balancer server and distributed among these different records. For example, suppose there is a total amount of available storage space of 1000 GB, and each user can apply for 3 GB of free storage space. Correspondingly, the total value can be 1000, and each transaction (i.e., user application for 3 GB of storage space) results in an operation of subtraction by 3. The total value of 1000 can be divided into 10 sub-values, each being 100, and stored in 10 database records. Each subtract-by-3 operation is dispatched by a load-balancer to one of the 10 data records. For example, if an incoming subtract operation is forwarded to sub-value record number 2, the corresponding residual value of this data record becomes 97, while the values of the rest of the sub-value data records remain to be 100. Note that in this disclosure a value indicating the remaining value of a sub-value data record can be referred to as a residual value.

[0005] In the first method mentioned above (centralized management), the centralized execution of database commands and I/O operations can result in hot-spot problems. That is, a large number of operations during a short period of time can burden the database system and result in extended wait time and reduced processing efficiency. Furthermore, concentrated processing of a single database record that stores the residual value of the total value can cause a bottleneck in updating this data record and makes the system more prone to update errors.

[0006] In the second method mentioned above (distributed management), the incoming operations are distributed to multiple data records. However, because each data record is updated independently, the total residual value can be fragmented among these date records. Using the same example above, if the residual value of each sub-value data record is 1, although the total residual value (sum of residual values of all sub-value data records) is 10, none of the sub-value records can accept further subtraction operations. These residual values that can no longer accept subtraction operations are referred to residual-value fragments. Such fragmentation can be more prominent when the subtraction values vary. For example, if a user can apply for 3 GB, 5 GB, or 15 GB of storage space, because the amount of subtraction of each transaction is unpredictable, it cannot be guaranteed that each sub-value record can eventually be reduced to zero. As a result, a large number of residual-value fragments can be created. Correspondingly, the residual value in multiple sub-value records cannot be utilized and the total residual value cannot be minimized, which can cause waste to the system resource and database storage space.

SUMMARY

[0006a] The invention is defined in the independent claims. Further embodiments of the invention are defined in the dependent claims.

[0007] One embodiment of the present invention provides a system for facilitating residual-value management. During operation, the system stores in a computing system a total

value, which corresponds to a total amount of goods or service. The system divides the total value into a number sub-values, and determining that a sub-value is less than or equal to a

What is claimed is:

1. A computer-implemented method for facilitating efficient residual-value management, the method comprising:

determining, by a computing device, a total value in a data record corresponding to a total amount of goods or service;

dividing the total value into a number of sub-values in corresponding sub-value data records;

determining that a first sub-value of the number of sub-values in a first sub-value data record is less than or equal to a threshold, wherein the threshold indicates an insufficient value for the first sub-value;

selecting a merged residual-value in a second sub-value data record based on a selection condition;

merging the first sub-value with the merged residual-value in the second sub-value data record;

receiving a transaction that indicates a subtraction operation associated with the total amount of goods or service; and

processing the transaction based on the merged residual-value, thereby reducing residual-value fragmentation.

2. The method of claim 1, wherein the threshold is greater than or equal to a minimum value associated with the subtraction operation.

3. The method of claim 1, further comprising selecting the merged residual-value from the sub-values greater than or equal to the threshold for performing the subtraction operation.

4. The method of claim 1, further comprising indicating a sub-value as disabled when a residual value thereof is zero.

5. The method of claim 1, further comprising:

obtaining snapshots of the sub-value data records storing the sub-values and the merged residual-value;

selecting a qualified sub-value or the merged residual-value, wherein the snapshot associated with a qualified sub-value indicates a residual value greater than or equal to the threshold; and

responsive to a qualified sub-value being selected, applying a lock to the sub-value data record storing the selected sub-value and processing a second transaction based on the selected sub-value.

6. The method of claim 1, further comprising:

maintaining version information for the sub-value data records storing the sub-values and the merged residual-value; and

updating the version information for the snapshot for which a sub-value or the merged residual-value has been updated.

7. The method of claim 1, wherein the total value corresponds to an inventory of merchandise;

wherein the transaction is a purchase order for the merchandise; and

wherein the subtraction operation corresponding to the transaction represents a deduction to the inventory as a result of the purchase order.

8. The method of claim 1, wherein the total value corresponds to a total amount of available storage space;

wherein the transaction is a request for allocating a storage space to a user; and

wherein the subtraction operation corresponding to the transaction represents a deduction to the total amount of available storage space as a result of the allocation.

9. A system for facilitating efficient residual-value management, the system comprising:

a processor; and

a storage device coupled to the processor and storing instructions which when executed by the processor cause the processor to perform a method, the method comprising:

determining, by a computing device, a total value in a data record corresponding to a total amount of goods or service;

dividing the total value into a number of sub-values in corresponding sub-value data records;

determining that a first sub-value of the number of sub-values in a first sub-value data record is less than or equal to a threshold, wherein the threshold indicates an insufficient value for the first sub-value;

selecting a merged residual-value in a second sub-value data record based on a selection condition;

merging the first sub-value with the merged residual-value in the second sub-value data record;

receiving a transaction that indicates a subtraction operation associated with the total amount of goods or service; and

processing the transaction based on the merged residual-value, thereby reducing residual-value fragmentation.

10. The system of claim 9, wherein the threshold is greater than or equal to a minimum value associated with the subtraction operation.

11. The system of claim 9, wherein the method further comprises selecting the merged residual-value from the sub-values greater than or equal to the threshold for performing the subtraction operation.

12. The system of claim 9, wherein the method further comprises indicating a sub-value as disabled when a residual value thereof is zero.

13. The system of claim 9, wherein the method further comprises:

obtaining snapshots of the sub-value data records storing the sub-values and the merged residual-value;

selecting a qualified sub-value or the merged residual-value, wherein the snapshot associated with a qualified sub-value indicates a residual value greater than or equal to the threshold; and

responsive to a qualified sub-value being selected, applying a lock to the sub-value data record storing the selected sub-value and processing a second transaction based on the selected sub-value.

14. The system of claim 9, wherein the method further comprises;

maintaining version information for the sub-value data records storing the sub-values and the merged residual-value; and

updating the version information for the snapshot for which a sub-value or the merged residual-value has been updated.

15. The system of claim 9, wherein the total value corresponds to an inventory of merchandise;

wherein the transaction is a purchase order for the merchandise; and

wherein the subtraction operation corresponding to the transaction represents a deduction to the inventory as a result of the purchase order.

16. The system of claim 9, wherein the total value corresponds to a total amount of available storage space;

wherein the transaction is a request for allocating a storage space to a user; and

wherein the subtraction operation corresponding to the transaction represents a deduction to the total amount of available storage space as a result of the allocation.

17. A non-transitory storage medium storing instructions which when executed by a processor cause the processor to perform a method, the method comprising:

determining, by a computing device, a total value in a data record corresponding to a total amount of goods or service;

dividing the total value into a number of sub-values in corresponding sub-value data records;

determining that a first sub-value of the number of sub-values in a first sub-value data record is less than or equal to a threshold, wherein the threshold indicates an insufficient value for the first sub-value;

selecting a merged residual-value in a second sub-value data record based on a selection condition;

merging the first sub-value with the merged residual-value in the second sub-value data record;

receiving a transaction that indicates a subtraction operation associated with the total amount of goods or service; and

processing the transaction based on the merged residual-value, thereby reducing residual-value fragmentation.

18. The non-transitory storage medium of claim 17, wherein the threshold is greater than or equal to a minimum value associated with the subtraction operation.

19. The non-transitory storage medium of claim 17, wherein the method further comprises selecting the merged residual-value from the sub-values greater than or equal to the threshold for performing the subtraction operation.

20. The non-transitory storage medium of claim 17, wherein the method further comprises indicating a sub-value as disabled when a residual value thereof is zero.