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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

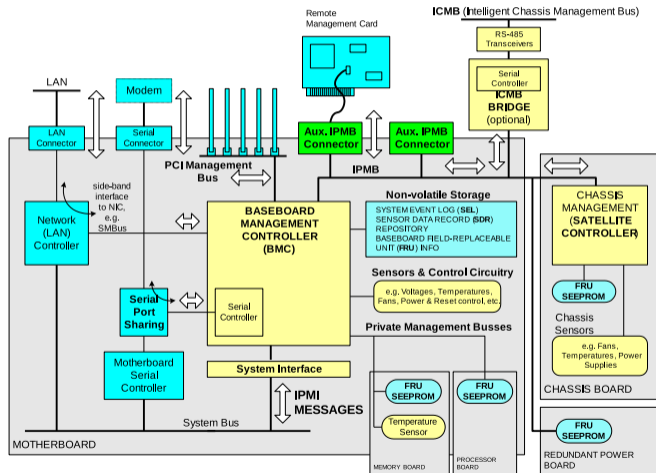


Image source: IPMI Specification v2.0, Revision 1.1, 2013

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>

intel Integrated BMC Web Console

System Server Health Configuration Remote Control Virtual Media Summary

Summary

KCS Policy Control Mode is Allow All. This Summary

Host Power Status : Host is current  
Remote Management Module key : Installed  
Device (BMC) Available : Yes  
BMC Firmware Build Time :  
BIOS ID :  
BMC FW Rev :  
Backup BMC FW Rev :  
Build ID :  
SDR Package Version :  
Mgmt Engine (ME) FW Rev :  
Baseboard Serial Number :  
Overall System Health : ● ●

System Information  
FRU Information  
CPU Information  
DIMM Information  
NVMe Information  
NIC Information  
Storage Information  
Current Users

Web Session Timeout  
30 Min(s)

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