

The Applicant also observes that the count of the power consumption actually consumed is achieved in existing solutions by the presence of meters on each server rack. This represents a significant hardware investment, which also requires skilled labour.

Apparatuses for centralized data reporting are furthermore required in order to install these meters.

In any event, the Applicant submits that, to date, the state of the art has no simple and effective technical solutions to optimize the distribution of the power to the server racks in a datacenter while guaranteeing phase load balancing within each power source.

Summary

The object of the present disclosure is to improve the current situation.

One objective of the present disclosure is to overcome the disadvantages of the prior art mentioned above by providing dynamic switching of the apparatuses (such as, for example, servers or server racks in a datacenter) on the power sources.

The term apparatus here refers a device that requires a power supply to operate.

The proper functioning of such an apparatus is directly related to the quality of the electric power supply.

According to a first aspect, the present disclosure refers to a method for managing power of a plurality of apparatuses in a facility, each of the apparatuses, which consume electric power, being electrically connected to a plurality of power sources through at least one distribution device comprising a central processing unit and switching elements interfacing between said apparatuses and said power sources, each of the power sources having a predetermined yield curve, said switching elements, operated real-time via control circuits being configured to distribute, at the beginning of operation, the electrical energy required to operate said apparatuses according to a predetermined nominal allocation, said method implemented by computer means comprising, during an operating phase, the following steps: determining a load plan by said central processing unit on the basis of at least one subscribed power for each of the apparatuses and a distribution algorithm; a dynamic switching of said apparatuses of the power sources formed by said switching elements on the basis of said load plan transmitted by said central processing unit to each of

the control circuits.

According to a second aspect, the present disclosure refers to a computer program comprising instructions adapted for executing the steps of the method according to the first aspect when said computer program is executed by at least one processor.

5 According to a third aspect, the present disclosure refers to a recording medium readable by a computer on which is recorded a computer program comprising instructions for executing the steps of the method according to the first aspect.

 According to a fourth aspect, the present disclosure refers to a management system of the electrical supply of a plurality of apparatuses in a facility, wherein each of the
10 apparatuses, which consume electrical energy, is electrically connected to a plurality of power sources through at least one distribution device, wherein each of the power sources has a specific yield curve, and wherein said at least one distribution device comprises switching elements, forming an interface between said each of apparatuses and said power sources configured to distribute, at the beginning of operation, the electrical energy required to
15 operate the apparatuses according to a predetermined nominal allocation, characterized in that said at least one distribution device comprises: a central processing unit configured to determine a load plan on the basis of at least one subscribed power for each of the apparatuses and a distribution algorithm; control circuitry configured to operate, in real time on the basis of said load plan transmitted by said central processing unit said switching
20 elements, so as to produce a dynamic switching of said apparatuses on the power sources.

 According to a fifth aspect, the present disclosure refers to a data processing center type facility, or datacenter, comprising: a plurality of electric power sources; a plurality of a server rack type computer apparatuses; and a system of the power management according to the fourth aspect.

25 The present disclosure relates in a first example a power management method of a plurality of apparatuses in a facility (e.g., servers or server racks in a data processing center or datacenter).

 According to the present disclosure, each of the apparatuses (e.g., servers or server racks in a datacenter), which consume electrical energy, is electrically connected to a
30 plurality of power sources by means of at least one distribution device comprising each of the switching elements forming the interface between the apparatuses and the power sources.

 According to an example, each of the power sources has a yield curve of its own.

 According to an example, the switching elements are controlled in real time by control circuits, such as for example, programmable logic circuits, and are configured to

distribute the electrical energy needed to operate the apparatuses (e.g., servers or server racks).

At the beginning of operation, this energy distribution is made according to a nominal allocation. The nominal allocation is determined by said nominal load plan.

5 Advantageously, the method according to the present disclosure is implemented by computer means and includes the following steps in an operational phase:

- determining a load plan by the central unit according to at least one subscribed power to an apparatus and a distribution algorithm taking into consideration the performance curves of each of the sources so as to adjust the nominal allocation of power sources to each of the apparatuses (e.g., servers or server racks) maximizing the performance of said sources, or more precisely by maximizing efficiency;
- a dynamic switching of the apparatuses (e.g., servers or server racks) on the power supplies carried out by the switching elements on the basis of said load plan from the central unit to each of the control circuits.

Thus, the present disclosure, through the combination of these different technical steps which are characteristic of the present disclosure, enables dynamic wiring that takes into consideration the different power subscribed to for each apparatus.

It is possible for example for a subscriber to a service to change in operation the power subscribed for a rack.

In this case, the load plan will be automatically changed taking into consideration this new subscribed power.

Such dynamic cabling eliminates static wiring used presently. It is no longer necessary to provide for the manual establishment of a new load plan (or “capacity planning”) for each commissioning of new apparatuses or when a new subscriber subscribes to services.

According to optional features alone or in combination:

- the method includes a continuous measurement of the power consumption of each of the apparatuses (e.g., servers or server racks);
- the load plan is determined on the basis of the measured consumption;
- the switching elements measure by magnetically coupling the power consumption of each of the apparatuses (e.g., servers or server racks) that they respectively supply;
- the measured power consumption is time-stamped and then stored in a computer file, known as a log file, and periodically transmitted to the central unit;
- the method comprises a continuous monitoring of the status of each power source for detecting the failure of at least one of the power sources;

- the load plan is determined according to the source status;
- when monitoring of the status of each of the power sources, a power source is considered to be in a failure status when it delivers a voltage outside a range between a lower failure threshold and an upper failure threshold;
- 5 - preferably, the lower failure threshold and/or the upper failure threshold are configurable voltage values;
- the method comprises an initialization phase during which, during a step of subscription, the nominal load plan is determined on the basis of an electric power previously subscribed to by a subscriber, the subscribed electric power being
- 10 moreover associated with a certain level of service quality;
- the process comprises an interruption of the power supply to an apparatus (e.g., a server rack) by said power source associated in the event of detecting abnormal consumption by said apparatus, when for example it is strictly greater than 150% of the subscribed power.

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Correspondingly, the present disclosure relates in a second example to a computer program comprising instructions adapted for executing the steps of the method as described above, when said computer program is executed by at least one processor.

Such a computer program may use any programming language and take the form of

20 source code, target code or a code intermediate between source code and target code, such as in a partially compiled form, or in any other desirable form.

Similarly, the present disclosure relates in a third example to a storage medium readable by a computer on which a computer program is recorded comprising instructions for

25 executing the steps of the method as described above.

First, the recording medium can be any entity or device capable of storing the program. For example, the medium may comprise storage means such as a ROM type memory microelectronic circuit, or a magnetic recording medium or a hard disk.

On the other hand, this recording medium can also be a transmissible carrier such as

30 an electrical or optical signal, such a signal can be conveyed via an electrical or optical cable, by classical or terrestrial radio or by self-directed laser beam or other ways. The computer program of the invention may particularly be downloaded over an Internet-type network.

Alternatively, the recording medium may be an integrated circuit in which the computer program is embedded, the integrated circuit being adapted to execute or to be used in executing the process in question.

5 The present disclosure relates in a fourth example to a power supply management system to a plurality of apparatuses (e.g., such as server racks) in a system (e.g., such as data processing centers or datacenter).

Advantageously, said system comprises computer means configured for the implementation of the method steps as described above.

10 More particularly, in this system, each apparatus (e.g., server racks) is electrically connected to a plurality of power sources through at least one distribution device.

According to the present disclosure, each source has a yield curve of its own.

According to the present disclosure, each distribution device includes switching elements forming the interface between the apparatuses and the power sources.

15 These switching elements are preferably configured to distribute the electricity needed to operate the equipment.

At the beginning of operation, this distribution is made according to a predetermined nominal allocation.

- 20 - Advantageously, the distribution device comprises: a central processing unit configured to determine a load plan on the basis of at least one subscribed power for each device and a predetermined distribution algorithm taking into consideration the performance curves of each source so as to adjust the nominal allocation of power sources to each of the devices (e.g., server racks) maximizing efficiency; and
- 25 - control circuits configured to control in real time the switching elements so as to achieve dynamic switching of the apparatuses (e.g., server racks) on the power sources according to the load plan from the central unit.

In a particular embodiment, the switching elements comprise:

- a semiconductor of the IGBT type (acronym for “Insulated Gate Bipolar Transistor”), and/or
- 5 - a TRIAC-type electronic component (acronym for “Triode for Alternating Current”). Such a component is equivalent to the parallel connection of two anti-parallel connected thyristors.

Preferably, the distribution device is configured to deliver single-phase respectively, from three-phase and/or four-phase.

Such a system also allows a disjunction system that can be changed hot without interrupting the entire site's power.

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The present disclosure relates in a fifth example to a data processing center or the datacenter type facility comprising:

- a plurality of power sources;
- a plurality of apparatuses notably including server racks; and
- 10 - a power management system such as that described above.

Preferably, each power source includes an inverter.

Thus, the present disclosure, through its various functional and structural aspects described above, provides datacenter with real dynamic wiring of the apparatuses on power
15 sources taking into consideration the subscribed powers, the actual energy consumption, and possibly the source statuses.

As applicable to the field of datacenters, the present disclosure optimizes the energy efficiency of datacenters and ensure the security, integrity and availability of data stored in datacenters.

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Brief description of the appended figures

Other characteristics and advantages of the present invention will emerge in the description below with reference to appended Figures 1 and 4 which show a non-limiting embodiment in which:

- 25 - Figure 1 shows a schematic view of a power management system for datacenter server racks according to an example embodiment of the invention;
- Figure 2 shows a flowchart of the steps of the management method according to an example embodiment of the present invention;
- Figure 3 shows a schematic view of an example casing structure in a switch panel
30 according to an example embodiment;
- Figure 4 shows a schematic view of an example distribution panel according to an example embodiment.

Detailed description of the invention

CLAIMS

1. A method for managing power of a plurality of apparatuses in a facility, each of the apparatuses, which consume electric power, being electrically connected to a plurality
5 of power sources through at least one distribution device comprising a central processing unit and switching elements interfacing between said apparatuses and said power sources,
each of the power sources having a predetermined yield curve,
said switching elements, operated real-time via control circuits being configured to
10 distribute, at the beginning of operation, the electrical energy required to operate said apparatuses according to a predetermined nominal allocation,
said method implemented by computer means comprising, during an operating phase, the following steps:
 - determining a load plan by said central processing unit on the basis of at least
15 one subscribed power for each of the apparatuses and a distribution algorithm;
 - a dynamic switching of said apparatuses of the power sources formed by said switching elements on the basis of said load plan transmitted by said central processing unit to each of the control circuits.
- 20 2. The method of claim 1 comprising a continuous measurement of the power consumption of each apparatus, and wherein the determination of said load plan by said central unit is further performed on the basis of said measured consumption.
3. The method of claim 2, wherein the switching elements measure the power
25 consumption of each apparatus that each respectively feeds by magnetically coupling.
4. The method according to any preceding claim, comprising continuously monitoring the status of each of the power sources for detecting the failure of at least one of the supply sources, wherein the determination of said load plan by said central unit is
30 further performed on the basis of said statuses.
5. The method of claim 4, wherein, when monitoring the status of each of the power sources, a power source is considered to be in a failure status when said power source

delivers a voltage outside a range between a lower failure threshold and a higher failure threshold.

- 5 6. The method of claim 5, wherein the lower failure threshold and/or the higher failure threshold are configurable voltage values.
- 10 7. The method according to any preceding claim, wherein the determination of a load plan with said central unit is carried out further on the basis of a predetermined allocation algorithm taking into consideration the performance curves of each of the sources so as to adjust the nominal allocation of said power sources to each of the apparatuses while maximizing efficiency.
- 15 8. The method according to any preceding claim, comprising an initialisation phase at which the load plan is determined in a designation step on the basis of an electric power subscribed to beforehand by a subscriber, said subscribed electric power being associated with a predetermined level of quality of service.
- 20 9. The method according to any one of the preceding claims, comprising an interruption of the power supply to an apparatus by an associated source upon detection of abnormal consumption by said apparatus, strictly greater than 150% of subscribed nominal power according to said predetermined nominal allocation.
- 25 10. A computer program comprising instructions adapted for executing the steps of the method according to any one of claims 1 to 9 when said computer program is executed by at least one processor.
- 30 11. A recording medium readable by a computer on which is recorded a computer program comprising instructions for executing the steps of the method according to any one of claims 1 to 9.
12. Management system of the electrical supply of a plurality of apparatuses in a facility, wherein each of the apparatuses, which consume electrical energy, is electrically connected to a plurality of power sources through at least one distribution device, wherein each of the power sources has a specific yield curve, and

wherein said at least one distribution device comprises switching elements, forming an interface between said each of apparatuses and said power sources configured to distribute, at the beginning of operation, the electrical energy required to operate the apparatuses according to a predetermined nominal allocation,

5 characterized in that said at least one distribution device comprises:

- a central processing unit configured to determine a load plan on the basis of at least one subscribed power for each of the apparatuses and a distribution algorithm;

- control circuitry configured to operate, in real time on the basis of said load plan transmitted by said central processing unit said switching elements, so as to produce a dynamic switching of said apparatuses on the power sources.

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13. The system according to claim 12 comprising computer means configured for the implementation of the method steps according to any one of claims 2 to 9.

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14. The system according to claim 12 or 13, wherein the switching elements comprise a semiconductor of the IGBT type and/or an electronic component of the TRIAC-type.

15. The system according to one of claims 12 to 14, wherein said at least one distribution device is configured to deliver respectively single-phase, three-phase and/or four-phase.

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16. A data processing center type facility, or datacenter, comprising:

- a plurality of electric power sources;
- a plurality of a server rack type computer apparatuses; and
- A system of the power management according to one of claims 12 to 15.

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