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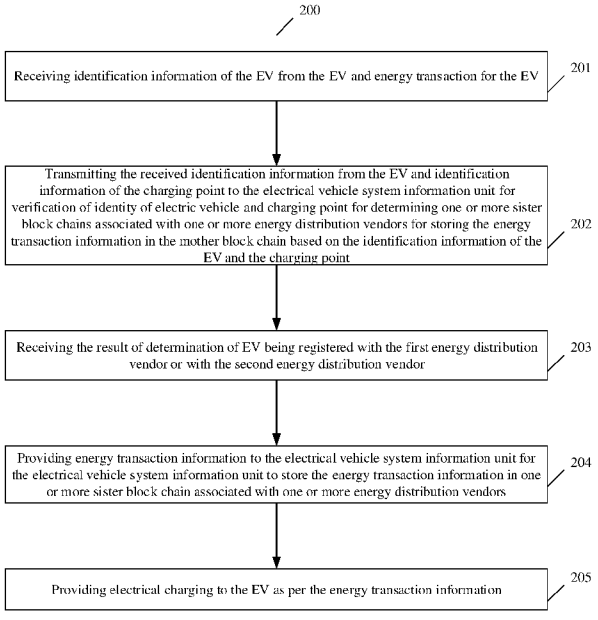

FIGURE 2

(57) **Abstract:** The present invention relates to a method and a system for charging Electric Vehicles (EV) (101) at charging points associated with a first or a second energy distribution vendor (104). A charging point (103) connected to an electric vehicle system operator (EVSO) (105) receives information related to the EV (101) and an energy transaction for charging the EV (101). The EVSO (105) verifies the identity of the EV and charging point(lOl) and authorizes the charging point (103) to charge the EV (101) based on the energy transaction. The EVSO (105) determines the one or more sister block chain (401, 402 and 403) associated with the first or the second distribution vendor for storing the energy transaction. The EVSO (105) stores all the energy transactions associated with plurality of energy distribution vendors (104) in a mother block chain (404). Upon receiving the authorization, the charging point (103) charges, the EV (101).

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A METHOD AND SYSTEM FOR CHARGING ELECTRIC VEHICLES (EVS) USING BLOCK CHAIN

Technical Field

[0001] The current invention relates in general to electric vehicle chargers and more particularly to electric vehicle chargers for charging electric vehicles using a block chain.

Background

[0002] In recent past, there is increase in the trend to use Electric Vehicle (EV). The EV is driven by the electric motors. The energy for the electric motors is supplied via the rechargeable batteries associated with the EV. In this type of electrically driven vehicle, the rechargeable batteries must be charged when the voltage of the rechargeable batteries decreases. The electric energy needed to charge the EV can be supplied over long distances from the electric grid and distributed to plurality of energy distribution vendors for charging the rechargeable batteries associated with the EV.

[0003] An issue with the existing techniques is the lack of authentication scheme for the EV to allow guest charging using a smart sub metering mechanism at home or commercial complex. Further, an EV with single authentication key may not be able to charge the rechargeable batteries associated with the EV from multiple energy distribution vendors, home or commercial complex.

[0004] Another issue with the existing techniques is the centralized EV energy transaction repository does not allow plurality of energy distribution vendors to store and verify the energy transaction using the centralized EV energy transaction repository.

[0005] In view of the above, there is a need to address at least one of the abovementioned limitations and propose a method and system to overcome the abovementioned problems.

Summary of the Invention

[0001] In an embodiment the present invention relates to a method for charging an Electric Vehicle (EV) from a charging point of an EV charger. In an embodiment, identification information of the EV is stored in a vendor information unit associated with a first energy distribution vendor or a second energy distribution vendor among plurality of energy distribution vendors and with an electric vehicle system information unit (112) associated with an electric vehicle system operator (EVSO). The charging point of the EV charger is communicably connected to the electrical vehicle system information unit. Identification

information of the charging point of the EV charger is stored in the vendor information unit associated with the first energy distribution vendor, and identification information of the plurality of energy distribution vendors are stored in the electric vehicle system information unit (112), and a plurality of information relating to energy transactions performed by the plurality of energy distribution vendors is stored in a mother block chain associated with the electric vehicle system information unit (112) of the EVSO. In an embodiment, the charging point receives identification information of the EV from the EV and energy transaction for the EV. Further, the charging point transmits the received identification information from the EV and identification information of the charging point to the electrical vehicle system information unit. The electrical vehicle system information unit verifies identity of electric vehicle and identity of charging point and determines one or more sister block chains associated with one or more energy distribution vendors from the plurality of energy distribution vendors for storing the energy transaction information and for storing the energy transaction information in the mother block chain. In an embodiment, the EV is registered with the first energy distribution vendor or with the second energy distribution vendor. The charging point receives the result of determination of EV being registered with the first energy distribution vendor or with the second energy distribution vendor. Thereafter, the charging point provides energy transaction information to the electrical vehicle system information unit for the electrical vehicle system information unit to store the energy transaction information in one or more sister block chain associated with one or more energy distribution vendors based on determination of EV being registered with the first energy distribution vendor or with the second energy distribution vendor. Upon the determination, the charging point provides electrical charging to the EV as per the energy transaction information.

[0002] In an embodiment, the energy transaction information is stored in at least one of a sister block chain associated with the first energy distribution vendor when the charging is being performed by the first energy distribution vendor, and the sister block chain associated with the first energy distribution vendor and the second energy distribution vendor, when the charging is being performed by the second energy distribution vendor.

[0003] In an embodiment, the identification information of the EV comprises at least one of EV manufacturer information, parent distribution unit information associated with the EV, EV registration information, EV model information, and EV owner information.

[0004] In an embodiment, the energy transaction information comprises at least one of details of the EV, details of the EV charging point of the EV charger, details of the first or second energy distribution vendor, details of manufacturer of the EV, duration of charging the EV at the charging point of the EV charger, details of unit cost of energy transfer, details of total cost of charging the EV at the charging point of the EV charger.

[0005] In an embodiment, the energy transaction information is recorded according IEC 61850 protocol.

[0006] In an embodiment, current and voltage samples values of the EV charging is recorded using IEC 61850 9-2 protocol and transmitted to the first distribution unit for performing remote diagnostic check of the EV charging point.

[0007] In an embodiment, total energy consumed by the EV during charging is verified using the energy transaction information stored in the mother block chain and one or more sister block chain.

[0008] Systems of varying scope are described herein. In addition to the aspects and advantages described in this summary, further aspects and advantages will become apparent by reference to the drawings and with reference to the detailed description that follows.

Brief Description of the Drawings

[0009] The subject matter of the invention will be explained in more detail in the following text with reference to preferred exemplary embodiments which are illustrated in the drawings, in which:

[0010] Figure 1 shows an exemplary environment for charging Electric Vehicles, in accordance with an embodiment of the present disclosure;

[0011] Figure 2 shows an exemplary flow chart for charging Electric Vehicles at a charging point of the EV charger, in accordance with an embodiment of the present disclosure;

[0012] Figure 3 illustrates an exemplary environment to select a charging point, in accordance with an embodiment of the present disclosure;

[0013] Figure 4 illustrates an exemplary mother and sister block chain for storing an energy transaction, in accordance with an embodiment of the present disclosure;

[0014] Figure 5 illustrates an exemplary registration process of the EV, in accordance with an embodiment of the present disclosure;

[0015] Figure 6 illustrates an exemplary registration process of the EV charger, in accordance with an embodiment of the present disclosure;

[0016] Figure 7 illustrates an exemplary verification of total energy received and consumed by the data miners, in accordance with an embodiment of the present disclosure;

[0017] Figure 8 illustrates an exemplary EV charger, in accordance with an embodiment of the present disclosure;

[0018] Figure 9 illustrates an exemplary first EV to second EV charging, in accordance with an embodiment of the present disclosure;

[0019] Figure 10 illustrates an exemplary docker container for storing the block chain, in accordance with an embodiment of the present disclosure. and

[0020] Figure 11 shows an exemplary consortium of the EVSO, in accordance with an embodiment of the present disclosure.

Detailed Description:

[0021] The present invention discloses a method and system for charging electric vehicles using block chain. A charging point connected to an EVSO receives information related to the EV and an energy transaction for charging the EV. The EVSO verifies the identity of the EV and authorizes the charging point to charge the EV based on the energy transaction. The EVSO determines the one or more sister block chain associated with the first or the second distribution vendor for storing the energy transaction. The EVSO stores all the energy transactions associated with plurality of energy distribution vendors in a mother block chain. Upon receiving the authorization, the charging point charges, the EV.

[0022] Figure 1 shows an exemplary environment for charging electric vehicles. The Electric Vehicle (EV) (101) is a vehicle propelled by one or more electric motors, using energy stored in rechargeable batteries of the EV (101). An EV manufacturer (106) manufactures the EV (101) and a server (herein referred as EV manufacturer (106) server) hosted by the EV manufacturer (106) is communicatively connected to the EV (101). In an embodiment, the EV (101) and the EV manufacturer (106) server are connected using at least one of, a cellular network, vehicular networks and the like. The EV manufacturer (106) server calculates the

energy stored in the rechargeable batteries of the EV (101) based on the information received from the EV (101). Typically, the EV manufacturer (106) server receives a plurality of information of the EV (101) for analytics and to further improve the EV (101). In one example, the EV manufacturer (106) server can receive information related to battery charging and discharging and can use this information to improve the batteries. In another example, the EV manufacturer (106) server can monitor EV battery state and can recommend nearby charging points. In an embodiment, the EV manufacturer (106) may be associated with one or more energy distribution vendors (104) for providing chargers comprising charging points to charge the EV (101). For example, an EV manufacturer (106) like XYZ can be associated with energy distribution vendors (104) like vendor 1. In one embodiment, the energy distribution vendors (104) can install chargers in a plurality of locations for the EVs of the associated EV manufacturers to charge the EVs. In one embodiment, chargers may be similar to a charging station. In a further embodiment, the chargers comprise a plurality of charging point (103). In an embodiment, the charging point (103) may be an energy vending machine configured to transfer charges to the EV (101). In an embodiment, each of plurality of energy distribution vendors (104) has a vendor information unit (111) for storing identification information of the EV (101), identification information of the charging point (103) of an EV charger (102) and energy transaction associated with charging of the EV (101). For example, when an EV (101) enters an EV charger (102) for charging, the EV (101) may be authenticated prior to charging. Likewise, the charging point (103) of the charger and an energy transaction initiated by the EV (101) are authenticated. Let us consider a first energy distribution vendor (104) among the plurality of energy distribution vendor (parent energy distribution vendor) is registered to buy power along with several energy distribution vendors who are in business of providing power. In an embodiment, a charger comprising one or more charging points is installed by a first energy distribution vendor (parent energy distribution vendor (104)). In an embodiment, a plurality of such chargers can be installed by the first energy distribution vendor.

[0023] In an embodiment, the one or more charging points are primarily configured to charge the EV (101) associated with the first energy distribution vendor (104). In one embodiment, EVs associated with other energy distribution vendors (104) can also be charged by the one or more charging points i.e. the EV can also be charged by another energy distribution vendor (second energy distribution vendor) apart from the parent energy distribution vendor (first energy distribution vendor). In one embodiment, a cost of charging the EV (101) associated with the first energy distribution vendor (104) can be less than a cost of charging the EVs

associated with other energy distribution vendor (104). Each of the energy distribution vendor (104) are associated with a vendor information storage unit (a database). Each energy distribution vendor (104) can monitor respective chargers and can store information related to respective chargers, respective one or more charging points, EVs charged in the respective one or more charging points, transaction details in respective vendor information storage units. The DSO (107) can include one or more computing units operated by one or more operators. The one or more computing units along with the one or more operators together can be referred as DSO (107). The DSO (107) is configured to distribute the electric energy from a grid (108) to the plurality of chargers. In an embodiment, the grid (108) is an interconnected network of power generating stations, transmission lines, distribution lines for delivering electricity from producers to consumers. In an embodiment, amount of energy distributed to each charger from the grid (108) is recorded in an EV system information unit associated with the EVSO and information unit (112) associated with DSO. The EV system information unit (112) also store identification information of the plurality of energy distribution vendors (104). The one or more charging points of the EV charger (102) is connected to a gateway (110) via a communication network (109). The gateway (110) is used to route the information between the EVSO (105), plurality of energy distribution vendor (104) and the one or more charging points of the EV charger (102). Further description is provided with respect to one charging point (103). However, this should not be considered as a limitation and aspects associated with to a single charging point (103) can be applicable to the one or more charging points of the EV charger (102).

[0024] Figure 2 illustrates an exemplary flow chart for charging the EV (101) at a charging point (103) of the EV charger (102). In an embodiment, the EV (101) may select the EV charger (102) from a plurality of EV chargers present at a particular geographical area as shown in Figure 3. The EV (101) queries the location information regarding the EV charger (102) in a geographical area of the EV (101). In one embodiment, the query can be made to the EV manufacturer (106) and the EV manufacturer (106) forwards the query to the EVSO (105). In another embodiment, the EV (101) may query the EVSO (105). Further, the EVSO (105) will query the plurality of energy distribution vendors (104) for the location information of respective EV chargers available in the geographical area of the EV (101). The plurality of energy distribution vendors (104) shares the location information of the plurality of the EV chargers, price of charging the EV (101) at the charging point (103) of the respective EV charger (102), required charging time to charge the rechargeable batteries of the EV (101) or a

waiting time for the availability of the charging point (103) at the EV charger (102) with the EVSO (105) and in turn to the EV (101) via the EV manufacturer (106) or directly to the EV (101). The EV (101) selects the charging point (103) of the EV charger (102) based on the received information. Further, the EV (101) uses navigation information for example from the satellites of the Global Positioning System (GPS) to navigate to the selected charging point (103) of the EV charger (102) for charging the EV (101).

[0025] At the step 201, the charging point (103) receives identification information of the EV (101) from the EV (101) and energy transaction information for charging the EV (101). The identification information of the EV (101) includes at least one of EV manufacturer (106) information, energy distribution unit information associated with the EV (101), EV (101) registration information, EV (101) model information, EV (101) battery capacity, compatibility of the battery with the charging point (103), and EV (101) owner information. For example, the EV manufacturer (106) information may include at least one of name and address of the EV manufacturer (106) and EV manufacturer (106) cryptographic hash, the energy distribution unit information associated with the EV (101) may include a cryptographic hash of the first energy distribution vendor (104), EV (101) registration information may include device account name, EV public key and public key for transaction with EVSO (105), EV model information may include the type of vehicle and the registration number, and EV owner information may include the device owner name and address. The Table 1 below shows an exemplary identification information the EV (101) according to the IEC61850 standard. The IEC 61850 is an international standard defining communication protocols for intelligent electronic devices at electrical substations, Part 90-8: Object model for E-mobility:

Electric Vehicle identification information - IEC 61850	
Device account name: DEEV.NamPlate.name:	XYZ Car 1
Device owner name: DEEV.NamPlate.ownName:	Shankar
EV details (LD0.LDEV.DevName.serNum):	Tesla IN KA53 L 4742
EV public key (LD0. DEEV. NamPlate.publicKey):	87af7157
Public Key for transaction with EVSO (LD0.GSAL.PublicKey.stVal):	ac14705af1c5
First Energy distributor vendor hash (LDO.GSAL.EDAuthHash.stVal):	B566D
EV manufacturer hash (LDO.GSAL.EVManHash.stVal):	23776d4e

Table 1

[0026] Further, the energy transaction for the EV (101) includes at least one of the time duration for charging the EV (101) at the charging point (103) of the EV charger (102), the total cost for charging the EV (101) at the charging point (103) of the EV charger (102) and the like. In an embodiment, the identification information of the EV (101) can be obtained by the charging point (103) using for example a Radio Frequency Identification (RFID) tag mounted on the EV (101), a QR code on the EV (101), a smart card provided with the EV (101), or any such means that provide identification information. In an embodiment, the transaction information is provided by a driver/ passenger of the EV (101). For example, the driver of the EV (101) can provide information such as charging the EV (101) for 10 minutes, charging the EV (101) equivalent to 500$ or charging the battery to full capacity.

[0027] At the step 202, the charging point (103) transmits the received identification information from the EV (101) and identification information of the charging point (103) to the electrical vehicle system information unit for verification of identity of the EV (101) and the charging point (103). The identification information of the charging point (103) includes EV charger (102) details, energy distribution unit information associated with the EV charger (102), battery storage capacity of EV charger (102), and EV charger (102) owner information. For example, the EV charger (102) details includes name and address of the EV charge manufacturer and model of the EV charger (102), the energy distribution unit information associated with the EV charger (102) includes the first energy distribution vendor (104) cryptographic hash, the battery storage capacity of EV charger (102) includes the total charge measured in kilo watt hour (kWh) the battery can store, and EV charger (102) owner information includes device owner name and address of the EV charger (102). Table 2 shows exemplary EV charger (102) information.

EV charger Identification Information - IEC 61850	
Device account name: DESE.NamPlate.name :	XYZ charging station
Device owner name: DESE.NamPlate.ownName :	Ravi
EV charger ID details (LD0.LDEV.DevName.serNum) :	XYZ CHAdeMO 1.0 Terra 53 CJG Ser.No 45A68BCCA0
EV charger public key (LD0. DESE. NamPlate.publicKey) :	247e0a80

Public Key for transaction with in EVSO (LD0.GSAL.PublicKey.stVal):	ac14705af1c5
First Energy distributor vendor hash (LDO.GSAL.EVEDAuthKey.stVal):	95b7e7843b2f
Battery storage capacity of EV charger (LD0.PEMMTR1.StoSupWh.actVal)	1kWh

Table 2

[0028] In an embodiment the verification of identity of the EV (101) by the EVSO (105) includes comparing the cryptographic hash of the first energy distribution vendor (104), the cryptographic hash of the EV manufacturer (106) and the EV model information, and EV registration information with the data stored in the EV system information unit (112) associated with the EVSO (105). The comparison determines the registration of the EV (101) with the first energy distribution vendor (parent energy distribution vendor) or another vendor i.e. a second energy distribution vendor (104).

[0029] Further, the EVSO (105) determines one or more sister block chains (401, 402 and 403) associated with one or more energy distribution vendors (104) for storing the energy transaction information based on the identification information of the EV (101). Upon verification of the identification information of the EV (101), the energy transaction information is stored in the one or more sister block chain (401, 402 and 403) and the mother block chain (404). A blockchain is a time-stamped series of immutable record of data that is managed by cluster of computers or servers not owned by any single entity. Each record of data known as a block of data or block is secured and bound to previous block using cryptographic principles to form a chain of blocks. The block chain is a shared and immutable ledger, the information stored in the block chain is read by EVSO and plurality of energy distribution vendor. All the computers or servers involved in an energy transaction is accountable for the actions for example verification of the energy transaction performed by the computers or servers. The blockchain is a simple way of passing data from one computer or server say A to other computer or server B in an automated and safe technique. A transaction is initiated by creating a block. The block is verified by plurality of computers or servers distributed around the network. The verified block is added to a blockchain. The block chain is stored across in a database associated with the plurality of computers or servers with in EVSO and plurality of energy distribution vendor.

[0006] As shown in Figure 4, an exemplary mother block chain (404) is associated with the EVSO (105) and one or more sister block chains (401, 402 and 403) are associated with the plurality of the energy distribution vendors (104). The EVSO (105) and the plurality of the energy distribution vendors (104) are communicatively connected via the gateway (110). The mother block chain (404) stores all the energy transactions associated with the plurality of the energy distribution vendors (104). Further, based on the received identification information of the EV (101) from the charging point (103) the EVSO (105) determines the one or more sister block chains (401, 402 and 403) associated with the plurality of the energy distribution vendors (104) for storing the energy transaction of the EV (101). In an embodiment, each energy distribution vendor (104) is associated with a plurality of sister block chains (401, 402 and 403). Each sister block chain (401, 402 and 403) corresponding to an energy distribution vendor (104) comprises energy transaction information of that energy distribution vendor (104) with other energy distribution vendor (104). For example, considering three vendors, namely vendor 1, vendor 2 and vendor n. The sister block chains (401, 402 and 403) associated with vendors can be:

Vendor 1 to other vendors:

EVSO.Block chain Vendor 1_1 : transaction in vendor 1;

EVSO.Block chain Vendor 1_2 : transaction between vendor 1 and vendor 2;

EVSO.Block chain Vendor 1_3 : transaction between vendor 1 and vendor 3;

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EVSO.Block chain Vendor 1_n : transaction between vendor 1 and vendor n;

Vendor 2 to other vendors:

EVSO.Block chain Vendor 2_2 : transaction in vendor 2;

EVSO.Block chain Vendor 2_1 : transaction between vendor 2 and vendor 1;

EVSO.Block chain Vendor 2_3 : transaction between vendor 2 and vendor 3;

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EVSO.Block chain Vendor 2_n : transaction between vendor 2 and vendor n;

Vendor n to other vendors:

EVSO.Block chain Vendor n_n : transaction in vendor n;

EVSO.Block chain Vendor n_1 : transaction between vendor n and vendor 1;

EVSO.Block chain Vendor n2 : transaction between vendor n and vendor 2;

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EVSO.Block chain Vendor n_{n-1} : transaction between vendor n and vendor n-1;

[0030] For example, consider the first energy distribution vendor (104) associated with the EV (101) to be vendor 2, the energy distribution vendor (104) associated with the charging point (103) of the EV charger (102) to be the vendor 2 as well and the EV (101) is to be charged by the charging point (103) of the EV charger (102). The EVSO (105) determines a sister block chain (402A) (Block chain 2_2) corresponding to vendor 2 for storing the energy transaction.

[0031] In another example, consider the first energy distribution vendor (104) associated with the EV (101) to be the vendor 2, the energy distribution vendor (104) associated with the charging point (103) of the EV charger (102) to be the vendor 1 and the EV (101) is to be charged by the charging point (103) of the EV charger (102). The EVSO (105) determines a sister block chain (402B) (Block chain 2_2) corresponding vendor 2 and a sister block chain (401B) (Block chain 2_1) corresponding vendor 2 and a sister block chain (Block chain 1_1) corresponding vendor 1 for storing the energy transaction.

[0032] At the step 203, the charging point (103) receives the result of determination of EV (101) being registered with the first energy distribution vendor (104) or with the second energy distribution vendor (104), where the EV (101) is registered with the first energy distribution vendor (104) or with the second energy distribution vendor (104). In one embodiment, the EV charger (102) is registered with the first energy distribution vendor (104). In another embodiment, the EV charger (102) is registered with the second energy distribution vendor (104). The result of determination of the EV (101) being registered is obtained from the EVSO (105) based on the verification of the identification information performed by the EVSO (105). The EVSO (105) compares the received information with the stored information. The result of determination is indicated as a “success” or a “failure” based on the comparison.

[0033] As shown in Figure 5, the EV (101) registers itself with the first energy distribution vendor (104) among the plurality of distribution vendors and the EVSO (105). In an embodiment the registration process includes sharing the EV identification information (for example Device account name, Device owner name, EV (101) details and the like) as shown

in the Table 1 below with the first energy distribution vendor (104) and EVSO (105). The EV identification information is stored in the electric vehicle system information unit (112) (e.g., database) associated with the EVSO (105). Further, the identification information of the EV (101) is verified with the EV manufacturer (106) by the EVSO (105) and EVSO (105) creates a public key for the EV (101), a private key for the EV (101) and digitally signs the EV (101) certificate using the private key of the EV (101) indicating the completion of the EV (101) registration. Furthermore, the EVSO (105) shares the public key of the EV (101) with the plurality of the energy distribution vendors (104). The plurality of energy distribution vendors (104) verifies the EV (101) based on the public key of the EV (101). The public key of the EV (101) and private key of the EV (101) is used to securely send and receive information with the EVSO (105) and the EV manufacturer (106). The information for example identification information or the energy transaction information is encrypted using the public key by the sender and sent to a receiver. The receiver decrypts the information using the private key. In an embodiment, the information is encrypted using the public key by the sender and sent to a receiver. The receiver decrypts the information using the private key.

[0034] As shown in Figure 6, the EV charger (102) registers itself with the first energy distribution vendor (104) or the second energy distribution vendor (104) among the plurality of distribution vendors and the EVSO (105). In another embodiment, the registration process includes sharing the EV charger (102) identification information (for example Device account name, Device owner name, EV charger (102) details and the like) as shown in the Table 2 with the first energy distribution vendor (104) and EVSO (105). The EV charger (102) identification information is stored in the electric vehicle system information unit (112) associated with the EVSO (105) and the vendor information unit (111) associated with the first energy distribution vendor (104) or the second energy distribution vendor (104). Further, the identification information of the EV charger (102) is verified with the EV charger (102) manufacturer by the EVSO (105) and EVSO (105) creates a public key for the EV charger (102), a private key for the EV charger (102) and digitally signs the EV charger (102) certificate using the private key of the EV charger (102) indicating the completion of the EV charger registration. Furthermore, the EVSO (105) shares the public key of the EV charger(101) with the plurality of the energy distribution vendors (104). The plurality of energy distribution vendors (104) verifies the identification information of the EV (101) charger and the digitally signed EV (101) charger certificate based on the public key of the EV (101). The public key of the EV (101) and private key of the EV (101) is used to securely send and receive information with the EVSO (105) and

the EV manufacturer (106). The information for example identification information or the energy transaction information is encrypted using the public key by the sender and sent to a receiver. The receiver decrypts the information using the private key. In an embodiment, the information is encrypted using the public key by the sender and sent to a receiver. The receiver decrypts the information using the private key. Further, the public and private key is used to encrypt and decrypt the messages between the charging point (103) and the EVSO (105).

[0035] At the step 204, the charging point (103) provides the energy transaction information to the EV system information unit (112) to store the energy transaction information in one or more sister block chain (401, 402 and 403) associated with one or more energy distribution vendors (104). The energy transaction information is stored in at least one of a sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) when the charging is being performed by the first energy distribution vendor (104) and the sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) and the second energy distribution vendor (104), when the charging is being performed by the second energy distribution vendor (104). In an embodiment, each energy transaction information is time stamped using ".t" attribute of the IEC 61850 protocol. The energy transaction information from the plurality of the energy distribution vendors (104) are stored in one block of a blockchain within the predefined time period. Each block of the block chain is joined to the previous block of the block chain by a cryptographic hash, a linked list and a dedicated block chain software.

[0036] Further, the energy transaction information comprises at least one of details of the EV (101), details of the EV charging point (103) of the EV charger (102), details of the first or second energy distribution vendor (104), details of manufacturer of the EV (101), duration of charging the EV (101) at the charging point (103) of the EV charger (102), details of unit cost of energy transfer, details of total cost of charging the EV (101) at the charging point (103) of the EV charger (102). The EV charger (102) calculates charging energy information over the charging time period for the EV (101) using the equations given below.

$$Total\ charging\ Energy = \pm \sum_{t=0}^{n} Pn * \Delta t \qquad (1)$$

where Pn is energy measured at "n^{th}" instant

Δt is a time between measurement iteration

n = total number of iterations within charging period

$$Total\ charging\ cost = \sum_{t=0}^{n} Pn * \Delta t * Cn + \sum_{t=0}^{n} EVn * t \quad (2)$$

where Cn is cost of energy at "n[th]" instant

EVn is a profit margin of the EV (101) charging host, first energy distribution vendor (104) of the EV charger (102), as defined by first energy distribution vendor (104) within rules prescribed by EVSO (105).

[0037] The energy transaction information is recorded according IEC 61850 protocol. An example of the energy transaction information is shown in the Table 3 below:

Energy transaction details	**Value/Hash value**	**Access rights**	**Access to data miners**
Device account name: DEEV.NamPlate.name :	Tesla Car 1	Read by EVSO , plurality of energy distribution vendor	No read/write access
Device owner name: DEEV.NamPlate.ownName :	Shankar	Read by EVSO , plurality of energy distribution vendor	No read/write access
EV details (LD0.LDEV.DevName.serNum) :	Tesla IN KA53 L 4742	Read by EVSO , plurality of energy distribution vendor	No read/write access
EV public key (LD0. DEEV. NamPlate.publicKey) :	87af7157	Read by EVSO , plurality of energy distribution vendor in EV charging ecosystem	Read access
Public Key for transaction with EVSO (LD0.GSAL.PublicKey):	ac14705af1c5	Read by EVSO , plurality of energy distribution vendor	Read access
First Energy distributor vendor hash (LDO.GSAL.EDAuthHash.stVal):	B566D	Read by EVSO and plurality of energy distribution vendor	Read access
EV manufacturer hash (LDO.GSAL.EVManHash.stVal) :	23776d4e	Read by EVSO and plurality of energy distribution vendor	No Read access
Device account name: DESE.NamPlate.name :	XYZ charging station	Read by EVSO , plurality of energy distribution vendor	No read/write access

Device owner name: DESE.NamPlate.ownName :	Ravi	Read by EVSO , plurality of energy distribution vendor	No read/write access
EV charger details (LD0.LDEV.DevName.serNum) :	XYZ CHAdeMO 1.0 Terra 53 CJG Ser.No 45A68BCCA0	Read by EVSO , plurality of energy distribution vendor	No read/write access
EV charger public key (LD0. DESE. NamPlate.publicKey) :	247e0a80	Read by everyone in EV ecosystem	Read access
EV charger Public Key for transaction with EVSO (LD0.GSAL.PublicKey.stVal):	ac14705af1c5	Read by EVSO and plurality of energy distribution vendor Others no read access	Read access
First Energy distributor vendor (LDO.GSAL.EVEDAuthKey.stVal):	95b7e7843b2f	Read by EVSO and plurality of energy distribution vendor Others no read access	Read access
Battery storage capacity of the EV charger (LD0.PEMMTR1.StoSupWh.actVal)	1kWh	Read by EVSO and plurality of energy distribution vendor and EV charging host, Write by EV charging host Others no read access	No read access
Time stamp of total energy consumption during charging Energy: measurement using metering logical node LD0.PEMMTR1.SupWh.t(start) LD0.PEMMTR1.SupWh.t(end)	19-Sept-17:10:20AM (Start) 19-Sept-17:10:40AM (End)	Read by EVSO and plurality of energy distribution vendor and EV charging host, Write by EV charging host Others no read access	Read access
Unit cost of Energy defined by DSO LD0.DSODSCH1.CostSupWh.actVal	1INR/kWh	Read by public	Read access
Total cost of consumption by EV: Energy: measurement DER energy and/or ancillary services schedule logical node LD0.EVDSCH1.CostSupWh.actVal	1000 INR	Write by EVSO and plurality of energy distribution vendor Read by EV, EV charging point Others no read access	Read access
Total profit earned by EV charging host DER energy and/or ancillary services schedule logical node	100 INR	Write by EVSO and plurality of energy distribution	Read access

LD0.EVHODSCH1.CostSupWh .actVal		vendor, Read be EV charging host	
Total profit earned by parent EV charging host: DER energy and/or ancillary services schedule logical node LD0.EVCHDSCH.CostSupWh.a ctVal	10 INR	Write by EVSO Read be EV charging host parent company plurality of energy distribution vendor Others no access	Read access
Total profit earned by EV parent company: DER energy and/or ancillary services schedule logical node LD0.EVPCDSCH1.CostSupWh. actVal	10 INR	Write by EVSO Read EV energy parent company or EV energy distributor company	Read access
Total profit earned by EVSO Internal EVSO data LD0.EVPCDSCH1.ProfSupWh. actVal	5INR	Read and write by EVSO Others no read access	No read/write access
LD0.EVPCDSCH1. TrdRdy.stVal Transaction Read	True	Read by EVSO, plurality of energy distribution vendor	Write/read access
Hashing of each block LD0.EVPCDSCH1. BlkHash.stVal	8DE98019CDD599C7 5DFB96CB0004922B 0AF2074D277882FF0 A7B2BD3DF413F1D	Read/write by Software	Read/write by Software

Table 3

[0038] The energy transaction shown in the Table 3 includes a plurality of attributes (for example EV (101) details) associated with the charging of the EV (101) at the charging point (103) of the EV charger (102) in the column 1 of the table above. Every attribute among the plurality of attributes has a corresponding value as shown in the column 2 of the Table 3. Further, the column 3 of the Table 3 indicates the access rights of the attributes in the energy transaction information. The access rights indicate read and write permissions to at least one of the EVSO (105), first energy distribution vendor (104) and second energy distribution vendor (104). The column 4 indicates the access rights to the data miners (701). In an embodiment, the data miners (701) are a computer or a server for verifying the total energy expenditure with the total energy received.

[0039] At the step 205, the charging point (103) provides the electrical charging to the EV (101) as per the energy transaction information as detailed in the step 204.

[0040] In an embodiment, current and voltage samples values of the EV (101) charging is recorded using IEC 61850 9-2 protocol and transmitted to the first distribution unit for performing remote diagnostic check of the EV (101). The current and voltage sample values are stored in time series in the vendor information unit (111) associated with the first distribution vendor. In an exemplary embodiment, the current and voltage sample values are analyzed using moving window method. The moving window method includes determining a Discrete Fourier Transform (DFT) and a wavelet transform of the current and the voltage sample values. Based on the DFT and wavelet transform the frequency and time series a probabilistic failure information of the converter in EV charger can be identified. An example of the current and voltage sample values recorded using IEC 61850 9-2 protocol is shown below.

	Time-1	Time-2	...	Time-n
Device ID	LD0.LDEV.DevName.serNum	LD0.LDEV.DevName.serNum	...	LD0.LDEV.DevName.serNum
Current Sample values	LD0.DESE.A.instMag-1	LD0.DESE.A.instMag-2	...	LD0.DESE.A.instMag-n
Voltage Sample values	LD0.DESE.PhV.instMag-1	LD0.DESE.PhV.instMag-2	...	LD0.DESE.PhV.instMag-n
Time stamp	LD0.DESE.A.t-1	LD0.DESE.A.t-2	...	LD0.DESE.A.t-n

Table - 4

[0041] In an embodiment, the data miners (701) are provided with an access to read all the energy transaction information stored in the mother block chain (404) and one or more sister block chain (401, 402 and 403) as shown in Figure 7. Every transaction stored in the mother block chain (404) and the one or more sister block chains (401, 402 and 403) are verified based on the public key of the EV (101), the public key of the EV charger (102) in energy transaction information and the public key of EVSO (105). The energy consumed by EV (101) for charging the rechargeable batteries of the EV (101) must be approximately equal to the energy supplied by the plurality of EV energy distribution vendors (104) to the EV (101) excluding the tolerance of energy losses. The verification of the energy consumed by the EV (101) and the energy

supplied by the plurality of the EV energy distribution vendors (104) is verified using the equation given below.

$$\sum_{i=1}^{n} E_{EV(i)} \cong \sum_{k=1}^{m} E_{EVcharingPoint(k)} \quad (3)$$

[0042] In an embodiment, if the demand in an energy distribution vendor (104) among the plurality of the energy distribution vendors (104) is greater than a predefined threshold value then the DSO (107) could issue a circuit breaker command to the EVSO (105). Further, the EVSO (105) could limit the EV (101) charging power or switch off the EV (101) charging remotely of the energy distribution vendors (104) among the plurality of the energy distribution vendors (104) to prevent a grid (108) collapse.

[0043] In an embodiment, a house or a commercial complex can act as an EV (101) charging including a charging point (103) as shown in Figure 8. The charging point (103) has an energy storage unit (801) for storing energy generated during excessive generation by the grid (108). Further, the energy storage unit (801) can store the energy generated by the renewable sources of energy for example solar energy as shown in Figure 8. The EVSO (105) monitored by the DSO (107) sets an energy charge pricing for the EV (101) charging at the home or the commercial complex. Further, the energy transaction is stored in the mother block chain (404) and the sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) of the EV (101).

[0044] In an embodiment, if a first EV (101) and a second EV (101) have a compatible power socket then a first EV (101) can charge the second EV (101) or vice versa as shown in Figure 9. The EV (101) providing the charge acts as the charging point (103). Further, the charging of the EV (101) is performed after the EVSO (105) verifies the identification information of the first EV (101) and the identification information of the second EV (101). The identification information of the first EV (101) and the second EV (101) is sent to the EVSO (105) via the gateway (110) through the cellular network. The energy transaction is stored in the mother block chain (404) associated with the EVSO (105), and the sister block chain (401, 402 and 403) associated with the corresponding first energy distribution vendor (104) of the first EV (101) (for example vendor 1) and the first energy distribution vendor (104) of the second EV (101) (for example vendor 2) as shown in the Figure 9.

[0045] In an embodiment, the block chain associated with an EV energy distribution vendor (104) among the plurality of energy distribution vendors (104) are stored in a dedicated

application on a host cloud using containers as shown in Figure 10. A container is a standard unit of software that packages up code and all its dependencies, so the dedicated application runs quickly and reliably regardless of the environment. The container program runs on Dockers/Kubernetes which enables executions of containers in any host machine or virtual machine or cloud. A Docker container image is a lightweight, standalone, executable package of software that includes everything needed to run an application for example a code, runtime, system tools, system libraries and settings. The public key of the energy distribution vendor (104) is used to authenticate the containers. Further, a Data exchange server (DES) associated with the EVSO (105) stores the energy transactions of the mother block chain (404) in a historian file system (for example HADOOP). The DES provides EVSO (105), data miners (701) and the plurality of energy distribution vendors (104) the required data for based on the access rights of charging the EV (101) at the charging point (103) of the EV charger (102).

[0046] In an embodiment, one or more EVSO can associate with each other to co-ordinate and manage the charging of the EV at a charging point of the EV charger. The one or more EVSO involved in the association forms a consortium of EVSO as shown in Figure 11. Each EVSO in the consortium of EVSO performs a handshake using an intercloud operation. The one or more EVSO in the CONSORTIUM of EVSO creates a sister block chain corresponding to the vendor 1 governed by the EVSO 1 and vendor 2 governed by the EVSO 2 for storing the energy transaction between the vendor 1 of the EVSO 1 and a vendor 2 of the EVSO 2. For example, the energy transactions within plurality of vendors governed by the EVSO_Z is stored in a mother block chain of the EVSO_Z (CONSORTIUM.EVSO_Z as shown in Table - 5). Further, in another example, consider an energy transaction between a vendor K governed by EVSO_X and a vendor N governed by EVSO_Z. The energy transaction is stored in a sister block chain (CONSORTIUM. EVSO_X.VENDER_K->EVSO_Z.VENDER_N as shown in Table - 5), a mother block chain of the EVSO_X (CONSORTIUM.EVSO_X as shown in Table - 5), and a mother block of the EVSO_Z (CONSORTIUM.EVSO_Z as shown in Table - 5) as shown in Figure 11. The Table 5 indicates exemplary mother and sister block chain associated with one or more EVSO in the consortium of EVSO.

Number	Block chain	Comments
EVSO 1	CONSORTIUM.EVSO_1:Tag:MotherBlockChain	Mother block chain within EVSO 1:

EVSO 1 ->2	CONSORTIUM.EVSO_1.VENDER_K-> EVSO_2.VENDOR_N:Tag:SisterBlockChain	transaction between vendor K who is governed by EVSO_1 and Vendor N who is governed by EVSO_2
EVSO 2	CONSORTIUM.EVSO_2:Tag:MotherBlockChain	Mother block chain within EVSO 2:
EVSO 2 ->1	CONSORTIUM.EVSO_2.VENDER_N-> EVSO_1.VENDOR_K:Tag:SisterBlockChain	transaction between vendor N who is governed by EVSO_2 and Vendor K who is governed by EVSO_1
	...	
EVSO Z	CONSORTIUM.EVSO_Z:Tag:MotherBlockChain	Mother block chain within EVSO Z:
EVSO Z ->X	CONSORTIUM.EVSO_Z.VENDER_K-> EVSO_X.VENDOR_N:Tag:SisterBlockChain	transaction between vendor K who is governed by EVSO_Z and Vendor N who is governed by EVSO_X
EVSO X	CONSORTIUM.EVSO_X:Tag:MotherBlockChain	Mother block chain within EVSO X:
EVSO X ->Z	CONSORTIUM.EVSO_X.VENDER_N-> EVSO_Z.VENDOR_K:Tag:SisterBlockChain	transaction between vendor N who is governed by EVSO_X and Vendor K who is governed by EVSO_Z

Table - 5

[0047] In an embodiment, a single authentication key is used to authenticate and charge the EV (101) from a plurality of energy distribution vendors (104), a house, or a commercial complex. The EV (101) can locate the charging point (103) from a plurality of charging points for charging the EV (101) based on the distance to the plurality of charging points, unit energy cost for charging the EV (101) and availability of the plurality of charging points. The energy

transaction is stored in mother and sister block chain (401, 402 and 403) and the total energy received and consumed is verified by the data miners (701). The EVSO (105) based on the guidelines of the DSO (107) monitors and manages the energy distribution to the plurality of energy distribution vendors (104).

[0048] This written description uses examples to describe the subject matter herein, including the best mode, and also to enable any person skilled in the art to make and use the subject matter. The patentable scope of the subject matter is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

Referral Numerals:

101 – Electric Vehicle

102 – EV Charger

103 – Charging point

104 – energy distribution vendor

105 – EV system operator

106 – EV manufacturer

107 – Distribution System Operator

108 – Grid

109 – Communication Network

110 – Gateway

111 – Vendor Information Unit

112 – EV system information unit

401, 402 and 403 – Sister blockchain of vendor 1

404 – Mother blockchain

701 – Data Miners

801 – Energy storage unit

Claim:

1. A method for charging an Electric Vehicle (EV) (101) from a charging point (103) of an EV charger, wherein identification information of the EV (101) is stored in a vendor information unit (111) associated with a first energy distribution vendor (104) or a second energy distribution vendor (104) among plurality of energy distribution vendors (104) and with an electric vehicle system information unit (112) associated with an electric vehicle system operator (EVSO) (105),

wherein the charging point (103) of the EV charger (102) is communicably connected to the electrical vehicle system information unit,

identification information of the charging point (103) of the EV charger (102) is stored in the vendor information unit (111) associated with the first energy distribution vendor (104), and identification information of the plurality of energy distribution vendors (104) are stored in the electric vehicle system information unit (112), and a plurality of information relating to energy transactions performed by the plurality of energy distribution vendors (104) is stored in a mother block chain (404) associated with the electric vehicle system information unit (112) of the EVSO (105), the method comprises, the charging point (103):

receiving identification information of the EV (101) from the EV (101) and energy transaction for the EV (101);

transmitting the received identification information from the EV (101) and identification information of the charging point (103) to the electrical vehicle system information unit for verification of identity of electric vehicle and identity of charging point for determining one or more sister block chains (401, 402 and 403) associated with one or more energy distribution vendors (104) from the plurality of energy distribution vendors (104) for storing the energy transaction information in the mother block chain (404) based on the identification information of the EV and charging point;(101);

receiving the result of determination of EV (101) being registered with the first energy distribution vendor or with the second energy distribution vendor wherein the EV (101) is registered with the first energy distribution vendor or with the second energy distribution vendor;

providing energy transaction information to the electrical vehicle system information unit for the electrical vehicle system information unit to store the energy transaction

information in one or more sister block chain (401, 402 and 403) associated with one or more energy distribution vendors (104) based on determination of EV (101) being registered with the first energy distribution vendor (104) or with the second energy distribution vendor (104); and

providing electrical charging to the EV (101) as per the energy transaction information.

2. The method as claimed in claim 1, wherein the storing of the energy transaction information in the one or more sister block chain (401, 402 and 403) comprises storing the energy transaction information in at least one of:

a. a sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) when the charging is being performed by the first energy distribution vendor (104), and

b. the sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) and the second energy distribution vendor (104), when the charging is being performed by the second energy distribution vendor (104).

3. The method as claimed in claim 1, wherein the identification information of the EV (101) comprises at least one of EV manufacturer (106) information associated with the EV (101), EV (101) registration information, EV (101) model information, and EV (101) owner information.

4. The method as claimed in claim 1, wherein the energy transaction information comprises at least one of identification information of the EV (101), identification information of the EV charging point (103) of the EV charger (102), identification information of the first or second energy distribution vendor (104), duration of charging the EV (101) at the charging point (103) of the EV charger (102), unit cost of energy transfer, total cost of charging the EV (101) at the charging point (103) of the EV charger (102).

5. The method as claimed in claim 1, wherein the energy transaction information is recorded according IEC 61850 protocol.

6. The method as claimed in claim 1, wherein current and voltage samples values of the EV charging is recorded using IEC 61850 9-2 protocol and transmitted to the first energy distribution vendor for performing remote diagnostic check of the EV (101).

7. The method as claimed in claim 1, wherein the energy transaction information stored in the mother block chain (404) is used by data miners to verify total energy consumed by the EV (101) during charging.

8. A charging point (103) for charging an EV charger (102) of an Electric Vehicle (EV) (101), wherein identification information of the EV (101) is stored in a vendor information unit (111) associated with a first energy distribution vendor (104) or a second energy distribution vendor (104) among plurality of energy distribution vendors (104) and with an electric vehicle system information unit (112) associated with an electric vehicle system operator (EVSO) (105),

wherein the charging point (103) of the EV charger (102) is communicably connected to the electrical vehicle system information unit,

identification information of the charging point (103) of the EV charger (102) is stored in the vendor information unit (111) associated with the first energy distribution vendor (104), and identification information of the plurality of energy distribution vendors (104) are stored in the electric vehicle system information unit (112), and a plurality of information relating to energy transactions performed by the plurality of energy distribution vendors (104) is stored in a mother block chain (404) associated with the electric vehicle system information unit (112) of the EVSO (105), the charging point (103), comprises:

a processor; and

a memory communicatively coupled to the processor, wherein the memory stores the processor instructions, which, on execution, causes the processor to:

receive identification information of the EV (101) from the EV (101) and energy transaction for the EV (101);

transmit the received identification information from the EV (101) and identification information of the charging point (103) to the electrical vehicle system information unit for verification of identity of electric vehicle and for determining one or more sister block chains (401, 402 and 403) associated with one or more energy distribution vendors (104) from the plurality of energy distribution vendors (104) for storing an energy transaction information and for storing an energy transaction information and for storing the energy transaction information in the mother block chain (404) based on the identification information of the EV (101);

receive the result of determination of EV (101) being registered with the first energy distribution vendor (104) or with the second energy distribution vendor (104) wherein the EV (101) is registered with the first energy distribution vendor (104) or with the second energy distribution vendor;

provide energy transaction information to the electrical vehicle system information unit for the electrical vehicle system information unit to store the energy transaction information in one or more sister block chain (401, 402 and 403) associated with one or more energy distribution vendors (104) based on determination of EV (101) being registered with the first energy distribution vendor (104) or with the second energy distribution vendor (104); and

provide electrical charging to the EV (101) as per the energy transaction information.

9. The charging point (103) as claimed in claim 8, wherein the processor is configured to store the energy transaction information in the one or more sister block chain (401, 402 and 403) comprises storing the energy transaction information in at least one of:

a. a sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) when the charging is being performed by the first energy distribution vendor (104), and

b. the sister block chain (401, 402 and 403) associated with the first energy distribution vendor (104) and the second energy distribution vendor (104), when the charging is being performed by the second energy distribution vendor (104).

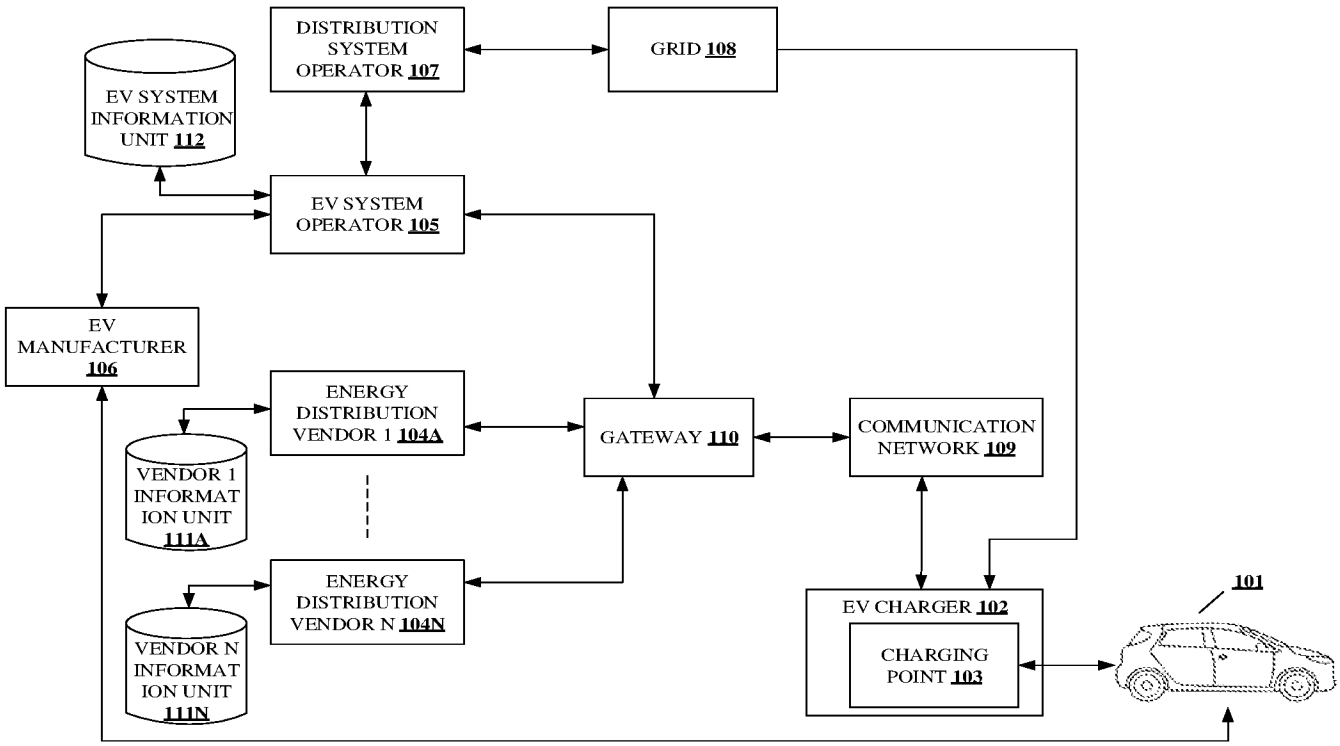
DISTRIBUTION SYSTEM OPERATOR 107
GRID 108
EV SYSTEM INFORMATION UNIT 112
EV SYSTEM OPERATOR 105
EV MANUFACTURER 106
ENERGY DISTRIBUTION VENDOR 1 104A
GATEWAY 110
COMMUNICATION NETWORK 109
VENDOR 1 INFORMATION UNIT 111A
ENERGY DISTRIBUTION VENDOR N 104N
VENDOR N INFORMATION UNIT 111N
EV CHARGER 102
CHARGING POINT 103
101

FIGURE 1

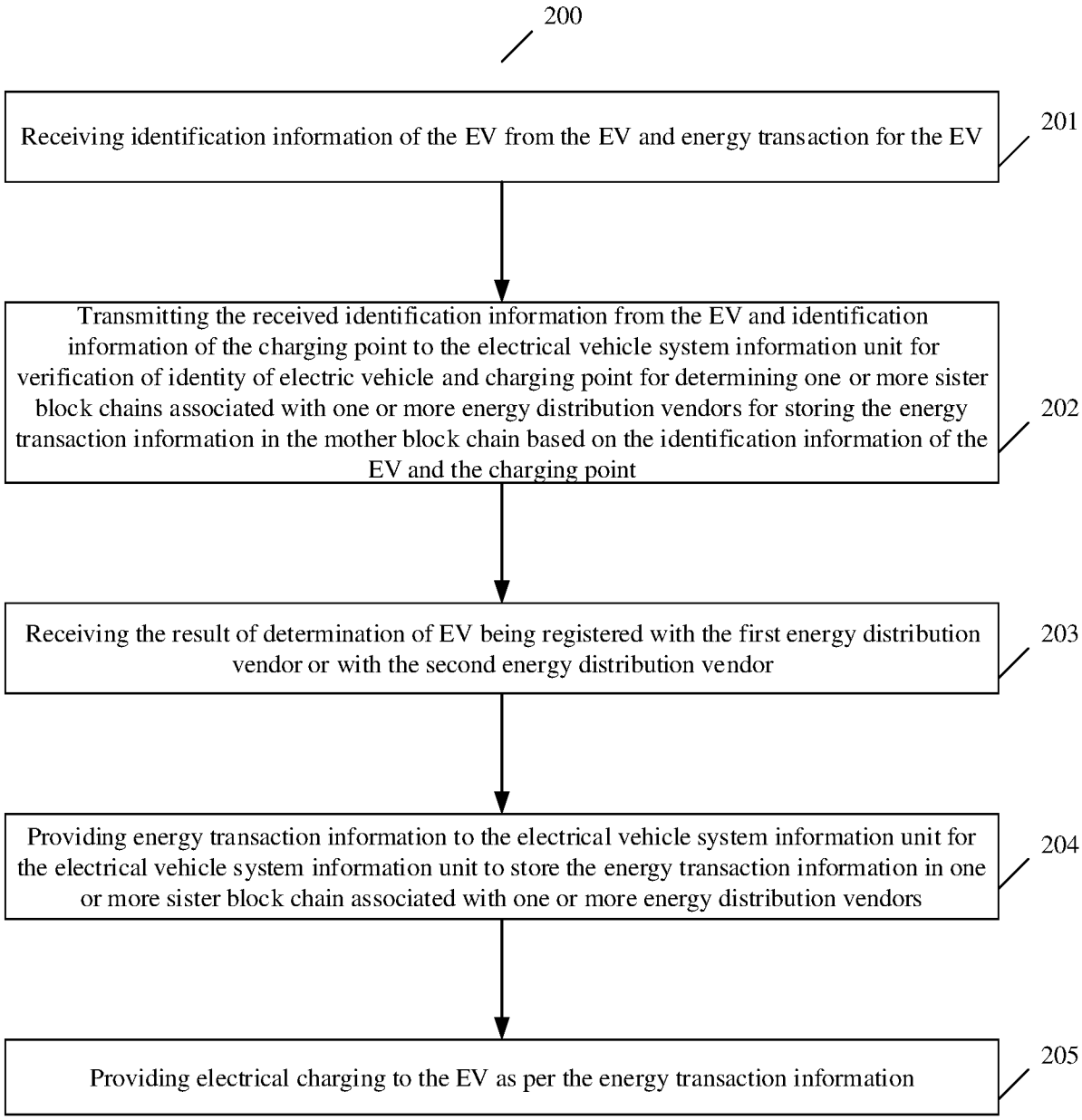
200
Receiving identification information of the EV from the EV and energy transaction for the EV
201
Transmitting the received identification information from the EV and identification information of the charging point to the electrical vehicle system information unit for verification of identity of electric vehicle and charging point for determining one or more sister block chains associated with one or more energy distribution vendors for storing the energy transaction information in the mother block chain based on the identification information of the EV and the charging point
202
Receiving the result of determination of EV being registered with the first energy distribution vendor or with the second energy distribution vendor
203
Providing energy transaction information to the electrical vehicle system information unit for the electrical vehicle system information unit to store the energy transaction information in one or more sister block chain associated with one or more energy distribution vendors
204
Providing electrical charging to the EV as per the energy transaction information
205

FIGURE 2

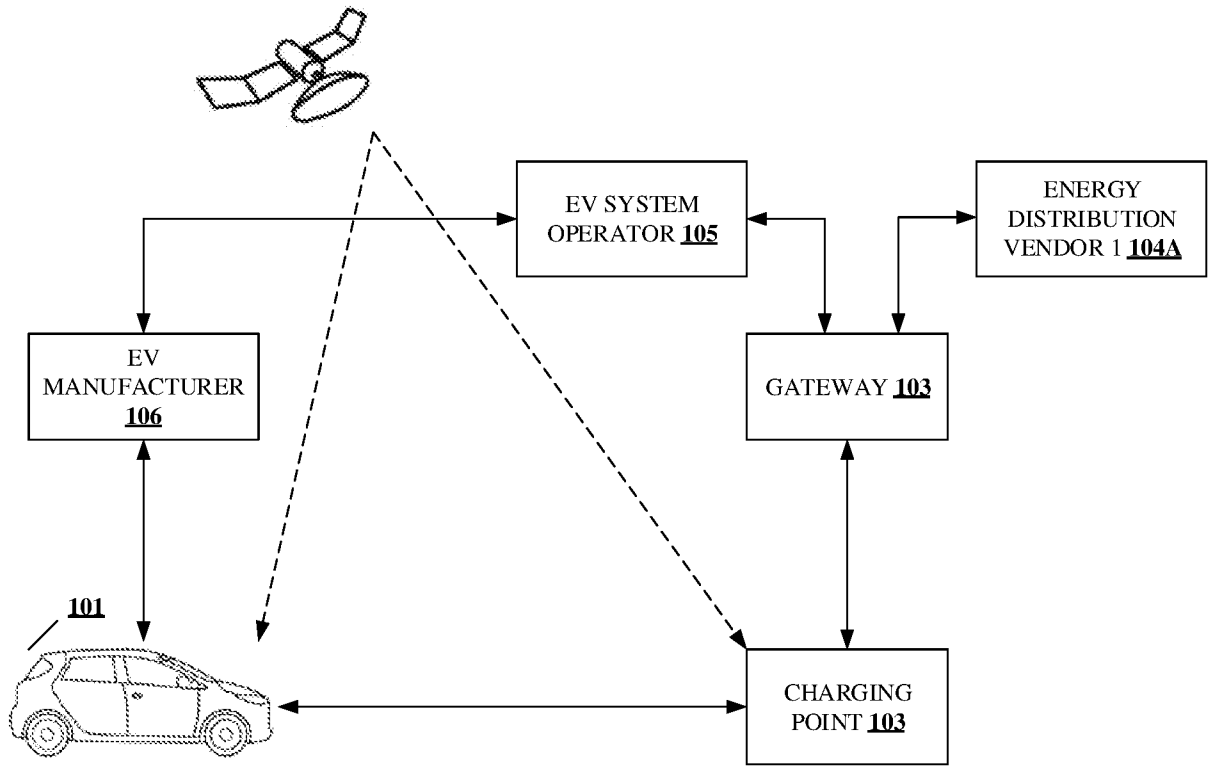
EV SYSTEM OPERATOR 105
ENERGY DISTRIBUTION VENDOR 1 104A
EV MANUFACTURER 106
GATEWAY 103
101
CHARGING POINT 103

FIGURE 3

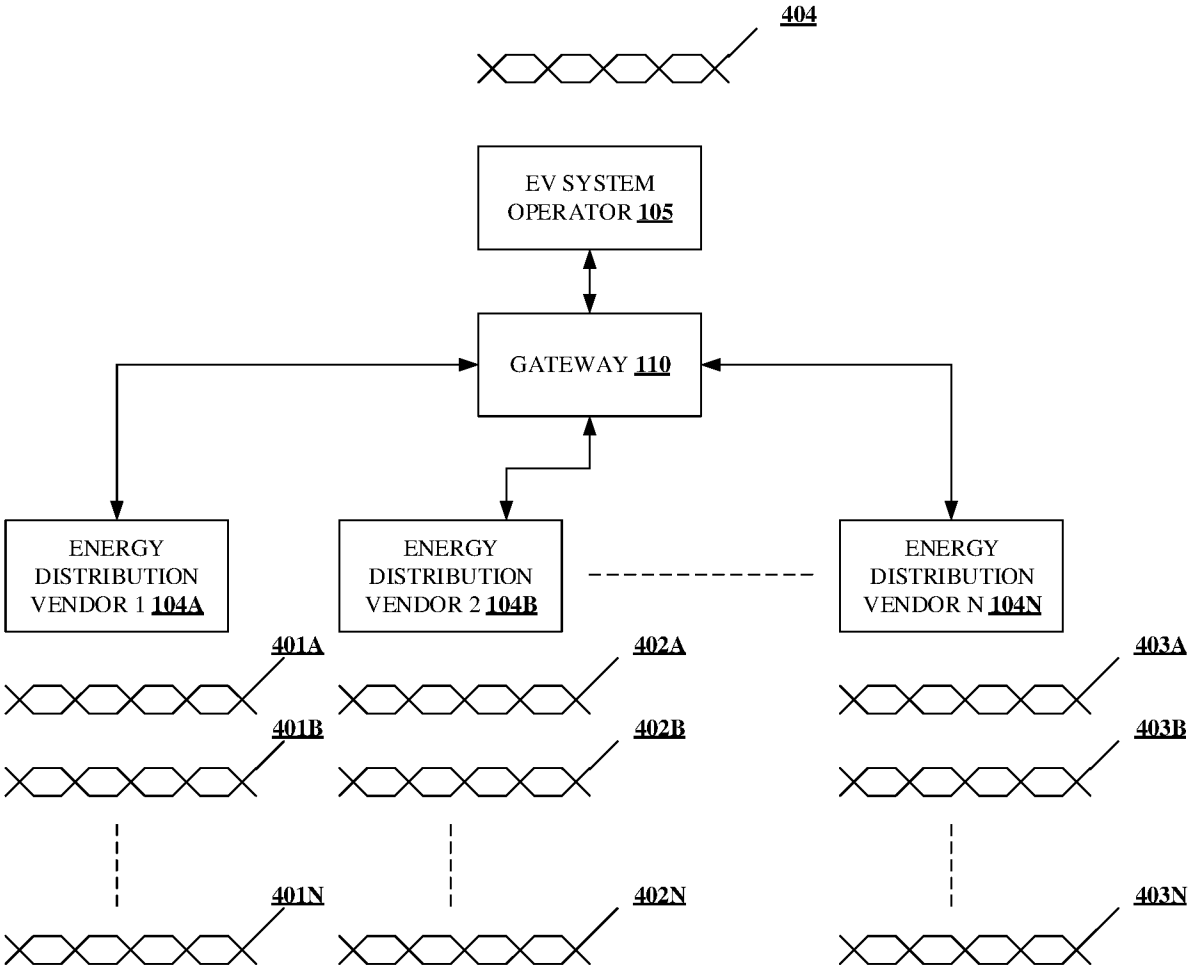
404
EV SYSTEM OPERATOR 105
GATEWAY 110
ENERGY DISTRIBUTION VENDOR 1 104A
ENERGY DISTRIBUTION VENDOR 2 104B
ENERGY DISTRIBUTION VENDOR N 104N
401A
401B
401N
402A
402B
402N
403A
403B
403N

FIGURE 4

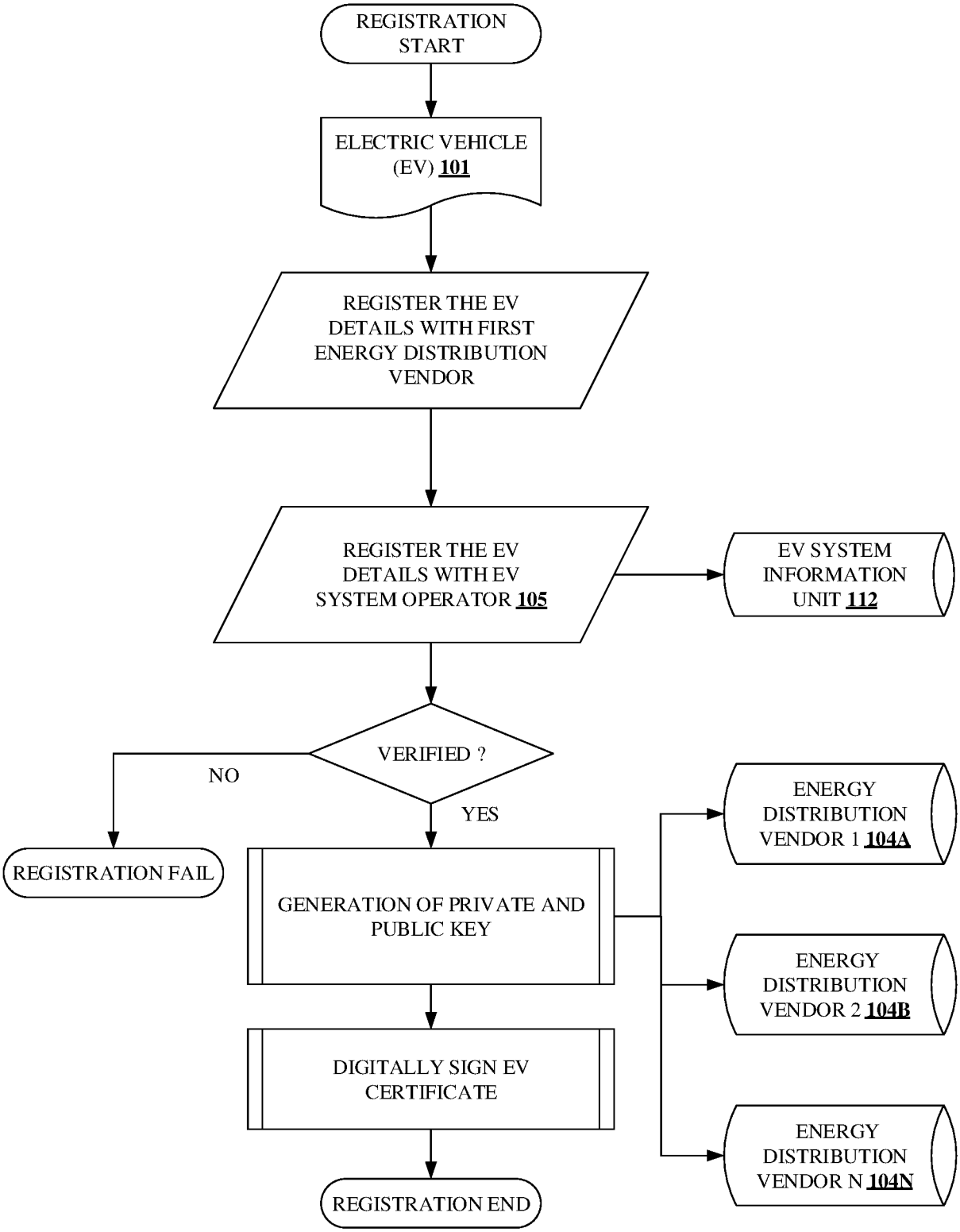
REGISTRATION START
ELECTRIC VEHICLE (EV) 101
REGISTER THE EV DETAILS WITH FIRST ENERGY DISTRIBUTION VENDOR
REGISTER THE EV DETAILS WITH EV SYSTEM OPERATOR 105
EV SYSTEM INFORMATION UNIT 112
VERIFIED ?
NO
YES
REGISTRATION FAIL
GENERATION OF PRIVATE AND PUBLIC KEY
ENERGY DISTRIBUTION VENDOR 1 104A
ENERGY DISTRIBUTION VENDOR 2 104B
ENERGY DISTRIBUTION VENDOR N 104N
DIGITALLY SIGN EV CERTIFICATE
REGISTRATION END

FIGURE 5

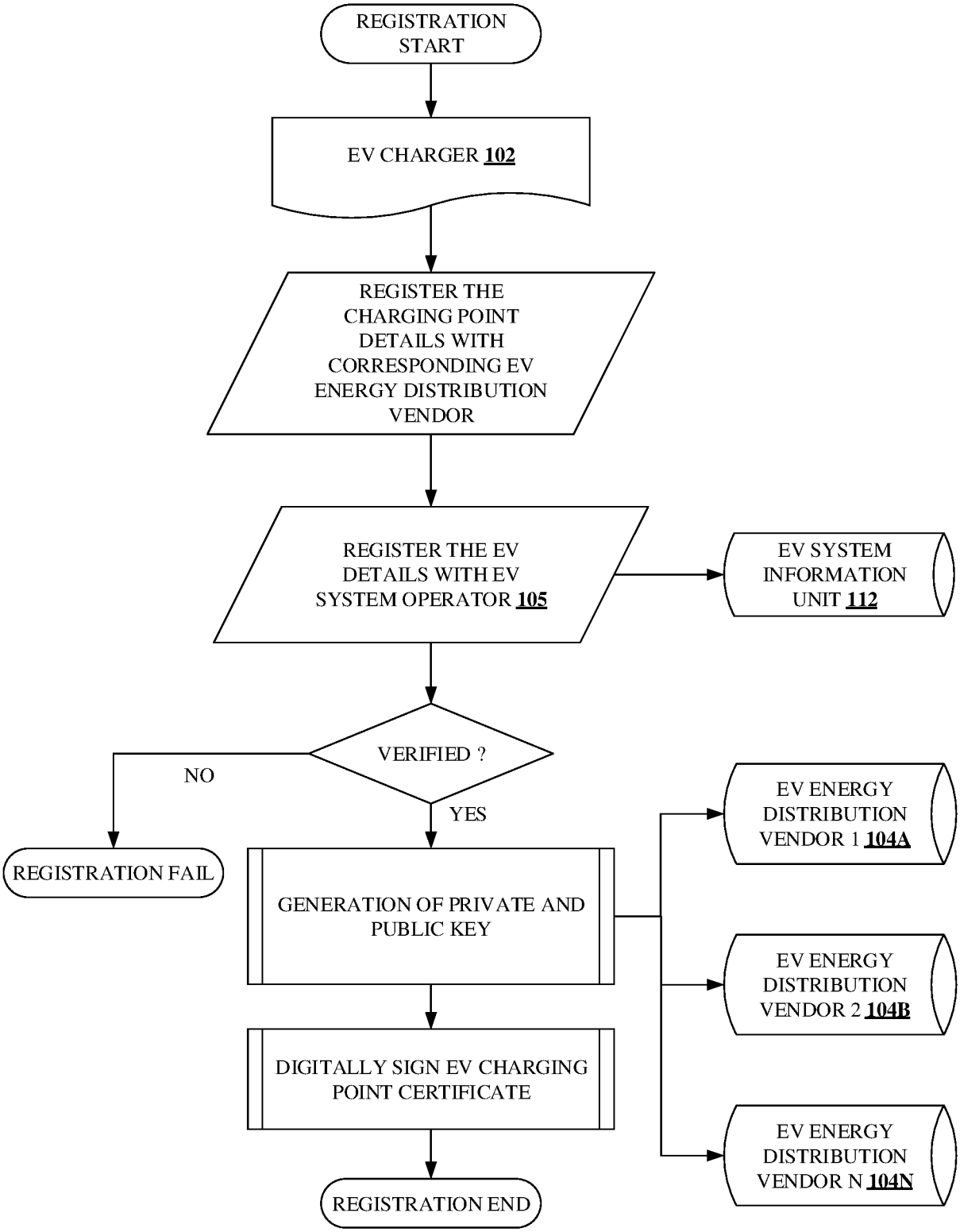
REGISTRATION START
EV CHARGER 102
REGISTER THE CHARGING POINT DETAILS WITH CORRESPONDING EV ENERGY DISTRIBUTION VENDOR
REGISTER THE EV DETAILS WITH EV SYSTEM OPERATOR 105
EV SYSTEM INFORMATION UNIT 112
VERIFIED ?
NO
YES
REGISTRATION FAIL
GENERATION OF PRIVATE AND PUBLIC KEY
EV ENERGY DISTRIBUTION VENDOR 1 104A
EV ENERGY DISTRIBUTION VENDOR 2 104B
EV ENERGY DISTRIBUTION VENDOR N 104N
DIGITALLY SIGN EV CHARGING POINT CERTIFICATE
REGISTRATION END

FIGURE 6

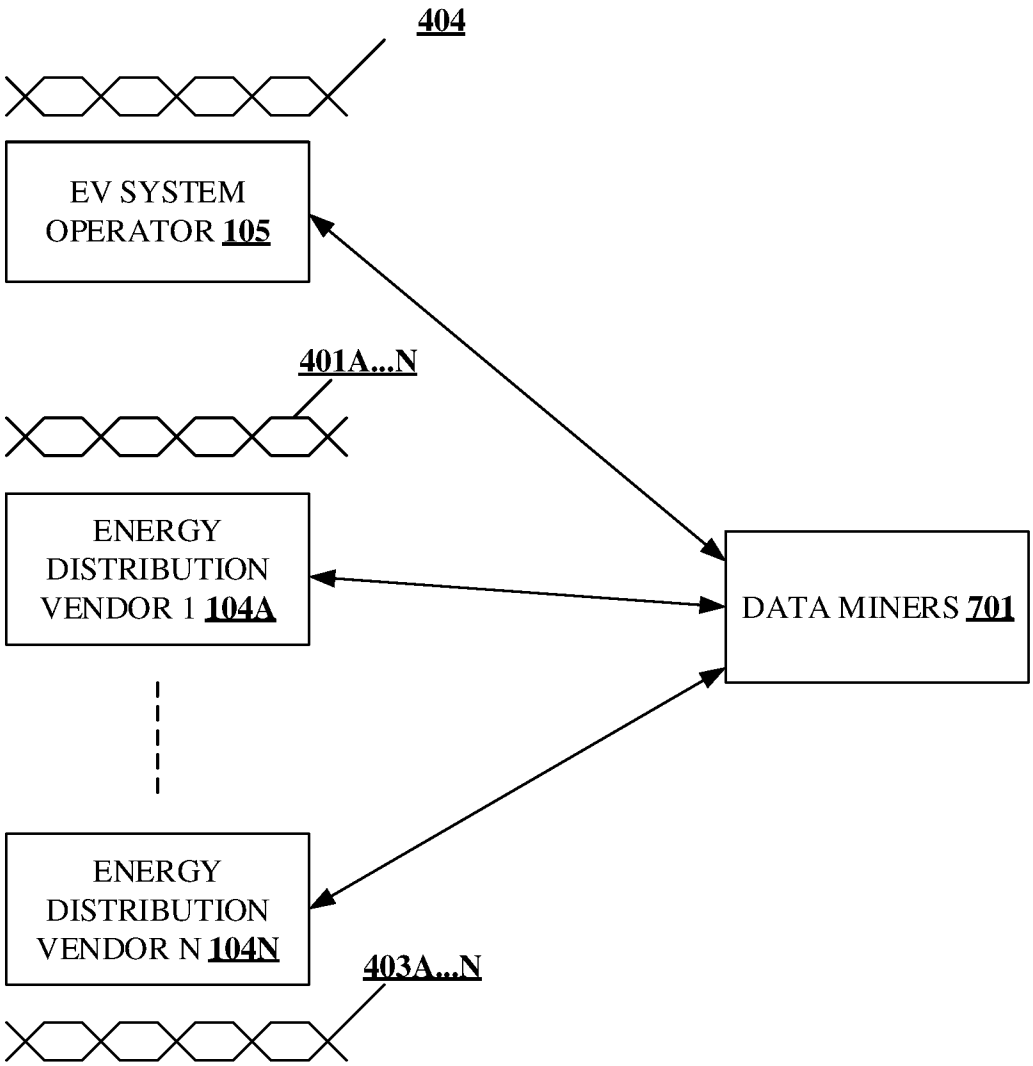
404
EV SYSTEM OPERATOR 105
401A...N
ENERGY DISTRIBUTION VENDOR 1 104A
DATA MINERS 701
ENERGY DISTRIBUTION VENDOR N 104N
403A...N

FIGURE 7

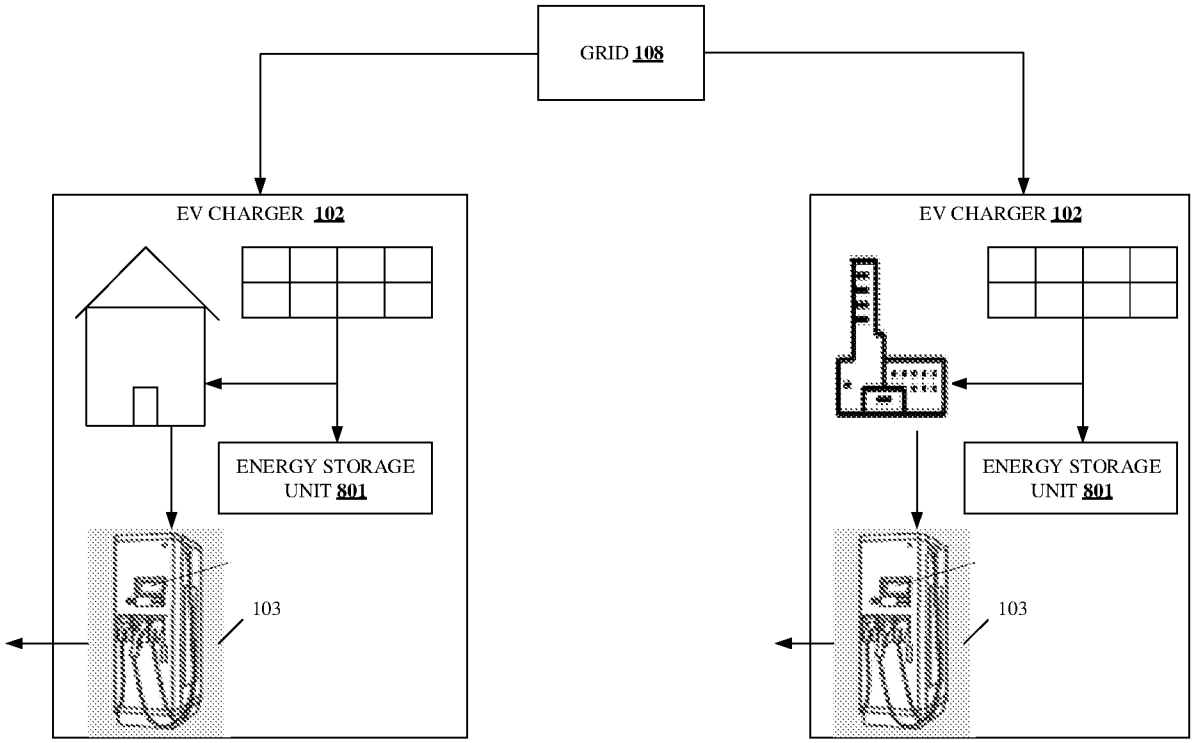
GRID 108
EV CHARGER 102
ENERGY STORAGE UNIT 801
103
EV CHARGER 102
ENERGY STORAGE UNIT 801
103

FIGURE 8

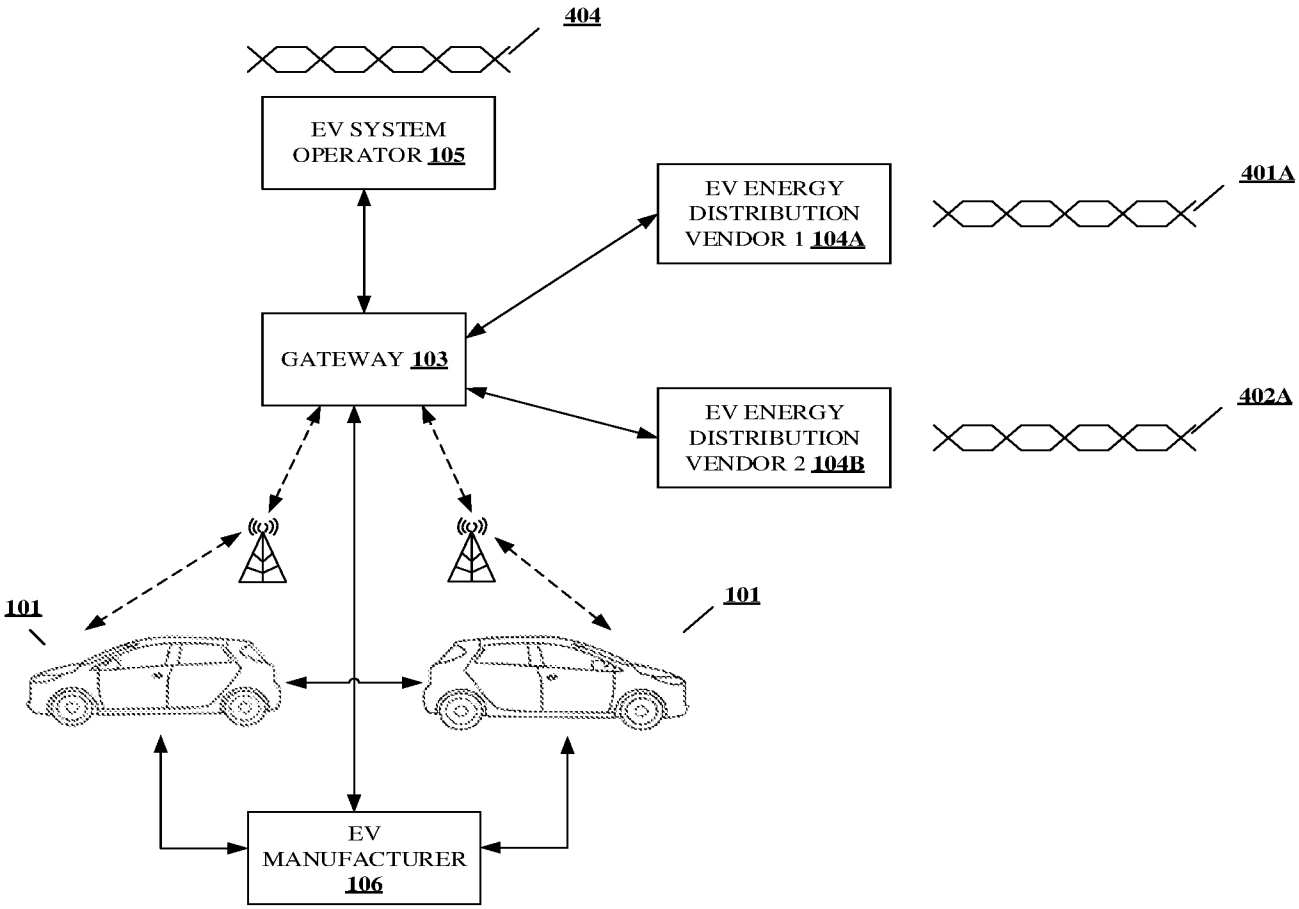
404
EV SYSTEM OPERATOR 105
EV ENERGY DISTRIBUTION VENDOR 1 104A
401A
GATEWAY 103
EV ENERGY DISTRIBUTION VENDOR 2 104B
402A
101
101
EV MANUFACTURER 106

FIGURE 9

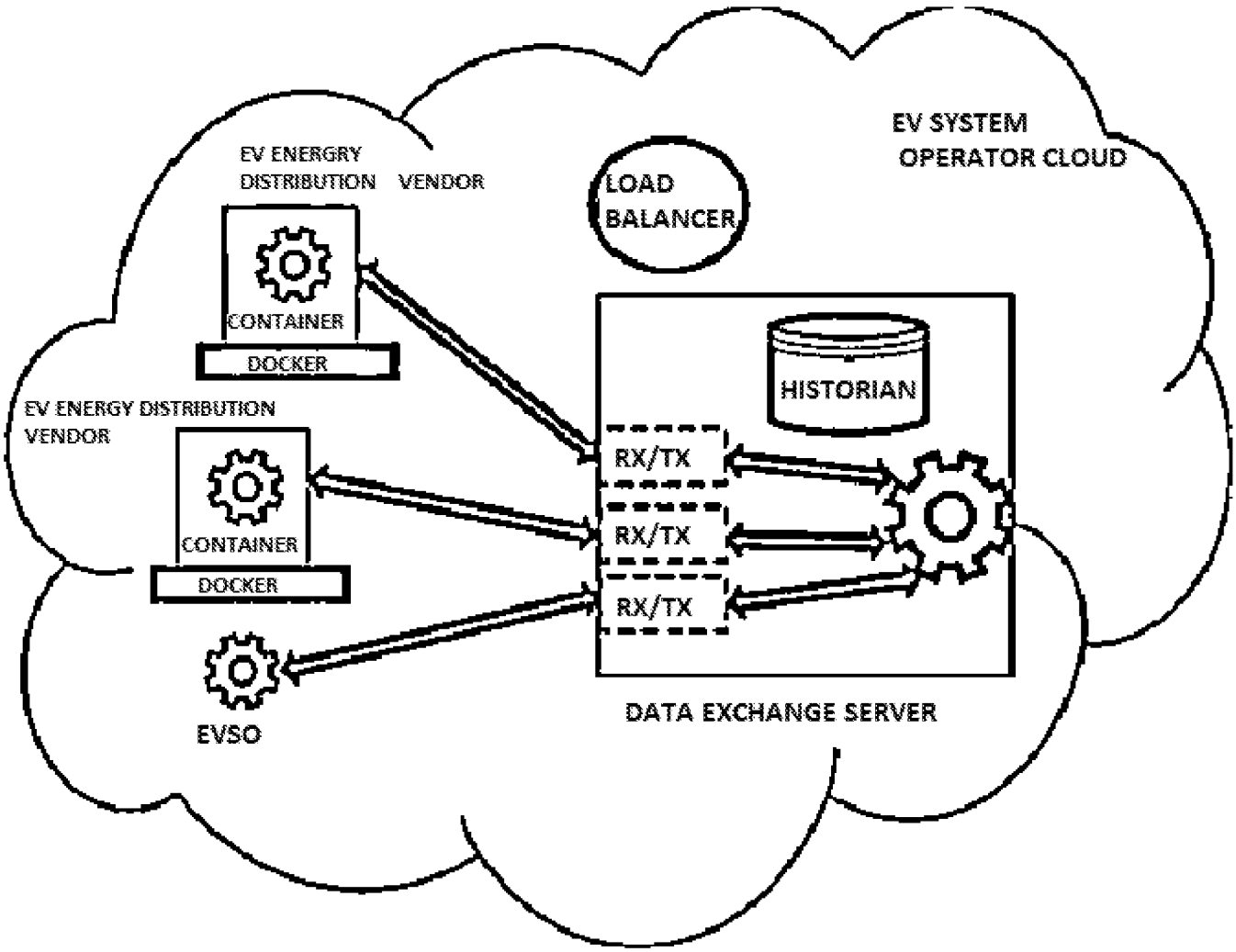
EV SYSTEM
OPERATOR CLOUD
EV ENERGRY
DISTRIBUTION VENDOR
LOAD
BALANCER
CONTAINER
DOCKER
HISTORIAN
EV ENERGY DISTRIBUTION
VENDOR
RX/TX
RX/TX
CONTAINER
DOCKER
RX/TX
EVSO
DATA EXCHANGE SERVER

FIGURE 10

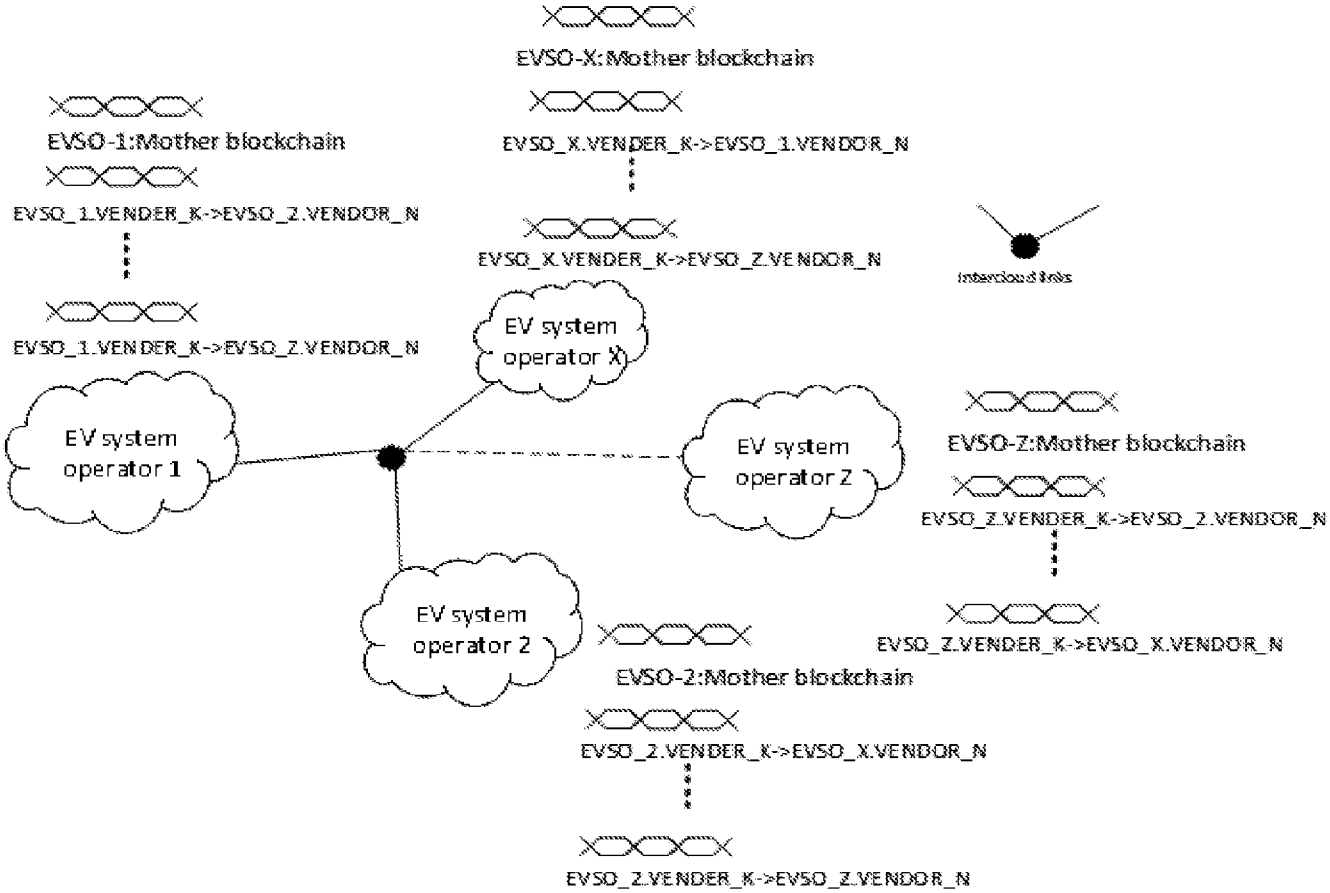
EVSO-X:Mother blockchain
EVSO-1:Mother blockchain
EVSO_X.VENDER_K->EVSO_1.VENDOR_N
EVSO_1.VENDER_K->EVSO_Z.VENDOR_N
EVSO_X.VENDER_K->EVSO_Z.VENDOR_N
Interclound links
EVSO_1.VENDER_K->EVSO_Z.VENDOR_N
EV system operator X
EV system operator 1
EV system operator Z
EVSO-Z:Mother blockchain
EVSO_Z.VENDER_K->EVSO_Z.VENDOR_N
EV system operator 2
EVSO_Z.VENDER_K->EVSO_X.VENDOR_N
EVSO-2:Mother blockchain
EVSO_2.VENDER_K->EVSO_X.VENDOR_N
EVSO_Z.VENDER_K->EVSO_Z.VENDOR_N

FIGURE 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/055152

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60L53/65 B60L53/66 H04L9/32 G06Q20/40 G06F21/64
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60L H04L G07G G06Q G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018/272886 A1 (STÖCKER CARSTEN [DE] ET AL) 27 September 2018 (2018-09-27) paragraph [0002] - paragraph [0018]; claims 1,18; figure 1 paragraph [0019] - paragraph [0053] paragraph [0080] - paragraph [0110]; figures 2, 3 paragraph 166 - line 181; figure 9	1-9
A	US 2018/111494 A1 (PENILLA ANGEL A [US] ET AL) 26 April 2018 (2018-04-26) paragraph [0004] - paragraph [0016]; figures 1-3 paragraph [0131]	1,7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2020	02/09/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Utz, Tilman

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/055152

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 2017169648 A1	15-06-2017
		US 2018111494 A1	26-04-2018
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		US 2020006969 A1	02-01-2020
		US 2020144838 A1	07-05-2020