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United States Patent	12387203
Kind Code	B2
Date of Patent	August 12, 2025
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Distributed electronic ledger with metadata

Abstract

A system has a storage medium encoded with program instructions, and a processor coupled to access the program instructions. The instructions configure the processor for: receiving a first request at a POS terminal to surrender a previously purchased first asset in exchange for at least a portion of a second asset that was used to purchase the first asset, receiving the private key from the first asset; accessing a set of rules stored in a distributed electronic ledger, the set of rules specifying conditions associated with the first request; transmitting an authorization to return the at least a portion of the second asset in exchange for surrender of the first asset, in the case where the conditions are satisfied; and invalidating the first request in the case where one or more of the conditions are not satisfied.

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Appl. No.: 18/133244

Filed: April 11, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20230245113 A1	Aug. 03, 2023

Related U.S. Application Data

continuation parent-doc US 15285869 20161005 US 11651359 child-doc US 18133244

Publication Classification

Int. Cl.: G06Q20/38 (20120101); G06Q20/06 (20120101); G06Q20/10 (20120101); G06Q20/20 (20120101)

U.S. Cl.:

CPC G06Q20/3829 (20130101); G06Q20/0658 (20130101); G06Q20/102 (20130101); G06Q20/20 (20130101); G06Q20/38215 (20130101); G06Q2220/00 (20130101)

Field of Classification Search

CPC: G06Q (20/3829); G06Q (20/0658); G06Q (20/102); G06Q (20/20)

USPC: 705/71

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION (1) This application is a continuation of and claims the benefit of priority to U.S. application Ser. No. 15/285,869, filed Oct. 5, 2016, the disclosure of which is incorporated by reference herein to its entirety.

FIELD

(1) This disclosure relates generally to improvements in computer related technology.

BACKGROUND

(2) Distributed electronic ledgers, such as block chains, have generated interest in a variety of fields as a decentralized data storage mechanism with reliable redundant validation.

(3) A block chain includes a distributed database comprising blocks of data records (e.g., transaction records). Each block has a timestamp and a hash of the immediately preceding block. Blocks record and confirm valid transactions. Users known as miners perform proof-of-work in the course of generating the blocks. Each transaction identifies a source address, a destination address, and an amount transferred from the source to the destination. Many account holders have been attracted to digital currencies based on block chains, such as “BITCOIN™”, because the public ledger contains no information about the parties, other than addresses, allowing anonymity.

SUMMARY

(4) In some embodiments, a system comprises a non-transitory machine readable storage medium encoded with program instructions, and a processor coupled to the storage medium to access the program instructions. The instructions configure the processor to perform a method comprising: receiving a first request at a point-of-service (POS) terminal to surrender a previously purchased first asset in exchange for at least a portion of a second asset, wherein the second asset was used to purchase the first asset, and the first request includes a public key of the first asset; transmitting a second request to the first asset for a private key associated with the public key; receiving the private key associated with the public key from the first asset; accessing a set of rules stored in a distributed electronic ledger, the set of rules specifying conditions associated with the first request; transmitting an authorization to return the at least a portion of the second asset in exchange for surrender of the first asset, in the case where the conditions are satisfied; and invalidating the first request in the case where one or more of the conditions are not satisfied.

(5) In some embodiments, a point-of-service (POS) terminal comprises a non-transitory machine readable storage medium encoded with program instructions, and a processor coupled to the storage medium to access the program instructions. The instructions configure the processor to perform a method comprising: generating and transmitting a request for validation of a first exchange of a first asset of a seller for a second asset of a buyer; receiving a validation of the first exchange; querying an electronic database containing parameters; obtaining from the electronic database a subset of the parameters associated with the first asset, the parameters defining a second exchange in which the first asset is surrendered in exchange for at least a portion of the second asset; automatically providing a program based on a subset of the parameters, the program containing instructions for executing the second exchange in the case where one or more conditions based on the subset of the parameters are satisfied; and transmitting the program and a first record of the first exchange to a plurality of peer processors for storage in a distributed electronic ledger,

wherein the first exchange is executed by transferring the first asset to the buyer and transferring the second asset to the seller at a time the program and the first record are transmitted.

(6) In some embodiments, a method comprises: transmitting a first request to surrender a previously purchased first asset in exchange for at least a portion of a second asset from a point-of-service (POS) terminal to a distributed database processor, wherein the second asset was used to purchase the first asset, and the request includes a public key of the first asset; transmitting to the first asset a request for a private key associated with the public key; receiving from the first asset the private key associated with the public key; accessing a set of rules stored in a distributed electronic ledger, the set of rules specifying conditions associated with the first request; transmitting an authorization to return the at least a portion of the second asset in exchange for surrender of the first asset, in the case where the conditions are satisfied; and invalidating the first request in the case where the conditions are not satisfied.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a block diagram of a system according to some embodiments.

(2) FIG. 2 is a block diagram of an embodiment of the client device shown in FIG. 1.

(3) FIG. 3 is a block diagram of an embodiment of the POS terminal of FIG. 1.

(4) FIG. 4 is a flow chart of an embodiment of a method of extracting metadata related to a POS purchase and providing the metadata to a database in the system of FIG. 1.

(5) FIG. 5 is a flow chart of an embodiment of a method of automating a return of the goods purchased in the method of FIG. 5, using the system of FIG. 1.

(6) FIG. 6 is a flow chart of details of an embodiment of the step of applying the conditions in the return process of FIG. 5.

(7) FIG. 7 shows an embodiment of metadata extracted during a POS purchase in the example of FIG. 5.

DETAILED DESCRIPTION

(8) This description of the exemplary embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description, relative terms such as “lower,” “upper,” “horizontal,” “vertical,” “above,” “below,” “up,” “down,” “top” and “bottom” as well as derivative thereof (e.g., “horizontally,” “downwardly,” “upwardly,” etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description and do not require that the apparatus be constructed or operated in a particular orientation. Terms concerning attachments, coupling and the like, such as “connected” and “interconnected,” refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise.

(9) The anonymity of digital currency transactions is considered an attractive feature to many users. At the same time that users appreciate the privacy of block chain tracked assets, instances may also arise in which it is advantageous to obtain additional information about the tracked assets and their histories. For example, in a series of two or more related transactions, various parties may have uses for additional data about their transactions. Various block chain programs allow storage of additional information. For example, a transferor (sender) of a block chain tracked asset can store extra information within the transaction block. However any information residing in the block is available to anyone with read access to the block chain. This can be undesirable in the case where the transaction involves highly sensitive information.

(10) Some embodiments of a method described below store additional information related to a

transaction in a separate database in a non-transitory storage medium that is not easily accessible by the public. Users of this information related to the transaction can access the database at different frequencies than the frequency at which they access the transaction records in the block chain itself. In some embodiments, the database is optimized for rapid access to the data on demand.

(11) In some embodiments, at the time of a point-of-service (also referred to as point-of-sale or POS) purchase, the buyer pays the seller using a block chain tracked asset (e.g., digital currency) as a medium of exchange. The buyer presents a device, such as a near-field-communications (NFC) equipped phone or a hardware wallet to the POS terminal. The POS terminal generates a transaction and sends this transaction to a plurality of block chain peer processors. The POS terminal also appends metadata to the transaction ID of the transaction and sends this metadata to a separate non-public database that tracks the transaction metadata.

(12) The transaction metadata can include, but is not limited to: shelf-keeping-unit (SKU) level data (related to a first asset that is purchased), merchant classification, location of transaction, Transaction ID, and the like. These data are communicated via a POS network connection to one or more financial servers which store the data. In this context, the term “merchant” can refer to a proprietorship, a partnership, or a corporate entity having one or more stores at corresponding locations.

(13) Subsequently, the data can be accessed to link transactions together, to verify the validity of transactions, for fraud detection, or for other purposes. For example, as described below, the data can be used for validation of merchandise returns or early termination of service contracts and/or access to access controlled digital content.

(14) FIG. 1 is a block diagram of a system **100** in accordance with some embodiments of the present disclosure. System **100** may be a computing environment including one or more block chain peer processing systems **124**, **128**, **132**, and client devices such as client **102**. In some embodiments, one or more clients **102** have respective secure elements **103**. A point of service (POS) terminal **122** is located in a merchant's facility. In some embodiments, the POS terminal **122** has a processor **123**, a secure element **120** and/or a secure element reader **426** (FIG. 3). A metadata server **150** has a non-transitory machine readable storage device storing a metadata database **152** containing information about the transactions recorded in the block chain **126**.

(15) A communications network **140** (e.g., the Internet, a wide area network (WAN), a local area network (LAN), or a personal area network (PAN)) connects various components of system **100**. Alternatively, the client device **102** can communicate with the POS terminal **122** directly via near field communications (NFC).

(16) Communications network **140** may include one or more communication networks or media of digital data communication. Examples of communication network **140** include a local area network (“LAN”), a wireless LAN, a RF network, a Near Field Communication (NFC) network, (e.g., a “WiFi” network), a wireless Metropolitan Area Network (MAN) connecting multiple wireless LANs, NFC communication link(s), and a wide area network (“WAN”), e.g., the Internet. In accordance with various embodiments of the present disclosure, communications network **140** may include the Internet and any publicly accessible network or networks interconnected via one or more communication protocols, including, but not limited to, hypertext transfer protocol (HTTP) and transmission control protocol/internet protocol (TCP/IP). Communications protocols in accordance with various embodiments also include protocols facilitating data transfer using radio frequency identification (RFID) communications and/or NFC. Moreover, communications network **120** may also include one or more mobile device networks, such as a GSM network or a PCS network, allowing client device **104** to send and receive data via applicable communications protocols, including those described herein.

(17) In some embodiments, a merchant processor **160** has a non-transitory machine readable storage device storing a merchant database **162** containing information about business entities

and/or chains of business entities. For example, in some embodiments, the merchant database **162** stores respective refund policies of a plurality of merchants. The database can store a plurality of return policies for respectively different products or classes of products sold by any given one of the plurality of merchants.

(18) In other embodiments, each merchant has its own respective merchant database **162**, and the merchant processor **160** is the respective enterprise server of the merchant. The database **162** stores a plurality of return policies for respectively different products or classes of products sold by that merchant.

(19) In some embodiments, a manufacturer processor **170** has a non-transitory machine readable storage device storing manufacturer database **172** containing information about manufacturers. For example, in some embodiments, the manufacturer database **172** stores respective warranty policies of a plurality of manufacturers and their products. In some embodiments, the warranty policies specify a length of a warranty period. In some embodiments, the manufacturer can provide specific warranty limitations, such as disclaiming coverage for certain types of damage (e.g., a cracked display screen or case in a laptop computer).

(20) In some embodiments, the metadata server **150**, merchant server **160** and manufacturer server **170** are operated by a central authority or financial institution.

(21) In some embodiments, a buyer enters an exchange in which the merchant provides a first asset **180** to the buyer in return for the buyer providing a second asset (e.g., digital currency or other medium of exchange) to the seller. In some embodiments, the first asset **180** comprises one or more goods. In some embodiments, the first asset **180** is a network connected device having a bi-directional communication module **181**, embedded electronics and/or a processor **182** and software, and/or sensors **183** that enable the device to collect and exchange data (also referred to as an Internet-of-things (IoT) device). In other embodiments, the first asset includes services, financial assets, intangible assets and/or digital media access rights.

(22) Although FIG. **1** shows three client block chain peer processors **124**, **128**, **132**, any number of block chain peer processors can be included. Although one client device **102**, is shown in this example, any number of client devices can be included. Although one POS terminal **122** is shown in this example, any number of POS terminals can be included.

(23) FIG. **2** is a block diagram of an example of a client device **102** as shown in FIG. **1** according to some embodiments. The client device **102** can be a mobile device (e.g., laptop, tablet, phone, smart watch, or the like). The client device **102** has a memory **302** storing program instructions and data, a processor **304**, a bus **308**, and a communications module **306**. The communications module **306** provides one or more communications channels, such as PSTN, Ethernet, WiFi (IEEE 802.11), Bluetooth, or the like. In some embodiments, the memory **302** stores one or more wallets **318**, **328** of the user. Each wallet **318** has an address **320** and an encryption key **321**.

(24) In some embodiments, the client device **102** can include a secure element (SE) **103** such as a Universal Integrated Circuit Card (UICC), embedded SE or microSD, and the digital wallets and keys are stored in the SE **103**. The secure element **103** has its own processor **310**, memory **312**, key(s) **316**, and program (or function(s)) **332** performed by the processor **310**. In some embodiments, the secure element **103** is configured to communicate with the secure element reader **426** of POS terminal **122**. In embodiments having an SE **103**, the secure elements **103** in each respective client **102** store one or more digital wallets **318**, **328** (including an address **320**, **330** and one or more keys **321**, **331**) of the respective user **108**.

(25) FIG. **3** is a block diagram of a POS terminal **122** according to some embodiments. The POS terminal **122** has a POS processor **123** for executing instructions, and a POS memory **121**, which stores data **121A** and program instructions **121B**. POS terminal **122** can include a cash drawer, computer, and input/output devices, such as a display **420**, keypad **422**, a 1-dimensional or 2-dimensional scanner **424**, a printer **425**, and a secure element reader **426**. The POS terminal **122** can also include other devices (not shown), such as a keyboard, receipt printer, and a debit/credit

card reader, configured for processing retail transactions. The secure element reader **426** may be used by, or on behalf of, a buyer or retail customer to present a means of payment. In various embodiments, the means of payment can be a credit card, debit card, prepaid card, a chip card, or wallet hardware device. In some embodiments, the POS terminal **122** is equipped with an internal secure element **120**. The secure element **120** stores the merchant's private key **412**, and provides the merchant's signature when appropriate. The merchant's secure element **120** also stores one or more tracked assets such as one or more digital wallets (e.g. a wallet owned by a merchant) for receiving payments from buyers, denominated in digital currency.

(26) In some embodiments, the POS terminal **122** has a non-transitory machine readable storage medium **121** storing a set of computer program instructions; and a processor **123** coupled to the storage medium **121**, such that when the processor **123** executes the computer program instructions, the processor **123** provides an interface for prompting a user to present his/her payment instrument (e.g., credit, debit or prepaid card, hardware wallet, mobile phone, or the like). In some embodiments, the buyer's secure element **103** interacts with the secure element reader **426** of the POS terminal **122** to request a payment transaction transferring an amount of a digital currency from the buyer's account to the merchant's account.

(27) In some embodiments, the POS terminal **122** executes instructions to append merchant metadata to the transaction message and transmitting the message with the metadata to the metadata server **150** for incorporation into the metadata database. These can include data which are automatically obtained by the merchant at the time of sale, such as SKU level data, merchant classification, location of transaction, Transaction ID, or the like.

(28) In some embodiments, the POS terminal **122** requests that the merchant processor **160** access the merchant database **162** and provide the terms of the merchant's return policy for this particular transaction. In some embodiments, the return policy is a general store policy across goods and customers. In some embodiments, the merchant has a plurality of return policies, each associated with one or more classes of goods. In some embodiments, the merchant has a plurality of return policies, each associated with different classes of customers (e.g., the merchant can sell premium memberships entitling buyers to a longer return period). The return policy information can be appended to the transaction with the other metadata.

(29) In some embodiments, the POS terminal **122** requests that the manufacturer processor **170** access the merchant database **172** and provide the terms of the manufacturer's warranty policy for this particular transaction. In some embodiments, the warranty policy is a general manufacturer policy across goods and customers. In some embodiments, the manufacturer has a plurality of warranty policies, each associated with one or more classes of goods. In some embodiments, the manufacturer or the merchant offers a plurality of warranty policies, which the customer can purchase. The warranty policy information can be appended to the transaction with the other metadata.

(30) In some embodiments, the metadata can also include information about the buyer, which may be available from a previous relationship or transaction between buyer and merchant, or may be input at the time of this transaction. For example, the metadata can include the buyer's contact information and/or identification of other payment instruments and accounts which the same buyer has used previously.

(31) In some embodiments, the POS terminal **122** subsequently uses the metadata database for automating the processing of a merchandise or digital rights return.

(32) FIG. 7 is a diagram of a record associated with one transaction in the metadata database. In some embodiments, the record indicates whether the first asset **180** is returnable, the number of days within which the first asset **180** can be returned for full refund, the number of additional days (after the end of the full refund period) in which the first asset **180** can be returned for a partial refund, whether the first asset **180** must be free from damage or failure to qualify for return, whether the first asset **180** has a consumable material, whether the first asset **180** can be returned

after some or all of the consumable material has been consumed, a percentage reduction in the refund if the materials have been consumed, and the maximum number of hours that the first asset **180** can be used and still qualify for return.

(33) In some embodiments, the POS terminal **122** obtains warranty information from the Manufacturer's database **172**, and the metadata record includes whether warranty coverage is available for any detected hardware failure, and the length of the warranty period.

(34) Referring back to FIG. **1**, peer systems **124**, **128**, **132** may include one or more special purpose hardware and/or computing systems configured to execute software instructions to perform one or more operations in accordance with various embodiments. In some embodiments, peer systems **124**, **128**, **132** may include computing components configured to store, maintain, and generate data and software instructions. For example, each of peer systems **124**, **128**, **132** may include one or more computing devices (e.g., a server, network computer, or mainframe computer) having one or more processors that may be selectively activated or reconfigured by executable instructions (e.g., computer programs) stored in one or more tangible, non-transitory computer-readable storage devices.

(35) In some embodiments, one or more of peer systems **124**, **128**, **132** are configured to receive, from client device **102** across network **140**, information associated with a distribution of, transaction involving, or other action associated with one or more assets tracked within block-chain ledgers **126**, **130**, **134** in accordance with various embodiments.

(36) In some embodiments, one or more of peer systems **124**, **128**, **132** are configured (e.g., by the executed software programs) to validate the received information and to generate a new block of the block-chain ledger **126**, **130**, **134**. The new block includes the received information, either alone (e.g., using a "one transaction, one block" paradigm) or in combination with information identifying additional distributions, transactions, or other actions associated with one or more tracked assets (e.g., as a multiple-transaction block). In some embodiments, the one or more peer systems **124**, **128**, **132** may maintain the updated versions of the public ledger (i.e., the latest, longest public ledger), and may provide the updated version of the ledger to client devices **102**, **104**, and/or **106** (or other client devices associated with other users) upon receipt of a request across network **120** and/or at regular or predetermined intervals.

(37) In some embodiments, in addition to a connection with network **120**, peer systems **124**, **128**, **132** may be interconnected across a peer-to-peer network (not depicted in FIG. **1**) using any of the wired or wireless communications protocols outlined above. Further, in some instances, one or more of peer systems **124**, **128**, **132** may function as a "miner," where any miner may be compensated in units of a virtual currency (e.g., "Bitcoin™", Ethereum™") for validating the received data and for generating updated versions of the block-chain ledger.

(38) FIG. **4** is a flow chart of a method of checking out and storing metadata, as performed by the POS terminal **122** according to some embodiments.

(39) At step **450**, the POS terminal **122** initiates a check out of a first asset **180**, such as goods or digital rights to be purchased by a buyer.

(40) At step **452**, the buyer presents a payment device to initiate a transaction to transfer a second asset, such as an amount of digital currency, to the merchant as payment for the first asset **180**. In some embodiments, the buyer enters information via a keyboard interface. In other embodiments, the buyer places the payment device in or proximate the secure element reader **426** of the POS terminal **122**.

(41) At step **454**, the POS terminal **122** generates and transmits a request for validation of a first exchange of a first asset **180** of a seller for a second asset of a buyer. The POS processor **123** can transmit this request to the merchant's central enterprise server (not shown). The enterprise server can apply the merchant's internal criteria for accepting the proffered digital currency, which can include one or more of: verifying that the amount of the transaction is within the credit limit for this buyer, verifying that the buyer's account payment history with the merchant is in good

standing, verifying that the same buyer has not previously double-spent at any of this merchant's stores from the same digital currency account, verifying that the amount of this purchase is within a maximum amount accepted using this digital currency, or the like. In other embodiments, the merchant's central enterprise server The POS terminal receives a validation of the first exchange from the merchant's enterprise server. This internal verification by the merchant is separate from block chain confirmation of the transaction by the peer processors **124, 128, 132** after the transaction is submitted to the block chain.

(42) At step **456**, the POS terminal **122** querying the electronic merchant database **162** and obtains from the merchant database **162** a subset of the parameters associated with the first asset **180**. The parameters define a second exchange (i.e., a return) in which the first asset **180** is surrendered in exchange for at least a portion of the second asset (e.g., digital currency) that was used to make the purchase of the first asset **180**. In some embodiments, the conditions define a return policy for relinquishing the first asset **180** in exchange for at least a partial refund of a purchase price of the first asset **180**.

(43) At step **458**, the POS terminal automatically provides a program based on a subset of the parameters, where the program contains instructions for executing the second exchange in the case where one or more conditions based on the subset of the parameters are satisfied. For example, the program can be a smart contract for executing the return if one or more conditions based on the subset of the parameters of the merchant's return policy obtained from the merchant database **162** are satisfied, or for refusing to accept the returned product if one or more conditions are not satisfied. A smart contract includes conditional entries into the transactions on a blockchain that are automatically executed if the parameters of a transaction meet the conditions. These entries can be added to each block.

(44) At step **460**, the POS terminal **122** transmits the program (e.g., smart contract) and a first record of the first exchange (e.g., the transaction transferring the second asset from buyer to seller) to a plurality of peer processors **124, 128, 132** for storage in a distributed electronic ledger (e.g., a block chain ledger **126**).

(45) At step **462**, the first exchange (the sale) is executed by transferring the first asset **180** to the buyer and transmitting a transaction transferring the second asset (e.g., an amount of a digital currency) from the buyer's address to the seller's address at the time the program and the first record are transmitted and processed by the block chain peer processors **124, 128, 132**. Thus, the asset transferred by the buyer is not placed in escrow or locked up waiting for expiration of the return period. The second asset is available to the merchant upon confirmation of the transfer from the block chain.

(46) At step **464**, the POS terminal **122** transmits metadata associated with the first exchange to a server **150** that stores the metadata in a metadata database **152**, and the metadata includes at least a transaction identifier (ID) of the first exchange (the sale) and a block number of a block in the block chain ledger where the transaction is recorded.

(47) FIG. 5 is a flow chart of the method performed by the POS terminal **122** during a return of the first asset **180** by the buyer.

(48) At step **500**, the POS terminal **122** receives a first request to execute the second exchange (e.g., return of the first asset **180**) from the buyer. In the case of tangible goods, the buyer can present the goods to the merchant for return. In the case of digital media rights (e.g., access to audio, video, information, or literature content), the buyer can initiate the transaction using a user interface (such as a graphical user interface) of the merchant.

(49) At step **502**, the POS terminal **122** obtains the transaction ID and the block number from the metadata database **152**. The query can be based on one or more of the parameters included in the database **152**.

(50) At step **504**, the POS terminal **122** retrieves the block from the block chain using the transaction ID and the block number.

(51) At step **506**, the POS terminal **122** retrieves the program from the block by decrypting the block to access the set of rules stored in the distributed electronic ledger, where the set of rules specifies conditions associated with the first request.

(52) At step **508**, the POS terminal **122** executes the program (e.g., the smart contract). In some embodiments, the smart contract includes two transactions (exchanges). In the first transaction, the buyer transfers an amount of the second asset to the merchant. The second transaction (the return) is a conditional transaction with an expiration date, stored in the smart contract in the block chain. If the goods are not relinquished or returned before the end of the expiration period, the second transaction is null.

(53) At step **510**, the program executed in the POS terminal **122** determines whether all of the conditions for accepting the return/relinquishment are satisfied. If all conditions are met, step **512** is executed. If fewer than all of the conditions are satisfied, step **514** is executed.

(54) At step **512**, in the case where each of the one or more conditions are satisfied, the POS terminal **122** transmits a second record of the second exchange to the plurality of peer processors **124, 128, 132** for storage in the block chain. The second exchange transfers the first asset **180** to the seller and transfers at least a portion of the second asset to the buyer at a time the second record is transmitted.

(55) At step **514**, the return request is invalidated.

(56) FIG. **6** is a flow chart of an exemplary program executed by the POS terminal **122** during the return process.

(57) At step **600**, the POS terminal **122** receives a first request from the buyer to surrender a previously purchased first asset **180** in exchange for return of at least a portion of the second asset, where the second asset was used to purchase the first asset **180**, and the first request includes a public key of the first asset **180**. For example, the buyer can request that the merchant return part or all of the digital currency used in the original purchase to the same account, from which the buyer paid the merchant.

(58) At step **602**, the POS terminal transmits a second request to the first asset **180** for a private key associated with the public key. In the case where the first asset **180** is a networked device (e.g., an Internet-of-things or IoT device), such as a printer, television, automotive vehicle, BD-ROM player, smart watch, the second request is sent directly to the networked device. In some embodiments, the second request includes a command for the first asset **180** to transmit a message describing a state of the first asset **180**.

(59) At step **604**, the POS terminal receives the private key associated with the public key from the first asset **180**. In some embodiments, where the distributed electronic ledger is a block chain ledger, for validation, the buyer's request to return the first asset **180** further includes the private key of the user making the first request.

(60) The first asset **180** also transmits its state information. In some embodiments, if the device has been damaged, the device provides a hardware failure code. In some embodiments, the state of the first asset **180** identifies whether a circuit or processor in the first asset **180** detects a hardware failure in the first asset **180**, and at least one of the conditions is not satisfied in the case where the first asset **180** detects a hardware failure. In some embodiments, if the device includes a consumable material (e.g., an ink or toner supply of a networked printer), the device provides an indication of the amount or fraction of the consumable material remaining. In some embodiments, where the device tracks the length of time it has been operated, the state is an indication of how many hours the device has been used since purchase.

(61) At step **606**, the POS terminal **122** applies the rules in the smart contract to determine whether the current state of the first asset **180** (as reported electronically by the first asset **180**) is an acceptable state in which the buyer can return or relinquish the asset and receive a partial or full refund of the second asset. For example, a printer may only be eligible for partial refund if part or all of the consumable material (e.g., ink or toner) has been consumed. In some embodiments, at

least one of the conditions is not satisfied in the case where the amount of the consumable remaining is less than an original amount of the consumable material at a time the first asset **180** was purchased, or where the fraction of the original amount of the consumable material remaining in the first asset **180** is less than 100%. In another example, a television may only be eligible for a partial refund if the buyer has watched the television more than a threshold number of hours since purchase. If the state is an acceptable state for return, step **608** is executed. If the state is not an acceptable state for return, step **616** is executed.

(62) At step **608**, the POS terminal **122** applies the rules specified in the program (e.g., smart contract) retrieved from the block chain. For example, the rules can include additional conditions that apply regardless of the state information received from the first asset **180**. In some embodiments, the return policy specifies a limited period during which the buyer has the option to return the goods for a full or partial refund. For example, in some embodiments, the set of rules specify a return period, and the conditions are not satisfied in the case where the first request is received after an end of the return period. In some embodiments, in the case where the first asset **180** is a right to access an electronic information source, the program includes computation of an amount of the portion of the second asset based on a time the program is executed. In some embodiments, the rules specify that a restocking fee be subtracted from any refund. In some embodiments, where the first asset **180** is access to digital media for a specified subscription period, the state identifies the percentage of the subscription period that has passed at the time the request to return the second asset is made. In some embodiments, the rules allow an exchange or store credit—but not a refund—after a predetermined period of time.

(63) At step **608**, the POS terminal **122** determines whether all of the return conditions have been satisfied. If the conditions are all satisfied, step **610** is performed. If fewer than all of the conditions are satisfied, step **614** is performed.

(64) At step **612**, in the case where the conditions are satisfied, the POS terminal **122** transmits an authorization to return the at least a portion of the second asset in exchange for surrender of the first asset **180**. Upon an indication by the merchant that the first asset **180** has been relinquished and inspected, the program transmits a transaction to the block chain to transfer at least a portion of the second asset to the address associated with the buyer. In some embodiments the merchant inputs a vender key to the POS terminal **122** to confirm that the first asset **180** has been returned and inspected. The rules can specify that at least one of the conditions is not satisfied in the case where the vendor key is not input. In the case where digital media access rights

(65) At step **614**, in the case where one or more of the conditions are not satisfied, the POS terminal **122** invalidates the first request. The merchant does not accept the return of the first asset **180**.

(66) At step **616**, in the case where the state of the first asset **180** is not acceptable for return (and refund) because of a hardware failure or defect reported by the first asset **180**, the POS terminal **122** determines whether the first asset **180** is covered by a warranty, based on the information obtained from the metadata database **152**. For example, the POS terminal **122** determines whether the warranty claim has been made before expiration of the warranty period. In some embodiments, in the case where the warranty period has not expired, and the warranty includes exclusions and/or disclaimers, the POS terminal **122** determines whether warranty coverage is excluded by any exclusion or disclaimer. If the warranty period has not expired, and no exclusion or disclaimer is applicable, then warranty coverage is available, and step **618** is executed. If warranty coverage is not available, step **614** is executed.

(67) At step **618**, the POS terminal **122** approves the warranty claim and prints a shipping label (e.g., using printer **425**) indicating whether the first asset **180** is being sent to the manufacturer for repair or refurbishment. In some embodiments, the POS terminal **122** selects “repair” for certain types of defects and “refurbishment” for other types of defects. In other embodiments, a manufacturer service processor generates a label indicating a repair or refurbishment to be performed in the case where the circuit or processor in the first asset detects a hardware failure, and

transmits a digital representation of the label to the POS terminal for printing. The manufacturer service processor can be the processor **170** shown in FIG. **1**, or a separate processor at the manufacturer's service facility.

(68) At step **620**, in the case where the POS terminal **122** is approving transfer of the first asset to the manufacturer for repair or refurbishment, in some embodiments, the manufacturer's service facility transmits to the POS terminal **122** a third request for a vendor key. The manufacturer's service facility accepts the warranty claim in the case where it is accompanied by the vendor key, and determines that at least one of the conditions for providing warranty coverage is not satisfied in the case where the vendor key is not received in response to the third request.

(69) In other embodiments, where the first asset **180** has a defect or malfunction, the buyer can proceed directly with a warranty claim at step **616**. For example, in some embodiments, the state of the first asset **180** identifies whether a circuit or processor **182** in the first asset **180** detects a hardware failure in the first asset, and at least one of the conditions for a warranty claim is not satisfied in the case where the circuit or processor **182** in the first asset does not detect a hardware failure.

(70) Examples are discussed above in which the merchant policy database **160**, manufacturer policy database **170** and metadata database **152** are used to automate purchase, return and or warranty claims of an IoT device **180**. In other embodiments, the metadata database is used for automating exchanges of non-IoT devices and property, services, digital media access rights, digital currency, or intangible assets.

(71) Examples are discussed above in which the exchange is between a client device **102** and a POS terminal **122**. In other embodiments (not shown), the exchange can be between two client devices, or between two POS terminals.

(72) The methods and system described herein may be at least partially embodied in the form of computer-implemented processes and apparatus for practicing those processes. The disclosed methods may also be at least partially embodied in the form of tangible, non-transitory machine readable storage media encoded with computer program code. The media may include, for example, RAMs, ROMs, CD-ROMs, DVD-ROMs, BD-ROMs, hard disk drives, flash memories, or any other non-transitory machine-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the method. The methods may also be at least partially embodied in the form of a computer into which computer program code is loaded and/or executed, such that, the computer becomes a special purpose computer for practicing the methods. When implemented on a general-purpose processor, the computer program code segments configure the processor to create specific logic circuits. The methods may alternatively be at least partially embodied in a digital signal processor formed of application specific integrated circuits for performing the methods.

(73) Although the subject matter has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly, to include other variants and embodiments, which may be made by those skilled in the art.

Claims

1. An apparatus comprising: a communications interface; a memory storing instructions; and at least one processor coupled to the communications interface and to the memory, the at least one processor being configured to execute the instructions to: receive, via the communications interface, a first request to exchange a first asset for at least a portion of a second asset, the first asset comprising a device, and the first request comprising a public key of the device; transmit, via the communication interface, a second request for a private key from the device, wherein the private key of the device is associated with the public key of the device; responsive to the second request, receive the private key from the device via the communications interface, access an

element of a distributed electronic ledger based on an identifier associated with at least the device, and decrypt an encrypted set of rules maintained within the element of a distributed electronic ledger using the private key, the decrypted set of rules comprising conditions associated with the requested exchange; and based on a determination the requested exchange satisfies the conditions, transmit, via the communications interface, data authorizing the requested exchange to a computing system associated with the first asset, and perform operations that record transaction data associated with the authorized exchange within an additional element of the distributed electronic ledger.

2. The apparatus of claim 1, wherein the at least one processor is further configured to execute the instructions to: receive an updated distributed electronic ledger via the communications interface, the updated distributed electronic ledger comprising the additional element; and store the updated distributed electronic ledger within the memory, the updated distributed electronic ledger replacing the distributed electronic ledger within the memory.

3. The apparatus of claim 2, wherein the additional element of the updated distributed electronic ledger comprises the encrypted set of rules.

4. The apparatus of claim 1, wherein: the at least one processor is further configured to execute the instructions to transmit, via the communications interface, a second request to record the transaction data associated with the authorized exchange to one or more peer processing systems; and the one or more peer processing systems are configured to record at least a portion of the transaction data within the additional element of the distributed electronic ledger.

5. The apparatus of claim 1, wherein the at least one processor is further configured to execute the instructions to: receive data characterizing a state of the device from the device via the communications interface; and determine whether the requested exchange satisfies the conditions based on at least a portion of the data characterizing the state of the device.

6. The apparatus of claim 5, wherein: the data characterizing the state of the device identifies a hardware failure; and the at least one processor is further configured to execute the instructions to determine that the requested exchange fails to satisfy at least one of the conditions based on the identified hardware failure.

7. The apparatus of claim 5, wherein: the data characterizing the state of the device comprises information characterizing a current amount of a consumable material associated with the device; and the at least one processor is further configured to execute the instructions to establish that the requested exchange fails to satisfy at least one of the conditions based on the information characterizing the current amount of the consumable material associated with the device.

8. The apparatus of claim 1, wherein the at least one processor is further configured to execute the instructions to: load the distributed electronic ledger from a portion of the memory; and determine the identifier associated with at least one of the first or second assets, and access the element of the distributed electronic ledger based on the identifier.

9. The apparatus of claim 1, wherein: the second asset comprises an amount of a digital currency; the distributed electronic ledger comprises a block chain ledger; and the at least one processor is further configured to execute the instructions to: determine at least one of a transaction or block identifier associated with a previous purchase of the first asset using the amount of digital currency; access an element of the block chain ledger based on the at least one of the transaction or block identifier, the accessed element comprising encrypted data; and decrypt the encrypted data using the private key and extract the decrypted set of rules from the decrypted data.

10. A computer-implemented method, comprising: receiving, using at least one processor, a first request to exchange a first asset for at least a portion of a second asset, the first asset comprising a device, and the first request comprising a public key of the device; transmitting, using the at least one processor, a second request for a private key from the device, wherein the private key of the device is associated with the public key of the device; using the at least one processor, receiving the private key from the device in response to the second request, accessing an element of a distributed

electronic ledger based on an identifier associated with at least the device, and decrypting an encrypted set of rules maintained within the element of a distributed electronic ledger using the private key, the decrypted set of rules comprising conditions associated with the requested exchange; and based on a determination the requested exchange satisfies the conditions, transmitting, using the at least one processor, data authorizing the requested exchange to a computing system associated with the first asset, and performing operations, using the at least one processor, that record transaction data associated with the authorized exchange within an additional element of the distributed electronic ledger.

11. The computer-implemented method of claim 10, further comprising: receiving, using the at least one processor, an updated distributed electronic ledger via the communications interface, the updated distributed electronic ledger comprising the additional element; and storing, using the at least one processor, the updated distributed electronic ledger within a storage medium; the updated distributed electronic ledger replacing the distributed electronic ledger within the memory.

12. The computer-implemented method of claim 11, wherein the additional element of the updated distributed electronic ledger comprises the encrypted set of rules.

13. The computer-implemented method of claim 10, wherein: the computer-implemented method further comprises transmitting, using the at least one processor, a second request to record the transaction data associated with the authorized exchange to one or more peer processing systems; and the one or more peer processing systems are configured to record at least a portion of the transaction data within the additional element of the distributed electronic ledger.

14. The computer-implemented method of claim 10, further comprising: receiving, using the at least one processor, data characterizing a state of the device from the device; and determining, using the at least one processor, whether the requested exchange satisfies the conditions based on at least a portion of the data characterizing the state of the device.

15. The computer-implemented method of claim 14, wherein: the data characterizing the state of the device identifies a hardware failure; and the determining comprises determining that the requested exchange fails to satisfy at least one of the conditions based on the identified hardware failure.

16. The computer-implemented method of claim 10, further comprising: loading the distributed electronic ledger from a portion of a storage medium using the at least one processor; using the at least one processor, determining the identifier associated with at least one of the first or second assets, and accessing the one or more elements of the distributed electronic ledger based on the identifier.

17. The computer-implemented method of claim 10, wherein: the second asset comprises an amount of a digital currency; the distributed electronic ledger comprises a block chain ledger; and the computer-implemented method further comprises: determining, using the at least one processor, at least one of a transaction or block identifier associated with a previous purchase of the first asset using the amount of digital currency; accessing, using the at least one processor, an element of the block chain ledger based on the at least one of the transaction or block identifier, the accessed element comprising encrypted data; and using the at least one processor, decrypting the encrypted data using the private key and extracting the decrypted set of rules from the decrypted data.

18. A tangible, non-transitory computer-readable medium storing instructions that, when executed by at least one processor, cause the at least one processor to perform a method, comprising: receiving a first request to exchange a first asset for at least a portion of a second asset, the first asset comprising a device, and the first request comprising a public key of the device; transmitting a second request for a private key from the device, wherein the private key is associated with the public key of the device; responsive to the second request, receiving the private key from the device, accessing an element of a distributed electronic ledger based on an identifier associated with at least the device, and decrypting an encrypted set of rules maintained within one or more elements of a distributed electronic ledger using the private key, the decrypted set of rules

comprising conditions associated with the requested exchange; and based on a determination the requested exchange satisfies the conditions, transmitting data authorizing the requested exchange to a computing system associated with the first asset, and performing operations that record transaction data associated with the authorized exchange within an additional element of the distributed electronic ledger.
