

Redfish Green500 Benchmark (RGB): Towards Automation of the Green500 Process for Data Centers

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1- Background



Green500

- **Performance**  **Top500**
- **Energy efficiency**  **Green500**

To encourage cluster stakeholders to make sure that they are aware of the level of energy consumption in their data center.

Green500(aspects and quality levels)

aspects of a power measurement:

- 1. Granularity, time span, and type of raw measurement
- 2. Machine fraction instrumented
- 3. Subsystems included in instrumented power
- 4. Location of measurement in the power distribution network, and power-meter accuracy.

quality levels:

- Adequate, called Level 1 (L1)
- Moderate, called Level 2 (L2)
- Best, called Level 3 (L3)

To grant a given quality level for a submission, the submission must satisfy the requirements of all four aspects at that quality level or higher.

<https://www.top500.org/static/media/uploads/methodology-2.0rc1.pdf>



DMTF's Redfish™

- Redfish is an open standard which contains a collection of specifications and human-readable schemas to monitor and manage the hardware layer of the data center.
- Redfish standard is (and will continue) growing to cover the hardware layer of data center entirely.
- This feature helps RGB project to use the internal capability of the Redfish enabled equipment to automate the Green500 process.

<https://h20195.www2.hp.com/V2/getpdf.aspx/4AA6-1727ENW.pdf>



RGB Objective

■ Benefits

- To design and develop a Green500 checking tool using Redfish technology (the integration of Redfish and Green500).
- to automate benchmarking the energy efficiency of high performance computing systems based on the Green500 methodology via direct measurements obtained from the baseboard management controllers using Redfish standard, instead of via an external power meter and a manual process.



Motivations

1- RGB would benefit Green500 project:

2- RGB would benefit supercomputer stakeholders:

3- RGB would benefit DMTF:

ISSUE

Green500 provides a “manual methodology” to find the level of energy consumption and performance per watt.

ISSUE

Green500 procedure is a manual process.

How it is addressed by RGB

- RGB automates Green500 methodology.
- RGB accomplishes what green500 needs to achieve using the internal capability of equipment by Redfish Standard technology.

How it is addressed by RGB

- It makes Green500 calculations easy for clusters.
- RGB provides an open benchmark tool for data centers to go through the Green500 methodology easily with no cost, and using the internal capability of Redfish-enabled facilities instead of external expensive tools to gather power samples.

- We evaluated and demonstrated Redfish usage.

- We provided a feedback from the HPC community to DMTF, to improve the Redfish standard project to support the energy consumption calculation part of the Green500 methodology.

2- RGB Methodology



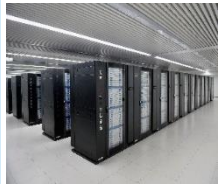
Contribution

We designed and developed a Green500 checking tool using Redfish technology through the integration of Redfish and Green500 methods.

We evaluated and demonstrated Redfish usage, and provided feedback from the HPC community to DMTF and Green500.



Overview (RGB process)



RGB Input:

- A supercomputer with Redfish enabled instruments to be submitted to the Green500 List.
- Requested Green500 level (1,2, 3)

Step A) Initialization step

1. Select Granularity Algorithm based on the input level
2. Select Timing Algorithm based on the input level
3. Select Measurements Algorithm based on the input level
4. Select Machine fraction based on the input level
5. Select Subsystems based on the input level
6. Select Meter accuracy based on the input level

RGB Output:

The average of the following values:

- **GFLOPS Per Watt**
- $\bar{P}(R_{max})$

Step B) Measurement Step

1. Launch the Linpack benchmark
2. Start recording the power measurement samples using Redfish command
3. Stop recording the power measurement samples based on selected algorithms in the **initialization step**
4. Save the Linpack performance
5. Calculate the unit average power by repeating the above steps based on the selected algorithms in the **initialization step**
6. Derive the output
7. Repeat the above measurement procedure at least three times and find the average of each output



Introduced benchmark Tools

■ The RGB Checker

The RGB Checker helps DMTF to find the limitations of Redfish to address the explained Green500 requirements and improve the Redfish standard project to make sure it supports the energy consumption calculation part of the Green500 methodology.

■ RGB based on the Redfish Standard

RGB based on the Redfish Standard benefits data center stakeholders, and also the Green500 project by introducing an open source benchmark tool for the Green500 calculation.

<https://github.com/nsfcac/RGB-Checker>

<https://github.com/nsfcac/RGB-Standard>



3- Implementations and Results



Results of running RGB checker in ten different testbeds

Total power sample requests	Avg. # of requests took more than 1 Sec	Avg. time to get a power sample (ms)	Precision Level (%)	Total energy usage (Watt)	Min time To get a power Sample (ms)	Max time to get a power Sample (ms)
10000	220.8	725.7	77%	97343	251	1900

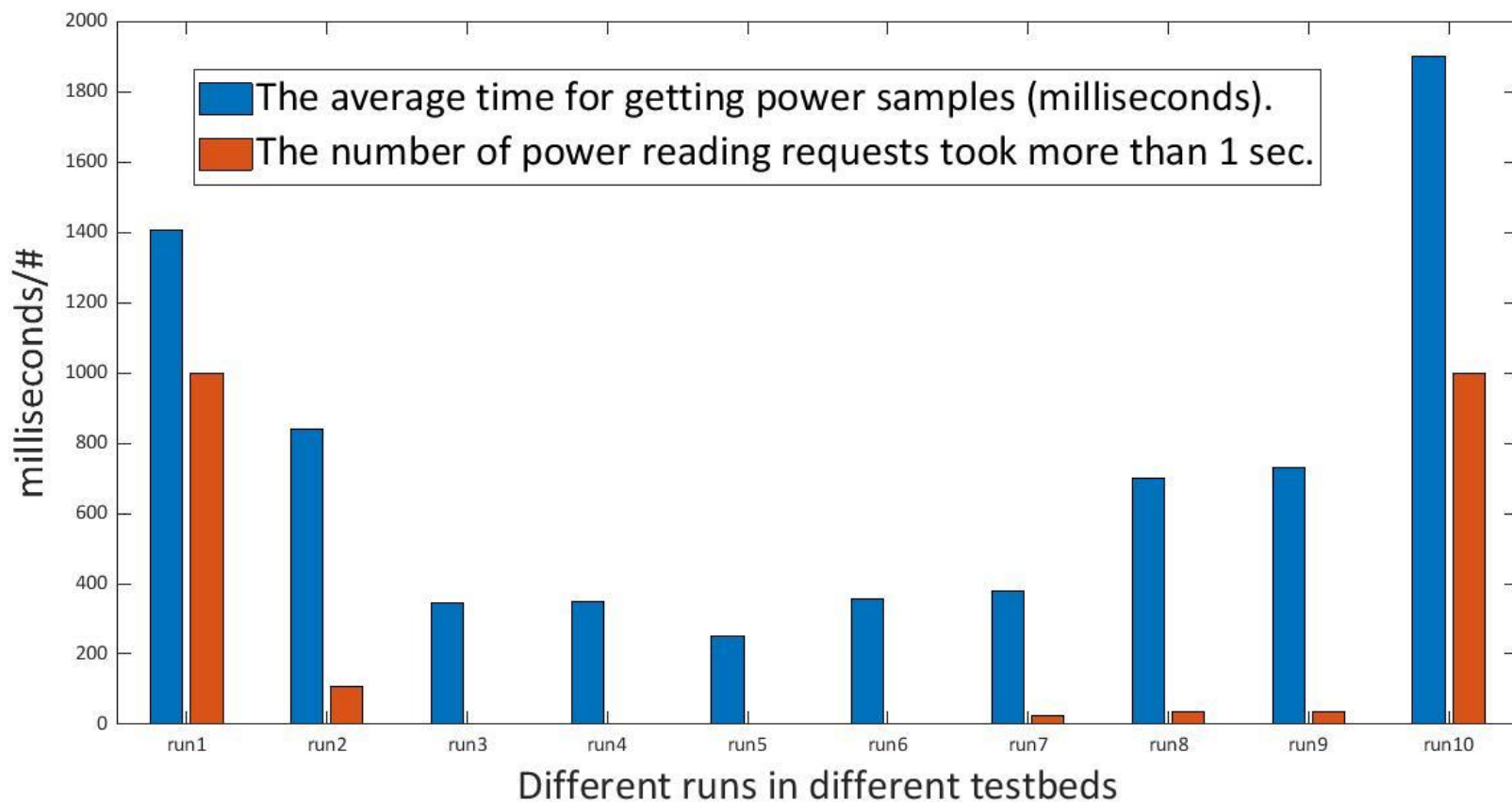
Testbed:

Ten different type of servers from different brands:

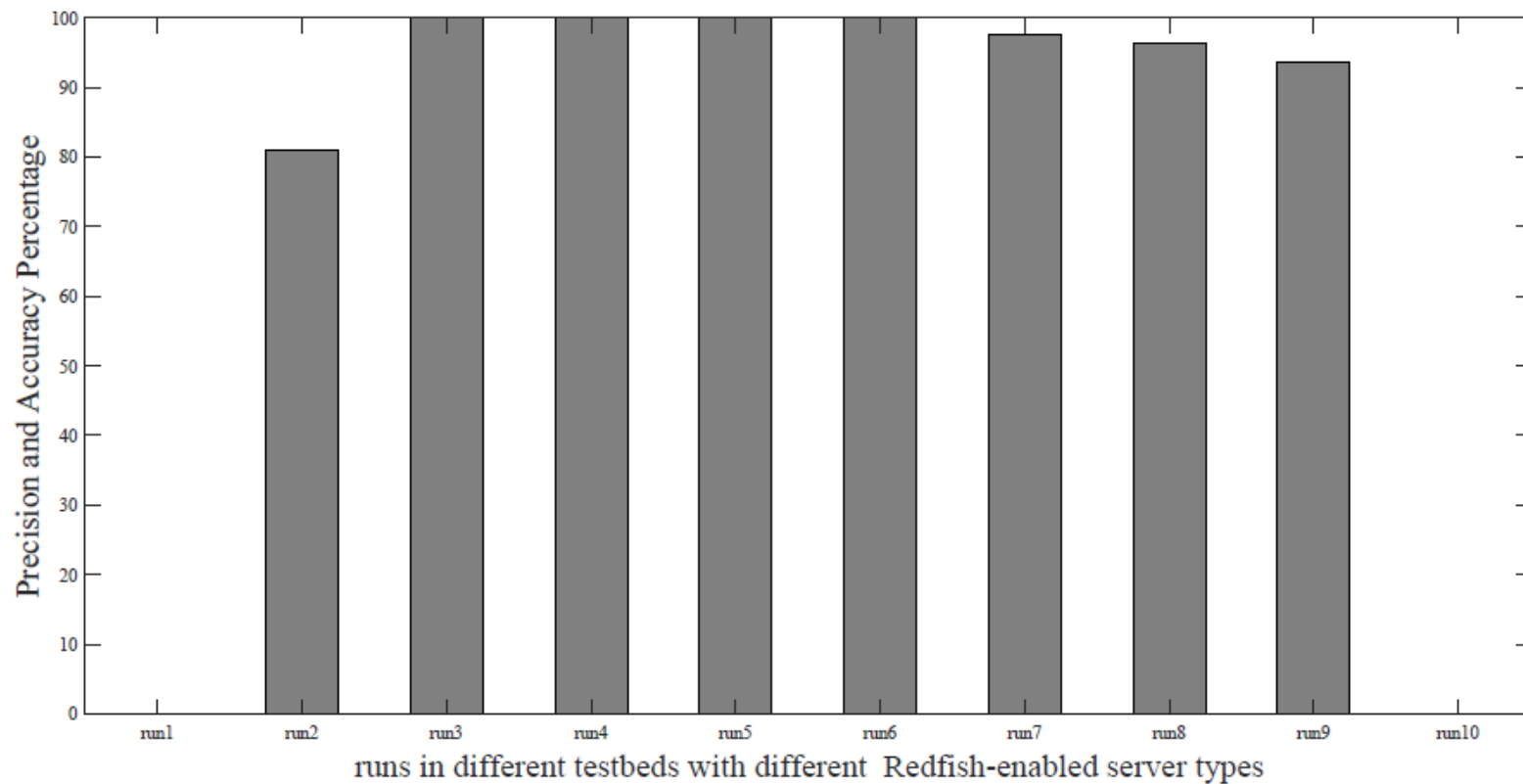
(Dell-XR2, IDRAC 14g, Intel, Supermicro, HPE, PowerPC (Supermicro), Insyde, and Dell PowerEdge C6320)



The average time for getting power samples (milliseconds), and the number of power reading requests took more than 1 sec.



The precision and the accuracy percentage of RGB for level 1 and 2 of Green500, in ten different testbeds with ten different Redfish-enabled server types

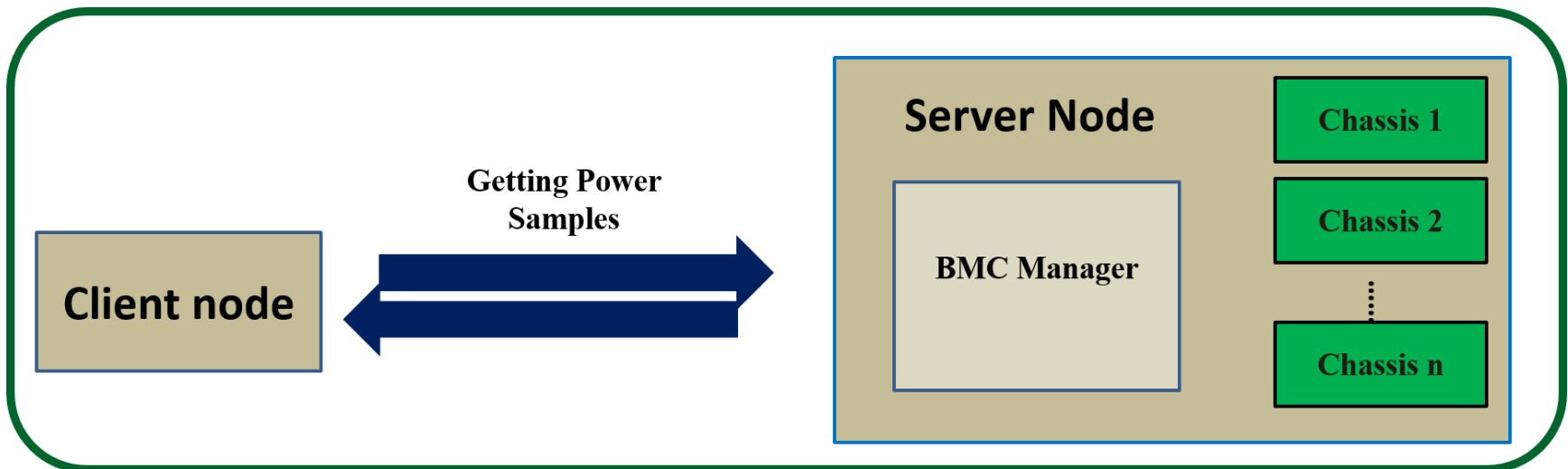


4- Current Limitations of RGB



Current Limitations of RGB

- A server with a collection of chassis may receive several Redfish requests related to different chassis at the same time.
- Due to the lack of using multi-tasking or multithreading techniques in a server with a chassis collection, and the lack of timestamps in Redfish reports, the RGB may not satisfy the requirements of the Green500 granularity aspect in this scenario.



The structure of a chassis collection



Current Limitations of RGB (cont'd)

Limitation Number	Name	quality level	comment
1	Lack of Timestamp	1, 2, 3	<p>There is no substantial timestamping for reading sensors, therefore the current version of RGB is not completely accurate. To have precise output, it is necessary to have timestamps for:</p> <ul style="list-style-type: none"> • PowerConsumedWatts • AverageConsumedWatts
2	Inadequate sampling rate	3	<p>The rate of reading Energy consumption is not enough. To achieve the third quality level, it is necessary to be able to read voltage and current sampled at rate of 5 kHz for AC / 120 Hz for DC.</p>
3	Lack of using multi-processing or multi-threading techniques in collection of chassis	1,2,3	



5- Conclusions, Future Work



Conclusions

The main objective :

- To automate the process of Green500 methodology using the internal capability of data center equipment.

The main achievements:

- Automating the manual Green500 process.
- Providing an open benchmark tool for data centers to go through the Green500 methodology easily with no cost.
- Using the internal capability of Redfish-enabled facilities instead of external expensive tools to gather power samples.
- Introduced benchmark Tools: (The **RGB Checker**, **RGB based on the Redfish Standard**)



Future Work

we plan to design a Redfish Green500 Benchmark based on additional and recently proposed features of the Redfish standard, such as the telemetry model.

The telemetry provides a Redfish service to support defining registries of metrics and specifying ways to retrieve measurements at intervals through a metric report.

https://www.dmtf.org/sites/default/files/standards/documents/DSP2051_1.0.0.pdf



Thanks

If you have any question, please contact us:

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