SHARED BACKUP POWER FOR DATA CENTERS

RELATED APPLICATIONS

[0001] The present application claims priority to US Patent Application No. 14/010,781 filed on August 27, 2013, entitled "Shared Backup Power For Data Centers", which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] Data centers are facilities used to house and operate computing resources such as computers, processors, servers, telecommunications equipment, data storage systems, and so forth. Data centers may be used to provide services such as large-scale internet applications. Data centers may also be used to provide infrastructure services to customers who may implement their own applications using the resources provided by data centers. Data centers are increasingly critical to various types of computing activities, services, and applications.

[0003] The reliability and continuous availability of data center equipment are critically important. Various equipment redundancies are typically implemented within data centers to ensure continuous availability. In particular, redundant power sources are provided to ensure continuous operation during power failures or outages.

[0004] Many data centers may include multiple resource zones, each having its own infrastructure and support system. Electrical power for the equipment within a resource zone is provided by an uninterruptible power supply (UPS).

[0010] FIG. 6 is a flow diagram illustrating an example method of operating a data center using shared UPS power storage elements.

DETAILED DESCRIPTION

[0011] This disclosure describes systems and techniques for providing backup power to computing resources and other equipment within a data center. The data center has multiple resource zones supported by infrastructures that are generally independent of each other, so that failures relating to one resource zone do not affect the ongoing operations of other resource zones.

[0012] Various types of computing resources are located within each of the resource zones. With regard to power distribution, each resource zone has an uninterruptible power supply (UPS) that provides power to the computing resources within the zone. A set of batteries or other energy storage elements are located in the resource zone along with the UPS. Each resource zone may also have a backup generator for providing power during power outages.

[0013] The UPS within a particular resource zone normally receives alternating current (AC) power from an electric mains of a power utility. Upon failure of the electric mains, the UPS receives AC power from a backup generator that is dedicated to the resource zone. In the time between failure of the AC mains and startup of the backup generator, the UPS draws direct current (DC) power from its associated batteries and uses an electrical inverter to generate AC power for the equipment of the resource zone.

[0017] Each resource zone 102 has or contains multiple computing resources 104. The resources 104 may include computers, processors, servers, storage devices, networking equipment, telecommunications equipment, control equipment, support equipment, and so forth. The computing resources 104 are typically housed in racks, which are arranged in rows within the data center 100.

[0018] Each resource zone 102 has an uninterruptible power supply (UPS) 106 and associated UPS power storage elements 108. The power storage elements 108 may comprise sets of batteries or other power storage mechanisms, including chemical and kinetic power storage devices. For example, each UPS storage element 108 may comprise one or more batteries connected to provide direct current (DC) power to the associated UPS 106. The UPS 106 charges the batteries during normal mains-powered operation, and may draw upon the batteries when conditioning alternating current (AC) mains power or generator-provided AC power. Alternatively, each UPS power storage element or set 108 may comprise a flywheel energy storage unit.

[0019] Each resource zone 102 may have its own UPS 106 and corresponding set of storage elements 108, which may be physically located within the resource zone 102.

[0020] Each resource zone 102 may also have its own dedicated backup generator 110 or set of backup generators 110 for use during power outages or interruptions. During normal operation, the UPS 106 operates from AC mains provided by an electric power utility. In the case of an AC mains failure, AC

[0047] An action 608 comprises sharing the temporary power from the power storage elements located in the different resource zones among the UPS's located in the different resource zones. In some embodiments, this may be accomplished by use a power bus that extends between the power storage elements. In some cases, the action 608 may comprise selectively directing the temporary power provided by a first of the power storage elements to the uninterruptible power supply associated with a second of the power storage elements in response to power depletion of the second of the power storage elements.

[0048] Embodiments of the disclosure can be described in view of the following clauses:

1. A data center, comprising:

a plurality of resource zones;

computing resources located within each of the resource zones;

a plurality of uninterruptible power supplies, wherein each resource zone is associated with a respective uninterruptible power supply, and wherein the respective uninterruptible power supply provides operating power to the computing resources located within the resource zone associated with the respective uninterruptible power supply;

a plurality of battery sets, wherein each resource zone is associated with at least one of the battery sets, and wherein a battery set provides temporary power to the uninterruptible power supply of the resource zone associated with the battery set; and

a power bus that extends to each of the resource zones, the power bus connecting the plurality of battery sets to share the temporary power provided by the plurality of battery sets among the uninterruptible power supplies.

2. The data center of clause 1, further comprising control logic that selectively directs the temporary power provided by the battery sets among the interruptible power supplies in response to power depletion the battery sets.

3. The data center of clause 1, further comprising control logic that selectively directs the temporary power provided by a first of the battery sets to the uninterruptible power supply associated with a second of the battery sets in response to power depletion of said second of the battery sets.

4. The data center of any preceding clause, wherein:

each uninterruptible power supply is located at its associated resource zone; and

each battery set is located at its associated resource zone.

5. The data center of any preceding clause, further comprising a plurality of backup generators, wherein the battery sets are configured to provide the temporary power during startup of the backup generators.

6. The data center of any preceding clause, further comprising a supplemental battery set that provides supplemental power, wherein the power bus extends from the supplemental battery set to each of the resource zones, the power bus connecting the supplemental battery set to the battery sets associated with the resource zones to supplement the temporary power of the battery sets associated with the resource zones.

7. A data center, comprising:

a plurality of resource zones;

computing resources located within each of the resource zones;

a plurality of uninterruptible power supplies, wherein each uninterruptible power supply is associated with an individual one of the resource zones, and wherein each uninterruptible power supply provides operating power to the computing resources located within the associated resource zone;

one or more power storage elements that provide temporary power; and

a power bus that extends to each of the resource zones to share the temporary power provided by the one or more power storage elements among the uninterruptible power supplies.

8. The data center of clause 7, further comprising control logic that selectively directs the temporary power among the uninterruptible power supplies in response to power depletion of the one or more power storage elements.

9. The data center of clause 7, wherein:

the one or more power storage elements comprise a plurality of power storage elements that are commonly located; and

the power bus extends from the plurality of uninterruptible power supplies to each of the resource zones.

10. The data center of clause 7, wherein:

a particular one of the uninterruptible power supplies is associated with a first of the one or more power storage elements; and

further comprising control logic that selectively directs the temporary power provided by a second of the one or more power storage elements to said particular one of the uninterruptible power supplies in response to power depletion of said first of the one or more power storage elements.

11. The data center of clause 7, wherein:

a first of the uninterruptible power supplies is associated with a first of the one or more power storage elements;

a second of the uninterruptible power supplies is associated with a second of the one or more power storage elements; and

further comprising control logic that selectively directs the temporary power provided by the second of the one or more power storage elements to the first of the uninterruptible power supplies in response to power depletion of said first of the one or more power storage elements.

12. The data center of clause 7, wherein:

each uninterruptible power supply is located at its associated resource zone;

each power storage element is located at a corresponding one of the resource zones; and

the power storage element located at a particular resource zone provides temporary power to the uninterruptible power supply located at said particular resource zone.

13. The data center of clause 7, further comprising a plurality of backup generators, wherein the one or more power storage elements are configured to provide the temporary power during startup of the backup generators.

14. The data center of clause 7, wherein the one or more power storage elements comprise:

a plurality of dedicated power storage elements associated respectively with individual uninterruptible power supplies, wherein each dedicated power storage element provides temporary power to the associated uninterruptible power supply;

a supplemental power storage element that provides supplemental power; and

wherein the power bus connects the supplemental power storage element to the dedicated power storage elements to supplement the temporary power of the dedicated power storage elements.

15. The data center of clause 14, further comprising control logic that selectively directs the temporary power provided by the supplemental power storage element to the uninterruptible power supply associated with one of the dedicated power storage elements in response to power depletion of said one of the dedicated power storage elements.

16. The data center of clause 7, wherein the one or more power storage elements comprise:

a plurality of dedicated battery sets associated respectively with individual uninterruptible power supplies, wherein each dedicated battery set provides temporary power to the associated uninterruptible power supply;

a supplemental battery set that provides supplemental power; and

wherein the power bus connects the supplemental battery set to the dedicated battery sets to supplement the temporary power of the dedicated battery sets.

17. The data center of clause 7, wherein the one or more power storage elements comprise:

a plurality of kinetic energy storage devices associated respectively with individual uninterruptible power supplies, wherein each kinetic energy storage device provides temporary power to the associated uninterruptible power supply;

one or more batteries that provide supplemental power; and

wherein the power bus connects the one or more batteries to the uninterruptible power supplies associated with the kinetic energy storage devices to supplement the temporary power of the one or more kinetic energy storage devices.

18. A method, comprising:

operating computing resources within resource zones of a data center;

supplying operating power to the computing resources from uninterruptible power supplies associated respectively with the resource zones;

providing temporary power to the uninterruptible power supplies from one or more power storage elements; and

sharing the temporary power from the one or more power storage elements among the uninterruptible power supplies associated with the resource zones.

19. The method of clause 18, wherein the one or more power storage elements include at least one power storage element that is located at a corresponding one of the resource zones.

20. The method of clause 18, wherein the one or more power storage elements include at least one power storage element located at each of the resource zones.

21. The method of clause 18, wherein the one or more power storage elements include at least one kinetic energy storage device that is associated with each of the resource zones and at least one chemical power storage device that is associated with a plurality of the resource zones.

22. The method of clause 18, wherein:

a particular one of the uninterruptible power supplies is associated with a first of the one or more power storage elements; and

sharing the temporary power comprises selectively directing the temporary power provided by a second of the one or more power storage elements to said particular one of the uninterruptible power supplies in response to power depletion of said first of the one or more power storage elements.

23. The method of clause 18, wherein:

a first of the uninterruptible power supplies is associated with a first of the one or more power storage elements;

a second of the uninterruptible power supplies is associated with a second of the one or more power storage elements; and

sharing the temporary power comprises selectively directing the temporary power provided by the second of the one or more power storage elements to the first of the uninterruptible power supplies in response to power depletion of said first of the one or more power storage elements.

CLAIMS

1. A data center, comprising:

a plurality of resource zones;

computing resources located within each of the resource zones;

a plurality of uninterruptible power supplies, wherein each uninterruptible power supply is associated with an individual one of the resource zones, and wherein each uninterruptible power supply provides operating power to the computing resources located within the associated resource zone;

a plurality of power storage elements that provide temporary power, wherein the power storage elements are associated respectively with individual uninterruptible power supplies and wherein each power storage element provides temporary power to the associated uninterruptible power supply;

a supplemental power storage element that provides supplemental power; and

a power bus that extends to each of the resource zones to share the temporary power provided by the power storage elements among the uninterruptible power supplies, wherein the power bus connects the supplemental power storage element to the power storage elements to supplement the temporary power of the power storage elements.

2. The data center of claim 1, further comprising control logic that selectively directs the temporary power among the uninterruptible power supplies in response to power depletion of the power storage elements.

3. The data center of any preceding claim, wherein:

the power bus extends from the plurality of uninterruptible power supplies to each of the resource zones.

4. The data center of any preceding claim, wherein:

a particular one of the uninterruptible power supplies is associated with a first of the power storage elements; and

further comprising control logic that selectively directs the temporary power provided by a second of the power storage elements to said particular one of the uninterruptible power supplies in response to power depletion of said first of the power storage elements.

5. The data center of any of claims 1-3, wherein:

a first of the uninterruptible power supplies is associated with a first of the power storage elements;

a second of the uninterruptible power supplies is associated with a second of the power storage elements; and

further comprising control logic that selectively directs the temporary power provided by the second of the power storage elements to the first of the uninterruptible power supplies in response to power depletion of said first of the power storage elements.

6. The data center of any preceding claim, wherein:

each uninterruptible power supply is located at its associated resource zone;

each power storage element is located at a corresponding one of the resource zones; and

the power storage element located at a particular resource zone provides temporary power to the uninterruptible power supply located at said particular resource zone.

7. The data center of any preceding claim, further comprising a plurality of backup generators, wherein the power storage elements are configured to provide the temporary power during startup of the backup generators.

8. The data center of claim 1, further comprising control logic that selectively directs the temporary power provided by the supplemental power storage element to the uninterruptible power supply associated with one of the power storage elements in response to power depletion of said one of the power storage elements.

9. The data center of any preceding claim, wherein the power storage elements comprise:

a plurality of battery sets associated respectively with individual uninterruptible power supplies, wherein each battery set provides temporary power to the associated uninterruptible power supply;

a supplemental battery set that provides supplemental power; and

wherein the power bus connects the supplemental battery set to the battery sets to supplement the temporary power of the battery sets.

10. The data center of any preceding claim, wherein the power storage elements comprise:

a plurality of kinetic energy storage devices associated respectively with individual uninterruptible power supplies, wherein each kinetic energy storage device provides temporary power to the associated uninterruptible power supply;

one or more batteries that provide supplemental power; and

wherein the power bus connects the one or more batteries to the uninterruptible power supplies associated with the kinetic energy storage devices to supplement the temporary power of the one or more kinetic energy storage devices.

11. A method, comprising:

operating computing resources within resource zones of a data center;

supplying operating power to the computing resources from uninterruptible power supplies associated respectively with the resource zones;

providing temporary power to the uninterruptible power supplies from a plurality of power storage elements, wherein the power storage elements are associated

respectively with individual uninterruptible power supplies and wherein each power storage element provides temporary power to the associated uninterruptible power supply;

sharing the temporary power from the power storage elements among the uninterruptible power supplies associated with the resource zones; and

supplementing the temporary power of the power storage elements with supplemental power from a supplemental power storage element.

12. The method of claim 11, wherein the power storage elements include at least one power storage element that is located at a corresponding one of the resource zones, or wherein the power storage elements include at least one power storage element located at each of the resource zones, or wherein the power storage elements include at least one kinetic energy storage device that is associated with each of the resource zones and at least one chemical power storage device that is associated with a plurality of the resource zones.

13. The method of claim 11 or 12, wherein:

a particular one of the uninterruptible power supplies is associated with a first of the power storage elements; and

sharing the temporary power comprises selectively directing the temporary power provided by a second of the power storage elements to said particular one of the uninterruptible power supplies in response to power depletion of said first of the power storage elements.

14. The method of any of claims 11-13, wherein:

a first of the uninterruptible power supplies is associated with a first of the power storage elements;

a second of the uninterruptible power supplies is associated with a second of the power storage elements; and

sharing the temporary power comprises selectively directing the temporary power provided by the second of the power storage elements to the first of the uninterruptible power supplies in response to power depletion of said first of the power storage elements.