Google Data Center Power Trace

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Introduction

This document describes the access and format of the power traces of a few Google data center power domains. We assume familiarity with this paper:

> Varun Sakalkar, Vasileios Kontorinis, David Landhuis, Shaohong Li, Darren De Ronde, Thomas Blooming, Anand Ramesh, James Kennedy, Christopher Malone, Jimmy Clidaras, and Parthasarathy Ranganathan. 2020. Data Center Power Oversubscription with a Medium Voltage Power Plane and Priority-Aware Capping. In *Proceedings of the Twenty-Fifth International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS '20), March 16–20, 2020, Lausanne, Switzerland.* ACM, New York, NY, USA, 15 pages.

The traces cover one month of total and production workload power data beginning 2019 May 1 00:00 PT, consisting of 10 clusters and 57 power domains (PDUs).

These traces complement data previously published: Google Cluster Workload Traces 2019. We've included power traces for the eight clusters included in that dataset, along with traces corresponding to two new PDUs of the new MVPP design.

Power data is derived according to the methodology outlined in the paper.

Power Trace Fields

For confidentiality reasons, some information in the trace has been obfuscated. In particular, we've re-named cells and power domains, and provided power data in the form of utilization: the ratio between usage and capacity.

time

UINT64. This field marks the beginning of a 5-minute interval for which power measurements were taken and correspond to the average value observed over the 5 mins. It represents the number of microseconds since 600 seconds before the start of the trace period. For instance, a measurement occurring at 2019 May 1 00:05 PT (5 minutes after the start of the trace period) will have a `time` value of `900000000`.

The times have been presented this way to be consistent with the Google borg usage traces.

cell

STRING. Name of the cell, such as "a."

pdu

STRING. Name of the power domain, such as "pdu1."

measured_power_util

DECIMAL in the range [0,1]. Total power utilization averaged over the 5-minute window beginning at `time`. Includes power from non-IT equipment, specifically power from data center floor cooling equipment.

production_power_util

DECIMAL in the range [0,1]. The power utilization attributed to production workloads. This is estimated with interpolation of cpu utilization and idle / busy machine power.Includes power from non-IT equipment, specifically power from data center floor cooling equipment.

bad_measurement_data

BOOLEAN. When false, indicates low-confidence in the correctness of the `measured_power_util` value due to a meter issue or telemetry collection pipeline issue.

bad_production_power_data

BOOLEAN. When false, indicates low-confidence in the correctness of the `production_power_util` value due to a meter issue or telemetry collection pipeline issue.

Machine to PDU/Cell Mapping

We've included a map of machines to their power domain and cell for cells *a* through *h*, which have the traditional "radial" power architecture design. We hope this is useful in analyzing the power traces in conjunction with the borg usage traces.

Accessing the Trace Data

We provide the traces as BigQuery tables and CSV files.

BigQuery access

To facilitate easier use with the Google Borg usage traces, we have made the power traces accessible via BigQuery.

> **Important**: the trace data is freely available, but using BigQuery will consume project resources that may have to be paid for. We strongly encourage researchers to keep an eye on their resource consumption, and to sample the data when developing queries.

Here are some simple examples of using the BigQuery command line tool to query the data set:

List all tables available in the dataset:

```
Unset
bq ls --all=true --max_results=100 google.com:google-cluster-data:powerdata_2019
```

Checking the data for PDU 7 in cell a:

```
Unset
bq show google.com:google-cluster-data:powerdata_2019.cella_pdu7
```

Counting the number of machines per PDU:

```
Unset
bq query --use_legacy_sql=false 'SELECT COUNT(machine_id) AS machine_count, pdu
FROM `google.com:google-cluster-data`.powerdata_2019.machine_to_pdu_mapping GROUP
BY pdu'
```

CSV access

In addition to BigQuery access, the trace is also available to download as compressed CSVs from Google cloud storage (GCS).

There is one file per power domain (such as `cella_pdu6.csv.gz`) plus an additional file (`machine_to_pdu_mapping.csv.gz`) containing the mapping between machines and their associated PDU and cell. These files are in the powerdata_2019 bucket.

To download the data, one can use gsutil:

```
Unset
gsutil cp gs://powerdata_2019/cella_pdu6.csv.gz <destination dir>
```

To inspect the content of a file, one needs to first decompress the data using GZIP. E.g.:

```
Unset
unzip cella_pdu6.csv.gz
```

Document History

Date	Notes
Feb 15, 2024	Initial version.