December 2022

Rack Power System with Optimal Efficiency Point Tracking

n/a

Rack Power System with Optimal Efficiency Point Tracking

ABSTRACT

This disclosure describes techniques for improving the operational efficiency of rack power systems. A standby state is configured for each power supply unit (PSU). In the standby states, the PSU does not supply current to the load but is operationally ready to immediately transition to a power sourcing mode as needed. Transition between modes can be controlled through logic built within the PSU or through logic included in a power shelf controller that monitors the power draw of each PSU. The power shelf controller can calculate and deploy the number of PSUs that are to be placed in standby state in order to enable the remaining PSUs that are in a power sourcing mode to operate close to their peak efficiency point. The techniques enable power supply units (PSU) in the rack power system to operate near the peak efficiency point, thereby optimizing the performance of the overall rack power system and reducing operational costs.

KEYWORDS

- Data center
- Power Supply Unit (PSU)
- Rack Power System
- Power sourcing
- Efficiency point
- Standby state
- Power shelf
- Total cost of operation (TCO)

BACKGROUND

Mission critical systems such as data center infrastructure commonly include system redundancies (e.g., hardware and software redundancies) to maintain high availability of system operations. From a power system design perspective, multiple power feeds from a diversified set of utilities (sources) are utilized to provide power to data center racks. For example, diesel generators can be used to provide backup power in case of power interruptions from grid-based utilities. Redundant power feeds are typically distributed all the way to machine racks through medium voltage (MV) transformers, switch boards, and busways.

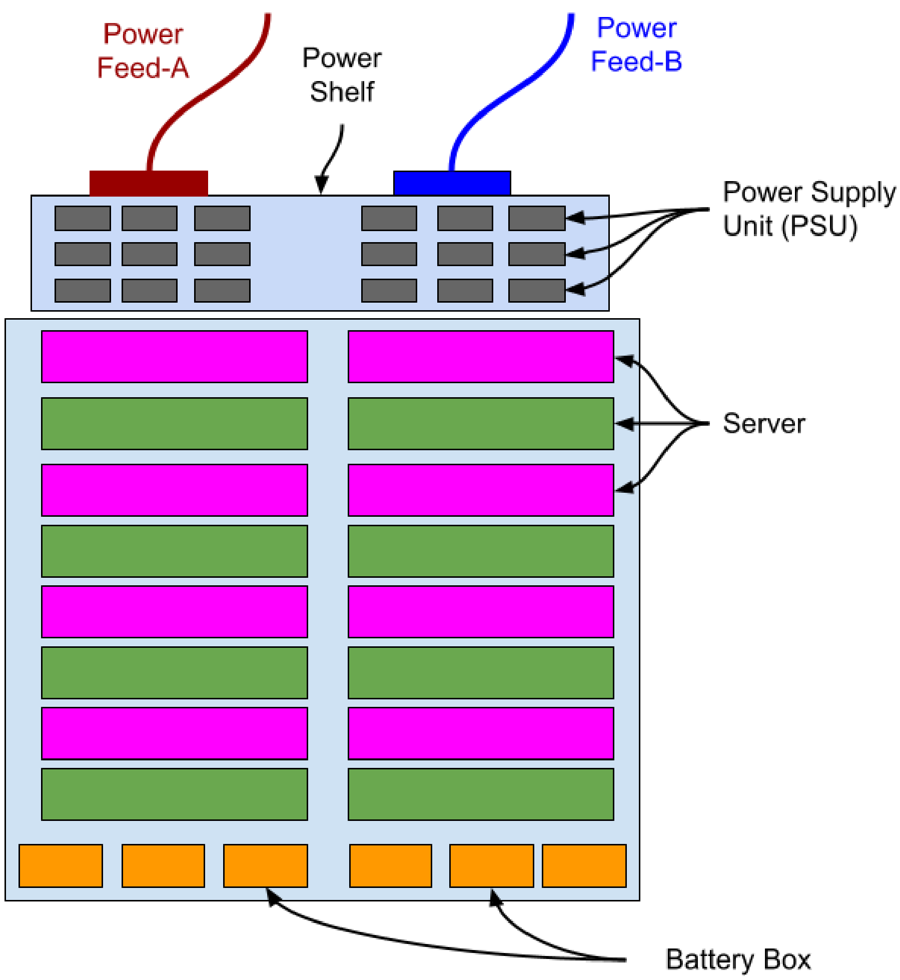

Fig. 1: Rack Power System

Fig. 1 depicts an example data center rack system. As depicted in Fig. 1, in this illustrative example, the rack system is powered by two power feeds (Feed-A and Feed-B). Power Feed-A provides power to the power supply units (PSUs) on one side while Power Feed-B powers the PSUs on the other side. The PSUs condition and process the input power received from their corresponding feeds such that it is suitable for the data center racks. The number of PSUs is determined such that the PSUs can operate at about a 50% load when all the servers in the rack are running at their provisioned full load. Output power of the PSUs is aggregated within the power shelf and then distributed to the servers through power distribution busbars. This enables continuous power supply to the rack even if one of the power feeds is interrupted. The rack additionally includes battery boxes that are utilized to provide uninterrupted power supply (UPS) power to the servers in the event that the power feeds are interrupted.

The power conversion efficiency of the PSU is an important factor in the total cost of operation (TCO) of the rack power system. The operating efficiency of a PSU depends on its operating point (load percentage). During data center operations, average rack power is between 50% and 70% of the full provisioned power, and the PSUs operate at about 25%-35% of their rated power. At this operating point, the PSUs operate well below their optimal operating point, leading to increased operational costs and wasted power.

DESCRIPTION

This disclosure describes techniques for improving the operational efficiency of rack power systems. Per techniques of this disclosure, a system control method is utilized to enable each power supply unit (PSU) in the rack power system to operate near its peak efficiency point, thereby optimizing the performance of the overall rack power system and reducing operational costs.

A new operating state, referred to as a standby state, is configured for each PSU. When a PSU is in the standby state, it does not supply current to the load (power sourcing) but is in a state where it is operationally ready to immediately transition to a power sourcing mode as needed. The transition from standby mode to power sourcing mode and vice versa can be controlled through logic built within the PSU or through logic included in a power shelf controller that monitors the power draw of each PSU. The power shelf controller can calculate and deploy the number of PSUs that are to be placed in standby state in order to enable the remaining PSUs that are in a power sourcing mode to operate close to their peak efficiency point.

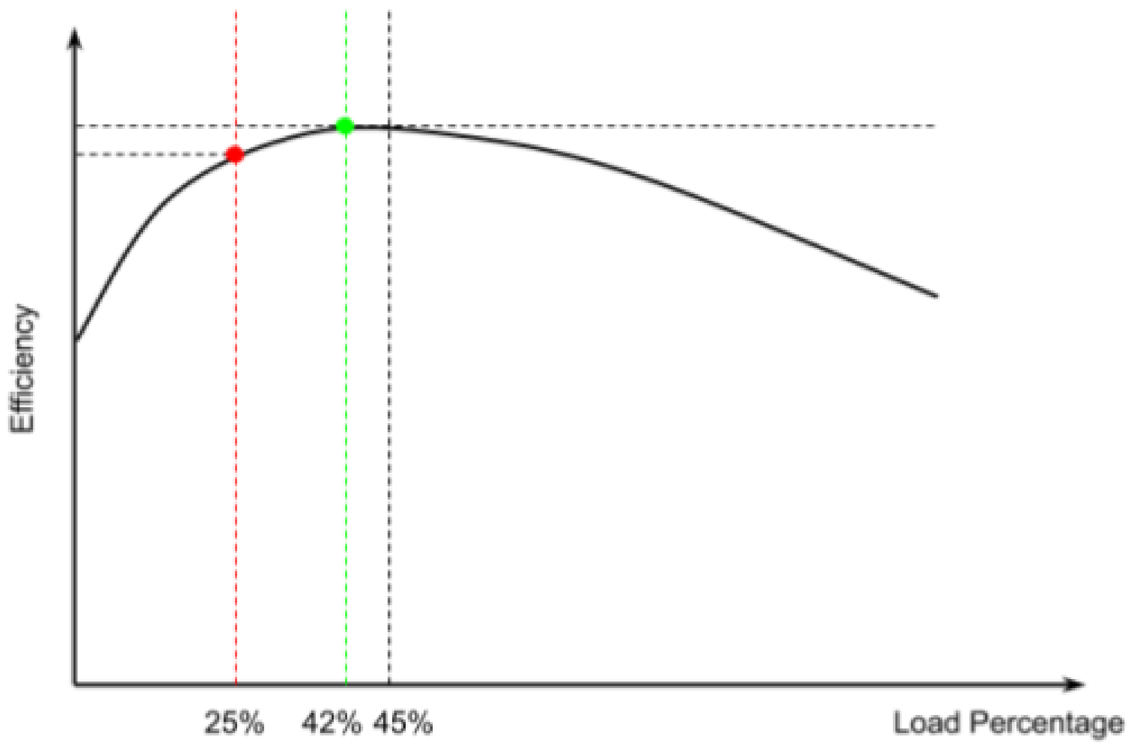

Fig. 2: PSUs in standby state enable peak efficiency for power sourcing PSUs

Fig. 2 depicts a graph of PSU efficiency versus operating point. In this illustrative example, PSU efficiency increases with the load initially and peaks at around 45% after which the efficiency starts to drop.

In an example scenario, when a standby state is not deployed (depicted in red), each PSU runs at 25% of its capacity when the rack power is at 50% of its provisioned power and all the PSUs are providing power to the rack load. However, with the use of a standby state of a PSU per techniques of this disclosure, the operating point of each PSU can be shifted to 42% (depicted in green), which is close to its peak efficiency operating point. This near-optimal operating point can be attained by deploying a portion of the PSUs to operate in power sourcing mode while the other PSUs operate in standby state.

Techniques of this disclosure can be utilized to provide rack power systems with optimal efficiency point tracking and reduce operational costs in a data center or other setting.

CONCLUSION

This disclosure describes techniques for improving the operational efficiency of rack power systems. A standby state is configured for each power supply unit (PSU). In the standby states, the PSU does not supply current to the load but is operationally ready to immediately transition to a power sourcing mode as needed. Transition between modes can be controlled through logic built within the PSU or through logic included in a power shelf controller that monitors the power draw of each PSU. The power shelf controller can calculate and deploy the number of PSUs that are to be placed in standby state in order to enable the remaining PSUs that are in a power sourcing mode to operate close to their peak efficiency point. The techniques enable power supply units (PSU) in the rack power system to operate near the peak efficiency point, thereby optimizing the performance of the overall rack power system and reducing operational costs.