A method for remotely managing a sensor network topology includes: receiving a device management DM command sent by a device management server, where the DM command acts on a preconstructed management object MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology; and managing a sensor network according to the DM command, where the management includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology. By adopting the present invention, remote topology management of a sensor network successive to an M2M gateway can be implemented and the complexity for implementing the management is reduced.

A gateway receives a DM command sent by a device management server, where the DM command acts on a preconstructed MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe the sensor network topology, or a node configured to modify the sensor network topology.

The gateway manages the sensor network according to the DM command, where the management includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology.

FIG. 1
Description

[0001]  This application claims priority to Chinese Patent Application No. 201010527473.9, filed with the Chinese Patent Office on October 27, 2010 and entitled "METHOD FOR REMOTELY MANAGING A SENSOR NETWORK TOPOLOGY AND GATEWAY", which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002]  The present invention relates to the communications technologies, and in particular, to a method for remotely managing a sensor network topology and a gateway.

BACKGROUND OF THE INVENTION

[0003]  The machine-to-machine communications (Machine-to-Machine Communications, M2M) is a type of networked application and service with machine-to-machine intelligent interactions being the core. The M2M communications implements data communications without human intervention by embedding wireless or wired communication modules and application processing logic in machines, so as to satisfy user's informatization requirements in the aspects such as detecting, directing and dispatching, and data collection and measurement. A conventional M2M system architecture includes M2M terminals, an M2M gateway, an M2M service platform, and an M2M application platform, where the M2M terminals may be a sensor, a microcontroller, and the like. The M2M terminals are connected to the M2M gateway by using the technology of stub sensor network (for example, the ZigBee and the BlueTooth) and further connected to the M2M service platform through the M2M gateway using a remote access technology (for example, a 2G/3G wireless cellular network). Moreover, all types of M2M application platform (for example, electric meter reading and intelligent traffic) acquire, through the M2M service platform, data collected by the M2M terminals, or remotely control and manage the M2M terminals in a sensor network.

[0004]  The management of a remote device is an important function of an M2M system, that is, the M2M application platform or an M2M service provider is required to perform daily management and maintenance of the M2M terminals in the stub sensor network remotely through the M2M service platform and the M2M gateway. Because the stub sensor network generally performs networking in a self-organized manner, sometimes, it is difficult to predict a network topology and a working status of a device. Therefore, an administrator needs to discover a topology to adjust the topology. The topology discovery is to find which devices are contained in the sensor network and the communication connection relationships among the devices through a remote network topology management function. The topology adjustment is to perform proper manual adjustment when necessary.

[0005]  In the prior art, remote device management technologies based on a wide area network mainly include the device management (Device Management, DM) regulations defined by the Open Mobile Alliance (OMA). The technology can implement remote management for the M2M gateway through operating management object (Management Object, MO) data on the M2M gateway, but still does not support remote topology management for a stub sensor network through the M2M gateway. In another aspect, in the field of sensor networks, the ZigBee gateway device regulations define a technology of remote network management based on an Internet protocol (Internet Protocol, IP) bearer. The technology can provide a simple remote ZigBee network device and an operation method for service discovery rather than directly provide topology information of the sensor network and a topology adjustment method. The above function can only be implemented by further combining other ZigBee management commands, where the operation method is complicated. Other sensor network protocols (for example, the BlueTooth) do not provide a method for remotely managing a topology through a gateway.

[0006]  In the prior art, no solution is provided for remote topology management of a sensor network successive to an M2M gateway or the management is difficult and complicated.

SUMMARY OF THE INVENTION

[0007]  Embodiments of the present invention provide a method for remotely managing a sensor network topology and a gateway, so as to implement remote topology management for a sensor network successive to an M2M gateway, thereby reducing the complexity of implementing the management.

[0008]  An embodiment of the present invention provides a method for remotely managing a sensor network topology, including:

- receiving a DM command sent by a device management server, where the DM command acts on a pre-constructed MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology; and
- managing a sensor network according to the DM command, where the managing includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology.

[0009]  An embodiment of the present invention provides a gateway, including:

- a receiving module, configured to receive a DM com-
mand sent by a device management server, where the DM command acts on a preconstructed MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology; and a management module, configured to manage a sensor network according to the DM command, where the management includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology.

[0010] It can be seen from the above technical solutions that, in the method for remotely managing a sensor network topology and the gateway in the embodiments of the present invention, a DM command is received through information of a preconstructed topology and a uniform management interface (that is, a DM protocol interface) consistent with the existing remote device management technologies is used, so that an M2M service platform (or other device management servers) can perform remote topology management and maintenance not only on the M2M gateway, but also on a sensor network connected to the M2M gateway, thereby reducing the complexity of implementing the management.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] To illustrate the technical solutions in the embodiments of the present invention or in the prior art more clearly, the following briefly describes the accompanying drawings required for describing the embodiments of the prior art. Apparently, the accompanying drawings in the following description show some embodiments of the present invention, and persons of ordinary skill in the art can derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a schematic flow chart of a method according to Embodiment 1 of the present invention;
FIG. 2 is a tree-like MO structural model for implementing remote management of a sensor network topology according to an embodiment of the present invention;
FIG. 3 is a schematic diagram of an MO child tree of a ZigBee device according to an embodiment of the present invention;
FIG. 4 is a schematic diagram of an MO child tree of a BlueTooth device according to an embodiment of the present invention;
FIG. 5A and FIG. 5B is a schematic flow chart of a method according to Embodiment 2 of the present invention;
FIG. 6 is a schematic flow chart of a method according to Embodiment 3 of the present invention;
FIG. 7A and FIG. 7B is a schematic flow chart of a method according to Embodiment 4 of the present invention;
FIG. 8 is a schematic flow chart of a method according to Embodiment 5 of the present invention;
FIG. 9 is a schematic flow chart of a method according to Embodiment 6 of the present invention;
FIG. 10 is a schematic flow chart of a method according to Embodiment 7 of the present invention;
FIG. 11A and FIG. 11B is a schematic flow chart of a method according to Embodiment 8 of the present invention; and
FIG. 12 is a schematic structural diagram of a gateway according to Embodiment 9 of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0012] To make the objectives, technical solutions, and advantages of the present invention more comprehensible, the following clearly and completely describes the technical solutions according to the embodiments of the present invention with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the embodiments in the following description are merely a part of rather than all the embodiments of the present invention. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0013] FIG. 1 is a schematic flow chart of a method according to Embodiment 1 of the present invention. The method includes the following steps:

Step 11: A gateway receives a DM command sent by a device management server, where the DM command acts on a preconstructed MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology.

[0014] The node configured to describe a sensor network topology includes at least one of:

a first MO node configured to describe overall information of the sensor network, in which, for example, referring to the topology tree shown in FIG. 2, the first MO node includes at least one of: Topo/NetWorkId and Topo/TopoTyp;
a second MO node configured to describe characteristic information of each sensor device and/or information of a topology connection relationship among the sensor devices, in which, for example, referring to the topology tree shown in FIG. 2, the second MO node includes at least one of: Topo/DevList/<x>/DevId, Topo/DevList/<x>/Name, Topo/DevList/<x>/DevTyp, Topo/DevList/<x>/LocAddr, and Topo/DevList/<x>/Neighbors (of course, it can be understood that a child node "Operations" under
"Neighbors" is not included); and a third MO node configured to describe information about a service provided by each sensor device, in which, for example, referring to the topology tree shown in FIG. 2, the third MO node includes the following item: Topo/DevList/<x>/Service (of course, it can be understood that the child node "Operations" under "Neighbors" is not included).

[0015] The node configured to discover the sensor network topology includes:

- a fourth MO node configured to discover the topology connection relationship among the sensor devices and/or the information about a service provided by each sensor device, in which, for example, referring to the topology tree shown in FIG. 2, the second MO node includes at least one of: Topo/Operations/DiscTopo and Topo/Operations/DiscTopoAndServices.

[0016] The node configured to modify a sensor network topology includes at least one of:

- a fifth MO node configured to modify the topology connection relationship among the sensor devices, in which, for example, referring to the topology tree shown in FIG. 2, the fifth MO node includes at least one of: Topo/DevList/<x>/Operations and Topo/DevList/<x>/Neighbors/<x>/Operations; and
- a sixth MO node configured to modify the information about a service provided by the sensor devices, in which, for example, referring to the topology tree shown in FIG. 2, the sixth MO node includes the following item: Topo/DevList/<x>/Services/<x>/Operations.

[0017] Furthermore, this embodiment may also include:

- constructing a topology tree, where the topology tree is composed of a plurality of MO nodes.

[0018] The constructed topology tree is shown in FIG. 2. FIG. 2 is a tree-like MO structural model for implementing remote management of a sensor network topology in the embodiment of the present invention, where each block indicates one MO node or its one child node in a management tree. For the sake of conciseness, FIG. 2 does not list information of all nodes in the management tree, but only lists the information of nodes closely related to the embodiment of the present invention.

[0019] It should be noted that, different symbols may be marked after node names in the blocks, which are as follows: "?" indicates that the node may have 0 or 1 instance; "***" indicates that the node may have 0 or more instances; no symbol indicates that the node may have 1, and only 1, instance; and "*" indicates that the node may have 1 or more instances. When a node name is "<x>", it indicates that the node name may be assigned at will as long as no repetition occurs among the plurality of instances.

[0020] The meanings and usages of each MO node are introduced one by one in the following:

The Topo node records all MO information for remotely managing a sensor network topology, the MO information generally includes: overall characteristic information and a management method of a sensor network, information and a management method of each sensor network device, and information and a management method of a topology relationship among the sensor network devices. The Topo node may be placed at a proper location (under a root node or other MO leaf nodes) in the management tree of the gateway according to requirements of specific implementation. Specifically, the Topo node includes the following child nodes:

1) NetworkID: used to describe information of an identifier of a sensor network managed by the gateway. For example, in the case of a ZigBee network, the NetworkID corresponds to a 16-bit PANID parameter and/or a 64-bit ExtendedPANID parameter; and in the case of a BlueTooth network, the NetworkID corresponds to a device identifier of a master device (Master) in the network. The information may be extracted from a management information base of the gateway device. 2) TopoTyp: used to describe a topology type of the sensor network, which may be a ring topology, star topology, tree topology, mesh topology, bus topology, hybrid topology, and the like. The information may be decided according to a specific technology sensor network connected to the gateway device (for example, a BlueTooth network uses a star structure and a ZigBee network uses a tree structure or mesh structure), or the information may be further extracted from the management information base of the gateway device. 3) Ext: used to extend other nodes to describe other topology characteristics of the sensor network managed by the gateway. 4) Operations: used to provide an overall operation method for the topology management for the sensor network managed by the gateway. The following executable child nodes are further included:

41) DiscTopo: indicating that the gateway discovers and reports information of the sensor network topology. The node may further include a child node: 411) Notification: where the value of the node may be TRUE or FALSE, used to indicate whether the gateway proactively notifies a remote device management server (M2M service platform) of a subsequent change status of the sensor network topol-
ogy, and some filtering conditions (for example, the topology changes related to which device need to be notified, the frequency of the notification, and which device management servers the notification need to be sent to) may be further included.

42) DiscTopoAndService: indicating that the gateway discovers and reports information of the sensor network topology, and discovers and reports service and application provided by each sensor network device. The node may further include the following child node:

421) Notification: where the value of the node may be TRUE or FALSE, used to indicate whether the gateway proactively notifies a remote device management server (M2M service platform) of the subsequent change status of the sensor network topology and change status of the service of the sensor device. And some filtering conditions (for example, the topology and service changes related to which device require to be notified, the frequency of the notification, and which device management servers the notification needs to be sent to) may be further included.

43) Ext: indicating that other topology management operation methods may also be extended for different sensor network technologies. For example, for a ZigBee network, a FormNetwork node and a StartRouter node may be extended, used to indicate that the gateway device acts as a coordinator to reconstruct the ZigBee network and acts as a router to rejoin in the network, respectively. Accordingly, their respective child nodes may be further extended to store corresponding operation parameters.

5) DevList: used to describe information of a topology related to each sensor network device managed by the gateway and a topology management operation method related to each sensor network device managed by the gateway, where the information of each sensor network device is represented by one <x> node under the DevList. Moreover, the <x> node further includes the following child nodes:

51) DevId: the identifier of a sensor device, where the specific form of the DevId may differ in different sensor network technologies. For example, ZigBee devices may be classified into a coordinator (Coordinator), a router (Router), and an end device (End Device); while BlueTooth devices may be classified into a master device (Master), a slave device (Slave), or may be classified into a device of a basic rate, a device with an enhanced rate, a high-speed device, and an energy saving device.

52) DevTyp: the type of a sensor device, where a specific form of the DevTyp may differ in different sensor network technologies. For example, ZigBee devices may be classified into a coordinator (Coordinator), a router (Router), and an end device (End Device); while BlueTooth devices may be classified into a master device (Master), a slave device (Slave), or may be classified into a device of a basic rate, a device with an enhanced rate, a high-speed device, and an energy saving device.

53) Name: the name or nickname of a device.

54) LocAddr: the local address of a device for local communications of a sensor network, where the specific form of the LocAddr may differ in different sensor network technologies. For example, a 16-bit network address of a ZigBee device and a 3-bit LT_ADDR of a BlueTooth device. For some sensor network devices which may have a plurality of local addresses for different working modes or purposes (for example, a BlueTooth device may further include 8-bit PM_ADDR and AR_ADDR for a Park working mode), the node may also be configured to describe the plurality of different local addresses by including a plurality of child nodes.

55) Services: describing service provided by a sensor device, where each service is described by an MO child tree included in a corresponding <x> node, and the specific form of the MO child tree may differ in different sensor network technologies. For example, service of a ZigBee device and service of a BlueTooth device may be described by an MO child tree shown in FIG. 3 and that shown in FIG. 4, respectively.

FIG. 3 is a schematic diagram of an MO child tree of service of a ZigBee device in an embodiment of the present invention. For each ZigBee device, a service provided by the ZigBee device is run on a corresponding endpoint (EndPoint) and has a corresponding group and binding relationship, so each service <x> may be described by MO nodes in the following:

31) EPNum: the sequence number (1-240) of an EndPoint for running the service.

32) Descriptor: the descriptor for describing the service, where the specific content may include, according to the ZigBee regulations, a simple descriptor (SimpleDescriptor) and a complex descriptor (ComplexDescriptor).

33) Groups: used to describe information of a group where the service belongs to, where each group where the service belongs to is identified by an <x> node. The following child nodes may be further included:

331) GroupName: used to describe a group
name which is readable by a user.

332) GroupId: used to describe a group identifier, which specifically is a 16-bit group address.

333) Remove: indicating that the node is an executable node, configured to instruct the removal of a current service from a current group.

34) Bindings: used to describe information related to bindings of a current service, where each binding relationship is represented by one <x>, and the following child nodes are further included:

341) ClusterId: the identifier of a cluster bound with a current service.

342) DstMode: the mode of a bound destination address, for example, a group mode or a single device mode.

343) DstAddr: a bound destination address.

344) DstEP: the sequence number of an EndPoint of a bound destination device, which is necessary only when the DstMode is the single device mode.

345) Unbind: the node is an executable node, used to instruct the removal of a current binding relationship of a current service.

35) Operations: used to provide a management operation method for a current service, and the following executable child nodes are included:

351) AddGroup: used to add a current service to specified groups, where each group is described by one <x> node, and child nodes, namely, GroupId and GroupName, used to specify an identifier and a name of the specified group are further included.

352) RemoveAllGroups: used to remove a current service from all groups where the service is located.

353) Bind: used to add several pieces of binding information for a current service, where each piece of binding information is described by an <x> node, and the child nodes, namely, ClusterId, DstModeId, DstAddr, and DstEP, the meanings of which are the same as those of child nodes corresponding to the Services/<x>/Bindings/<x> node.

354) RemoveAllBindings: used to remove all binding relationships of a current service.

FIG. 4 is a schematic diagram of an MO child tree of service of a BlueTooth device according to an embodiment of the present invention. Referring to FIG. 4, for each BlueTooth device, each service <x> provided by the BlueTooth device is described by a series of attributes (Attribute). Each attribute is described by one <Attribute> MO node, which the following child nodes are further included:

AttributeId: the attribute identifier defined by the BlueTooth regulations; and

AttributeValue: the value of an attribute.

56) Neighbors: describing a topology connection relationship between the sensor network device and a neighbor device, where each neighbor device is represented by one <x> node, and the following child nodes are further included:

561) Ref: directed to a link reference for describing the location of an MO node of the neighbor device (that is, Topo/DevList/<x> corresponding to the neighbor device), so that complete information of the neighbor device may be acquired according to the reference.

562) DevId: optional, used to directly describe the device identifier of the neighbor device (the same as Topo/DevList/<x>/DevId), so that when it is unnecessary to acquire the complete information of the neighbor device, the device identifier of the neighbor device may be directly acquired.

563) LQI: when being supported by the sensor network technologies, LQI is used to record the quality of the communication link between a current device and a neighbor device.

564) Relationship: describing a topology link relationship between the neighbor device and a current device, where the specific form of the Relationship may differ in different sensor network technologies. For example, relationships such as parent (Parent), child (Child), sibling (Sibling), and none (None) may be included among ZigBee devices, while relationships such as master (Master), slave (Slave), parked slave (Parked Slave), advertising (Advertising), and none (None) may be included among BlueTooth network devices.

565) Operations: providing a topology management operation for the neighbor sensor device through some executable child nodes, and including:

5651) Connect: used to instruct the current device to establish a topology connection relationship with the neighbor device, in which, for example, assuming that a current Relationship with the
neighbor device is None, a Parent (ZigBee network) or a Slave (BlueTooth network) relationship with the neighbor device may be established through executing the MO node. If the current device has established a topology connection relationship with another neighbor device, according to requirements of a specific sensor network technology, the connection relationship with the other neighbor device might first need to be disconnected.

5652) Ext: indicating that other topology management operation child nodes may also be extended for different sensor network technologies. For example, for a BlueTooth network, nodes of Park, Unpark, and SwitchRole may be extended to instruct the current device to send to neighbor device topology connection management commands such as parking a slave device, activating a slave device, and switching a master/slave relationship, respectively.

57) Operations: providing a topology management operation for the current sensor device through some executable child nodes, including:

571) Disconnect: used to instruct the current device to leave the sensor network. For some sensor network technologies (for example, ZigBee) which support a multi-hop topology, the node may further include the following child node:

5711) RemoveChildren: its value being TRUE or FALSE, used to, when the current device is still connected to another child device or slave device, indicate the current device whether it is necessary to further remove the child device or the slave device from the sensor network.

572) Ext: other topology management operation child nodes may also be extended for different sensor network technologies.

58) Ext: for different sensor network technologies, other child nodes may also be extended to describe information related to other topologies of a current sensor network device. For example, for a ZigBee device, a PermitJoining node may be extended to record whether the current device permits other device to establish a topology connection relationship with the ZigBee device.
In addition, the fourth MO node further includes searching for binding information among the service group information related to the service of the device, searching for device service information, and searching for binding information among the service of the device.

Moreover, if the DM server does not need to obtain a notification of a subsequent change of the information of the sensor network topology or the service information of the sensor device, it is unnecessary to set a management object Topo/Operations/DiscTopoAndService/Notification, or the value of the management object is set to be FALSE.

Subsequently, the M2M gateway parses the DM command and determines that it is necessary to complete the process of discovering information of the ZigBee network topology and service information of the ZigBee device through a corresponding ZigBee protocol request. The step 53 of discovering a topology includes the step 531 of searching for identifiers and address information of a device and an associated device of the device, the step 532 of searching for additional information (type) of the device, and the step 533 of searching for identifiers and address information of the sensor network or the service information of the sensor device, it is unnecessary to set a management object Topo/Operations/DiscTopoAndService/Notification, or the value of the management object is set to be FALSE.

FIG. 5A and FIG. 5B is a schematic flow chart of a method according to Embodiment 2 of the present invention. This embodiment describes remote discovery of a ZigBee network topology and device service information through a gateway. Referring to FIG. 5A and FIG. 5B, this embodiment includes the following steps:

Step 531: A device management server (DM Server) establishes a remote DM session with an M2M gateway (M2M gateway).

- Step 5312: The ZigBee device returns an IEEE address search request (IEEE_Addr_req) to the ZigBee device.

- Step 5313: Specifically, the M2M network sends the IEEE address search request (IEEE_Addr_req) in sequence to devices (ZigBee Device) in the ZigBee network where the M2M gateway is located, which carries a network address (NwkAddr, starting from a ZigBee coordinator 0x0000) and an extended response indication parameter (Extended) of a target device, where the target device refers to a corresponding ZigBee device each time the search is performed.

Step 532: The ZigBee device returns an IEEE address search response (IEEE_Addr_rsp) to the M2M gateway.

Step 532: The ZigBee device returns an IEEE address search response (IEEE_Addr_rsp) to the M2M gateway, where the IEEE address of the target device is returned through a parameter IEEEAddr, and a list of network addresses of ZigBee devices associated with
the target device is returned through a parameter NWKAddrAssocDevList.

According to the list of the network addresses of the associated ZigBee devices, the M2M gateway may perform iteration one by one using the same method to discover information of all ZigBee devices in the whole network and IEEE addresses of the ZigBee devices, map the information all ZigBee devices in the whole network and IEEE addresses of the ZigBee devices to a Topo/DevList/<x>/DevId node in the gateway MO tree, and at the same time map network addresses of all the ZigBee devices to a Topo/DevList/<x>/LocAddr node in the gateway MO tree.

0041 The searching for additional information of the device (for example, a type or name of the device) 532 includes the following steps.

0042 Step 5321: The M2M gateway sends a basic information search request (Node_Desc_req) to the ZigBee device.

0043 Specifically, the M2M gateway sends the basic information search request (Node_Desc_req), which carries a network address (NwkAddr=0x?) of the target device, to all devices in the ZigBee network where the M2M gateway is located.

0044 Step 5322: The ZigBee device returns a basic information search response (Node_Desc_rsp) to the M2M gateway.

0045 Specifically, the target device returns the basic information search response (Node_Desc_rsp) to the M2M, where the type of the device is returned through a parameter NodeDescriptor in the response message, and the type is mapped to a Topo/DevList/<x>/DevTyp node in the MO tree by the M2M gateway.

0046 The step 533 of searching for the list of neighbors of the device includes the following steps:

Step 5331: The M2M gateway sends a link quality search request (Mgmt_Lqi_req) to the ZigBee device.

Specifically, the M2M gateway sends the link quality search request (Mgmt_Lqi_req), which carries the network address and a start index (NwkAddr, StartIndex) of the target device, to all devices in the ZigBee network where the M2M gateway is located.

Step 5332: The ZigBee device returns a link quality search response (Mgmt_Lqi_rsp) to the M2M gateway.

Specifically, the target device returns the link quality search response (Mgmt_Lqi_rsp) to the M2M, where the information of all neighbor devices can be discovered is returned through a parameter NeighborTableList in the response message, and the information of all neighbor devices includes the information of link quality and the information of a topology connection relationship, and the returned information of all neighbor devices is mapped one by one to a Topo/DevList/<x>/Neighbors/<x> node in the MO tree by the M2M gateway.

0047 Specifically, the target device returns the link quality search response (Mgmt_Lqi_rsp) to the M2M, where the information of all neighbor devices can be discovered is returned through a parameter NeighborTableList in the response message, and the information of all neighbor devices includes the information of link quality and the information of a topology connection relationship, and the returned information of all neighbor devices is mapped one by one to a Topo/DevList/<x>/Neighbors/<x> node in the MO tree by the M2M gateway.

0048 The step 541 of searching for the active end point (EndPoint, EP) on the device includes the following steps:

Step 5411: The M2M gateway sends an EndPoint search request (Active_Ep_req) to the ZigBee device.

Specifically, according to a topology discovery result in step 53, the M2M gateway sends the EndPoint search request (Active_Ep_req) to all devices in the ZigBee network where the M2M gateway is located, where, the EndPoint search request (Active_Ep_req) carries the network address (NwkAddr) of the target device.

Step 5412: The ZigBee device returns an EndPoint search response (Active_Ep_rsp) to the M2M gateway.

0049 Specifically, the target device returns the EndPoint search response (Active_Ep_rsp) to the M2M gateway, where a list of EndPoints activated by the target device is returned through a parameter ActiveEPList in the response message, and the list of EndPoints is mapped to a Topo/DevList/<x>/Services/<x>/EPNum node in the MO tree by the M2M gateway.

0050 The step 542 of traversing the service on each EP includes the following steps:

Step 5421: The M2M gateway sends a simple description search request (Simple_Desc_req) to the ZigBee device.

0051 Specifically, according to a search result in step 541, the M2M gateway further sends the basic service information search request (Simple_Desc_req) to each activated EndPoint of all ZigBee devices, where, the Simple_Desc_req carries the network address (NwkAddr) and the sequence number of an EndPoint (EP) of the target device.

0052 Step 5422: The ZigBee device returns a basic service information search response (Simple_Desc_rsp) to the M2M gateway.

0053 Specifically, the target device returns the simple description search response (Simple_Desc_rsp) to the M2M gateway, where, the description information of a service run by a specified EndPoint is returned through a SimpleDescriptor parameter in the response message, and the description information is mapped to a Topo/DevList/<x>/Services/<x>/Descriptor node in the MO tree by the M2M gateway.

0054 The step 543 of traversing the group where each EP is located includes the following steps:

Step 5431: The M2M gateway sends a group search request (Get_GroupMembership_req) to the ZigBee device.

0055 Specifically, according to the search result in
step 541, the M2M gateway further sends the group search request (Get_GroupMembership_req) to each activated EndPoint of all ZigBee devices, where, the group search request carries the network address (NwkAddr) and the sequence number of an EndPoint (EP) of the target device.

10056] Step 5432: The ZigBee device returns a group search response (Get_GroupMembership_rsp) to the M2M gateway.

10057] Specifically, the target device returns the group search response (Get_GroupMembership_rsp) to the M2M gateway, where, the information of the table of groups where the specified EndPoint is run is returned through a parameter GroupList in the response message, and the information of the table of groups is mapped to a Topo/DevList/<x>/Services/<x>/Groups node in the MO tree by the M2M gateway.

10058] The step 544 of searching for the list of device service binding relationship includes the following steps:

Step 5441: The M2M gateway sends a binding information search request (Mgmt_Bind_req) to the ZigBee device.

10059] Specifically, according to the topology discovery result in step 541, the M2M gateway sends the binding information search request (Mgmt_Bind_req) to all devices in the ZigBee network where the M2M gateway is located, where, the binding information search request carries the network address and the start index (NwkAddr, StartIndex) of the target device.

10060] Step 5442: The ZigBee device returns a binding information search response (Mgmt_Bind rsp) to the M2M gateway.

10061] Specifically, the target device returns the binding information search response (Mgmt_Bind rsp) to the M2M gateway, where a list of service binding information of the target device is returned through a BindingTableList parameter in the response message, and the list of service binding information is mapped to a Topo/DevList/<x>/Services/<x>/Bindings node in the MO tree by the M2M gateway.


10063] Specifically, the M2M gateway sends a DM response message to the device management server, where, the carried <Alert> element indicates that a topology management function of discovering the information of the ZigBee network topology and the topology management function of discovering the service information of the ZigBee device is successfully executed.

10064] Step 56: Acquire topology information and service information of each device, which includes the following steps:

Step 561: The DM server sends a DM get (Get) command (Get:Topo/DevList?list=StructData) to the M2M gateway.

10065] Specifically, the DM server sends to the M2M gateway one DM get (Get) command, which acts on a Topo/DevList management object node shown in FIG. 2, and the DM get command further carries a parameter list=StructData for instructing the M2M gateway to return a child tree structure and a value of each node under Topo/DevList node.

10066] Step 562: The M2M gateway returns a result (Result:/GW/DevList/...) to the DM server. Specifically, the M2M gateway returns the result to the DM server so as to restore the information of the ZigBee network topology and the service information of the ZigBee device acquired by the M2M gateway, where, the result carries the child tree structure and the value of each node (Result:/GW/DevList/...) under the Topo/DevList node.

10067] In addition, the device management server may also send to the M2M gateway one DM get (Get) command, which acts on management object nodes such as the Topo/NetworkId or the Topo/TopoTyp shown in FIG. 2 to acquire information of another related network topology.

10068] It should be noted that:

in step 56, the DM server may also send to the M2M gateway the DM get (Get) command and acts on some specific management object nodes (Topo/DevList/<x>Neighbors), so as to acquire a portion of the information of the network topology or a portion of the device service information.

10069] In this embodiment, the DM server sends the DM command to the M2M gateway. The DM command acts on the MO information for discovering the ZigBee network topology and the device service information, so as to conveniently implement the discovery of the ZigBee network topology and the device service information.

10070] FIG. 6 is a schematic flow chart of a method according to Embodiment 3 of the present invention. This embodiment describes the step of reporting joining/leaving of a ZigBee network device through a gateway. Referring to FIG. 6, this embodiment includes the following steps:

Step 61: A device management server (DM Server) establishes a remote DM session with an M2M gateway (M2M gateway).

10071] For the specific content, refer to step 51.

10072] Step 62: The DM server sends a DM replacement (Replace) and an execution (Exec) command (Replace:Topo/Operations/DiscTopo/Notification=True; Exec:Topo/Operations/DiscTopo) to the M2M gateway.

10073] Specifically, if the DM server may obtain a notification of a change of the topology information after the DM server discovers the information of a sensor network topology connected to the M2M gateway the DM server
first sends to the M2M gateway one DM replacement (Replace) command, where, the replacement command acts on the management object node Topo/Operations/DiscTopo/Notification defined in FIG. 2, and the value of the node is set to be TRUE or is set to be the address identifier of the device management server, and then the DM server sends to the M2M gateway one DM execution (Exec) command, which acts on the node Topo/Operations/DiscTopo.

[0074] The M2M gateway parses the DM command and determines that it is necessary to complete the process of discovering the information of the sensor network topology through a corresponding sensor network protocol request, and that it is necessary to report a subsequent topology information update, which specifically includes the following steps:

Step 63: The process of discovering a ZigBee network topology.

[0075] For the specific content, refer to step 53, step 55, and step 56 in FIG. 5A and FIG. 5B.

Step 64: Detect joining/leaving of a device, which specifically includes the following steps:

Step 641: A ZigBee device sends a leaving message (Nwk_leave) to the M2M gateway.

[0076] Specifically, when a ZigBee device leaves the ZigBee network managed by the gateway, the ZigBee device sends a leaving message (Nwk_leave) to the M2M gateway, where, the leaving message carries a parameter IEEEAddr that indicates leaving, , and the gateway learns about the leaving of the ZigBee device according to the parameter IEEEAddr.

[0077] Step 642: The ZigBee device sends a notification message (Device_annce) to the M2M gateway.

[0078] Specifically, when a ZigBee device joins in the ZigBee network managed by the gateway, the ZigBee device sends a notification message (Device_annce) to the M2M gateway, where, the notification message carries a network address (NwkAddr) and a IEEEAddr parameter that indicates joining, and the gateway learns about the joining of the new device according to the IEEEAddr parameter.

Step 641 and step 642 are not necessarily in chronological order.

Step 65: The M2M gateway updates device list information.

[0079] According to the information of the leaving or the joining of the ZigBee device, the M2M gateway updates the information of the topology management tree in FIG. 2, removes topology and service information related to the ZigBee device which has left, and adds topology and service information related to the newly joined ZigBee device.


[0081] Specifically, according to the setting information of the Topo/Operations/DiscTopo/Notification node in step 62, the M2M gateway sends a DM notification message to the device management server, where <Alert> may be used to indicate that the notification is used for reporting a change of the sensor network topology information (Alert: Topology Changed).

[0082] Step 67: Rediscover the ZigBee network topology and device service information through the gateway.

[0083] Specifically, similar to step 56, the DM server further acquires, according to the notification in step 66, the updated ZigBee sensor network topology information from the M2M gateway; or, similar to step 52 to step 56, the DM server executes the process of discovering sensor network topology information and device service information again.

[0084] In this embodiment, the DM server sends a DM command to the M2M gateway. The DM command acts on MO information for reporting joining/leaving of a ZigBee network device, so as to conveniently implement the reporting of the joining/leaving of the ZigBee network device.

[0085] FIG. 7A and FIG. 7B are a schematic flow chart of a method according to Embodiment 4 of the present invention. This embodiment describes the discovery of a BlueTooth network topology and device service information through a gateway. Referring to FIG. 7A and FIG. 7B, this embodiment includes the following steps:

Step 701: A device management server (DM Server) establishes a remote DM session with an M2M gateway (M2M gateway).

[0086] For the specific content, refer to step 51.

[0087] Step 702: The DM server sends to the M2M gateway a DM replacement (Replace) command and a DM execution (Exec) command (Replace:Topo/Operations/DiscTopoAndService/Notification=True and Exec:Topo/Operations/DiscTopoAndService).

[0088] Specifically, if the DM server expects to further obtain, after discovering the sensor network topology information and the device service information, a notification of a change of the information, the DM server first sends to the M2M gateway one DM replacement (Replace) command, where, the DM replacement command acts on the management object node Topo/Operations/DiscTopoAndService/Notification defined in FIG. 2, and the value of the node is set to be TRUE or is set to be an address identifier of the device management server. And then the DM server sends to the M2M gateway one DM execution (Exec) command, which acts on the node Topo/Operations/DiscTopoAndService. The M2M gateway parses the DM command and determines that it is necessary to complete the process of discovering information of the BlueTooth network topology and the device
service through a corresponding BlueTooth protocol request, and that it is necessary to report a subsequent information update.

Step 703: Discover a topology, which includes the following steps:

Step 7031: Search for the address identifier of a device, which includes the following steps:

Step 70311: The M2M gateway sends a BlueTooth inquiry request (Inquiry_req) to a BlueTooth device (BT device).

1. Specifically, the M2M gateway advertises the BlueTooth inquiry request (Inquiry_req) to the vicinity.

2. Step 70312: The BlueTooth device returns an inquiry response (Inquiry_rsp) to the M2M gateway.

3. If a neighbor BlueTooth device receives the request, the neighbor BlueTooth device returns an inquiry response (Inquiry_rsp) and carries a device identifier of the neighbor BlueTooth device through a BD_ADDR parameter. The M2M gateway maps the device identifier to the neighbor BlueTooth device through a BD_ADDR parameter. The M2M gateway maps the device identifier to a Topo/DevList/<x>/DevId node in the gateway MO tree.

4. Optionally, if the neighbor BlueTooth device which are then mapped by the gateway to a Topo/DevList/<x>/DevId node in the gateway MO tree.

5. Specifically, the M2M gateway sends an inquiry response (Inquiry_rsp) to the M2M gateway.

6. If a neighbor BlueTooth device receives the request, the neighbor BlueTooth device returns an inquiry response (Inquiry_rsp) and carries a device identifier of the neighbor BlueTooth device through a BD_ADDR parameter.

Step 704: Discover device service information, which includes the following steps:

Step 7041: Search for device service information, which includes the following steps:

Step 7041: The M2M gateway sends a service search request (SDP_ServiceSearchAttribute_req) to all devices in the BlueTooth network where the M2M gateway is located, where, the service search request carries the network address of the target device and a parameter ServiceSearchPattern=PublicBrowseRoot.

Step 70412: The BT device returns a service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway.

7. Specifically, the target device returns the service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway, where the information of a list of service provided by the target device is returned through a parameter ServiceSearchPattern=PublicBrowseRoot.

8. Step 7042: The BT device returns a service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway.

9. Specifically, the target device returns the service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway, where the information of a list of service provided by the target device is returned through a parameter ServiceSearchPattern=PublicBrowseRoot.

10. Step 7043: The BT device returns a service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway.

11. Specifically, the target device returns the service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway, where the information of a list of service provided by the target device is returned through a parameter ServiceSearchPattern=PublicBrowseRoot.

12. Step 7044: The BT device returns a service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway.

13. Specifically, the target device returns the service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway, where the information of a list of service provided by the target device is returned through a parameter ServiceSearchPattern=PublicBrowseRoot.

14. Step 7045: The BT device returns a service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway.

15. Specifically, the target device returns the service search response (SDP_ServiceSearchAttribute_rsp) to the M2M gateway, where the information of a list of service provided by the target device is returned through a parameter ServiceSearchPattern=PublicBrowseRoot.

Step 705: Acquire topology information and service information of each device.

Step 706: Acquire topology information and service information of each device.

Step 707: Detect joining/leaving of a device in or from the BlueTooth network, which includes the following steps:

Step 7071: A device joins in the BlueTooth network managed by the gateway, the BlueTooth device sends a BlueTooth connection establishment request (LMP_Host_Connection_req) to the M2M gateway, where a BD_ADDR parameter indicates the identifier of the joined device.

Step 7072: The M2M gateway returns a BlueTooth connection establishment complete (LMP_Setup_Complete) message to the BlueTooth device to confirm that the device has successfully joined in the network.

Step 7073: When a device is leaving, the BlueTooth device sends a leaving (LMP_Detach) message to the M2M gateway.

For a joining scenario, in step 7071, when a device joins in the BlueTooth network managed by the gateway, the BlueTooth device sends a BlueTooth connection establishment request (LMP_Host_Connection_req) to the M2M gateway, where a BD_ADDR parameter indicates the identifier of the joined device.

Alternatively, for a leaving scenario:

Step 7073: When a device is leaving, the BlueTooth device sends a leaving (LMP_Detach) message to the M2M gateway.
Step 7074: The M2M gateway may determine, according to a current connection corresponding to the leaving message, the identifier of the device which has left and return an acknowledgment (BB-Ack) message to the BlueTooth device.

Step 708: Update device list information.

[0110] Specifically, according to the information of the leaving or the joining of the BlueTooth device, the M2M gateway updates the information of the topology management tree in FIG. 2, removes topology and service information related to the device which has left, and adds topology and service information related to the newly joined device.

[0111] Step 709: The M2M gateway sends a notification message (Alert: Topology Changed) to the DM server.

[0112] Specifically, according to the setting condition of the Topo/Operations/DiscTopoAndService/Notification node in step 72, the M2M gateway sends the DM notification message to the device management server, where <Alert> may be used to indicate that the notification is used for reporting a change of the sensor network topology information.

[0113] Step 710: Rediscover the BlueTooth network topology and service information of the BlueTooth device through the gateway.

[0114] Specifically, similar to step 706, the DM server further acquires, according to the notification in step 705, the updated BlueTooth sensor network topology information from the M2M gateway; or, similar to step 702 to step 706, the device management server executes the process of discovering sensor network topology information and device service information again.

[0115] In this embodiment, the DM server sends the DM command to the M2M gateway. The DM command acts on the MO information for discovering the BlueTooth network topology and the device service information, so as to conveniently implement the discovery of the BlueTooth network topology and the device service information.

[0116] A modification procedure includes removing a specified device, removing a specified device and a child device of the specified device, adding a specified device, and changing a topology connection relationship between a specified device and a neighbor device.

[0117] During the removal of a specified device, the receiving the DM command sent by the device management server includes: receiving a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to remove the specified device and the child node thereof from the sensor network; and the managing the sensor network according to the DM command includes: sending a removal command to the specified device, where the removal command includes indication information of removing the child device, and updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

[0118] During removal of a specified device and the child node thereof, the receiving the DM command sent by the device management server includes: receiving a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to remove the specified device and the child node thereof from the sensor network; and the managing the sensor network according to the DM command includes: sending a removal command to the specified device, where the removal command includes indication information of removing the child device, and updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

[0119] During the adding of a specified device, the receiving the DM command sent by the device management server includes: receiving a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to add the specified device into the sensor network; and the managing the sensor network according to the DM command includes: sending a connection establishment request message to the specified device and updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

[0120] During the changing of a topology connection relationship between a specified device and a neighbor device, the receiving the DM command sent by the device management server includes: receiving a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to modify the topology connection relationship between the specified device and the neighbor device; and the managing the sensor network according to the DM command includes: permitting a specified neighbor device to admit a new child device, prohibiting other neighbor devices from admitting the child device, instructing the specified device to rejoin the network, and updating the topology connection relationship among the sensor devices in the second MO node. Through the foregoing processing, the specified device is enabled to establish a connection relationship with the specified neighbor device and disconnect the connection relationships with other neighbor devices.

[0121] The topology information is modified in the foregoing, and service information may also be modified. At this time, the receiving the DM command sent by the device management server includes: receiving a DM
modification command sent by the device management server, where the DM modification command acts on the sixth MO node. The managing the sensor network according to the DM command includes: modifying service information related to a specified sensor network device, including: modifying a group and/or binding relationship of a specified service, and updating the information about a service provided by a specified sensor device in the third MO node. The following provides an embodiment in the foregoing modification condition in combination with a specific sensor network.

[0122] After the above discovery procedure, or further after the modification procedure, the description nodes (the first MO node, the second MO node, and the third MO node) store corresponding information, and at this time, an acquisition procedure may be performed, so that the gateway sends the corresponding information to the device management server.

[0123] Specifically, the receiving the DM command sent by the device management server includes: receiving a DM get command sent by the device management server, where the DM get command acts on the first MO node. The managing the sensor network according to the DM command includes: sending the overall information of the sensor network stored in the first MO node to the device management server.

[0124] Alternatively, the receiving the DM command sent by the device management server includes: receiving a DM get command sent by the device management server, where the DM get command acts on the second MO node.

[0125] The managing the sensor network according to the DM command includes: sending the characteristic information of each sensor device and/or the information of the topology connection relationship among the sensor devices stored in the second MO node to the device management server.

[0126] Alternatively, the receiving the DM command sent by the device management server includes: receiving a DM get command sent by the device management server, where the DM get command acts on the third MO node.

[0127] Of course, in the acquisition procedure, the information acquired from the second MO node and/or the third MO node is the updated information if the updating is already performed, and otherwise the information is the information mapped and stored initially.

[0128] Some modification embodiments are provided in the following in combination with specific scenarios.

[0129] FIG. 8 is a schematic flow chart of a method according to Embodiment 5 of the present invention. This embodiment describes the removal of a ZigBee device and a related child device through a gateway. Referring to FIG. 8, this embodiment includes the following steps:

Step 81: Establish a remote DM session.

For the specific content, refer to step 51.

Step 82: Discover a ZigBee network topology.

For the specific content, refer to step 52 to step 56.

[0130] Step 83: The DM server sends to the M2M gateway a DM replacement (Replace) command and a DM execution (Exec) command.


[0132] Specifically, if the device management server expects to remove the ZigBee device 1 (Dev1) and all child devices X (DevX) associated with the ZigBee device 1, the device management server first sends to the M2M gateway one DM replacement (Replace) command, which acts on the MO node Topo/DevList/Dev1/Operations/Disconnect/RemoveChildren corresponding to the device 1 defined in FIG. 2, where the value of the node is TRUE, and then the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on a node Topo/DevList/Dev1/Operations/Disconnect. The M2M gateway parses the DM command and determines that it is necessary to remove the device 1 and all the associated child devices X in the current ZigBee network through a corresponding ZigBee protocol request.

[0133] Step 84: The M2M gateway sends to the ZigBee device 1 a device removal request (Mgmt_Leave_req). Where, the device removal request carries a network address (IEEEAddr=Dev1) of the ZigBee device 1 and a parameter RemoveChildren=True for instructing the ZigBee device 1 to further remove all the child devices associated with the ZigBee device 1.

[0134] Step 85: Remove all the child devices, which includes the following steps:

Step 851: The ZigBee device 1 sends the device removal request (Mgmt_Leave_req) to all the child devices X associated with the ZigBee device 1, where, the device removal request carries network addresses of the devices X and parameters RemoveChildren=True for instructing the devices X to further remove all child devices associated with the devices X.

Step 852: After the devices X remove all the child devices associated at a low layer to the devices X according to the same method, the devices X each return a device removal response (Mgmt_Leave_rsp) to the ZigBee device 1 and enable the devices X to leave the current ZigBee network, where, the device removal response which carries the success information (SUCCESS).

Step 86: The ZigBee device 1 sends the device removal response (Mgmt_Leave_rsp), which carries the success information (SUCCESS).
Specifically, according to the information of the network topology after the device is removed, the M2M gateway updates the information of the topology management tree in FIG. 2 and removes topology and service information related to the device which has left.

Step 88: The M2M gateway returns a success response (Alert:OK) to the DM server.

Specifically, the M2M gateway sends a DM response message to the DM server, where the carried element of <Alert>:OK indicates that a topology management function of removing the ZigBee device 1 and all the child devices associated with the ZigBee device 1 is successfully executed.

It should be noted that, if the device management server expects to remove only the ZigBee device 1 but not to remove all the child devices X (DevX) associated with the ZigBee device 1, in step 83, the value of the MoveChildren node is FALSE, or the node is not set, in step 84, the parameter MoveChildren=FALSE, and it is unnecessary to execute step 85.

In this embodiment, the DM server sends a DM command to the M2M gateway. The DM command acts on MO information for removing a ZigBee device and associated child devices, so as to conveniently remove the ZigBee device and the associated child devices.

FIG. 9 is a schematic flow chart of a method according to Embodiment 6 of the present invention. This embodiment describes removal or adding of a BlueTooth slave device through a gateway. Referring to FIG. 9, this embodiment includes the following steps:

It is assumed that the M2M gateway (Dev0) serves as a master device (Master) in a BlueTooth network, a BlueTooth device 1 (Dev1) serves as a slave device (Slave), and a BlueTooth device 2 has not joined in the current BlueTooth network yet, but is turned on and in a working status to be discoverable by the M2M gateway.

Step 91: Establish a remote DM session. For the specific content, refer to step 701.

Step 92: Discover a BT network topology. For the specific content, refer to step 702 to step 706.

Step 93: Remove a BlueTooth slave device, which includes the following steps:

Step 931: The DM server sends a DM execution (Exec) command (Exec:Topo/DevList/Dev1/Operations/Disconnect) to the M2M gateway.

Specifically, according to the BlueTooth network topology discovery result in step 92, if the device management server expects to remove the BlueTooth slave device 1 (Dev1), the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on an MO node Topo/DevList/Dev1/Operations/Disconnect corresponding to the device 1 defined in FIG. 2. The M2M gateway parses the DM command and determines that it is necessary to remove the device 1 in the current BlueTooth network according to a corresponding BlueTooth protocol request.

Specifically, the M2M gateway sends a DM removal request (LMP_Detach) to the BlueTooth device 1.

The BlueTooth device 1 sends a device removal response (BB_Ack) to the M2M gateway, where the acknowledgment of successful removal of the device is obtained through the response message.

Specifically, according to a BlueTooth network topology discovery result in step 92, if the device management server expects to add the BlueTooth device 2 (Dev2) as a slave device into the current BlueTooth network, the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on an MO node Topo/DevList/Dev0/Neighbors/Dev2/Operations/Connect to the M2M gateway.

Specifically, according to a BlueTooth network topology discovery result in step 92, if the device management server expects to add the BlueTooth device 2 (Dev2) as a slave device into the current BlueTooth network, the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on an MO node Topo/DevList/Dev0/Neighbors/Dev2/Operations/Connect defined in FIG. 2. The M2M gateway parses the DM command and determines that it is necessary to add a neighbor BlueTooth device 2 discovered by the M2M gateway as a slave device into the current BlueTooth network through a corresponding BlueTooth protocol request.

The M2M gateway sends a DM execution (Exec) command (Exec:Topo/DevList/Dev2/Operations/Connect) to the M2M gateway.

Specifically, according to a BlueTooth network topology discovery result in step 92, if the device management server expects to add the BlueTooth device 2 (Dev2) as a slave device into the current BlueTooth network, the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on an MO node Topo/DevList/Dev0/Neighbors/Dev2/Operations/Connect to the M2M gateway.

Specifically, according to a BlueTooth network topology discovery result in step 92, if the device management server expects to add the BlueTooth device 2 (Dev2) as a slave device into the current BlueTooth network, the device management server sends to the M2M gateway one DM execution (Exec) command, which acts on an MO node Topo/DevList/Dev0/Neighbors/Dev2/Operations/Connect to the M2M gateway.

Specifically, according to the condition of the network topology after the device is removed or added, the M2M gateway updates the information of the topology management tree shown in FIG. 2, that is, removes topology and service information related to the device which has left, and adds topology and service information related to the newly joined device.

Step 96: The M2M gateway returns a success response (Alert:OK) to the DM server.

Specifically, the M2M gateway sends a DM response message to the device management server, where the carried <Alert> element indicates that the topology management function of removing or adding a BlueTooth device is successfully executed.
adding can be implemented through setting GroupId

tuple pieces of group information expect to be added, the
a group identifier and a group name to be added. If mul-
FIG. 2 and FIG. 3 respectively and are configured to set
It should be noted that:
[0153]  It should be noted that:

step 93 and step 94 are operation steps independent
from each other, so step 95 and step 96 may occur
after step 93, and also may occur after step 94.

[0154]  In this embodiment, the DM server sends a DM
command to the M2M gateway. The DM command acts
on MO information for removing or adding a BlueTooth
slave device, so as to conveniently implement the remov-
al or adding of a BlueTooth slave device.

[0155]  FIG. 10 is a schematic flow chart of a method
according to Embodiment 7 of the present invention. This
embodiment describes remote modification of service in-
formation of a ZigBee device through a gateway. Refer-
ing to FIG. 10, this embodiment includes the following steps:

Since a ZigBee network supports the function of re-

dvice management server can remotely modify, through an M2M gate-
way, service information of a specified ZigBee device
according to an MO management tree shown in FIG. 3. The service information includes information of a
group where a service is located and binding infor-
mation related to the service. This embodiment only
takes the modification of the group information as
example. The operation method of modifying the binding information related to the service is similar,
which is not described again.

[0156]  Step 101: Establish a remote DM session.

[0157]  For the specific content, refer to step 51.

[0158]  Step 102: Discover a ZigBee network topology.

[0159]  For the specific content, refer to step 52 to step
56.

[0160]  Step 103: The DM server sends to the M2M
gateway a DM replacement (Replace) command and a
DM execution (Exec) command (Replace:Topo/DevList/
Dev1/Services/Sev1/Operations/AddGroup/<x>/Group-
Idd; Replace:Topo/DevList/Dev1/Services/Sev1/Opera-
tions/AddGroup/<x>/GroupName; and Exec:Topo/Dev-
List/Dev1/Services/Sev1/Operations/AddGroup).

[0161]  Specifically, according to the result of discover-
ing the ZigBee network topology and the device service
information in step 102, if the device management server
expects to add information of a group where a service 1
(Sev1) of a device 1 (Dev1) is located for the service 1
and the device 1, the device management server first
sends to the M2M gateway two DM replacement (Re-
place) commands, which act on an MO node Topo/Dev-
List/Dev1/Services/Sev1/Operations/AddGroup/<x>/
GroupId and an MO node Topo/DevList/Dev1/Services/
Sev1/Operations/AddGroup/<x>/GroupName defined in
FIG. 2 and FIG. 3 respectively and are configured to set
a group identifier and a group name to be added. If mul-
tiple pieces of group information expect to be added, the
adding can be implemented through setting GroupId

nodes and GroupName nodes under the plurality of <x>
nodes. Then the device management server again sends
to the M2M gateway one DM execution (Exec) command,
which acts on an MO node Topo/DevList/Dev1/Servic-
es/Sev1/Operations/AddGroup. The M2M gateway pars-
es the DM command and determines that it is necessary
to add corresponding group information for the service 1
on the ZigBee device 1 through a corresponding ZigBee
protocol request.

[0162]  Step 104: Add group information of the device
service, which includes the following steps:

Step 1041: The M2M gateway sends to the ZigBee
device an add group request (Add_Group_req),
which carries a sequence number of an EndPoint
where the service 1 on the device 1 is located and
the configured group identifier (GroupId) and the
group name (GroupName) to be added.

[0163]  Specifically, the M2M gateway first acquires,
according to the management tree defined in FIG. 3, a
sequence number of the EndPoint (EPNum) where the
service 1 on the device 1 is located, and then sends to
the ZigBee device 1 an add group request Add_Group_-
req, which carries the sequence number of the EndPoint
where the service 1 on the device 1 is located and the
configured group identifier (GroupId) and the group name
(GroupName) to be added. The device 1 updates, ac-
cording to the request, group table information related to
a local service, and then returns a response of adding a
group successfully to the M2M gateway.

[0164]  Step 1042: The ZigBee device updates a local
group table (GroupTable).

[0165]  Step 1043: The ZigBee returns a response of
adding a group successfully (Add_Group_rsp(SUC-
CESS)) to the M2M gateway.

[0166]  Step 105: The M2M gateway updates group in-
formation of a corresponding device.

[0167]  Specifically, the M2M gateway updates the in-
formation of the topology management tree shown in
FIG. 2 and FIG. 3, that is, adds the group information of
the service 1 on the device 1.

[0168]  Step 106: The M2M gateway returns a success
response (Alert:OK) to the DM server.

[0169]  Specifically, the M2M gateway sends a DM re-
response message to the device management server,
where the carried <Alert> element indicates that a topol-
ogy management function of modifying the device serv-
ication is successfully executed.

[0170]  It should be noted that:

if a remote device management server needs to
modify other service information on a specified Zig-
Bee device, in step 103, the remote device manage-
ment server send, according to the information of
the topology management tree shown in FIG. 3, to
the M2M gateway a replacement (Replace) com-
mand and an execution (Exec) command which act
on corresponding MO nodes, that is, instruct the M2M gateway to execute corresponding management operation of modifying the device service information, for example, add service binding information through Exec Topo/DevList/Dev1/Services/Sev1/Operations/Bind and remove group information through Exec Topo/DevList/Dev1/Services/Sev1/Operations/RemoveAllGroups or Exec Topo/DevList/Dev1/Services/Sev1/Groups/<x>/Remove.

[0171] In this embodiment, the DM server sends a DM command to the M2M gateway. The DM command acts on MO information for remotely modifying the service information of the ZigBee device, so as to conveniently implement the remote modification of the service information of the ZigBee device.

[0172] FIG. 11A and FIG. 11B a schematic flow chart of a method according to Embodiment 8 of the present invention. This embodiment describes the modification of a topology connection relationship among ZigBee devices through a gateway. Referring to FIG. 11A and FIG. 11B, this embodiment includes the following steps:

- **Step 1101**: Establish a remote DM session.
- **Step 1102**: Discover a ZigBee network topology.
- **Step 1103**: The DM server sends a request for setting to permit a child device connection (Mgmt_Permit_Joining_req) to a neighbor device (for example, the ZigBee device 1) (Dev1). For the device 2 (Dev2), a carried parameter PermitDuration=0xff indicates that the child device connection is permitted.
- **Step 1104**: The ZigBee device 2 sends a success response message (Mgmt_Permit_Joining_rsp (SUCCESS)) to the M2M gateway to acknowledge the completion of setting.
- **Step 1105**: The M2M gateway sends the request for setting to permit a child device connection (Mgmt_Permit_Joining_req) to a neighbor device (for example, other ZigBee devices) of the ZigBee device 1 (Dev1). For other neighbor devices, a carried parameter PermitDuration=0x00 indicates that the child device connection is not permitted.
- **Step 1106**: Instruct the Dev1 to rejoin in the network. Specifically, the ZigBee device 1 leaves the current network according to the request and then executes the process of spontaneous network scanning and joining. Since only the neighbor device 2 (Dev2) permits the device 1 to join in the network at this time, the device 1 (Dev1) only can use the device 2 (Dev2) as the parent device thereof to establish a connec-
Step 11071: The M2M gateway sends a leaving network request (Mgmt_Leave_req) to the ZigBee device 1 (Dev1), where a carried IEEEAddr parameter indicates the identifier of the device 1, and at the same time, a carried parameter Rejoin=True indicates that the device 1 further needs scanning and rejoining after leaving the network.

Step 11072: The ZigBee device 1 sends to the M2M gateway a leaving network response (Mgmt_Leave_rsp), which carries a SUCCESS parameter.

Step 11073: The ZigBee device 1 (Dev1) is associated with the ZigBee device 2 (Dev2) through a network scanning and joining process.

Step 11074: The ZigBee device 1 sends to the M2M gateway a notification message (Device_annce), which carries a network address (NwkAddr) and an IEEE address (IEEEAddr).

Step 1107: If a change occurs, restore configuration information of the related devices. Specifically, if the configuration parameter of permitting the child device connection of the neighbor device of the device 1 (Dev1) is modified in step 1105, as compared with step 1104, at this time, the gateway needs to restore the configuration parameter stored in step 1104 to the corresponding device through a method similar to that in step 1105. Step 1107 includes the following steps:

Step 11071: The M2M gateway sends to the ZigBee device 2 the request for setting to permit the child device connection (Mgmt_Permit_Joining_req), which carries a parameter PermitDuration=0x00, indicating that the child device connection is not limited.

Step 11072: The ZigBee device 2 sends a success response message (Mgmt_Permit_Joining_rsp (SUCCESS)) to the M2M gateway to acknowledge the completion of setting.

Step 11073: The M2M gateway sends to other ZigBee devices the request for setting to permit the child device connection (Mgmt_Permit_Joining_req), which carries the parameter PermitDuration=0xff, indicating that the child device connection is permitted.

Step 11074: Other ZigBee devices send a success response message (Mgmt_Permit_Joining_rsp (SUCCESS)) to the M2M gateway to acknowledge the completion of setting.

Step 1108: Optionally, rediscover the network topology.

Specifically, optionally, the M2M gateway may execute a process from step 3 to step 9 in Embodiment 1 to rediscover the topology information of the current ZigBee network and the device service information, so as to guarantee the accuracy of related information.

Step 1109: The M2M gateway updates the network topology information.

Specifically, according to the changed topology connection relationship, the M2M updates the information of the topology management trees shown in FIG. 6 and FIG. 7A and FIG. 7B.

Step 1110: The M2M gateway returns a success response (Alert:OK) to the DM server.

Specifically, the M2M gateway sends a DM response message to the device management server, where the carried <Alert> element indicates that a topology management function of modifying the device service information is successfully executed.

In this embodiment, the DM server sends a DM command to the M2M gateway. The DM command acts on MO information for modifying the topology connection relationship among the ZigBee devices, so as to conveniently implement the modification of the topology connection relationship among the ZigBee devices.

FIG. 12 is a schematic structural diagram of a gateway according to Embodiment 9 of the present invention. The gateway includes a receiving module 121 and a management module 122. The receiving module 121 is configured to receive a DM command sent by a device management server. The DM command acts on a preconstructed MO node. The MO node includes a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology.

The management module 122 is configured to manage a sensor network according to the DM command. The management includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology.

The node configured to describe a sensor network topology includes at least one of: a first MO node configured to describe the overall information of the sensor network, a second MO node configured to describe characteristic information of each sensor device and/or information of a topology connection relationship among the sensor devices, and a third MO node configured to describe information about a service provided by each sensor device;

and/or,

the node configured to discover the sensor network topology includes: a fourth MO node configured to discover the topology connection relationship among the sensor devices and/or the information about a service provided by each sensor device;

and/or,

the node configured to modify a sensor network topology includes at least one of: a fifth MO node configured to modify the topology connection relationship among the sensor devices and a sixth MO node configured to modify the information about a service provided by the sensor device.
Specifically, the receiving module 121 is specifically configured to receive a DM discovery command sent by the device management server, where the DM discovery command acts on the fourth MO node. The management module 122 is specifically configured to discover the topology, and map and store the topology to the second MO node. The topology discovery includes at least one of: searching for the information of an identifier and an address of a device, searching for additional information of the device, searching for information of an associated device, searching for information of a connection status among the devices, and/or, discovering service, and mapping and storing the service to the third MO node. The service discovery includes at least one of: searching for service device information, searching for information of removing the child device, and update the service provided by each sensor device in the third MO node. Alternatively, the receiving module 121 is specifically configured to receive a DM get command sent by the device management server, where the DM get command acts on the sixth MO node; and the management module 122 is specifically configured to add a specified device into the sensor network; and the management module 122 is specifically configured to send a connection establishment request message to the specified device and update the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

Alternatively, the receiving module 121 is specifically configured to receive a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to add a specified device into the sensor network; and the management module 122 is specifically configured to send a connection establishment request message to the specified device and update the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

Alternatively, the receiving module 121 is specifically configured to receive a DM modification command sent by the device management server, where the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to modify a topology connection relationship between a specified device and a neighbor device; and the management module 122 is specifically configured to permit a specified neighbor device to admit a new child device and prohibit other neighbor devices from admitting the child device, instruct the specified device to rejoin in the network, and update the topology connection relationship among the sensor devices in the second MO node.

Alternatively, the receiving module 121 is specifically configured to receive a DM get command sent by the device management server, where the DM get command acts on the first MO node. The management module 122 is specifically configured to send the overall information of the sensor network stored in the first MO node to the device management server.

Alternatively, the receiving module 121 is specifically configured to receive a DM get command sent by the device management server, where the DM get command acts on the second MO node; and the management module 122 is specifically configured to send the characteristic information of each sensor device and/or the information of the topology connection relationship among the sensor devices stored in the second MO node to the device management server.

Alternatively, the receiving module 121 is specifically configured to receive a DM get command sent by the device management server, where the DM get command acts on the third MO node; and the manage-
ment module 122 is specifically configured to send the information about a service provided by each sensor device stored in the third MO node to the device management server.

[0199] In this embodiment, a DM command is received through information of a preconstructed topology and a uniform management interface (that is, a DM protocol interface) consistent with existing remote device management technologies is used, so that an M2M service platform (or other device management servers) can perform remote topology management and maintenance not only on the M2M gateway, but also on a sensor network successive to the M2M gateway, thereby reducing the complexity of implementing the management.

[0200] It may be understood that, related features in the method and device may be referenced mutually. In addition, "first" and "second" in the preceding embodiments are configured to distinguish embodiments, but do not represent superiority or inferiority of all embodiments.

[0201] Persons of ordinary skill in the art should understand that all or part of the steps of the method specified in any embodiment of the present invention may be implemented by a program instructing relevant hardware. The program may be stored in a computer readable storage medium. When the program is run, the program executes the steps of the method specified in any embodiment above. The storage medium may be any medium capable of storing program codes, such as ROM, RAM, magnetic disk, or optical disk.

[0202] Finally, it should be noted that the above embodiments of the present invention are merely intended for describing the technical solutions of the present invention other than limiting the present invention. Although the present invention is described in detail with reference to the foregoing embodiments, persons of ordinary skill in the art should understand that they can still make modifications to the technical solution described in the foregoing embodiments or make equivalent substitutions to some technical features thereof, without departing from the spirit and scope of the technical solution of the embodiments of the present invention.

Claims

1. A method for remotely managing a sensor network topology, comprising:
   - receiving a device management DM command sent by a device management server, wherein the DM command acts on a preconstructed management object MO node and the MO node comprises a node configured to discover a sensor network topology, a node configured to describe a sensor network topology, or a node configured to modify a sensor network topology; and managing a sensor network according to the DM command, wherein the managing comprises discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology.

2. The method according to claim 1, wherein the node configured to describe a sensor network topology comprises at least one of:
   - a first MO node, configured to describe overall information of the sensor network;
   - a second MO node, configured to describe characteristic information of each sensor device and/or information of a topology connection relationship among sensor devices; and
   - a third MO node, configured to describe information about a service provided by each sensor device.

3. The method according to claim 2, wherein the node configured to discover the sensor network topology comprises:
   - a fourth MO node, configured to discover the topology connection relationship among the sensor devices and/or the information about a service provided by each sensor device.

4. The method according to claim 2, wherein the node configured to modify a sensor network topology comprises at least one of:
   - a fifth MO node, configured to modify the topology connection relationship among the sensor devices; and
   - a sixth MO node, configured to modify the information about a service provided by the sensor device.

5. The method according to claim 3, wherein, the receiving the DM command sent by the device management server comprises:
   - receiving a DM discovery command sent by the device management server, wherein the DM discovery command acts on the fourth MO node; the managing the sensor network according to the DM command comprises:
     - discovering a topology, and mapping and storing the topology to the second MO node, wherein the discovering the topology comprises at least one of: searching for information of an identifier and an address of a device, searching for additional information of the device, searching for information of an associated device, and searching for information of a connection status among the devices; and/or
     - discovering a service, and mapping and storing the service to the third MO node, wherein the discovering the services comprises at least one of: searching for device service information,
searching for group information related to the service of a device, and searching for binding information among the service of a device.

6. The method according to claim 5, wherein the fourth MO node further comprises a child node configured to instruct reporting of a subsequent topology change;

the managing the sensor network according to the DM command further comprises:
detecting joining or leaving of a sensor device in or from the sensor network;
updating, according to the detected joining or leaving of the sensor device, the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node; and
reporting a notification message to the device management server.

7. The method according to claim 4, wherein,

the receiving the DM command sent by the device management server comprises:
receiving a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to remove a specified device from the sensor network;
the managing the sensor network according to the DM command comprises:
sending a removal command to the specified device; and
updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

8. The method according to claim 4, wherein,

the receiving the DM command sent by the device management server comprises:
receiving a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is configured to add a specified device into the sensor network;
the managing the sensor network according to the DM command comprises:
sending a connection establishment request message to the specified device; and
updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

9. The method according to claim 4, wherein,

the receiving the DM command sent by the device management server comprises:
receiving a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is configured to add a specified device into the sensor network;
the managing the sensor network according to the DM command comprises:
sending a removal command to the specified device, wherein the removal command comprises indication information of removing the child device; and
updating the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

10. The method according to claim 4, wherein,

the receiving the DM command sent by the device management server comprises:
receiving a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is configured to modify a topology connection relationship between a specified device and a neighbor device;
the managing the sensor network according to the DM command comprises:
permitting a specified neighbor device to admit a new child device and prohibiting other neighbor device from admitting a child
device; and
instructing the specified device to rejoin in
the network and updating the topology con-
nection relationship among the sensor de-
vices in the second MO node.

11. The method according to claim 4, wherein,
the receiving the DM command sent by the de-
vice management server comprises:
receiving a DM discovery command sent by
the device management server, wherein the
DM discovery command acts on the sixth
MO node;
the managing the sensor network according to
the DM command comprises:
modifying service information related to a
specified sensor network device, compris-
ing: modifying a group and/or binding rela-
tionship of a specified service; and
updating information about a service pro-
vided by the specified sensor device in the
third MO node.

12. The method according to claim 2, wherein,
the receiving the DM command sent by the de-
vice management server comprises:
receiving a DM get command sent by the
device management server, wherein the
DM get command acts on the first MO node;
the managing the sensor network according to
the DM command comprises:
sending the overall information of the sen-
or network stored in the first MO node to
the device management server.

13. The method according to claim 2, wherein
the receiving the DM command sent by the de-
vice management server comprises:
receiving a DM get command sent by the
device management server, wherein the
DM get command acts on the second MO
node;
the managing the sensor network according to
the DM command comprises:
sending the described characteristic infor-
mation of each sensor device and/or the in-
formation of the topology connection rela-
tionship among the sensor devices stored
in the second MO node to the device man-
agement server.

14. The method according to claim 2, wherein,
the receiving the DM command sent by the de-
vice management server comprises:
receiving a DM get command sent by the
device management server, wherein the
DM get command acts on the third MO
node;
the managing the sensor network according to
the DM command comprises:
sending the information about a service pro-
vided by each sensor device stored in the
third MO node to the device management
server.

15. A gateway, comprising:
a receiving module, configured to receive a DM
command sent by a device management server,
wherein the DM command acts on a precon-
structed management object MO node and the
MO node comprises a node configured to dis-
cover a sensor network topology, a node con-
figured to describe a sensor network topology,
or a node configured to modify a sensor network
topology; and
a management module, configured to manage
a sensor network according to the DM com-
mand, wherein the management comprises dis-
covering the sensor network topology, describ-
ing the sensor network topology, or modifying
the sensor network topology.

16. The gateway according to claim 15, wherein,
the node configured to describe a sensor net-
work topology comprises at least one of: a first
MO node configured to describe overall infor-
mation of the sensor network, a second MO
node configured to describe characteristic infor-
mation of each sensor device and/or information
of a topology connection relationship among
sensor devices, and a third MO node configured
to describe information about a service provided
by each sensor device;
and/or,
the node configured to discover the sensor net-
work topology comprises: a fourth MO node con-
figured to discover the topology connection re-
lationship among the sensor devices and/or the
information about a service provided by each sensor device;
and/or,
the node configured to modify a sensor network topology comprises at least one of: a fifth MO node configured to modify the topology connection relationship among the sensor devices and a sixth MO node configured to modify the information about a service provided by the sensor device.

17. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM discovery command sent by the device management server, wherein the DM discovery command acts on the fourth MO node; the management module is specifically configured to:

discover a topology, and map and store the topology to the second MO node, wherein the topology discovery comprises at least one of: searching for information of an identifier and an address of a device, searching for additional information of the device, searching for information of an associated device, and searching for information of a connection status among the devices; and/or,

discover a service, and map and store the service to the third MO node, wherein the discovering the service comprises at least one of: searching for device service information, searching for group information related to the service of a device, and searching for binding information among the service of a device.

18. The gateway according to claim 17, wherein the management module is further configured to:

detect joining or leaving of a sensor device in or from the sensor network;
update according to the detected joining or leaving of the sensor device, the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node; and reporting a notification message to the device server.

19. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to remove a specified device from the sensor network; and
the management module is specifically configured to send a removal command to the specified device and update the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

20. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to remove a specified device and a child device of the specified device from the sensor network; and
the management module is specifically configured to send a removal command to the specified device, wherein the removal command comprises indication information of removing the child device, and update the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

21. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM modification command sent by the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to add a specified device into the sensor network; and
the management module is specifically configured to send a connection establishment request message to the specified device and update the characteristic information of each sensor device and/or the topology connection relationship among the sensor devices in the second MO node, and/or, the information about a service provided by each sensor device in the third MO node.

22. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM modification command sent by
the device management server, wherein the DM modification command acts on the fifth MO node and the fifth MO node is specifically configured to modify a topology connection relationship between a specified device and a neighbor device; and the management module is specifically configured to permit a specified neighbor device to admit a new child device, prohibit other neighbor devices from admitting a child device, instruct the specified device to rejoin in the network, and update the topology connection relationship among the sensor devices in the second MO node.

23. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM modification command sent by the device management server, wherein the DM modification command acts on the sixth MO node; and the management module is specifically configured to modify service information related to a specified sensor network device, comprising: modifying a group and/or binding relationship of a specified service and update information about a service provided by the specified sensor device in the third MO node.

24. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM get command sent by the device management server, wherein the DM get command acts on the first MO node; and the management module is specifically configured to send the overall information of the sensor network stored in the first MO node to the device management server.

25. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM get command sent by the device management server, wherein the DM get command acts on the second MO node; and the management module is specifically configured to send the described characteristic information of each sensor device and/or the information of the topology connection relationship among the sensor devices stored in the second MO node to the device management server.

26. The gateway according to claim 16, wherein,

the receiving module is specifically configured to receive a DM get command sent by the device management server, wherein the DM get command acts on the third MO node; and the management module is specifically configured to send the information about a service provided by each sensor device stored in the third MO node to the device management server.
A gateway receives a DM command sent by a device management server, where the DM command acts on a preconstructed MO node and the MO node includes a node configured to discover a sensor network topology, a node configured to describe the sensor network topology, or a node configured to modify the sensor network topology

The gateway manages the sensor network according to the DM command, where the management includes discovering the sensor network topology, describing the sensor network topology, or modifying the sensor network topology

FIG. 1
51. Establish a remote DM session

52. DM execution command
   (Exec:Topo/Operations/DiscTopoAndService)

53. Topology discovery

  531. Search for identifiers and address information of a device and an associated device
       5311. IEEE address search request (IEEE_Addr_req(NwkAddr,Extended))
       5312. IEEE address search response (IEEE_Addr_rsp(IEEEAddr,NWKAddrAssocDevList))

  532. Search for supplementary information of the device
       5321. Basic information search request (Node_Desc_req(NwkAddr))
       5322. Basic information search response (Node_Desc_rsp(NodeDescriptor))

  533. Search for a list of neighbors of the device
       5331. Link quality search request (Mgmt_Lqi_req(NwkAddr,SrcRtIndex))
       5332. Link quality search response (Mgmt_Lqi_rsp(NeighborTableList))

TO FIG. 5B

FIG. 5A
541. Search for an active EP on the device

5411. Endpoint search request
(Active_EP_req(NwkAddr))

5412. Endpoint search response
(Active_EP_rsp(ActiveEPList))

542. Traverse services on each EP

5421. Simple description search request
(Simple_Desc_req(NwkAddr, EP))

5422. Simple description search response
(Simple_Desc_rsp(SimpleDescriptor))

543. Traverse groups where each EP is located

5431. Group search request
(GetGroupMembership_req(NwkAddr, EP))

5432. Group search response
(GetGroupMembership_rsp(GroupList))

544. Search for a list of device service binding relationships

5441. Binding information search request
(Mgmt_Bind_req(NwkAddr, StartIndex))

5442. Binding information search response
(Mgmt_Bind_rsp(BindingTableList))

55. Success response (Alert:OK)

56. Acquire topology tree information and service information of each device

FIG. 5B
61. Establish a remote DM session

62. DM replacement and execution command
(Replace:Topo/Operations/DiscTopo/Notification=Ture
Exec:Topo/Operations/DiscTopo)

63. The process of discovering a ZigBee network topology

64. detect joining/leaving of a node

641. Leaving message (Nwk_Leave(IEEEAddr))

642. Notification message (Device_annotate(NwkAddr,IEEEAddr))

65. Update device list information

66. Notification message (Alert: topology Changed)

67. Rediscover the ZigBee network topology and device service information through the gateway

FIG. 6
701. Establish a remote DM session

702. DM replacement and execution command
(Replace: Topo/Operations/DiscTopoAndService/Notification=True
Exec: Topo/Operations/DiscTopoAndService)

703. Topology discovery

703.1. Search for an address identifier of a device

703.2. Search for additional information of the device

704. Service discovery

704.1. Search for device service information

704.11. Service search request
(SDP_ServiceSearchAttribute_req
(ServiceSearchPattern=PublicBrowseRoot))

704.12. Service search response
(SDP_ServiceSearchAttribute_rsp
(ServiceAttributeList))

704.2. Service search request
(LMP_Name_Req(BD_ADDR))

704.21. Name inquiry request
(LMP_Name_Req(BD_ADDR))

704.22. Name inquiry response
(LMP_Name_rsp(Name))

704.3. Service search request
(Extended_Inquiry_response)

704.31. BlueTooth inquiry request
(Inquiry_req)

704.32. Inquiry response
(Inquiry_rsp(BD_ADDR))

FIG. 7A
705. Success response (Alert:OK)

706. Acquire topology tree information and service information of each node

707. Detect joining/leaving of a device in or from the BlueTooth network

7071. BlueTooth connection establishment request (LMP_Host_Connection_req (BD_ADDR))

7072. BlueTooth connection establishment complete (LMP_Setup_Complete)

7073. Leaving message (LMP_Detach)

7074. Acknowledgement message (BB_Ack)

708. Update device list information

709. Notification message (Alert:Topology Changed)

710. Rediscover the BlueTooth network topology and service information of the BlueTooth device through the gateway

FIG. 7B
81. Establish a remote DM session
82. Discover a ZigBee network topology
84. Device removal request (Mgmt_Leave_req(IEEEAddr=Dev1,RemoveChildren=True))
85. Removal of all child devices
851. Device removal request (Mgmt_Leave_req(IEEEAddr=DevX, RemoveChildren=True))
852. Device removal response (Mgmt_Leave_rsp(SUCCESS))
86. Device removal response (Mgmt_Leave_rsp(SUCCESS))
87. Update device list information
88. Success response (Alert:OK)

FIG. 8
91. Establish a remote DM session

92. Discover a BT network topology

931. DM execution command (Exec:Topo/DevList/Dev1/Operations/Disconnect)

932. Device removal request (LMP_Detach)

933. Device removal response (BB_Ack)

93. Removal of a BlueTooth slave device

941. DM execution command (Exec:Topo/DevList/Dev0/Neighbors/Dev2/Operations/Connect)

94. Add one BlueTooth slave device

942. Connection establishment request (LMP_Host_Connection_req(BD_ADDR=Dev2))

943. Connection establishment complete message (LMP_Setup_Complete)

95. Update device list information

96. Success response (Alert:OK)

FIG. 9
101. Establish a remote DM session

102. Discover a ZigBee network topology

103. DM replacement and execution command
(Replace:Topo/DevList/Dev1/Ser1/Operations/AddGroup/x/GroupId
Replace:Topo/DevList/Dev1/Ser1/Operations/AddGroup/x/GroupName
Exec:Topo/DevList/Dev1/Ser1/Operations/AddGroup)

104. Add group information of the device service

1041. Adding group request
(Add_Group_req(EPNum, GroupId,GroupName))

1042. Update a local GroupTable

1043. Response of adding a group successfully
(Add_Group_rsp (SUCCESS))

105. Update device list information

106. Success response (Alert:OK)

FIG. 10
1101. Establish a remote DM session

1102. Discover a ZigBee network topology

1103. DM execution command
        (Exec:Topo/DevList/Dev1/Neighbors/Dev2/Operations/Connect)

1104. Store configuration information of the related devices

1105. Permit the Dev2 to admit a new child device and prohibit other devices from admitting a child device

11051. Request for setting to permit a child device connection
        (Mgmt_PermIt_Joining_req(PermitDuration=0xff))

11052. Success response message
        (Mgmt_PermIt_Joining_rsp(SUCCESS))

11053. Request for setting to permit a child device connection
        (Mgmt_PermIt_Joining_req(PermitDuration=0x00))

11054. Success response message
        (Mgmt_PermIt_Joining_rsp(SUCCESS))
1106. Instruct the Dev1 to rejoin in the network

11061. Leaving network request (Mgmt_Leave_req (IEEEAddr=Dev1,Rejoin=True))

11062. Leaving network response (Mgmt_Leave_rsp (SUCCESS))

11063. The Dev1 is associated with the Dev2 through a network scanning and joining process

11064. Notification message (Device_annce (NwkAddr,IEEEAddr))

1107. Restore configuration information of the related devices

11071. Request for setting to permit a child device connection (Mgmt_Permit_Joining_req(PermitDuration=0x00))

11072. Success response message (Mgmt_Permit_Joining_rsp(SUCCESS))

11073. Request for setting to permit the child device connection (Mgmt_Permit_Joining_req(PermitDuration=0xff))

11074. Success response message (Mgmt_Permit_Joining_rsp(SUCCESS))

1108. Rediscover the network topology

1109. Update the network topology information

1110. Success response (Alert:OK)
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

H04W84/18 (2009.01)i
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)

IPC: H04W; H04Q; H04B; H04M; H04L

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)

CPRSABS, CNKI, WPI, EPDOC: device w manage+, management w object, sensor, Bluetooth, infrared, topo+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>CN101313512A (HUAWEI TECHNOLOGIES CO LTD) 26 Nov. 2008 (26.11.2008) Page 2 paragraph 5, page 4 paragraph 1-6, page 5 paragraph 5-page 6 paragraph 6, page 9 paragraph 3 of the description</td>
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<td>CN101854343A (HUAWEI DEVICE CO LTD) 06 Oct. 2010 (06.10.2010) The whole document</td>
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search
02 Aug. 2011 (02.08.2011)

Date of mailing of the international search report
08 Sep. 2011 (08.09.2011)

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jining Bridge, Haidian District, Beijing, China 100088

Authorized officer
WANG Xiaoli
Telephone No. (86-10)62411389

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EP 2 605 610 A1

INTERNATIONAL SEARCH REPORT
Information on patent family members

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REFERENCES CITED IN THE DESCRIPTION

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