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# Intelligent Platform Management Interface (IPMI)

How to Avoid a Bike Ride to the Data Center

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# Why IPMI?

- Want to find out why compute job on Emmy node `gcn2960` failed
- No chance because node crashed and is not reachable?

```
# ssh gcn2960
ssh: connect to host gcn2960 port 22: No route to host
```

- Next step: Bike ride to data center and press reset button?
- No, reset node via IPMI

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin power reset
```

# What is IPMI?

- Intelligent platform management interface
- Manage server even if powered off or unresponsive
  - Power on, restart and even control server as if on-site
  - Monitoring, logging, access hardware information
- Network connection to dedicated controller independent of CPU and OS
- IPMI specification led by Intel and supported by over 200 vendors

# IPMI Architecture

- Baseboard management controller (BMC): Heart of IPMI
- Network: Dedicated LAN port (preferred) or shared with host
- Satellite controller for chassis connected to BMC via bus
- Sensors on motherboard and for chassis

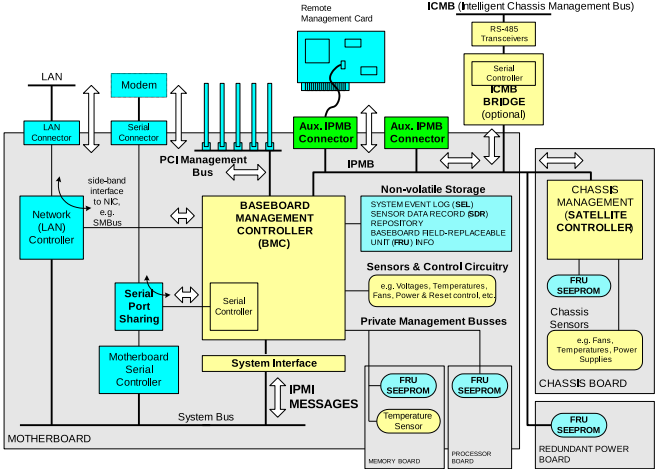


Image source: IPMI Specification v2.0, Revision 1.1, 2013

# System Management Software

- IPMItool
  - Access server remotely via LAN

```
# ipmitool -I lanplus -H <BMC-IP-ADDRESS> -U <USER> <COMMAND>
```

  - Access local server (requires OpenIPMI kernel modules)

```
# ipmitool <COMMAND>
```

  - Command overview

```
# ipmitool [<COMMAND>] help
```

- Some other software packages
  - OpenIPMI: Kernel modules and higher-level abstraction via libraries
  - FreeIPMI: Alternative to IPMItool, no need for kernel modules

# Power and Chassis

- Overview of power commands

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin power help
Password:
chassis power Commands: status, on, off, cycle, reset, diag, soft
```

- Check chassis status

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin chassis status
System Power         : on
Power Overload       : false
Power Interlock      : inactive
Main Power Fault     : false
Power Control Fault  : false
[...]
```

# System Event Log (SEL)

- Analyze cause of crash/problem
- List of system events stored in non-volatile memory (IDs in hexadecimal)

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin sel list
339 | 07/20/2022 | 12:35:01 | Temperature #0x21  | Upper Non-critical
445 | 02/07/2023 | 16:10:29 | Power Supply #0x50 | Power Supply AC lost
44d | 02/15/2023 | 08:42:15 | System Event #0x83 | OEM System boot event
45a | 02/16/2023 | 20:33:09 | Power Unit #0x01   | Power off/down
[...]
```

- Details of specific event (ID in decimal)

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin sel get <ID>
```

- Some events hardware-specific: Intel SEL Troubleshooting Guide

# Sensor Data Repository (SDR)

- Current readings of all sensors

```
# ipmitool [...] sdr list
System Airflow  | 52 CFM       | ok
Inlet Temp      | 33 degrees C | ok
CPU0 VR Temp    | 44 degrees C | ok
MBrd Temp       | 36 degrees C | ok
System Fan 1A   | 7728 RPM     | ok
Fan 1 Present   | 0x00         | ok
Mem 0 VR Temp   | 36 degrees C | ok
PS1 Input Power | 732 Watts    | ok
BB +12.0V       | 12.32 Volts  | ok
[...]
```

- Details of specific sensor

```
# ipmitool [...] sdr get "MBrd Temp"
Sensor ID       : MBrd Temp (0x25)
Entity ID       : 7.1 (System Board)
Sensor Type     : Temperature (0x01)
Sensor Reading  : 34 degrees C
Status          : ok
Nominal Reading : 60.000
Normal Minimum  : 10.000
Normal Maximum  : 105.000
Upper critical  : 115.000
[...]
```

- Sensors crossing thresholds recorded in SEL, thresholds adjustable

# Serial Over LAN (SOL)

- Redirect data for serial port of motherboard through IPMI session
- Access to BIOS/UEFI and Linux console possible
- Enable SOL and start session (exit with ~~.)

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin sol set enabled true
# ipmitool -I lanplus -H gcn2960-bmc -U admin sol activate
[SOL Session operational.  Use ~? for help]
CentOS Linux 7 (Core)
Kernel 3.10.0-1160.76.1.el7.x86_64 on an x86_64
gcn2960 login:
```

- Enter BIOS/UEFI by changing boot device before starting session

```
# ipmitool -I lanplus -H gcn2960-bmc -U admin chassis bootdev bios
```

# BMC Web Console

- Vendor-specific, not part of IPMI specification
- Graphical interface for IPMI features and more
  - Keyboard video mouse (KVM): `Remote Control/iKVM over HTML5`
  - Using remote image files: `Virtual Media`
- Access via laptop
  - Forward port of web console

```
laptop$ ssh -L 4443:gcn2960-bmc:443 gadm1
```

  - Open in browser: `https://localhost:4443`

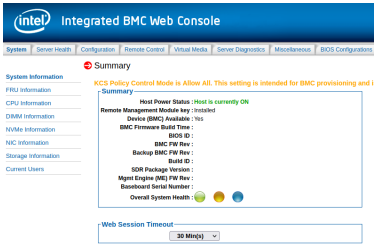


Image source: Screenshot of Intel Integrated BMC Web Console

# Telegraf Plugin: Sensor Data as Time Series

- Only current sensor readings available via IPMI
- Telegraf IPMI plugin imports readings into InfluxDB
- Telegraf and InfluxDB part of TIG/TICK monitoring
- IPMItool executed at regular intervals for all nodes
- No performance impact because via BMC not CPU

Image source: Screenshot of Chronograf showing IPMI data

# Redfish: IPMI Successor

- Aim: Industry standard replacing IPMI over LAN
- Redfish specification v1.0 in 2015, actively developed
- Secure and easy to use: RESTful API via HTTPS and JSON data format
- Client applications, browser interfaces and libraries
- Manage IT infrastructure beyond servers: Storage, network, power/cooling

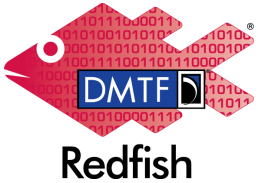


Image source: DMTF Redfish Forum

# Key Takeaways

- IPMI indispensable for admins of HPC clusters
- Power control, event logs (SEL) and sensor data (SDR)
- Independent of host system: Separate controller (BMC) with LAN interface
- IPMItool utility to manage servers: Only essential commands covered in talk

- Exercise: What does this command do?

```
# ipmitool raw 0x00 0x02 0x03
```

# IPMI References

- Thomas-Krenn - IPMI Basics
  See also other articles in IPMI section
- Thomas-Krenn - IPMItool Cheat Sheet
- IPMI Specification v2.0, Revision 1.1, 2013
  Over 600 pages including 25-page non-technical introduction
- ADMIN 03/2010 - IPMI
  Old but informative article
- Dan Farmer - IPMI
  Critical discussion of IPMI and BMC security