

EFFICIENT LIVE-MIGRATION OF REMOTELY ACCESSED DATA

BACKGROUND

[001] Cloud computing refers to network-based computing in which collections of servers housed in data centers or “server farms” provide computational resources and data storage as needed to remote end users. Some cloud computing services provide access to software applications such as word processors and other commonly used applications to end users who interface with the applications through web browsers or other client-side software. Users’ electronic data files are usually stored in the server farm rather than on the users’ computing devices. Maintaining software applications and user data on a server farm simplifies management of end user computing devices. Some cloud computing services allow end users to execute software applications in virtual machines. In a public cloud computing environment, multiple users are able to launch virtual machines (VMs).

[002] Often times the data for a particular virtual machine is stored on one or more physical machines that are separate from the physical machine on which the virtual machine is instantiated. For a variety of reasons – load sharing, server maintenance, etc. – some or all of the data stored on a particular physical machine may be migrated to another physical machine. Live-migration of data is the process of moving data off of one physical machine to another physical machine while the virtual machine (or alternatively, a non-virtual processing entity) performs arbitrary reads and writes on the data.

SUMMARY

[003] This specification relates to live migration of data.

[004] This document describes a systematic method and system for moving data off of a storage computer to another storage computer while providing consistent and high performance access to the data to a third-party processing device (e.g., a virtual machine or an application) that is accessing the data remotely from another physical machine.

[004a] In a first aspect, the present disclosure provides a method performed by a data processing system, the method comprising: storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data

stored according to a plurality of data subsets; for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range by the data processing process; enabling read and write access to the data for the data processing process according to the logical addressing; and in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine, blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets.

[004b] In a second aspect, the present disclosure provides a system, comprising: a data processing device; and a non-transitory computer-readable memory in data communication with the data processing device and storing instructions executable by the data processing device and that upon such execution cause the data processing device to perform operations comprising: storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data stored according to a plurality of data subsets; for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range for the data processing process; enabling read and write access to the data by the data processing process according to the logical addressing; and in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine, blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets.

[004c] In a third aspect, the present disclosure provides A non-transitory computer-readable memory in data communication with the data processing device and storing instructions executable by the data processing device and that upon such execution cause the data processing device to perform operations comprising: storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data stored according to a plurality of data subsets; for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range for the data processing process; enabling read and write access to the data by the data processing process according to the logical

addressing; in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine, blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets; and in response to a migration of the first data subset from the first physical machine to the second physical machine to store the data subset on the second physical machine, updating the mapping by logically mapping an address range for the first data subset on the second physical machine to the respective logical address range for the data processing process..

[005] In general, one innovative embodiment of the subject matter described in this specification can be embodied in methods that include the actions of storing, in a first physical machine, data for a data processing process running on a second physical machine

CLAIMS

1. A method performed by a data processing system, the method comprising:
 - storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data stored according to a plurality of data subsets;
 - for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range for the data processing process;
 - enabling read and write access to the data by the data processing process according to the logical addressing; and
 - in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine, blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets.
2. The method of claim 1, wherein:
 - the determination that the first data subset stored on the first physical machine is to be migrated to the second physical machine is performed by the first physical machine; and
 - blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets comprises blocking, by the first physical machine, read and write access by the data processing process to the first data subset.
3. The method of claim 2, further comprising:
 - receiving, from the first physical machine by the data processing process, a notification of the migration of the first data subset to the second physical machine; and
 - wherein updating the mapping by logically mapping the address range for the first data subset on the second physical machine to the respective logical address range for the data processing process is done in response to the data processing process receiving the notification provided by the first physical machine.

4. The method of claim 3, wherein the notification instructs the data processing process to not access the first data subset.
5. The method of claim 3, further comprising:
 - receiving, from the second physical machine by the data processing process, a notification of the migration of the first data subset to the second physical machine; and
 - wherein updating the mapping by logically mapping the address range for the first data subset on the second physical machine to the respective logical address range for the data processing process is done in response to receiving the notification by the data processing process.
6. The method of claim 1, further comprising determining, by the data processing process, that the first data subset stored on the first physical machine is to be migrated to the second physical machine; and
 - migrating, from the first physical machine to the second physical machine, the first data subset to store the data subset on the second physical machine comprises:
 - instructing, by the data processing process, the first physical machine to send the first data subset to the data processing process; and
 - sending, by the data processing process, the first data subset received from the first physical machine to the second physical machine;
 - the updating the mapping is done by the data processing process.
7. The method of claim 1, further comprising restoring read and write access to the first data subset by the data processing process after the migration of the first data subset from the first physical machine to the second physical machine.
8. The method of claim 1, wherein the data subsets are data chunks logically mapped to a physical address range.
9. The method of claim 1, wherein the data subsets are data blocks.

10. A system, comprising:
a data processing device; and
a non-transitory computer-readable memory in data communication with the data processing device and storing instructions executable by the data processing device and that upon such execution cause the data processing device to perform operations comprising:
storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data stored according to a plurality of data subsets;
for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range for the data processing process;
enabling read and write access to the data by the data processing process according to the logical addressing; and
in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine,
blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets.
11. The system of claim 10, wherein:
the determination that the first data subset stored on the first physical machine is to be migrated to the second physical machine is performed by the first physical machine; and
blocking read and write access by the data processing process to the first data subset while maintaining read and write access by the data processing process to the other data subsets comprises blocking, by the first physical machine, read and write access by the data processing process to the first data subset.

12. The system of claim 10, further comprising, in response to a migration of the first data subset from the first physical machine to the second physical machine to store the data subset on the second physical machine, updating the mapping by logically mapping an address range for the first data subset on the second physical machine to the respective logical address range for the data processing process.

13. The system of claim 12, the operation further comprising:
receiving, from the first physical machine by the data processing process, a notification of the migration of the first data subset to the second physical machine; and
wherein updating the mapping by logically mapping the address range for the first data subset on the second physical machine to the respective logical address range for the data processing process is done in response to the data processing process receiving the notification provided by the first physical machine.

14. The system of claim 13, wherein the notification instructs the data processing process to not access the first data subset.

15. The system of claim 13, the operations further comprising:
receiving, from the second physical machine by the data processing process, a notification of the migration of the first data subset to the second physical machine; and
wherein updating the mapping by logically mapping the address range for the first data subset on the second physical machine to the respective logical address range for the data processing process is done in response to receiving the notification by the data processing process.

16. The system of claim 10, the operations further comprising determining, by the data processing process, that the first data subset stored on the first physical machine is to be migrated to the second physical machine ; and

migrating, from the first physical machine to the second physical machine, the first data subset to store the data subset on the second physical machine comprises:

instructing, by the data processing process, the first physical machine to send the first data subset to the data processing process; and

sending, by the data processing process, the first data subset received from the first physical machine to the second physical machine;

the updating the mapping is done by the data processing process.

17. The system of claim 10, wherein the data subsets are data chunks logically mapped to a physical address range.

18. The system of claim 10, wherein the data subsets are data blocks.

19. A non-transitory computer-readable memory in data communication with the data processing device and storing instructions executable by the data processing device and that upon such execution cause the data processing device to perform operations comprising:

storing, in a first physical machine, a mapping for a data processing process that processes data stored in the first physical machine, the data stored according to a plurality of data subsets;

for each data subset, logically mapping in the mapping an address range for the data subset on the first physical machine to a respective logical address range for the data processing process;

enabling read and write access to the data by the data processing process according to the logical addressing;

in response to a determination that a first data subset stored on the first physical machine is to be migrated to a second physical machine separate from the first physical machine, blocking read and write access by the data processing process to the first data

subset while maintaining read and write access by the data processing process to the other data subsets; and

in response to a migration of the first data subset from the first physical machine to the second physical machine to store the data subset on the second physical machine, updating the mapping by logically mapping an address range for the first data subset on the second physical machine to the respective logical address range for the data processing process.

20. The method of claim 1, further comprising, in response to a migration of the first data subset from the first physical machine to the second physical machine to store the data subset on the second physical machine, updating the mapping by logically mapping an address range for the first data subset on the second physical machine to the respective logical address range for the data processing process.