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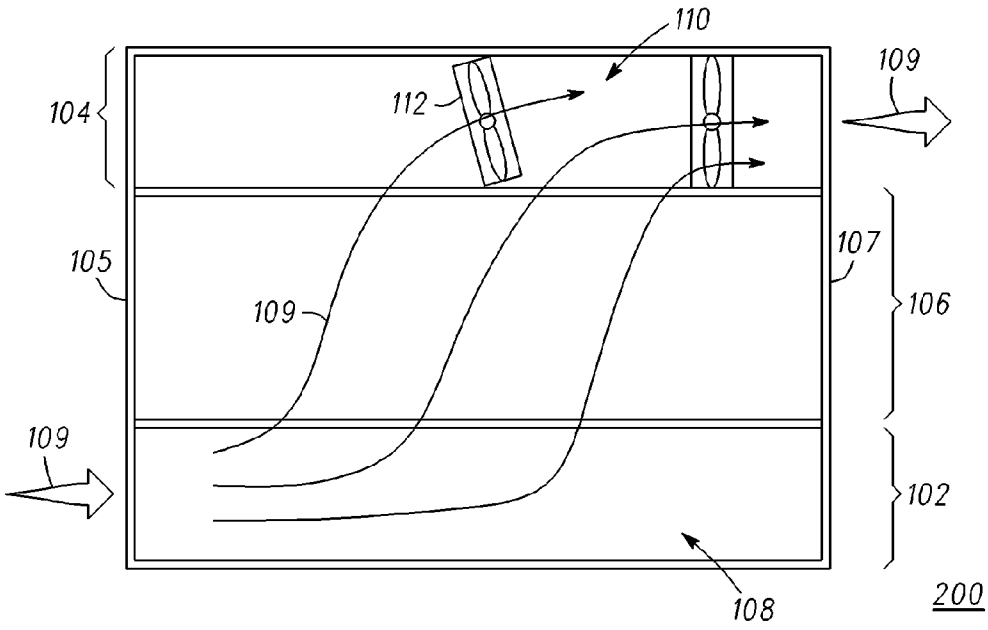

(57) **Abstract:** An embedded computer chassis (100) may include a fan tray receptacle (102) adapted to receive at least one primary fan tray (108), where the at least one primary fan tray is adapted to be non-redundant in providing cooling air to the embedded computer chassis. Embedded computer chassis may also include a cooling air plenum (104), where the cooling air plenum is adapted to receive a service fan tray (110), where the service fan tray is adapted to temporarily provide the cooling air to the embedded computer chassis absent the at least one primary fan tray.

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COMPUTER CHASSIS WITH SERVICE FAN TRAY

BACKGROUND OF INVENTION

[0001] Existing embedded computer chassis generally employ forced air convection cooling of electronic modules. The forced air convection is achieved through use of one or more fan trays, each containing one or more fans. In the prior art, there may be a redundant number of fans in each fan tray, such that if a fan fails, the fan tray can continue to cool the embedded computer chassis adequately. Also in the prior art, there may be a redundant number of fan trays in the embedded computer chassis, such that if a fan tray is removed, the remaining fan trays can continue to cool the embedded computer chassis adequately.

[0002] Fan trays need to be removed for maintenance and replacement without interrupting the operation of the embedded computer chassis. For low-profile and/or low cost embedded computer chassis, interior volume is at a premium, and space is not available for a redundant fan tray. So, even though a fan tray may have a redundant number of fans, if the fan tray is removed for maintenance, the chassis will have to be shutdown, which is unacceptable from a quality of service standpoint. Despite only having a single fan tray, low-profile and low-cost systems must be

highly-available and operate without interruption, even in the event of a faulty fan tray.

[0003] The prior art is deficient in providing a method for temporary redundancy for cooling in an embedded computer chassis. Accordingly, there is a significant need for an apparatus and method that overcomes the deficiencies of the prior art outlined above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Representative elements, operational features, applications and/or advantages of the present invention reside *inter alia* in the details of construction and operation as more fully hereafter depicted, described and claimed – reference being made to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout. Other elements, operational features, applications and/or advantages will become apparent in light of certain exemplary embodiments recited in the Detailed Description, wherein:

[0005] FIG. **1** representatively illustrates an embedded computer chassis in accordance with an exemplary embodiment of the present invention;

[0006] FIG. **2** representatively illustrates an embedded computer chassis in accordance with another exemplary embodiment of the present invention;

[0007] FIG. **3** representatively illustrates a block diagram of an embedded computer chassis in accordance with an exemplary embodiment of the present invention; and

[0008] FIG. **4** representatively illustrates a flow diagram of a method in accordance with an exemplary embodiment of the present invention.

[0009] Elements in the Figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the Figures may be exaggerated relative to other elements to help improve understanding of various embodiments of the present invention. Furthermore, the terms "first", "second", and the like herein, if any, are used *inter alia* for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. Moreover, the terms "front", "back", "top", "bottom", "over", "under", and the like in the Description and/or in the Claims, if any, are generally employed for descriptive purposes and not necessarily for comprehensively describing exclusive relative position. Any of the preceding terms so used may be interchanged under appropriate circumstances such that various embodiments of the invention described herein may be capable of operation in other configurations and/or orientations than those explicitly illustrated or otherwise described.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0010] The following representative descriptions of the present invention generally relate to exemplary embodiments and the inventor's conception of the best mode, and are not intended to limit the applicability or configuration of the invention in any way. Rather, the following description is intended to provide convenient illustrations for implementing various embodiments of the invention. As will become apparent, changes may be made in the function and/or arrangement of any of the elements described in the disclosed exemplary embodiments without departing from the spirit and scope of the invention.

[0011] The terms "a" or "an", as used herein, are defined as one, or more than one. The term "plurality," as used herein, is defined as two, or more than two. The term "another," as used herein, is defined as at least a second or more. The terms "including" and/or "having," as used herein, are defined as comprising (i.e., open language). The term "coupled," as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically.

[0012] A detailed description of an exemplary application is provided as a specific enabling disclosure that may be generalized to any application of the disclosed system, device and method for a computer cooling system in accordance with various embodiments of the present invention.

[0013] FIG. **1** representatively illustrates an embedded computer chassis **100** in accordance with an exemplary embodiment of the present invention. Embedded computer chassis **100** may be defined by a plurality of outer surfaces including a front side **105** and a rear side **107**. Embedded computer chassis **100** may include a card portion **106** having any number of slots suitably adapted for receiving one or more computer cards. For example, card portion **106** can be suitably adapted for receiving at least one of a payload card, switch card, rear transition module, and the like. In an embodiment, cards in card portion **106** may be coupled to a backplane, midplane, serpentine backplane, and the like.

[0014] Embedded computer chassis **100** may include hardware and software necessary to implement a data network using a parallel multi-drop topology, switched fabric topology, and the like. Backplane, midplane, and the like may be disposed substantially vertical or substantially horizontal within embedded computer chassis **100**.

[0015] Each card disposed to interface with card portion **106** may include a printed circuit board (PCB) having any number of electronic devices located thereon, for example, and without limitation, processors, memory, storage devices, I/O elements, wireless and wireline communication elements, and the like.

[0016] Embedded computer chassis **100** may be adapted for use in any application requiring modular, embedded computing resources, for

example and without limitation, telecommunications, industrial control, system control and data acquisition (SCADA), and the like. In the exemplary embodiment, embedded computer chassis **100** can be a 1U, 3U, 6U, 9U chassis, and the like. Embedded computer chassis **100** may be coupled together and "stacked" to form a distributed computing system coupled to share resources from each chassis.

[0017] As is known in the art, "U" and multiples of "U" can refer to both the width of a card and the height of the embedded computer chassis **100**. In an embodiment, "U" can measure approximately 1.75 inches. Any size chassis or cards are within the scope of the invention. The "U" terminology is not limiting of the invention. As such, the invention is not limited to "U" as a form factor reference. Other form factor reference notations and increments are within the scope of the invention.

[0018] In an embodiment, embedded computer chassis **100** may include a backplane or midplane and a card portion **106** suitably adapted to operate a parallel multi-drop network, for example, a VERSAmodule Eurocard (VMEbus) network using any of the VMEbus protocols known in the art. VMEbus is defined in the ANSI/VITA 1-1994 and ANSI/VITA 1.1-1997 standards, promulgated by the VMEbus International Trade Association (VITA), P.O. Box 19658, Fountain Hills, Arizona, 85269 (where ANSI stands for American National Standards Institute). In an embodiment of the invention, VMEbus

based protocols can include, but are not limited to, Single Cycle Transfer protocol (SCT), Block Transfer protocol (BLT), Multiplexed Block Transfer protocol (MBLT), Two Edge VMEbus protocol (2eVME) and Two Edge Source Synchronous Transfer protocol (2eSST). These VMEbus protocols are known in the art.

[0019] In another embodiment, embedded computer chassis **100** may include backplane or midplane and card portion **106** suitably adapted to operate a switched fabric. Switched fabric may use switch card as a central switching hub with any number of payload cards coupled to switch card. Switched fabric can be based on a point-to-point, switched input/output (I/O) fabric, whereby cascaded switch devices interconnect end node devices. In an embodiment, switched fabric can be configured as a star topology, mesh topology, and the like as known in the art for communicatively coupling switched fabrics. Switched fabric can include both card-to-card (for example computer systems that support I/O card add-in slots) and chassis-to-chassis environments (for example interconnecting computers, external storage systems, external Local Area Network (LAN) and Wide Area Network (WAN) access devices in a data-center environment). Switched fabric can be implemented by using one or more of a plurality of switched fabric network standards, for example and without limitation, InfiniBand™, Serial RapidIO™, FibreChannel™, Ethernet™, PCI Express™, AdvancedTCA™, Hypertransport™, Gigabit Ethernet, and the like.

Switched fabric is not limited to the use of these switched fabric network standards and the use of any switched fabric network standard is within the scope of the invention.

[0020] In another embodiment, embedded computer chassis **100** may include backplane or midplane and card portion **106** suitably adapted to comply with CompactPCI® standard. In still another embodiment, embedded computer chassis **100** can include backplane or midplane and card portion **106** suitably adapted to may comply with MicroTCA standard as defined in PICMG® MicroTCA 1.0 – Micro Telecom Compute Architecture Base Specification (and subsequent revisions).

[0021] In still yet another embodiment, embedded computer chassis **100** may include backplane or midplane and card portion **106** suitably adapted to operate a VXS network conforming to the VERSAmodule Eurocard (VMEbus) switched serial standard backplane (VXS) as set forth in VITA 41 promulgated by VMEbus International Trade Association (VITA), P.O. Box 19658, Fountain Hills, Arizona, 85269. The embodiment of the invention is not limited to a computer system complying with any of these standards, and computer systems complying with other standards are within the scope of the invention.

[0022] When in operation, cards disposed in card portion **106**, among other devices, may generate heat that must be removed from embedded computer chassis **100**. Embedded computer chassis

100 may include a fan tray receptacle **102** adapted to receive at least one primary fan tray **108**, and a cooling air plenum **104**. In an embodiment, fan tray receptacle **102** may be any size so as to receive at least one primary fan tray **108**, where at least one primary fan tray **108** may be suitably adapted to slidably engage fan tray receptacle **102**. The specific size and configuration of fan tray receptacle **102** can be tailored by one skilled in the art to fit a specific application and be within the scope of the invention. At least one primary fan tray **108** is adapted to couple backplane, midplane, and the like, of embedded computer chassis **100**. For example, at least one primary fan tray **108** may couple to a backplane and receive power control signals via the backplane.

[0023] In an embodiment, at least one primary fan tray **108** may include any number of fans **113**, which can include, for example and without limitation, centrifugal fans, axial fans, blowers, and the like. Fans **113** may be suitably configured in any combination of "push" or "pull" patterns and disposed at any appropriate angle in the at least one primary fan tray **108**. Fans **113** may either "push" cooling air **109** over one or more computer cards or "pull" cooling air **109** over one or more computer cards, or any combination thereof. In pushing or pulling cooling air **109** over computer cards, cooling air **109** may flow over one or both sides of computer cards. As an example of an embodiment, at least one primary fan tray **108** may include one or more axial fans. The number and operating point of

fans **113** can be chosen to fit a particular application and is well within the abilities of one of ordinary skill in the art. Although the embodiment shown illustrates fans **113** pushing cooling air **109**, other configurations are within the scope of the invention, including fans **113** pulling cooling air **109** though embedded computer chassis **100**.

[0024] In an embodiment, a surface of embedded computer chassis **100**, for example front side **105** may include one or more orifices to allow cooling air **109** to be drawn into embedded computer chassis **100** in a direction substantially perpendicular to front side **105**. Cooling air plenum **104** may include a cavity where cooling air **109** leaves embedded computer chassis **100** through for example rear side **107**. Cooling air **109** may follow a substantially defined path through embedded computer chassis **100** such that heat is removed from card portion **106** and a given temperature range is maintained within embedded computer chassis **100**. In an optional embodiment, a cooling air entry plenum may be located in the cooling air path such that the cooling air **109** passes through the cooling air entry plenum before the at least one primary fan tray **108**. Although cooling air **109** is shown entering embedded computer chassis **100** through front side **105** and exiting through rear side **107**, air may enter and exit embedded computer chassis **100** through any side or combination of sides and be within the scope of the invention.

[0025] In the embodiment shown, fan tray receptacle **102** is shown below card portion **106**, while cooling air plenum **104** is shown above card portion **106**. This is not limiting of the invention, as the fan tray receptacle **102** and cooling air plenum **104** may be disposed in any configuration in or around card portion **106** and be within the scope of the invention.

[0026] In an embodiment, the at least one primary fan tray **108** is not redundant in removing the heat generated in embedded computer chassis **100**. In other words, when at least one primary fan tray **108** fails or is removed from embedded computer chassis **100**, there will be inadequate cooling of card portion **106** and embedded computer chassis **100**. There are no redundant fan tray receptacles, fan trays or locations for redundant fan trays that match the operability of at least one primary fan tray **108** in embedded computer chassis **100**. Optionally, at least one primary fan tray **108** may include temperature sensors and other hardware and software modules to detect and react to temperature changes in embedded computer chassis **100**.

[0027] FIG. **2** representatively illustrates an embedded computer chassis **200** in accordance with another exemplary embodiment of the present invention. In the embodiment of FIG. **2**, a service fan tray **110** is placed in the cooling air plenum **104** to temporarily provide cooling air **109** to the embedded computer chassis **200** absent the at least one primary fan tray **108**.

[0028] Cooling air plenum **104** is adapted to receive service fan tray **110**, where service fan tray **110** may comprise at least one service fan **112**. In the event at least one primary fan tray **108** fails, or requires service that causes at least one primary fan tray **108** to be removed from fan tray receptacle **102** of embedded computer chassis **200**, service fan tray **110** may be inserted into cooling air plenum **104** to temporarily provide cooling air **109** to embedded computer chassis **200** until at least one primary fan tray **108** can be returned to operation.

[0029] In the embodiment shown, at least one primary fan tray **108** "pushes" cooling air **109** through card portion **106**, while service fan tray **110** "pulls" cooling air **109** though card portion **106**. This configuration is not limiting of the invention. For example, at least one primary fan tray **108** may "'pull" cooling air **109**, while service fan tray **110** "pushes" cooling air **109**. In another example, both of at least one primary fan tray **108** and service fan tray **110** may "push" or "pull" cooling air **109**, or any combination thereof.

[0030] In an embodiment, service fan tray **110** may include any number of service fans **112**, which can include, for example and without limitation, centrifugal fans, axial fans, blowers, and the like. Service fans **112** may be suitably configured in any combination of "push" or "pull" patterns and disposed at any appropriate angle in the service fan tray **110**. Service fans **112** may either "push" cooling air **109** over one or more computer cards or "pull" cooling air **109** over one

or more computer cards, or any combination thereof. In pushing or pulling cooling air **109** over computer cards, cooling air **109** may flow over one or both sides of computer cards. As an example of an embodiment, service fan tray **110** may include one or more axial fans. The number and operating point of service fans **112** may be chosen to fit a particular application and is well within the abilities of one of ordinary skill in the art. Although the embodiment shown illustrates service fans **112** pulling cooling air **109**, other configurations are within the scope of the invention, including service fans **112** pushing cooling air **109** though embedded computer chassis **200**.

[0031] In an embodiment, at least one service fan **112** may operate at a single speed. In another embodiment, at least one service fan **112** may operate at multiple speeds or be variable speed. In another embodiment, service fan tray **110** may comprise any number of service fans **112** operating in any combination of single speed, multiple speeds and variable speed configurations.

[0032] In an embodiment, service fan tray **110** may provide cooling air **109** to embedded computer chassis **200** for a limited period of time such that computer cards in card portion **106** remain functional. For example, service fan tray **110** may be adapted to provide cooling air **109** for a limited period of time such that at least one primary fan tray **108** may be swapped out (i.e. one primary fan tray removed and another one inserted in its place). In another example, service

fan tray **110** may provide cooling air **109** for a limited period of time only, such that the limited period of time is of a fixed duration. In yet another example, service fan tray **110** may provide cooling air **109** for an indefinite period of time.

[0033] FIG. **3** representatively illustrates a block diagram of an embedded computer chassis **300** in accordance with an exemplary embodiment of the present invention. As shown in FIG. **3**, embedded computer chassis **300** may include a backplane **103** (where backplane may be a backplane, midplane, and the like), operating control bus **120** transmitting and receiving control logic **118** from/to, for example, a controller unit.

[0034] Control logic **118** may be suitably adapted to power up at least one primary fan tray **108**, monitor fans **113**, and increase/decrease fans **113** to a selected speed based on feedback from one or more temperature sensors. At least one primary fan tray **108** may be suitably adapted to report fan management data over control bus **120**, for example an Intelligent Platform Management Bus (IPMB). Fan management data may include, but is not limited to, temperature, fan speed, voltage, amperage, bus traffic, status indications, and the like.

[0035] In an embodiment, service fan tray **110** operates independently of control bus **120**. In other words, in this embodiment service fan tray **110** does not interface with control bus **120** and does not operate with control logic **118**. In this instance service fan tray **110** may

operate, for example, at a single speed without utilizing feedback mechanisms (such as temperature sensors) to vary service fan speed. In a variation of this embodiment, service fan tray **110** does not interface with backplane, but merely is inserted into cooling air plenum **104**.

[0036] In another embodiment, service fan tray **110** is coupled to control bus **120** and operates in conjunction with control logic **118**, similar to at least one primary fan tray **108**. In this embodiment, service fan tray **110** may be connected to control bus **120** and report fan management data similar to at least one primary fan tray **108**.

[0037] In an embodiment, embedded computer chassis **300** includes an internal power source **114** that provides power to embedded computer chassis **300**, including at least one primary fan tray **108**. For example, internal power source **114** may provide power to at least one primary fan tray **108** through backplane **103**. Internal power source **114** may include a transformer to convert alternating current to direct current, battery system, and the like, where internal power source **114** is dedicated to providing power to embedded computer chassis **300**.

[0038] In another embodiment, service fan tray **110** operates from an external power source **116** that is independent from internal power source **114** of the embedded computer chassis **300**. External power source **116** is a separate and independent power source from internal power source **114**. In an embodiment, external power

source **116** is not delivered over backplane **103**, but may be supplied to service fan tray **110**, for example, via external connectors, and the like. External power source **116** may include a separate conducting path to, for example, a wall outlet, a battery, a backup generator, a fuel cell, and the like. External power source **116** may be self-contained, for example a power source that is on-board service fan tray **110**, such as a battery, and the like. In this embodiment, external power source **116** allows service fan tray **110** to operate independently of the internal power source **114** supplying power to embedded computer chassis **300**. In another embodiment, service fan tray **110** may be coupled to backplane and operate from internal power source **114**.

[0039] Although at least one primary fan tray **108** is shown with three fans **113** and service fan tray is shown with two service fans **112**, this is not limiting of the invention. At least one primary fan tray **108** and service fan tray **110** may each have any number of fans respectively. Further, service fan tray **110** need not have fewer or more fans than primary fan tray **108**. Each of primary fan tray **108** and service fan tray **110** may include any number of fans as determined by one skilled in the art to provide cooling as required for a particular application.

[0040] FIG. **4** representatively illustrates a flow diagram **400** of a method in accordance with an exemplary embodiment of the present invention. In step **402**, at least one primary fan tray is providing

cooling air to the embedded computer chassis, where the at least one primary fan tray is non-redundant in providing the cooling air. In step **404**, a cooling air plenum is provided that is adapted to receive a service fan tray. The service fan tray is adapted to temporarily provide cooling air to the embedded computer chassis absent the at least one primary fan tray.

[0041] In step **406**, service fan tray is inserted into the cooling air plenum of embedded computer chassis. In step **408**, service fan tray operates to provide cooling air temporarily to embedded computer chassis. In step **410**, at least one primary fan tray discontinues operation and may be removed from embedded computer chassis. While at least one primary fan tray is not operating, service fan tray may provide cooling air to embedded computer chassis. In step **412**, at least one primary fan tray is connected or reconnected to embedded computer chassis via fan tray receptacle. In step **414**, service fan tray ceases operation and is disconnected from embedded computer chassis.

[0042] The above embodiments offer the advantage over the non-redundant embedded computer chassis of the prior art by allowing the insertion of a service fan tray in the cooling air plenum while the primary fan tray is taken off-line for service. This allows the embedded computer chassis to maintain operation even when it's at least one primary fan tray is out of service.

[0043] This paragraph describes the advantages of the proposed invention over the non-redundant prior art. The above embodiments also offer advantages over the redundant cooling of the prior art. For example, the service fan tray is simpler than redundant fan tray and therefore less expensive. Further, redundant fan trays of the prior art burden initial price of system with additional cost "for each system sold" whereas cost of service fan tray can be shared among many deployed systems. Due to the fact that the service fan tray is simpler and only needs to cool the system for a relatively short amount of time (for example 5-10 minutes), systems constructed using a service fan tray may be more compact than systems constructed using a redundant fan tray and this may significantly increase the number of systems we can fit into a rack and therefore the number of boards that can fit into a rack. The redundant fan tray solution has more fans running full time and therefore more fans that require periodic maintenance. The redundant fan tray solution has more fans running full time and therefore higher probability of encountering fan failure and therefore higher maintenance costs.

[0044] In the foregoing specification, the invention has been described with reference to specific exemplary embodiments. However, it will be appreciated that various modifications and changes may be made without departing from the scope of the present invention as set forth in the claims below. The specification and figures are to be

regarded in an illustrative manner, rather than a restrictive one and all such modifications are intended to be included within the scope of the present invention. Accordingly, the scope of the invention should be determined by the claims appended hereto and their legal equivalents rather than by merely the examples described above.

[0045] For example, the steps recited in any method or process claims may be executed in any order and are not limited to the specific order presented in the claims. Additionally, the components and/or elements recited in any apparatus claims may be assembled or otherwise operationally configured in a variety of permutations to produce substantially the same result as the present invention and are accordingly not limited to the specific configuration recited in the claims.

[0046] Benefits, other advantages and solutions to problems have been described above with regard to particular embodiments; however, any benefit, advantage, solution to problem or any element that may cause any particular benefit, advantage or solution to occur or to become more pronounced are not to be construed as critical, required or essential features or components of any or all the claims.

[0047] Other combinations and/or modifications of the above-described structures, arrangements, applications, proportions, elements, materials or components used in the practice of the present

invention, in addition to those not specifically recited, may be varied or otherwise particularly adapted to specific environments, manufacturing specifications, design parameters or other operating requirements without departing from the general principles of the same.

CLAIMS

We claim:

1. An embedded computer chassis, comprising:

a fan tray receptacle adapted to receive at least one primary fan tray, wherein the at least one primary fan tray is adapted to be non-redundant in providing cooling air to the embedded computer chassis; and

a cooling air plenum, wherein the cooling air plenum is adapted to receive a service fan tray, wherein the service fan tray is adapted to temporarily provide the cooling air to the embedded computer chassis absent the at least one primary fan tray.

2. The embedded computer chassis of claim **1**, further comprising:

an internal power source powering the at least one primary fan tray, and

an external power source powering the service fan tray, wherein the external power source is separate from the internal power source.

3. The embedded computer chassis of claim **1**, wherein an internal power source power source powers the at least one primary fan tray and the service fan tray.

4. The embedded computer chassis of claim **1**, wherein the service fan tray provides the cooling air for a limited time period.

5. A method of cooling an embedded computer chassis, comprising:

at least one primary fan tray providing cooling air to the embedded computer chassis, wherein the at least one primary fan tray is non-redundant in providing cooling air to the embedded computer chassis;

providing a cooling air plenum, wherein the cooling air plenum is adapted to receive a service fan tray, wherein the service fan tray is adapted to temporarily provide the cooling air to the embedded computer chassis absent the at least one primary fan tray;

inserting the service fan tray into the cooling air plenum;

the service fan tray operating to provide the cooling air temporarily to the embedded computer chassis; and

disconnecting the at least one primary fan tray from the embedded computer chassis.

6. The method of claim **5**, further comprising:

controlling the at least one primary fan tray via a control bus, and

operating the service fan tray independently of the control bus.

7. The method of claim **5**, further comprising operating the service fan tray without control logic.

8. The method of claim **5**, further comprising:

reconnecting the at least one primary fan tray to the embedded computer chassis; and

disconnecting the service fan tray from the embedded computer chassis.

9. A service fan tray, comprising:

at least one service fan, wherein the service fan tray is adapted to interface with a cooling air plenum on an embedded computer chassis, wherein the at least one service fan is adapted to temporarily provide cooling air to the embedded computer chassis absent at least one primary fan tray, and wherein the at least one primary fan tray is adapted to be non-redundant in providing cooling air to the embedded computer chassis.

10. The service fan tray of claim **9**, wherein the at least one service fan operates at a single speed.

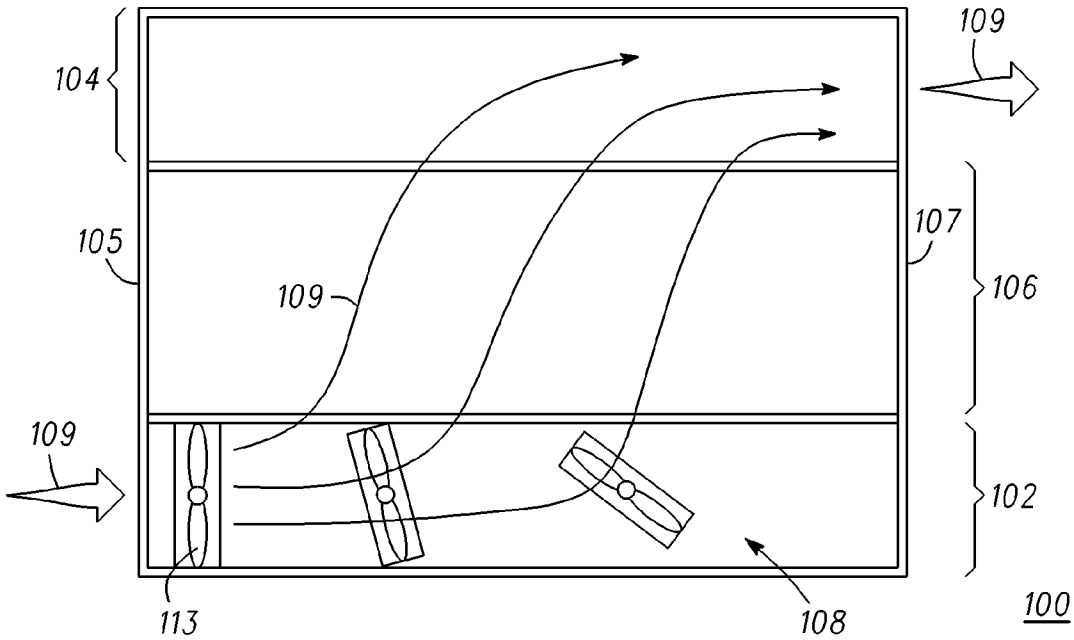
104
105
109
107
106
109
109
102
113
108
100

FIG. 1

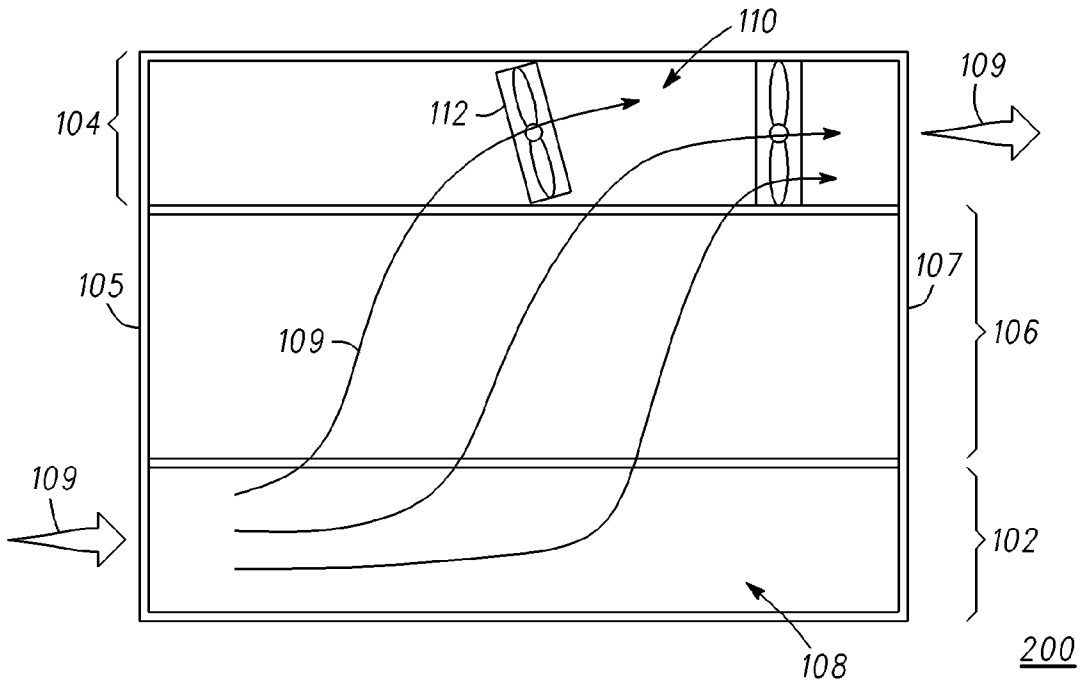
110
112
104
109
105
107
106
109
109
102
108
200

FIG. 2

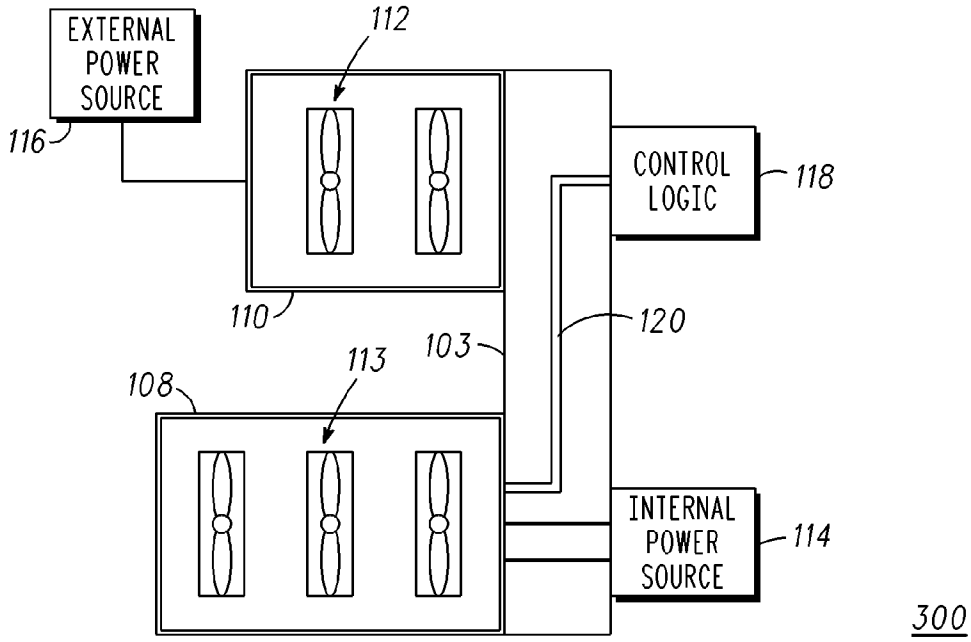
EXTERNAL POWER SOURCE
116
112
110
CONTROL LOGIC
118
120
103
113
108
INTERNAL POWER SOURCE
114
300

FIG. 3

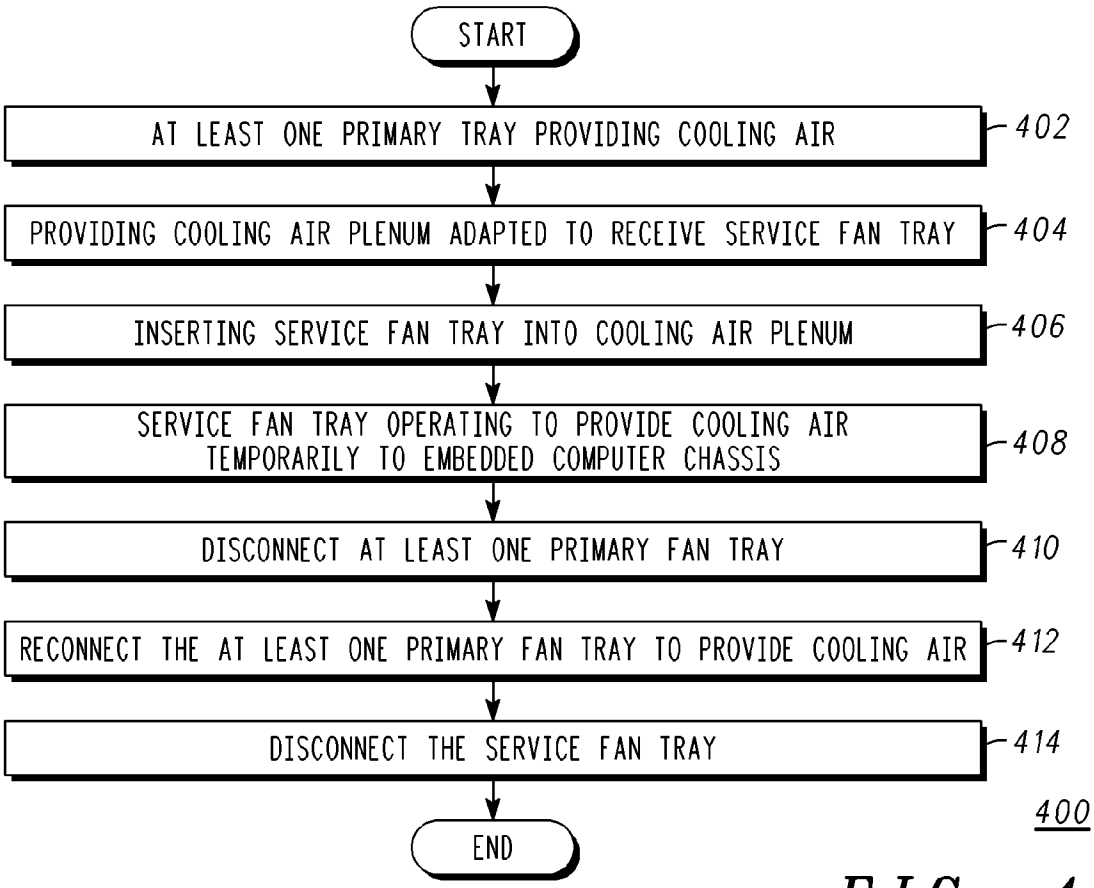
START
AT LEAST ONE PRIMARY TRAY PROVIDING COOLING AIR
402
PROVIDING COOLING AIR PLENUM ADAPTED TO RECEIVE SERVICE FAN TRAY
404
INSERTING SERVICE FAN TRAY INTO COOLING AIR PLENUM
406
SERVICE FAN TRAY OPERATING TO PROVIDE COOLING AIR TEMPORARILY TO EMBEDDED COMPUTER CHASSIS
408
DISCONNECT AT LEAST ONE PRIMARY FAN TRAY
410
RECONNECT THE AT LEAST ONE PRIMARY FAN TRAY TO PROVIDE COOLING AIR
412
DISCONNECT THE SERVICE FAN TRAY
414
END
400

FIG. 4