



Advanced Power Technologies for SSD Applications

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Portable Devices



Data Intensive

Processing power is increasing for future portable devices

Battery life

Device usage is increasing while battery capacity remain the same

More Features

More features are added with the same battery capacity and form factor

Computing/ Storage



Processing Power

More processing power is required for next gen computing platform

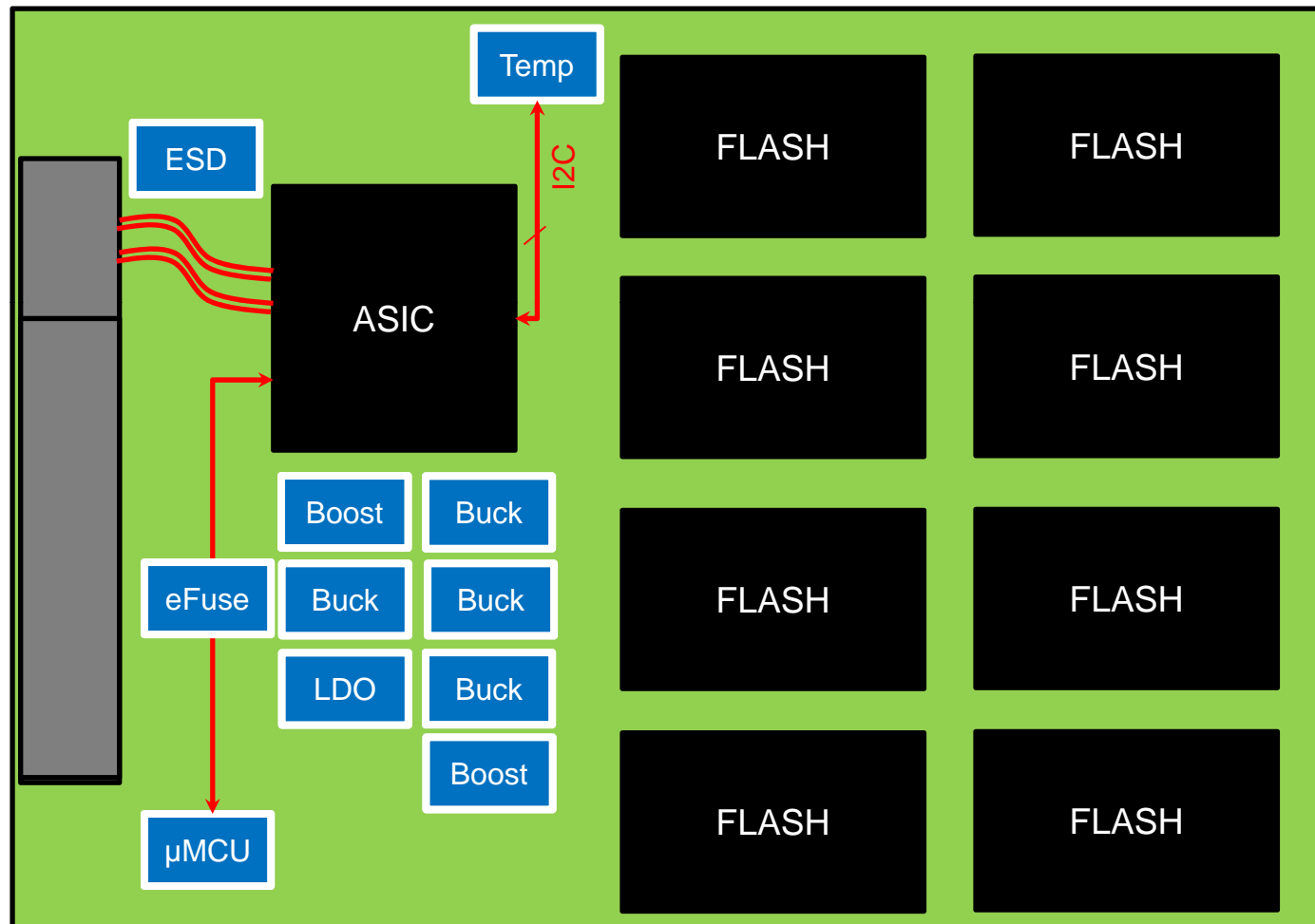
Storage Technology

Solid State Drives are emerging in datacenter storage segment

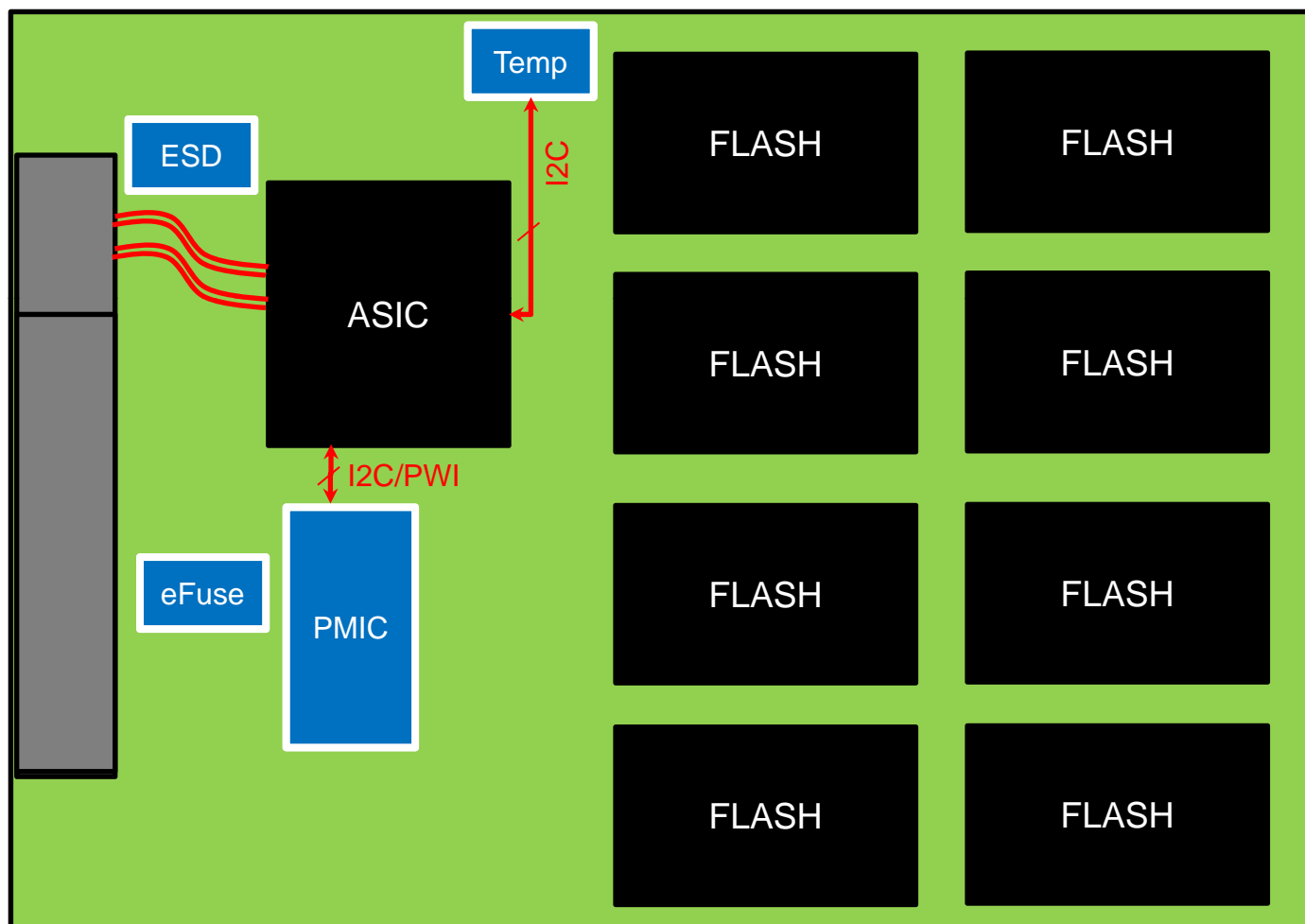
Lower OPEX

Reduced operating cost (especially from power & cooling)

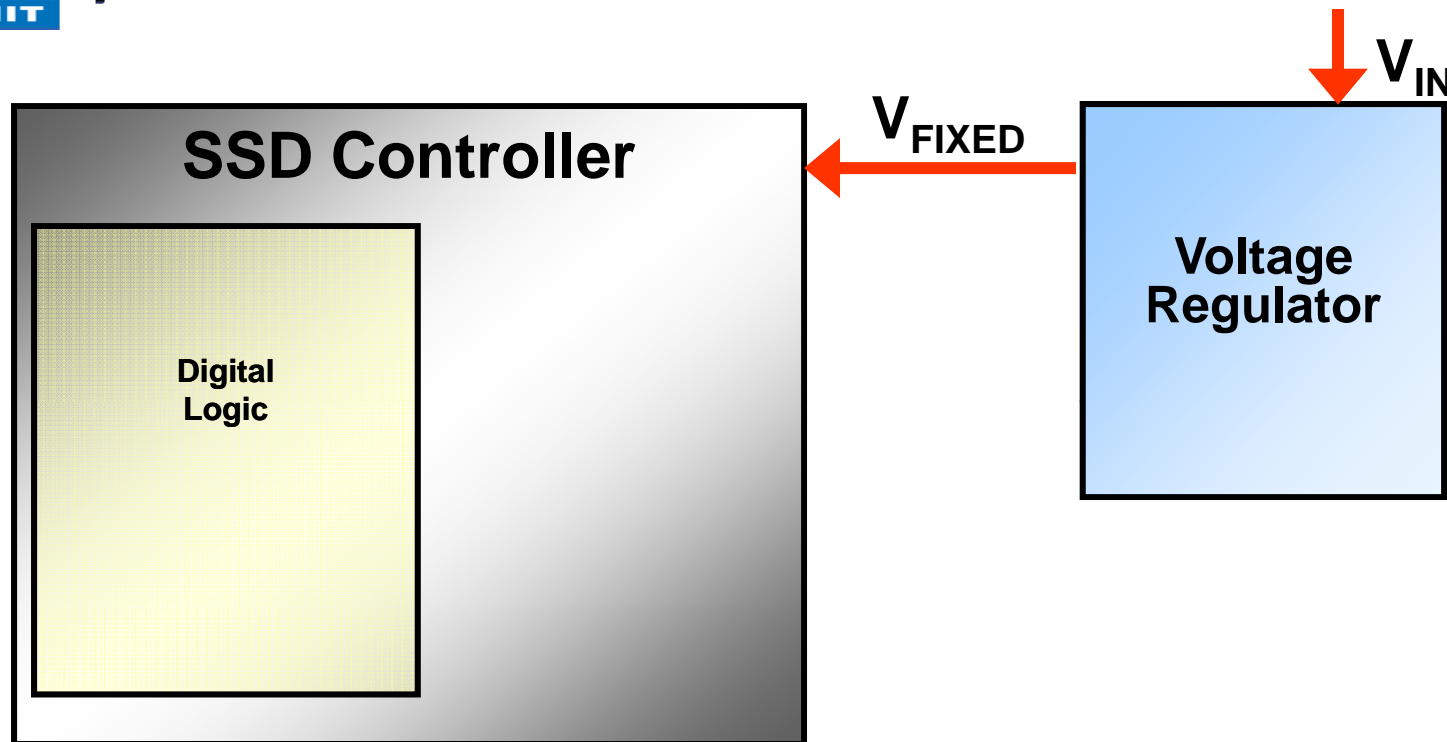
Solid State Drive Power Tree



Solid State Drive Power Tree



Traditional Power Management Delivery

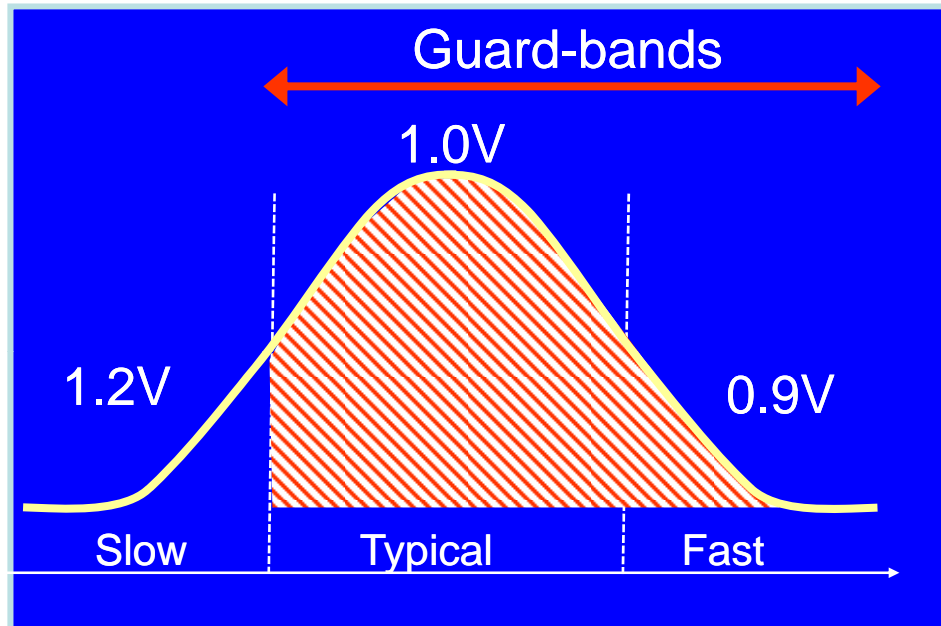


Fixed Voltage = Inefficient System!

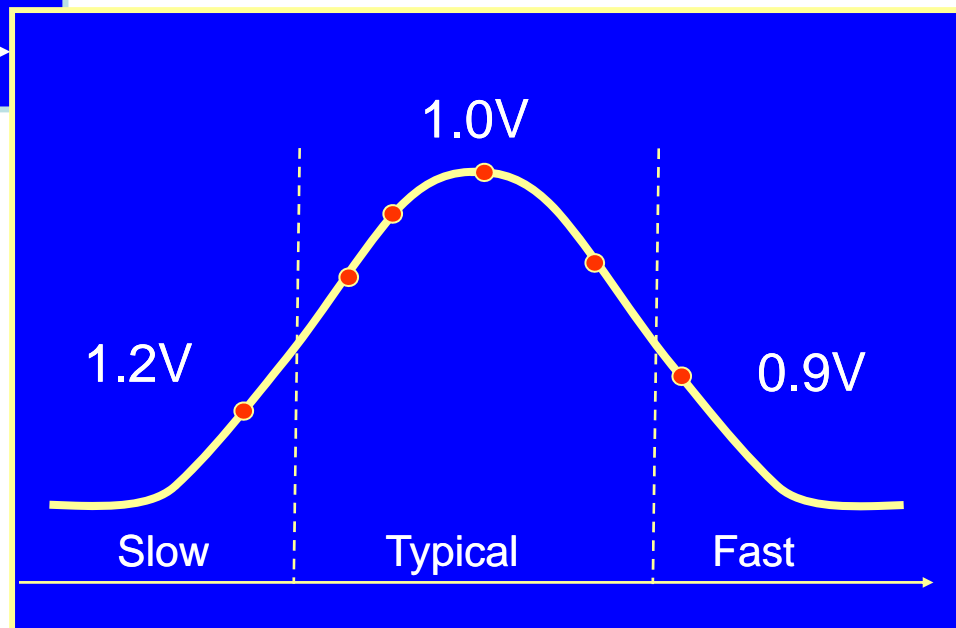
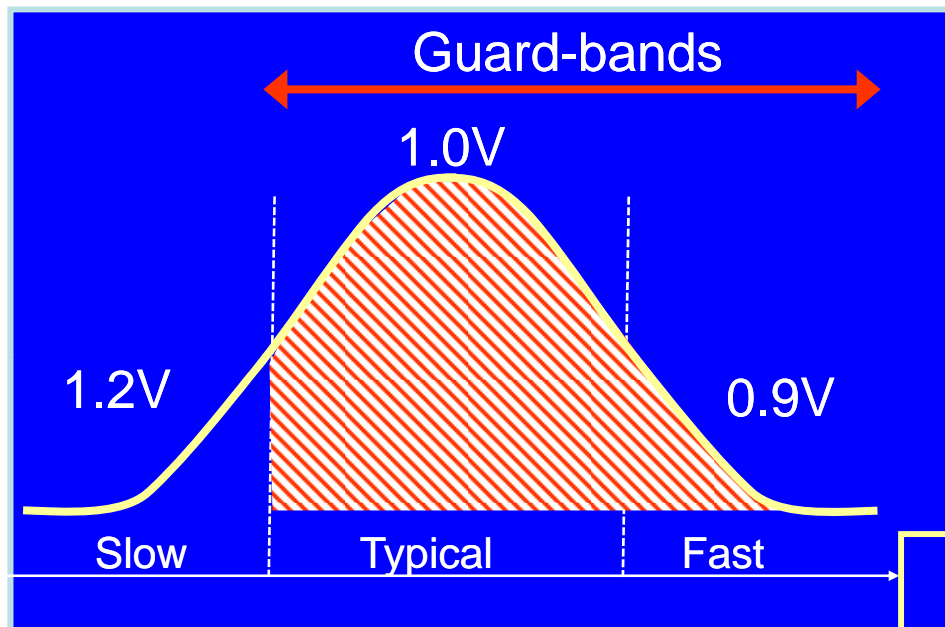
- No temperature compensation
- No adjustment for lower voltages at lower frequencies
- No compensating for process variation



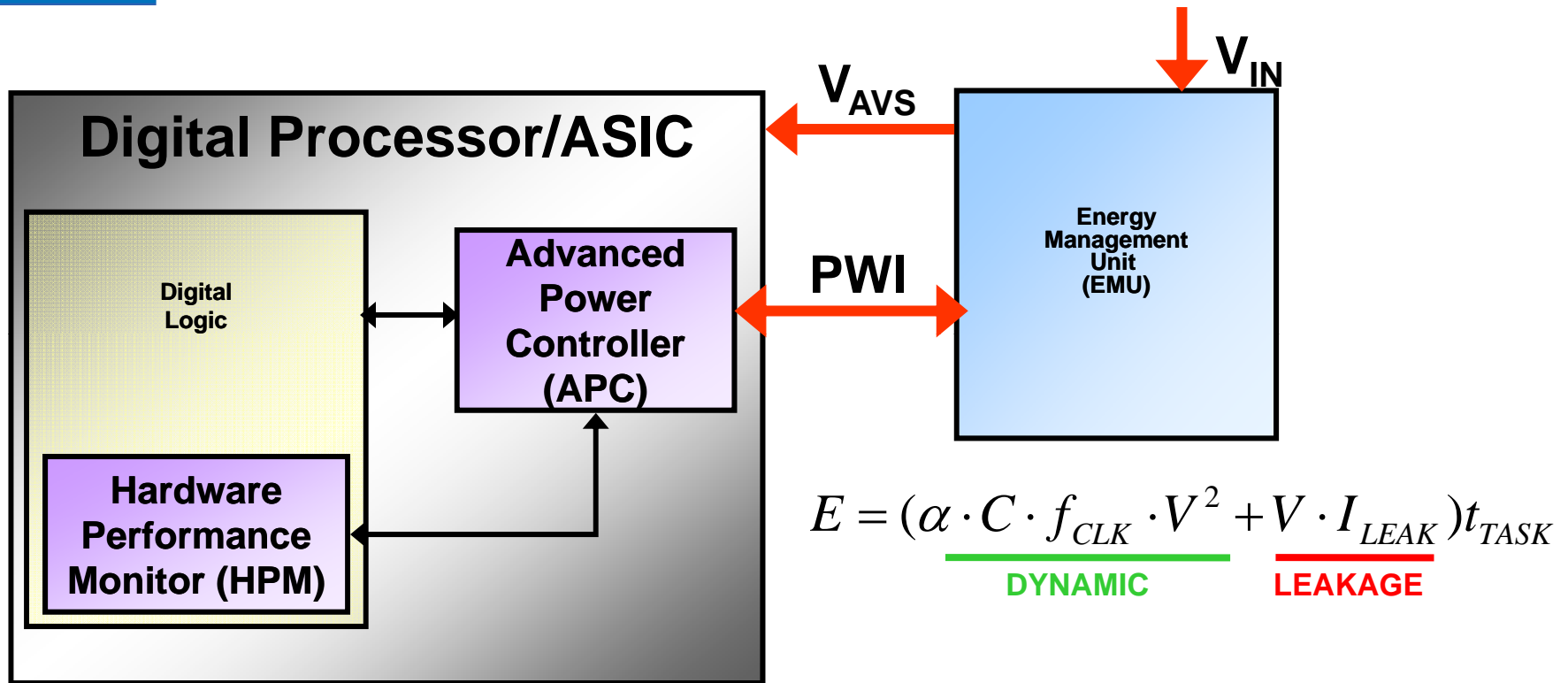
Silicon Process Guard-band



Silicon Process Guard-band



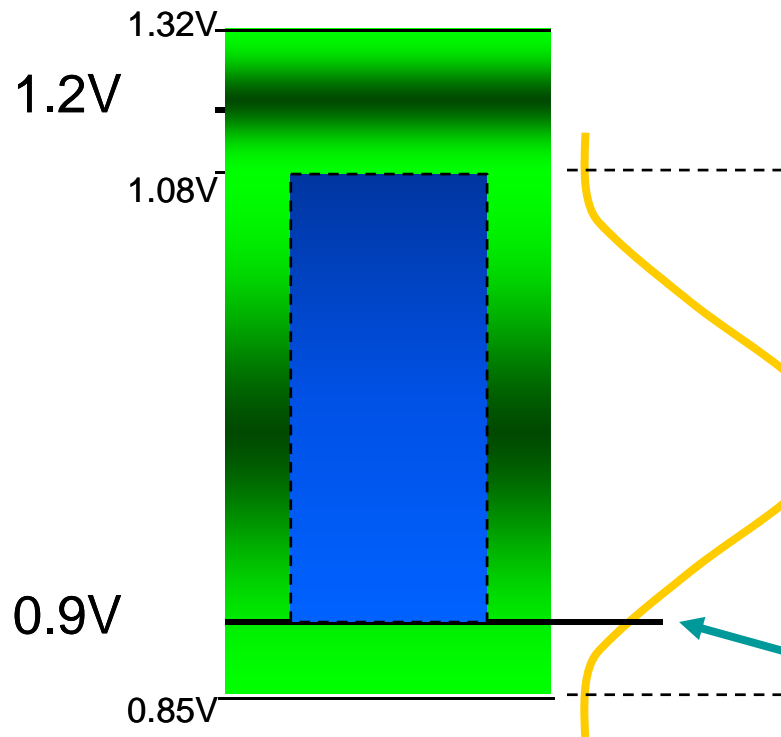
Adaptive Voltage Scaling (AVS)



Adaptive Voltage Scaling = Maximum power savings

- Process and Temperature Compensation
- No need for frequency-voltage lookup tables
- Real-time continuous closed-up

AVS Optimizing Power / Full Range



Published (Fixed) V_{DD}

- All silicon guaranteed to function
- Timing models for PTV corners at F


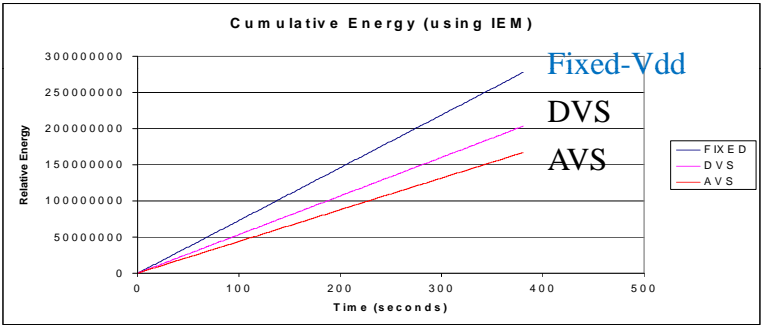
AVS_Vdd for Lowest Power

- Power controller maintains Vdd to lowest level possible based on on-chip PTV performance measurement
- Slow silicon possible lower Vdd based on slack timing

Clamp Minimum V_{DD}

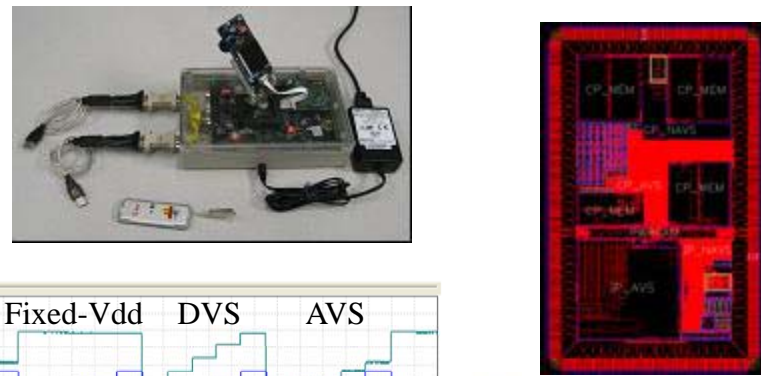
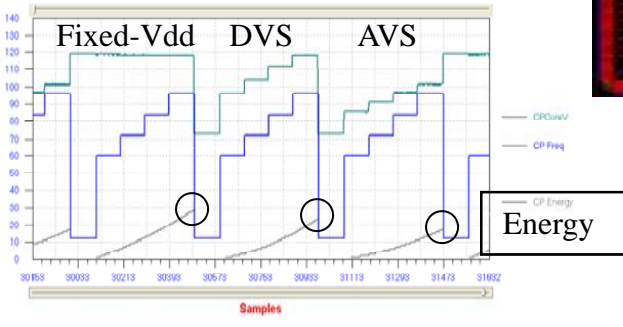
- Independent clamp level for minimum Vdd set with power controller
- Overrides monitor request to go to a lower Vdd

Adaptive Voltage Scaling Results

Time (seconds)	Fixed-Vdd (Relative Energy)	DVS (Relative Energy)	AVS (Relative Energy)
0	0	0	0
100	~500,000,000	~300,000,000	~200,000,000
200	~1,000,000,000	~600,000,000	~400,000,000
300	~1,500,000,000	~900,000,000	~600,000,000
400	~2,000,000,000	~1,200,000,000	~800,000,000
500	~2,500,000,000	~1,500,000,000	~1,000,000,000

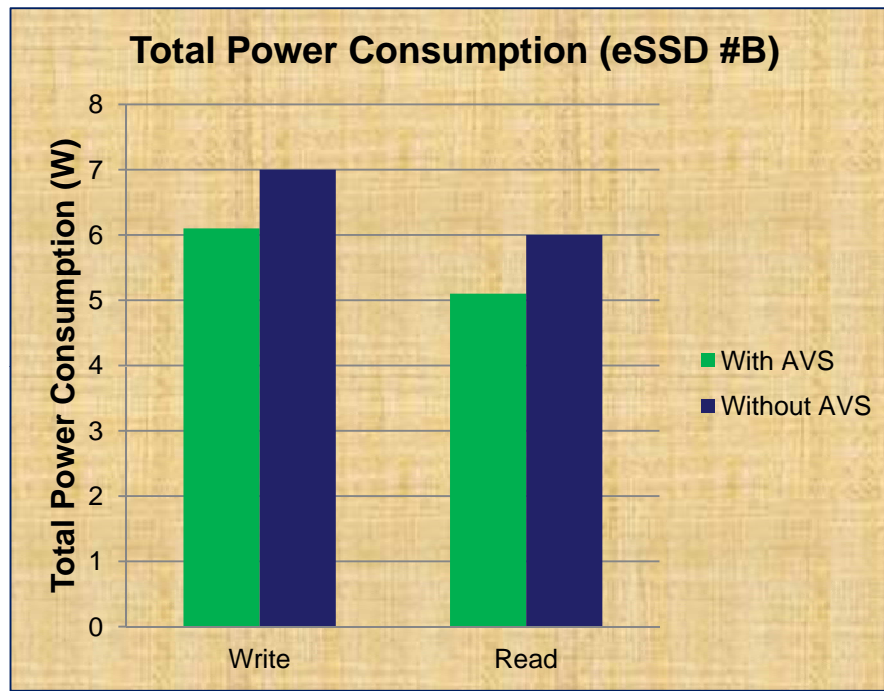
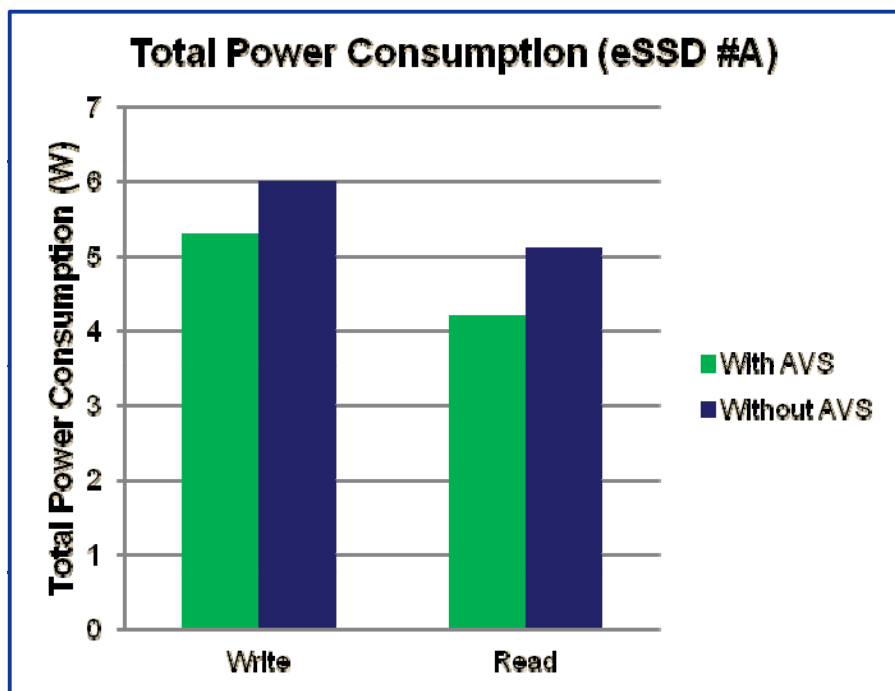
- ARM926EJ-S core
- Voltage and frequency scaling of CPU, Caches and TCMs
- Four performance points:
 - 60, 120, 180, 240 MHz
 - 0.6V – 1.2V Adaptive Voltage Range
- 40% energy savings with AVS
 - typical silicon verses fixed Vdd

- Dual ARM7 CPU cores
- Voltage and frequency scaling of ARM7 AHB clusters
- Performance points:
 - 96, 84, 72, 60, 12 MHz
 - 0.6V – 1.2V Adaptive Voltage Range
- 43% energy savings with AVS
 - typical silicon verses fixed Vdd

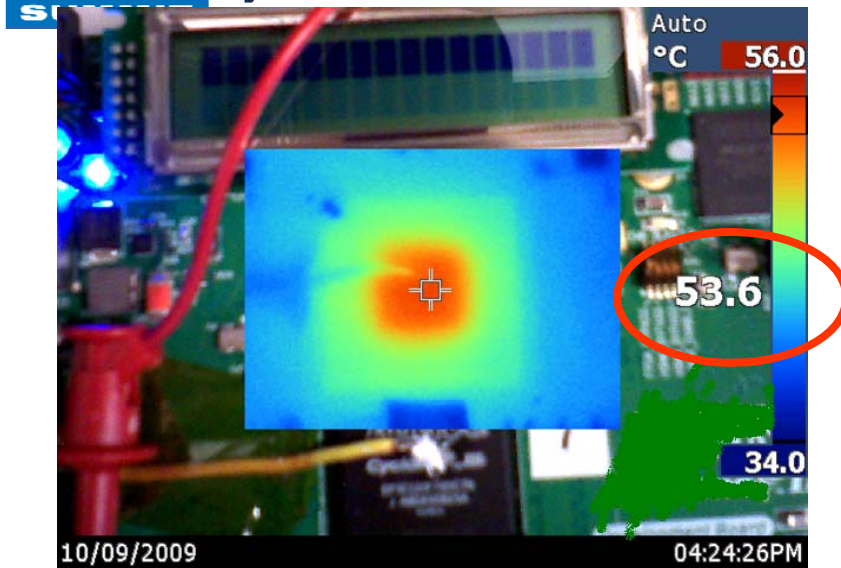


Solid State Drive AVS Power Savings

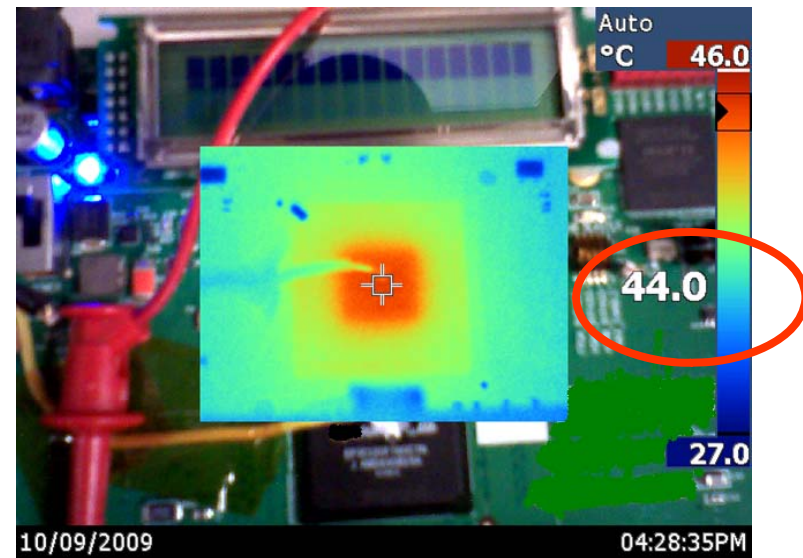


- 10% power savings of total eSSD power consumption
- Lower power consumption leads to better thermal dissipation and reliability
- AVS technology can also be used for over clocking to increase performance of SSD controller.

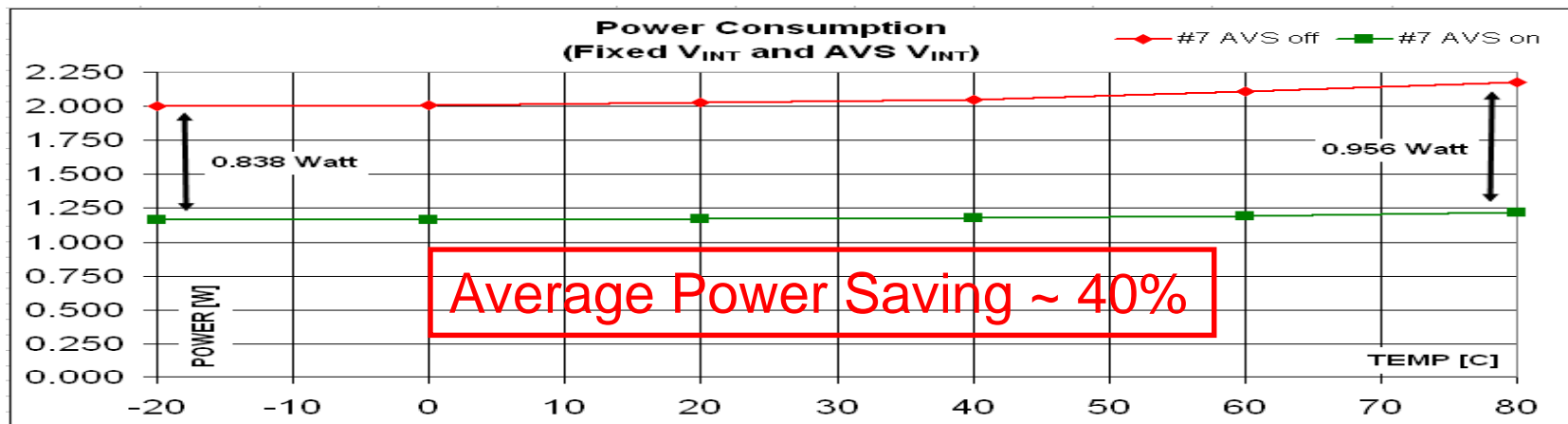
Power and Thermal Performance



Without AVS



With AVS





AVS System Impact

- System Performance
 - Once enabled AVS runs in background
 - No processing overhead

- Energy Savings – Scaled Voltage Domain
 - Savings vary depending on process geometry, design implementation, and frequency scaling profile
 - Expected energy savings for typical silicon will be 20-50% based on process and temperature variations

- System Risk Mitigation
 - AVS is an additional function in the ASIC/Processor and the power conversion device
 - AVS compliant ASIC/Processor and power conversion devices can still operate at fixed voltage or DVS without any design changes