Server efficiency Metric from SERT Worklet Results

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DIGITALEUROPE has worked with the Green Grid SERT™ Analysis Working Group (WG) and the SPECpower Committee to establish an industry position on the best method to construct a single value server active energy efficiency metric from the data generated from the SERT™ metric tool. An assessment of various metric options has been performed through the analysis of an extensive data set consisting of SERT data from ENERGY STAR® certified systems and the SPECpower Committee's dataset generated by that group's testing work. Based on this work, DIGITALEUROPE has reached the following metric proposal, which is the recognized consensus of DIGITALEUROPE's members.

The SERT™ tool reports performance and power data for seven CPU worklets, two memory worklets, two storage worklets and one hybrid workload. For each worklet, data is reported for a set of proportional performance intervals and associated, measured power values along with other test measurements. An interval efficiency value can be calculated by dividing each normalized performance value by the interval power value. The set of individually measured Performance and Power values with their associated efficiency value will be referred to as interval data.

Of the seven CPU worklets, six are used in the creation of the single value efficiency metric: Compress, LU, CryptoAES, SOR, Sort, and SHA 256. XML_validate is represented in the capacity metric and is therefore excluded from the CPU workload calculation. The Hybrid SSJ workload is also considered as a CPU workload for the purposes of creating a single combined efficiency metric. The two memory worklets are Flood3 and Capacity3 and the two storage worklets are Sequential and Random. In order to create a single energy efficiency metric for a server it is necessary to combine the worklet interval performance and power values for all the different worklets. The method developed by the Green Grid SERT Analysis Working Group (WG) and the SPECPower Committee to create a single efficiency metric follows the following general procedure.

1. Combine individual worklet normalized performance and power interval data to obtain an overall Efficiency value (Performance/Power) for the worklet.
2. Combine worklet Efficiency, Performance and Power values by workload type (CPU, Memory, Storage) to obtain a workload type value
3. Combine workload types using a weighted geomean to obtain a single, total server Efficiency, Performance or Power value. The chosen weightings are 65% for the CPU, 30% for the memory and 5% for the storage workloads.

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The geomean function offers the best option to combine the interval data to a worklet efficiency score and the workload (CPU, memory, storage) worklet efficiency scores to create a workload efficiency score. Using the geomean prevents any single performance, power, worklet or workload efficiency score from unduly influencing the single metric.

Equations for the calculation of the Single Value Server Efficiency Metric from SERT Worklet Results

The method used to combine interval Efficiency, Performance and Power data is a geomean of the interval data. Equation 1 through Equation 3 below show how this is applied to Efficiency, Performance and Power respectively.

Equation 1

$$Eff_{worklet} = Geomean(Eff_1, Eff_2, Eff_3, \dots Eff_n) = \frac{Perf_{worklet}}{Pwr_{worklet}}$$

Equation 2

$$Perf_{worklet} = Geomean(Perf_1, Perf_3, \dots Perf_n)$$

Equation 3

$$Pwr_{worklet} = Geomean(Pwr_1, Pwr_2, Pwr_3, \dots Pwr_n)$$

Where:

n = the number of worklet interval values for the worklet being evaluated

$Eff_{worklet}$ = Efficiency value for the worklet in question. This value is calculated by taking the geomean of calculated worklet interval efficiencies or by taking the ratio of the geomean of the normalized interval performance to geomean of the interval power.

Eff_1 = Efficiency value of the first worklet interval

Eff_n = Efficiency value of the n^{th} worklet interval

$Perf_n$ = Performance value of the n^{th} worklet interval

$Perf_{worklet}$ = Geomean performance value of the worklet in question. This value is calculated by taking the geomean of the interval performance measurements for the worklet.

Pwr_n = Power value of the n^{th} worklet interval

$Pwr_{worklet}$ = Geomean power value of the worklet in question. This value is calculated by taking the geomean of the interval power measurements for the worklet.

Now that we have worklet Efficiency, Performance and Power values we combine these using a geomean in order to obtain a workload type value.

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Equation 4

$$Eff_{CPU} = Geomean(Eff_{Compress}, Eff_{LU}, Eff_{SOR}, Eff_{Crypto}, Eff_{Sort}, Eff_{SHA256}, Eff_{Hybrid\ SSJ})$$

Equation 5

$$Eff_{Memory} = Geomean(Eff_{Flood3}, Eff_{Capacity3})$$

Equation 6

$$Eff_{Storage} = Geomean(Eff_{Sequential}, Eff_{Random})$$

Where:

Eff_{CPU} is the CPU workload subtype efficiency value

Eff_{Memory} is the Memory workload subtype efficiency value

$Eff_{Storage}$ is the Storage workload subtype efficiency value

Similar workload level values are calculated for Performance and Power by substituting performance (Perf) or power (Pwr) for Eff in Equation 4 through Equation 6.

Using the CPU performance aggregation as an example, equation 4 would be reconstructed as follows:

Equation 7

$$Perf_{CPU} = Geomean(Perf_{Compress}, Perf_{LU}, Perf_{SOR}, Perf_{Crypto}, Perf_{Sort}, Perf_{SHA256}, Perf_{Hybrid\ SSJ})$$

Next we combine the three geomeaned workload efficiency, performance and power values to get overall server Efficiency, Performance and Power values using a weighted geomean of the workload values as shown in Equation 8 through *Equation 10*. A weighted geomean is achieved by applying a weighting factor to the log function of each workload type, summing the resulting weighted workload type values and then taking the Exponent function of the weighted sum to generate a single efficiency score (Equation 7). The server level performance and power values are calculated by replacing EFF in Equation 7 with performance (Perf) resulting in equation 8 or power (Pwr) resulting in Equation 9.

Equation 8

$$Eff_{server} = EXP((0.65 * \ln(Eff_{CPU}) + 0.30 * \ln(Eff_{Memory}) + 0.05 * \ln(Eff_{Storage}))$$

Equation 9

$$Perf_{server} = EXP(0.65 * ln(Perf_{CPU}) + 0.30 * ln(Perf_{Memory}) + 0.05 * ln(Perf_{Storage}))$$

Equation 10

$$Pwr_{server} = EXP(0.65 * \ln(Pwr_{CPU}) + 0.30 * \ln(Pwr_{Memory}) + 0.05 * \ln(Pwr_{Storage}))$$

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