

CLAIMS

1. A computer-implemented method comprising:
 - instantiating, by a processor, a plurality of virtual memory (VM) metadata containers, wherein a total number of VM metadata containers comprise enough VM metadata blocks to represent total real physical memory provisioned to a computer system as virtual memory;
 - grouping, by the processor, the plurality of VM metadata containers into two or more container groups, wherein each of the two or more container groups is controlled by a different lock;
 - scanning, by the processor, the two or more container groups for a first container group that is a least used container group, in response to a request to allocate memory object metadata to a VM metadata block;
 - querying, by the processor, the first container group for a first VM metadata container that is a least used VM metadata container within the first container group;
 - allocating, by the processor, the memory object metadata to the VM metadata block of the first VM metadata container, fulfilling the request to allocate the memory object metadata.
2. The computer-implemented method of claim 1, wherein the step of instantiating the plurality of VM metadata containers is performed during boot-up of the computer system and managed automatically by an operating system of the computer system.
3. The computer-implemented method of claim 1, further comprising:
 - receiving, by the processor, a request to grow a memory object and increasing a number of VM metadata blocks allocated to the memory object metadata associated with the memory object;
 - calculating, by the processor, VM metadata block requirements to meet the request to grow the allocation of the VM metadata blocks storing the memory object metadata;
 - comparing, by the processor, an amount of remaining space of the first VM metadata container with the VM metadata block requirements;
 - in response to the comparing step determining the amount of remaining space of the first VM metadata container is greater than the VM metadata block requirements, allocating, by the processor an additional VM metadata block to store the memory object metadata to the first VM metadata container, fulfilling the request to grow the memory object.
4. The computer-implemented method of claim 1, further comprising:
 - receiving, by the processor, a request to grow a memory object associated with the memory object metadata, and increasing a number of VM metadata blocks allocated to the memory object;
 - calculating, by the processor, VM metadata block requirements to meet the request to grow the memory object;

scanning the first VM metadata container to determine whether an amount of remaining space of the first VM metadata container is greater than space requirements to fulfill the request to grow the memory object;

in response to determining that the amount of remaining space of the first VM metadata container is not greater than the space requirements to fulfill the request to grow the memory object, scanning, by the processor, within the first container group for a second VM metadata container with enough remaining space to satisfy the request to grow the memory object.

5. The computer-implemented method of claim 4, further comprising:

in response to determining that the second VM metadata container with enough space to satisfy the request to grow the memory object cannot be found within the first container group, scanning, by the processor, for the second VM metadata container with enough remaining space to satisfy the request to grow the memory object within a second container group; and

allocating, by the processor, a VM metadata block of the second VM metadata container to store the memory object metadata.

6. A computer-implemented method comprising:

receiving, by a processor, a request to perform a memory management operation on a metadata block allocation comprising a plurality of container groups comprising one or more VM metadata containers, wherein access to individual container groups of the plurality of container groups are controlled by different locks;

acquiring, by the processor, a first lock controlling a first container group;

performing, by the processor, all memory management operations on memory object metadata stored by VM metadata blocks of the first container group that are part of the metadata block allocation;

releasing, by the processor, the first lock; and

acquiring, by the processor, a second lock controlling a second container group.

7. The computer implemented method of claim 6, wherein the step of performing all memory management operations on the memory object metadata within the first container group that are part of the metadata block allocation comprises:

freeing, by the processor, all of the VM metadata blocks stored by the first container group that are part of the metadata block allocation simultaneously.

8. A computer implemented method comprising:

instantiating, by a processor, a plurality of virtual memory (VM) metadata containers, wherein a total number of VM metadata containers comprise enough VM metadata blocks to represent total real physical memory provisioned to a computer system, as virtual memory;

grouping, by the processor, the plurality of VM metadata containers into two or more container groups wherein each of the two or more container groups is controlled by a different lock;

receiving, by the processor, a request to grow a memory object and increase a number of VM metadata blocks allocated to storing memory object metadata of the memory object

determining, by the processor, a first VM metadata container of a first container group responsible for previously allocating at least one VM metadata block for storage of the memory object metadata of the memory object;

calculating, by the processor, metadata block requirements for fulfilling the request to grow;

determining, by the processor, whether the metadata block requirements to fulfill the request to grow are greater than a size of free VM metadata blocks of the first VM metadata container.

9. The computer implemented method of claim 8, wherein the step of instantiating the plurality of VM metadata containers is performed during boot-up of the computer system and managed automatically by an operating system of the computer system.

10. The computer implemented method of claim 8, further comprising:

in response to determining that the metadata block requirements to fulfill the request to grow are not greater than the size of the free metadata blocks of the first VM metadata container, allocating, by the processor, the memory object metadata to a free metadata block of the first metadata container.

11. The computer implemented method of claim 8, further comprising:

in response to determining that the metadata block requirements to fulfill the request to grow are greater than the size of the free metadata blocks of the first VM metadata container;

scanning, by the processor, the first container group for a least used VM metadata container within the first container group; and

allocating, by the processor, the memory object metadata to a free metadata block of the least used VM metadata container within the first container group.

12. The computer implemented method of claim 8, further comprising:

in response to determining that the metadata block requirements to fulfill the request to grow are greater than the size of the free metadata blocks of the first metadata container;

scanning, by the processor, a second container group for a least used VM metadata container within the second container group; and

allocating, by the processor, the memory object metadata to a free metadata block of the least used VM metadata container within the second container group.

13. The computer implemented method of claim 8, further comprising:
in response to determining that the metadata block requirements to fulfill the request to grow are greater than the size of the free metadata blocks of the first VM metadata container;
scanning, by the processor, the two or more container groups for a least used container group;
further scanning, by the processor, the least used container group for a least used VM metadata container;
determining, by the processor, the metadata block requirements to fulfill the request to grow are greater than the size of the free metadata blocks of the least used VM metadata container;
posting, by the processor, a kernel process to create one or more new VM metadata containers comprising at least enough free VM metadata blocks to fulfill the grow request.
14. A computer system comprising:
a processor; and
a computer-readable storage media coupled to the processor, wherein the computer-readable storage media contains program instructions executing a computer-implemented method comprising:
instantiating, by the processor, a plurality of virtual memory (VM) metadata containers, wherein a total number of VM metadata containers comprise enough VM metadata blocks to represent total real physical memory provisioned to a computer system as virtual memory;
grouping, by the processor, the plurality of VM metadata containers into two or more container groups, wherein each of the two or more container groups is controlled by a different lock ;
scanning, by the processor, the two or more container groups for a least used container group, in response to a request to allocate memory object metadata to a VM metadata block; and
querying, by the processor, the least used container group for a least used VM metadata container within the least used container group.
15. The computer system of claim 14, further comprising:
allocating, by the processor, the memory object metadata to a VM metadata block of the least used VM metadata container, fulfilling the request to allocate the memory object metadata.
16. The computer system of claim 14, further comprising:
determining, by the processor, the least used VM metadata container lacks a requisite amount of VM metadata blocks to store the memory object metadata.
17. The computer system of claim 16, further comprising:
posting, by the processor, a kernel process to create one or more new VM metadata containers comprising enough available VM metadata blocks to fulfill the request to allocate the memory object metadata.

18. The computer system of claim 17, further comprising:
querying, by the processor, a state of the computer system;
comparing, by the processor, the state of the computer system with a system management plan of an operating system to maintain a minimum amount of computing resources available for use by the computer system;
in response to comparing the state of the computer system with the system management plan, determining that maintaining the minimum amount of computing resources available has not been met, instantiating, by the processor, the one or more new VM metadata containers.
19. The computer system of claim 17 further comprising:
querying, by the processor, a state of the computer system;
comparing, by the processor, the state of the computer system with a system management plan of an operating system to maintain a minimum amount of computing resources available for use by the computer system;
and
in response to comparing the state of the computer system with the system management plan, determining that maintaining the minimum amount of computing resources available has been met, cancelling, by the processor, the kernel process to create the one or more new VM metadata containers.
20. The computer system of claim 15, further comprising:
receiving, by the processor, a request to grow a memory object associated with the memory object metadata and increase a number of VM metadata blocks allocated to the memory object;
calculating, by the processor, VM metadata block requirements to meet the request to grow the memory object;
scanning, by the processor, the least used VM metadata container to determine whether an amount of remaining space of the least used VM metadata container is greater than space requirements to fulfill the request to grow the memory object;
in response to determining that the amount of remaining space of the least used VM metadata container is not greater than the space requirements to fulfill the request to grow the memory object, identifying, by the processor, a second VM metadata container with enough space to satisfy the request to grow the memory object, wherein the second VM metadata container cannot be found within the least used container group; and
allocating, by the processor, VM metadata blocks of a second VM metadata container residing within a second container group to store the memory object metadata.
21. A computer program product comprising:
one or more computer-readable storage media having computer-readable program instructions stored on the one or more computer-readable storage media said program instructions executes a computer-implemented method comprising:

instantiating a plurality of virtual memory (VM) metadata containers, wherein a total number of VM metadata containers comprise enough VM metadata blocks to represent total real physical memory provisioned to a computer system as virtual memory;

grouping the plurality of VM metadata containers into two or more container groups;

scanning the two or more container groups for a least used container group, in response to a request to allocate memory object metadata to a VM metadata block; and

querying the least used container group for a least used VM metadata container within the least used container group.

22. The computer program product of claim 21, further comprising:

allocating the memory object metadata to a VM metadata block of the least used VM metadata container, fulfilling the request to allocate the memory object metadata.

23. The computer program product of claim 21, further comprising:

determining the least used VM metadata container lacks a requisite amount of VM metadata blocks to store the memory object metadata.

24. The computer program product of claim 23, further comprising:

posting, a kernel process to create one or more new VM metadata containers comprising at least enough available VM metadata blocks to fulfill the request to allocate the memory object metadata.

25. The computer program product of claim 24, further comprising:

querying, by the processor, a state of the computer system;

comparing, by the processor, the state of the computer system with a system management plan of an operating system to maintain a minimum amount of computing resources available for use by the computer system;

in response to comparing the state of the computer system with the system management plan, determining that maintaining the minimum amount of computing resources available has not been met, instantiating the one or more new VM metadata containers.