BRIEF SUMMARY

[0006] In one aspect, a method for maintaining a piece of equipment is provided. The method includes providing a distributed block-chain database, the distributed block-chain database corresponding to a plurality of databases distributed between at least an equipment manufacturer, an equipment operator, and an equipment maintainer, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database; generating, in response to a request from an equipment manufacturer, a first block in a database of the distributed block-chain database associated with the equipment manufacturer that corresponds to a first bill-of-material and specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component identification information that specifies original constituent components of the equipment, subsequently copying the first block to other databases of the distributed block-chain database; updating, by the equipment operator, the component tracking data store associated with the equipment operator that is associated with the original component to update usage information associated with the original component; smart contract logic for determining whether the original component has reached an end of its useful service life based on the usage information of the component; determining that the end of its useful service life is reached, causing, by the smart contract logic, a replacement component to be sent to an equipment maintainer; replacing, by the equipment maintainer, the original component with the replacement component; and generating, in the database of the distributed block-chain database associated with the equipment maintainer, a second block corresponding to a second bill-of-material that specifies component identification information associated with the replacement component. The method further includes subsequently copying the second block to other databases of the distributed block-chain database; receiving a request for a current listing of components in the equipment and locating records blocks in the distributed block-chain database of the component tracking system associated with the

equipment. The method further includes determining from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block; determining whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks; generating a third bill-of-material as modified by any replacement component specified in the second block, updating the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks; generating a third block in the distributed block-chain database corresponding to the updated third bill-of-material; subsequently copying the third block to other databases of the distributed block-chain database; and communicating the updated third bill-of-material that includes the current listing of components and replacement components to a requesting entity.

[0007] In a second aspect, a system for tracking components of equipment includes an equipment manufacturer sub-system associated with an equipment manufacturer; an equipment maintainer sub-system associated with an equipment maintainer, the equipment maintainer sub-system in communication with the equipment manufacturer sub-system; and an equipment operator sub-system associated with an equipment operator, the equipment operator sub-system in communication with the equipment maintainer sub-system and the equipment manufacturer sub-system; wherein each sub-system includes a database that is part of a distributed block-chain database, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database; wherein the equipment manufacturer sub-system is configured to:. generate a first block in the database of the distributed block-chain database associated with the equipment manufacturer corresponding to a first bill-of-material and that specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component identification information that specifies original constituent components of the equipment, and subsequently copy the first block to other databases of the distributed block-chain database; wherein the

equipment operator sub-system is configured to: update the component tracking data store associated with the equipment operator that is associated with the original component to update usage information associated with the original component; wherein the equipment manufacturer sub-system is further configured to: execute smart contract logic for determining whether the original component has reached an end of its useful service life; and if the end of its useful service life is reached, the smart contract logic causes a replacement component to be sent to the equipment maintainer, wherein the equipment maintainer subsequently replaces the original component with the replacement component; wherein the equipment maintainer sub-system is configured to: generate, in the database of the distributed block-chain database associated with the equipment maintainer, a second block corresponding to a second bill-of-material that specifies replacement component identification information associated with the replacement component. And subsequently copy the second block to other databases of the distributed block-chain database; wherein the equipment manufacturer sub-system is further configured to: receive a request for a current listing of components in the equipment and locate blocks in the distributed block-chain database of the component tracking system associated with the equipment; determine from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block; determine whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks; generate a third bill-of-material as modified by any replacement component specified in the second block, update the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks; generate a third block in the distributed block-chain database corresponding to the updated third bill-of-material; subsequently copy the third block to other databases of the distributed block-chain database; and communicate a bill-of-material that includes the current listing of components to a requesting entity.

[0008] In a third aspect, a non-transitory computer readable medium is provided that has instruction code stored therein for maintaining a piece of equipment. The instruction code having first, second, and third code section being executable by first, second, and third machines, wherein each machine includes a database that is part of a distributed block-chain database, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database; wherein the first code section is executable by the first machine for causing the first machine to perform acts comprising: generating a first block in a database of the distributed block-chain database associated with an equipment manufacturer corresponding to a first bill-of-material and that specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component identification information that specifies original constituent components of the equipment and subsequently copying the first block to other databases of the distributed block-chain database; wherein the second code section is executable by the second machine for causing the second machine to perform acts comprising: updating the database of the component tracking data store associated with the second machine that is associated with the original component to update usage information associated with the original component; and subsequently updating the other databases of the distributed block-chain database to reflect the updated usage information; wherein the first code section is further executable by the first machine for causing the first machine to perform acts comprising: executing smart contract logic for determining whether the original component has reached an end of its useful service life; and if the end of its useful service life is reached, the smart contract logic causes a replacement component to be sent to an equipment maintainer, wherein the equipment maintainer subsequently replaces the original component with the replacement component; wherein the third code section is executable by the third machine for causing the third machine to perform acts comprising: generating, in the database of the distributed block-chain database associated with the third machine, a second block corresponding to a second bill-of-material that specifies component identification information associated with the replacement component

and subsequently copying the second block to other databases of the distributed block-chain database; wherein the first code section is further executable by the first machine for causing the first machine to perform acts comprising: receiving a request for a current listing of components in the equipment and locating blocks in the distributed block-chain database of the component tracking system associated with the equipment; determining from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block; determining whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks; generating a third bill-of-material as modified by any replacement component specified in the second block, updating the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks; generating a third block in the distributed block-chain database corresponding to the updated third bill-of-material; subsequently copying the third block to other databases of the distributed block-chain database; and communicating a bill-of-material that includes the current listing of components to a requesting entity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1A illustrates an exemplary environment that facilitates real-time tracking of equipment components;

[0010] Fig. 1B illustrates an exemplary computer tracking system of the exemplary environment;

[0011] Fig. 2A illustrates exemplary component information that may be stored in a component data store of the computer tracking system;

[0012] Fig. 2B illustrates exemplary smart contracts that may be stored in a contract data store of the computer tracking system;

[0013] Fig. 2C illustrates exemplary block-chain blocks that may be stored in a block-chain data store of the computer tracking system;

[0014] Figs. 3A and 3B illustrate exemplary details of the blocks illustrated in Fig. 2;

CLAIMS

We claim:

1. A method for maintaining a piece of equipment, the method comprising:

providing a distributed block-chain database, the distributed block-chain database corresponding to a plurality of databases distributed between at least an equipment manufacturer, an equipment operator, and an equipment maintainer, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database;

generating, in response to a request from an equipment manufacturer, a first block in a database of the distributed block-chain database associated with the equipment manufacturer that corresponds to a first bill-of-material and specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component identification information that specifies original constituent components of the equipment;

subsequently copying the first block to other databases of the distributed block-chain database;

updating, by the equipment operator, the component tracking data store associated with the equipment operator that is associated with the original component to update usage information associated with the original component;

smart contract logic for determining whether the original component has reached an end of its useful service life based on the usage information of the component;

determining that the end of its useful service life is reached, causing, by the smart contract logic, a replacement component to be sent to an equipment maintainer;

replacing, by the equipment maintainer, the original component with the replacement component;

generating, in the database of the distributed block-chain database associated with the equipment maintainer, a second block corresponding to a second bill-of-material that specifies component identification information associated with the replacement component;

subsequently copying the second block to other databases of the distributed block-chain database;

receiving a request for a current listing of components in the equipment;

locating records blocks in the distributed block-chain database of the component tracking system associated with the equipment;

determining from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block;

determining whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks;

generating a third bill-of-material as modified by any replacement component specified in the second block;

updating the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks;

generating a third block in the distributed block-chain database corresponding to the updated third bill-of-material;

subsequently copying the third block to other databases of the distributed block-chain database; and

communicating the updated third bill-of-material that includes the current listing of components and replacement components to a requesting entity.

2. The method according to claim 1, wherein blocks of the distributed block-chain database store records associated with a plurality of equipment, wherein the equipment includes parts of an aircraft.

3. The method according to claim 1, further comprising encrypting the constituent component identification information and the replacement component identification information prior to storing the constituent component identification information and the replacement component identification information into the first and second blocks.

4. The method according to claim 1, wherein the original constituent component identification information defines a unique token identifier for each constituent component of the equipment and the replacement component identification information defines a unique token identifier for the replacement component.

5. The method according to claim 1, further comprising:

receiving the original constituent component identification information and/or the replacement component identification information, and

storing the information in the distributed block-chain database.

6. The method according to claim 1, wherein the components of the equipment comprise a nested series of a plurality of components of a complex equipment.

7. The method according to claim 1, wherein each component is associated with a unique serial number that uniquely identifies a component among all components within the component tracking data store, wherein the bill-of-material defines a serial-number hierarchy of components.

8. A system for tracking components of equipment, the system comprising:

an equipment manufacturer sub-system associated with an equipment manufacturer;

an equipment maintainer sub-system associated with an equipment maintainer, the equipment maintainer sub-system in communication with the equipment manufacturer sub-system; and

an equipment operator sub-system associated with an equipment operator, the equipment operator sub-system in communication with the equipment maintainer sub-system and the equipment manufacturer sub-system;

wherein each sub-system includes a database that is part of a distributed block-chain database, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database;

wherein the equipment manufacturer sub-system is configured to:

generate a first block in the database of the distributed block-chain database associated with the equipment manufacturer corresponding to a first bill-of-material and that specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component

identification information that specifies original constituent components of the equipment; and

subsequently copy the first block to other databases of the distributed block-chain database;

wherein the equipment operator sub-system is configured to:

update the component tracking data store associated with the equipment operator that is associated with the original component to update usage information associated with the original component;

wherein the equipment manufacturer sub-system is further configured to:

execute smart contract logic for determining whether the original component has reached an end of its useful service life; and if the end of its useful service life is reached, the smart contract logic causes a replacement component to be sent to the equipment maintainer, wherein the equipment maintainer subsequently replaces the original component with the replacement component;

wherein the equipment maintainer sub-system is configured to:

generate, in the database of the distributed block-chain database associated with the equipment maintainer, a second block corresponding to a second bill-of-material that specifies replacement component identification information associated with the replacement component; and

subsequently copy the second block to other databases of the distributed block-chain database;

wherein the equipment manufacturer sub-system is further configured to:

receive a request for a current listing of components in the equipment;

locate blocks in the distributed block-chain database of the component tracking system associated with the equipment;

determine from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block;

determine whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks;

generate a third bill-of-material as modified by any replacement component specified in the second block;

update the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks;

generate a third block in the distributed block-chain database corresponding to the updated third bill-of-material;

subsequently copy the third block to other databases of the distributed block-chain database; and

communicate a bill-of-material that includes the current listing of components to a requesting entity.

9. The system according to claim 8, wherein blocks of the distributed block-chain database store records associated with a plurality of equipment.

10. The system according to claim 8, wherein each block in the block-chain distributed database includes a timestamp, wherein the instruction code is further operable to cause the processor to:

calculate an elapsed amount of time between a current time and a timestamp of a block; and

when the elapsed amount of time exceeds a useful service life associated with a component stored in a record that is stored in the block, communicate a notification to an entity associated with the equipment that is associated with the component that the component requires replacement.

11. A non-transitory computer readable medium having instruction code stored therein for maintaining a piece of equipment, the instruction code having first, second, and third code section being respectively executable by first, second, and third machines,

wherein each machine includes a database that is part of a distributed block-chain database, wherein blocks of data in each database of the distributed block-chain database are replicated in other databases of the distributed block-chain database;

wherein the first code section is executable by the first machine for causing the first machine to perform acts comprising:

generating a first block in a database of the distributed block-chain database associated with an equipment manufacturer corresponding to a first bill-of-material and that specifies component identification information associated with an actual original component of the equipment, wherein a component tracking data store stores original constituent component identification information that specifies original constituent components of the equipment; and

subsequently copying the first block to other databases of the distributed block-chain database;

wherein the second code section is executable by the second machine for causing the second machine to perform acts comprising:

updating the database of the component tracking data store associated with the second machine that is associated with the original component to update usage information associated with the original component; and

subsequently updating the other databases of the distributed block-chain database to reflect the updated usage information;

wherein the first code section is further executable by the first machine for causing the first machine to perform acts comprising:

executing smart contract logic for determining whether the original component has reached an end of its useful service life; and

if the end of its useful service life is reached, the smart contract logic causes a replacement component to be sent to an equipment maintainer, wherein the equipment maintainer subsequently replaces the original component with the replacement component;

wherein the third code section is executable by the third machine for causing the third machine to perform acts comprising:

generating, in the database of the distributed block-chain database associated with the third machine, a second block corresponding to a second bill-of-material that specifies component identification information associated with the replacement component; and

subsequently copying the second block to other databases of the distributed block-chain database;

wherein the first code section is further executable by the first machine for causing the first machine to perform acts comprising:

receiving a request for a current listing of components in the equipment;

locating blocks in the distributed block-chain database of the component tracking system associated with the equipment;

determining from the located blocks sorted by timestamps a current listing of components to be the original constituent components of the first block;

determining whether any original constituent components have been replaced based on the timestamp of the second block in the located blocks;

generating a third bill-of-material as modified by any replacement component specified in the second block;

updating the third bill-of-material based on any additional replacement components specified in additional blocks of the located blocks according to the time stamps of the additional blocks;

generating a third block in the distributed block-chain database corresponding to the updated third bill-of-material;

subsequently copying the third block to other databases of the distributed block-chain database; and

communicating a bill-of-material that includes the current listing of components to a requesting entity.

12. The non-transitory computer readable medium according to claim 11, wherein the component tracking system is one of a plurality of computer tracking systems that are in network communication with one another, wherein each component tracking system hosts a component tracking data store and wherein the component tracking data stores define a distributed block-chain database.