



(51) International Patent Classification:

G06F 13/14 (2006.01) G06F 1/20 (2006.01)
G06F 1/26 (2006.01) G06F 1/16 (2006.01)

(21) International Application Number:

PCT/US2010/041734

(22) International Filing Date:

12 July 2010 (12.07.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant (for all designated States except US):
HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P. [US/US]; 11445 Compaq Center Drive West,
Houston, Texas 77070 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GODRICH, Kfir L.**
[IL/US]; EYP Mission Critical Facilities, Inc., 440 Park
Ave South, 16th Floor, New York, New York 10016
(US). **GROSS, Peter** [US/US]; EYP Mission Critical Fa-
cilities, Inc., 621 Hawaii Street, El Segundo, California

90245 (US). **WILSON, Scott A.** [US/US]; EYP Mission
Critical Facilities, Inc., 54 State Street, 3rd Floor, Albany,
New York 12207 (US). **ZUPPAN, James** [US/US]; EYP
Mission Critical Facilities, Inc., 303 Second Street, Suite
500, South Tower, San Francisco, California 94107 (US).
KURKJIAN, Christopher W. [US/US]; EYP Mission
Critical Facilities, Inc., 54 State Street, 3rd Floor, Albany,
New York 12207 (US). **YOUNG, Gregory K. K.**
[US/US]; EYP Mission Critical Facilities, Inc., 303 Sec-
ond Street, Suite 500, South Tower, San Francisco, Cali-
fornia 94107 (US). **GMITER, Peter F.** [US/US]; EYP
Mission Critical Facilities, Inc., 621 Hawaii Street, El Se-
gundo, California 90245 (US).

(74) Agents: **HART, Kevin M.** et al.; Hewlett-Packard Com-
pany, Intellectual Property Administration, 3404 East
Harmony Road, Mail Stop 35, Fort Collins, Colorado
80528 (US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,

[Continued on next page]

(54) Title: FLEXIBLE DATA CENTER AND METHODS FOR DEPLOYMENT

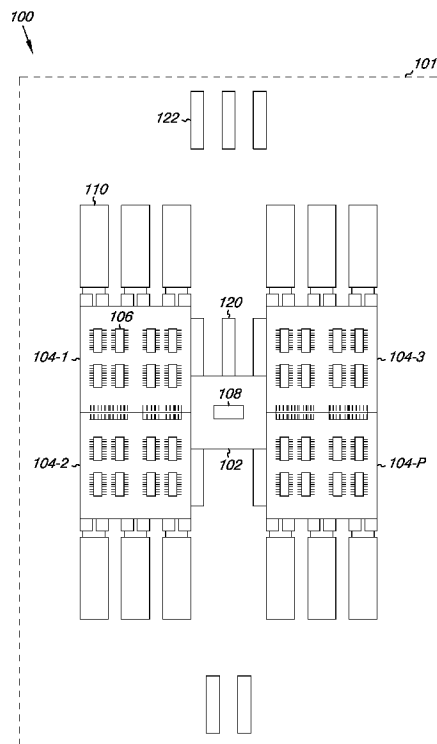


Fig. 1

(57) Abstract: Flexible data center systems and methods of deployment are provided. A flexible data center (100, 200) including T rows of server racks (106, 206, 306) can be deployed by constructing a number B of blocks (101, 201). Constructing each block (101, 201) can include constructing from one to a number P of perimeter structures (104, 204, 304) each housing up to a number R of rows of server racks (106, 206, 306). Constructing each block (102, 201) can include constructing a connecting structure (102, 202) connected to the perimeter structures (104, 204, 304), the connecting structure (102, 202) housing operations monitoring equipment (108, 208) for the server racks (106, 206, 306). A total integer number T/R of perimeter structures (104, 204, 304) can be constructed for the flexible data center (100, 200). At most one perimeter structure (10, 204, 304) houses less than R rows of server racks (106, 206, 306). B is equal to an integer number (T/R)/P. At most one block (101, 201) includes less than P perimeter structures (104, 204, 304).



DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

- with international search report (Art. 21(3))

FLEXIBLE DATA CENTER AND METHODS FOR DEPLOYMENT

Background

A data center is a facility used to house computing systems and associated components. Data centers may include racks to store computing systems, elevated floors, cable runways, cooling systems, power systems, security systems, and the like. Many of the computing systems housed in a data center can be stored on server racks, which may be arranged in rows forming corridors therebetween. Current data center design may be based on a client-server computing model to provide, for instance, Internet connectivity and/or solutions for systems operation.

New data centers may generally take the form of either brick and mortar or containerized. A brick and mortar data center can include a number of buildings or additions to an existing building, which house the data center. A new brick and mortar data center may be designed and built according to a specific customer demand. New brick and mortar data centers may come with a significant initial capital expenditure to provide for the design, provisioning, and construction of the new brick and mortar data center. New brick and mortar data centers may take approximately 9 to 24 months to design and build (e.g., depending upon a size of the data center).

A containerized data center can provide a more timely and cost effective solution. Containerized data centers may be prefabricated mass produced and may be shipped to a customer (e.g., by ships and trucks). However, containerized data centers may be unappealing in that they may provide, or may be perceived to provide, a short-term, low reliability solution without considering long-term needs for an organization served by the data center. Furthermore, as organizations continue to rethink fiscal expenditures for data centers, containerized approaches, while including lower initial capital expenditures than brick and mortar facilities, may be perceived as wasteful due to the real or perceived short-term solution they offer.

Brick and mortar data centers designed and built according to some previous approaches were generally non-scalable and built with one goal in

mind, therefore limited with respect to flexibility. However, such brick and mortar data centers could provide a traditional data center environment with some creature comforts that are not afforded by the use of containerized data centers. Such containerized data centers may take a minimalist approach (e.g.,
5 by installing server racks in a containerized solution that provides for rapid deployment with little to no creature comforts). Brick and mortar data centers still account for a majority of the market, while containerized data centers are gaining a foothold in the market of fast deployment and/or the market of 5-year strategies with tech-refresh in mind.

10

Brief Description of the Drawings

Figure 1 illustrates a block diagram of an example of a flexible data center according to the present disclosure.

15 Figure 2 illustrates a block diagram of an example of a flexible data center according to the present disclosure.

Figure 3 illustrates a perspective view of an example of a number of cooling units connected to an exterior of a perimeter structure for a flexible data center including according to the present disclosure.

20 Figure 4 provides a flow chart illustrating an example of a method for deploying 440 of a flexible data center including T sever racks according to the present disclosure.

Detailed Description

Embodiments of the present disclosure may include flexible data center
25 (FlexDC) systems and methods of deployment. A flexible data center including T rows of server racks can be deployed by constructing a number B of blocks. Constructing each block can include constructing from one to a number P of perimeter structures each housing up to a number R of rows of server racks. Constructing each block can include constructing a connecting structure
30 connected to the perimeter structures, the connecting structure housing operations monitoring equipment for the server racks. A total integer number T/R of perimeter structures can be constructed for the flexible data center. At

most one perimeter structure houses less than R rows of server racks. B is equal to an integer number $(T/R)/P$. At most one block includes less than P perimeter structures.

Examples of the present disclosure can provide modularity, scalability,
5 flexibility, industrialization, cloud computing, Infrastructure as a Service (IaaS) platform, and containerization of mechanical and electrical solutions, climate control, expanding criteria for information technology (IT) space, and supply chain management for data centers. Such examples of flexible data centers can bridge the gap between containerized data centers and brick and mortar
10 data centers to provide the advantages of each in a cost effective long term solution for data center design and deployment. For example, a flexible data center, according to the present disclosure, can be provided with an initial price of less than \$7 million per megawatt and a time to market of 24 to 36 weeks. Furthermore, short-term demand for expansion and growth of data centers is
15 addressed by the present disclosure. Accordingly, examples of the present disclosure can provide a valuable solution for cloud computing and IaaS with improved optimization of availability, energy efficiency, and total cost of ownership as compared to previous approaches. Such an approach can allow business growth to be synchronized to the capital and operational investment
20 from their IT in an "industrialized IT" fashion.

Examples of the present disclosure can provide a flexible data center that is responsive to growth requirements and flexible enough to meet changing aspects of data center technology. For example, flexible data centers according to the present disclosure can be provided as greenfield projects (e.g.,
25 unconstrained by prior data center solutions) or adjacent to existing buildings.

In the following detailed description of the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration how examples of the disclosure may be practiced. These examples are described in sufficient detail to enable those of ordinary
30 skill in the art to practice the embodiments of this disclosure, and it is to be understood that other examples may be utilized and that process, electrical, and/or structural changes may be made without departing from the scope of the

present disclosure. As used herein, the designators "T," "B," "P," and "R," including reference numerals in the drawings, indicate that a number of the particular feature so designated can be included with examples of the present disclosure. The designators can represent the same or different numbers of the particular features.

The figures herein follow a numbering convention in which the first digit or digits correspond to the drawing figure number and the remaining digits identify an element or component in the drawing. Similar elements or components between different figures may be identified by the use of similar digits. For example, 102 may reference element "02" in Figure 1, and a similar element may be referenced as 202 in Figure 2. Elements shown in the various figures herein can be added, exchanged, and/or eliminated so as to provide a number of additional examples of the present disclosure. In addition, the proportion and the relative scale of the elements provided in the figures are intended to illustrate the examples of the present disclosure, and should not be taken in a limiting sense.

Figure 1 illustrates a block diagram of an example of a flexible data center 100 according to the present disclosure. The flexible data center 100 can include a number B of blocks 101 on a site. Although only one block 101 is illustrated in Figure 1, Figure 2 illustrates a flexible data center 200 including more than one block 201. Each block 101 can include one to a number P of perimeter structures 104 (e.g., perimeter structures 104-1, 104-2, 104-3, . . . , 104-P). Each perimeter structure 104 can house up to a number R of rows of server racks 106.

Each block 101 can include a connecting structure 102 connected to the number of perimeter structures 104. The connecting structure 102 can house operations monitoring equipment 108 for the rows of server racks 106 in the block 101. The connecting structure 102 can house security systems, shipping and receiving, a network operations center, administration areas, and/or meeting rooms, among others. The number of perimeter structure 104 in each block 101 can retain full functionality with a complete loss of the connecting

structure 102 (e.g., the connecting structure 102 is not a single point of failure for each block 101, and thus for the flexible data center 100).

The flexible data center 100 can include a total integer number T/R of perimeter structures 104. As used herein, "a total integer number T/R " indicates
5 that the total number of perimeter structures 104 is equal to T (the total number of rows of server racks 106 housed in the data center 100) divided by R (the upper limit of the number of rows of server racks 106 housed in each perimeter structure 104) rounded up to an integer. Thus, for example, if T is equal to 33 and R is equal to 10, then the total integer number T/R of perimeter structures
10 104 would be $33/10$ rounded up to an integer 4.

At most, one perimeter structure 104 associated with the flexible data center 100 houses less than R rows of server racks 106. That is, design of the flexible data center 100 can be such that a new perimeter structure 104 is not added until all of the current perimeter structures 104 contain the upper limit R
15 of rows of server racks 106. Such examples can be beneficial to make efficient use of the space provided by the perimeter structures 104 as it may be more cost effective to fill perimeter structures 104 with rows of server racks 106 before incurring the cost of adding an additional perimeter structure 106. The total number B of blocks 101 included with the data center 100 can be equal to
20 an integer number $(T/R)/P$, as is described in more detail with respect to Figure 2. In some instances, a particular block 101 may initially be constructed with fewer than P perimeter structures 104 and then an additional perimeter structure 104 may be constructed after the flexible data center 100 has been deployed according to an increased demand for rows of server racks 106 for the
25 flexible data center 100.

At most, one block 101 associated with the flexible data center 100 can include less than P perimeter structures 104. That is, design of the flexible data center 100 can be such that a new block 101 is not added until all of the current blocks 101 include the upper limit P of perimeter structures (e.g., until each
30 connecting structure 102 associated with the flexible data center 100 is connected to P perimeter structures 104). Such examples can be beneficial to make efficient use of the ability of the blocks 101 to include up to P perimeter

structures before constructing a new block 101 with a new connecting structure 102 and at least one perimeter structure 104.

A number of cooling units 110 can be connected to an exterior of a respective perimeter structure 104. The type of and/or the number of cooling units 110 is particular to a climate of the site. According to some examples of the present disclosure, cooling can be provided for the flexible data center 100 without the use of mechanical chiller plants. The cooling units 110 are described in more detail with respect to Figure 3.

A number of power conditioner units 120 can be connected to an exterior of the respective perimeter structure 104. According to some examples of the present disclosure, the number of perimeter structures 104 do not include a power distribution unit. Not including a power distribution unit in a perimeter structure 104 may be advantageous by increasing end-to-end efficiency. A type of and/or the number of power conditioner units 120 can be particular to a desired power quality for the flexible data center 100. For design of the flexible data center 100, the number of power conditioner units 120 can be associated with an uninterruptable power supply (UPS) module selected from the group of UPS modules including a delta conversion UPS module, a double conversion UPS module, an offline UPS module, a flywheel UPS module, and a diesel rotary UPS module. A number of electrical topologies can be provided for a particular flexible data center 100. For example, topologies can include "N" (a single utility source), "N+1" (at least one redundant component), and a "2N" (dual path), or a combination of topologies to achieve redundancy, concurrent maintainability, and/or a fault tolerance of the flexible data center 100, among others.

Each perimeter structure 104 (e.g., the rows of server racks 106 therein) can consume up to a particular quantity of power. A number of backup power generators 122 may be electrically connected to the flexible data center 100 according to the particular quantity of power used by each of the perimeter structures 104 associated therewith. As used herein, "electrically connected" means that the backup power generators 122 may be connected to the flexible data center 100 so as to provide electrical power to the flexible data center 100,

however it does not require that the backup power generators 122 be mechanically coupled to an exterior of the structure of the flexible data center 100. In various examples of the present disclosure, the backup power generators 122 may either be adjacent to the structure of the flexible data center 100 or they may be free-standing backup power generators separate 122 from the structure of the flexible data center 100.

An example of the present disclosure includes a flexible data center 100 including one block 101 having one connecting structure 102 and up to four perimeter structures 104. With four perimeter structures 104, the flexible data center 100 can provide a total of 3.2 megawatts of IT power and 400 kilowatts of network/communications support power with a power usage effectiveness (PUE) less than 1.28.

The four perimeter structures 104 can be connected to the connecting structure 102 in a butterfly configuration (e.g., an "H" configuration) as illustrated in Figure 1. That is, a first perimeter structure 104-1 can be connected along an exterior wall to an exterior wall of a second perimeter structure 104-2. The exterior walls connecting the first 104-1 and the second 104-2 perimeter structures can be perpendicular to the connecting structure 102. The first 104-1 and the second 104-2 perimeter structures can have collinear exterior walls perpendicular to the walls connecting the perimeter structures and connected to an exterior wall of the connecting structure 102. A third 104-3 and a fourth 104-P perimeter structure can be connected to each other analogous to the connection between the first 104-1 and the second 104-2 perimeter structures. Likewise, the third 104-3 and the fourth 104-P perimeter structures can be connected to the connecting structure 102 analogous to the connection between the first 104-1 and the second 104-2 perimeter structures and the connecting structure 102, although the third 104-3 and the fourth 104-P perimeter structures can be connected to an exterior wall of the connecting structure 102 opposite the exterior wall of the connecting structure 102 to which the first 104-1 and the second 104-2 perimeter structures are connected.

An example of a benefit of including a number of perimeter structures 104 with the design of a flexible data center 100 is that the perimeter structures

104 can allow for segregation of IT assets. IT assets can be segregated, for example, by group, security level, and/or function type (e.g., software development, production, disaster recovery, etc.), among others. Another example may be deployment of Converged Infrastructure with flexible data center 100 including perimeter structures of server, storage, desktops, and/or network devices.

Figure 2 illustrates a block diagram of an example of a flexible data center 200 according to the present disclosure. The flexible data center 200 includes a number of blocks 201-1, 201-2, 201-3, 201-4, 201-5, 201-6, 201-7, . . . , 201-B. Each block 201 can be analogous to block 101 illustrated in Figure 1. Each block 201 can include a connecting structure 202 housing operations monitoring equipment 208. The connecting structure 202 can be connected to a number of perimeter structures 204 housing a number of rows of server racks 206. Each block 201 can include a number of cooling units 210, a number of power conditioning units 220, and a number of backup power generation units 222.

The total number B of blocks 201 included with the flexible data center 200 can be equal to an integer number $(T/R)/P$, where T is equal to the total number of rows of server racks 206 in the flexible data center 200, R is equal to an upper limit of the number of rows of server racks 206 for each perimeter structure 204, and P is equal to an upper limit of the number of perimeter structures 204 for each block 201. As described herein, "equal to an integer number" indicates that a result of $(T/R)/P$ is rounded up to an integer number. Thus, for example, where T is equal to 300, R is equal to ten, and P is equal to four, B is equal to $(300/10)/4$, which rounds up to an integer of eight (e.g., as illustrated in Figure 2).

As illustrated in Figure 2, constructing the number of blocks 201 can include constructing a first block 201-1 and constructing a second block 201-2 adjacent to the first block 201-1 without connecting structures associated with the second block 201-2 to structures associated with the first block 201-1. Structures associated with a block 201 can include a connecting structure 202 and/or a number of perimeter structures 204, among others.

Although not specifically illustrated in Figure 2, constructing a first block 201-1 can include constructing P first perimeter structures 204 and constructing a second block 201-2 can include constructing from one to P second perimeter structures 204 above the first perimeter structures 204. That is, according to
5 some examples of the present disclosure, two or more blocks 201 can be constructed in a vertical stack (e.g., analogous to a two or more story building) vertically rather than constructing the blocks 201 horizontally adjacent to each other on the ground (e.g., analogous to one story buildings). Such examples of stacking blocks 201 can be beneficial for those sites where space is at a
10 premium (e.g., in urban areas, densely populated areas, areas of rough terrain, etc.).

Figure 3 illustrates a perspective view of an example of a number of cooling units 310 connected to an exterior of a perimeter structure 304 for a flexible data center including according to the present disclosure. The perimeter
15 structure 304 includes a number of rows of server racks 306 therein. An interior of the perimeter structure can be pressurized with cool air from the number of cooling units 310. Cool air can be input 316 from the number of cooling units 310 into a volume of the perimeter structure 304 at a level of the number of rows of server racks 306 as illustrated in Figure 3. Warm air can be outlet 318
20 from the volume of the perimeter structure 304 via hot aisle 312 containing the number of rows of server racks 306 and ducting 314 warm air from above the number of rows of server racks 306. In some examples of the present disclosure a length of the number of rows of server racks 306 can have an upper limit of 18 feet.

25 For design of the flexible data center, the number of cooling units 310 can be selected from a group of cooling units 310 including direct expansion and direct evaporative cooling units, direct expansion and indirect evaporative cooling units, heat transfer wheel cooling units, and air-to-air exchanger with direct expansion cooling units. A direct expansion and direct evaporative
30 cooling unit can include a supply fan, filters, direct evaporative media, and a direct expansion cooling assembly. A direct expansion and indirect evaporative cooling unit can include a supply fan, filters, indirect evaporative media, and a

direct expansion cooling assembly. A heat transfer wheel cooling unit can include multiple supply and exhaust fans, filters, a heat transfer wheel, and a direct expansion cooling assembly. Each type of cooling unit 310 can provide particular efficiencies for a given climate (e.g., some may function more efficiently in certain climates). Furthermore, some cooling unit 310 types can help reduce or eliminate introduction of external contaminants into the flexible data center, which may occur with some outdoor air economizers.

A menu driven process can be provided for selecting the type of cooling unit 310 from a predetermined number of types of cooling units 310. The selection process can be validated via an energy optimization evaluation of selected cooling units 310 according to the climate of the site where the flexible data center is constructed. Such a menu driven process can be provided by a set of machine readable instructions stored in a tangible non-transitory medium.

A machine (e.g., a computing device) can include a tangible non-transitory medium storing a set of machine readable instructions. Such a tangible non-transitory medium can include volatile and/or non-volatile memory such as random access memory (RAM), magnetic memory such as a hard disk, floppy disk, and/or tape memory, a solid state drive (SSD), flash memory, phase change memory, and the like. The instructions can be executed by a processor associated with the machine to provide the menu driven process for cooling unit 310 selection and/or selection of other features such as a number of rows of server racks 306, a number of blocks, a number of perimeter structures 304, a number and/or type of power conditioner units, a number and/or type of backup power generation, among others.

Figure 4 provides a flow chart illustrating an example of a method for deploying 440 of a flexible data center including T server racks according to the present disclosure. The method includes constructing 442 a number B of blocks, wherein constructing each block includes: constructing from one to a number P of perimeter structures, wherein each perimeter structure houses up to a number R of rows of server racks; and constructing a connecting structure connected to the number of perimeter structures, wherein the connecting structure houses operations monitoring equipment for the rows of server racks.

The method includes constructing 444 a total integer number T/R of perimeter structures for the flexible data center, wherein: at most one perimeter structure houses less than R rows of server racks; B is equal to an integer number $(T/R)/P$; and at most one block includes less than P perimeter structures.

It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Although specific examples have been illustrated and described herein, other component arrangements, instructions, and/or device logic can be substituted for the specific examples shown.

What is claimed:

1. A method of deploying (440) a flexible data center (100, 200) including T rows of server racks (106, 206, 306), comprising:
 - 5 constructing (442) a number B of blocks (101, 201), wherein constructing each block (101, 201) includes:
 - constructing from one to a number P of perimeter structures (104, 204, 304), wherein each perimeter structure (104, 204, 304) houses up to a number R of rows of server racks (106, 206, 306); and
 - 10 constructing a connecting structure (102, 202) connected to the number of perimeter structures (104, 204, 304), wherein the connecting structure (102, 202) houses operations monitoring equipment (108, 208) for the server racks (106, 206, 306); and
 - constructing (444) a total integer number T/R of perimeter structures
 - 15 (104, 204, 304) for the flexible data center (100, 200), wherein:
 - at most one perimeter structure (104, 204, 304) houses less than R rows of server racks (106, 206, 306);
 - B is equal to an integer number $(T/R)/P$; and
 - at most one block (101, 201) includes less than P perimeter
 - 20 structures (104, 204, 304).
 2. The method of claim 1, wherein:
 - the number of perimeter structures (104, 204, 304) retain functionality independent of the connecting structure (102, 202);
 - 25 P is equal to four; and
 - the method includes connecting P perimeter structures (104, 204, 304) to the connecting structure (102, 202) in a butterfly configuration.
 3. The method of claim 1, wherein the method includes:
 - 30 constructing the number of blocks (101, 201) on a site;

selecting a type of cooling unit (110, 210, 310) from a predetermined plurality of types of cooling units (110, 210, 310) according to a climate of the site; and

5 connecting a number of the cooling units (110, 210, 310) to an exterior of a respective perimeter structure (104, 204, 304).

4. The method of claim 3, wherein the method includes:

pressurizing the respective perimeter structure (104, 204, 304) with cool air from the number of cooling units (110, 210, 310);

10 inputting (316) cool air from the number of cooling units (110, 210, 310) into a volume of the respective perimeter structure (104, 204, 304) at a level of the number of rows of server racks (106, 206, 306); and

15 outleting (318) warm air from the volume of the respective perimeter structure (104, 204, 304) into the number of cooling units (110, 210, 310) by ducting (314) warm air from above the number of rows of server racks (106, 206, 306).

5. The method of claim 3, wherein the method includes:

20 providing a menu driven process for selecting the type of cooling unit (110, 210, 310) from the predetermined plurality of types of cooling units (110, 210, 310); and

validating the selection process via an energy optimization evaluation of selected cooling units (110, 210, 310) according to the climate of the site.

25 6. The method of claim 1, wherein each perimeter structure (104, 204, 304) consumes up to a particular quantity of power, and the method includes:

connecting a number of power conditioner units (120, 220) to each perimeter structure (104, 204, 304) according to a desired power quality; and

30 validating a selection of the number of power conditioner units (120, 220) via an energy optimization evaluation of the selected power conditioner units (120, 220) according to a climate of the site.

7. The method of claim 6, wherein the method includes connecting a number of backup power generation units (122, 222) to the flexible data center (100, 200) according to the particular quantity of power.

5 8. The method of claim 1, wherein constructing the number of blocks (101, 201) includes constructing a particular block (101, 201) including:
initially constructing less than P perimeter structures (104, 204, 304); and
constructing an additional perimeter structure (104, 204, 304) after the
data center (100, 200) has been deployed according to an increased demand
10 for rows of server racks (106, 206, 306) for the flexible data center (100, 200).

9. The method of claim 1, wherein constructing the number of blocks (101, 201) includes constructing a first block (101, 201) including:

constructing P first perimeter structures (104, 204, 304); and
15 constructing a second block (101, 201) includes constructing one to P
second perimeter structures (104, 204, 304) above the first perimeter structures
(104, 204, 304).

10. The method of claim 1, wherein constructing the number of blocks (101, 201) includes constructing a first block (101, 201) and constructing a second
20 block (101, 201) adjacent to the first block (101, 201) without connecting
structures associated with the second block (101, 201) to structures associated
with the first block (101, 201).

25 11. A flexible data center (100, 200), comprising:

a number B of blocks (101, 201) on a site, each block (101, 201)
including:

one to a number P of perimeter structures (104, 204, 304),
wherein each perimeter structure (104, 204, 304) houses up to a number R of
30 rows of server racks (106, 206, 306); and

a connecting structure (102, 202) connected to the number of
perimeter structures (104, 204, 304), wherein the connecting structure (102,

202) houses operations monitoring equipment (108, 208) for the server racks (106, 206, 306), and wherein the one to the number P of perimeter structures (104, 204, 304) retain functionality independent of the connecting structure (102, 202);

5 a total integer number T/R of perimeter structures (104, 204, 304), wherein:

 at most one perimeter structure (104, 204, 304) houses less than R rows of server racks (106, 206, 306);

 B is equal to an integer number (T/R)/P; and

10 at most one block (101, 201) includes less than P perimeter structures (104, 204, 304);

 a number of cooling units (110, 210, 310) connected to an exterior of a respective perimeter structure (104, 204, 304), wherein a type of the number of cooling units (110, 210, 310) is particular to a climate of the site; and

15 a number of power conditioner units (120, 220) connected to an exterior of the respective perimeter structure (104, 204, 304), wherein a type of the number of power conditioner units (120, 220) is particular to a desired power quality and end-to-end energy efficiency for the flexible data center (100, 200).

20 12. The flexible data center (100, 200) of claim 11, wherein:

 the number of cooling units (110, 210, 310) are selected from the group of cooling units (110, 210, 310) including:

 direct expansion and direct evaporative cooling units (110, 210, 310);

25 direct expansion and indirect evaporative cooling units (110, 210, 310);

 heat transfer wheel cooling units (110, 210, 310); and

 air-to-air heat exchanger with direct expansion cooling units (110, 210, 310); and

30 the number of power conditioner units (120, 220) are associated with a uninterruptable power supply (UPS) selected from the group of UPS modules including:

a delta conversion uninterruptable power supply (UPS) module;
a double conversion UPS module;
an offline UPS module;
a flywheel UPS module; and
5 a diesel rotary UPS module.

13. The flexible data center (100, 200) of claim 11, wherein the total integer number T/R of perimeter structures (104, 204, 304) is greater than P; and
a number of the total integer number T/R of perimeter structures (104,
10 204, 304) are constructed in a location selected from the group of locations including:
in one of the number of blocks (101, 201) above a block (101, 201) including P of the perimeter structures (104, 204, 304); and
in one of the number of blocks (101, 201) adjacent to a block (101,
15 201) including P of the perimeter structures (104, 204, 304)..
14. The flexible data center (100, 200) of claim 11, wherein:
B equals one;
P equals four and the flexible data center (100, 200) includes four
20 perimeter structures (104, 204, 304); and
the flexible data center (100, 200) provides a total of 3.2 megawatts of information technology (IT) power and 400 kilowatts of network/communications support with a power usage effectiveness less than 1.28.
- 25 15. The flexible data center (100, 200) of claim 11, wherein the number of perimeter structures (104, 204, 304) do not include a power distribution unit.

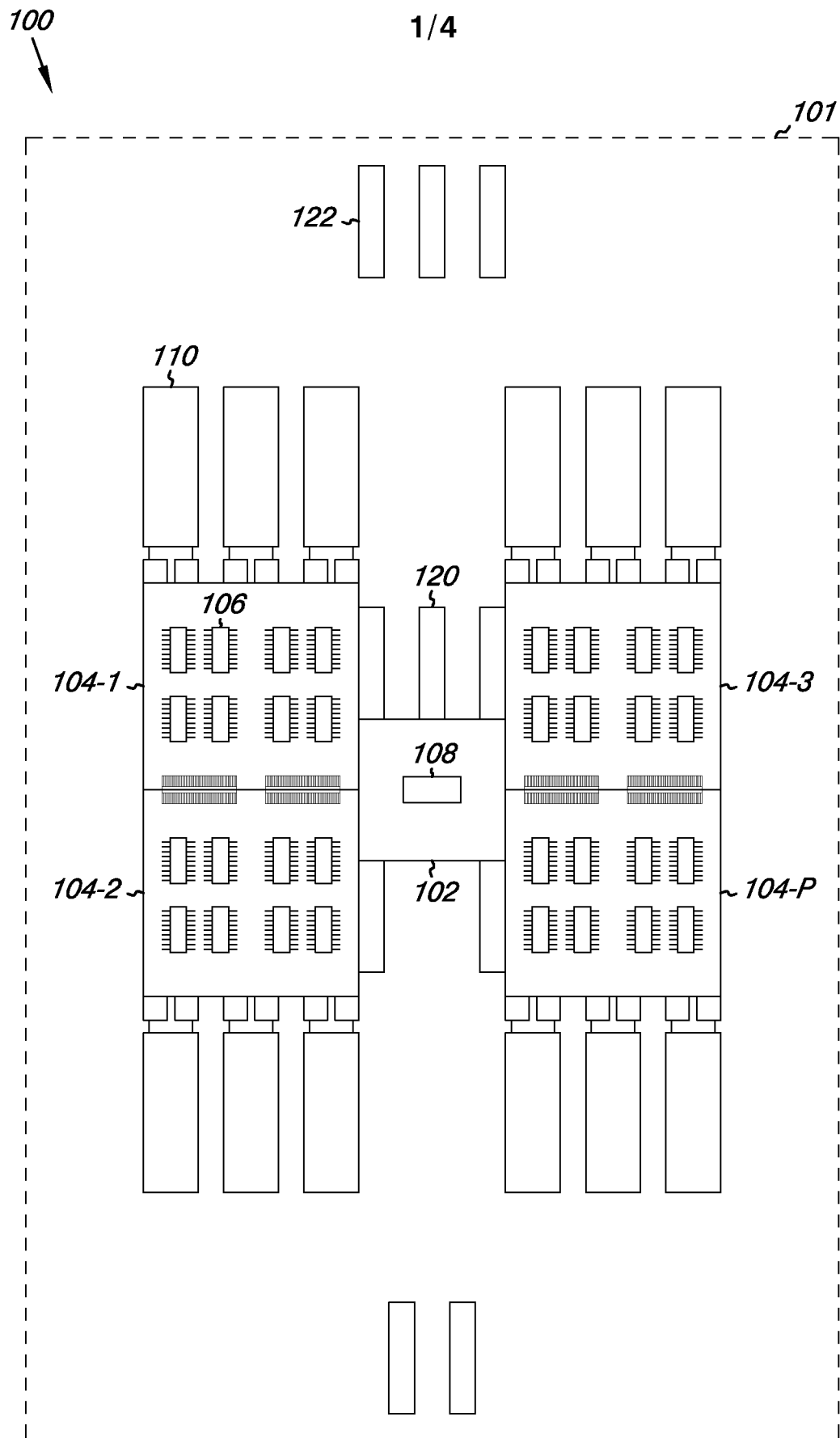
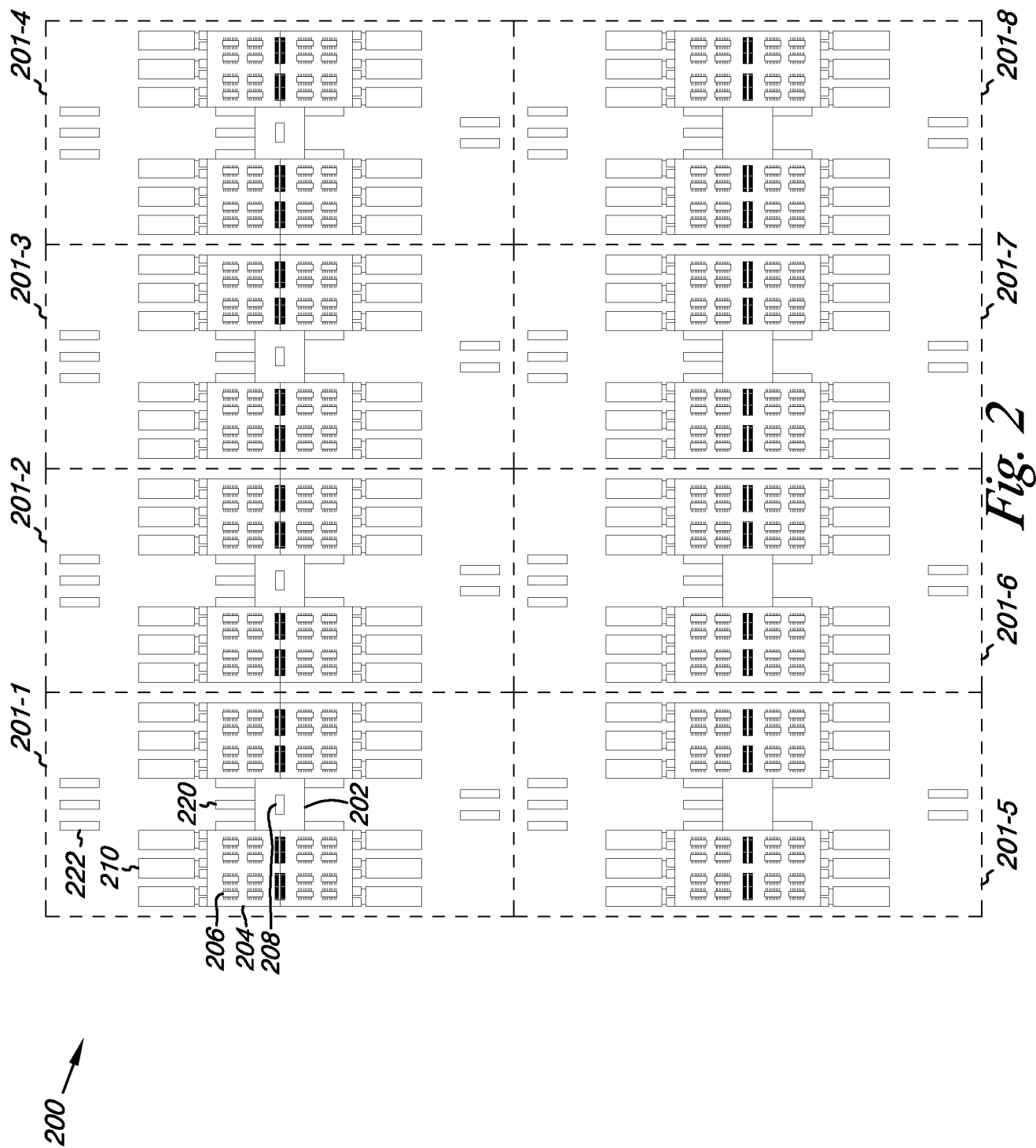


Fig. 1



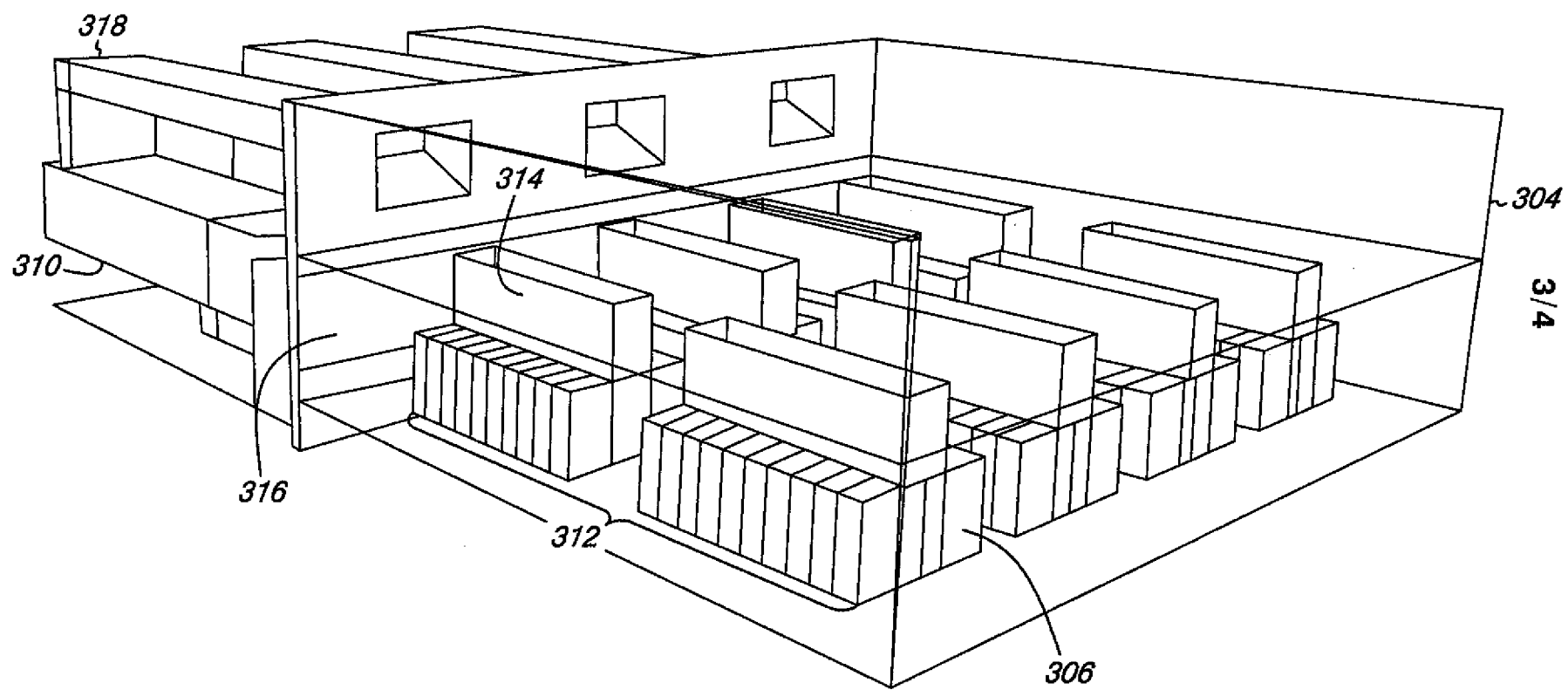
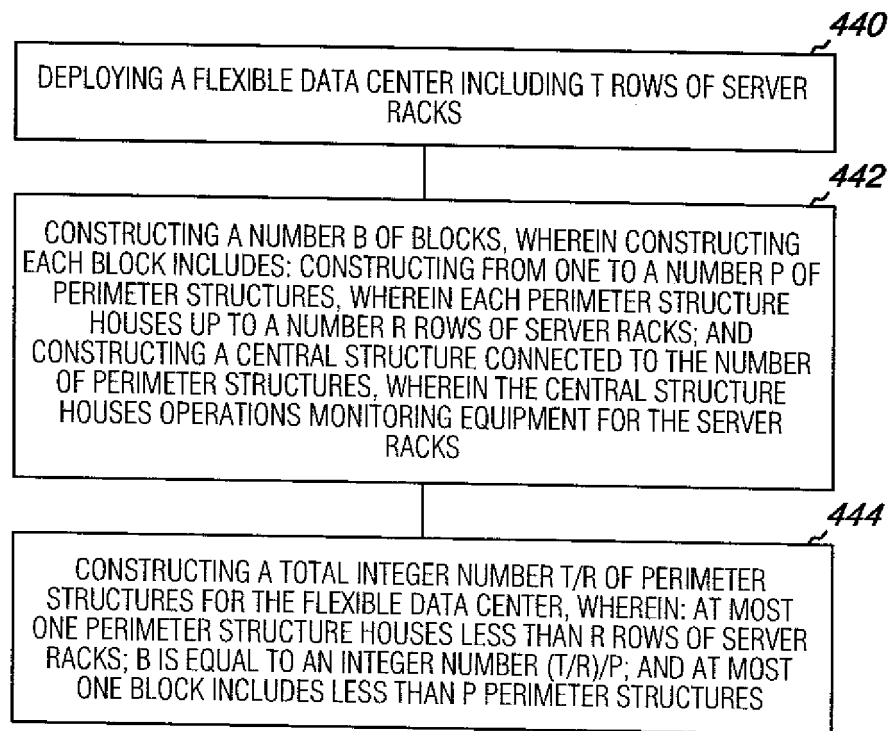


Fig. 3

4/4

*Fig. 4*

A. CLASSIFICATION OF SUBJECT MATTER**G06F 13/14(2006.01)i, G06F 1/26(2006.01)i, G06F 1/20(2006.01)i, G06F 1/16(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F 13/14; H05K 7/20; E04H 1/00; F28D 15/00; A47B 77/08; H05K 5/02; G08B 17/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: data, denter, server, rack, deploy, flexible, perimeter structure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009-0229194 A1 (ENRIQUE DAUNERT ARMILLAS) 17 September 2009 See paragraphs [0003]-[0006], [0027],[0110],[0124]-[0125],[0174]; figure 11.	1-15
A	US 2007-0076373 A1 (JAMES FINK) 05 April 2007 See paragraphs [0015] - [0030]; figures 1-2.	1-15
A	US 2004-0227435 A1 (NEIL RASMUSSEN) 18 November 2004 See paragraphs [0063]-[0076], [0103]; figures 4-7, 17.	1-15
A	US 2008-0158818 A1 (JIMMY CLIDARAS et al.) 03 July 2008 See paragraphs [0020] - [0044], [0059] - [0080]; figures 1, 5.	1-15
A	WO 2007-095144 A2 (AMERICAN POWER CONVERSION CORP.) 23 August 2007 See page 5, line 27 - page 12. line 5; figures 1-4.	1-15
A	US 2010-0136895 A1 (RICHARD O. SGRO) 03 June 2010 See paragraphs [0026] - [0029]; figures 1-2.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

31 MARCH 2011 (31.03.2011)

Date of mailing of the international search report

31 MARCH 2011 (31.03.2011)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsu-ro,
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

KIM Jong Kee

Telephone No. 82-42-481-8301



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2010/041734

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009-0229194 A1	17.09.2009	None	
US 2007-0076373 A1	05.04.2007	CN 100584168 C	20.01.2010
		CN 101686629 A	31.03.2010
		CN 1777855 A	24.05.2006
		CN 1777855 B	09.06.2010
		CN 1777855 C0	24.05.2006
		CN 1977575 A	06.06.2007
		CN 1977575 C0	06.06.2007
		EP 1604263 A2	14.12.2005
		EP 1604263 B1	22.07.2009
		EP 1774842 A1	18.04.2007
		EP 1774842 B1	03.11.2010
		EP 2079000 A2	15.07.2009
		EP 2079000 A3	12.08.2009
		EP 2261769 A2	15.12.2010
		JP 2006-526205 A	16.11.2006
		JP 2008-502082 A	24.01.2008
		JP 2009-104650 A	14.05.2009
		JP 2010-169392 A	05.08.2010
		JP 2010-170522 A	05.08.2010
		JP 2010-170523 A	05.08.2010
		JP 2010-182318 A	19.08.2010
		US 2004-0184232 A1	23.09.2004
		US 2004-0223300 A1	11.11.2004
		US 2005-0099770 A1	12.05.2005
		US 2006-0007653 A1	12.01.2006
		US 2006-0187636 A1	24.08.2006
		US 2007-0274035 A1	29.11.2007
		US 6859366 B2	22.02.2005
		US 6980433 B2	27.12.2005
		US 7046514 B2	16.05.2006
		US 7145772 B2	05.12.2006
		US 7173820 B2	06.02.2007
		US 7529086 B2	05.05.2009
		WO 2004-083743 A2	30.09.2004
		WO 2004-083743 A3	30.09.2004
		WO 2005-122664 A1	22.12.2005
US 2004-0227435 A1	18.11.2004	CN 100488346 C	13.05.2009
		CN 101044808 A	26.09.2007
		CN 101044808 A0	26.09.2007
		CN 1806477 A	19.07.2006
		CN 1806477 C0	19.07.2006
		EP 1623611 A2	08.02.2006
		EP 2100490 A1	16.09.2009
		EP 2252136 A2	17.11.2010
		JP 2007-502027 A	01.02.2007
		JP 2007-502027 T	01.02.2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2010/041734

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2004-0257766 A1	23.12.2004
		US 2006-0276121 A1	07.12.2006
		US 2007-0129000 A1	07.06.2007
		US 7033267 B2	25.04.2006
		US 7112131 B2	26.09.2006
		US 7878888 B2	01.02.2011
		WO 2004-103046 A2	25.11.2004
		WO 2004-103046 A3	25.11.2004
		WO 2004-103046 A3	14.07.2005
		WO 2005-081607 A1	01.09.2005
US 2008-0158818 A1	03.07.2008	US 2008-158818 A1	03.07.2008
		US 7564685 B2	21.07.2009
WO 2007-095144 A2	23.08.2007	AU 2007-215267 A1	23.08.2007
		AU 2007-215267 B2	10.02.2011
		CA 2641824 A1	23.08.2007
		CN 101401498 A	01.04.2009
		EP 1981374 A2	22.10.2008
		EP 1981374 A4	28.07.2010
		JP 2009-526407 A	16.07.2009
		JP 2009-526407 T	16.07.2009
		KR 10-2008-0097221 A	04.11.2008
		WO 2007-095144 A3	02.10.2008
		WO 2007-095144 A3	23.08.2007
US 2010-0136895 A1	03.06.2010	None	