexity of decreasing operating voltages as move continue to lower fabrication nodes



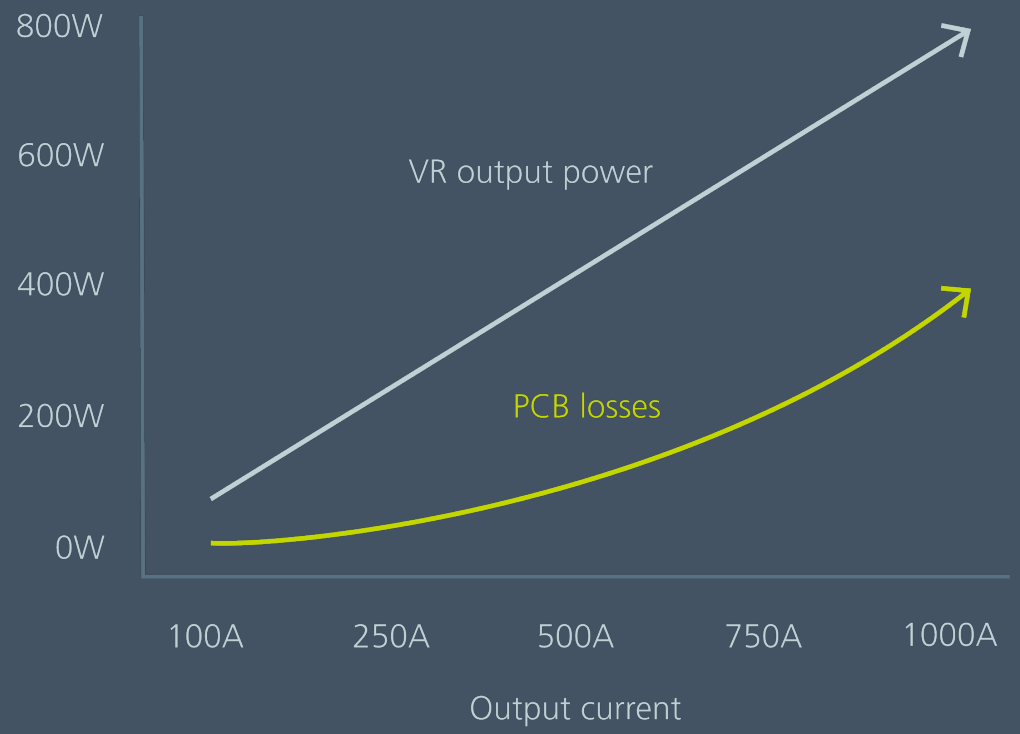
Progression of processor peak current requirements and lower operating voltages

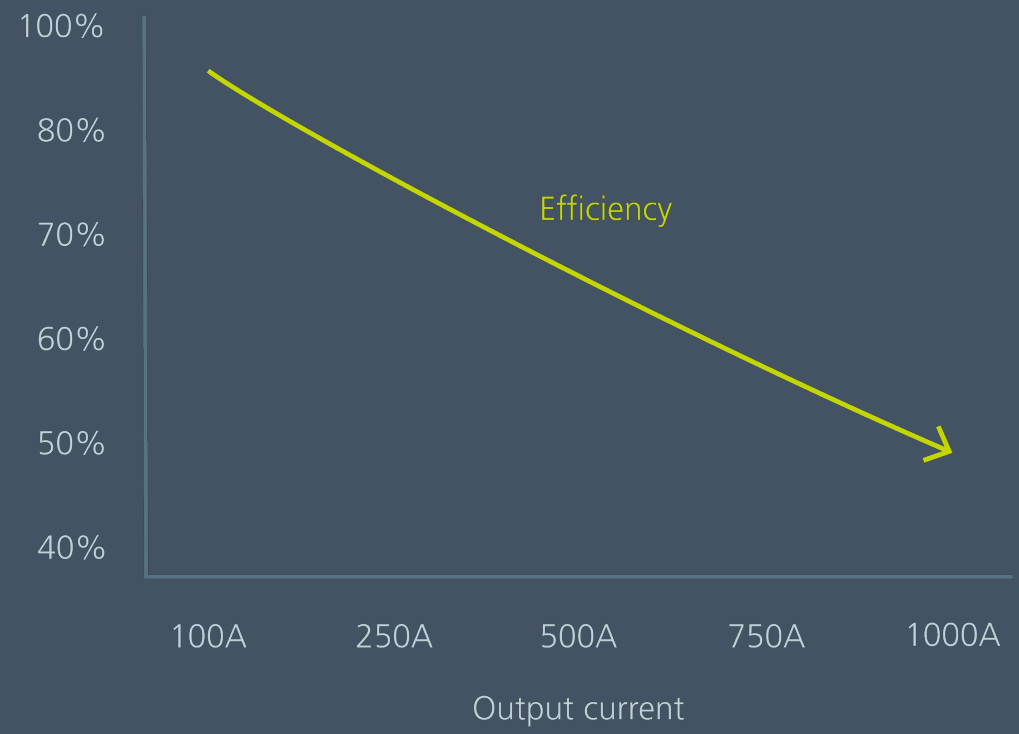
The “last inch”

Power Distribution Network losses



VR to the processor losses, the “last inch”



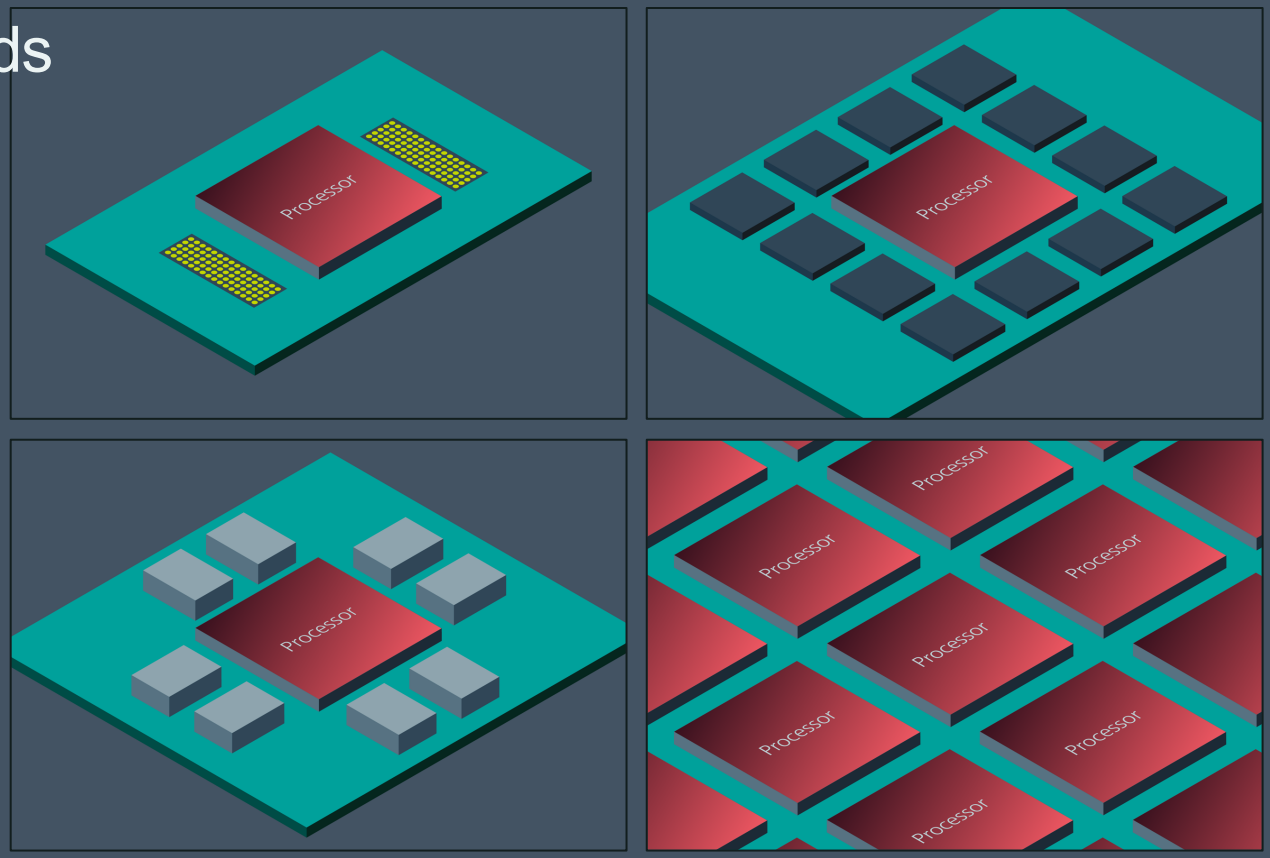


Example with PCB resistance of 400uOhm (VR at 0.8Vout)

Current Delivery

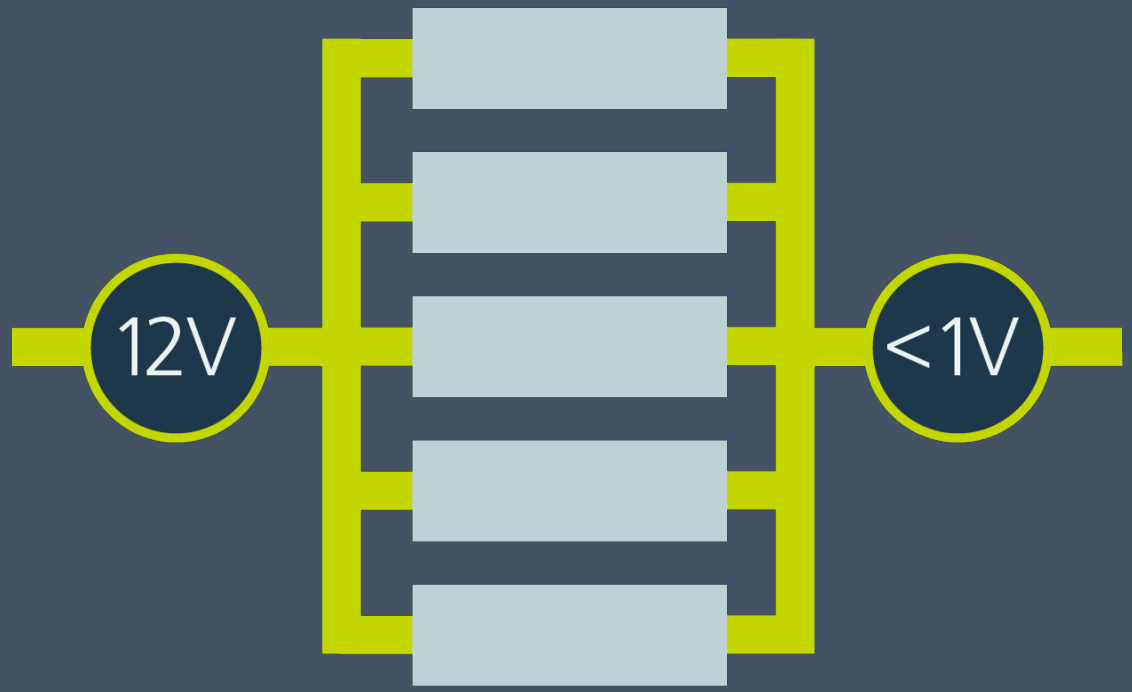
New space constraints challenge traditional PDNs

- OAM and custom AI accelerator cards
  - PCB size limitations
  - Connector constraints
  - On-board memory blockage
- Network switch processors
  - High speed transceiver blockage
- Cluster computing
  - Wafer Scale Engine
  - PCB level xPU grid fabric



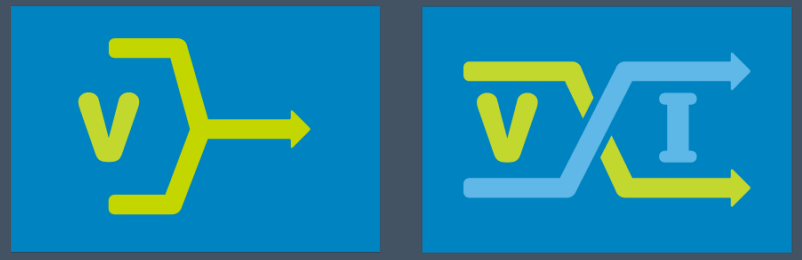
Conventional multiphase

- Conversion performed by DrMOS/Inductor
- High conversion ratio (minimum 12:1)
- Challenging to scale for higher currents
- Phase unbalancing
- Noise generation
- Size prohibits reducing PDN



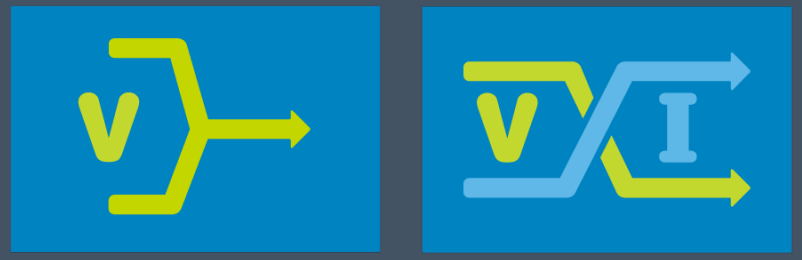
Factorized Power Architecture

Factorized Power Architecture



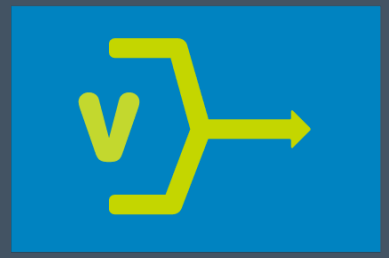
- Regulation followed by transformation
- Allows for optimization of each function
- Enables re-distribution of power
- High density
- Low noise

Factorized Power Architecture



Processor

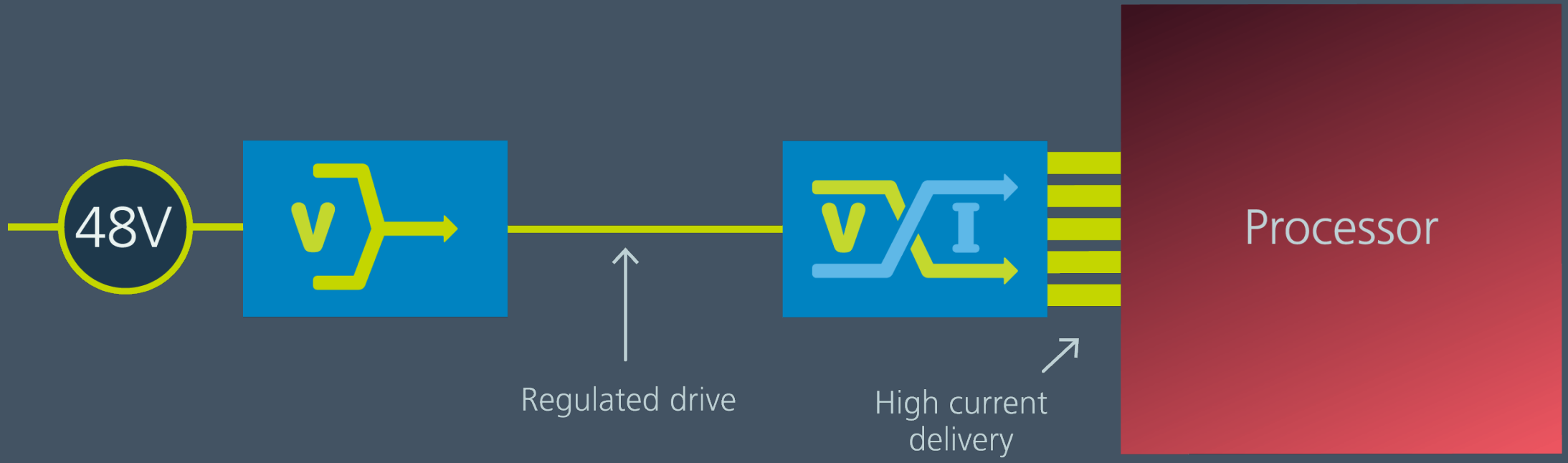
Factorized Power Architecture



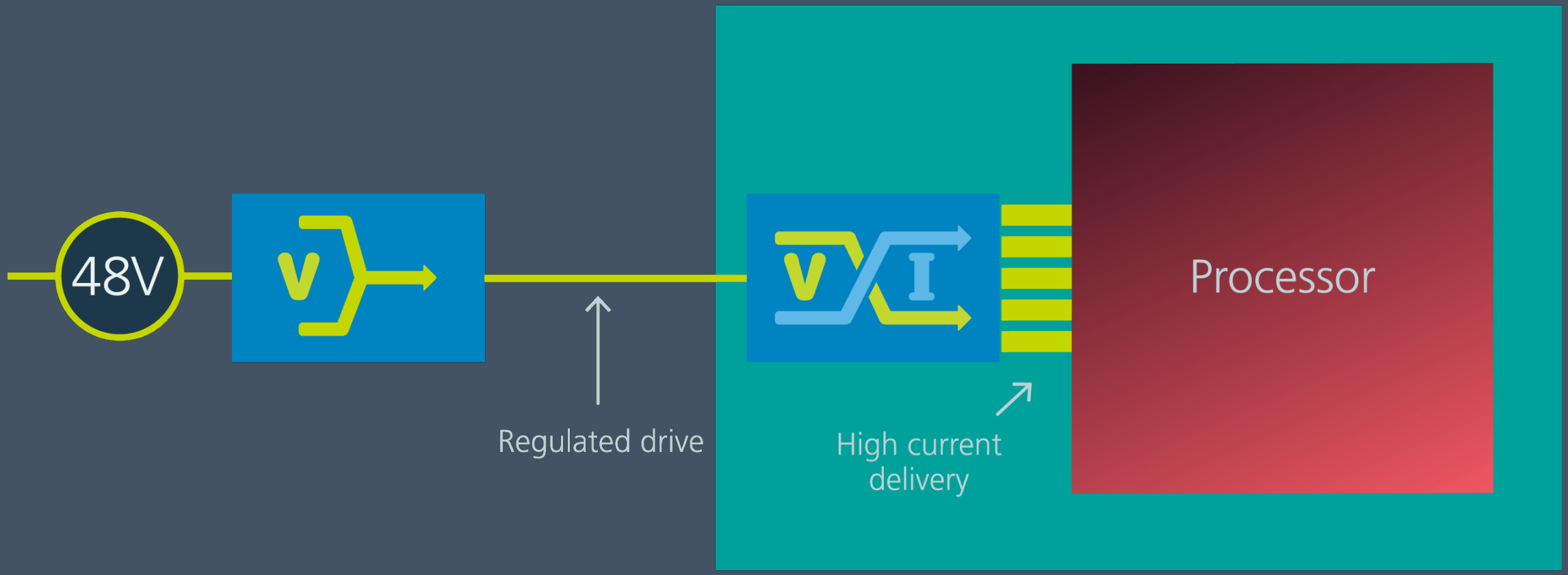
Processor

Factorized Power Architecture

Factorized Power Architecture



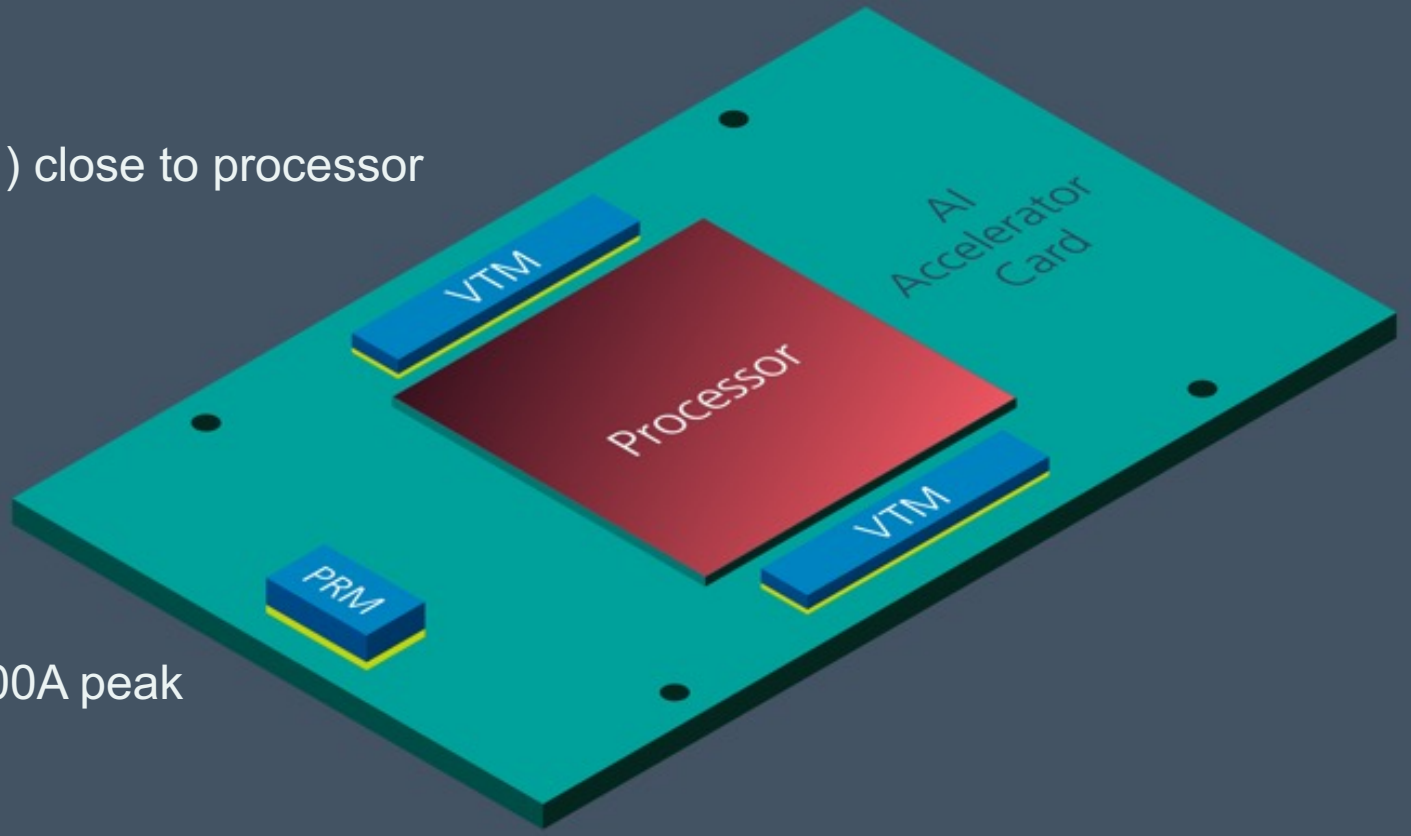
Lateral Power Delivery



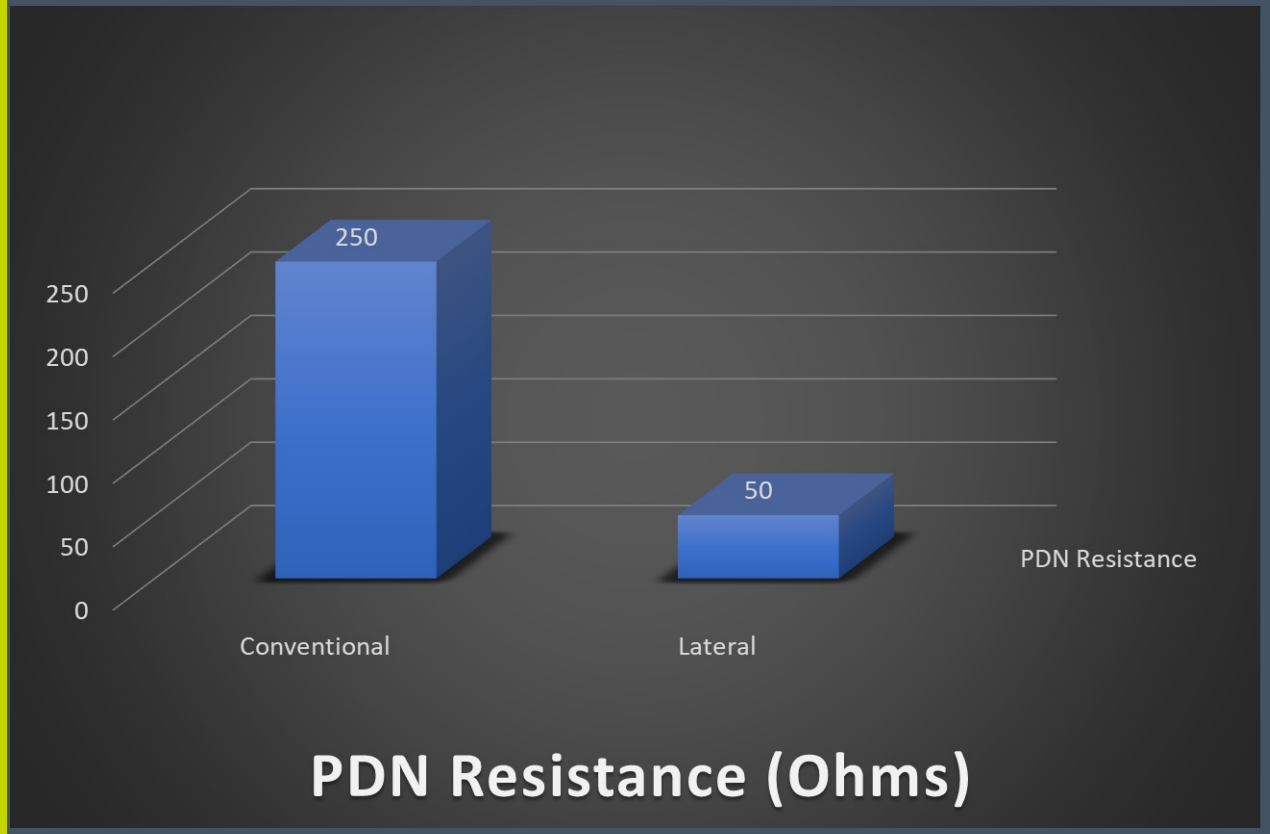
Power Delivery Networks

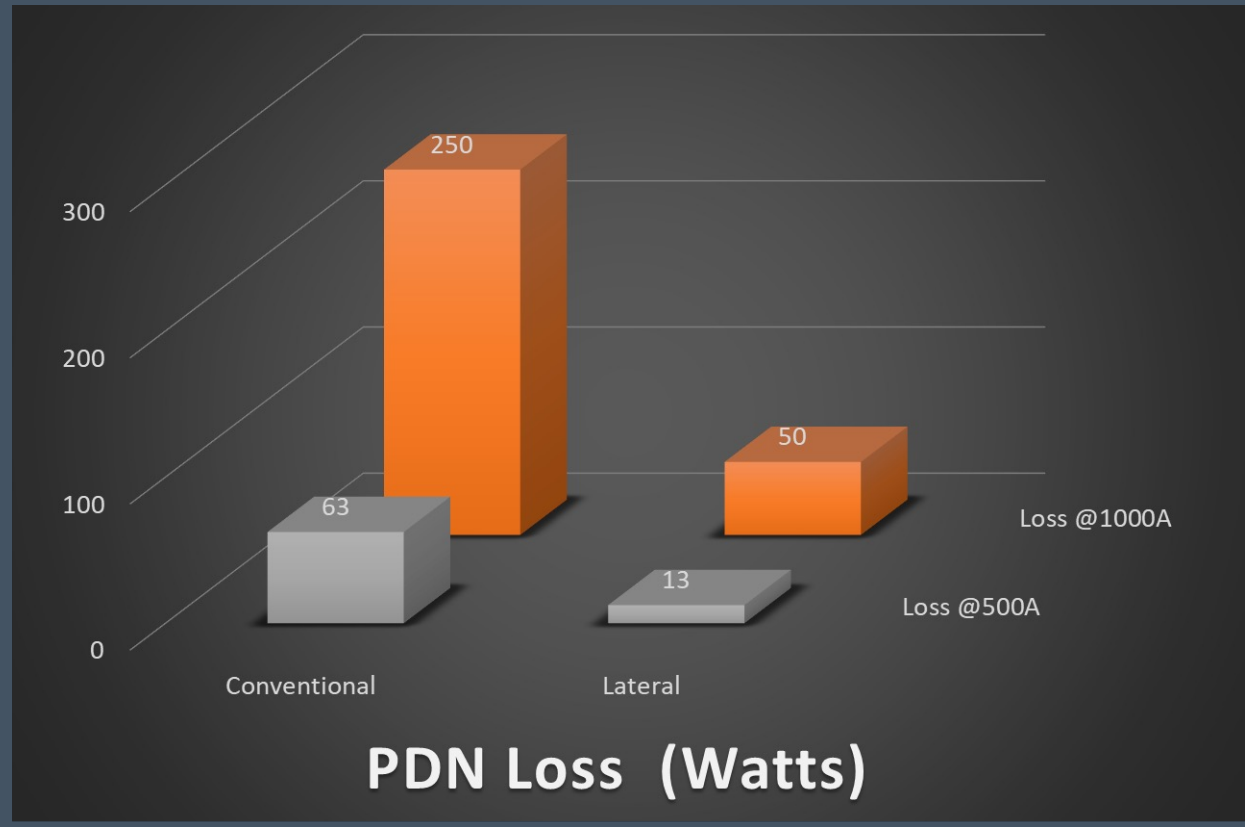
Lateral Power Delivery

- Current Multipliers (VTMs)
  - Current Multiplication (e.g. 64-to-1) close to processor
  - New scalable VTMs from:
    - 22x8mm = 125A
    - 47x8mm = 375A
- OAM module performance
  - Two 47 x 8 x 2.8mm devices
  - Provide 750A continuous and 1,500A peak



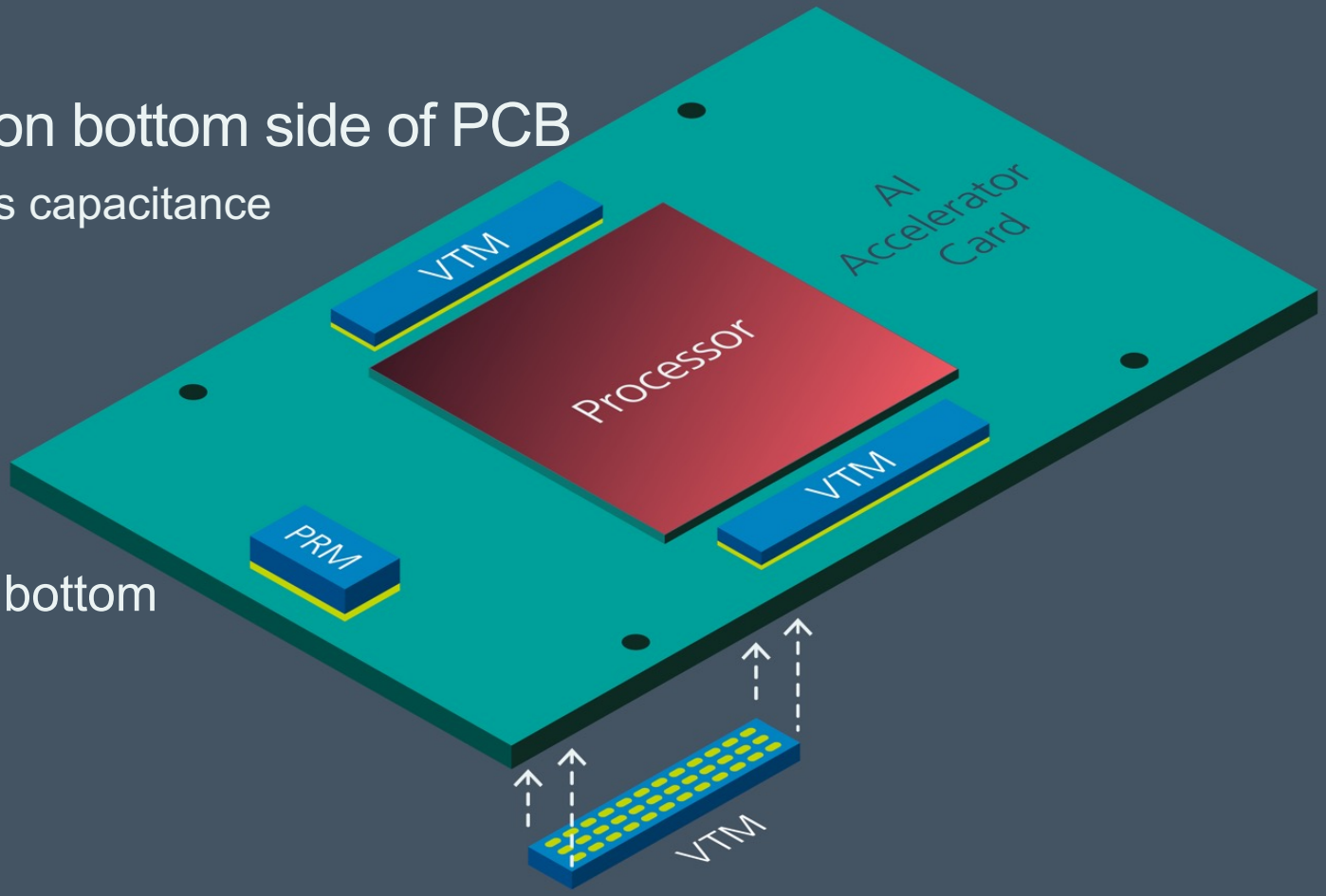
Performance loss analysis





Lateral-Vertical Power Delivery

- One or more VTMs placed on bottom side of PCB
  - Minimal displacement of bypass capacitance
  - VTM height is 2.8mm
- Reduces PDN by over 50%
  - With just one VTM place on bottom



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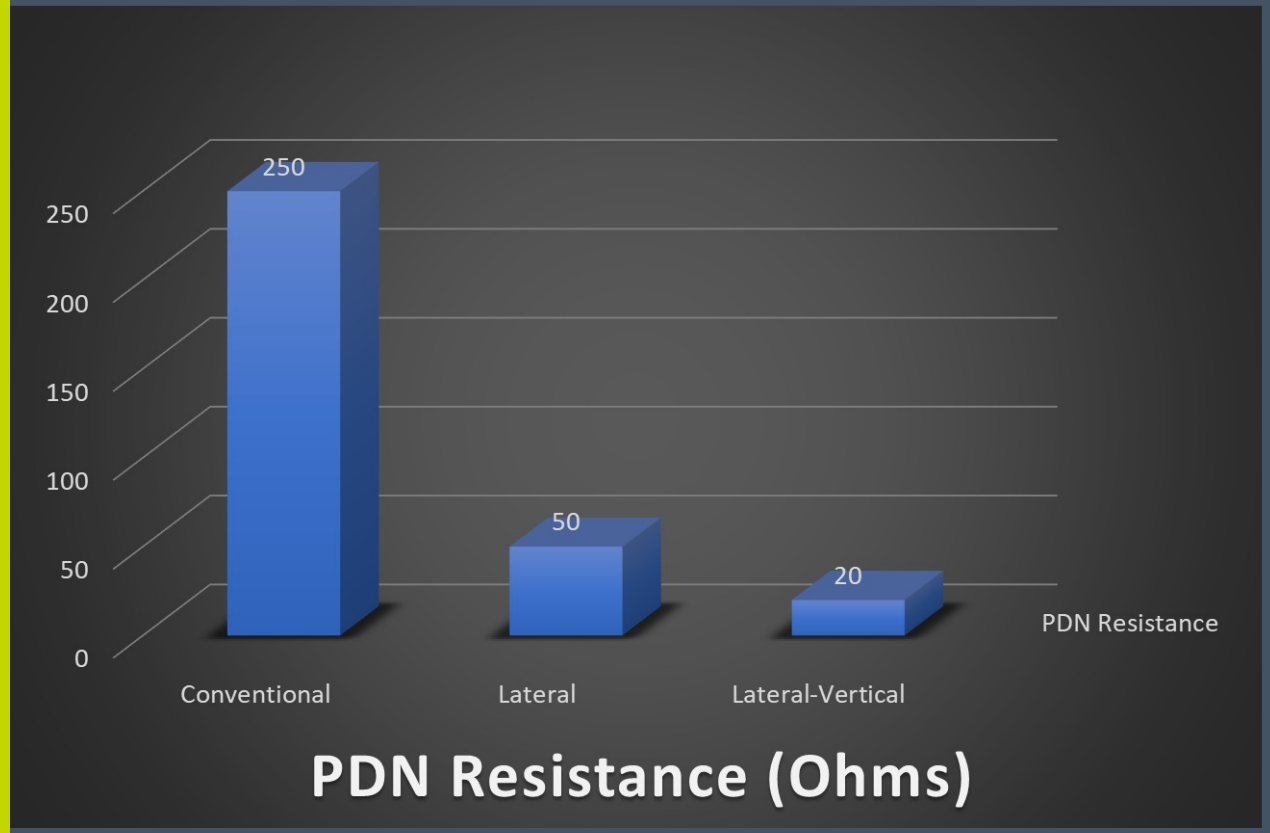
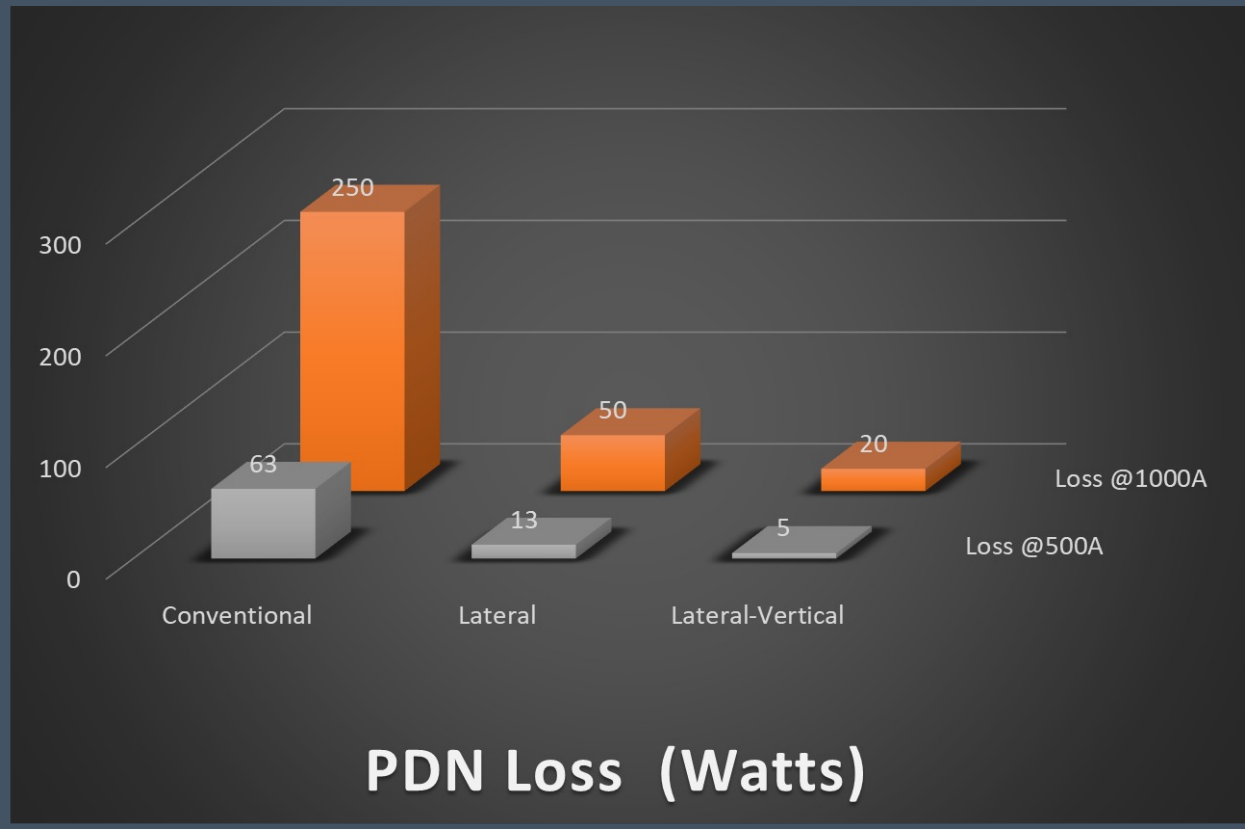
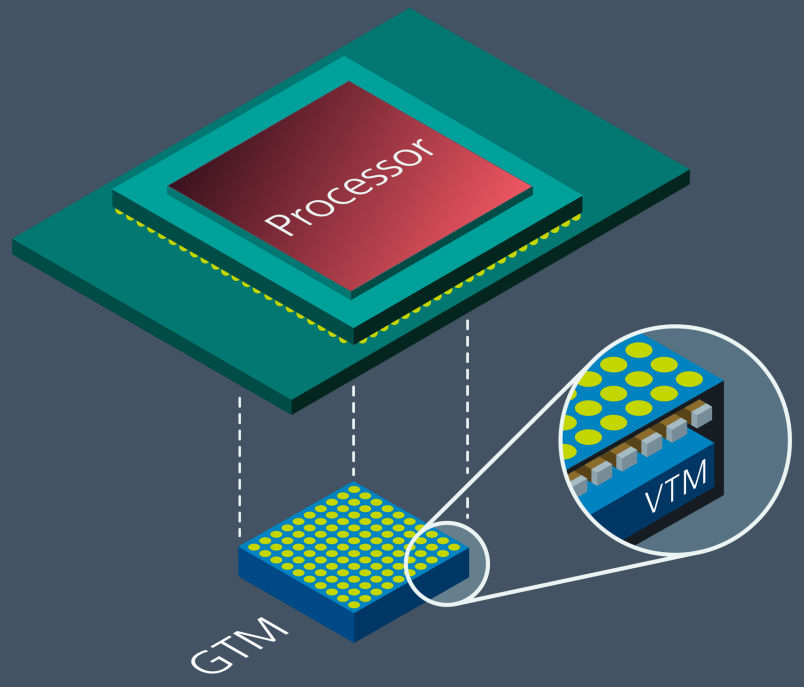




Lateral-Vertical

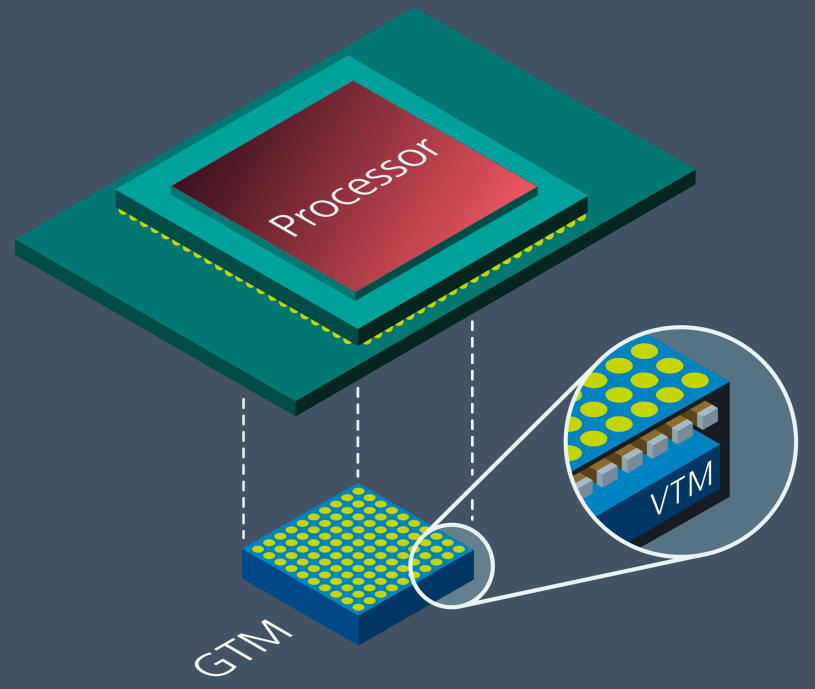
Vertical Power Delivery

- Geared Current Multiplier (“GCM”)
  - Low interconnect resistance
  - Terminal pitch matched to processor (e.g., 1mm)
  - Processor perimeter unobstructed
- Power integrity
  - Bypass capacitors re-located within the GCM
  - Low GCM output inductance
  - Low noise ZCS/ZVS current multiplication



Vertical Power Delivery

- Easy to cool
  - Vertical PDN loss much lower than Lateral PDN
  - Relatively low GCM heat density
- Example GCM module performance
  - One 33 x 30 x 4.1mm
  - Provides 1,000A continuous and 1,800A peak
- Also enables GCM mounted above processor for top side power delivery



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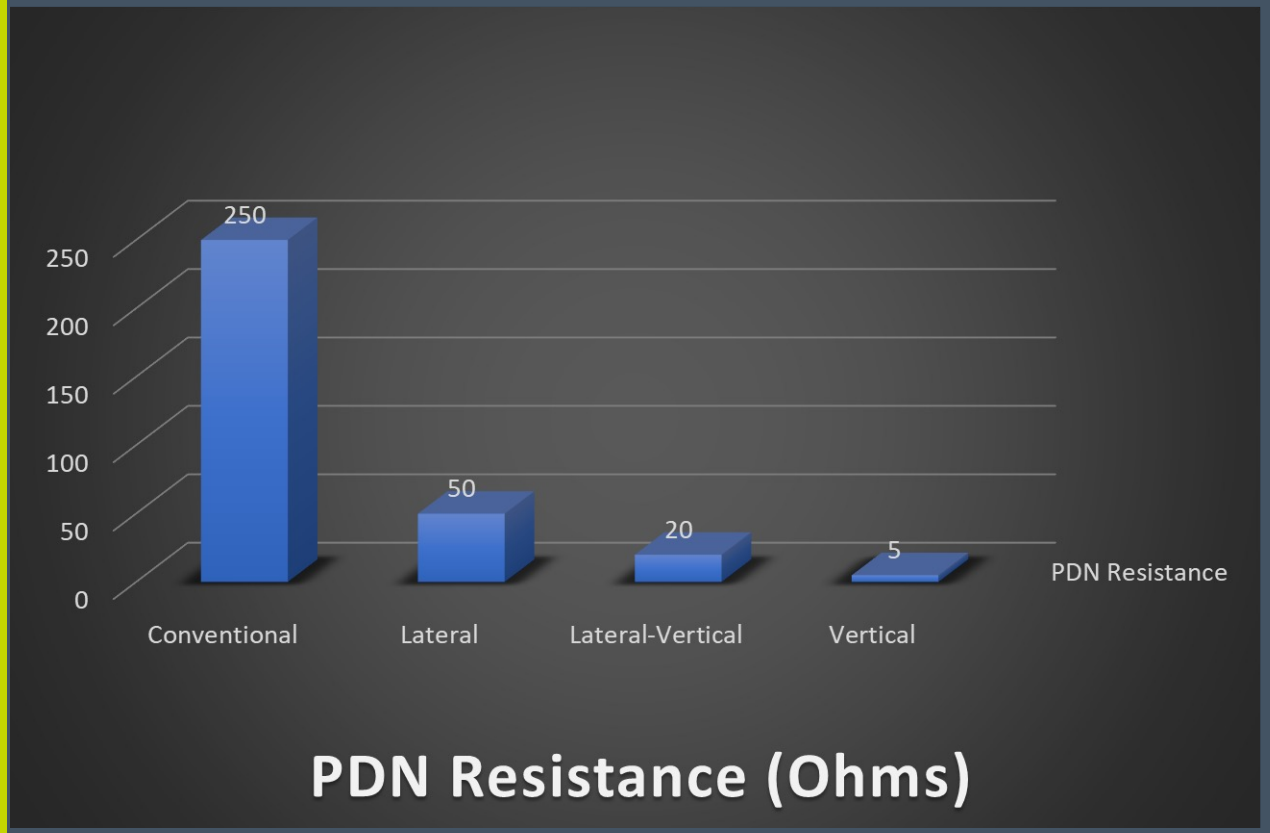

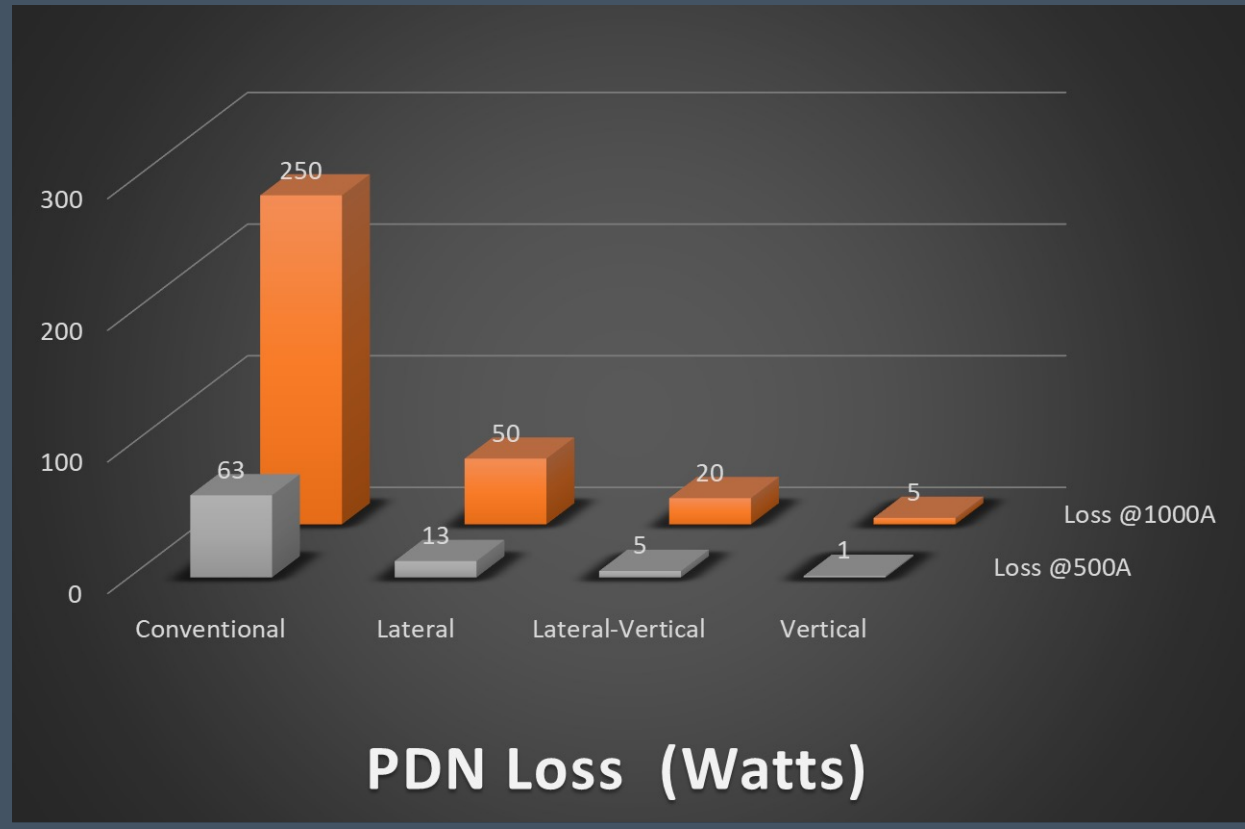

Thank You