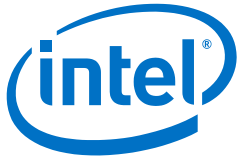
Intel® Node Manager

Intel® DCM



Energy/Power Management capabilities

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Agenda

Energy/Power Management capabilities in:

Intel® Xeon Phi Coprocessor

Intel® Xeon Processor E5 V2 Family

Intel® Node Manager

Intel® DCM

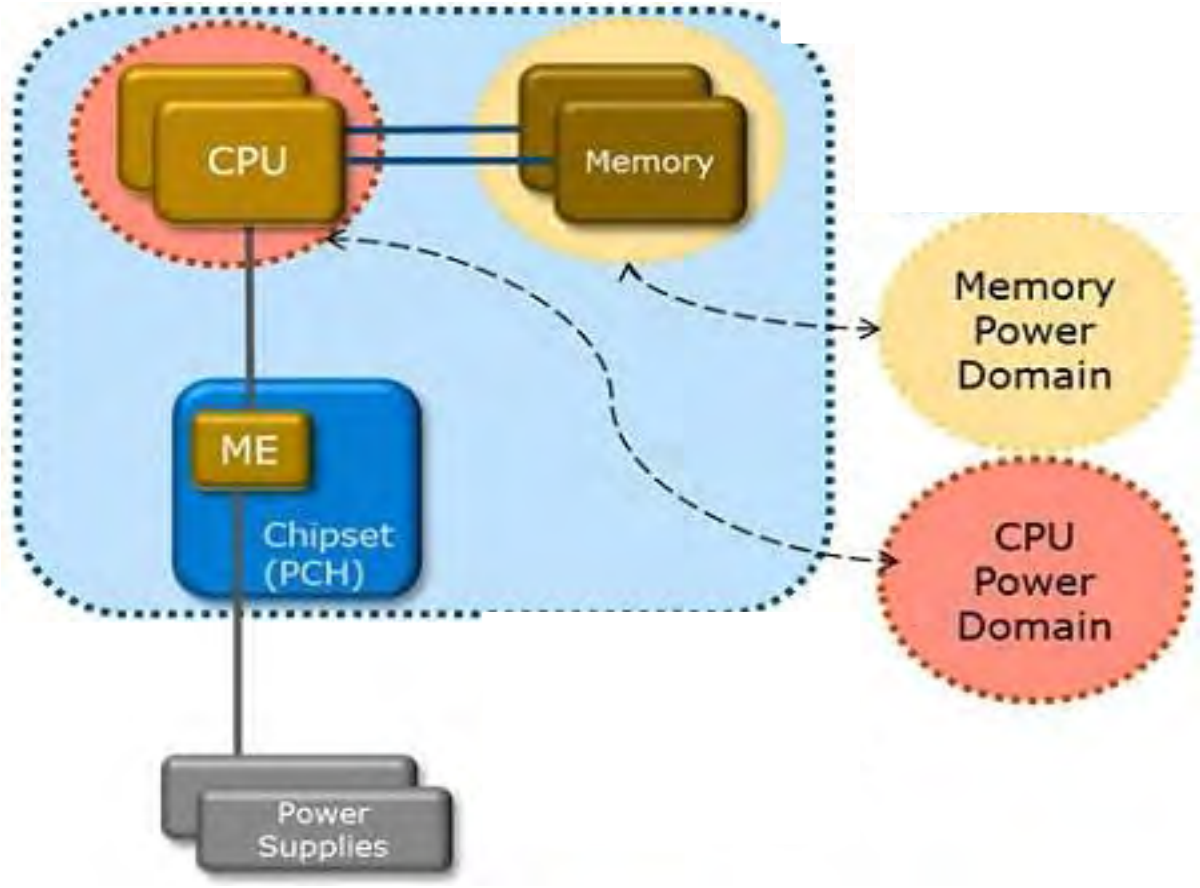
Summary

Intel® Energy/Power Management Capabilities from Component to System

Energy/Power Management capabilities from Component to System

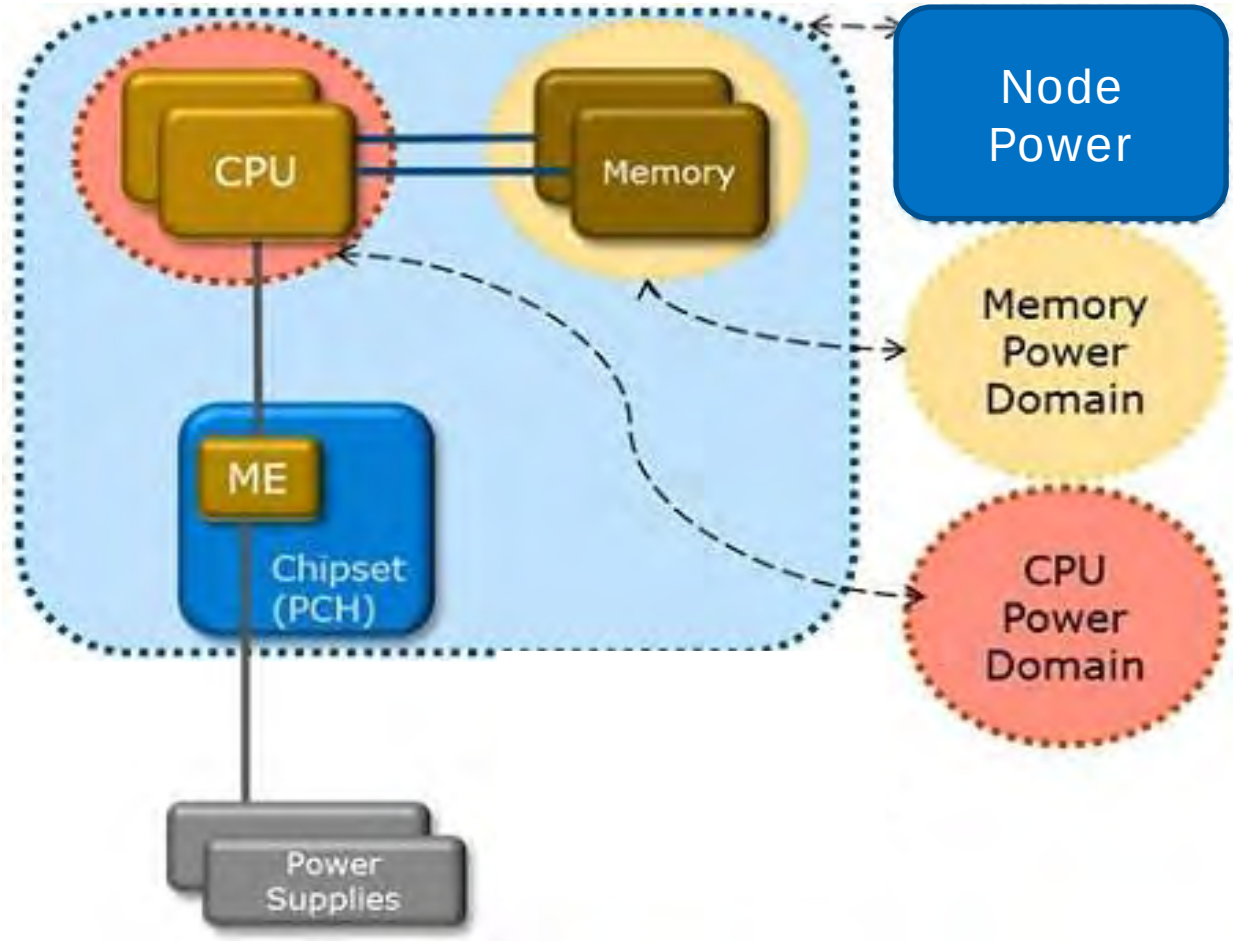
- Component
  - RAPL (Running Average Power Limit) to Monitor and Limit – CPU and Memory Power
- Node
  - Intel Node Manager to Monitor & Limit Node Power
- System/Cabinet
  - Intel Data Center Manager (DCM) to monitor and limit power at System/Cabinet

Intel Xeon Component Level Energy Measurement



RAPL (Running Average Power Limit) to Monitor and Limit – CPU and Memory Power

Intel Node Manager



Node Level Power Monitoring & Limiting Capability using Intel Node Manager

Intel Data Center Manager (DCM)

SDK with Web Service APIs for Data Center Power and Thermal Power Management

Management Console

Easy integration in the Management Console

Intel® DCM SDK (Web Service API)

- Monitor
- Control
- Trend
- Scalability
- Standards

Servers

System/Cabinet power monitoring and limiting using Intel DCM

Intel® Xeon Phi Coprocessor

Intel® Xeon Phi™ Coprocessor Product Lineup

3 Family
Outstanding Parallel Computing Solution
Performance/$ leadership

6GB GDDR5
240GB/s
>1TF DP

3120P

3120A

5 Family
Optimized for High Density Environments
Performance/watt leadership

8GB GDDR5
>300GB/s
>1TF DP
225-245W

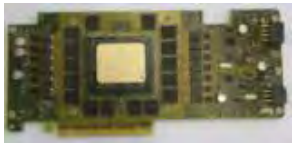
5110P

5120D

7 Family
Highest Performance, Most Memory
Performance leadership

16GB GDDR5
352GB/s
>1.2TF DP

7120P



7120X

Intel Xeon Phi Coprocessor Power States

Coprocessor Power State	7120P/3120P Power (Watts)	5110P Power (Watts)
C0	300	225
C1	<115	<115
PC3	<50	<45
PC6	<30	

P States & Turbo Mode

- All cores run at the same frequency
- Intel® Xeon Phi™ coprocessor 7120 supports Turbo Mode
  - When the card is operating below its specified power and temperature limits, it will enter turbo while still remaining within the power and thermal specifications.

Manageability

- Intel® Xeon Phi™ coprocessor manageability relies on a System Management Controller (SMC) on the PCI Express* card.
- The system provides sensor telemetry information for management by in-band (host) software and out-of-band software via the PCI Express* SMBus.
- SMC monitors power and temperatures within the Intel® Xeon Phi™ coprocessor and through sensors located on the PCI Express* card

Measurements: Components

(Info) Components are the physically discrete units that comprise the node. This level of measurement is important to analyze application energy performance trade-offs. This level is analogous to performance counters and carries many of the same motivations. Components may not only be silicon devices. For example, it would be useful to know how much fan energy is being used by the Muffin fans at the back of the rack or by some active rear door cooling methodology. Also, some systems may have a CDU. How much energy is being used by the CDU for motors, fans.

(enhancing) The ability to measure the current and voltage of each individual component must be provided.

The measurement sampling frequency should be:
(mandatory) 10 samples per second
(important) 100 samples per second
(enhancing) 1000 samples per second

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12 September 2013

(mandatory) The current and voltage data shall be both real electrical measurements and based on heuristic models.

Measurement Capabilities

- Power/energy data is sampled every 50ms
- Two user programmable power threshold levels
  - PL0
    - Defaults to 125% of TDP
  - PL1
    - Defaults to 105% of TDP

Intel® Xeon Processor E5 V2 family

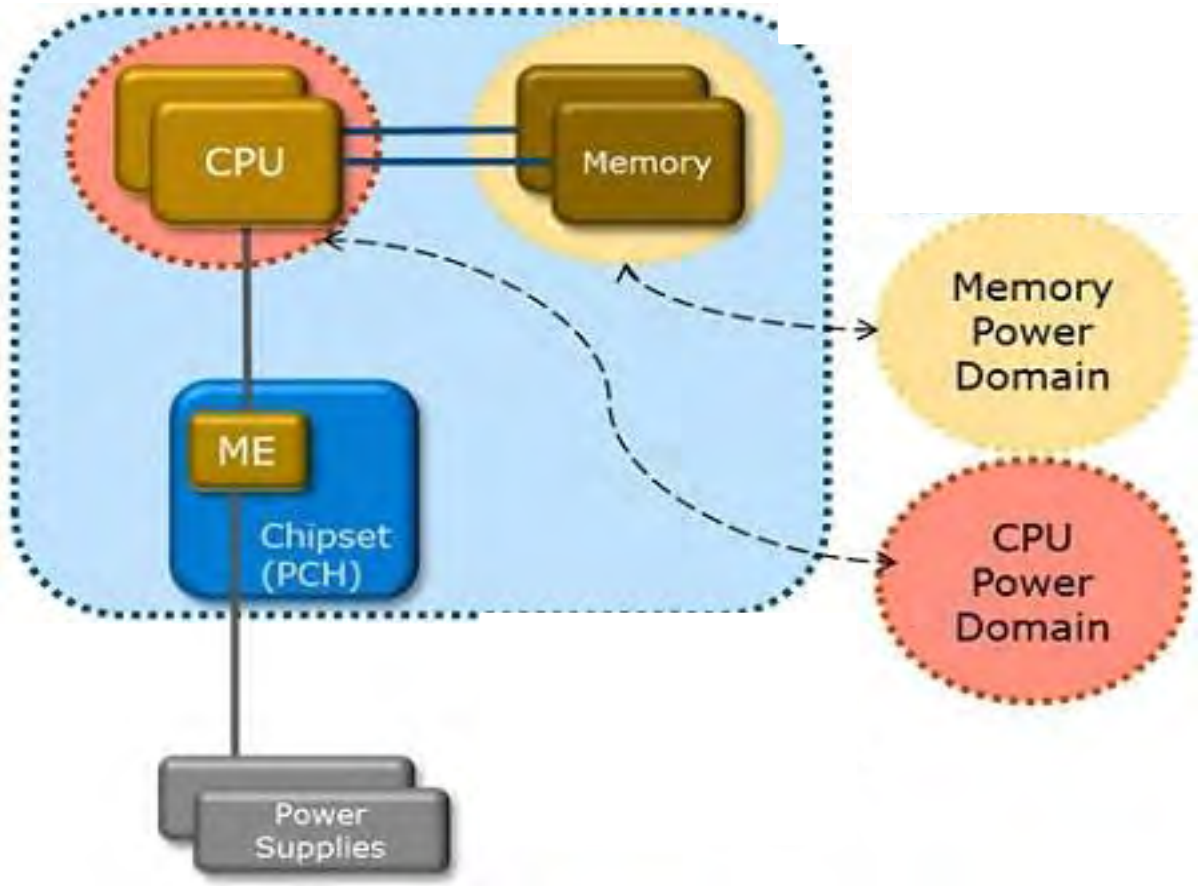
Intel® Xeon® Processor E5-2600 v2 Product Family

Today's focus

Feature	Intel® Xeon® E5-2600 (Sandy Bridge-EP)	Intel® Xeon® E5-2600 v2 (Ivy Bridge-EP)
QPI Speed (GT/s)	8.0, 7.2 and 6.4	
Addressability	46 bits physical, 48 bits virtual	
Cores	Up to 8	**Up to 12**
Threads Per Socket	Up to 16 threads	**Up to 24 threads**
Last-level Cache (LLC)	Up to 20 MB	**Up to 30 MB**
Intel® Turbo Boost Technology[1]	Yes	
Memory Population	4 channels of up to 3 RDIMMs, 3 LRDIMMs or 2 UDIMMs	
Max Memory Speed	Up to 1600	**Up to 1866**
Memory RAS	ECC, Patrol Scrubbing, Demand Scrubbing, Sparing, Mirroring, Lockstep Mode, x4/x8 SDDC	
PCIe* Lanes / Controllers/Speed (GT/s)	40 / 10 (PCIe* 3.0 at 8 GT/s)	
TDP (W)	150 (Workstation only), 130, 115, 95, 80, 70, 60, 50	
Idle Power Targets (W)	15W or higher, 12W for LV SKUs	**10.5W or higher, 7.5W for LV SKUs**

Running Average Power Limit (RAPL)

- RAPL
  - Ability to monitor and Limit CPU and DRAM power



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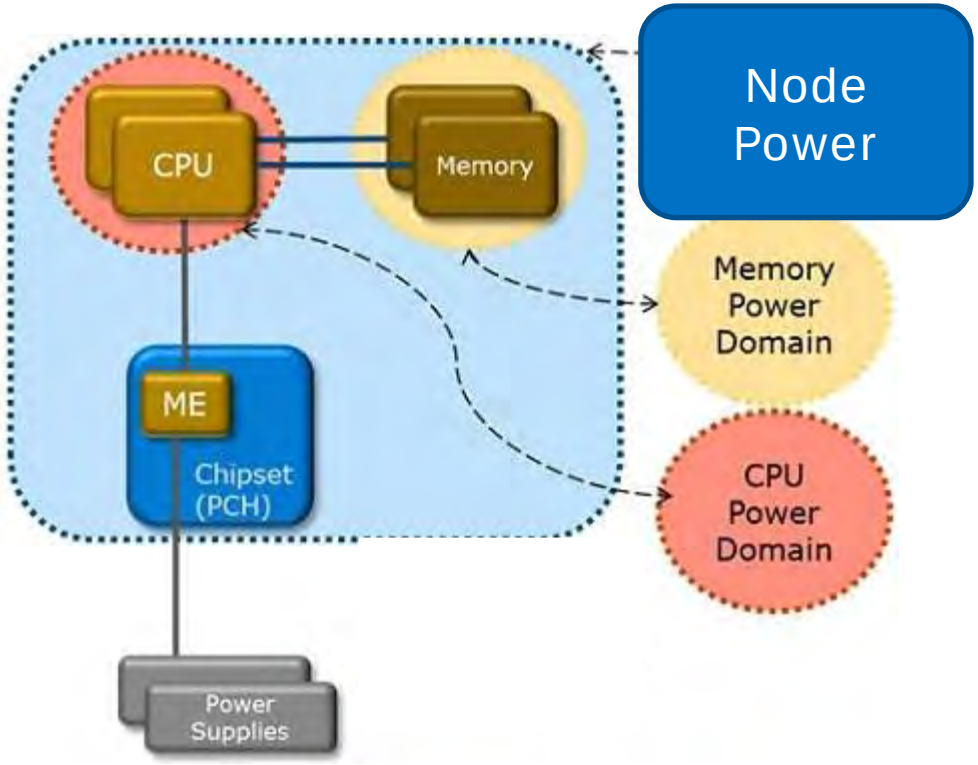
Measurement Capabilities

- RAPL counters are updated approximately every millisecond
- In Intel's experience the accuracy of the data is good around TDP (Thermal Design Power) levels, and may be 10% off at lower power load levels.
- Intel® Power Governor (power_gov) or Intel® Performance Counter Monitor utility can be used to (a) monitor power and (b) limit power

Intel® Node Manager

Intel Node Manager



- Intel Node Manager periodically queries the Power Supply Unit (PSU), CPU and memory about power consumption.
- It can also query about inlet temperature.
- Based on this data, Intel Node Manager calculates various statistics.
- Intel Node Manager can simultaneously monitor total system power, CPU power and memory power.

Node Manager Features

Platform Level Power Monitoring - monitoring and statistics (min, max, avg) of the total board power. Intel Node Manager reads this either directly from PSU or HSC using the PMBus protocol (PMBus v1.2 preferred) or from an external BMC using IPMI.

Platform Level Power limiting - ability enforce a policy to limit the total board power consumption.

Processor subsystem power monitoring – monitoring and statistics (min, max, avg) of the processor subsystem power

Processor power limiting - ability to enforce a policy to limit the power consumption of the processor package (socket) subsystem

Memory subsystem power monitoring – monitoring and statistics (min, max, avg) on the memory subsystem power

Memory power limiting - ability to enforce a policy to limit the power consumption of the memory subsystem

Inlet air temperature monitoring - monitoring and statistics (min, max, avg) of the inlet air temperature

Measurements: Nodes

(Info) A node level measurement shall consist of a combined measurement of all components that make up a node in the architecture. For example, these components may include the CPU, memory and the network interface. If the node contains other components such as spinning or solid state disks they shall also be included in this combined measurement. The utility of the node level measurement is to facilitate measurement of the power or energy profile of a single application. The *node* may be part of the network or storage equipment, such as network switches, disk shelves and disk controllers.

(important) The ability to measure the current and voltage of any and all nodes shall be provided.

The current and voltage measurements shall provide a readout capability of:

(mandatory) ≥ 1 per second
(important) ≥50 per second
(enhancing) ≥ 250 per second

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(mandatory) The current and voltage data must be real electrical measurements, not based on heuristic models.

Node Manager Sampling

- How often power monitoring value is updated?
  - Sampled every 100ms
- What is the accuracy?
  - It is based on PMBUS power supply specification
  - Around +/- 5%

Intel® DCM

Intel® Data Center Manager (DCM)

A middleware with web service APIs for data center power and thermal management – easy to integrate in the Management Console

ISV Management Console

DCM Middleware (Web Service API)

MONITOR | CONTROL | TREND

SCALABILITY | STANDARDS

Hardware Protocols

Node Manager IPMI | iDRAC IPMI | iLO/DCMI IPMI | IMM IPMI | CMC HTTPS/WS-MAN | OA SSH/CLI | IMM SSH/CLI | SNMP

Rack Servers

Blade Servers

PDU and UPS

IPMI = Intelligent Platform Management Interface
IMM = Integrated Management Module
SNMP = Simple Network Management Protocol
WS-MAN = Web Services-Management
iDRAC = Integrated Dell Remote Access Controller
CMC = chassis management controller
CLI = command line interface
DCMI = Data Center Manageability Interface
iLO = Integrated Lights-out
OA = Onboard Administrator
SSH = Secure Shell

Intel DCM Features

- Monitor Power and Thermals – Aggregated actual and historical trend data and alerts for racks and groups of servers
- Policy-based Management – Intelligent heuristics engine maintains group power cap on demand
- Scalability – Manage 10000s nodes using agentless technology.
- Retrieve real-time PDU and UPS power data

Measurements: System, Platform and Cabinet

(mandatory) Shall be able to measure the current and voltage of the system, platform(s) and cabinet(s).

The current and voltage measurements shall provide a readout capability of
(mandatory) ≥ 1 per second
(important) ≥ 50 per second
(enhancing) ≥ 250 per second

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(mandatory) The current and voltage data shall be real electrical measurements, not based on heuristic models

(important) The vendor shall assist in the effort to collect these data in whatever other subsystems are provided (e.g., another vendor's back-end storage system).

(important) Those elements of the system, platform and cabinet that perform infrastructure-type functions (e.g., cooling and power distribution), shall be measured separately with the ability to isolate their contribution to the energy and power measurements.

DCM Sampling

- CPU RAPL updates data every ~1ms
- NM updates data every ~100ms
- DCM updates aggregated data every few seconds
  - Can go faster if needed

Summary

Summary

- Intel delivers complete power management solution for HPC systems
  - Component
    - RAPL - CPU and Memory Power
  - Node
    - Intel Node Manager
  - System/Cabinet
    - Intel Data Center Manager