Improving the cost to cool efficiency from 25% to 10% translates to a saving of $219,000 per month or $2.63 million a year.

[0008] In a data center room, server racks are typically laid out in rows with alternating cold and hot aisles between them. All servers are installed into the racks to achieve a front-to-back airflow pattern that draws conditioned air in from the cold rows, located in front of the rack, and ejects heat out through the hot rows behind the racks. A raised floor room design is commonly used to accommodate an underfloor air distribution system, where cooled air is supplied through vents in the raised floor along the cold aisles.

[0009] A factor in efficient cooling of data center is to manage the air flow and circulation inside a data center. Computer Room Air Conditioners (CRAC) units supply cold air through floor tiles including vents between the racks. In addition to servers, CRAC units consume significant amounts of power as well. One CRAC unit may have up to three 5 horsepower motors and up to 150 CRAC units may be needed to cool a data center. The CRAC units collectively consume significant amounts of power in a data center. For example, in a data center room with hot and cold row configuration, hot air from the hot rows is moved out of the hot row and circulated to the CRAC units. The CRAC units cool the air. Fans powered by the motors of the CRAC units supply the cooled air to an underfloor plenum defined by the raised sub-floor. The pressure created by driving the cooled air into the underfloor plenum drives the cooled air upwardly through vents in the subfloor, supplying it to the cold aisles where the server racks are facing. To achieve a sufficient air flow rate, hundreds of powerful CRAC units may be installed throughout a typical data center room. However, since CRAC units are generally installed at the corners of the data center room, their ability to efficiently increase air flow rate is negatively impacted. The cost of building a raised floor generally is high and the cooling efficiency generally is low due to inefficient air movement inside the data center room. In addition, the location of the floor vents requires careful planning throughout the design and construction of the data center to prevent short circuiting of supply air. Removing tiles to fix hot spots can cause problems throughout the system.

SUMMARY

[0010] The present teaching relates to cooling systems.

[0011] In one example, an air handler building structure is disclosed, which includes a floor, a plurality of lateral walls, a roof, and a plurality of ~~one or more~~ openings ~~located either on the roof,~~

~~or on at least one of the lateral walls.~~ The lateral walls include a lower and an upper lateral walls opposing to each other having different respective heights determined in accordance with a ratio. The roof has a pitch consistent with the ratio associated with the lower and upper lateral walls. The plurality of openings are located on the roof and the lower and upper lateral walls, that enable ~~The shape of the building structure allows~~ air within the building structure to rise and exit the building structure via natural convection. In addition, a first dimension along a first direction

defined between the lower and upper lateral walls relative to a second dimension along a second direction perpendicular to the first direction is such that the building structure provides access to outside natural air via one or more openings on the lower lateral wall.

[0012] In another example, a server cooling system is disclosed, which includes a first space defined by a floor, one or more lateral walls, and a ceiling, having a plurality of servers installed therein, and second space defined by the ceiling and a roof. One or more openings are located on at least one of the ceiling, the roof, and at least one of the one or more lateral walls. The server cooling system also includes an air inlet coupled with a first lateral wall and operable to allow outside natural air to enter, one or more air-handling units coupled with the air inlet to draw the outside natural air and to provide air to the first space, and an air outlet coupled with a second lateral wall and operable to allow air in the second space to exit. The server cooling system further includes a control system configured to control the one or more air-handling units to operate in one of a plurality of modes that is determined based on ~~provide air to the first space in accordance with~~ temperatures measured within and outside of the first space.

[0013] In still another example, a server cooling system is disclosed, which includes a first space defined by a floor, a plurality of lateral walls including a lower and an upper lateral walls opposing to each other having different respective heights, and a ceiling, and a second space defined by the ceiling and a sloped roof constructed in accordance with a pitch. A plurality of ~~One or more~~ openings are located on ~~at least one of~~ the roof, the ceiling, and ~~at least one of~~ the lower and upper lateral walls, that enable outside natural air to enter the first space and air in the second

space to exit by natural convection. The server cooling system also includes an interior space inside the first space, that is substantially enclosed and engaging the ceiling, and a rack engaging the interior space in a substantially sealed manner and having a plurality of rack-mounted servers mounted thereon. Respective front faces of the rack-mounted servers interface with the first space respective back faces of the rack-mounted servers interface with the interior space. Each rack-mounted server includes one or more fans installed therein operable to draw air from the first space through its front face and expel heated air to the interior space through its back face.

[0014] In yet another example, an air handler building structure is disclosed, which includes a floor, a plurality of lateral walls, a roof portion, a protruding portion, and ~~one or more~~ a plurality of

openings located on ~~at least one of~~ the roof portion, at least one of the lateral walls, and the protruding portion. The roof portion has opposing sides, each having a pitch. The protruding portion extends above the roof portion. The plurality of openings enable ~~In addition, the shape of the building structure allows~~ outside natural air to enter through one or more openings on at least one of the lateral walls via natural convection and exit through one or more openings on ~~at least one of~~ the roof portion and the protruding portion.

[0015] The following detailed description together with the accompanying drawings will provide a better understanding of the nature and advantages of various embodiments of the present invention.

DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a diagram showing an exemplary server cooling system;

[0017] FIG. 2 is a diagram showing an example server cooling system wherein the server cooling system comprises an attic space;

[0018] FIG. 3 is a diagram showing an example server cooling system wherein air is re-circulated inside the example server cooling system;

[0019] FIG. 4 is a diagram showing an example server cooling system with a hot row enclosure and a cold row enclosure;

[0020] FIG. 5 is a diagram showing an example server cooling system with a hot row enclosure and a cold row enclosure wherein air is re-circulated inside the a server cooling system;

[0021] FIG. 6 is a diagram showing an example server cooling system with a single-sloped roof;

[0022] FIG. 7 is a diagram showing a top view of an example server cooling system with a single-sloped roof;

[0023] FIG. 8 is a diagram showing an example server cooling system with a gable roof;

[0024] FIG. 9 is a diagram showing an example server cooling system with an air mixing chamber;

[0025] FIGS. 10A and 10B are diagrams showing an example air handler building structure;

[0026] FIG. 11 is a diagram showing an example server cooling system;

[0027] FIG. 12 is a diagram showing another example server cooling system;