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Vega

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(54) **ALLOCATION OF PROCESSOR RESOURCES IN AN EMULATED COMPUTING ENVIRONMENT**

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(58) **Field of Classification Search** ..... 703/23; 718/100, 104, FOR. 263, FOR. 163; 709/226, 709/229
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,261,089 A * 11/1993 Coleman et al. 707/8
6,269,391 B1 * 7/2001 Gillespie 718/100
6,330,686 B1 * 12/2001 Denny et al. 714/4
6,542,926 B1 * 4/2003 Zalewski et al. 709/213
6,633,916 B1 * 10/2003 Kauffman 709/229
6,961,941 B1 * 11/2005 Nelson et al. 719/319

* cited by examiner

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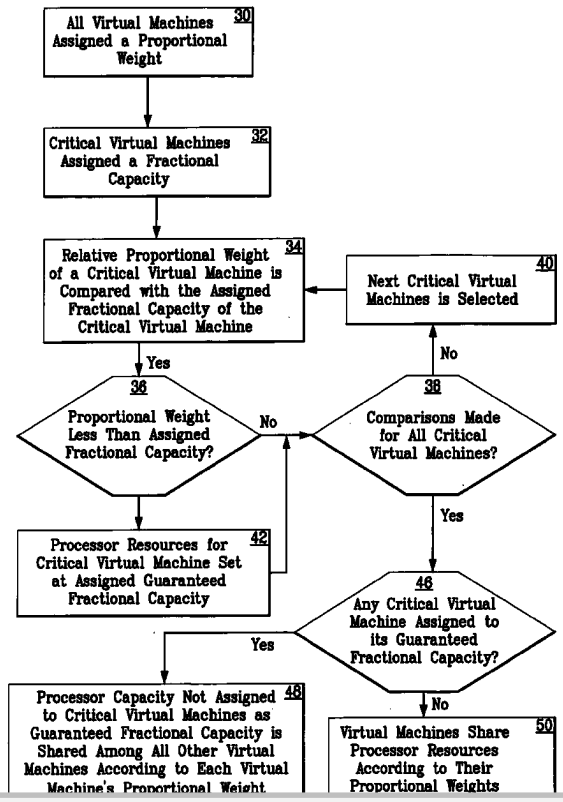
(57) **ABSTRACT**

In an emulated computing environment, a method is provided for allocating resources of the host computer system among multiple virtual machines resident on the host computer system. On the basis of the proportional weight of each virtual machine, a proportional share of resources is allocated for each virtual machine. If, for a particular virtual machine, the calculated share is less than a reserved minimum share, the virtual machine is allocated its reserved minimum share as its share of processor resources. An emulation program modulates the access of each virtual machine to the resources of the host computer system.

9 Claims, 3 Drawing Sheets



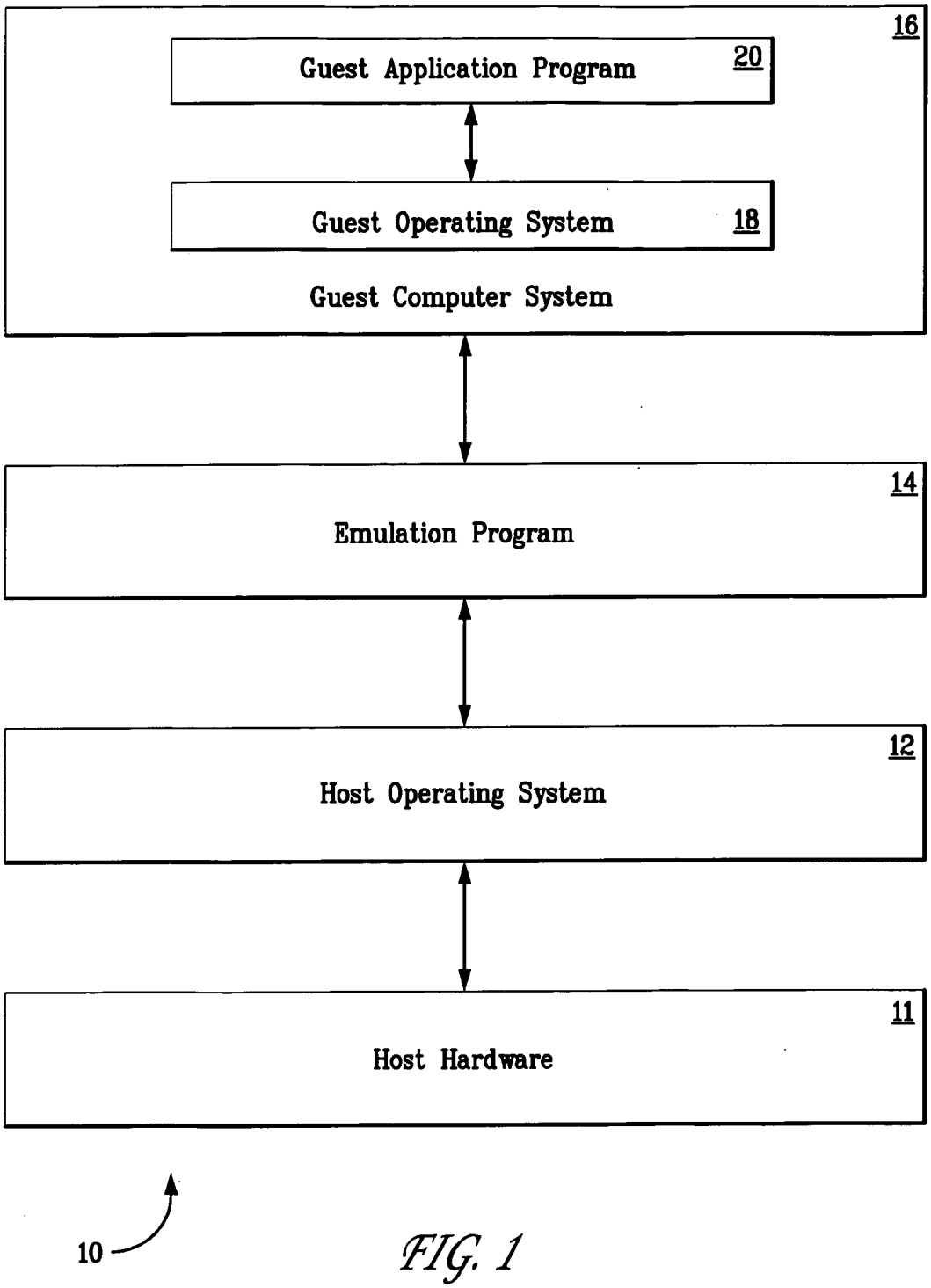


FIG. 1

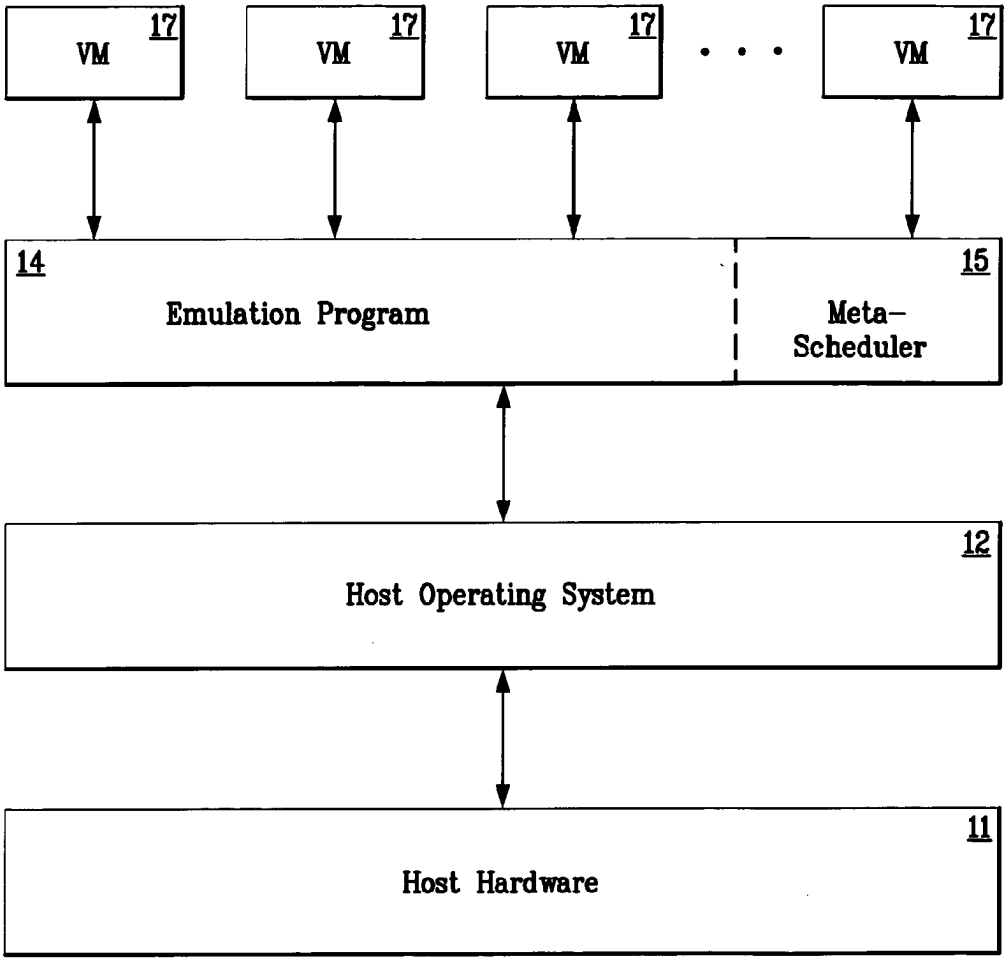


FIG. 2

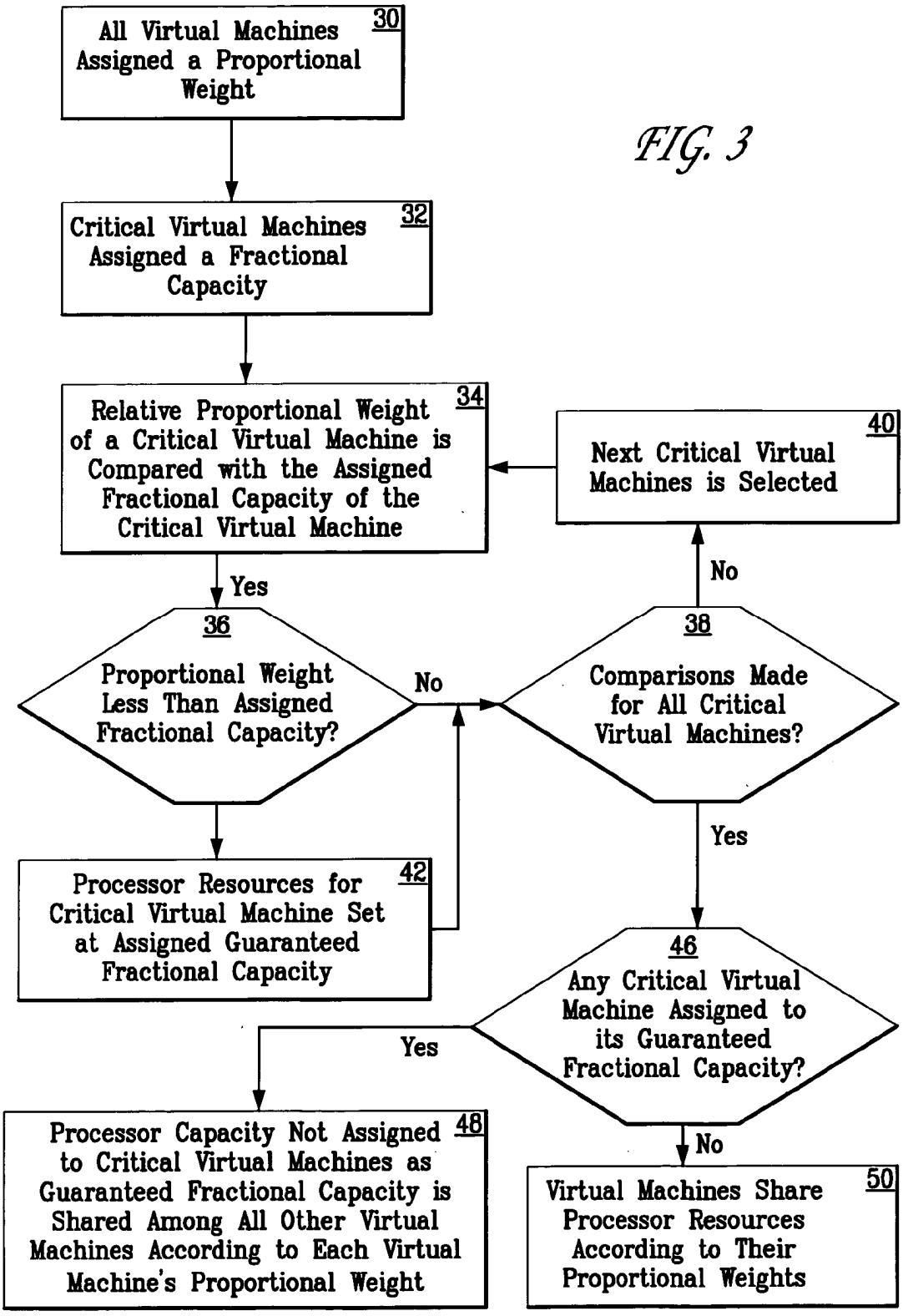


FIG. 3

ALLOCATION OF PROCESSOR RESOURCES IN AN EMULATED COMPUTING ENVIRONMENT

TECHNICAL FIELD OF THE INVENTION

The present invention relates in general to the field of computer system emulation and, more particularly, to a method for allocating processor resources in an emulated computing environment.

BACKGROUND OF THE INVENTION

Computers include general purpose central processing units (CPUs) that are designed to execute a specific set of system instructions. A group of processors that have similar architecture or design specifications may be considered to be members of the same processor family. Examples of current processor families include the Motorola 680X0 processor family, manufactured by Motorola, Inc. of Phoenix, Ariz.; the Intel 80X86 processor family, manufactured by Intel Corporation of Sunnyvale, Calif.; and the PowerPC processor family, which is manufactured by Motorola, Inc. and used in computers manufactured by Apple Computer, Inc. of Cupertino, Calif. Although a group of processors may be in the same family because of their similar architecture and design considerations, processors may vary widely within a family according to their clock speed and other performance parameters.

Each family of microprocessors executes instructions that are unique to the processor family. The collective set of instructions that a processor or family of processors can execute is known as the processor's instruction set. As an example, the instruction set used by the Intel 80X86 processor family is incompatible with the instruction set used by the PowerPC processor family. The Intel 80X86 instruction set is based on the Complex Instruction Set Computer (CISC) format. The Motorola PowerPC instruction set is based on the Reduced Instruction Set Computer (RISC) format. CISC processors use a large number of instructions, some of which can perform rather complicated functions, but which require generally many clock cycles to execute. RISC processors use a smaller number of available instructions to perform a simpler set of functions that are executed at a much higher rate.

The uniqueness of the processor family among computer systems also typically results in incompatibility among the other elements of hardware architecture of the computer systems. A computer system manufactured with a processor from the Intel 80X86 processor family will have a hardware architecture that is different from the hardware architecture of a computer system manufactured with a processor from the PowerPC processor family. Because of the uniqueness of the processor instruction set and a computer system's hardware architecture, application software programs are typically written to run on a particular computer system running a particular operating system.

A computer manufacturer will seek to maximize its market share by having more rather than fewer applications run on the microprocessor family associated with the computer manufacturer's product line. To expand the number of operating systems and application programs that can run on a computer system, a field of technology has developed in which a given computer having one type of CPU, called a host, will include an emulation program that allows the host computer to emulate the instructions of an unrelated type of

application that will cause one or more host instructions to be called in response to a given guest instruction. Thus, the host computer can both run software designed for its own hardware architecture and software written for computers having an unrelated hardware architecture. As a more specific example, a computer system manufactured by Apple Computer, for example, may run operating systems and programs written for PC-based computer systems. It may also be possible to use an emulation program to operate concurrently on a single CPU multiple incompatible operating systems. In this arrangement, although each operating system is incompatible with the other, an emulation program can host one of the two operating systems, allowing the otherwise incompatible operating systems to run concurrently on the same computer system.

When a guest computer system is emulated on a host computer system, the guest computer system is said to be a virtual machine, as the guest computer system exists only as a software representation of the operation of the hardware architecture of the emulated guest computer system. The terms emulator and virtual machine are sometimes used interchangeably to denote the ability to mimic or emulate the hardware architecture of an entire computer system. As an example, the Virtual PC software created by Connectix Corporation of San Mateo, Calif. emulates an entire computer that includes an Intel 80X86 Pentium processor and various motherboard components and cards. The operation of these components is emulated in the virtual machine that is being run on the host machine. An emulation program executing on the operating system software and hardware architecture of the host computer, such as a computer system having a PowerPC processor, mimics the operation of the entire guest computer system. The emulation program acts as the interchange between the hardware architecture of the host machine and the instructions transmitted by the software running within the emulated environment. The emulation program is sometimes referred to as a virtual machine monitor.

Multiple virtual machines can be established on a single host machine. In this scenario, a host machine of a certain processor family may host several virtual machines of the same processor family. In this computing environment, each virtual machine operates as its own stand-alone computer system, allowing a user to install separate operating systems or multiple instances of a single operating system on one or more of the virtual machines. Because each virtual machine is independent of all other virtual machines and the host machine, software running within one virtual machine has no effect on the operation of any other virtual machines or the underlying host machine. An emulated computing environment can therefore support a number of operating systems, including an array of related operating systems or multiple, concurrent instances of the same operating system, on a single host computer system.

In this emulated computing environment, a user may run multiple virtualized computer systems on a single physical computer system, eliminating the need for multiple hardware systems to support multiple computer systems. As an alternative to purchasing and configuring an additional physical computer system, an additional virtual machine may be established on an existing computer system. Running multiple, independent virtual machines on a single physical host machine provides, among other benefits, the ability to test software applications across multiple computing environments and support legacy software applications

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