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(54) **DOMAIN SPECIFIC LANGUAGE FOR PROTECTED MESH COMMUNICATION**

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(51) **Int. Cl.**

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H04L 9/40 (2022.01)
H04L 61/45 (2022.01)
H04L 101/668 (2022.01)

(57)

ABSTRACT

A system and method of protecting communication in a mesh network of nodes. The method including receiving a request from a joiner node of the mesh network to join the mesh network. The method including validating permissions for the joiner node responsive to receiving the request. The method including acquiring one or more dictionary objects based on the permissions. The method including granting, by a control node of a mesh network, access rights for the joiner node to join the mesh network by transmitting an access rights message comprising the one or more dictionary objects to the joiner node, wherein the access rights message causes the joiner node to locally store the one or more dictionary objects and use the one or more dictionary objects when communicating with one or more nodes of the mesh network.

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(58) **Field of Classification Search**

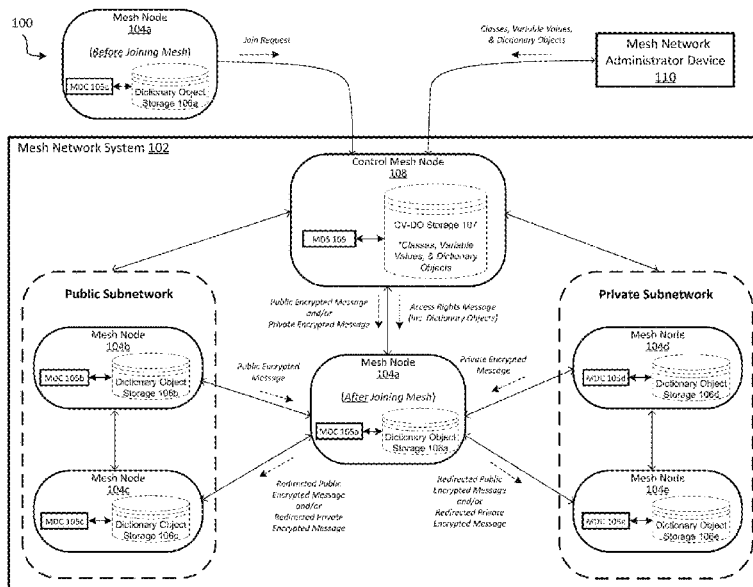
None
See application file for complete search history.

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20 Claims, 5 Drawing Sheets



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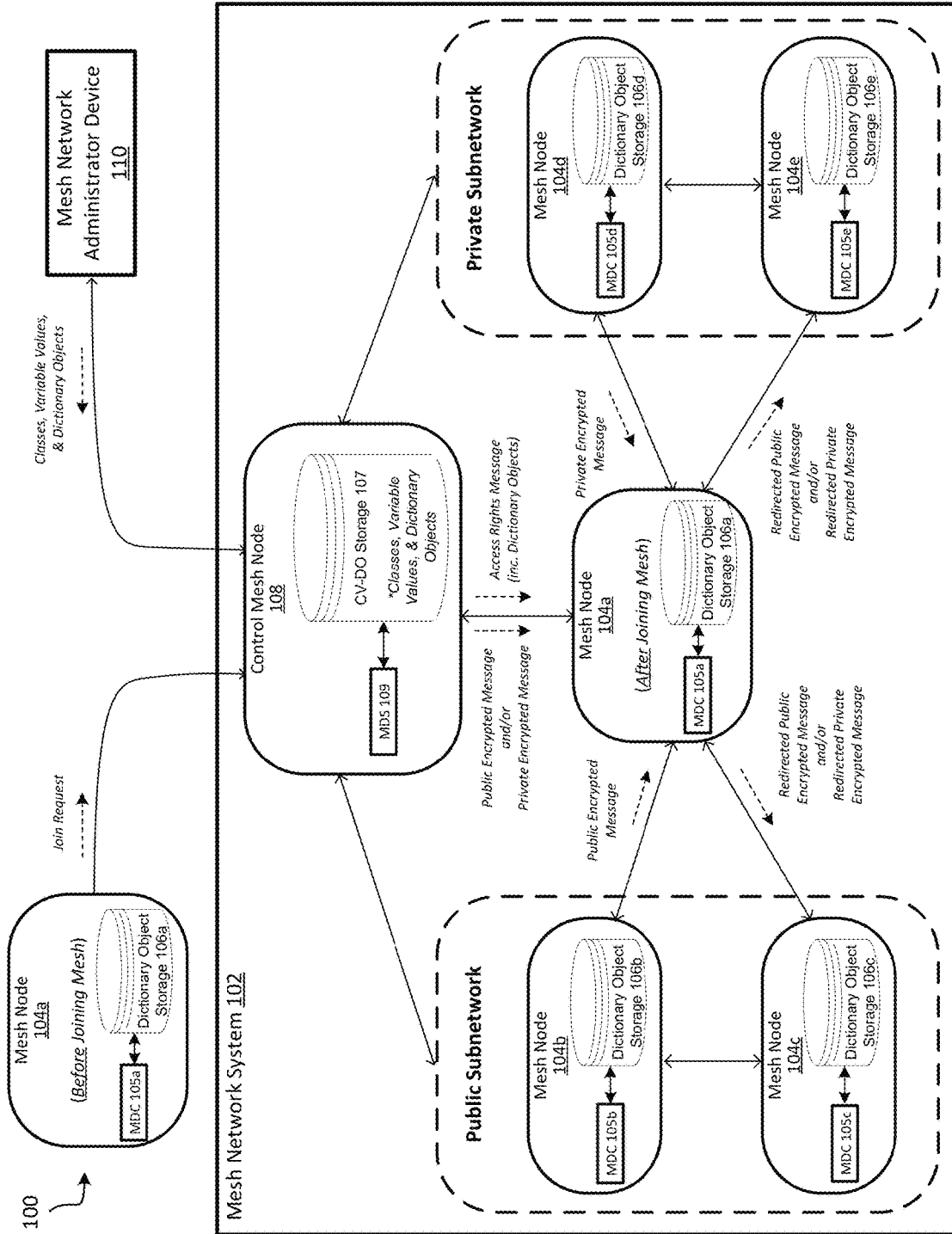


FIG. 1

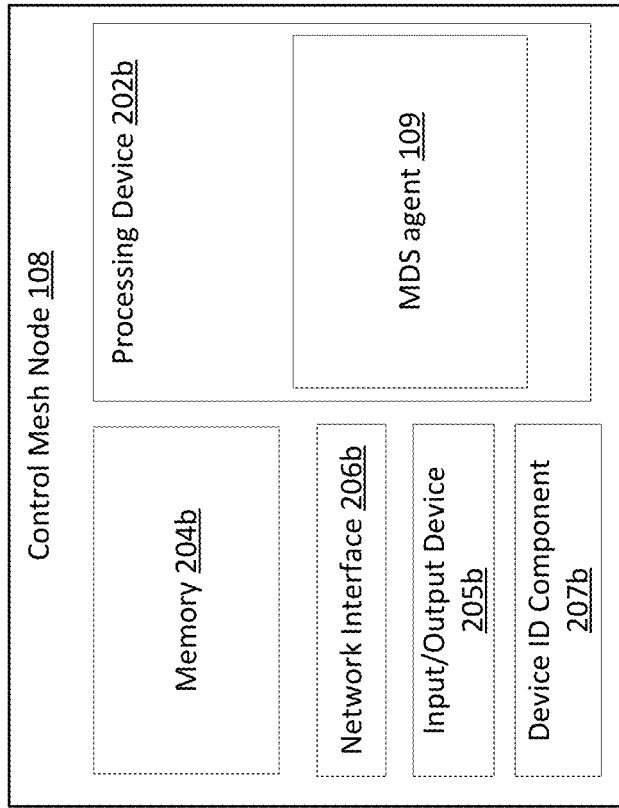


FIG. 2B



FIG. 2A

200c

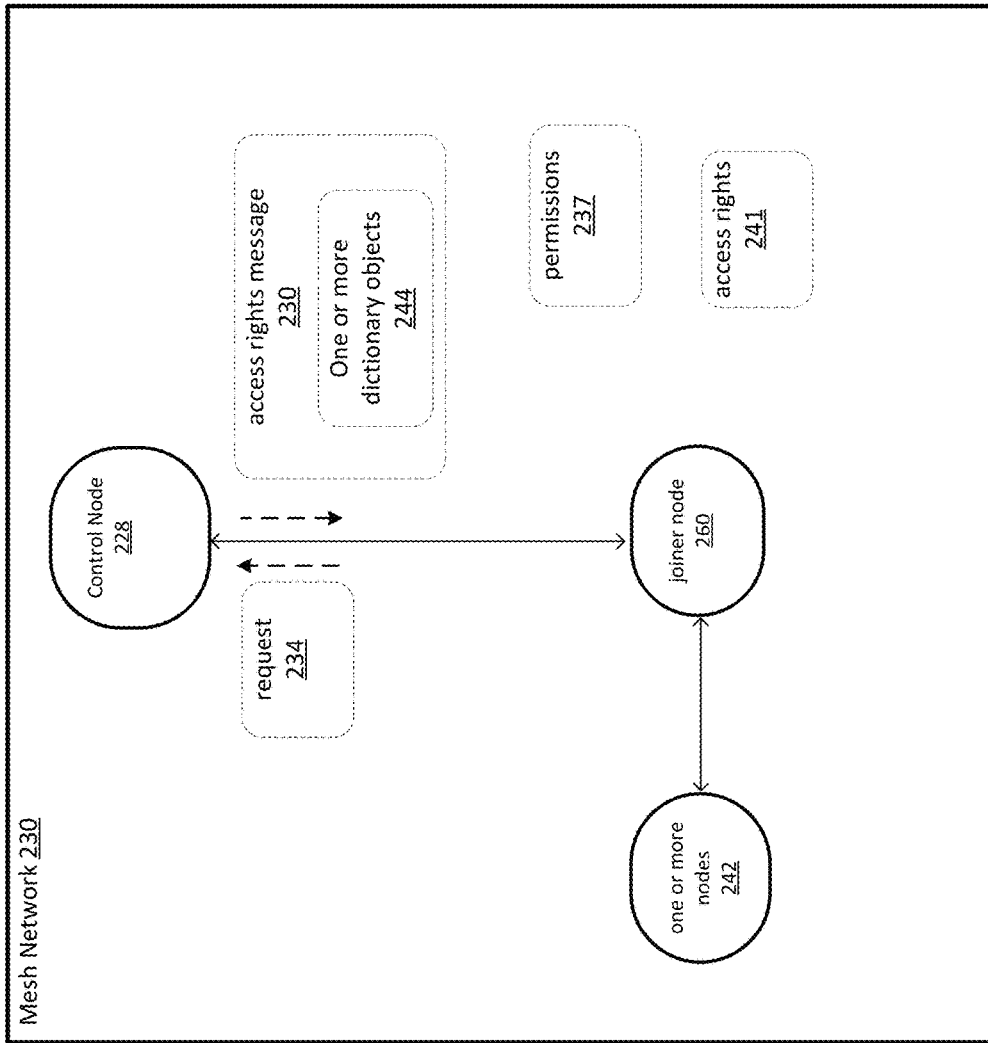


FIG. 2C

300

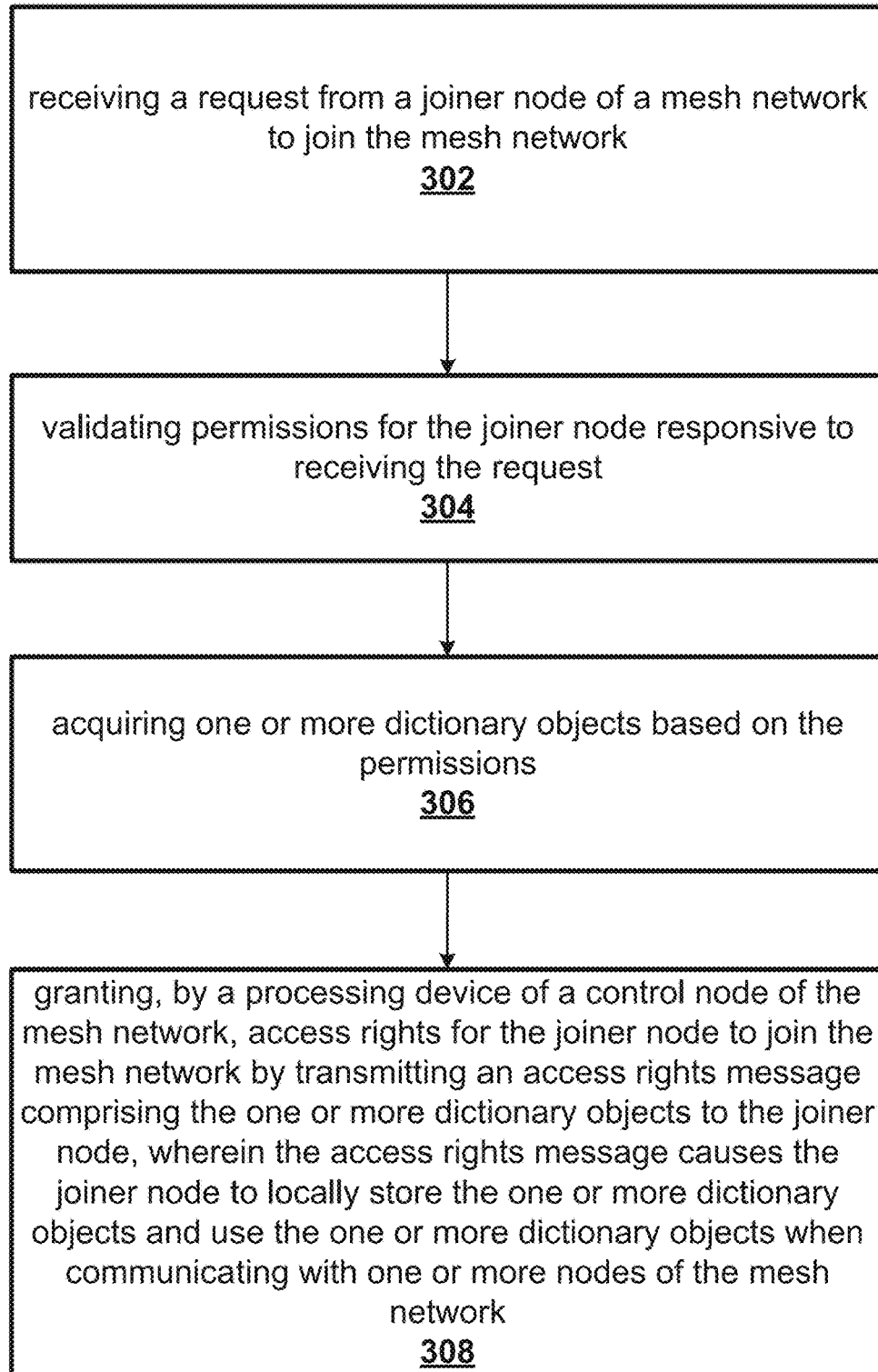


FIG. 3

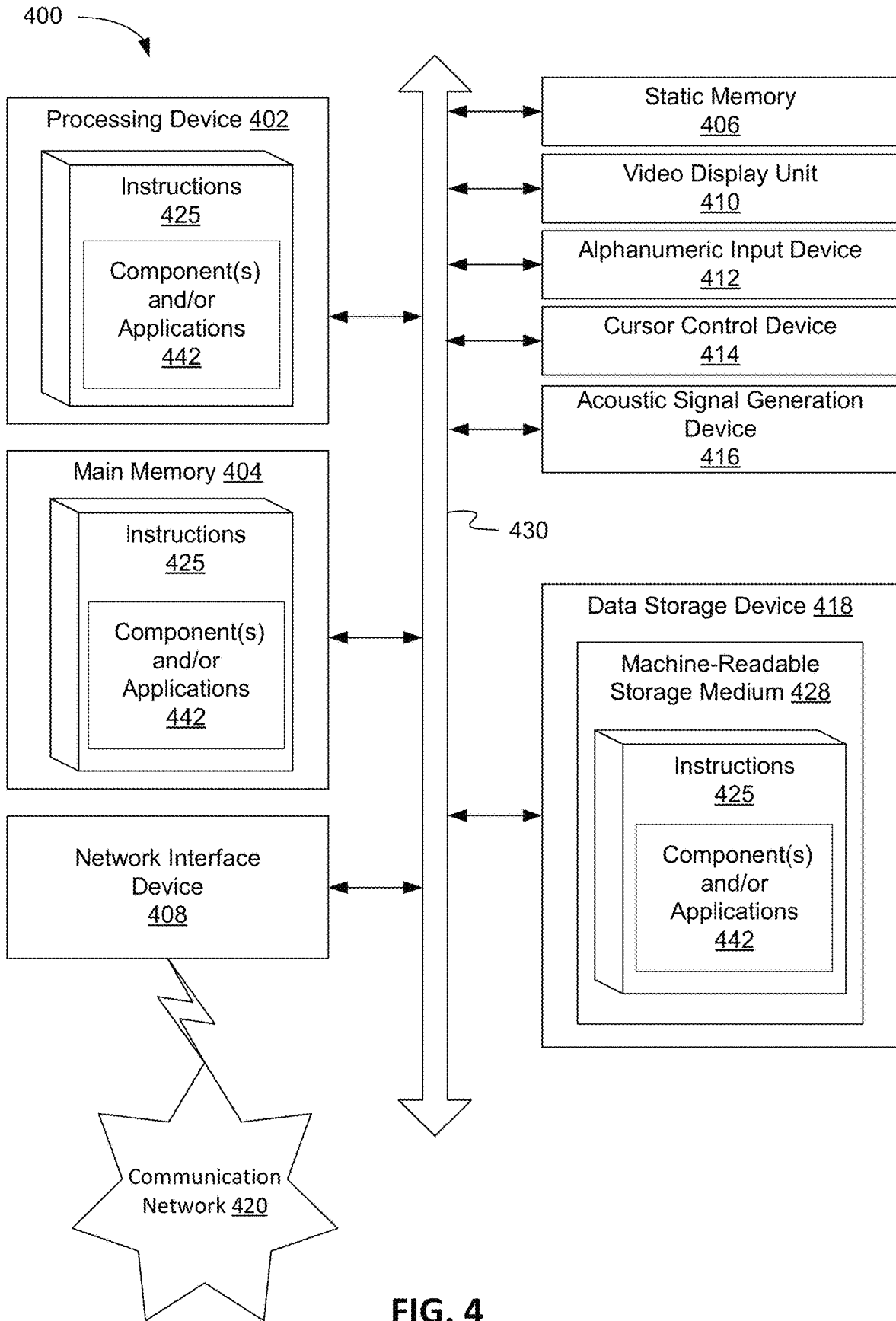


FIG. 4

DOMAIN SPECIFIC LANGUAGE FOR PROTECTED MESH COMMUNICATION

TECHNICAL FIELD

The present disclosure relates generally to software technology, and more particularly, to systems and methods of protecting communication in a mesh network of nodes using domain specific language.

BACKGROUND

A mesh network is a network in which devices— or nodes—are linked together, branching off other devices or nodes. These networks are set up to efficiently route data between devices and clients. They help organizations provide a consistent connection throughout a physical space.

BRIEF DESCRIPTION OF THE DRAWINGS

The described embodiments and the advantages thereof may best be understood by reference to the following description taken in conjunction with the accompanying drawings. These drawings in no way limit any changes in form and detail that may be made to the described embodiments by one skilled in the art without departing from the spirit and scope of the described embodiments.

FIG. 1 is a block diagram depicting an example environment for protecting communication in a mesh network of nodes, according to some embodiments;

FIG. 2A is a block diagram depicting an example mesh node **104** of the mesh network system **102** in FIG. 1, according to some embodiments;

FIG. 2B is a block diagram depicting an example of the control mesh node **108** of the environment in FIG. 1, according to some embodiments;

FIG. 2C is a block diagram depicting an example environment of a mesh network system **102**, according to some embodiments;

FIG. 3 is a flow diagram depicting a method of protecting communication in a mesh network of nodes, according to some embodiments; and

FIG. 4 is a block diagram of an example computing device that may perform one or more of the operations described herein, in accordance with some embodiments.

DETAILED DESCRIPTION

Software running on nodes within a mesh can include programming language ecosystems such as Java, Python or Javascript. Domain Specific Language (DSLs) are used to create a customized language that represents the domain such that domain experts can easily interpret it. Such languages are highly customized to be strong at and good at certain roles rather than a more generic language. DSLs require their own compiler and interpreters and DSLs come in two flavors, an external DSL and an internal DSL with the latter being a language constructed within another general language, leveraging the host languages tooling. However, within clusters or Internet of Things (IoT) like environments where devices can enter and interact with other devices, there is a problem with ensuring security and communication between the nodes, especially if a node maliciously gains unauthorized access to secure regions of the mesh network. Thus, there is a long felt need to solve the problem related to access control and interpretation of private messages and execution asks within a mesh network.

Aspects of the present disclosure address the above-noted and other deficiencies by protecting communication in a mesh network using a DSL. As discussed in greater detail below, a control mesh node of a mesh network executes a Mesh Dictionary Service (MDS) agent that acquires a dictionary object (sometimes referred to as, “object dictionary”) and make it available to requesting nodes of the mesh network that have adequate permissions and need to utilize the internal mesh DSL for service purposes. The control mesh node validates the node to ascertain trust before granting the dictionary object to the node. That is, the MDS agent receives a request from the node, validates the permissions of the node, and grants the node access to the mesh network by sharing the dictionary object with the node. The object is an instantiation of an object oriented-style class (such as in Java), which is made available to a running agent on the node, in the same host language using something like Remote Method Invocation (RMI) or other object transfer approaches. Once the dictionary object is received, the receiving node can then store this object in memory and utilize the dictionary as a means to interpret the instructions encoded within the base programming language and which will form part of standard communication headers between devices.

A benefit of this approach is homogenization of the course code, wherein a language embedded within is not interpretable and can be awoken so to speak by having the right dictionary. This means that all devices have the same service capability but crucially will not be able to interpret or act upon the code paths contained within unless it has the right dictionary. This approach allows for embodiments that range from the intelligent encoding of Role-Based Access Code (RBAC) style policies within a DSL to allowing for cryptographic information to be stored right through to an internal message bus paradigm enabled by the language. This would see a very simple benefit of allowing nodes join the mesh with common language capabilities installed but would not be able to participate in certain mesh communications such as message buses or invoking application-specific interfaces (APIs) that utilize the DSL descriptors until granted permission which is the dictionary. In one embodiment, the DSL would become part of an Multi Factor Authentication approach wherein one challenge would be to answer and respond in the mesh language using the same language.

FIG. 1 is a block diagram depicting an example environment for protecting communication in a mesh network of nodes, according to some embodiments. The environment **100** includes a mesh network system **102** (sometimes referred to as, “mesh network”) and a mesh network administrator device **110**. The mesh network system **102** includes a public subnetwork associated with a public dictionary object and a private subnetwork associated with a private dictionary object. The mesh network system **102** includes mesh nodes **104** (e.g., mesh nodes **104a**, **104b**, **104c**, **104d**, **104e**). Each mesh node includes a dictionary object storage **106** for storing one or more dictionary objects (sometimes referred to as a, “DSLs”). Specifically, the mesh node **104a** includes a dictionary object storage **106a**, the mesh node **104b** includes a dictionary object storage **106b**, the mesh node **104c** includes a dictionary object storage **106c**, the mesh node **104d** includes a dictionary object storage **106d**, and the mesh node **104e** includes a dictionary object storage **106e**.

The mesh nodes **104b**, **104c** are members of and/or are included in the public subnetwork and each locally store, in their respective dictionary object storages **106**, a copy of the

public dictionary object that is used to encrypt/decrypt the messages (e.g., either the entire message or portions of the message) that are communicated between the mesh nodes **104** of the public subnetwork. Conversely, mesh nodes **104d**, **104e** are members of and/or are included in the private subnetwork and each locally store, in their respective dictionary object storages **106**, a copy of the private dictionary object that is used to encrypt/decrypt the messages (e.g., either the entire message or portions of the message) that are communicated between the mesh nodes **104** of the private subnetwork. The mesh nodes **104** (e.g., mesh node **104d**, **104e**) that have the appropriate permissions to join the private subnetwork might also have the appropriate permissions to join the public subnetwork. For example, mesh nodes **104d**, **104e** are members of both the private subnetwork and the public subnetwork, thereby allowing each of the mesh nodes **104d**, **104e** to have access to (and store) a copy of the private dictionary object and a copy of the public dictionary object. However, mesh nodes **104** (e.g., mesh node **104b**, **104c**) that do not have the appropriate permissions to join the private subnetwork are prohibited from joining the private subnetwork. As such, the mesh nodes **104** (e.g., mesh node **104b**, **104c**) that can only join the public subnetwork will only have access to the public dictionary object.

It should be noted that the phrase “private” in the private dictionary object that is associated with the private subnetwork and the phrase “public” in the public dictionary object associated with the public subnetwork are each not being used to indicate that the dictionary objects are defined as being public or private objects in the context of the base language (e.g., Java, etc.). Rather, the phrases “public” and “private” are simply being used to clarify that the public dictionary object is different from the private dictionary object.

As shown in FIG. 1, mesh node **104a** (sometimes referred to as, “joiner node **104a**”) resides outside of the mesh network system **102** prior to joining the mesh network system **102**, but resides inside the mesh node system **102** after joining the mesh network system **102**. Upon joining the mesh network system **102**, the mesh node **104a** is added to the public subnetwork and/or the private subnetwork (despite being shown in FIG. 1 outside of the public and private subnetwork) based on the permissions associated with the mesh node **104a**.

The mesh network system **102** includes a control mesh node **108** (sometimes referred to as, “control node”), which is a mesh node **104** that is further configured with additional administrative functionality for controlling and/or managing the other mesh nodes **104** in the mesh network system **102**. The control mesh node **108** is communicably coupled to the mesh network administrator device **110** via an external network (not shown in FIG. 1). As discussed herein, the control mesh node **108** is configured to determine whether a mesh node **104** is permitted to join, or stay joined to, the one or more subnetworks of the mesh network system **102** based on the permissions associated with the mesh node **104a**, and then add (or remove) the mesh node **104** to the one or more subnetworks of the mesh network system **102**.

The control mesh node **108** includes a Class, Member Variable Values, & Dictionary Object (CV-DO) storage **107** for storing (a) classes, (b) member variable values for initializing the classes, and (c) dictionary objects. The control mesh node **108** may receive the classes, member variable values, and/or the dictionary objects from the mesh network administrator device **110**.

Each of the mesh nodes **104** execute a mesh dictionary client (MDC) agent **105**. Specifically, the mesh node **104a** executes an MDC agent **105a**, the mesh node **104b** executes an MDC agent **105b**, the mesh node **104c** executes an MDC agent **105c**, the mesh node **104d** executes an MDC agent **105d**, and the mesh node **104e** executes an MDC agent **105e**.

The MDC agent **105** of a mesh node **104** (e.g., joiner node **104a**) is configured to send a request (shown in FIG. 1 as, “join request”) to the control mesh node **108** to join the mesh network system **102**. The request may include information (e.g., a device identification, a device type (e.g., insulin pump, smartphone, smartwatch, etc.), security policies, permissions, etc.) associated with the mesh node **104** (e.g., joiner node **104a**), which the control mesh node **108** may then use to validate whether the mesh node **104** (e.g., joiner node **104a**) has the permission to join one or more subnetworks of the mesh network system **102**. The MDC agent **105** is configured to receive an access rights message (e.g., shown in FIG. 1 as, “access rights message”) from the control mesh node **108**, where the access rights include a public dictionary object indicating that the mesh node **104** (e.g., joiner node) has been added to the public subnetwork and/or a private dictionary object indicating that the mesh node **104** (e.g., joiner node) has been added to the private subnetwork.

The MDC agent **105** of a mesh node **104** (e.g., joiner node **104a**) stores a copy of the dictionary objects that it receives from the control mesh node **108** in its dictionary object storage **106** and uses the appropriate dictionary object to encrypt/decrypt communication between mesh nodes **104** of the public subnetwork and/or private subnetwork. For example, the MDC agent **105** selects/uses the public dictionary object to encrypt/decrypt the messages that are communicated between the mesh nodes **104** of the public subnetwork. If the MDC agent **105** has the appropriate permissions, then the MDC agent **105** selects/uses the private dictionary object to encrypt/decrypt the messages (e.g., the entire message or portions of the message) that are communicated between the mesh nodes **104** of the private subnetwork.

If a mesh node (e.g., joiner node **104a**) receives a message that is entirely encrypted with the public dictionary object, then the MDC agent **105** of the joiner node **104a** may entirely decrypt the message to generate a decrypted message that can be fully understood (e.g., read) by the joiner node **104a**. If the joiner node **104a** is a member of the private subnetwork and receives a message that is entirely encrypted with the private dictionary object, then the MDC agent **105** of the joiner node **104a** may entirely decrypt the message to generate a decrypted message that can be fully understood (e.g., read) by the joiner node **104a**.

However, if the joiner node **104a** is only a member of the public subnetwork and receives a message that includes a first portion (e.g., the message header) encrypted with the public dictionary object and a second portion (e.g., data) encrypted with the private dictionary object, then the MDC agent **105** of the joiner node **104a** may only decrypt the first portion of the message using its public dictionary object. That is, the joiner node **104a** will be unable to decrypt the entire message because the joiner node **104a** does not have access to the private dictionary object that is required to decrypt the remaining portions (e.g., data payload) of the message. Thus, after decrypting the first portion of the message, the joiner node **104a** will be left with the remaining portions of the message that are still encrypted.

The joiner node **104a** may redirect messages to any of its neighboring mesh nodes. For example, the joiner node **104a**

may receive a “private” message (shown in FIG. 1 as, “Private Encrypted Message”) from mesh node **104d**, where a portion of the message is encrypted with the private dictionary object. The joiner node **104a** may decrypt the private message using its public dictionary object to decrypt (e.g., reveal) the header portion of the message, but where the remaining data portion of the message is still encrypted. The joiner node **104a** may then determine that the decrypted header indicates that one or more of its neighboring nodes are the intended recipients of the message. As such, the joiner node **104a** may redirect the private message (shown in FIG. 1 as, “Redirected Private Encrypted Message”) to the appropriate mesh nodes (e.g., mesh node **104c**, mesh node **104e**, etc.).

As another example, the joiner node **104a** may receive a “public” message (shown in FIG. 1 as, “Public Encrypted Message”) from mesh node **104b**, where the entire message is encrypted with the public dictionary object. As such, the joiner node **104a** may decrypt the entire message (e.g., header and data) to generate a decrypted message. The joiner node **104a** may then determine that the decrypted header indicates that one or more of its neighboring nodes are the intended recipients of the message. As such, the joiner node **104a** may redirect the public message (shown in FIG. 1 as, “Redirected Public Encrypted Message”) to the appropriate mesh nodes (e.g., mesh node **104c**, mesh node **104e**, etc.), where the redirected message is still in its encrypted form.

Each mesh node (e.g., mesh node **104a**, control mesh node **108**, etc.) of a mesh network system (e.g., mesh network system **102**, mesh network system **112**) is positioned (e.g., arranged, organized) within the mesh network system, such that the mesh node may be within a minimum physical distance (e.g., up to 10 meters with a Bluetooth connection, up to 46 meters with a wireless local area network (WLAN) connection) of neighboring mesh nodes to be able to communicate with its neighboring nodes by using one or more types of communication capabilities.

As shown in FIG. 1, the mesh node **104a** has neighboring mesh nodes that include control mesh node **108** and mesh nodes **104b**, **104c**, **104d**, **104e** when using a first type of communication capability (e.g., a Bluetooth, etc.). The mesh node **104b** has neighboring mesh nodes that include mesh nodes **104c**, **104a**, and control mesh node **108** when using the first type of communication capability. The mesh node **104c** has neighboring mesh nodes that include mesh nodes **104a**, **104b** when using the first type of communication capability. The mesh node **104d** has neighboring mesh nodes that include mesh nodes **104a**, **104e** and control mesh node **108** when using the first type of communication capability. The mesh node **104e** has neighboring mesh nodes that include mesh node **104a**, **104d** when using the first type of communication capability.

A mesh node (e.g., mesh node **104a**, control mesh node **108**, etc.) may have a greater number of neighboring mesh nodes when using a second type of communication capability (e.g., a WLAN connection). For example, the mesh node **104b** may expand its neighboring mesh nodes to also include mesh nodes **104d**, **104e** when using the second type of communication capability. The mesh node **104c** may expand its neighboring mesh nodes to also include mesh nodes **104d**, **104e** and control mesh node **108** when using the second type of communication capability. The mesh node **104d** may expand its neighboring mesh nodes to also include mesh nodes **104d**, **104c** when using the second type of communication capability. The mesh node **104e** may expand

its neighboring mesh nodes to also include mesh node **104b**, **104c** and control mesh node **108** when using the second type of communication capability.

A mesh node (e.g., mesh node **104a**, control mesh node **108**, etc.) may directly communicate with its neighboring mesh nodes **104** by using one or more types of communication capabilities. A communication capability may include the hardware and/or software resources for communicating via a Bluetooth (BT) connection, a WLAN connection, and/or a near field communication (NFC) connection. In some embodiments, a mesh node **104** includes the hardware and/or software resources for communicating via a cellular network (e.g., LTE, 5G, etc.), which allow the mesh node **104** to communicate with computing devices outside of the mesh network system **102**. In some embodiments, a mesh node **104** does not include the hardware and/or software resources for communicating via a cellular network (e.g., LTE, 5G, etc.), which prevent the mesh node **104** from communicating with computing devices outside of the mesh network system **102**.

In some embodiments, a mesh node (e.g., mesh node **104a**, control mesh node **108**, etc.) may be unable to directly communicate with a non-neighboring mesh node when using a particular communication capability because the non-neighboring node is outside of the radio frequency (RF) range of the particular communication capability. In some embodiments, a mesh node that is unable to directly communicate with a non-neighboring mesh node may indirectly communicate with the non-neighboring node by directly communicating through a neighboring mesh node. For example, if the control mesh node **108** wants to communicate with the mesh node **104a**, then the control mesh node **108** may send a first message (shown in FIG. 1 as, “Public Encrypted Message and/or Private Encrypted Message”) to mesh node **104a** to cause the mesh node **104a** to send a second message (shown in FIG. 1 as, “Public Encrypted Message and/or Private Encrypted Message”) to the mesh node **104c**, where the second message indicates the details of the first message. As another example, if the mesh node **104b** wants to communicate with the mesh node **104e**, then the mesh node **104b** may send a first message (shown in FIG. 1 as, “Public Encrypted Message”) to mesh node **104a** to cause the mesh node **104a** to redirect (e.g., forward, propagate) the first message to the mesh node **104e**.

A mesh node **104** may be configured to discover its neighboring mesh nodes by broadcasting a ping message outward using a particular communication capability and identifying the mesh nodes that responds to the ping message as its neighboring mesh nodes. For example, the mesh node **104a** may transmit ping messages toward the mesh nodes **104b**, **104c**, **104d**, **104e** and control mesh node **108** to cause each of the nodes to either respond with an acknowledgement (e.g., an ACK) or not respond (e.g., stay silent).

An external network may be a public network (e.g., the internet), a private network (e.g., a local area network (LAN) or wide area network (WAN)), or a combination thereof. In some embodiments, an external network may include a wired or a wireless infrastructure, which may be provided by one or more wireless communications systems, such as wireless fidelity (Wi-Fi) connectivity to the external network and/or a wireless carrier system that can be implemented using various data processing equipment, communication towers (e.g. cell towers), etc. The external network may carry communications (e.g., data, message, packets, frames, etc.) between any other the computing device.

A mesh node **104**, the control mesh node **108**, and a mesh network administrator device **110** may each be any suitable

type of computing device or machine that has a processing device, for example, a server computer (e.g., an application server, a catalog server, a communications server, a computing server, a database server, a file server, a game server, a mail server, a media server, a proxy server, a virtual server, a web server), a desktop computer, a laptop computer, a tablet computer, a mobile device, a smartphone, a set-top box, a graphics processing unit (GPU), etc. In some examples, a computing device may include a single machine or may include multiple interconnected machines (e.g., multiple servers configured in a cluster).

In some embodiments, the mesh node **104**, the control mesh node **108**, and the mesh network administrator device **110** may each be a wearable device (e.g., smartwatch, smart clothing, smart glasses, smart jewelry, wearable camera, wireless earbuds, fitness tracker, blood pressure monitor, heart rate monitor, etc.) or an implantable device (e.g., insulin pump, cochlear device, pacemaker, brain simulator, etc.).

Still referring to FIG. 1, the control mesh node **108** executes a mesh dictionary service (MDS) agent **109** that is configured to receive a request from a mesh node **104** (e.g., joiner node **104a**) to join the mesh network system **102**, where the joiner node **104a** is not yet a member of the mesh network system **102**. The control mesh node **108** uses the information in the request (e.g., device identifier, device type, permissions, etc.) to validate whether the joiner node **104a** has the appropriate permissions to join one or more subnetworks of the mesh network system **102**. The control mesh node **108** identifies, based on the permissions, the one or more subnetworks that the joiner node **104a** is permitted to join and then acquires the one or more dictionary objects that are associated with those subnetworks. In some embodiments, the control mesh node **108** may acquire a dictionary object by creating the dictionary object using information that is stored in the CV-DO storage **107**. For example, the control mesh node **108** may create (e.g., generate) a public dictionary object by initializing a base class using a first set of variables (sometimes referred to as, “public variables”), and create a private dictionary object by initializing the same base class using a set of second set of variables (e.g., sometimes referred to as, “private variables”). The control mesh node **108** may create a public dictionary object by initializing a first base class (sometimes referred to as, “public base class”) using the first set of variables and create a private dictionary object by initializing a second base class (sometimes referred to as, “private base class”) using the second set of variables. In some embodiments, the control mesh node **108** may receive the dictionary objects from the mesh network administrator device **110**.

The control mesh node **108** grants access rights for the joiner node **104a** to join one or more subnetworks of the mesh network system **102** by transmitting an access rights message that includes the one or more dictionary objects to the joiner node **104a**. The access rights message causes the joiner node **104a** to locally store the one or more dictionary objects in its dictionary object storage **106a**, and use the one or more dictionary objects to encrypt/decrypt the communication it has with other mesh nodes **104** in the mesh network system **102**. Thus, the control mesh node **108** is able to provide a mechanism for the mesh nodes **104** in the mesh network system **102** to protect their communication by only sharing the dictionary objects with those mesh nodes **104** that have the appropriate permissions to decrypt the secured communications.

Although FIG. 1 shows only a select number of computing devices (e.g., mesh nodes **104**, control mesh node **108**,

and mesh network administrator device **110**), the environment **100** may include any number of computing devices that are interconnected in any arrangement to facilitate the exchange of data between the computing devices. Furthermore, the public subnetwork and the private subnetwork are shown in FIG. 1 in order to explain that the mesh network system **102** may be divided into subnetworks. However, in other embodiments, the mesh network system **102** may have any number of subnetworks (including no subnetworks), and the control mesh node **108** may create any number of dictionary objects associated with the subnetworks in order to protect the communication between any number of mesh nodes **104** in the mesh network system **102**.

FIG. 2A is a block diagram depicting an example mesh node **104** of the mesh network system **102** in FIG. 1, according to some embodiments. While various devices, interfaces, and logic with particular functionality are shown, it should be understood that the one or more mesh nodes **104** (e.g., mesh nodes **104a-i**) of the mesh network system **102** each include any number of devices and/or components, interfaces, and logic for facilitating the functions described herein. For example, the activities of multiple devices may be combined as a single device and implemented on a same processing device (e.g., processing device **202a**), as additional devices and/or components with additional functionality are included.

The mesh node **104** includes a processing device **202a** (e.g., general purpose processor, a PLD, etc.), which may be composed of one or more processors, and a memory **204a** (e.g., synchronous dynamic random access memory (DRAM), read-only memory (ROM)), which may communicate with each other via a bus (not shown).

The processing device **202a** may be provided by one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. In some embodiments, processing device **202a** may include a complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or a processor implementing other instruction sets or processors implementing a combination of instruction sets. In some embodiments, the processing device **202a** may include one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. The processing device **202a** may be configured to execute the operations described herein, in accordance with one or more aspects of the present disclosure, for performing the operations and steps discussed herein.

The memory **204a** (e.g., Random Access Memory (RAM), Read-Only Memory (ROM), Non-volatile RAM (NVRAM), Flash Memory, hard disk storage, optical media, etc.) of processing device **202a** stores data and/or computer instructions/code for facilitating at least some of the various processes described herein. The memory **204a** includes tangible, non-transient volatile memory, or non-volatile memory. The memory **204a** stores programming logic (e.g., instructions/code) that, when executed by the processing device **202a**, controls the operations of the mesh node **104**. In some embodiments, the processing device **202a** and the memory **204a** form various processing devices and/or circuits described with respect to the mesh node **104**. The instructions include code from any suitable computer programming language such as, but not limited to, C, C++, C#, Java, JavaScript, VBScript, Perl, HTML, XML, Python, TCL, and Basic.

The processing device **202a** may execute a mesh dictionary client (MDC) agent **105** that is configured to send a request to the control mesh node **108** to join the mesh network system **102**. The MDC agent **105** is configured to receive an access rights message from the control mesh node **108**, where the access rights include a public dictionary object indicating that the mesh node **104** (e.g., joiner node) has been added to the public subnetwork and/or a private dictionary object indicating that the mesh node **104** (e.g., joiner node) has been added to the private subnetwork. The MDC agent **105** is configured to store the dictionary objects that it receives from the control mesh node **108** in its dictionary object storage **106**.

In some embodiments, a private message may include at least one of an application programming interface (API) endpoint, a seed phrase, or an access token. In some embodiments, a private message (when decrypted) may cause a mesh node **104** to install one or more application components.

The MDC agent **105** is configured to receive a public message (e.g., public encrypted message) from a mesh node **104** (e.g., mesh node **104b**, **104c**) in the public subnetwork, and decrypt the public message using one or more public dictionary objects to generate a decrypted message. The MDC agent **105** is configured to receive a private message (e.g., private encrypted message) from a mesh node **104** (e.g., mesh node **104d**, **104e**) in the private subnetwork, and decrypt the private message using one or more private dictionary objects to generate a decrypted message.

In some embodiments, the MDC agent **105** may be configured to support multi-factor authentication. For example, the MDC agent **105** may receive a private message from mesh node **104d** of the private subnetwork, where the private message is in a first language. The MDC agent **105** may decrypt the private message using the private dictionary object to generate a decrypted message. The MDC agent **105** may generate a response message using the private dictionary object, where the response message is also in the first language. The MDC agent **105** may then send the response message to the mesh node **104d** of the private subnetwork, where the mesh node **104d** may confirm that the joiner node **104a** of the MDC agent **105** is authenticated because the joiner node **104a** sent a response message that was in the same language as the private message.

The mesh node **104** includes a network interface **206a** configured to establish a communication session with a computing device for sending and receiving data over a communication network to the computing device. Accordingly, the network interface **206a** includes a cellular transceiver (supporting cellular standards), a local wireless network transceiver (supporting 802.11X, ZigBee, Bluetooth, Wi-Fi, or the like), a wired network interface, a combination thereof (e.g., both a cellular transceiver and a Bluetooth transceiver), and/or the like. In some embodiments, the mesh node **104** includes a plurality of network interfaces **206a** of different types, allowing for connections to a variety of networks, such as local area networks (public or private) or wide area networks including the Internet, via different sub-networks.

The mesh node **104** includes an input/output device **205a** configured to receive user input from and provide information to a user. In this regard, the input/output device **205a** is structured to exchange data, communications, instructions, etc. with an input/output component of the mesh node **104**. Accordingly, input/output device **205a** may be any electronic device that conveys data to a user by generating sensory information (e.g., a visualization on a display, one or

more sounds, tactile feedback, etc.) and/or converts received sensory information from a user into electronic signals (e.g., a keyboard, a mouse, a pointing device, a touch screen display, a microphone, etc.). The one or more user interfaces may be internal to the housing of the mesh node **104**, such as a built-in display, touch screen, microphone, etc., or external to the housing of the mesh node **104**, such as a monitor connected to the mesh node **104**, a speaker connected to the mesh node **104**, etc., according to various embodiments. In some embodiments, the mesh node **104** includes communication circuitry for facilitating the exchange of data, values, messages, and the like between the input/output device **205a** and the components of the mesh node **104**. In some embodiments, the input/output device **205a** includes machine-readable media for facilitating the exchange of information between the input/output device **205a** and the components of the mesh node **104**. In still another embodiment, the input/output device **205a** includes any combination of hardware components (e.g., a touchscreen), communication circuitry, and machine-readable media.

The mesh node **104** includes a device identification component **207a** (shown in FIG. 2A as device ID component **207a**) configured to generate and/or manage a device identifier (sometimes referred to as, "mesh node ID") associated with the mesh node **104**. The device identifier may include any type and form of identification used to distinguish the mesh node **104** from other computing devices. In some embodiments, to preserve privacy, the device identifier may be cryptographically generated, encrypted, or otherwise obfuscated by any device and/or component of mesh node **104**. In some embodiments, the mesh node **104** may include the device identifier in any communication (e.g., public encrypted message, private encrypted message, etc.) that the mesh node **104** sends to a computing device.

The mesh node **104** includes a bus (not shown), such as an address/data bus or other communication mechanism for communicating information, which interconnects the devices and/or components of mesh node **104**, such as processing device **202a**, network interface **206a**, input/output device **205a**, and/or device ID component **207a**.

In some embodiments, some or all of the devices and/or components of mesh node **104** may be implemented with the processing device **202a**. For example, the mesh node **104** may be implemented as a software application stored within the memory **204a** and executed by the processing device **202a**. Accordingly, such embodiment can be implemented with minimal or no additional hardware costs. In some embodiments, any of these above-recited devices and/or components rely on dedicated hardware specifically configured for performing operations of the devices and/or components.

FIG. 2B is a block diagram depicting an example of the control mesh node **108** of the environment in FIG. 1, according to some embodiments. While various devices, interfaces, and logic with particular functionality are shown, it should be understood that the control mesh node **108** includes any number of devices and/or components, interfaces, and logic for facilitating the functions described herein. For example, the activities of multiple devices may be combined as a single device and implemented on a same processing device (e.g., processing device **202b**), as additional devices and/or components with additional functionality are included.

The control mesh node **108** includes a processing device **202b** (e.g., general purpose processor, a PLD, etc.), which may be composed of one or more processors, and a memory

204b (e.g., synchronous dynamic random access memory (DRAM), read-only memory (ROM)), which may communicate with each other via a bus (not shown). The processing device **202b** includes identical or nearly identical functionality as processing device **202a** in FIG. 2a, but with respect to devices and/or components of the control mesh node **108** instead of devices and/or components of the mesh node **104**.

The memory **204b** of processing device **202b** stores data and/or computer instructions/code for facilitating at least some of the various processes described herein. The memory **204b** includes identical or nearly identical functionality as memory **204a** in FIG. 2A, but with respect to devices and/or components of the control mesh node **108** instead of devices and/or components of the mesh node **104**.

The processing device **202b** may execute a mesh dictionary service (MDS) agent **105** that is configured to receive classes, member variable values (e.g., integers, floating-point number) and/or dictionary objects from the mesh network administrator device **110**. A class is an extensible program-code-template for creating objects using an object-oriented programming language (e.g., Java, C++, C #, Python, etc.), providing initial values for state (e.g., member variables) and implementations of behavior (e.g., member functions or methods). An object can be a combination of variables, functions, and data structures; and in particular in class-based variations of the paradigm it refers to a particular instance of a class. The processing device **202a** may be configured to store the information that it receives from the mesh network administrator device **110** in the CV-DO storage **107**.

The MDS agent **105** may be configured to validate permissions for the joiner node **104a** responsive to receiving the request. In some embodiments, the MDS agent **105** may validate permissions for the joiner node **104a** by using public key cryptography (e.g., asymmetric encryption). In some embodiments, the MDS agent **105** may validate permissions for the joiner node **104a** by determining a first permission (e.g., allowed) of the joiner node **104a** to join a public subnetwork of the mesh network system **102**, and creating a public dictionary object associated with the public subnetwork responsive to determining the first permission. In some embodiments, the MDS agent **105** may validate permissions for the joiner node **104a** by determining a second permission (e.g., allowed) of the joiner node **104a** to join a private subnetwork of the mesh network system **102**; and creating a private dictionary object associated with the private subnetwork responsive to determining the second permission.

The MDS agent **105** may be configured to acquire one or more dictionary objects that are associated with those subnetworks. In some embodiments, the control mesh node **108** may acquire a dictionary object by creating the dictionary object using information that is stored in the CV-DO storage **107**. For example, the control mesh node **108** may create (e.g., generate) a public dictionary object by initializing a base class using a first set of variables (sometimes referred to as, "public variables"), and create a private dictionary object by initializing the same base class using a set of second set of variables (e.g., sometimes referred to as, "private variables"). The control mesh node **108** may create a public dictionary object by initializing a first base class (sometimes referred to as, "public base class") using the first set of variables and create a private dictionary object by initializing a second base class (sometimes referred to as, "private base class") using the second set of variables. The

first set of variables are different from the second set of variables, and the first base class is different from the second base class.

The MDS agent **105** may be configured to grant access rights for the joiner node **104a** to join the mesh network system **102** by transmitting an access rights message including the one or more dictionary objects to the joiner node **104a**. In some embodiments, the MDS agent **105** sends a copy of the public dictionary object and a copy of the private dictionary object to the joiner node **104a**. In some embodiments, the MDS agent **105** sends a copy of the public dictionary object, but does not send a copy of the private dictionary object to the joiner node **104a** in order to prevent the joiner node **104a** from having access to the private dictionary object.

In some embodiments, the access rights message may cause the joiner node **104a** to locally store the one or more dictionary objects in its dictionary object storage **106a**. In some embodiments, the access rights message may cause the joiner node **104a** to use the one or more dictionary objects to encrypt/decrypt communication that it exchanges (e.g., sends/receives) with one or more nodes of the mesh network system **102**. For example, the joiner node **104a** may decrypt a first message that it receives from mesh nodes **104b** by using the public dictionary object to generate a first decrypted message, and decrypt a second message that it receives from mesh nodes **104d** by using the private dictionary object to generate a second decrypted message.

In some embodiments, the access rights message may cause the joiner node **104a** to redirect messages (e.g., public encrypted messages, private encrypted messages) received from other mesh nodes **104** to its intended recipient. For example, the joiner node **104a** may receive a private encrypted message from mesh node **104d**, decrypt a portion of a private encrypted message using a public dictionary object from the access rights message to reveal a portion (e.g., header) of the message, determine that the intended recipient of the message is mesh node **104e**, and then redirect the message to mesh node **104e**. In some embodiments, the joiner node **104a** determine whether it has the capability to decrypt all portions of message. If the joiner node **104a** determines that it is unable to decrypt a portion of a private message, then the joiner node **104a** may redirect (e.g., forward) that portion (or all portions) of the private message to one or more mesh nodes **104** in the private subnetwork.

The MDS agent **105** may be configured to determine a timing for updating the one or more dictionary objects that have been distributed to the mesh nodes **104** of the mesh node system **102**. In some embodiments, the MDS agent **105** may determine that it is time to update the one or more dictionary objects responsive to (a) determining that there has been a change in the permissions (e.g., from allowed to disallowed, or vice versa) for the joiner node **104a**, (b) determining that there has been a change in available services of the mesh network system **102**, and/or (c) determining that the mesh network system **102** has been subjected to a malicious attack that originated from outside the mesh network system **102**. The MDS agent **105** may then acquire an updated set of the one or more dictionary objects. For example, the MDS agent **105** may create the updated set of the one or more dictionary objects based on the new permissions.

The MDS agent **105** may be configured to transmit the updated set of the one or more dictionary objects to the joiner node **104a** to cause the joiner node **104a** to update the one or more dictionary objects that are locally stored on the

joiner node **104a** using the updated set of the one or more dictionary objects. In some embodiments, a transmission of the updated set of the one or more dictionary objects to the joiner node **104a** might cause the joiner node **104a** to replace and/or delete its previously stored dictionary objects with the updated set of the one or more dictionary objects, such that its previously stored dictionary objects are now corrupted and/or inaccessible. This ensures that the joiner node **104a** may no longer access the private subnetwork if the joiner node's **104a** permissions have been down-graded from those allowing access to the private subnetwork to those disallowing access to the private subnetwork.

The control mesh node **108** includes a network interface **206b** configured to establish a communication session with a computing device for sending and receiving data over a network to the computing device. Accordingly, the network interface **206b** includes identical or nearly identical functionality as network interface **206a** in FIG. 2A, but with respect to devices and/or components of the control mesh node **108** instead of devices and/or components of the mesh node **104**.

The control mesh node **108** includes an input/output device **205b** configured to receive user input from and provide information to a user. In this regard, the input/output device **205b** is structured to exchange data, communications, instructions, etc. with an input/output component of the control mesh node **108**. The input/output device **205b** includes identical or nearly identical functionality as input/output device **205a** in FIG. 2A, but with respect to devices and/or components of the control mesh node **108** instead of devices and/or components of the mesh node **104**.

The control mesh node **108** includes a device identification component **207b** (shown in FIG. 2B as device ID component **207b**) configured to generate and/or manage a device identifier associated with the control mesh node **108**. The device ID component **207b** includes identical or nearly identical functionality as device ID component **207a** in FIG. 2A, but with respect to devices and/or components of the control mesh node **108** instead of devices and/or components of the mesh node **104**.

The control mesh node **108** includes a bus (not shown), such as an address/data bus or other communication mechanism for communicating information, which interconnects the devices and/or components of the control mesh node **108**, such as processing device **202b**, network interface **206b**, input/output device **205b**, and/or device ID component **207b**.

In some embodiments, some or all of the devices and/or components of control mesh node **108** may be implemented with the processing device **202b**. For example, the control mesh node **108** may be implemented as a software application stored within the memory **204b** and executed by the processing device **202b**. Accordingly, such embodiment can be implemented with minimal or no additional hardware costs. In some embodiments, any of these above-recited devices and/or components rely on dedicated hardware specifically configured for performing operations of the devices and/or components.

FIG. 2C is a block diagram depicting an example environment of a mesh network system **102**, according to some embodiments. The environment **200c** includes a mesh network **230** (e.g., mesh network system **102** in FIG. 1). The mesh network **230** includes a control node **228** (e.g., control mesh node **108** in FIG. 1), a joiner node **260** (e.g., mesh node **104a** in FIG. 1), and one or more nodes **242** (e.g., mesh node **104b** and mesh node **104c** in FIG. 1).

The control node **228** receives a request **234** from the joiner node **260** to join the mesh network **230**. The control node **228** validates the permissions **237** for the joiner node **260** responsive to receiving the request **234**. The control node **228** acquires one or more dictionary objects **244** based on the permissions **237**. The control node **228** grants access rights **241** for the joiner node **260** to join the mesh network **230** by transmitting an access rights message **230** comprising the one or more dictionary objects **244** to the joiner node **260**, wherein the access rights message **230** causes the joiner node **260** to locally store the one or more dictionary objects **244** and use the one or more dictionary objects **244** when communicating with one or more nodes **242** of the mesh network **230**.

FIG. 3 is a flow diagram depicting a method of protecting communication in a mesh network of nodes, according to some embodiments. Method **300** may be performed by processing logic that may include hardware (e.g., circuitry, dedicated logic, programmable logic, a processor, a processing device, a central processing unit (CPU), a system-on-chip (SoC), etc.), software (e.g., instructions and/or an application that is running/executing on a processing device), firmware (e.g., microcode), or a combination thereof. In some embodiments, method **300** may be performed by a control mesh node, such as control mesh node **108** in FIG. 1. In some embodiments, method **300** may be performed by one or more mesh nodes, such as mesh nodes **104** in FIG. 1. In some embodiments, method **300** may be performed by a mesh network system, such as mesh network system **102** in FIG. 1.

With reference to FIG. 3, method **300** illustrates example functions used by various embodiments. Although specific function blocks ("blocks") are disclosed in method **300**, such blocks are examples. That is, embodiments are well suited to performing various other blocks or variations of the blocks recited in method **300**. It is appreciated that the blocks in method **300** may be performed in an order different than presented, and that not all of the blocks in method **300** may be performed.

As shown in FIG. 3, the method **300** includes the block **302** of receiving a request from a joiner node of a mesh network to join the mesh network. The method **300** includes the block **304** of validating permissions for the joiner node responsive to receiving the request. The method **300** includes the block **306** of acquiring one or more dictionary objects based on the permissions. The method **300** includes the block **308** of granting, by a processing device of a control node of the mesh network, access rights for the joiner node to join the mesh network by transmitting an access rights message comprising the one or more dictionary objects to the joiner node, wherein the access rights message causes the joiner node to locally store the one or more dictionary objects and use the one or more dictionary objects when communicating with one or more nodes of the mesh network.

FIG. 4 is a block diagram of an example computing device **400** that may perform one or more of the operations described herein, in accordance with some embodiments. Computing device **400** may be connected to other computing devices in a LAN, an intranet, an extranet, and/or the Internet. The computing device may operate in the capacity of a server machine in client-server network environment or in the capacity of a client in a peer-to-peer network environment. The computing device may be provided by a personal computer (PC), a set-top box (STB), a server, a network router, switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that

specify actions to be taken by that machine. Further, while only a single computing device is illustrated, the term “computing device” shall also be taken to include any collection of computing devices that individually or jointly execute a set (or multiple sets) of instructions to perform the methods discussed herein.

The example computing device **400** may include a processing device (e.g., a general purpose processor, a PLD, etc.) **402**, a main memory **404** (e.g., synchronous dynamic random access memory (DRAM), read-only memory (ROM)), a static memory **406** (e.g., flash memory and a data storage device **418**), which may communicate with each other via a bus **430**.

Processing device **402** may be provided by one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. In an illustrative example, processing device **402** may include a complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or a processor implementing other instruction sets or processors implementing a combination of instruction sets. Processing device **402** may also include one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. The processing device **402** may be configured to execute the operations described herein, in accordance with one or more aspects of the present disclosure, for performing the operations and steps discussed herein.

Computing device **400** may further include a network interface device **408** which may communicate with a communication network **420**. The computing device **400** also may include a video display unit **410** (e.g., a liquid crystal display (LCD) or a cathode ray tube (CRT)), an alphanumeric input device **412** (e.g., a keyboard), a cursor control device **414** (e.g., a mouse) and an acoustic signal generation device **416** (e.g., a speaker). In one embodiment, video display unit **410**, alphanumeric input device **412**, and cursor control device **414** may be combined into a single component or device (e.g., an LCD touch screen).

Data storage device **418** may include a computer-readable storage medium **428** on which may be stored one or more sets of instructions **425** that may include instructions for one or more components, agents, and/or applications **442** (e.g., MDC agent **105** in FIG. 2A, MDS agent **109** in FIG. 2B) for carrying out the operations described herein, in accordance with one or more aspects of the present disclosure. Instructions **425** may also reside, completely or at least partially, within main memory **404** and/or within processing device **402** during execution thereof by computing device **400**, main memory **404** and processing device **402** also constituting computer-readable media. The instructions **425** may further be transmitted or received over a communication network **420** via network interface device **408**.

While computer-readable storage medium **428** is shown in an illustrative example to be a single medium, the term “computer-readable storage medium” should be taken to include a single medium or multiple media (e.g., a centralized or distributed database and/or associated caches and servers) that store the one or more sets of instructions. The term “computer-readable storage medium” shall also be taken to include any medium that is capable of storing, encoding or carrying a set of instructions for execution by the machine and that cause the machine to perform the methods described herein. The term “computer-readable

storage medium” shall accordingly be taken to include, but not be limited to, solid-state memories, optical media and magnetic media.

Unless specifically stated otherwise, terms such as “receiving,” “validating,” “acquiring,” “granting,” or the like, refer to actions and processes performed or implemented by computing devices that manipulates and transforms data represented as physical (electronic) quantities within the computing device’s registers and memories into other data similarly represented as physical quantities within the computing device memories or registers or other such information storage, transmission or display devices. Also, the terms “first,” “second,” “third,” “fourth,” etc., as used herein are meant as labels to distinguish among different elements and may not necessarily have an ordinal meaning according to their numerical designation.

Examples described herein also relate to an apparatus for performing the operations described herein. This apparatus may be specially constructed for the required purposes, or it may include a general purpose computing device selectively programmed by a computer program stored in the computing device. Such a computer program may be stored in a computer-readable non-transitory storage medium.

The methods and illustrative examples described herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used in accordance with the teachings described herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will appear as set forth in the description above.

The above description is intended to be illustrative, and not restrictive. Although the present disclosure has been described with references to specific illustrative examples, it will be recognized that the present disclosure is not limited to the examples described. The scope of the disclosure should be determined with reference to the following claims, along with the full scope of equivalents to which the claims are entitled.

As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes,” and/or “including,” when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Therefore, the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting.

It should also be noted that in some alternative implementations, the functions/acts noted may occur out of the order noted in the figures. For example, two figures shown in succession may in fact be executed substantially concurrently or may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

Although the method operations were described in a specific order, it should be understood that other operations may be performed in between described operations, described operations may be adjusted so that they occur at slightly different times or the described operations may be distributed in a system which allows the occurrence of the processing operations at various intervals associated with the processing.

Various units, circuits, or other components may be described or claimed as “configured to” or “configurable to”

perform a task or tasks. In such contexts, the phrase “configured to” or “configurable to” is used to connote structure by indicating that the units/circuits/components include structure (e.g., circuitry) that performs the task or tasks during operation. As such, the unit/circuit/component can be said to be configured to perform the task, or configurable to perform the task, even when the specified unit/circuit/component is not currently operational (e.g., is not on). The units/circuits/components used with the “configured to” or “configurable to” language include hardware—for example, circuits, memory storing program instructions executable to implement the operation, etc. Reciting that a unit/circuit/component is “configured to” perform one or more tasks, or is “configurable to” perform one or more tasks, is expressly intended not to invoke 35 U.S.C. § 112, sixth paragraph, for that unit/circuit/component. Additionally, “configured to” or “configurable to” can include generic structure (e.g., generic circuitry) that is manipulated by software and/or firmware (e.g., an FPGA or a general-purpose processor executing software) to operate in manner that is capable of performing the task(s) at issue. “Configured to” may also include adapting a manufacturing process (e.g., a semiconductor fabrication facility) to fabricate devices (e.g., integrated circuits) that are adapted to implement or perform one or more tasks. “Configurable to” is expressly intended not to apply to blank media, an unprogrammed processor or unprogrammed generic computer, or an unprogrammed programmable logic device, programmable gate array, or other unprogrammed device, unless accompanied by programmed media that confers the ability to the unprogrammed device to be configured to perform the disclosed function(s).

The foregoing description, for the purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the present disclosure to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the embodiments and its practical applications, to thereby enable others skilled in the art to best utilize the embodiments and various modifications as may be suited to the particular use contemplated. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the present disclosure is not to be limited to the details given herein, but may be modified within the scope and equivalents of the appended claims.

What is claimed is:

1. A method of protecting communication in a mesh network of nodes, the method comprising:

receiving a request from a joiner node of the mesh network to join a public subnetwork of the mesh network;

validating one or more permissions for the joiner node responsive to receiving the request;

creating, based on the permissions, a private dictionary object and a public dictionary object, the private dictionary object associated with a private subnetwork of the mesh network and the public dictionary object associated with the public subnetwork of the mesh network; and

granting, by a processing device of a control node of the mesh network, access rights for the joiner node to join the public subnetwork of the mesh network by transmitting an access rights message comprising the private dictionary object associated with the private subnetwork and the public dictionary object associated with the public subnetwork to the joiner node of the public

subnetwork of the mesh network, wherein the access rights message causes the joiner node to locally store the private and the public dictionary object and use at least one of the private dictionary object or public dictionary object when communicating with one or more nodes of the mesh network.

2. The method of claim **1**, wherein validating the permissions of the joiner node comprises:

determining a first permission of the one or more permissions of the joiner node to join the public subnetwork of the mesh network; and

determining a second permission of the one or more permissions of the joiner node to join the private subnetwork of the mesh network.

3. The method of claim **2**, wherein creating the public dictionary object is further based

on a base class and a set of variable values associated with the public subnetwork, and wherein creating the private dictionary object is further based on the base class and a different set of variables associated with the private subnetwork.

4. The method of claim **2**, wherein creating the public dictionary object and the private dictionary object are each further based on different base classes.

5. The method of claim **2**, wherein the access rights message further causes the joiner node to decrypt, using the public dictionary object, a first message received from a first node of the public subnetwork to generate a first decrypted message.

6. The method of claim **5**, wherein the access rights message further causes the joiner node to decrypt, using the private dictionary object, a second message received from a second node of the private subnetwork to generate a second decrypted message, and generate a response message using the private dictionary object to send to the second node of the private subnetwork.

7. The method of claim **6**, wherein the second message comprises at least one of an application programming interface (API) endpoint, a seed phrase, or an access token.

8. The method of claim **2**, wherein the access rights message further causes the joiner node to decrypt, using the public dictionary object, a first portion of a first message received from a first node of the public subnetwork to generate a first decrypted message, and determine an inability of the joiner node to decrypt a second portion of the first message.

9. The method of claim **8**, wherein the access rights message further causes the joiner node to forward, responsive to determining the inability to decrypt the second portion of the first message, the second portion of the first message to a second node of the private subnetwork.

10. The method of claim **1**, further comprising: determining a timing for updating one or more dictionary objects comprising at least one of the private dictionary object or the public dictionary object;

acquiring an updated set of the one or more dictionary objects responsive to determining the timing; and transmitting the updated set of the one or more dictionary objects to the joiner node to cause the joiner node to update the one or more dictionary objects locally stored on the joiner node using the updated set of the one or more dictionary objects.

11. The method of claim **10**, wherein determining the timing comprises:

determining a change in the permissions for the joiner node;

determining a change in available services of the mesh network; or

determining that one or more nodes of the mesh network have been subjected to a malicious attack that originated from outside the mesh network.

12. A mesh network system, comprising:

a plurality of computing devices, wherein each computing device corresponds to a respective node of a plurality of nodes of the mesh network system, each computing device comprises a processing device,

wherein the processing device of a control node of the plurality of nodes to:

receive a request from a joiner node to join a public subnetwork of the mesh network;

validate one or more permissions for the joiner node responsive to receiving the request;

create, based on the permissions, a private dictionary object and a public dictionary object, the private dictionary object associated with a private subnetwork of the mesh network and the public dictionary object associated with the public subnetwork of the mesh network; and

grant access rights for the joiner node to join the public subnetwork of the mesh network by transmitting an access rights message comprising the private dictionary object associated with the private subnetwork and the public dictionary object associated with the public subnetwork to the joiner node of the public subnetwork of the mesh network, wherein the access rights message causes the joiner node to locally store the private dictionary object and the public dictionary object and use at least one of the private dictionary object or the public dictionary object when communicating with one or more nodes of the mesh network.

13. The mesh network system of claim 12, wherein the processing device of the control node further to:

determine a first permission of the one or more permissions of the joiner node to join the public subnetwork of the mesh network; and

determine a second permission of the one or more permissions of the joiner node to join the private subnetwork of the mesh network.

14. The mesh network system of claim 13, wherein to create the public dictionary object is further based on a base class and a set of variable values associated with the public subnetwork, and wherein to create the private dictionary object is further based on the base class and a different set of variables associated with the private subnetwork.

15. The mesh network system of claim 13, wherein to create the public dictionary object and the private dictionary object are each further based on different base classes.

16. The mesh network system of claim 13, wherein the access rights message further causes the joiner node to decrypt, using the public dictionary object, a first message

received from a first node of the public subnetwork to generate a first decrypted message.

17. The mesh network system of claim 16, wherein the access rights message further causes the joiner node to decrypt, using the private dictionary object, a second message received from a second node of the private subnetwork to generate a second decrypted message, and generate a response message using the private dictionary object to send to the second node of the private subnetwork.

18. The mesh network system of claim 13, wherein the access rights message further causes the joiner node to decrypt, using the public dictionary object, a first portion of a first message received from a first node of the public subnetwork to generate a first decrypted message, and determine an inability of the joiner node to decrypt a second portion of the first message.

19. The mesh network system of claim 12, wherein the processing device of the control node further to:

determine a timing for updating one or more dictionary objects comprising at least one of the private dictionary object or the public dictionary object;

acquire an updated set of the one or more dictionary objects responsive to determining the timing; and

transmit the updated set of the one or more dictionary objects to the joiner node to cause the joiner node to update the one or more dictionary objects locally stored on the joiner node using the updated set of the one or more dictionary objects.

20. A non-transitory computer-readable medium storing instructions that, when execute by a processing device of a control node of a mesh network system, cause the processing device to:

receive a request from a joiner node to join a public subnetwork of the mesh network;

validate one or more permissions for the joiner node responsive to receiving the request;

create, based on the permissions, a private dictionary object and a public dictionary object, the private dictionary object associated with a private subnetwork of the mesh network and the public dictionary object associated with the public subnetwork of the mesh network; and

grant, by the control node of the mesh network system, access rights for the joiner node to join the public subnetwork of the mesh network by transmitting an access rights message comprising the private dictionary object associated with the private subnetwork and the public dictionary object associated with the public subnetwork to the joiner node of the public subnetwork of the mesh network, wherein the access rights message causes the joiner node to locally store the private dictionary object and the public dictionary object and use at least one of the private dictionary object or the public dictionary object when communicating with one or more nodes of the mesh network.

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