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(54) Title: METHOD FOR ENABLING A COMMUNICATION DEVICE TO RECEIVE A PARTIAL MODIFICATION OF A RESOURCE

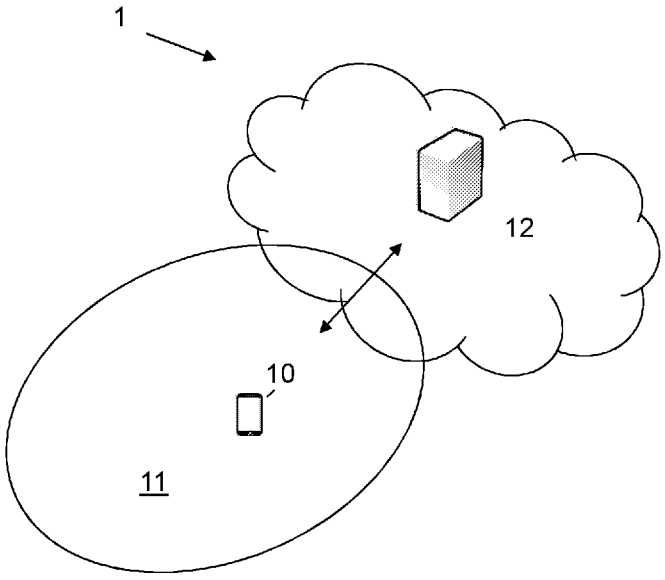

Fig. 1

(57) Abstract: Embodiments herein relate to a method performed by a first communication device (10) for handling data in a communication network (1). The first communication device transmits, to a second communication device (12), a first indication indicating a configuration enabling the first communication device (10) to receive a partial modification of resources. The first communication device (10) receives, from the second communication device (12), a second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource. The first communication device further maintains an internal value of the part of the resource based on the second indication. For example, it is herein disclosed a method to interact with resources in a more granular way in Internet of Things. Resources in Internet of Things are treated in an atomic way, as minimal units of information and the method is for partially update resources in Internet of Things. The new degree of granularity may make more efficient use of the network

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bandwidth and the limited resources of the constrained networks. Furthermore, the method may include performing an Observation of two instances of the same information in time; and using ETags to classify the different instances over time.

METHOD FOR ENABLING A COMMUNICATION DEVICE TO RECEIVE A PARTIAL MODIFICATION OF A RESOURCE

TECHNICAL FIELD

Embodiments herein relate to a first communication device, a second communication device and methods performed therein for communication. Furthermore, a computer program and a computer readable storage medium are also provided herein. In particular, embodiments herein relate to handling data of a resource in a communication network.

BACKGROUND

A constrained network is a communication network that may have limited packet sizes, may exhibit a high degree of packet loss, and/or may have a substantial number of communication devices that may be in a sleep mode, e.g., powered off, at any point in time but periodically "wake up" for brief periods of time. Communication devices of constrained networks may be characterized by limits on throughput, available power, and/or Random Access Memory (RAM), and may be connected over a low power wireless connection such as IEEE 802.15.4 connection.

A Constrained Application Protocol (CoAP) is a specialized web transfer protocol used by constrained network nodes and within constrained networks, e.g., network nodes of low-power or lossy networks. The web transfer protocol is designed for machine-to-machine (M2M) applications such as smart energy and building automation. CoAP provides a request/response interaction model between application endpoints, supports built-in discovery of services and resources, and includes key concepts of the Web such as Uniform Resource Identifiers (URI) and Internet media types. Servers make resources available under a URL, and clients access these resources using methods such as GET, PUT, POST, and DELETE.

CoAP has a set of documents specifying additional functionalities that complements the original specification. Some of these documents are; *Observing Resources in CoAP*, *The Constrained Object Language (CoOL), Patch Method for Constrained Application Protocol (CoAP)* and *CoAP FETCH Method*. The first document is an extension of the CoAP protocol, the second document describes a new compressed management interface, while the last documents are defining new methods for CoAP.

The *Observing Resources in CoAP* document was created to avoid continuously polling for resources, since the state of a resource on a CoAP server can change over time. A resource as defined by RFC2616 is a network data object or service that can be identified by a URI, e.g. Resources may be available in multiple representations, e.g. data formats, sizes, or vary in other ways. Resources may be observed by CoAP clients, i.e. the CoAP clients retrieve a representation of a resource and keep this representation updated by the server over a period of time.

The *Patch Method for Constrained Application Protocol (CoAP)* document describes two new atomic CoAP methods: PATCH and iPATCH. The PATCH method was created to complement the PUT method in CoAP. A PUT method only allows a complete replacement of a resource. In case of resources with larger or complex data, or in situations where resource continuity is required, replacing a resource is cumbersome. The PATCH method described in the document allows for a partial modification of a resource. iPATCH is an idempotent version of PATCH.

The *CoAP FETCH method* document describes a new CoAP method called FETCH. The FETCH method provides a solution that spans the gap between the use of GET and POST. As with POST, the input to the FETCH operation is passed along within the payload of the request rather than as part of the request URI. Unlike POST, however the semantics of the FETCH method are more specifically defined.

The *Constrained Object Language* document describes a management interface adapted to constrained devices and constrained, e.g., low-power, lossy, networks. CoOL resources, such as data stores, protocol operations and notifications, are defined using a YANG modeling language. Interactions with these resources are performed using the CoAP web transfer protocol and payloads and specific CoAP options are encoded using the Concise Binary Object Representation (CBOR) data format.

As described before, CoAP has been extended with a very broad number of extensions to increase its efficiency in constrained networks. The FETCH, PATCH and iPATCH methods have been designed to complement the PUT and GET methods in CoAP and make them more efficient in some particular scenarios. As well, the CoOL language deals with the information transferred in CoAP, compressing it, using the YANG modeling language and the CBOR data format.

Another extension broadly used in CoAP is the “observe” extension. This extension is very useful since the state of the CoAP resources change continuously over time. However, the continuously transfer of CoAP information between the CoAP entities can create a large amount of network traffic when the CoAP resources are changing

constantly. This amount of information cannot be reduced using any of the actual methods or extensions defined in CoAP leading to an inefficient use of resource that may limit the performance of the communication network.

SUMMARY

An object of embodiments herein is to provide a mechanism for improving performance of the communication network in an efficient manner.

According to an aspect the object is achieved by providing a method performed by a first communication device for handling data in a communication network. The first communication device transmits, to a second communication device, a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources. The first communication device receives, from the second communication device, a second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource. The first communication device further maintains an internal value of the part of the resource based on the second indication.

According to another aspect the object is achieved by providing a method performed by a second communication device for handling data in a communication network. The second communication device provides data of a resource to a first communication device in the communication network. The second communication device receives, from the first communication device, a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources. The second communication device obtains, internally or from another communication device, an update of a part of the resource, which update comprises a value. Furthermore, the second communication device transmits a second indication indicating a partial update, in time, associated with the resource and the value of the part of the resource.

According to yet another aspect the object is achieved by providing a first communication device for handling data in a communication network. The first communication device is configured to transmit, to a second communication device, a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources. The first communication device is further configured to receive, from the second communication device, a second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource. In addition, the first communication device is configured to maintain an internal value of the part of the resource based on the second indication.

According to still another aspect the object is achieved by providing a second communication device for handling data in a communication network, which second communication device is configured to provide data of a resource to a first communication device in the communication network. The second communication device is configured to receive, from the first communication device, a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources. The second communication device is further configured to obtain internally or from another communication device, an update of a part of the resource, which update comprises a value; and to transmit a second indication indicating a partial update, in time, associated with the resource and the value of the part of the resource.

It is furthermore provided herein a computer program comprising instructions, which, when executed on at least one processor, cause the at least one processor to carry out any of the methods above, as performed by the communication devices. It is additionally provided herein a computer-readable storage medium, having stored thereon a computer program comprising instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to any of the methods above, as performed by the communication devices.

Disclosed herein are methods to interact with resources in a more granular way in e.g. Internet of Things. The more granular way allows the network bandwidth and the limited resources of e.g. constrained networks to be used more efficiently. In particular, embodiments herein relate to partially handling data of a resource in e.g. a low-power lossy network. Embodiments herein thus enable that every time a part of the resource changes, which resource is being e.g. observed by the first communication device, it is just the part of the resource that has been changed that is sent and updated in the first communication device. This leads to an efficient handling of data in the communication network resulting in an improved performance of the communication network.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will now be described in more detail in relation to the enclosed drawings, in which:

Fig. 1 is a schematic overview depicting a communication network according to embodiments herein.

Fig. 2 is a combined flowchart and signalling scheme according to embodiments herein.

Fig. 3 is a signalling scheme according to embodiments herein.

Fig. 4 is a signalling scheme according to embodiments herein.

Fig. 5 is a signalling scheme according to embodiments herein.

Fig. 6 is a flowchart depicting a method performed by a first communication device according to embodiments herein.

Fig. 7 is a flowchart depicting a method performed by a second communication device according to embodiments herein.

Fig. 8 is a block diagram depicting a first communication device according to embodiments herein.

Fig. 9 is a block diagram depicting a second communication device according to embodiments herein.

DETAILED DESCRIPTION

Embodiments herein relate to communication networks in general. **Fig. 1** is a schematic overview depicting **a communication network 1**. The communication network 1 may use a number of different technologies, such as Wi-Fi, Bluetooth Low Energy, ZigBee, LoRA, just to mention a few possible implementations.

In the communication network 1 communication devices, e.g. **a first communication device 10** such as a M2M device, a wireless device, a user equipment and/or a wireless terminal, communicate with one another or the communication network. It should be understood by those skilled in the art that "communication device" is a non-limiting term which means any terminal, communication terminal, user equipment, Machine Type Communication (MTC) device, Device to Device (D2D) terminal, or node e.g. smart phone, laptop, mobile phone, sensor, relay, mobile tablets or any device communicating within a network or **a service area 11**. The first communication device 10 may be referred to as a first endpoint or a client.

The communication network 1 further comprises **a second communication device 12**. The second communication device 12 may be referred to as a second endpoint or a server. The second communication device 12 may e.g. be a Resource Directory. The second communication device 12 may be a CoAP server or an access point such as a wireless local area network (WLAN) access point a stand-alone access point or any other network unit capable of serving a communication device within the service area 11.

Embodiments herein relate to handling data e.g. updating of CoAP resources in the first communication device 10. Embodiments herein enable that every time the state of a resource changes, it is just the part of the resource that has been changed that is

sent and updated in the first communication device 10. In prior art, when a communication device performs an *Observe* operation on a resource, each notification is an additional CoAP response sent by the CoAP server which includes a complete representation of the resource state. It is herein described a way to partially update a resource describing ways to interact with one or more resources in e.g. a constrained environment in a more granular way. Resources are treated in an atomic way, as minimal units of information.

Embodiments herein thus provide a new degree of granularity in the resources that would make more efficient use of network bandwidth as it transfers a minimal description of the changes, rather than the entire new instance of the resource. This information is referred to as "**delta**" in this document for a matter of clarity. The *delta* is defined as a difference between two instances of the same information. The utilization of one or more *delta* attributes is beneficial in e.g. Internet of Things (IoT), especially since resource representations are increasing in size with new data structure representations such as YANG models or SENML/JSON notations and even though there are extensions to compress those data structures, such as CoOL, those extensions do not provide any solution to stop transmitting unnecessary information through the network to reduce the network bandwidth even more.

Embodiments herein provide a method at the first communication device 10 to observe the *delta* of a resource by transmitting a first indication, denoted as a Delta attribute, to the second communication device 12 and also methods to explicitly request the *delta* of e.g. a CoAP resource from the second communication device 12. CoAP resources may thus be treated in an atomic way, as minimal units of information and embodiments herein extend e.g. the CoAP protocol to observe partial changes in CoAP resources in different scenarios. This extension may be used in the *Observe protocol extension*, *Resource Directory* and GET and FETCH methods. In addition, a second indication denoted as an Entity-tag (ETag) attribute is extended to support the observation of partial modifications of the resource by indicating a partial update, in time, associated with the resource. The first communication device 10 then maintains an internal value of the part of the resource based on the second indication. Essentially, this new degree of granularity makes more efficient use of the network bandwidth and reduce the network traffic in e.g. the constrained networks.

Fig. 2 is a combined signaling scheme and flowchart according to embodiments herein.

Action 201. The first communication device 10 transmits, to the second communication device 12, the first indication, i.e. the Delta attribute, indicating a configuration enabling the first communication device to receive a partial modification of resources. For example, the first communication device 10 may request to receive partial modifications of a certain resource.

Action 202. The second communication device 12, e.g. a resource directory, receives an updated value of a part of the resource. This may be obtained internally as well as from a different communication device.

Action 203. Since the first communication device 10 has indicated that it requests partial modifications, the second communication device 12 adds an ETag to the update and transmits the updated value of the part of the resource along with the ETag, i.e. the second indication. The ETag may indicate version of the data of the resource.

Action 204. The first communication device 10 receives the updated value of the part and the ETag, and compares the ETag with a previously stored ETag. Based on the outcome of the comparison the first communication device 10 may update the stored version of the data of the resource with the updated value of the part of the resource e.g. in case of the .

Embodiments herein thus provide a solution for e.g. CoAP comprising : Setting a new attribute ***delta***(*Dl*) as *delta attribute* for performing e.g. an Observation of the *Delta* of a resource in CoAP; and using **ETags** as in Hypertext Transfer Protocol (HTTP) to define a *delta attribute*, i.e. define the part that has changed, and obtain partial modifications of a CoAP resource.

Advantages may be:

- Provides a novel degree of granularity to observe partial modification of resources in CoAP.
- Provides a method to partially request, e.g. extending FETCH, information of a resource.
- Provides a method to partially request, e.g. extending GET, information of a resource.
- This method prevents from transferring the whole IoT resource state unnecessarily.
- The method efficiently uses the network resources, such as bandwidth, and the constrained network resources.
- Enhanced and optimized the utilization of a Resource Directory in Constrained Networks.

- Extend the Observe protocol extension to observe partial changes in resources.
- Designed to be easy to integrate with the CoAP protocol

As explained before, the existing CoAP methods GET, POST, PUT and FETCH allow the CoAP protocol to modify fully a CoAP resource. The PATCH and iPATCH methods allow for partial CoAP resource modifications as well. Embodiments herein define a new degree of granularity in resources being smaller than e.g. a CoAP resource, which granularity is called *delta*. The *delta* is defined as a difference between two instances of the same resource and embodiments herein further expand a definition of the "ETag" attribute to include the *delta* within its meaning. A resource is a network data object or service that can be identified by a URI. Resources may be available in multiple representations, e.g. multiple languages, data formats, size, and resolutions, or vary in other ways. For example, a resource may be the value of a sensor, file, document or similar.

Additionally, embodiments herein relating to CoAP use the "delta" attribute to observe resources in CoAP. Using the method described herein, a CoAP client using the Observe protocol extension receives the *delta* of a CoAP resource instead of the entire new instance. The first communication device 10 may be configured with a CoAP client that holds a cached copy of the old instance of the CoAP resource and may apply the *delta* to construct the new instance of the CoAP resource.

Briefly, two different attributes are used to define the *delta* of a resource: ETag and *delta(dl)*. The ETag attribute is defined in the *Constrained Application Protocol* document, being an entity-tag intended to be used as a resource-local identifier for differentiating between representations of the same CoAP resource that changes over time. Embodiments herein add ETag attributes to be used for partial modifications. Thus, a CoAP server, such as the second communication device 12, may send a partial notification of a CoAP resource that has changed over time instead of sending the whole CoAP resource. Different CoAP methods, e.g. GET and FETCH, may include the ETag attribute in its messages to obtain more precise information of a resource too.

Fig. 3 shows an example of two clients updating partially a CoAP resource using the PATCH operation, see **actions 301-304**. 'op' stands for operation, x-coord = x coordinate, y-coord= y coordinate and 'replace' is the name of the operation but could be any other name. CON means Confirmable, meaning that the client expects a confirmation that the message sent has arrived to the destination. MID means message id and every

message has an identifier, and T stands for type of message. Token means that a Token is used to match responses to requests independently from the underlying messages.

After the CoAP resource is updated several times by different clients, client 3, i.e. the first communication device 10, is just interested in a particular update of the CoAP resource. Thus, client 3 indicates that it is only interested in the update of the resource's instance with identifier 50, **action 305**. The CoAP server, i.e. the second communication device 12, provides the client 3 with the partial update of that instance instead of all the other updates of the CoAP resource, **action 306**. In addition, an ETag could be assigned to every client modifying a CoAP resource. Thus, another CoAP client could ask for the updates of a single CoAP client enabling e.g. the client 3 to detect change of a part of the resource of every client. Even though that case is feasible, it requires all the CoAP clients that updated a CoAP resource to be authenticated in the system. The *Delta* (dl) is a new CoAP attribute defined herein, which Delta attribute informs the CoAP server about the willingness of a CoAP client, such as the client 3, to receive a partial modification of a CoAP resource instead of the whole resource. The delta attribute may be used in the Observe protocol extension.

Fig. 4 shows an example of how the new delta attribute could be used in e.g. CoAP. CON means Confirmable, meaning that the client expects a confirmation that the message sent has arrived to the destination. ACK means Acknowledgement and is used to confirm a received message. MID means message id and every message has an identifier, and T stands for type of message. Token means that a Token is used to match responses to requests independently from the underlying messages.

In the example, a CoAP client being an example of the first communication device 10 performs an observation of a CoAP resource with the first indication, also denoted herein as the delta attribute or a "dl" tag, e.g. the value is set to 1. **Action 401**: The CoAP client may observe a resource on a CoAP server, being an example of the second communication device 12, with both "dl" and "observe" tags activated i.e. values are set to 1. A first Notification from the CoAP server contains a full representation of the resource, e.g. values, units, min, max, see **Action 402**. The payload of following notifications will only contain modified values, as indicated by the delta attribute, of the CoAP resource e.g. value only, since units, min and max do not change, **actions 403, 404**.

Note that the name of the *Dl* attribute and its values are irrelevant. Different names and values could be used to define the attribute.

The first and second indications, Delta (dl) attribute and ETag, may be used in a different number of scenarios in CoAP. Besides using the ETag with different CoAP methods, e.g. GET and FETCH, and the dl attribute with the Observe protocol, both attributes could be used to filter the information in a resource directory too. Performing a GET request "/.well-known/core" to the resource directory returns a set of links available from the server (if any) in the CoRE Link Format. Most of the time, a CoAP client is interested in some specific parts of a CoAP resource, and obtaining again the pieces of information that have not changed can flood the CoAP client with unnecessary information. In this case, the ETag and dl attributes may be used to mitigate this issue.

ETag may be used in the resource directory to fetch partial information of a resource that has been created or changed at certain time. If the resource directory keeps historical track of the information, a CoAP client can fetch that information using the ETag and the CoAP methods such as GET. Entity tags (ETag) are used for comparing two or more entities from the same requested resource. HTTP/1.1 uses entity tags in the ETag, If-Match, If-None-Match, and If-Range header fields. The Etag comprises an opaque quoted string and may be used to find out whether a cache entry is an equivalent copy of an entity. An entity tag is unique across all versions of all entities associated with a particular resource. A given entity tag value MAY be used for entities obtained by requests on different URIs. The use of the same entity tag value in conjunction with entities obtained by requests on different URIs does not imply the equivalence of those entities. An ETag response header field may indicate the current value of the entity tag for the requested variant just created and the ETag response-header field provides the current value of the entity tag for the requested variant.

Delta(dl) attribute can be used by the first communication device 10 such as a CoAP client to subscribe to partial information of a CoAP resource. The CoAP client might be interested about some specific information of a CoAP resource. In addition, the CoAP client can subscribe to a resource but inform to the resource directory to send just the information that is periodically modified instead of the whole new instance. The CoAP client may do that by attaching the dl attribute to its registration request (GET) operation.

A Resource Directory (RD) is used to store pointers to where resources are stored. Normally, CoAP clients will register new resources as they appear (e.g. a new light or temperature sensor). It is therefore convenient, even if not specified in the standards, to perform a GET Observe on the Resource Directory itself. This way, clients would receive a notification for every new registered resource. However without the “dl” attribute as

specified in this invention, clients receive the whole RD every time, as they are observing the root path. **Fig. 5** shows an example of using the Delta attribute for observing root directories, in particular where a Resource Directory is an example of the second communication device 12. 'Rt' means Resource Type and is an attribute that is an opaque string used to assign an application-specific semantic type to a resource. 'Ins' means Resource Instance and maps to the <Instance> part of a Domain Name System Service Discovery (DNS-SD) service name. 'Ep' means endpoint and Rd means resource directory. The codes 2.03 and 2.05 are Response codes. The figure shows two endpoints: EP1 and EP2. EP1, being an example of the first communication device 10, performs an observation with the dl attribute on the Resource Directory (RD), **action 501**. Normally this would mean that the RD would treat the full RD as a resource, sending an update of the full RD every time a part of the resource is updated. This is not ideal since the RD can grow to a considerable size. EP2 registers a new light resource, **actions 502-503**, and since the dl attribute is on, EP1 will receive only the *delta* of the Resource Directory, i.e. the new part of the resource, **action 504**. Over time as new resource parts are added/deleted by EP2, **actions 505-506**, EP1 will be notified accordingly only about the updated information, **action 507**.

The method actions performed by the first communication device 10 for handling data in the communication network 1 according to some embodiments will now be described with reference to a flowchart depicted in **Fig. 6**. The actions do not have to be taken in the order stated below, but may be taken in any suitable order. Actions performed in some embodiments are marked with dashed boxes. The first communication device 10 may be a M2M device. The communication network may be a constrained network. The resources may be Constrained Application Protocol resources.

Action 601. The first communication device 10 may check whether the second communication device 12 supports sending partial modifications of resources.

Action 602. The first communication device 10 may receive a full set of data of the resource.

Action 603. The first communication device 10 transmits, to the second communication device 12, the first indication, e.g. the delta attribute, indicating a configuration enabling the first communication device 10 to receive a partial modification of resources. The first indication may be comprised in a message indicating that the communication device 10 subscribes to or requests partial information of one or more resources. The first communication device 10 may further transmit an identification

indicating the resource, e.g. an URI. The first indication and the identification may be sent in a single message indicating a request to retrieve information.

Action 604. The first communication device 10 receives, from the second communication device 12, the second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource. The second indication may identify a partial notification of a resource in time. The second indication may identify a version in time of the partial update of the resource. The first communication device may receive several second indications, which are assigned to the same resource. The second indication indicates a set of resources, e.g. the second communication device 12 may return several resources in the same response. The first indication may be denoted a delta attribute and the second indication may be denoted an entity tag attribute.

Action 605. The first communication device 10 maintains an internal value of the part of the resource based on the second indication. E.g. updates the internal value to the received value of the part of the resource. The first communication device 10 may e.g. compare the second indication with a previously stored indication and update the internal value of the part of the resource to the received value when the second indication is a consecutive value to the previously stored indication. The first communication device 10 may maintain the internal value of the part of the resource comprises updating the internal value of a part of the full set of data taking the second indication into account. It is thus herein disclosed a method to interact with resources in a more granular way in e.g. Internet of Things. Resources in Internet of Things are treated in an atomic way, as minimal units of information and the method may be for partially update resources in Internet of Things. The new degree of granularity may make more efficient use of the network bandwidth and the limited resources of the constrained networks. Furthermore, the method may include performing an Observation of two instances of the same information in time; and using ETags to classify the different instances over time.

The method actions performed by the first communication device 10 for handling data in the communication network 1 according to some embodiments will now be described with reference to a flowchart depicted in **Fig. 7**. The actions do not have to be taken in the order stated below, but may be taken in any suitable order. Actions performed in some embodiments are marked with dashed boxes. The second communication device 12 provides data of a resource to the first communication device 10 in the communication network and may e.g. be a server or a directory. The communication network may be a constrained network. The resources may be Constrained Application Protocol resources.

The first indication may be denoted the delta attribute (Delta) and the second indication may be denoted the entity tag attribute (ETag).

Action 701. The second communication device 12 may indicate support to send, or in sending, partial modifications of resources.

Action 702. The second communication device 12 receives, from the first communication device 10, the first indication. The first indication indicates the configuration enabling the first communication device 10 to receive a partial modification of resources. The first indication may be comprised in the message indicating that the first communication device 10 subscribes to or requests partial information of one or more resources. The second communication device 12 may further receive an identification indicating the resource such as a URI.

Action 703. The second communication device 12 may transmit the full set of data of the resource to the first communication device 10.

Action 704. The second communication device 12 obtains, internally or from another communication device, the update of a part of the resource, which update comprises a value or a set of values.

Action 705. The second communication device 12 may then tag the part of the resource with the second indication. The second indication may identify a partial notification of the resource in time. The second indication may e.g. identify a version in time of the partial update of the resource.

Action 706. The second communication device 12 transmits the second indication indicating the partial update, in time, associated with the resource. The second communication device further transmits the value of the part of the resource. The second communication device 12 may transmit several second indications, which are assigned to the same resource, hence, improving the granularity of the operation by splitting the resources with different indications. The second indication may indicate a set of resources and thus the second communication device 12 may return several resources in the same response.

Fig. 8 is a block diagram depicting the first communication device 10, e.g. a sensor, a CoAP client, or similar, for handling data in the communication network 1.

The first communication device 10 may comprise **a processing unit 801**, e.g. one or more processors, being configured to perform the methods herein.

The first communication device 10 comprises **a transmitting module 802.** The first communication device 10, the processing unit 801, and/or the transmitting module

802 may be configured to transmit, to the second communication device 12, the first indication indicating the configuration enabling the first communication device 10 to receive a partial modification of resources. The first indication may be comprised in the message indicating that the first communication device 10 subscribes to or requests partial information of one or more resources. The first communication device 10, the processing unit 801, and/or the transmitting module 802 may be configured to transmit the identification indicating the resource.

The first communication device 10 comprises **a receiving module 803.** The first communication device 10, the processing unit 801, and/or the receiving module 803 may be configured to receive, from the second communication device 12, the second indication indicating the partial update, in time, associated with the resource and the value of the part of the resource. The second indication may identify the version in time of the partial update of the resource. The first communication device 10, the processing unit 801, and/or the receiving module 803 may be configured to receive several second indications, which are assigned to the same resource. The second indication may indicate the set of resources.

The first communication device 10 comprises **a maintaining module 804.** The first communication device 10, the processing unit 801, and/or the maintaining module 804 may be configured to maintain the internal value of the part of the resource based on the second indication. The first communication device 10, the processing unit 801, and/or the maintaining module 804 may be configured to maintain the internal value by being configured to compare the second indication with a previously stored indication and to update the internal value of the part of the resource to the received value when the second indication is the consecutive value to the previously stored indication.

The first communication device 10, the processing unit 801, and/or the receiving module 803 may be configured to receive the full set of data of the resource; and the first communication device 10, the processing unit 801, and/or the maintaining module 804 may be configured to maintain the internal value of the part of the resource by being configured to update the internal value of the part of the full set of data taking the second indication into account.

The first communication device 10 comprises **a checking module 805.** The first communication device 10, the processing unit 801, and/or the checking module 805 may be configured to check whether the second communication device 12 supports sending partial modifications of resources.

The methods according to the embodiments described herein for the first communication device 10 are respectively implemented by means of e.g. **a computer program 806** or a computer program product, comprising instructions, i.e., software code portions, which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the first communication device 10. The computer program 806 may be stored on **a computer-readable storage medium 807**, e.g. a disc or similar. The computer-readable storage medium 807, having stored thereon the computer program, may comprise the instructions which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the first communication device 10. In some embodiments, the computer-readable storage medium may be a non-transitory computer-readable storage medium.

The first communication device 10 further comprises **a memory 808**. The memory comprises one or more units to be used to store data on, such as full set of data of the resource, Delta attributes and ETag attributes, mappings of second indications to parts of resources in time e.g. versions, applications to perform the methods disclosed herein when being executed, and similar.

Fig. 9 is a block diagram depicting the second communication node 12, e.g. second endpoint or Internet server, or CoAP server, for handling data in the communication network 1. The second communication device 12 is configured to provide data of the resource to the first communication device 10 in the communication network 1.

The second communication node 12 may comprise **a processing unit 901**, e.g. one or more processors, being configured to perform the methods herein.

The second communication node 12 comprises **a receiving module 902.** The second communication node 12, the processing unit 901, and/or the receiving module 902 may be configured to receive, from the first communication device 10, the first indication indicating the configuration enabling the first communication device 10 to receive a partial modification of resources. The first indication may be comprised in the message indicating that the first communication device 10 subscribes to or requests partial information of one or more resources. The second communication node 12, the processing unit 901, and/or the receiving module 902 may be configured to receive the identification indicating the resource such as the URI.

The second communication node 12 comprises **an obtaining module 903.** The second communication node 12, the processing unit 901, and/or the obtaining module 903 may be configured to obtain internally or from another communication device, the update of the part of the resource, which update comprises a value.

The second communication node 12 comprises **a transmitting module 904.** The second communication node 12, the processing unit 901, and/or the transmitting module 904 may be configured to transmit the second indication indicating the partial update, in time, associated with the resource and the value of the part of the resource. The second indication may identify the version in time of the partial update of the resource. The second communication node 12, the processing unit 901, and/or the transmitting module 904 may be configured to transmit several second indications, which are assigned to the same resource. The second indication may indicates the set of resources. The second communication node 12, the processing unit 901, and/or the transmitting module 904 may be configured to transmit to the first communication device 10, a full set of data of the resource.

The second communication node 12 comprises **an indicating module 905.** The second communication node 12, the processing unit 901, and/or the indicating module 905 may be configured to indicate support to send partial modification of resources.

The second communication node 12 comprises **a tagging module 906.** The second communication node 12, the processing unit 901, and/or the tagging module 906 may be configured to tag the part of the resource with the second indication.

The methods according to the embodiments described herein for the second communication node 12 are respectively implemented by means of e.g. **a computer program 907** or a computer program product, comprising instructions, i.e., software code portions, which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the second communication node 12. The computer program 907 may be stored on **a computer-readable storage medium 908**, e.g. a disc or similar. The computer-readable storage medium 908, having stored thereon the computer program, may comprise the instructions which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the second communication node 12. In some embodiments, the computer-readable storage medium may be a non-transitory computer-readable storage medium.

The second communication node 12 further comprises **a memory 909** and communication interfaces. The memory comprises one or more units to be used to store data on, such as full set of data of the resource, Delta attributes and ETag attributes, mappings of second indications to parts of resources in time e.g. versions, applications to perform the methods disclosed herein when being executed, and similar.

As will be readily understood by those familiar with communications design, that functions means or modules may be implemented using digital logic and/or one or more microcontrollers, microprocessors, or other digital hardware. In some embodiments, several or all of the various functions may be implemented together, such as in a single application-specific integrated circuit (ASIC), or in two or more separate devices with appropriate hardware and/or software interfaces between them. Several of the functions may be implemented on a processor shared with other functional components of a communication device, for example.

Alternatively, several of the functional elements of the processing means discussed may be provided through the use of dedicated hardware, while others are provided with hardware for executing software, in association with the appropriate software or firmware. Thus, the term “processor” or “controller” as used herein does not exclusively refer to hardware capable of executing software and may implicitly include, without limitation, digital signal processor (DSP) hardware, read-only memory (ROM) for storing software, random-access memory for storing software and/or program or application data, and non-volatile memory. Other hardware, conventional and/or custom, may also be included. Designers of communication devices will appreciate the cost, performance, and maintenance trade-offs inherent in these design choices.

It will be appreciated that the foregoing description and the accompanying drawings represent non-limiting examples of the methods and apparatus taught herein. As such, the apparatus and techniques taught herein are not limited by the foregoing description and accompanying drawings. Instead, the embodiments herein are limited only by the following claims and their legal equivalents.

CLAIMS

1. A method performed by a first communication device (10) for handling data in a communication network (1), the method comprising:
   - *transmitting* (603), to a second communication device (12), a first indication indicating a configuration enabling the first communication device (10) to receive a partial modification of resources;
   - *receiving* (604), from the second communication device (12), a second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource; and
   - *maintaining* (605) an internal value of the part of the resource based on the second indication.

2. The method according to claim 1, wherein the second indication identifies a version in time of the partial update of the resource.

3. The method according to any of the claims 1-2, wherein the *receiving* (604) comprises receiving several second indications, which are assigned to the same resource.

4. The method according to any of the claims 1-3, wherein the second indication indicates a set of resources.

5. The method according to any of the claims 1-4, wherein *maintaining* (605) comprises comparing the second indication with a previously stored indication and updating the internal value of the part of the resource to the received value when the second indication is a consecutive value to the previously stored indication.

6. The method according to any of the claims 1-5, wherein the first indication is comprised in a message indicating that the first communication device (10) subscribes to or requests partial information of one or more resources.

7. The method according to any of the claims 1-6, further comprising:
   - *receiving* (602) a full set of data of the resource; and the *maintaining* (605) the internal value of the part of the resource comprises updating the internal value of a part of the full set of data taking the second indication into account.

8. The method according to any of the claims 1-7, wherein the *transmitting* (603) the first indication comprises transmitting further an identification indicating the resource.

9. The method according to any of the claims 1-8, further comprising:
   - *checking* (601) whether the second communication device (12) supports sending partial modifications of resources.

10. A method performed by a second communication device (12) for handling data in a communication network (1), which second communication device (12) provides data of a resource to a first communication device (10) in the communication network (1), the method comprising:
   - *receiving* (702), from the first communication device (10), a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources;
   - *obtaining* (704), internally or from another communication device, an update of a part of the resource, which update comprises a value; and
   - *transmitting* (706) a second indication indicating a partial update, in time, associated with the resource and the value of the part of the resource.

11. The method according to claim 10, further comprising
   - *indicating* (701) support to send partial modification of resources.

12. The method according to any of the claims 10-11, further comprising
   - *tagging* (705) the part of the resource with the second indication.

13. The method according to any of the claims 10-12, wherein the second indication identifies a version in time of the partial update of the resource.

14. The method according to any of the claims 10-13, wherein the *transmitting* (706) comprises transmitting several second indications, which are assigned to the same resource.

15. The method according to any of the claims 10-14, wherein the second indication indicates a set of resources.

16. The method according to any of the claims 10-15, wherein the first indication is comprised in a message indicating that the first communication device (10) subscribes to or requests partial information of one or more resources.

17. The method according to any of the claims 10-16, comprising:
- *transmitting* (703) to the first communication device (10), a full set of data of the resource.

18. The method according to any of the claims 10-17, wherein the *receiving* the first indication comprises receiving further an identification indicating the resource.

19. A first communication device (10) for handling data in a communication network (1), wherein the first communication device is configured to:

transmit, to a second communication device (12), a first indication indicating a configuration enabling the first communication device (10) to receive a partial modification of resources;

receive, from the second communication device (12), a second indication indicating a partial update, in time, associated with a resource and a value of a part of the resource; and

maintain an internal value of the part of the resource based on the second indication.

20. The first communication device (10) according to claim 19, wherein the second indication identifies a version in time of the partial update of the resource.

21. The first communication device (10) according to any of the claims 19-20, further configured to receive several second indications, which are assigned to the same resource.

22. The first communication device (10) according to any of the claims 19-21, wherein the second indication indicates a set of resources.

23. The first communication device (10) according to any of the claims 19-22, being configured to maintain the internal value by being configured to compare the second indication with a previously stored indication and to update the internal

value of the part of the resource to the received value when the second indication is a consecutive value to the previously stored indication.

24. The first communication device (10) according to any of the claims 19-23, wherein the first indication is comprised in a message indicating that the first communication device (10) subscribes to or requests partial information of one or more resources.

25. The first communication device (10) according to any of the claims 19-24, further being configured to receive a full set of data of the resource; and to maintain the internal value of the part of the resource by being configured to update the internal value of a part of the full set of data taking the second indication into account.

26. The first communication device (10) according to any of the claims 19-25, being further configured to transmit an identification indicating the resource.

27. The first communication device (10) according to any of the claims 19-26, further being configured to check whether the second communication device (12) supports sending partial modifications of resources.

28. A second communication device (12) for handling data in a communication network (1), which second communication device (12) is configured to provide data of a resource to a first communication device (10) in the communication network (1), the second communication device (12) being configured to:

receive, from the first communication device (10), a first indication indicating a configuration enabling the first communication device to receive a partial modification of resources;

obtain internally or from another communication device, an update of a part of the resource, which update comprises a value; and to

transmit a second indication indicating a partial update, in time, associated with the resource and the value of the part of the resource.

29. The second communication device (12) according to claim 28, further being configured to indicate support to send partial modification of resources.

30. The second communication device (12) according to any of the claims 28-29, further being configured to tag the part of the resource with the second indication.

31. The second communication device (12) according to any of the claims 28-30, wherein the second indication identifies a version in time of the partial update of the resource.

32. The second communication device (12) according to any of the claims 28-31, being configured to transmit several second indications, which are assigned to the same resource.

33. The second communication device (12) according to any of the claims 28-32, wherein the second indication indicates a set of resources.

34. The second communication device (12) according to any of the claims 28-33, wherein the first indication is comprised in a message indicating that the first communication device (10) subscribes to or requests partial information of one or more resources.

35. The second communication device (12) according to any of the claims 28-24, being configured to transmit to the first communication device (10), a full set of data of the resource.

36. The second communication device (12) according to any of the claims 28-25, being configured to further receive an identification indicating the resource.

37. A computer program comprising instructions, which, when executed on at least one processor, cause the at least one processor to carry out any of the methods according to any of the claims 1-18, as performed by the first communication device (10) or the second communication device (12).

38. A computer-readable storage medium, having stored thereon a computer program comprising instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to any of the claims 1-18, as performed by the first communication device (10) or the second communication device (12).

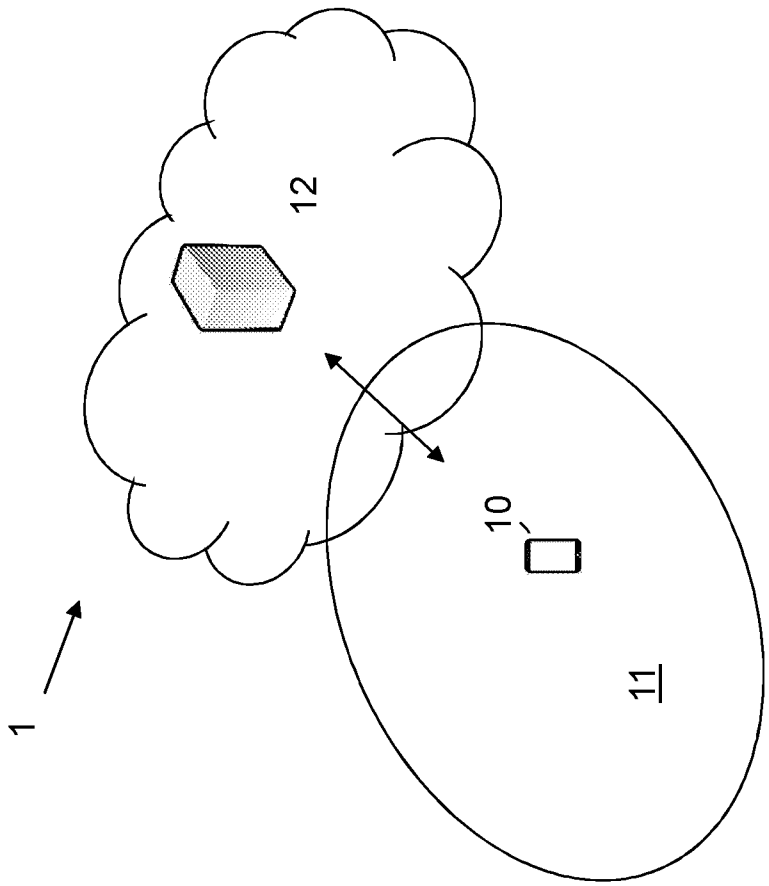

Fig. 1

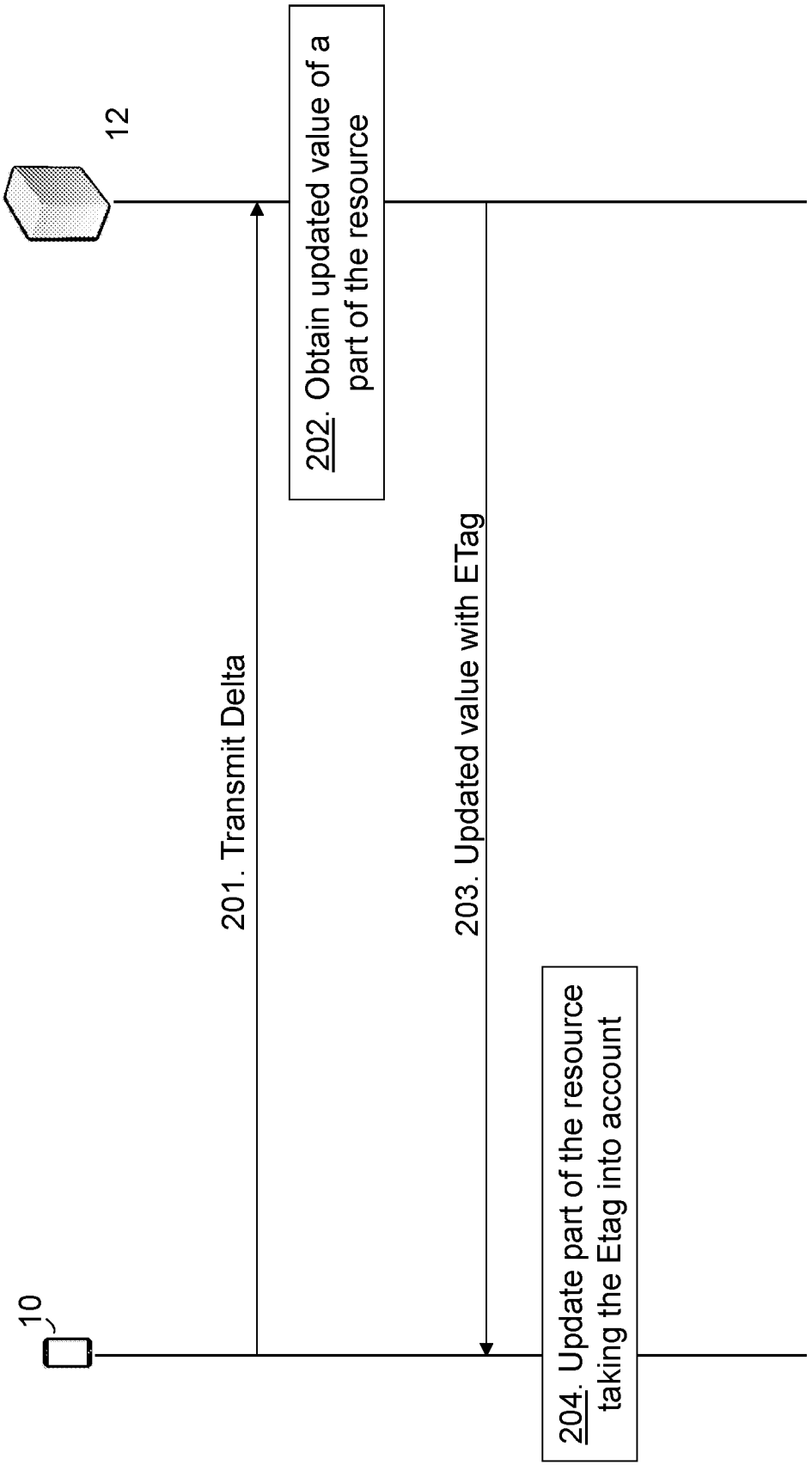
12
202. Obtain updated value of a part of the resource
201. Transmit Delta
203. Updated value with ETag
10
204. Update part of the resource taking the Etag into account

Fig. 2

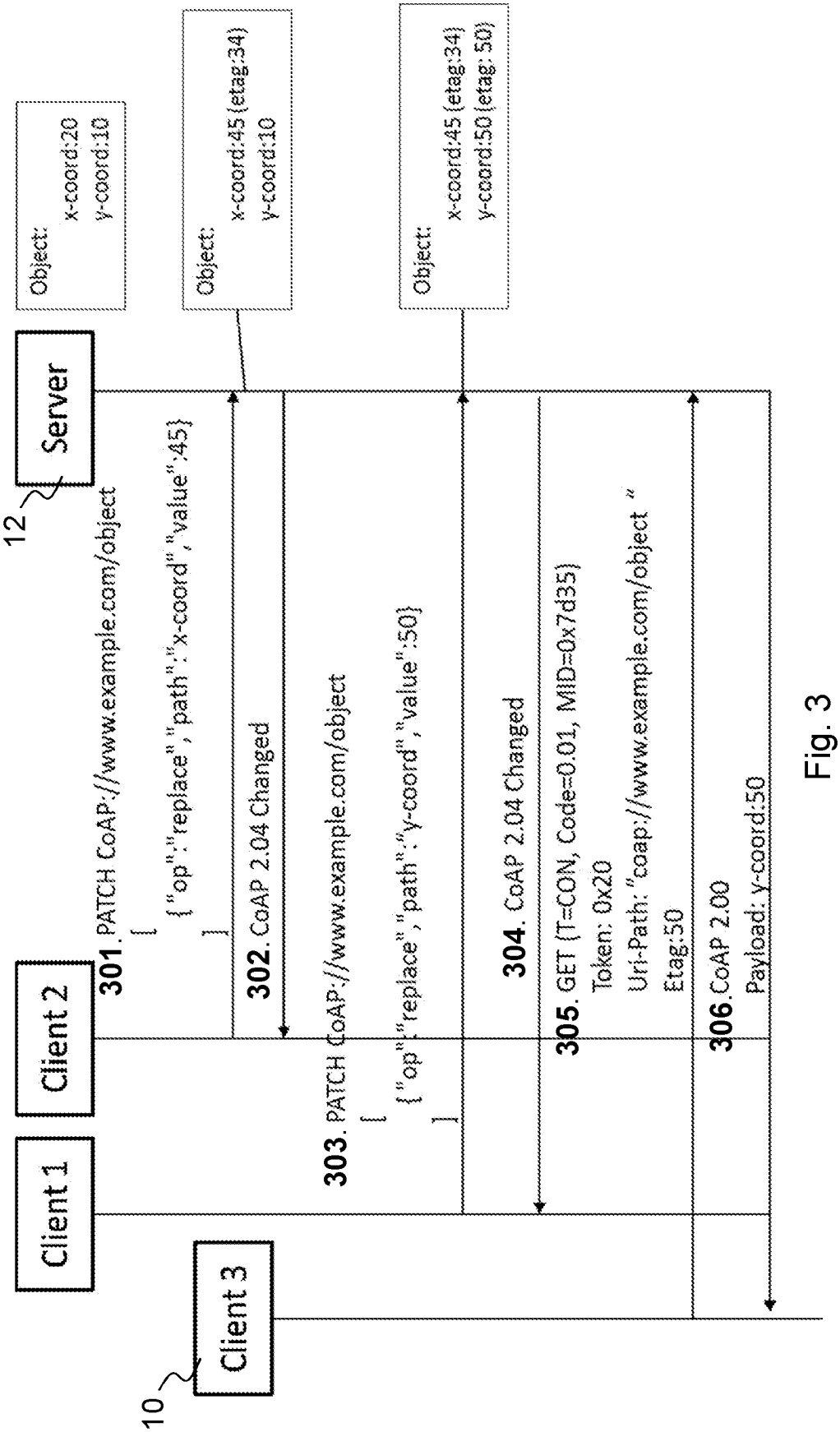
Object:
x-coord:20
y-coord:10
Object:
x-coord:45 (etag:34)
y-coord:10
Object:
x-coord:45 (etag:34)
y-coord:50 (etag: 50)
Server
12
Client 1
Client 2
Client 3
10
301. PATCH CoAP://www.example.com/object
[
{"op":"replace","path":"x-coord","value":45}
]
302. CoAP 2.04 Changed
303. PATCH CoAP://www.example.com/object
[
{"op":"replace","path":"y-coord","value":50}
]
304. CoAP 2.04 Changed
305. GET (T=CON, Code=0.01, MID=0x7d35)
Token: 0x20
Uri-Path: "coap://www.example.com/object"
Etag:50
306.CoAP 2.00
Payload: y-coord:50

Fig. 3

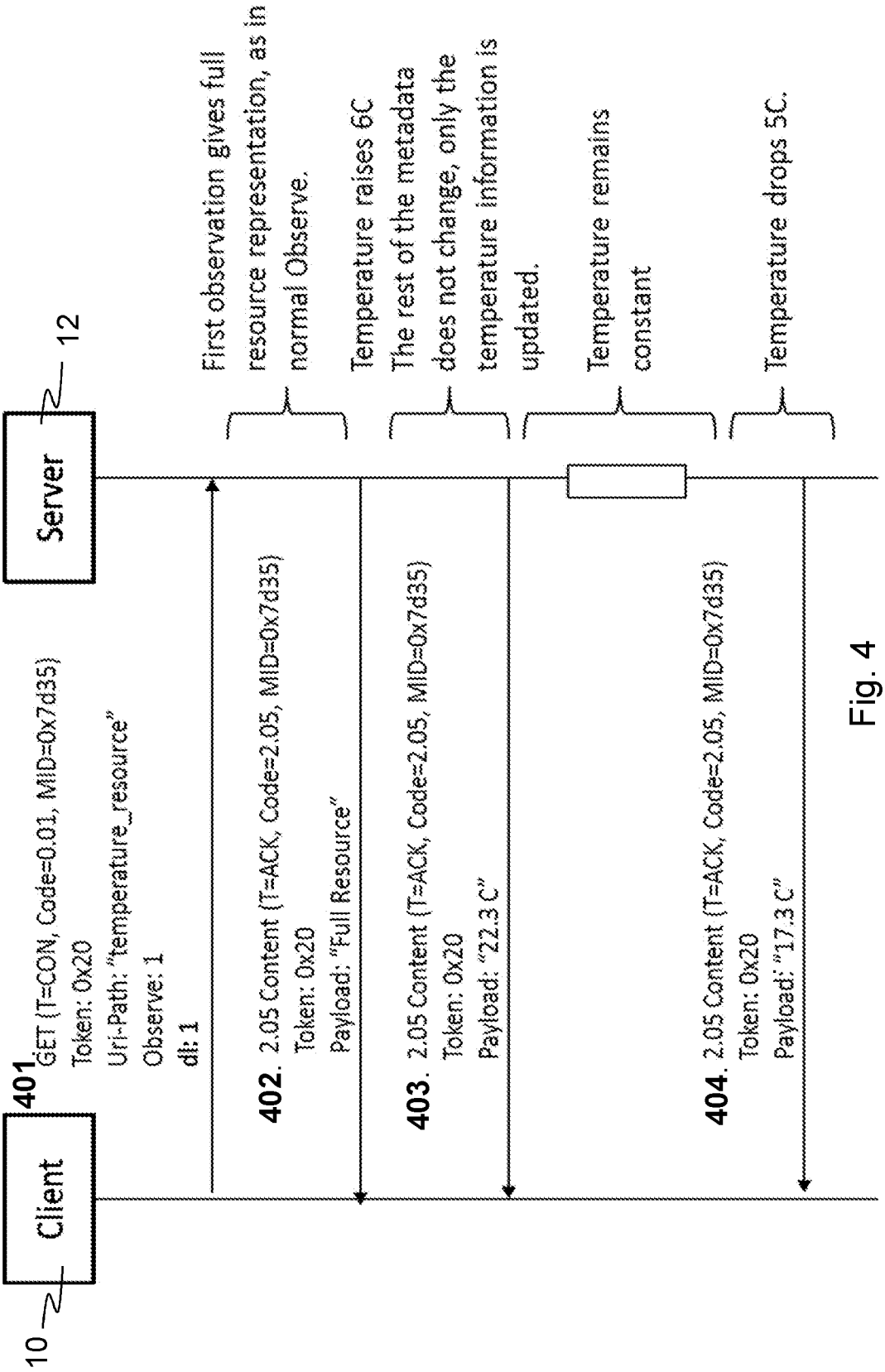
Client
10
Server
12
401. GET (T=CON, Code=0.01, MID=0x7d35)
Token: 0x20
Uri-Path: "temperature_resource"
Observe: 1
db: 1
First observation gives full resource representation, as in normal Observe.
402. 2.05 Content (T=ACK, Code=2.05, MID=0x7d35)
Token: 0x20
Payload: "Full Resource"
Temperature raises 6C
The rest of the metadata does not change, only the temperature information is updated.
403. 2.05 Content (T=ACK, Code=2.05, MID=0x7d35)
Token: 0x20
Payload: "22.3 C"
Temperature remains constant
404. 2.05 Content (T=ACK, Code=2.05, MID=0x7d35)
Token: 0x20
Payload: "17.3 C"
Temperature drops 5C.

Fig. 4

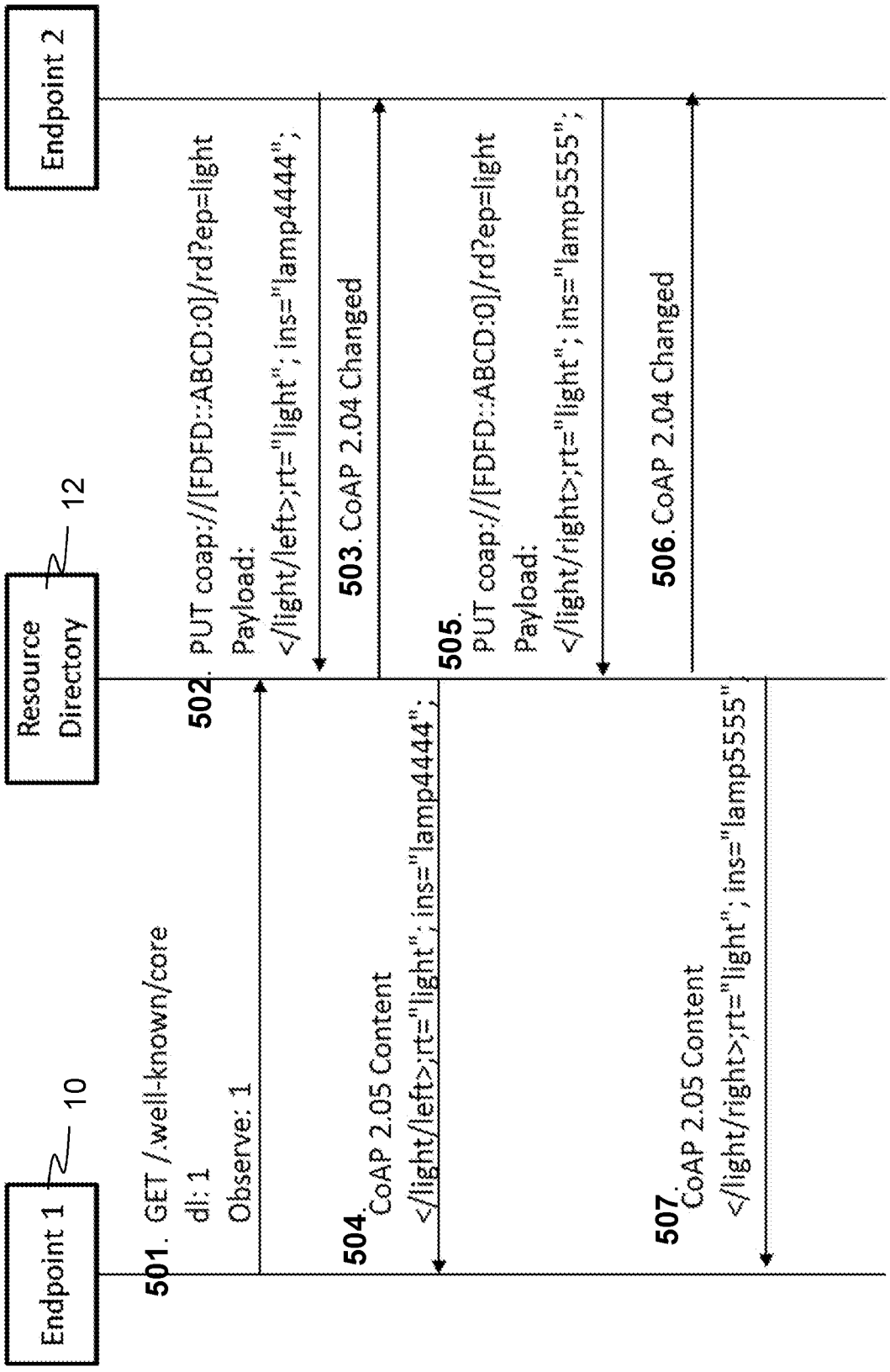
Endpoint 1
10
Resource Directory
12
Endpoint 2
501. GET /.well-known/core
dl: 1
Observe: 1
502. PUT coap://[FDFD::ABCD:0]/rd?ep=light
Payload:
</light/left>;rt="light"; ins="lamp4444";
503. CoAP 2.04 Changed
504. CoAP 2.05 Content
</light/left>;rt="light"; ins="lamp4444";
505. PUT coap://[FDFD::ABCD:0]/rd?ep=light
Payload:
</light/right>;rt="light"; ins="lamp5555";
506. CoAP 2.04 Changed
507. CoAP 2.05 Content
</light/right>;rt="light"; ins="lamp5555"

Fig. 5

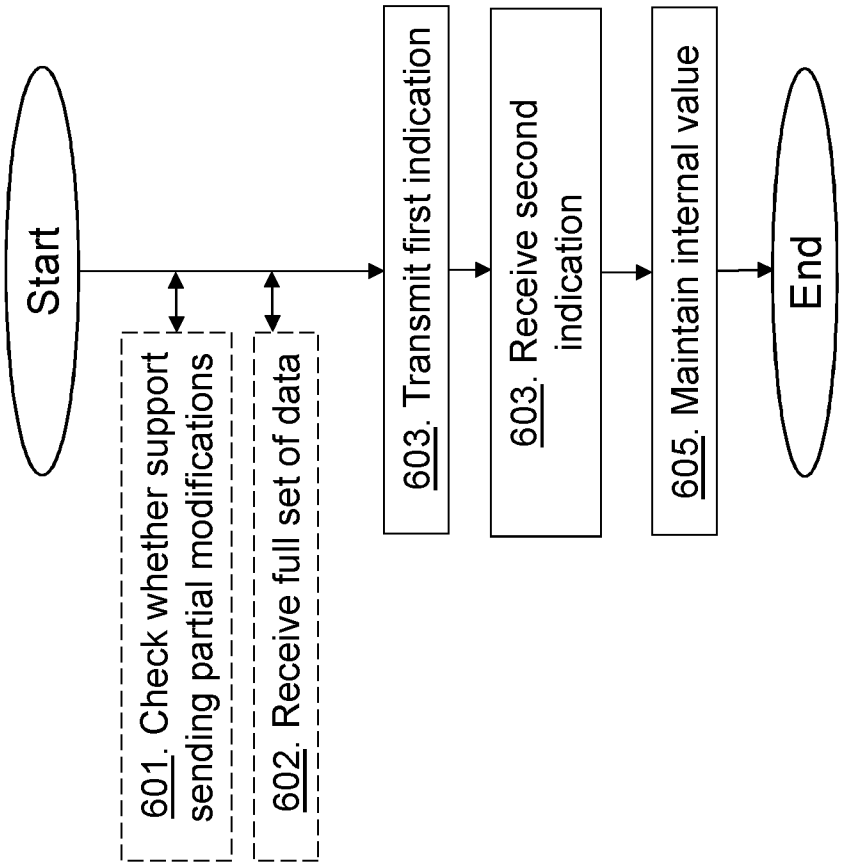
Start
601. Check whether support sending partial modifications
602. Receive full set of data
603. Transmit first indication
603. Receive second indication
605. Maintain internal value
End

Fig. 6

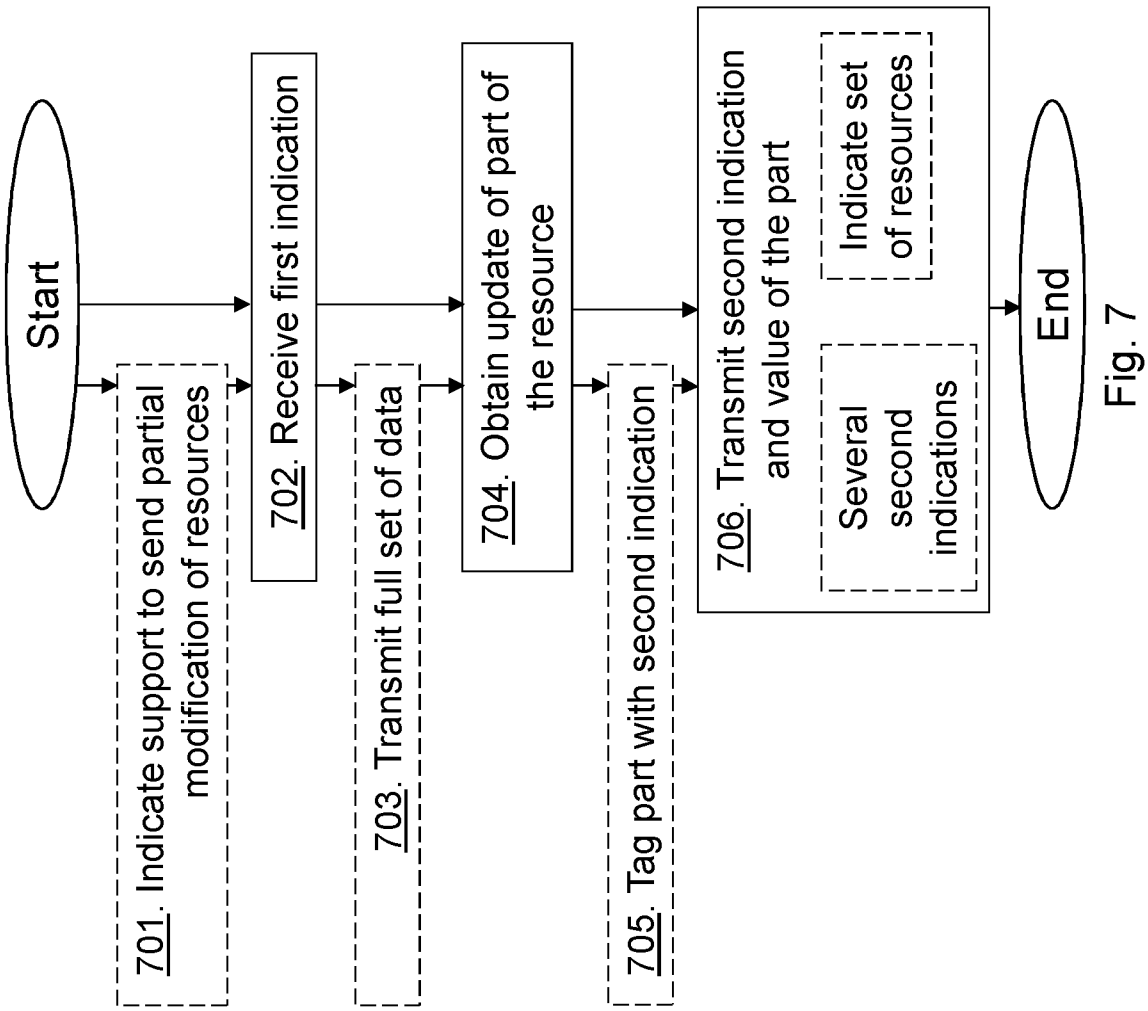
Start
701. Indicate support to send partial modification of resources
702. Receive first indication
703. Transmit full set of data
704. Obtain update of part of the resource
705. Tag part with second indication
706. Transmit second indication and value of the part
Several second indications
Indicate set of resources
End

Fig. 7

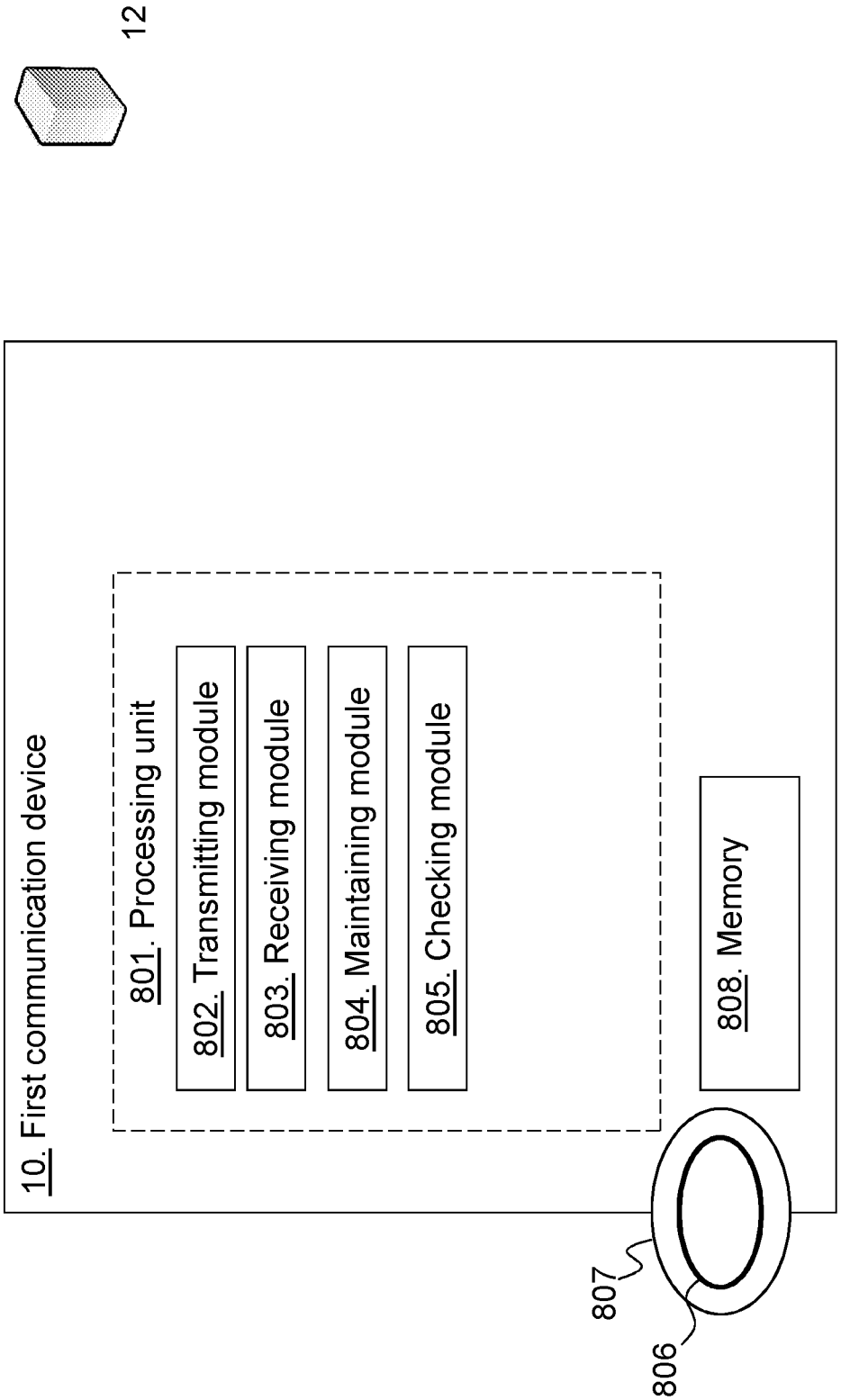
12
10. First communication device
801. Processing unit
802. Transmitting module
803. Receiving module
804. Maintaining module
805. Checking module
808. Memory
807
806

Fig. 8

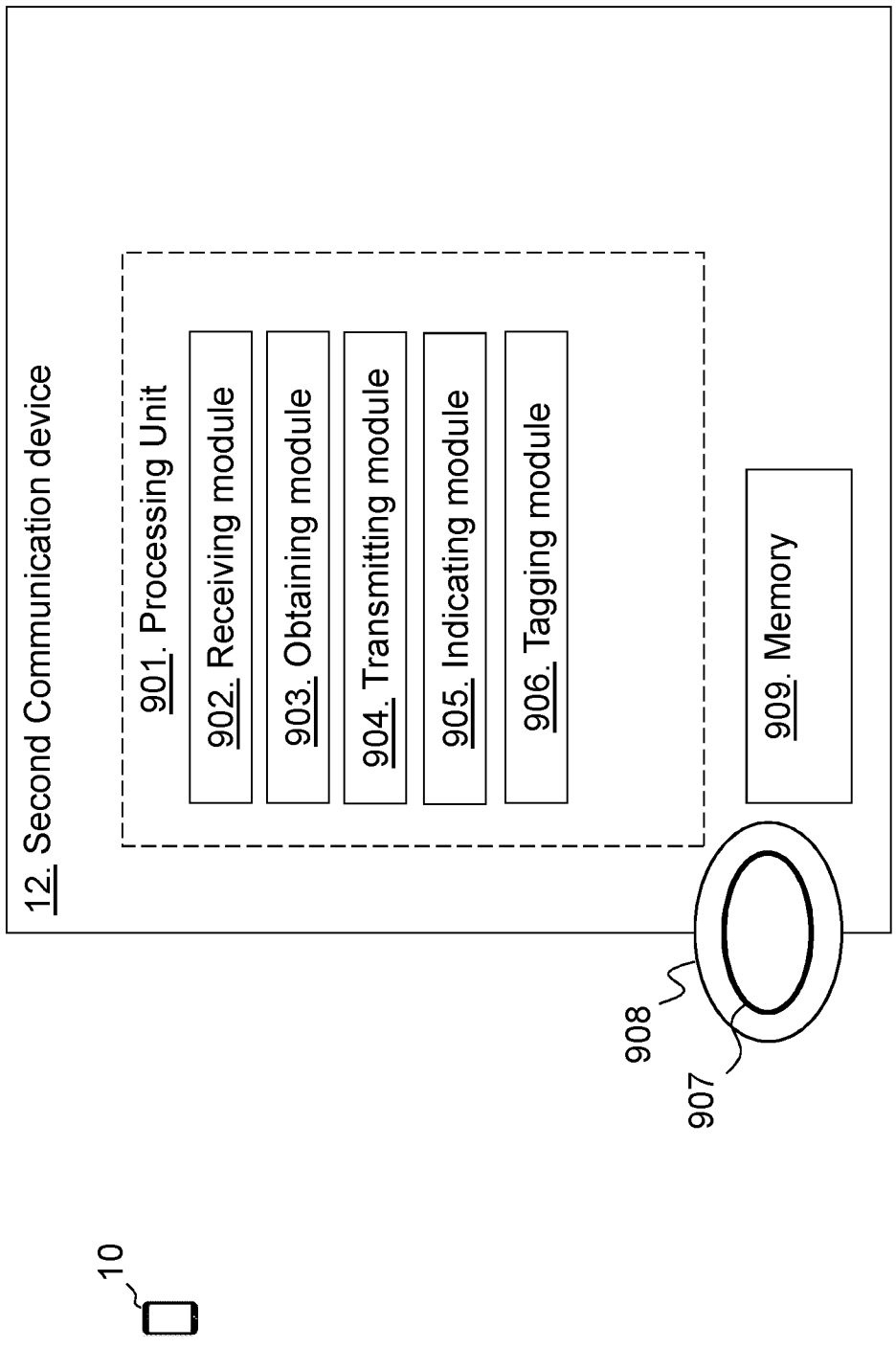
12. Second Communication device
901. Processing Unit
902. Receiving module
903. Obtaining module
904. Transmitting module
905. Indicating module
906. Tagging module
909. Memory
908
907
10

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050780

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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: G06F, H04L, H04W

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014107486 A1 (GEN INSTRUMENT CORP), 10 July 2014 (2014-07-10); abstract; paragraphs [0005]-[0009], [0036], [0068]; figures 8,11; claims 1-2,6 --	1-38
A	WO 2016100631 A1 (CONVIDA WIRELESS LLC), 23 June 2016 (2016-06-23); abstract; paragraphs [0052]-[0057] --	1-38
A	WO 2016048208 A1 (ERICSSON TELEFON AB L M), 31 March 2016 (2016-03-31); abstract -- --------	1-38

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18-04-2017	18-04-2017
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Ralf Boström Telephone No. + 46 8 782 28 00

International application No.
PCT/SE2016/050780

Continuation of: second sheet

International Patent Classification (IPC)

H04W 4/00 (2009.01)
G06F 17/30 (2006.01)
H04L 29/06 (2006.01)
H04W 80/04 (2009.01)

WO	2014107486	A1	10/07/2014	CA	2899462	A1	10/07/2014
WO	2016100631	A1	23/06/2016	NONE			
WO	2016048208	A1	31/03/2016	NONE			