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Estimating and Mitigating Harmful Effects of Phase Imbalance on Datacenter Performance

AzTE Case # M14-122P

Background

Data centers are under increasingly greater pressure to cut energy costs and reduce their carbon footprint. To save money, data centers use uninterruptible power supply (UPS) to store power during off-peak hours for use during peak times when electricity providers charge more. Within the data center, power distribution units (PDUs) regulate power usage and are typically designed with three phase delta circuits. Phase imbalance occurs when there is a significant difference in voltage between one or more phases. Current attempts to optimize power distribution include the manual configuration of PDUs via an experimentally developed lookup chart, and workload scheduling algorithms that do not objectively measure phase imbalance and assume the phases will be balanced by correctly routing power. These algorithms allow up to 20% imbalance that wastes a considerable amount of energy and weakens UPS efficiency.

Invention Description

Researchers at ASU have developed analytical and simulative techniques for estimating harmful effects of phase imbalance on a datacenter's performance and load balancing techniques to mitigate these effects. They've found that actual line loss is only 1% of the total power consumption, so the sophisticated optimization performed by the workload scheduling algorithms yield an insignificant return. Rather, using simple solutions such as improving power factor greatly reduces the effects of phase imbalance, especially for workload scheduling of multiple PDUs.

Potential Applications

- Data Center Infrastructure Management
- Load Balancing

Benefits and Advantages

- **Efficiency** – Minimizes draw on the power grid by UPS systems.
- **Longevity** – Balanced PDUs means better power distribution and increased equipment lifetime.
- **Lower Costs** – Saves money by reducing power consumption and device wear.