



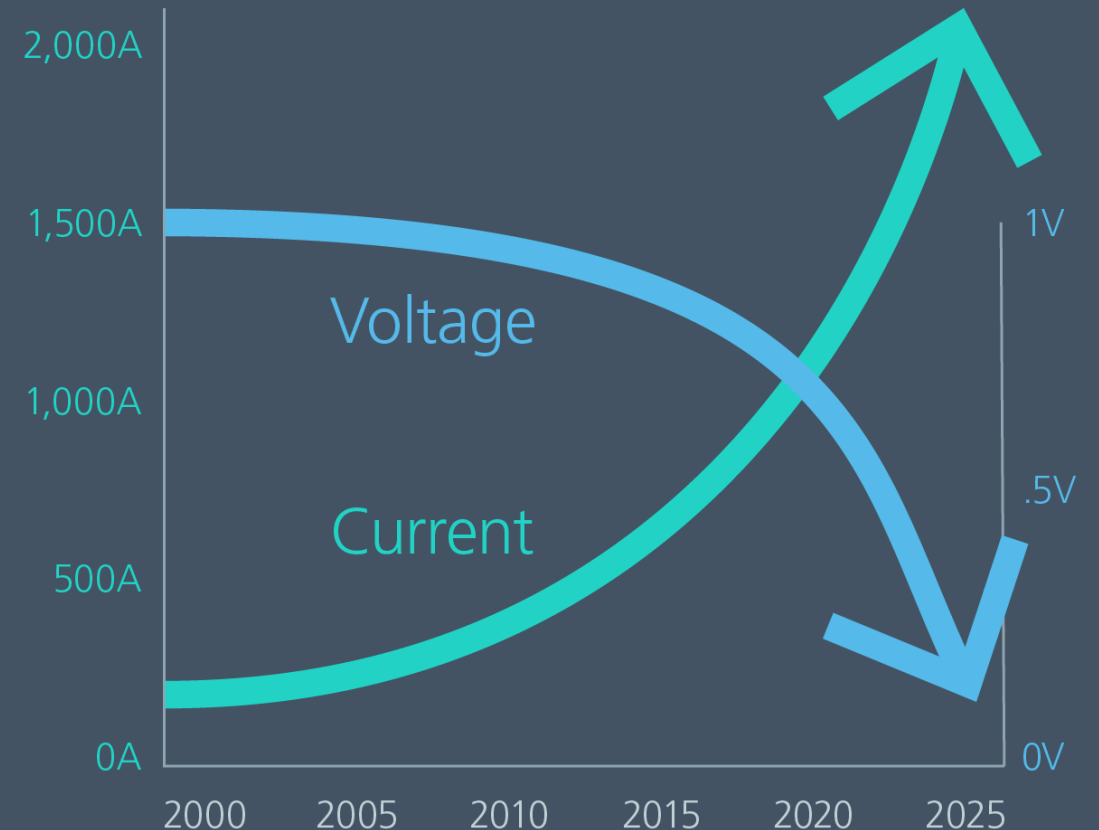
# Current Multiplier Technology Advances Enable New AI Processor Power Solutions

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# Powering high performance processors

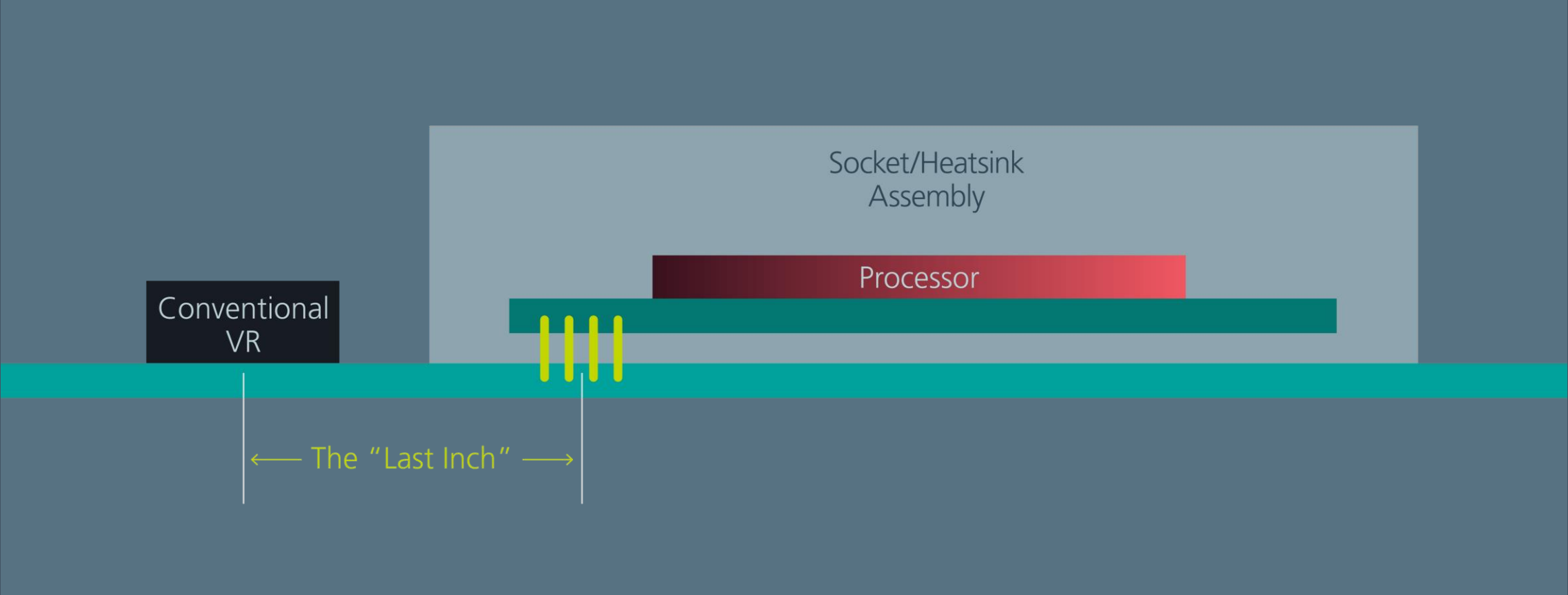
- Modern processors (GPU, CPU, NPU) need a lot of current...
- Decreases in power efficiency  
Increasing PDN distribution losses
- Significant operating performance reduction if power demands are not met
- Added complexity of decreasing operating voltages as move continue to lower fabrication nodes



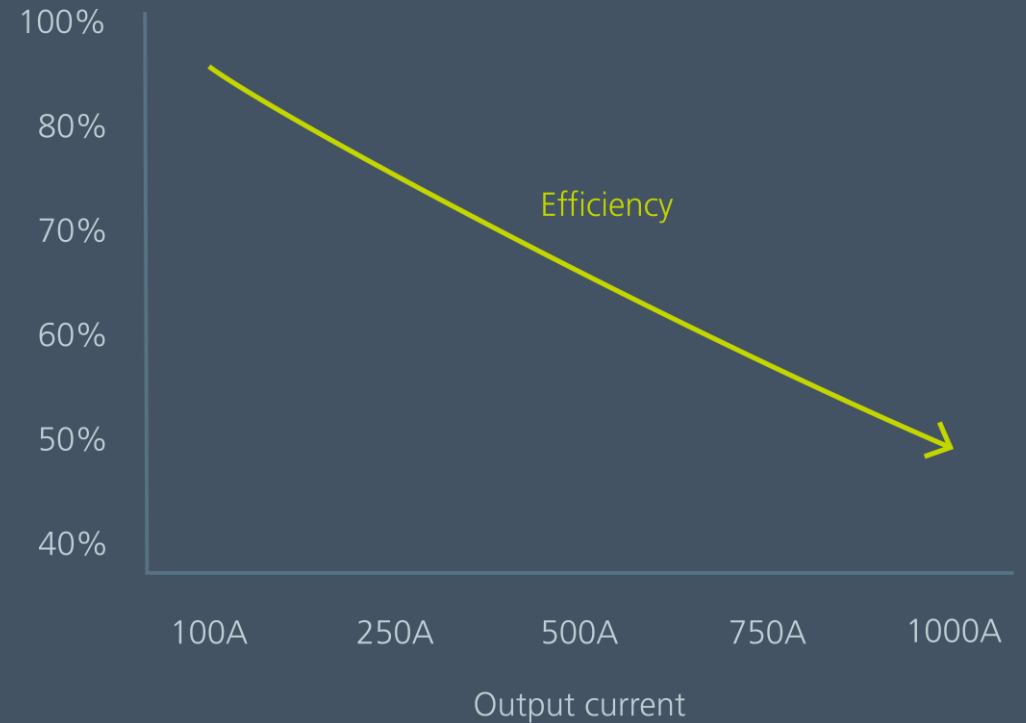
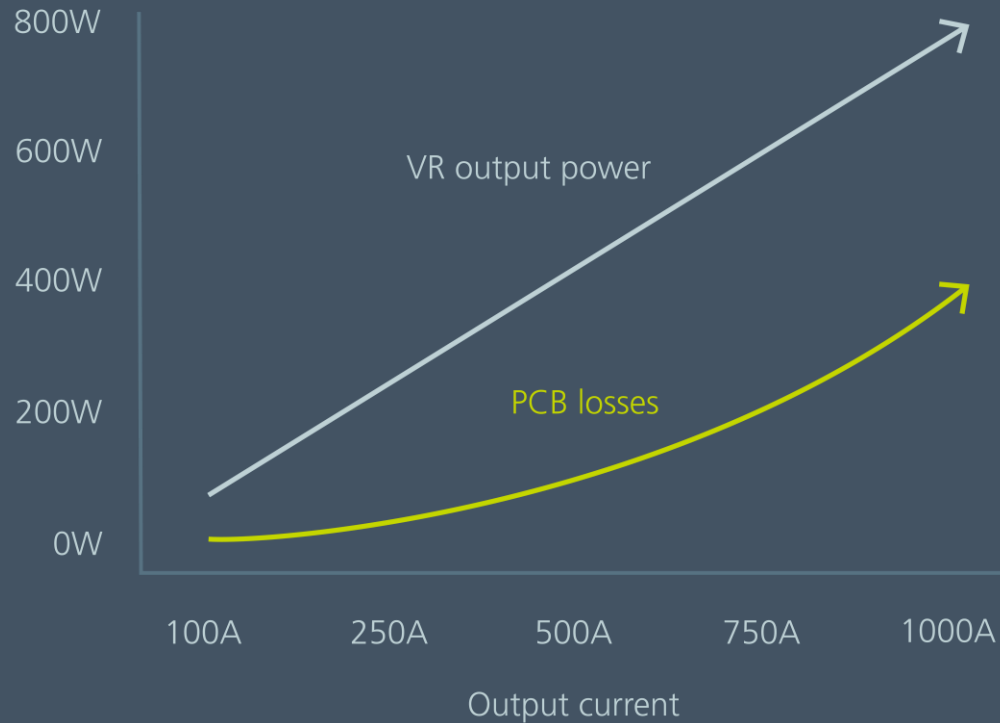
Progression of processor peak current requirements and lower operating voltages

# 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

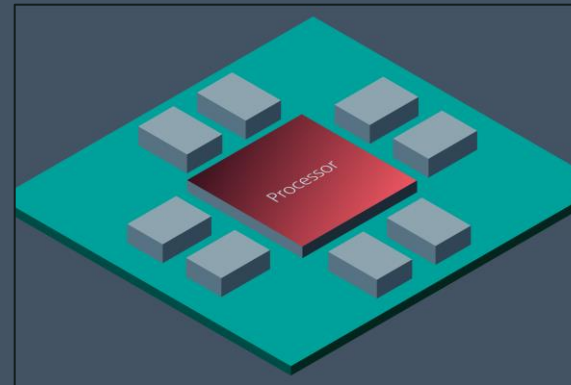
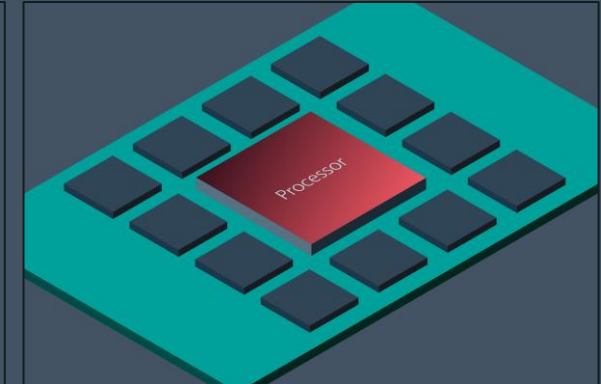
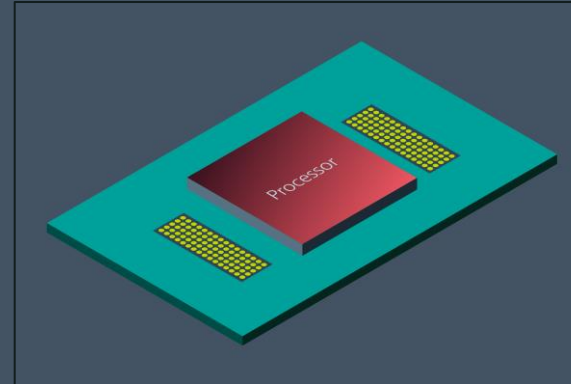
- PCB size limitations
- Connector constraints
- On-board memory blockage

## ■ Network switch processors

- High speed transceiver blockage

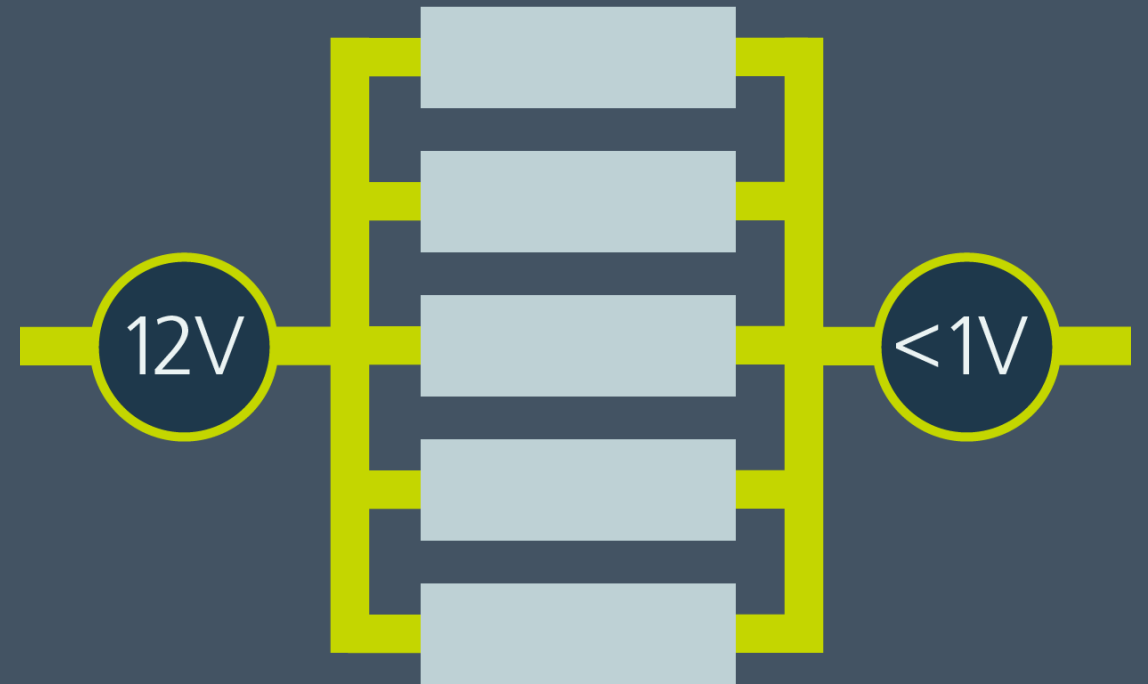
## ■ Cluster computing

- 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 imbalancing
- Noise generation
- Size prohibits reducing PDN



# Factorized Power Architecture

# Factorized Power Architecture

PRM



VTM



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



# Factorized Power Architecture

PRM



VTM



Processor

# Factorized Power Architecture

PRM



VTM

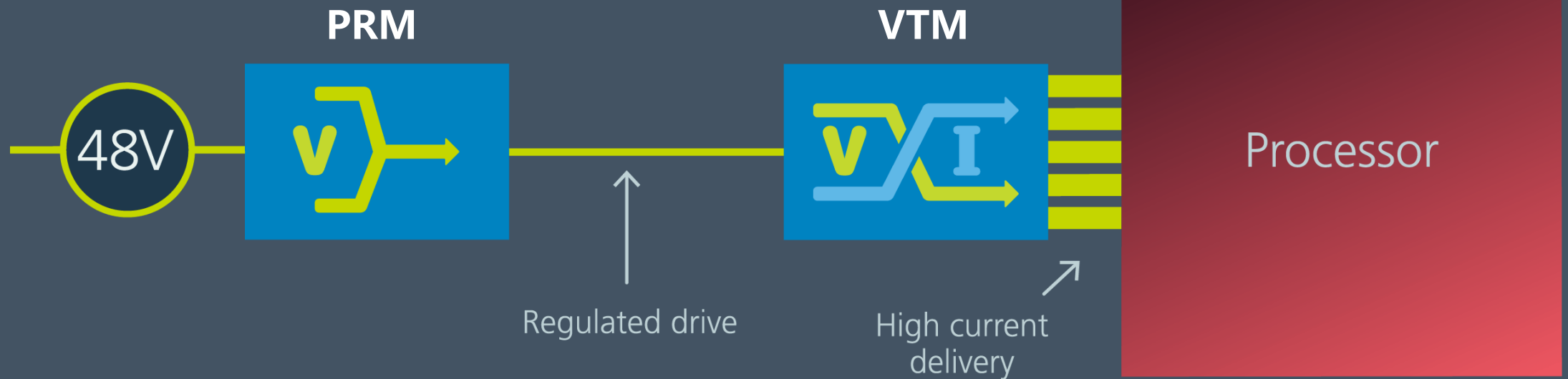


Processor

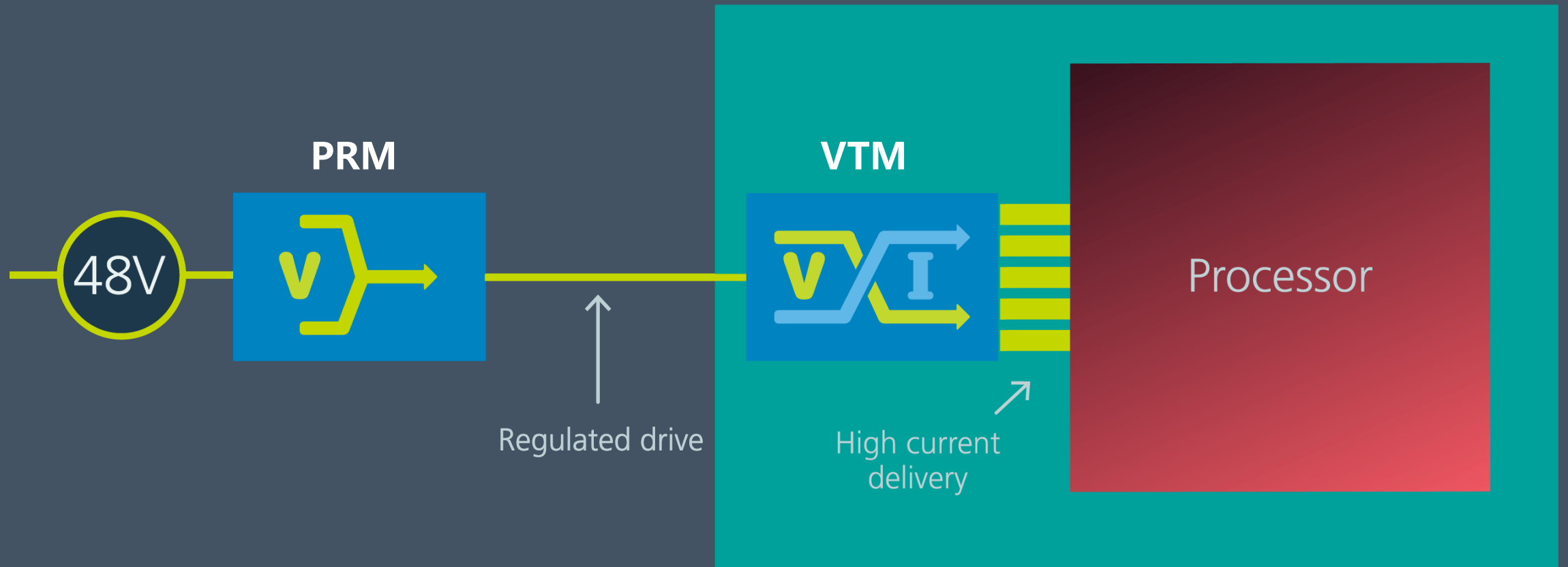
# Factorized Power Architecture



# Factorized Power Architecture



# Lateral Power Delivery



# Power Delivery Networks

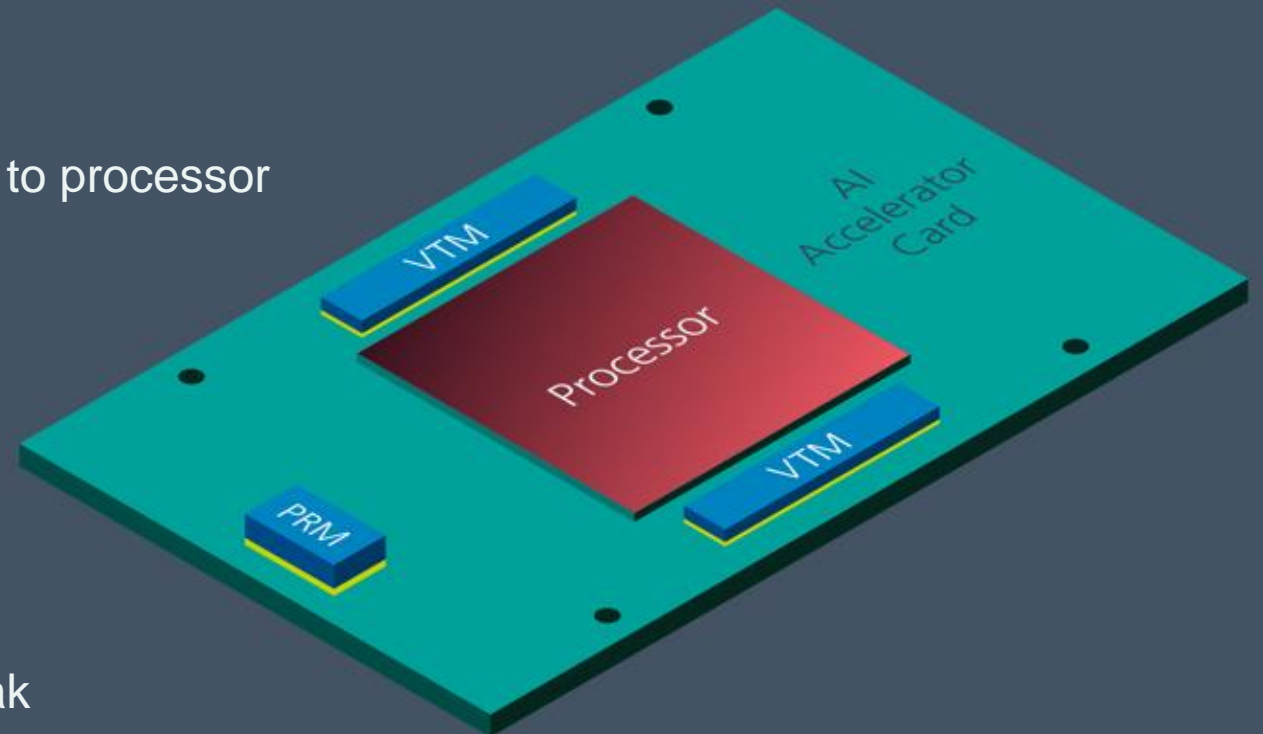
# Lateral Power Delivery

## ■ Current Multipliers (VTMs)

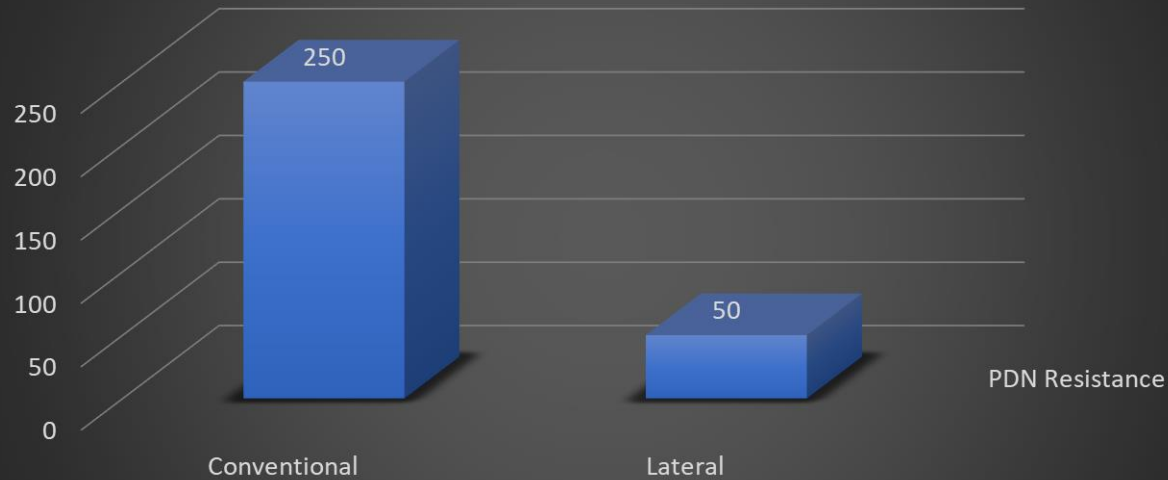
- Current Multiplication (e.g. 64-to-1) close to processor
- New scalable VTMs from:
  - 22x8mm = 125A
  - 47x8mm = 375A

## ■ OAM module performance

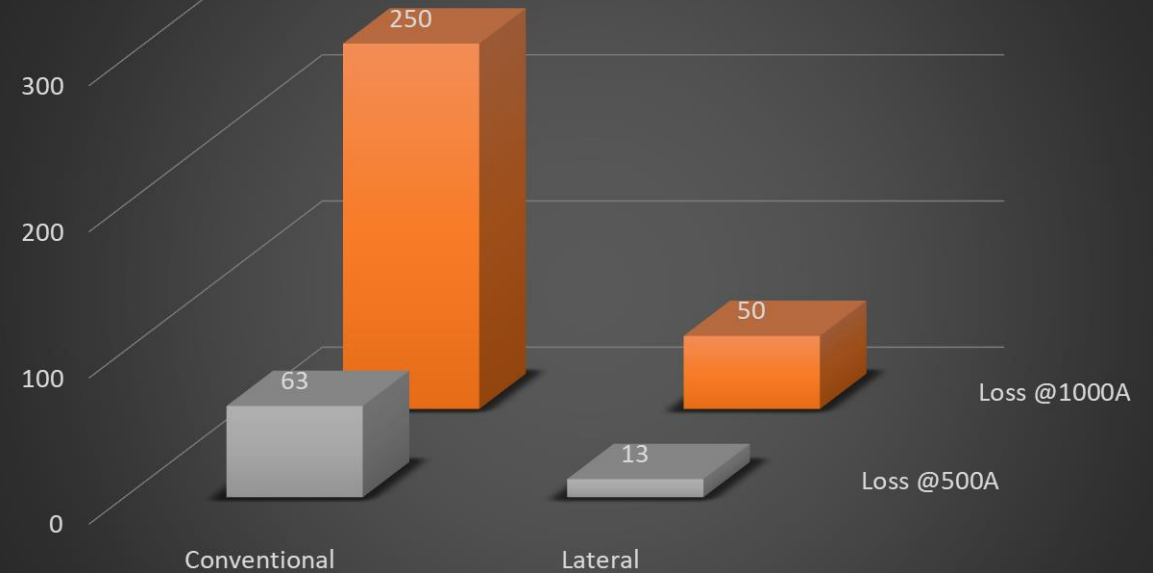
- Two 46 x 8 x 2.8mm devices
- Provide 750A continuous and 1,500A peak



# Performance loss analysis



**PDN Resistance (Ohms)**

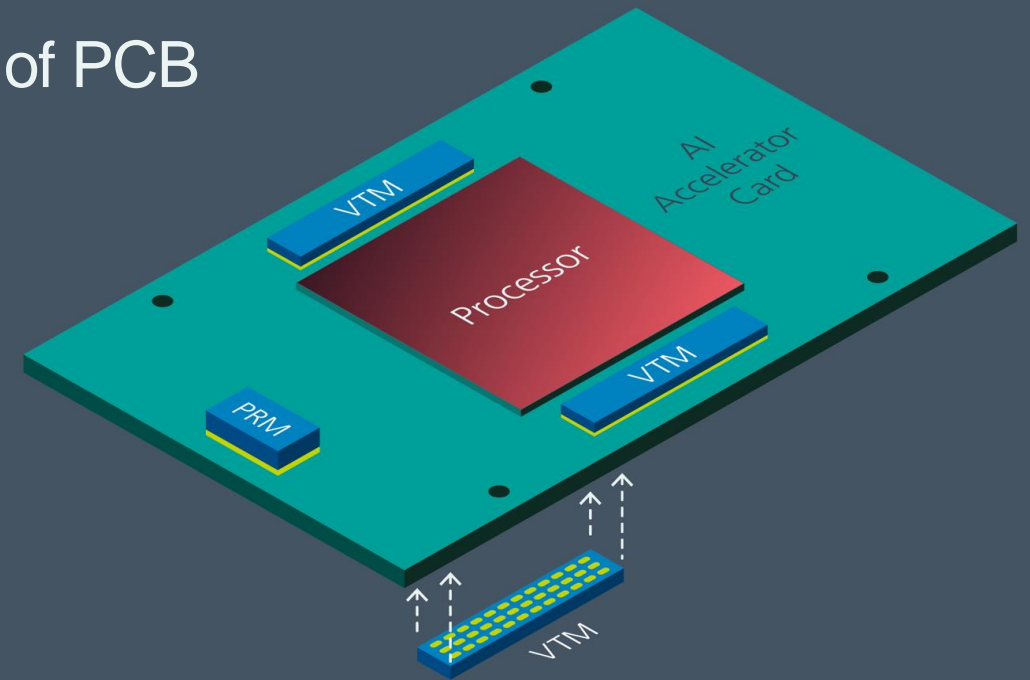


**PDN Loss (Watts)**

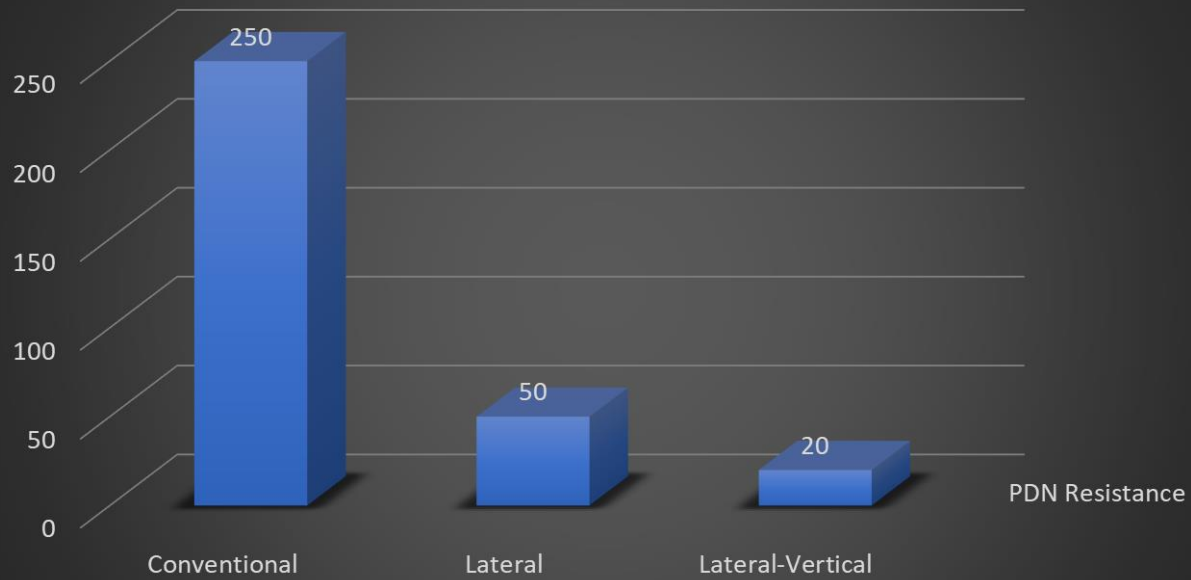


# Lateral-Vertical Power Delivery

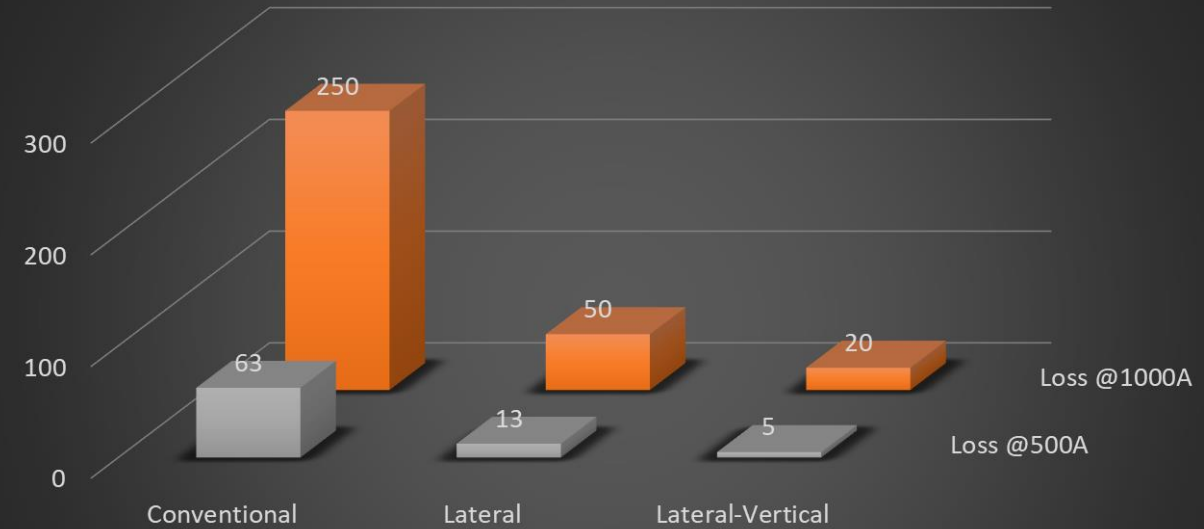
- One or more VTMs placed on bottom side of PCB
  - Minimal displacement of bypass capacitance
  - VTM height is 2.8mm
- Reduces PDN by over 50%
  - With just one VTM place on bottom



# Performance loss analysis



**PDN Resistance (Ohms)**



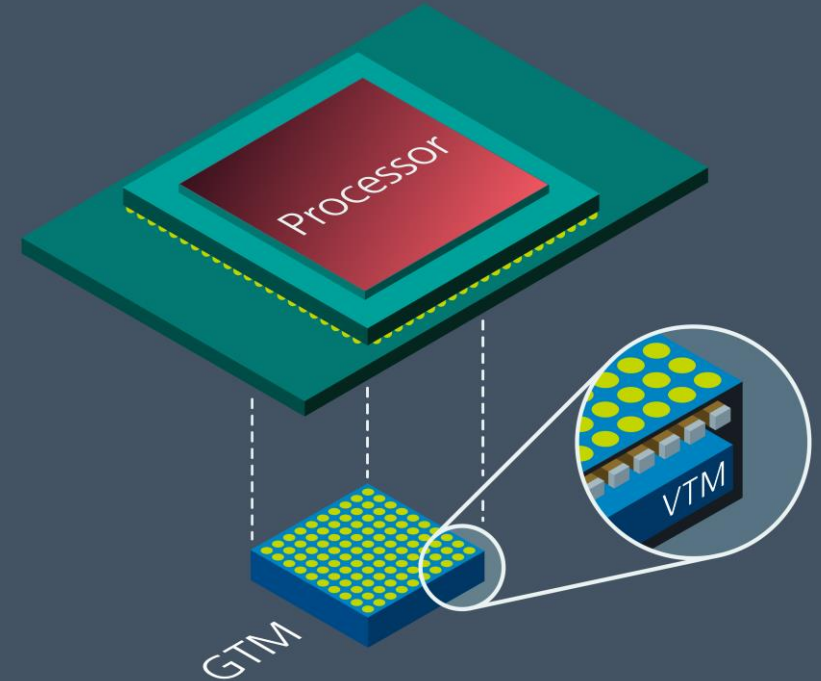
**PDN Loss (Watts)**

# Lateral-Vertical

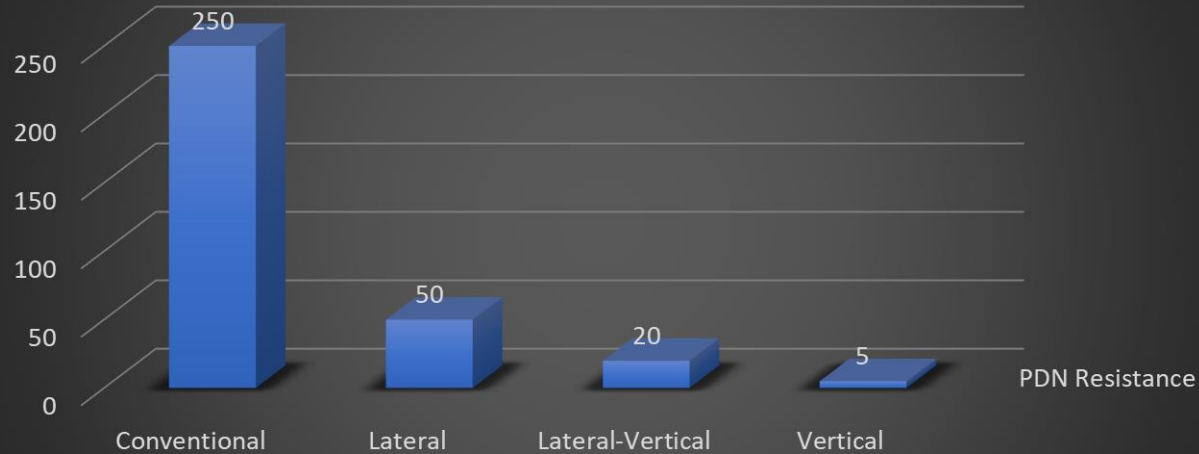


# Vertical Power Delivery

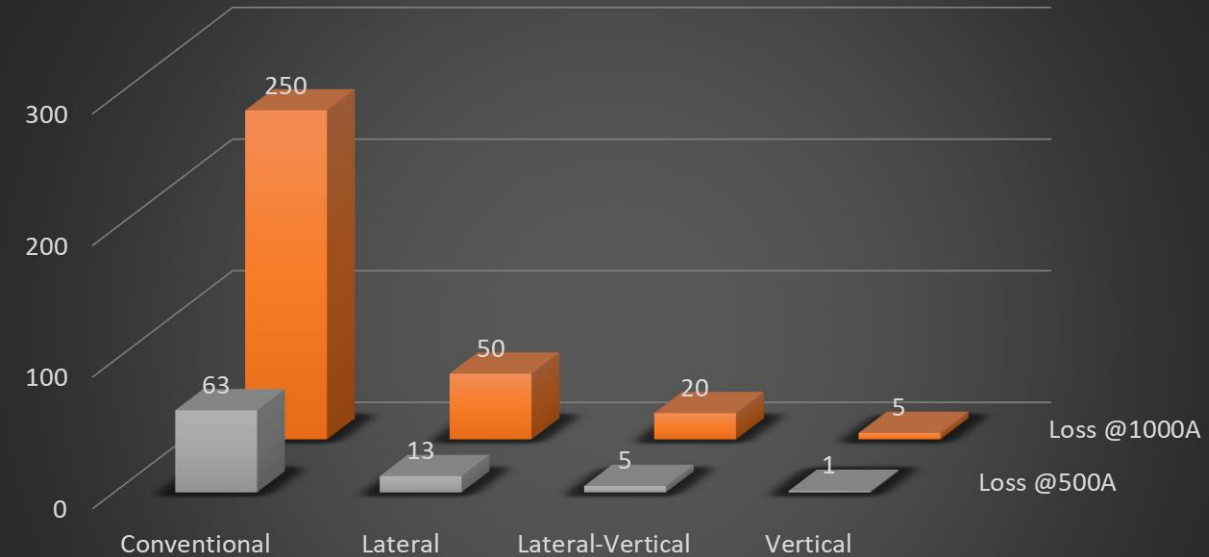
- Geared Current Multiplier (“GTM”)
  - Low interconnect resistance
  - Terminal pitch matched to processor (e.g., 1mm)
  - Processor perimeter unobstructed
- Power integrity
  - Bypass capacitors re-located within the GTM
  - Low GTM output inductance
  - Low noise ZCS/ZVS current multiplication



# Performance loss analysis



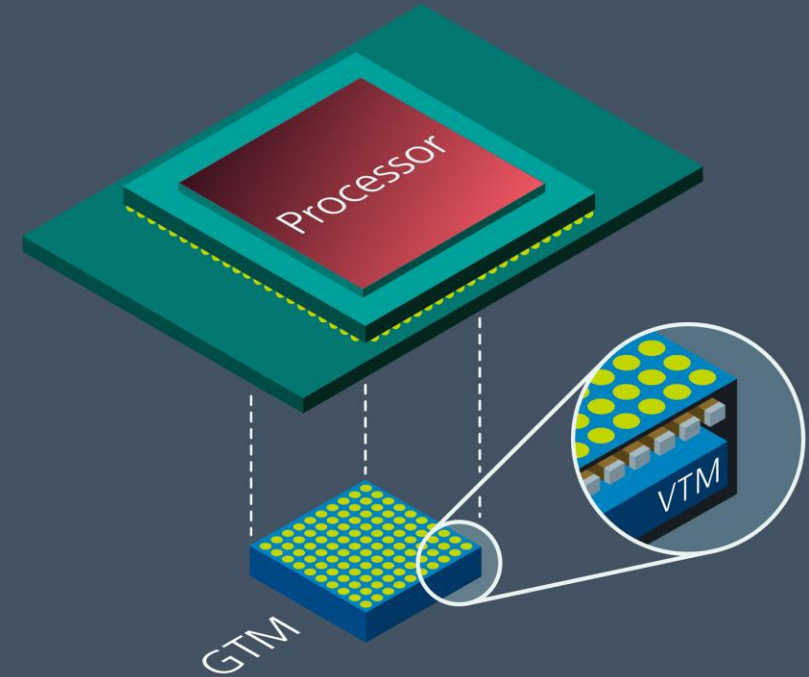
**PDN Resistance (Ohms)**



**PDN Loss (Watts)**

# Vertical Power Delivery

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



Thank You