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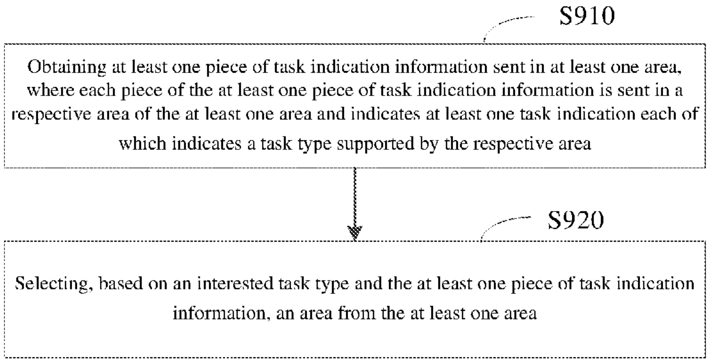

FIG. 9

(57) **Abstract:** Provided are a method, apparatus and system for semantic communications. A first device such as a sensing device can obtain at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area. Then the first device can select an area from the at least one area, based on an interested task type and the at least one piece of task indication information. Thus, only the task type each area supports and the interested task type are considered, and for selecting an area, there is no need to do measurements for all task types, the task delay or power consumption can be reduced.

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METHOD, APPARATUS AND SYSTEM FOR SEMANTIC COMMUNICATIONS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to US provisional patent application No. 63/509,421, filed on June 21, 2023, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of semantic communication technologies and, in particular, to a communication method, an apparatus and a system.

BACKGROUND

[0003] A sensing function will be integrated into the 6th generation (6G) system. A large number of the sensing user equipments (UEs) or sensing devices will be densely deployed in cities, factories, farms and so on. In addition to mobile phones, sensing devices will become an important type of UEs or devices that claim an arrival of IoT time.

[0004] Like internet searching engines, 6G will come up with the counterpart, an internet of thing (IoT) searching engine, in a true physical world. In fact, billions of IoT-based applications such as driverless cars, automation factories, smart cities, and autonomous farms, will heavily depend on an efficient and real-time searching engine in our physical world.

[0005] Recently, artificial intelligence (AI) has conquered various intellectual and cognitive domains. Some AI is exploring the cutting edge of our intellectual knowledge in chemistry, gaming, mathematic, gene engineering; some other AI is providing a human-level Q&A platform in the digital world; the domain that AI hasn't conquered is real-time physical world. Physical-world AI, in which AI technologies are to penetrate into all the aspects of our society and life, may be built on omnipresent IoT connections thanks to 6G.

[0006] More challenging than internet searching engine, real-world searching engine would have to search the physical world in real time over a large scale of physical areas and to deal with a multitude of types of data and information (some may be novel and some may haven't been invented yet). Furthermore, green technology, low-energy and low-emission, are also raised as key feature of 6G. A sensing device may be battery powered and/or completely powered by solar and wind. It would be costly and impracticable to ask all the sensing devices in a large scale to feedback what they are sensing at the same time. On one hand, the frequent sensing and transmission consumes a sensing device much energy and reduces their battery life time; on other hand, such a high density of the IoT deployment may block the uplink channels, especially the uplink (UL) bandwidth is more expensive than the downlink (DL) one.

[0007] This background information is provided to reveal information believed by the applicant to be of possible relevance to the present disclosure. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present disclosure.

SUMMARY

[0008] In a first aspect, the present disclosure provides a communication method, which includes:

obtaining at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area; and

selecting, based on an interested task type and the at least one piece of task indication information, an area from the at least one area.

[0009] Because the area is selected based on an interested task type and the task type(s) supported by each area, only the task type(s) each area supports and the interested task type are considered, and for selecting an area, there is no need to do measurements for all task types, and thus the task delay or power consumption can be reduced.

[0010] In a possible implementation of the first aspect, each of the at least one task indication includes a reference signal for measurement.

[0011] Because each of the at least one task indication includes a reference signal for measurement, after obtaining task indication information that indicates at least one task indication, measurement can be performed for the at least one task indication to obtain a measurement result corresponding to the at least one task indication.

[0012] In a possible implementation of the first aspect, the method further includes: determining the interested task type based on a capability of a first device and/or a current status of the first device.

[0013] Because the interested task type is determined based on a capability of a first device and/or a current status of the first device, when selecting an area from the at least one area, the task types beyond the capability of the first device and/or the task types that the first device does not support under the current status will not be considered, and measurement will not performed on these task types, thereby reducing the power consumption.

[0014] In a possible implementation of the first aspect, the selecting, based on the interested task type and the at least one piece of task indication information, an area from the at least one area includes: performing measurement for the interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, where a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type; and selecting an area from the one or more of the at least one area, where a measurement result corresponding to the selected area has a value higher than a threshold.

[0015] Because the area is selected from one or more areas that support the interested task type, and a measurement result corresponding to the selected area has a value higher than a threshold, it ensures the selected area supports the interested task type and has a good signal quality. And because measurement is performed only for the interested task type, the task delay or power consumption can be greatly reduced.

[0016] In a possible implementation of the first aspect, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

[0017] Because at least one first task indication indicated by a first piece of task indication information sent in a first area indicates a different task type from at least one second task indication indicated by a second piece of task indication information sent in a second area, different areas may support different task types, and the different task types supported by different areas can be effectively indicated by the task indications indicated by the task indication information sent in different areas, and after obtaining the task indication information sent in different areas, it can be known according to the task indication information that these areas support different task types.

[0018] In a possible implementation of the first aspect, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

[0019] Because the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent, which means, the task indication is scrambled with an identifier of an area supporting the task type indicated by the task indication, after obtaining the at least one piece of task indication information sent in the at least one area, the area supporting a task type can be determined according to the identifier of the area which is used to scramble the task indication indicating that task type.

[0020] In a possible implementation of the first aspect, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

[0021] In a possible implementation of the first aspect, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

[0022] Because time-frequency resources of one or more first task indications for a task type in a first area and time-frequency resources of one or more second task indications for the same task type in a second area may be same or different, the time-frequency resources of the task indication(s) for a task type can be flexibly configured.

[0023] In a possible implementation of the first aspect, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area.

[0024] Because time-frequency resources of one or more first reference signals for a task type in a first area and time-frequency resources of one or more second reference signals for the same task type in a second area may be same or different, the time-frequency resources of the reference signals for a task type can be flexibly configured.

[0025] In a possible implementation of the first aspect, the at least one task indication is represented by at least one pattern for at least one task type.

[0026] Because the at least one task indication is represented by at least one pattern for at least one task type, after obtaining the task indication information indicating the at least one task indication, the at least one task type can be easily read and known.

[0027] In a possible implementation of the first aspect, different patterns are defined for different task types.

[0028] Because different patterns are defined for different task types, different patterns may be used to indicate different task types, and each task type can be determined according to its corresponding pattern(s), which provide an efficient way to indicate the task type(s) supported by each area.

[0029] In a possible implementation of the first aspect, the at least one task indication is configurable.

[0030] Because the at least one task indication is configurable, a flexible configuration is achieved.

[0031] In a possible implementation of the first aspect, the different patterns are pre-defined in a specification and selectable depending on a current scenario.

[0032] Because the different patterns are pre-defined in a specification and selectable depending on a current scenario, resources for transmission of configuration of the patterns can be saved, and the patterns can be selected in a flexible manner depending on the current scenario.

[0033] In a possible implementation of the first aspect, the different patterns are broadcast, multicast or unicast through signaling.

[0034] In a possible implementation of the first aspect, the signaling is carried in radio resource control (RRC) signaling.

[0035] Because the different patterns are broadcast, multicast or unicast through signaling such as RRC signaling, the transmission of the patterns is more flexible.

[0036] In a possible implementation of the first aspect, different task types correspond to different task indications.

[0037] Because different task types correspond to different task indications, the task type that the task indication indicates can be easily known.

[0038] In a possible implementation of the first aspect, a message for a task type is scrambled with a task identifier of the task type.

[0039] Because a message for a task type is scrambled with a task identifier of the task type, after the message is received, the task type the message corresponds to can be easily known.

[0040] In a possible implementation of the first aspect, the at least one task indication belongs to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type.

[0041] Because task indications are grouped according to task types and each task type may correspond to a group of one or more task indications, the task indication(s) used to indicate the task type can be flexibly selected from the group according to actual conditions, and when multiple task indications are used to indicate a task type, the indicating of the task type can be more reliable.

[0042] In a possible implementation of the first aspect, each of the at least one area is a cell, or each of the at least one area is a paging area.

[0043] The area may be a cell or a paging area, which means, the method can be used in the selection of a cell or a paging area, thereby realizing task-specific cell selection or task-specific paging area selection.

[0044] In a possible implementation of the first aspect, the first device is a sensing device.

[0045] In a second aspect, the present disclosure provides a communication method, which includes:

sending, in at least one area, at least one piece of task indication information, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area.

[0046] Because each task indication indicates a task type supported by a respective area, when a device to which the task indication information is sent selects an area, there is no need to do measurements for all task types, the task delay or power consumption can be reduced.

[0047] In a possible implementation of the second aspect, each of the at least one task indication includes a reference signal for measurement.

[0048] Because each of the at least one task indication includes a reference signal for measurement, a device receiving the task indication information that indicates the at least one task indication can perform measurement for the at least one task indication to obtain a measurement result corresponding to the at least one task indication.

[0049] In a possible implementation of the second aspect, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

[0050] Because at least one first task indication indicated by a first piece of task indication information sent in a first area indicates a different task type from at least one second task indication indicated by a second piece of task indication information sent in a second area, different areas may support different task types, and different task types supported in different areas can be effectively indicated to a device receiving the task indication information through the task indications indicated by the task indication information sent in different areas.

[0051] In a possible implementation of the second aspect, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

[0052] Because the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent, which means, the task indication is scrambled with an identifier of an area supporting the task type indicated by the task indication, the area supporting a task type can be determined according to the identifier of the area which is used to scramble the task indication indicating that task type.

[0053] In a possible implementation of the second aspect, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

[0054] In a possible implementation of the second aspect, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

[0055] Because time-frequency resources of one or more first task indications for a task type in a first area and time-frequency resources of one or more second task indications for the same task type in a second area may be same or different, the time-frequency resources of the task indications for a task type can be flexibly configured.

[0056] In a possible implementation of the second aspect, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area.

[0057] Because time-frequency resources of one or more first reference signals for a task type in a first area and time-frequency resources of one or more second reference signals for the same task type in a second area may be same or different, the time-frequency resources of the reference signals for a task type can be flexibly configured.

[0058] In a possible implementation of the second aspect, the at least one task indication is represented by at least one pattern for at least one task type.

[0059] Because the at least one task indication is represented by at least one pattern for at least one task type, the at least one task type can be easily read and known.

[0060] In a possible implementation of the second aspect, different patterns are defined for different task types.

[0061] Because different patterns are defined for different task types, different patterns may be used to indicate different task types, and each task type can be determined according to its corresponding pattern(s), which provide an efficient way to indicate the task type(s) supported by each area.

[0062] In a possible implementation of the second aspect, the at least one task indication is configurable.

[0063] Because the at least one task indication is configurable, a flexible configuration is achieved.

[0064] In a possible implementation of the second aspect, the different patterns are pre-defined in a specification and selectable depending on a current scenario.

[0065] Because the different patterns are pre-defined in a specification and selectable depending on a current scenario, resources for transmission of configuration of the patterns can be saved, and the patterns can be selected in a flexible manner depending on the current scenario.

[0066] In a possible implementation of the second aspect, the different patterns are broadcast, multicast or unicast through signaling.

[0067] In a possible implementation of the second aspect, the signaling is carried in radio resource control (RRC) signaling.

[0068] Because the different patterns are broadcast, multicast or unicast through signaling such as RRC signaling, the transmission of the patterns is more flexible.

[0069] In a possible implementation of the second aspect, different task types correspond to different task indications.

[0070] Because different task types correspond to different task indications, the task type that the task indication indicates can be easily known.

[0071] In a possible implementation of the second aspect, a message for a task type is scrambled with a task identifier of the task type.

[0072] Because a message for a task type is scrambled with a task identifier of the task type, a device to which the message is sent can easily know which task type the message corresponds to.

[0073] In a possible implementation of the second aspect, the at least one task indication belongs to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type.

[0074] Because task indications are grouped according to task types, and each task type may correspond to a group of one or more task indications, the task indication(s) used to indicate the task type can be flexibly selected from the group according to actual conditions, and when multiple task indications are used to indicate a task type, the indicating of the task type can be more reliable.

[0075] In a possible implementation of the second aspect, each of the at least one area is a cell, or each of the at least one area is a paging area.

[0076] The area may be a cell or a paging area, which means, the method can be used in the selection of a cell or a paging area, thereby realizing task-specific cell selection or task-specific paging area selection.

[0077] In a possible implementation of the second aspect, the at least one piece of task indication information is sent by a central device.

[0078] In a third aspect, the present disclosure provides a first apparatus, which includes various modules configured to execute the communication method according to the first aspect or any implementation of the first aspect.

[0079] In a fourth aspect, the present disclosure provides a second apparatus, which includes various modules configured to execute the communication method according to the second aspect or any implementation of the second aspect.

[0080] In a fifth aspect, the present disclosure provides a third apparatus, which includes a processing circuitry for executing the communication method according to the first aspect or any implementation of the first aspect.

[0081] In a sixth aspect, the present disclosure provides a fourth apparatus, which includes a processing circuitry for executing the communication method according to the second aspect or any implementation of the second aspect.

[0082] In a seventh aspect, the present disclosure provides a wireless communication system, which includes: at least one first apparatus according to the third aspect or any implementation of the third aspect or at least one third apparatus according to the fifth aspect; and at least one second apparatus according to the fourth aspect or any implementation of the fourth aspect or at least one fourth apparatus according to the sixth aspect.

[0083] In an eighth aspect, the present disclosure provides a wireless communication system, which includes: a first processing circuitry for executing the communication method according to the first aspect or any implementation of the first aspect; and a second processing circuitry for executing the communication method according to the second aspect or any implementation of the second aspect.

[0084] In a ninth aspect, the present disclosure provides a computer-readable medium storing computer execution instructions which, when executed by a processor, cause the processor to execute the communication method according to the first aspect or any implementation of the first aspect or the second aspect or any implementation of the second aspect.

[0085] In a tenth aspect, the present disclosure provides a computer program product including computer execution instructions which, when executed by a processor, cause the processor to execute the communication method according to the first aspect or any implementation of the first aspect or the second aspect or any implementation of the second aspect.

[0086] The present disclosure provides a communication method, an apparatus, and a system, where the communication method includes: obtaining at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area; and selecting an area from the at least one area, based on an interested task type and the at least one piece of task indication information. Thus, only the task type each area supports and the interested task type are considered, and for selecting an area, there is no need to do measurements for all task types, and thus the task delay or power consumption can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0087] Reference will now be made, by way of example, to the accompanying drawings which show example embodiments of the present disclosure, and in which:

[0088] FIG. 1 is a simplified schematic illustration of a communication system according to one or more example embodiments of the present disclosure.

[0089] FIG. 2 is a schematic illustration of an example communication system according to one or more example embodiments of the present disclosure.

[0090] FIG. 3 is a schematic illustration of a basic component structure of a communication system according to one or more example embodiments of the present disclosure.

[0091] FIG. 4 is a block diagram of a device in a communication system according to one or more example embodiments of the present disclosure.

[0092] FIG. 5 is a schematic illustration of a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0093] FIG. 6 is a schematic illustration of a plurality of the sensing devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0094] FIG. 7 is a schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0095] FIG. 8 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0096] FIG. 9 is a schematic flowchart of a communication method according to one or more example embodiments of the present disclosure.

[0097] FIG. 10 is a schematic illustration of time-frequency resources for semantic/task indications according to one or more example embodiments of the present disclosure.

[0098] FIG. 11 is another schematic flowchart of a communication method according to one or more example embodiments of the present disclosure.

[0099] FIG. 12 is another schematic flowchart of a communication method according to one or more example embodiments of the present disclosure.

[0100] FIG. 13 is a schematic illustration of realizing a chain of thoughts according to one or more example embodiments of the present disclosure.

[0101] FIG. 14 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0102] FIG. 15 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0103] FIG. 16 is a schematic illustration of generating a query message.

[0104] FIG. 17 is a schematic illustration of reversing a semantic.

[0105] FIG. 18 is a schematic illustration of tokenizing a query semantic into a query token.

[0106] FIG. 19 is a schematic illustration of responding to a query token.

[0107] FIG. 20 is a schematic illustration of scoring the relevance with tokens.

[0108] FIG. 21 is another schematic illustration of responding to a query token.

[0109] FIG. 22 is a schematic illustration of scoring a relevance with semantic.

[0110] FIG. 23 is another schematic illustration of responding to a query token.

[0111] FIG. 24 is a schematic illustration of scoring the relevance with tokens converted from semantics.

[0112] FIG. 25 is a schematic illustration of generating query tokens.

[0113] FIG. 26 is a schematic illustration of generating query semantics.

[0114] FIG. 27 is a schematic illustration of responding to two queries with a common semantization model and two tokenization models.

[0115] FIG. 28 is a schematic illustration of responding to two queries with a common semantization model and a common tokenization model.

[0116] FIG. 29 is another schematic illustration of responding to two queries with two semantization models and two tokenization models.

[0117] FIG. 30 is another schematic illustration of responding to two queries with two semantization models and a common tokenization model.

[0118] FIG. 31 is a schematic illustration of responding to two query semantics with a common semantization model and two different tokenization models.

[0119] FIG. 32 is a schematic illustration of responding to two query semantics with a common semantization model and a common tokenization model.

[0120] FIG. 33 is a schematic illustration of responding to two query semantics with two semantization models and two tokenization models.

[0121] FIG. 34 is a schematic illustration of responding to two query semantics with two semantization models and one tokenization model.

[0122] FIG. 35 is a schematic illustration of responding to two query semantics with one semantization model without tokenization model.

[0123] FIG. 36 is a schematic illustration of responding to two query semantics with two semantization models without tokenization model.

[0124] FIG. 37 is a schematic illustration of processing two sensing semantics independently.

[0125] FIG. 38 is a schematic illustration of processing one sensing semantic but with two tasks independently.

[0126] FIG. 39 is a schematic structural diagram of a first apparatus according to one or more example embodiments of the present disclosure.

[0127] FIG. 40 is a schematic structural diagram of a second apparatus according to one or more example embodiments of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0128] In the following description, reference is made to the accompanying figures, which form part of the present disclosure, and which show, by way of illustration, specific aspects of embodiments of the present disclosure or specific aspects in which embodiments of the present disclosure may be used. It is understood that embodiments of the present disclosure may be used in other aspects and include structural or logical changes not depicted in the figures. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims.

[0129] To assist in understanding the present disclosure, examples of wireless communication systems and devices are described below.

[0130] **<u>Example communication systems and devices</u>**

[0131] The present disclosure uses the interaction and processing procedures among at least one UE (i.e., the sensing device which is also called sensing node, which is marked as ED in FIG. 1), at least one BS (i.e., the central device) and at least one GPT devices in a wireless system as an illustrative example. The exchanged information and protocol flows can also be used between other network nodes described below, for example, between ED 110 and TRP 170, between ED 110 and core network, between ED 110 and ED 110, between TRP 170 and TRP 170, between TRP 170 and GPT device 180. The UE in the procedure described in the present disclosure may be replaced with a sensing node mentioned below. The BS in the procedure described in the present disclosure may be replaced with a sensing coordinator. Sensing coordinator are nodes in a network that can assist in the sensing operation. These nodes can be stand-alone nodes dedicated to just sensing operations or other nodes (for example TRP 170, ED 110, or core network node shown in FIG. 1) doing the sensing operations in parallel with communication transmissions.

[0132] Referring to FIG. 1, as an illustrative example without limitation, a simplified schematic illustration of a communication system according to one or more example embodiments of the present disclosure is provided. The communication system 100 (which may be the wireless system in FIG. 1) includes a radio access network 120. The radio access network 120 may be a next generation (e.g. sixth generation (6G) or later) radio access network, or a legacy (e.g. 5G, 4G, 3G or 2G) radio access network. One or more communication electric device (ED) 110a, 110b, 110c, 110d, 110e, 110f, 110g, 110h, 110i, 110j (generically referred to as 110) may be interconnected to one another or connected to one or more network nodes (170a, 170b, generically referred to as 170) in the radio access network 120. A core network 130 may be a part of the communication system and may be dependent or independent of the radio access technology used in the communication system 100. Also the communication system 100 includes a public switched telephone network (PSTN) 140, the internet 150, and other networks 160.

[0133] The uplink messages/data transmitted between the central device (e.g., the network node 170) and the sensing device (e.g., ED 110) could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message. The downlink messages/data transmitted between the central device and the ED 110 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0134] In addition, the communication system 100 includes at least one GPT device 180. The GPT device 180 may be located within the one or more network node 170. The GPT device 180 may be an independent device connected to the network 170, such as an ED 110 which connected to the network node 170 via Uu interface. The GPT device 180 may be a device connected to the network node 170 via core network 130. When the GPT device 180 is an ED, the uplink messages/data transmitted between the central device (e.g., the network node 170) and the GPT device 180 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message. The downlink messages/data transmitted between the central device and the GPT device 180 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0135] FIG. 2 is a schematic illustration of an example communication system according to one or more example embodiments of the present disclosure, where FIG. 2 illustrates an example communication system 100. In general, the communication system 100 enables multiple wireless or wired elements to communicate data and other content. The purpose of the communication system 100 may be to provide content, such as voice, data, video, signaling and/or text, via broadcast, multicast and unicast, etc. The communication system 100 may operate by sharing resources, such as carrier spectrum bandwidth, between its constituent elements. The communication system 100 may include a terrestrial communication system and/or a non-terrestrial communication system. The communication system 100 may provide a wide range of communication services and applications (such as earth monitoring, remote sensing, passive sensing and positioning, navigation and tracking, autonomous delivery and mobility, etc.). The communication system 100 may provide a high degree of availability and robustness through a joint operation of a terrestrial communication system and a non-terrestrial communication system. For example, integrating a non-terrestrial communication system (or components thereof) into a terrestrial communication system can result in what may be considered a heterogeneous network including multiple layers. Compared to conventional communication networks, the heterogeneous network may achieve better overall performance through efficient multi-link joint operation, more flexible functionality sharing, and faster physical layer link switching between terrestrial networks and non- terrestrial networks.

[0136] The terrestrial communication system and the non-terrestrial communication system could be considered as sub-systems of the communication system. In the example shown in FIG. 2, the communication system 100 includes electronic devices (ED) 110a, 110b, 110c, 110d (generically referred to as ED 110), radio access networks (RANs) 120a-120b, a non-terrestrial communication network 120c, a core network 130, a public switched telephone network (PSTN) 140, the Internet 150, and other networks 160. The RANs 120a-120b include respective base stations (BSs) 170a-170b, which may be generically referred to as terrestrial transmit and receive points (T-TRPs) 170a-170b. The non-terrestrial communication network 120c includes an access node 172, which may be generically referred to as a non-terrestrial transmit and receive point (NT-TRP) 172.

[0137] Any ED 110 may be alternatively or additionally configured to interface, access, or communicate with any T-TRP 170a-170b and NT-TRP 172, the Internet 150, the core network 130, the PSTN 140, the other networks 160, or any combination of the preceding. In some examples, ED 110a may communicate an uplink and/or downlink transmission over a terrestrial air interface 190a with T-TRP 170a. In some examples, the EDs 110a, 110b, 110c and 110d may also communicate directly with one another via one or more sidelink air interfaces 190b. In some examples, ED 110d may communicate an uplink and/or downlink transmission over a non-terrestrial air interface 190c with NT-TRP 172.

[0138] The air interfaces 190a and 190b may use similar communication technology, such as any suitable radio access technology. For example, the communication system 100 may implement one or more channel access methods, such as code division multiple access (CDMA), space division multiple access (SDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), Direct Fourier Transform spread OFDMA (DFT-OFDMA) or single-carrier FDMA (SC-FDMA) in the air interfaces 190a and 190b. The air interfaces 190a and 190b may utilize other higher dimension signal spaces, which may involve a combination of orthogonal and/or non-orthogonal dimensions.

[0139] The non-terrestrial air interface 190c can enable communication between the ED 110d and one or multiple NT-TRPs 172 via a wireless link or simply a link. For some examples, the link is a dedicated connection for unicast transmission, a connection for broadcast transmission, or a connection between a group of EDs 110 and one or multiple NT-TRPs 172 for multicast transmission.

[0140] The RANs 120a and 120b are in communication with the core network 130 to provide the EDs 110a 110b, and 110c with various services such as voice, data, and other services. The RANs 120a and 120b and/or the core network 130 may be in direct or indirect communication with one or more other RANs (not shown), which may or may not be directly served by core network 130, and may or may not employ the same radio access technology as RAN 120a, RAN 120b or both. The core network 130 may also serve as a gateway access between (i) the RANs 120a and 120b or EDs 110a 110b, and 110c or both, and (ii) other networks (such as the PSTN 140, the Internet 150, and the other networks 160). In addition, some or all of the EDs 110a 110b, and 110c may include functionality for communicating with different wireless networks over different wireless links using different wireless technologies and/or protocols. Instead of wireless communication (or in addition thereto), the EDs 110a 110b, and 110c may communicate via wired communication channels to a service provider or switch (not shown), and to the Internet 150. PSTN 140 may include circuit switched telephone networks for providing plain old telephone service (POTS). Internet 150 may include a network of computers and subnets (intranets) or both, and incorporate protocols, such as Internet Protocol (IP), Transmission Control Protocol (TCP), User Datagram Protocol (UDP). EDs 110a 110b, and 110c may be multimode devices capable of operation according to multiple radio access technologies, and incorporate multiple transceivers necessary to support such.

[0141] **Basic component structure**

[0142] FIG. 3 is a schematic illustration of a basic component structure of a communication system according to one or more example embodiments of the present disclosure, where FIG. 3 illustrates another example of an ED

110 and a base station 170a, 170b and/or 170c. The ED 110 is used to connect persons, objects, machines, etc. The ED 110 may be widely used in various scenarios, for example, cellular communications, device-to-device (D2D), vehicle to everything (V2X), peer-to-peer (P2P), machine-to-machine (M2M), machine-type communications (MTC), Internet of things (IOT), virtual reality (VR), augmented reality (AR), mixed reality (MR), metaverse, digital twin, industrial control, self-driving, remote medical, smart grid, smart furniture, smart office, smart wearable, smart transportation, smart city, drones, robots, remote sensing, passive sensing, positioning, navigation and tracking, autonomous delivery and mobility, etc.

[0143] Each ED 110 represents any suitable end user device for wireless operation and may include such devices (or may be referred to) as a user equipment/device (UE), a wireless transmit/receive unit (WTRU), a mobile station, a fixed or mobile subscriber unit, a cellular telephone, a station (STA), a machine type communication (MTC) device, a personal digital assistant (PDA), a smartphone, a laptop, a computer, a tablet, a wireless sensor, a consumer electronics device, a smart book, a vehicle, a car, a truck, a bus, a train, or an IoT device, wearable devices such as a watch, head mounted equipment, a pair of glasses, an industrial device, or apparatus (e.g. communication module, modem, or chip) in the forgoing devices, among other possibilities. Future generation EDs 110 may be referred to using other terms. Each base station 170a and 170b is a T-TRP and will hereafter be referred to as T-TRP 170. Also shown in FIG.3, a NT-TRP will hereafter be referred to as NT-TRP 172. Each ED 110 connected to T-TRP 170 and/or NT-TRP 172 can be dynamically or semi-statically turned-on (i.e., established, activated, or enabled), turned-off (i.e., released, deactivated, or disabled) and/or configured in response to one of more of: connection availability and connection necessity.

[0144] The ED 110 includes a transmitter 201 and a receiver 203 coupled to one or more antennas 204. Only one antenna 204 is illustrated. One, some, or all of the antennas 204 may alternatively be panels. The transmitter 201 and the receiver 203 may be integrated, e.g. as a transceiver. The transceiver is configured to modulate data or other content for transmission by at least one antenna 204 or network interface controller (NIC). The transceiver is also configured to demodulate data or other content received by the at least one antenna 204. Each transceiver includes any suitable structure for generating signals for wireless or wired transmission and/or processing signals received wirelessly or by wire. Each antenna 204 includes any suitable structure for transmitting and/or receiving wireless or wired signals.

[0145] The ED 110 includes at least one memory 208. The memory 208 stores instructions and data used, generated, or collected by the ED 110. For example, the memory 208 could store software instructions or modules configured to implement some or all of the functionality and/or embodiments described herein and that are executed by one or more processing unit(s) (e.g., a processor 210). Each memory 208 includes any suitable volatile and/or non-volatile storage and retrieval device(s). Any suitable type of memory may be used, such as random access memory (RAM), read only memory (ROM), hard disk, optical disc, subscriber identity module (SIM) card, memory stick, secure digital (SD) memory card, on-processor cache, and the like.

[0146] The ED 110 may further include one or more input/output devices (not shown) or interfaces (such as a wired interface to the Internet 150 in FIG. 1). The input/output devices permit interaction with a user or other devices in the network. Each input/output device includes any suitable structure for providing information to or receiving information from a user, such as through operation as a speaker, a microphone, a keypad, a keyboard, a display, or a touch screen, including network interface communications.

[0147] The ED 110 includes the processor 210 for performing operations including those operations related to preparing a transmission for uplink transmission to the NT-TRP 172 and/or the T-TRP 170, those operations related to processing downlink transmissions received from the NT-TRP 172 and/or the T-TRP 170, and those operations related to processing sidelink transmission to and from another ED 110. Processing operations related to preparing a transmission for uplink transmission may include operations such as encoding, modulating, transmit beamforming, and generating symbols for transmission. Processing operations related to processing downlink transmissions may include operations such as receive beamforming, demodulating and decoding received symbols. Depending upon the embodiment, a downlink transmission may be received by the receiver 203, possibly using receive beamforming, and the processor 210 may extract signaling from the downlink transmission (e.g. by detecting and/or decoding the signaling). An example of signaling may be a reference signal transmitted by the NT-TRP 172 and/or by the T-TRP 170. In some embodiments, the processor 210 implements the transmit beamforming and/or the receive beamforming based on the indication of beam direction, e.g. beam angle information (BAI), received from the T-TRP 170. In some embodiments, the processor 210 may perform operations relating to network access (e.g. initial access) and/or downlink synchronization, such as operations relating to detecting a synchronization sequence, decoding and obtaining the system information, etc. In some embodiments, the processor 210 may perform channel estimation, e.g. using a reference signal received from the NT-TRP 172 and/or from the T-TRP 170.

[0148] Although not illustrated, the processor 210 may form part of the transmitter 201 and/or part of the receiver 203. Although not illustrated, the memory 208 may form part of the processor 210.

[0149] The processor 210, the processing components of the transmitter 201 and the processing components of the receiver 203 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory (e.g. in the memory 208). Alternatively, some or all of the processor 210, the processing components of the transmitter 201 and the processing components of the receiver 203 may each be implemented using dedicated circuitry, such as a programmed field-programmable gate array (FPGA), a graphical processing unit (GPU), a Central Processing Unit (CPU) or an application-specific integrated circuit (ASIC).

[0150] In some implementations, the ED 110 may be an apparatus (also called component) for example, communication module, modem, chip, or chipset, it includes at least one processor 210, and an interface or at least one pin. In this scenario, the transmitter 201 and receiver 203 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 may be referred as transmitting information to the interface or at least one pin, or as transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 via the interface or at least one pin, and receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 may be referred as receiving information from the interface or at least one pin, or as receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 via the interface or at least one pin. The information may include control signaling and/or data.

[0151] The T-TRP 170 may be known by other names in some implementations, such as a base station, a base transceiver station (BTS), a radio base station, a network node, a network device, a device on the network side, a transmit/receive node, a Node B, an evolved NodeB (eNodeB or eNB), a Home eNodeB, a next Generation NodeB (gNB), a transmission point (TP), a site controller, an access point (AP), a wireless router, a relay station, a remote radio head, a terrestrial node, a terrestrial network device, a terrestrial base station, a base band unit (BBU), a remote radio unit (RRU), an active antenna unit (AAU), a remote radio head (RRH), a central unit (CU), a distributed unit (DU), a positioning node, among other possibilities. The T-TRP 170 may be a macro BS, a pico BS, a relay node, a donor node, or the like, or combinations thereof. The T-TRP 170 may refer to the forgoing devices or refer to apparatus (e.g. a communication module, a modem, or a chip) in the forgoing devices.

[0152] In some embodiments, the parts of the T-TRP 170 may be distributed. For example, some of the modules of the T-TRP 170 may be located remote from the equipment that houses the antennas 256 for the T-TRP 170, and may be coupled to the equipment that houses the antennas 256 over a communication link (not shown) sometimes known as front haul, such as common public radio interface (CPRI). Therefore, in some embodiments, the term T-TRP 170 may also refer to modules on the network side that perform processing operations, such as determining the location of the ED 110, resource allocation (scheduling), message generation, and encoding/decoding, and that are not necessarily part of the equipment that houses the antennas 256 of the T-TRP 170. The modules may also be coupled to other T-TRPs. In some embodiments, the T-TRP 170 may actually be a plurality of T-TRPs that are operating together to serve the ED 110, e.g. through the use of coordinated multipoint transmissions.

[0153] The T-TRP 170 includes at least one transmitter 252 and at least one receiver 254 coupled to one or more antennas 256. Only one antenna 256 is illustrated. One, some, or all of the antennas 256 may alternatively be panels. The transmitter 252 and the receiver 254 may be integrated as a transceiver. The T-TRP 170 further includes a processor 260 for performing operations including those related to: preparing a transmission for downlink transmission to the ED 110, processing an uplink transmission received from the ED 110, preparing a transmission for backhaul transmission to the NT-TRP 172, and processing a transmission received over backhaul from the NT-TRP 172. Processing operations related to preparing a transmission for downlink or backhaul transmission may include operations such as encoding, modulating, precoding (e.g. multiple input multiple output (MIMO) precoding), transmit beamforming, and generating symbols for transmission. Processing operations related to processing received transmissions in the uplink or over backhaul may include operations such as receive beamforming, demodulating received symbols and decoding received symbols. The processor 260 may also perform operations relating to network access (e.g. initial access) and/or downlink synchronization, such as generating the content of synchronization signal blocks (SSBs), generating the system information, etc. In some embodiments, the processor 260 also generates an indication of beam direction, e.g. BAI, which may be scheduled for transmission by a scheduler 253. The processor 260 performs other network-side processing operations described herein, such as determining the location of the ED 110, determining where to deploy the NT-TRP 172, etc. In some embodiments, the processor 260 may generate signaling, e.g. to configure one or more parameters of the ED 110 and/or one or more parameters of the NT-TRP 172. Any signaling generated by the processor 260 is sent by the transmitter 252. Note that "signaling", as used herein, may alternatively be called control signaling. Dynamic signaling may be transmitted in a control channel, e.g. a physical downlink control channel (PDCCH), and static or semi-static higher layer signaling may be included in a packet transmitted in a data channel, e.g. in a physical downlink shared channel (PDSCH).

[0154] The scheduler 253 may be coupled to the processor 260. The scheduler 253 may be included within or operated separately from the T-TRP 170. The scheduler 253 may schedule uplink, downlink, and/or backhaul transmissions, including issuing scheduling grants and/or configuring scheduling-free ("configured grant") resources. The T-TRP 170 further includes a memory 258 for storing information and data. The memory 258 stores instructions and data used, generated, or collected by the T-TRP 170. For example, the memory 258 could store software instructions or modules configured to implement some or all of the functionality and/or embodiments described herein and that are executed by the processor 260.

[0155] Although not illustrated, the processor 260 may form part of the transmitter 252 and/or part of the receiver 254. Also, although not illustrated, the processor 260 may implement the scheduler 253. Although not illustrated, the memory 258 may form part of the processor 260.

[0156] The processor 260, the scheduler 253, the processing components of the transmitter 252 and the processing components of the receiver 254 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory, e.g. in the memory 258. Alternatively, some or all of the processor 260, the scheduler 253, the processing components of the transmitter 252 and the processing components of the receiver 254 may be implemented using dedicated circuitry, such as a FPGA, a GPU, a CPU, or an ASIC.

[0157] When the T-TRP 170 is an apparatus (also called as component), for example, communication module, modem, chip, or chipset in a device, it includes at least one processor, and an interface or at least one pin. In this scenario, the transmitter 252 and receiver 254 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or ED 110 may be referred as transmitting information to the interface or at least one pin, and receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or ED 110 may be referred as receiving information from the interface or at least one pin. The information may include control signaling and/or data.

[0158] Although the NT-TRP 172 is illustrated as a drone only as an example, the NT-TRP 172 may be implemented in any suitable non-terrestrial form, such as high altitude platforms, satellite, high altitude platform as international mobile telecommunication base stations and unmanned aerial vehicles, which forms will be discussed hereinafter. Also, the NT-TRP 172 may be known by other names in some implementations, such as a non-terrestrial node, a non-terrestrial network device, or a non-terrestrial base station. The NT-TRP 172 includes a transmitter 272 and a receiver 274 coupled to one or more antennas 280. Only one antenna 280 is illustrated. One, some, or all of the antennas may alternatively be panels. The transmitter 272 and the receiver 274 may be integrated as a transceiver. The NT-TRP 172 further includes a processor 276 for performing operations including those related to: preparing a transmission for downlink transmission to the ED 110, processing an uplink transmission received from the ED 110, preparing a transmission for backhaul transmission to T-TRP 170, and processing a transmission received over backhaul from the T-TRP 170. Processing operations related to preparing a transmission for downlink or backhaul transmission may include operations such as encoding, modulating, precoding (e.g. MIMO precoding), transmit beamforming, and generating symbols for transmission. Processing operations related to processing received transmissions in the uplink or over backhaul may include operations such as receive beamforming, demodulating received symbols and decoding received symbols. In some embodiments, the processor 276 implements the transmit beamforming and/or receive beamforming based on beam direction information (e.g. BAI) received from the T-TRP 170. In some embodiments, the processor 276 may generate signaling, e.g. to configure one or more parameters of the ED 110. In some embodiments, the NT-TRP 172 implements physical layer processing, but does not implement higher layer functions such as functions at the medium access control (MAC) or radio link control (RLC) layer. As this is only an example, more generally, the NT-TRP 172 may implement higher layer functions in addition to physical layer processing.

[0159] The NT-TRP 172 further includes a memory 278 for storing information and data. Although not illustrated, the processor 276 may form part of the transmitter 272 and/or part of the receiver 274. Although not illustrated, the memory 278 may form part of the processor 276.

[0160] The processor 276, the processing components of the transmitter 272 and the processing components of the receiver 274 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory, e.g. in the memory 278. Alternatively, some or all of the processor 276, the processing components of the transmitter 272 and the processing components of the receiver 274 may be implemented using dedicated circuitry, such as a programmed FPGA, a GPU, a CPU, or an ASIC. In some embodiments, the NT-TRP 172 may actually be a plurality of NT-TRPs that are operating together to serve the ED 110, e.g. through coordinated multipoint transmissions.

[0161] When the NT-TRP 172 is an apparatus (e.g. communication module, modem, chip, or chipset) in a device, it includes at least one processor, and an interface or at least one pin. In this scenario, the transmitter 272 and receiver 257 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the T-TRP 170 and/or another NT-TRP 172 and/or ED 110 may be referred as transmitting information to the interface or at least one pin, and receiving information from the T-TRP 170 and/or another NT-TRP 172 and/or ED 110 may be referred as receiving information from the interface or at least one pin. The information may include control signaling and/or data.

[0162] Note that "TRP", as used herein, may refer to a T-TRP or a NT-TRP. A T-TRP may alternatively be called a terrestrial network TRP ("TN TRP") and a NT-TRP may alternatively be called a non-terrestrial network TRP ("NTN TRP").

[0163] The T-TRP 170, the NT-TRP 172, and/or the ED 110 may include other components, but these have been omitted for the sake of clarity.

[0164] Any or all of the EDs 110 and BS 170 may be sensing nodes in the system 100. Sensing nodes are network entities that perform sensing by transmitting and receiving sensing signals. Some sensing nodes are communication equipment that perform both communications and sensing. However, it is possible that some sensing nodes do not perform communications, and are instead dedicated to sensing. The sensing agent 174 is an example of a sensing node that is dedicated to sensing. Unlike the EDs 110 and BS 170, the sensing agent 174 does not transmit or receive communication signals. However, the sensing agent 174 may communicate configuration information, sensing information, signaling information, or other information within the communication system 100. The sensing agent 174 may be in communication with the core network 130 to communicate information with the rest of the communication system 100. By way of example, the sensing agent 174 may determine the location of the ED 110a, and transmit this information to the base station 170a via the core network 130. Although only one sensing agent 174 is shown in FIG. 2, any number of sensing agents may be implemented in the communication system 100. In some embodiments, one or more sensing agents may be implemented at one or more of the RANs 120.

[0165] A sensing node may combine sensing-based techniques with reference signal-based techniques to enhance UE pose determination. This type of sensing node may also be known as a sensing management function (SMF). In some networks, the SMF may also be known as a location management function (LMF). The SMF may be implemented as a physically independent entity located at the core network 130 with connection to the multiple BSs 170. In other aspects of the present application, the SMF may be implemented as a logical entity co-located inside a BS 170 through logic carried out by the processor 260.

[0166] Although not presented in FIG. 3, a GPT device 180 may be included, which has similar structure to ED 110, e.g, GPT device 180 includes at least one processor, a transmitter and a receiver.

[0167] **Basic module structure**

[0168] FIG. 4 is a block diagram of a device in a communication system according to one or more example embodiments of the present disclosure, where one or more steps of the embodiment methods provided herein may be performed by corresponding units or modules, according to FIG. 4. FIG. 4 illustrates units or modules in a device, such as in the ED 110, in the T-TRP 170, in the NT-TRP 172, or in the GPT device 180. For example, a signal may be transmitted by a transmitting unit or by a transmitting module. A signal may be received by a receiving unit or by a receiving module. A signal may be processed by a processing unit or a processing module. Other steps may be performed by an artificial intelligence (AI) or machine learning (ML) module. The respective units or modules may be implemented using hardware, one or more components or devices that execute software, or a combination thereof. For instance, one or more of the units or modules may be an integrated circuit, such as a programmed FPGA, a GPU, a CPU, or an ASIC. It will be appreciated that where the modules are implemented using software for execution by a processor for example, the modules may be retrieved by a processor, in whole or part as needed, individually or together for processing, in single or multiple instances, and that the modules themselves may include instructions for further deployment and instantiation. The transmitter mentioned with reference to FIG. 3 may be a detailed implementation for the transmitting module. The receiver mentioned with reference to FIG. 3 may be a detailed implementation for the receiving module. The processor mentioned with reference to FIG. 3 may be a detailed implementation for the processing module.

[0169] Additional details regarding the EDs 110, the T-TRP 170, the NT-TRP 172 and the GPT device 180 are known to those of skill in the art. As such, these details are omitted here.

[0170] The details of the present disclosure will be elaborated in the following description.

[0171] FIG. 5 is a schematic illustration of a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0172] In present disclosure, the wireless system is also called communication system, or wireless communication system. Herein the wireless system includes a plurality of devices, for example, the plurality of devices include at least a central device, a plurality of distributed sensing devices and at least a GPT device (in FIG. 5).

[0173] The GPT device is responsible for encoding or decoding query messages and sensed data. In details, it generates a query message that contains one goal or goals in natural language for the central device; the central device semantizes the query message into a semantic vector, tokenizes the semantic vector into a goal semantic token (vector), and then broadcasts the goal token to the sensing devices. A sensing device, triggered by receiving the goal semantic token, measures its sensed data and converts the sensed data into a sensed semantic token. The sensing device compares and scores the relevance between the goal semantic token and sensed semantic token and transmit the sensed data in semantic vector only if the score of relevance is higher than a threshold. The central device fuses the sensed data in semantic vectors and output the fused one to the GPT device that will generate the next query message based on the fused input.

[0174] A central device may be a BS, e.g. gNB, or eNB etc., or the central device may be an access point (AP).

[0175] A sensing device is responsible for measuring and/or collecting local physical-world data. It may be sensing UE, sensing equipment, IoT equipment, UE, mobile phones, handset, or other equipment. The sensing device may be equipped with a sensing gadget or component to measure local physical-world data near it into a sensed data; the sensing encodes and transmits them to the central device.

[0176] A GPT device may generate a sequence of the query messages and receives a fused sensing message from the central device. In the present disclosure, the GPT device could be also called AI agent device, robot device, or smart controlling device.

[0177] In some implementations, a sensing device may be a UE, a mobile phone or a handset, wherein independence among any two sensing devices are assumed; thereby, a sensing device may be scheduled individually by the wireless system to which the sensing device is associated; and the sensed data that the sensing device measures may be application-level payload for the wireless system and protocol.

[0178] The above scheme of scheduling a sensing device is inefficient in terms of radio bandwidth and energy consumption. For instance, a sensing device blindly keeps transmitting its sensed data to the central device, regardless of whether the sensed data is required or not.

[0179] From a higher level perspective, it is better to wake a plurality of sensing devices to measure and transmit only when their sensed data would serve a goal or goals; for example, when a generative pre-trained transformer (GPT) device such as a driverless car, may request the information about the moving obstacles near itself, it is useless to keep transmitting irrelevant information to the driverless car, or to transmit all the moving obstacles nearby to the car when the car is parking on the roadside.

[0180] To avoid any missing probability of the information, resources in the wireless system in above implementations may be over-scheduled.

[0181] FIG. 6 is a schematic illustration of a plurality of the sensing devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0182] In details, a plurality of the sensing devices herein may be grouped or classified in terms of types of sensed data. The first group of the sensing devices may measure the first type of sensed data (e.g. red, green, blue (RGB) images or video), whereas the second group of sensing devices may measure the second type of sensed data (e.g. Radio RF point-cloud or Lidar Point cloud) as illustrated in FIG. 6.

[0183] FIG. 7 is a schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0184] The central device actively requests or triggers the sensing devices to transmit their most recent sensed data (in FIG. 7). Accordingly, the sensing devices will transmit their sensed data.

[0185] The central device may transmit the first query message or messages to one or some sensing devices in DL broadcast, multicast, or unicast channel or channel(s), which may be in physical broadcast channel, shared channel, or dedicated channel(s).

[0186] After a sensing device receives the first query message, the sensing device decides whether or not to transmit its sensed data. In details, the sensing device decodes the first query message, measures its data, and decides whether or not to transmit its sensed data, which is called as responding to the first query message. If the sensing device decides to respond to the first query message, the sensing device would encode/encapsulate the sensed data into a payload and then transmit it to the central device in UL channel or channel(s), which may be physical UL shared channel or dedicated UL channel.

[0187] After the central device of the wireless system receives all the payloads from the sensing devices that responded to the first query message, the central device may fuse all or some payloads into a fused payload. Optionally, the central device may input the fused payload into the GPT device that may process them and then generate the second query message.

[0188] The central device may transmit the second query message or messages to one or some sensing devices in DL broadcast, multicast, or unicast channel or channel(s).

[0189] The GPT device transmits the query messages to the central device to inform and configure the central device to schedule when, how, what, and which sensing devices to sense and transmit their sensed data to the central device. The GPT device may be implemented/located together with the central device for shorter latency, or the GPT device may be implemented in a remote data center, to which the central device may access via core network, or the GPT device may be on another connected device in the same wireless system of the central device. Please note that, in the present disclosure, the query message from the central device to the sensing device (downlink message) could be carried in higher layer signaling, such as radio resource control (RRC) signaling, or medium access control (MAC) layer signaling. Or, the query message could be carried in physical layer signaling, e.g., downlink control information (DCI). Or the query message is carried in the combination of the higher layer signaling and the physical signaling. It is similar for other downlink messages/data transmitted from the central device to the sensing device. Similarly, in the present disclosure, for uplink messages/data, they could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., uplink control information (UCI). Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0190] FIG. 8 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more example embodiments of the present disclosure.

[0191] The wireless system including a central device, sensing devices, and GPT device may form a series of interactions, in which the GPT device generates a sequence of the query messages for the sensing devices, the sensing devices collect and feedback the sensed data, and the central device fuses them and input them to the GPT device as illustrated in FIG. 8.

[0192] In some circumstances, some sensing devices may actively transmit their sensed data without receiving any query message from the central device. The sensing devices that transmit the sensed data may respond to some urgency queries such as fire alarming or car accident. In some sense, some query messages have been pre-defined and configured into the system by default.

[0193] FIG. 9 is a schematic flowchart of a communication method according to one or more example embodiments of the present disclosure. The method can be implemented by a first device. Optionally, the first device may be a sensing device or other device that has similar function (for example, the first device could be a chip), which is not limited herein. As shown in FIG. 9, the method may include the following steps.

[0194] S910, obtaining at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area.

[0195] In an implementation, a first device such as a sensing device may obtain a piece of task indication information from a central device, which broadcasts the semantic/task indications for some specific task types (or query tokens). The semantic/task indication may have two functions: it is a task-specific indicator, and it can also be used as a reference for measurements (for example, to measure the signal quality). For example, each of the at least one task indication includes a reference signal for measurement. Thus, after obtaining a piece of task indication information that indicates at least one task indication, measurement can be performed for the at least one task indication to obtain a measurement result corresponding to the at least one task indication.

[0196] In an implementation, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information. Thus, different areas may support different task types, and the different task types supported by different areas can be effectively indicated by the task indications indicated by the task indication information sent in different areas, and after obtaining the task indication information sent in different areas, it can be known by the sensing device according to the task indication information that these areas support different task types.

[0197] Specifically, each of the at least one area may be a cell or a paging area, different cell/paging area may have or support different task types, and broadcast corresponding semantic/task indications. FIG. 10 is a schematic illustration of time-frequency resources for semantic/task indications according to one or more example embodiments of the present disclosure. As shown in FIG. 10, cell A/paging area A support task type a, b and c, while cell B/paging area B support task type a, c and d. Cell A/Paging area A broadcast the reference signals or semantic/task indicators for task type a, b and c, while cell B/ paging area B broadcast the reference signals or semantic/task indicators for task type a, c and d.

[0198] In a specific implementation, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent, which means, the task indication is scrambled with an identifier of an area supporting the task type indicated by the task indication. In one example, the broadcasted semantic/task indications can be scrambled with cell ID or paging area ID. Thus, after obtaining the at least one piece of task indication information sent in at least one cell/paging area, the sensing device can know which cell/paging area supports an indicated task type.

[0199] In an implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same. In another implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different. Because time-frequency resources of one or more first task indications for a task type in a first area and time-frequency resources of one or more second task indications for the same task type in a second area may be same or different, the time-frequency resources of the task indication(s) for a task type can be flexibly configured.

[0200] In an implementation, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area. Thus, the time-frequency resources of the reference signals for a task type can be flexibly configured.

[0201] In an implementation, the at least one task indication may be represented by at least one pattern for at least one task type. For example, a pattern may be a sequence, and a task indication for a task type may be carried in some fields of the sequence. Thus, after obtaining the task indication information indicating the at least one task indication, the at least one task type corresponding to the at least one task indication can be easily read and known.

[0202] In an implementation, different patterns can be defined for different semantics/tasks, thus different patterns may be used to indicate different task types, and each task type can be easily determined according to its corresponding pattern(s), which provide an efficient way to indicate the task type(s) supported by each area.

[0203] Semantic/task indications are configurable. In an implementation, the at least one task indication is configurable, thus a flexible configuration is achieved. In an example, the patterns can be pre-defined in the specification and selected in real time depending on the scenarios, thus resources for transmission of configuration of the patterns can be saved, and the patterns can be selected in a flexible manner depending on the current scenario. In another example, the patterns can be signaled to the sensing devices through some signaling messages (for example, in radio resource control (RRC) signaling, or carried in some sequences) via broadcast/multicast/unicast way, thus the transmission of the patterns is more flexible.

[0204] Different types of tasks may have different semantic/task indications, thus a task type that a task indication indicates can be easily known. For example, the signaling can be scrambled with semantic/task type ID, e.g., a message (a configuration message or a query message) for a task type can be scrambled with a task identifier of the task type, thus after the message is received, the task type the message corresponds to can be easily known. In another example, all sets of semantics/task indications may be divided into different sub-sets, different sub-set used for different semantic/task, e.g., the at least one task indication can belong to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type. Since each task type may correspond to a group of one or more task indications, the task indication(s) used to indicate the task type can be flexibly selected from the group according to actual conditions, and when multiple task indications are used to indicate a task type, the indicating of the task type can be more reliable.

[0205] S920, selecting, based on an interested task type and the at least one piece of task indication information, an area from the at least one area.

[0206] FIG. 11 is another schematic flowchart of a communication method according to one or more example embodiments of the present disclosure. As shown in FIG. 11, the step S920 may include the following steps.

[0207] S9201, performing measurement for an interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, where a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type.

[0208] S9202, selecting an area from the one or more of the at least one area, where a measurement result corresponding to the selected area has a value higher than a threshold.

[0209] For example, the sensing device may perform measurement for the interested task type in one or more of the at least one area (cell or paging area) to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, where a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type. Then the sensing device may select an area from the one or more of the at least one area, where a measurement result corresponding to the selected area has a value higher than a threshold. Thus, the cell selection or paging area selection at sensing device can jointly consider the task/semantic type and measurement results, which is different from Reference Signal Received Power (RSRP)-based criteria. For example, the sensing device may camp on cell A due to the better measurement results of task m (the task/goal of this sensing device), instead of cell B with higher peak signal-to-noise ratio (PSNR). Thus it ensures the selected cell or the selected paging area supports the interested task type and has a good signal quality. And because measurement is performed only for the interested task type, the task delay or power consumption can be greatly reduced.

[0210] As shown in FIG. 11, before selecting the area from the at least one area, the communication method may further include: S930, determining the interested task type based on a capability of a first device and/or a current status of the first device. For example, the sensing device may determine the interested task type based on a capability of the sensing device and/or a current status of the sensing device. The current status may be, for example, the current location of the sensing device, the task being performed by the sensing device or the power of the sensing device (e.g., complex task will not be performed when the sensing device is running out of power). Thus, when selecting an area from the at least one area, the task types beyond the capability of the sensing device and/or the task types that the sensing device does not support under the current status will not be considered, and measurement will not performed on these task types, thereby reducing the power consumption.

[0211] Note that the sensing device does not need to do measurements for all the task/semantic types. It only performs measurement for task/semantic-specific indications. This is different from traditional cell selection. By doing measurements for only interested/required semantic/task indications, the task delay or power consumption of sensing device can be greatly reduced. The sensing device selects the interested task/semantic types and performs measurements for corresponding semantic/task indications based on its tasks/ goals/ current status, and then camp on the selected cell or select the appropriate paging area.

[0212] For low-latency scenario or for sensing device with some specific capability, new design is proposed to reduce the task delay or power consumption. Task-specific / semantic-specific cell selection is defined. The sensing device only detects and selects the cell, or Paging area, based on its specific task/semantic. With the communication method provided in the present disclosure, a first device such as a sensing device can obtain at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area. Then the sensing device can select an area from the at least one area, based on an interested task type and the at least one piece of task indication information. Thus, only the task type each area supports and the interested task type are considered, and for selecting an area, there is no need to do measurements for all task types, the task delay or power consumption can be reduced. Note that the above method is also applicable for cell reselection/paging area reselection.

[0213] In the above, the communication method of the present disclosure is described from the perspective of the first apparatus (such as the sensing device) with reference to FIG. 9 to FIG. 11. In the following, a communication method of the present disclosure will be described from the perspective of the second apparatus (such as the central device) in combination with FIG. 12.

[0214] FIG. 12 is another schematic flowchart of a communication method according to one or more example embodiments of the present disclosure. The method can be implemented by a second device. Optionally, the second device may be a central device or other device that has similar function (for example, the second device could be a chip), which is not limited herein. As shown in FIG. 12, the method may include the following steps.

[0215] S1210, sending, in at least one area, at least one piece of task indication information, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area.

[0216] In an implementation, a second device such as a central device may send a piece of task indication information to a sensing device, e.g., it may broadcast the semantic/task indications for some specific task types (or query tokens). The semantic/task indication may have two functions: it is a task-specific indicator, and it can also be used as a reference for measurements (for example, to measure the signal quality). For example, each of the at least one task indication includes a reference signal for measurement. Thus, the sensing device receiving the task indication information that indicates the at least one task indication may perform measurement for the at least one task indication to obtain a measurement result corresponding to the at least one task indication.

[0217] In an implementation, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information. Thus, different areas may support different task types, and different task types supported in different areas can be effectively indicated to a sensing device receiving the task indication information through the task indications indicated by the task indication information sent in different areas.

[0218] Specifically, each of the at least one area may be a cell or a paging area, different cell/paging area may have or support different task types, and broadcast corresponding semantic/task indications. As shown in FIG. 10, cell A/paging area A support task type a, b and c, while cell B/paging area B support task type a, c and d. Cell A/Paging area A broadcast the reference signals or semantic/task indicators for task type a, b and c, while cell B/ paging area B broadcast the reference signals or semantic/task indicators for task type a, c and d.

[0219] In a specific implementation, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent, which means, the task indication is scrambled with an identifier of an area supporting the task type indicated by the task indication. In one example, the broadcasted semantic/task indications can be scrambled with cell ID or paging area ID. Thus, the area supporting a task type can be determined according to the identifier of the area which is used to scramble the task indication indicating that task type.

[0220] In an implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same. In another implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different. Because time-frequency resources of one or more first task indications for a task type in a first area and time-frequency resources of one or more second task indications for the same task type in a second area may be same or different, the time-frequency resources of the task indication(s) for a task type can be flexibly configured.

[0221] In an implementation, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area. Thus, the time-frequency resources of the reference signals for a task type can be flexibly configured.

[0222] In an implementation, the at least one task indication is represented by at least one pattern for at least one task type. For example, a pattern may be a sequence, and a task indication for a task type may be carried in some fields of the sequence. Thus, the at least one task type corresponding to the at least one task indication can be easily read and known.

[0223] In an implementation, different patterns can be defined for different semantics/task, thus different patterns may be used to indicate different task types, and each task type can be easily determined according to its corresponding pattern(s), which provide an efficient way to indicate the task type(s) supported by each area.

[0224] Semantic/task indications are configurable. In an implementation, the at least one task indication is configurable, thus a flexible configuration is achieved. In an example, the patterns can be pre-defined in the specification and selected in real time depending on the scenarios, thus resources for transmission of configuration of the patterns can be saved, and the patterns can be selected in a flexible manner depending on the current scenario. In another example, the patterns can be signaled to the sensing device through some signaling messages (for example, in radio resource control (RRC) signaling, or carried in some sequences) via broadcast/multicast/unicast way, thus the transmission of the patterns is more flexible.

[0225] Different types of tasks may have different semantic/task indications, thus a task type that a task indication indicates can be easily known. For example, the signaling can be scrambled with semantic/task type ID, e.g., a message (a configuration message or a query message) for a task type can be scrambled with a task identifier of the task type, thus after the message is received, it can be easily known by the sensing device to which the message is sent which task type the message corresponds to. In another example, all sets of semantics/task indications may be divided into different sub-sets, different sub-set used for different semantic/task, e.g., the at least one task indication can belong to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type. Since each task type may correspond to a group of one or more task indications, the task indication(s) used to indicate the task type can be flexibly selected from the group according to actual conditions, and when multiple task indications are used to indicate a task type, the indicating of the task type can be more reliable.

[0226] With the communication method provided in the present disclosure, a second device such as a central device may send, in at least one area, at least one piece of task indication information, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area. Because each task indication indicates a task type supported by a respective area, when a device to which the task indication information is sent selects an area, there is no need to do measurements for all task types, the task delay or power consumption can be reduced.

[0227] FIG. 13 is a schematic illustration of realizing a chain of thoughts according to one or more example embodiments of the present disclosure, which shows how a chain of thoughts is realized by generative AI model and is embodied by a sequence of query messages in a possible implementation.

[0228] A GPT device may generate a sequence of the query messages based on the previous sensing messages, wherein the previous sensing messages are received and/or fused by the central device. The GPT device may inference one or several generative AI models. The generative AI model or model inferences deep neural network or networks (DNN) to output a query message or messages. The GPT device generates a sequence of the query messages, called as "a chain of the thoughts" by interacting with a sequence of the fused sensing messages into which the central device fuses the sensed data transmitted by the responsive sensing devices; as illustrated in FIG. 13.

[0229] A query message that the GPT device generate may convey semantic goals, tasks, or objectives. For example, a query message of "localize an incoming pedestrians" explicitly establishes a semantic goal for the sensing devices to focus on its nearby pedestrian and to prevent the sensing devices from being distracted. Since a query message conveys a semantic goal or goals, the query message that the central device transmits to the sensing devices may trigger a goal-oriented sensing task at each responsive sensing device that receives and responds to the very query message. Please note that a message may convey several goals. For example, a message of "find a moving pedestrian with white coat" conveys two semantic goals or tasks: a moving pedestrian and a pedestrian with white coat.

[0230] FIG. 14 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more embodiments of the present disclosure. In a possible implementation, as shown in FIG. 14, the central device may broadcast a sequence of the query messages, because it may be too costly or even forbidden to schedule sensing device individually in a wireless system including such a high density of sensing devices. Therefore, once a sensing device receives a query message, the sensing device may become waken but with little idea whether or not its sensed data is sufficiently relevant to the goal conveyed by the query message. Thereby the sensing device may enable its sensing gadget to sense its nearby environment into a sensed data and compare the sensed data with the query message. If the sensing device tells that the sensed data is sufficiently relevant with the query message, the sensing device encodes and transmits the sensed data to the central device (Sensing Device #1 in FIG. 14). Otherwise, the sensing may not respond to the query message at all (Sensing Device #2 in 14). In this sense, the wireless system doesn't schedule individual sensing device but schedule a common task across a collectivity of sensing devices. FIG. 15 is another schematic illustration of interaction among devices in a semantic communication scenario according to one or more embodiments of the present disclosure. In a possible implementation, as shown in FIG. 15, the central device may receive a plurality of sensed data from some or all the sensing devices that respond to the query message at the end of a pre-defined responding timing interval. The central device may fuse all the sensed data into one sensing message and input the sensing message to the GPT device that would generate the next query message based on the sensing message, as shown in 15. Because only those sensing devices that respond to the query message would transmit the sensed data, lots of radio resource would be saved in comparison with one-to-one scheduling algorithm.

[0231] FIG. 16 is a schematic illustration of generating a query message, which shows how the GPT device uses generative AI model to generate the query message and then use semantization model to translate the query message into a query semantic in a possible implementation. FIG. 17 is a schematic illustration of reversing a semantic, which shows how the semantic is reversible in a possible implementation, meaning that if someone had a de-semantization model, he could recover a query message from a query semantic.

[0232] A sequence of the query messages that the GPT device generates and the central device broadcasts is in a natural language, that is, human-readable. The GPT device may employ a LLM (large-language-model) to inference over a fused sensing message (in a natural language too) input to generate a new query message. The LLM model may be a "standard" foundation model like a transformer, or a "custom" model that is built for a narrower vocabulary and specific scenarios. For example, a customized LLM for dealing with industry 4.0 or a customized LLM for dealing with wireless communication signaling and protocols. The GPT device may change, update, downsize, upsize, replace its LLM or LLMs anytime as it wishes. Please note that broadcast, multicast or unicast is allowed.

[0233] A query message that the GPT device generates is in a natural language. Because of randomness in generating, two different query messages may convey very similar semantic goal or goals. For example, "find a pedestrian" and "localize a walking man" may have the same semantic goal. Therefore, the GPT device may semantize a query message into a query semantic, which is called as "embedding", "semantization", "encoding", "natural-language to machine translation" and so on. The GPT device may translate a query message into a query semantic that may include a vector, a matrix, or a tensor of scalars. The translation may be realized by deep-neural network or other classic functions. A query semantic may preserve all the key semantic goals conveyed by the query message such that the query semantic can be well translated (de-semantized) back to a query message. Optionally, the GPT device may transmit a query semantic instead of a query message to the central device, as illustrated in FIG. 16. Please note that if all the LLMs outputs to a common natural language (e.g. English), these LLMs are said to be aligned by the natural language; then whatever LLMs are used, everyone can be smoothly hooked into the GPT device and work well within the wireless system.

[0234] FIG. 18 is a schematic illustration of tokenizing a query semantic into a query token, which shows how a GPT device tokenizes a query semantic into a query token in a possible implementation.

[0235] In one implementation, the central device may further tokenize a query semantic into a query token. A query token is a fixed-length semantic but including a vector of scalars, simpler for transmission and comparison purposes. The wireless system may pre-specify a plurality of lengths for query tokens. Thus, the central device may choose a right token length when tokenizing a query semantic according to the size range of the query semantic. The tokenization can be such a harsh function to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages. The tokenization may be realized by deep-neural network or other classic functions; as shown in FIG. 18.

[0236] Optionally, the central device receives a query semantic from the GPT device, and then the central device converts the query semantic into a query token with a fixed length; the central device may broadcast the query token with the length to all the sensing devices; the central device may keep the query semantic in its memory or storage to check the feedback sensed data.

[0237] FIG. 19 is a schematic illustration of responding to a query token, which shows how a sensing device responds to a query token in a possible implementation. FIG. 20 is a schematic illustration of scoring the relevance with tokens, which shows how a sensing device scores the relevance with tokens in a possible implementation.

FIG. 21 is another schematic illustration of responding to a query token, which shows how a sensing device responds to a query token in a possible implementation. FIG. 22 is a schematic illustration of scoring a relevance with semantic, which shows how a sensing device scores the relevance with semantic in a possible implementation. FIG. 23 is another schematic illustration of responding to a query token, which shows how a sensing device responds to a query token in a possible implementation. FIG. 24 is a schematic illustration of scoring the relevance with tokens converted from semantics, which shows how a sensing device scores the relevance with tokens converted from semantics in a possible implementation.

[0238] A sensing device may compare its sensed data with the query message; after the sensing device receives a query token (with its length or indicator of its length), the sensing device is waked up to enable its sensing gadget to measure its nearby physical-word environment into a sensed data; the sensing device may be equipped with one LLM or LLMs as semantization model and input the sensed data into the semantization model to output a sensing semantic; optionally, the sensing device may choose a right length and format of the sensing semantic; and the sensing device may continue to tokenize the sensing semantic into a sensing token with the same length as the query token that the sensing device has received; the sensing device compares or scores the relevance between the query message and sensed data, which is based on what the sensing device has received.

[0239] Alternative #1 (FIG. 19 and FIG. 20): the sensing device receives a query token and scoring function; it compares and scores the relevance between the query token and the sensing token; if the score of relevance was greater than or equal to a pre-defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0240] Alternative #2 (FIG. 21 and FIG. 22): the sensing device receives a query semantic and scoring function; it compares and scores the relevance between the query semantic with the sensing semantic, if both semantics are in a similar size and format; if the score of relevance was greater than or equal to a pre-defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0241] Alternative #3 (FIG. 23 and FIG. 24): the sensing device receives a query semantic and scoring function; it firstly converts the query semantic into a query token by the local tokenization model; and it compares and scores the relevance between the query token and sensing token; if the score of relevance was greater than or equal to a pre-defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0242] If the score of relevance is greater than or equal to a pre-defined threshold, the sensing device may transmit information including the sensed data and optionally the score of relevance to the central device . The following are some alternatives of the contents in the transmitted information:

[0243] Alternative #1: raw sensed data

[0244] Alternative #2: sensing semantic

[0245] Alternative #3: half raw sensed data (e.g. exact value or number) + sensing semantic

[0246] Alternative #4: raw sensed data + score of relevance

[0247] Alternative #5: sensing semantic + score of relevance

[0248] Alternative #6: half raw sensed data (e.g. exact value or number) + sensing semantic + score of relevance.

[0249] A sensing device may be equipped with one or several semantization models to generate sensing semantic from sensed (raw) data, may be equipped with tokenization model to generate sensing token from sensing semantic, and may be configured to have a scoring function; unlike the GPT device, the LLMs, tokenization model, and scoring functions that a sensing device may use are configured by the central device; the central device may configure and inform the sensing devices of a common LLMs and/or tokenization model and scoring function at all the beginning or on the run.

[0250] A plurality of sensing devices, either in one type or in multiple types, may serve one or several tasks simultaneously; in an efficient way, a sensing device may be triggered once to serve as many tasks as possible.

[0251] A wireless system may include two GPT devices, or one GPT device that can conduct two separated tasks; in the following disclosure, two GPT devices is mentioned as an example. And the two GPT devices may be easily extended to one GPT device with two separated tasks.

[0252] Although the two GPT devices have their own separate and independent tasks, the two GPT devices may trigger the same sensing devices simultaneously; for example, a driverless car GPT device and a traffic-light GPT device may trigger the same roadside camera sensing devices; nevertheless, although the same sensing devices may be triggered by two GPT devices at the same time interval, the query message from the first GPT device may be different from the query message from the second GPT device; for example, the driverless car GPT device may broadcast a query message about "moving obstacles" and the traffic-light GPT device may broadcast a query message about "density of vehicles", both of which may be somehow relevant but not similar.

[0253] FIG. 25 is a schematic illustration of generating query tokens, which shows how GPT devices generate the query tokens in a possible implementation. FIG. 26 is a schematic illustration of generating query semantics, which shows how GPT devices generate the query semantics in a possible implementation.

[0254] The first GPT device generates the first query semantic to the central device and the second GPT device generates the second query semantic to the central device. There are two options shown as follows:

Alternative #1: as shown in FIG. 25, the central device may tokenize the first query message into the first query token and tokenize the second query message into the second query token; the central device may use the first tokenization model to tokenize the first query message and the second tokenization model to tokenize the second query message, or the central device may use a common tokenization model to tokenize the first query message and the second query message; then the central device may broadcast the first query token, the length of the first token, the first scoring function related to the first token, and the first threshold related to the first scoring function, and the second query token the length of the second token, the second scoring function related to the second token, and the second threshold related to the second scoring function in a multiplex way in DL channel(s).

Alternative #2: as shown in FIG. 26, the central device may not perform the tokenization, and the central device may broadcast the first query semantic, the length and format of the first semantic, the first scoring function related to the first semantic, and the first threshold related to the first scoring function, and the second query message the length of the second message, the second scoring function related to the second message, and the second threshold related to the second scoring function in a multiplex way in DL channel(s).

[0255] FIG. 27 is a schematic illustration of responding to two queries with a common semantization model and two tokenization models, which shows how a sensing device responds to two queries with a common semantization model and two tokenization models in a possible implementation. FIG. 28 is a schematic illustration of responding to two queries with a common semantization model and a common tokenization model, which shows how a sensing device responds to two queries with a common semantization model and a common tokenization model in a possible implementation. FIG. 29 is another schematic illustration of responding to two queries with two semantization models and two tokenization models, which shows how a sensing device responds to two queries with two semantization models and two tokenization models in a possible implementation. FIG. 30 is another schematic illustration of responding to two queries with two semantization models and a common tokenization model, which shows how a sensing device responds to two queries with two semantization models and a common tokenization model in a possible implementation.

[0256] A sensing device may receive both the first query token and the second query token and wakes to enable its sensing gadget to sense the physical-world around itself into a sensed data. There are two options shown as follows:

Alternative #1: the sensing device may convert the sensed data into one common sensing semantic by one LLM or LLMs; and then the sensing device may tokenize the sensing semantic into the first sensing token in terms of the length of the first query token and tokenize the sensing semantic into the second sensing token in terms of the length of the second query token, in which the sensing device may use the first tokenization model to tokenize the sensing semantic into the first sensing token and the second tokenization model to tokenize the sensing semantic into the second sensing token (FIG. 27), or may use a common tokenization model to tokenize the sensing semantic into both the first sensing token and the second sensing token (FIG. 28); the sensing device may score the relevance between the first query token and the first sensing token and the relevance between the second query token and the second sensing token; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query token if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query token if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

Alternative #2: as shown in FIG. 28, the sensing device may convert the sensed data into the first sensing semantic by one LLM or LLMs and convert the same sensed data into the second sensing semantic by one LLM or LLMs; and then the sensing device may tokenize the first sensing semantic into the first sensing token in terms of the length of the first query token and tokenize the second sensing semantic into the second sensing token in terms of the length of the second query token, in which the sensing device may use the first tokenization model to tokenize the first sensing semantic into the first sensing token and the second tokenization model to tokenize the second sensing semantic into the second sensing token (as shown in FIG. 29), or may use a common tokenization model to tokenize the sensing semantic into both the first sensing token and the second sensing token (as shown in FIG. 30); the sensing device may score the relevance between the first query token and the first sensing token and the relevance between the second query token and the second sensing token; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query token if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query token if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, the first sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, the second sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

[0257] FIG. 31 is a schematic illustration of responding to two query semantics with a common semantization model and two different tokenization models, which shows how a sensing device responds to two query semantics with a common semantization model and two different tokenization models in a possible implementation. FIG. 32 is a schematic illustration of responding to two query semantics with a common semantization model and a common tokenization model, which shows how a sensing device responds to two query semantics with a common semantization model and a common tokenization model in a possible implementation. FIG. 33 is a schematic illustration of responding to two query semantics with two semantization models and two tokenization models, which shows how a sensing device responds to two query semantics with two semantization models and two tokenization models in a possible implementation. FIG. 34 is a schematic illustration of responding to two query semantics with two semantization models and one tokenization model, which shows how a sensing device responds to two query semantics with two semantization models and one tokenization model in a possible implementation. FIG. 35 is a schematic illustration of responding to two query semantics with one semantization model without tokenization model, which shows how a sensing device responds to two query semantics with one semantization model without tokenization model in a possible implementation. FIG. 36 is a schematic illustration of responding to two query semantics with two semantization models without tokenization model, which shows how a sensing device responds to two query semantics with two semantization models without tokenization model in a possible implementation.

[0258] A sensing device may receive both the first query semantic and the second query semantic and wakes to enable its sensing gadget to sense the physical-world around itself into a sensed data. There are several options shown as follows:

Alternative #1: the sensing device may convert the sensed data into one common sensing semantic by one LLM or LLMs; and then the sensing device may tokenize the sensing semantic into the first sensing token and the first query semantic into the first query token, both tokens of which are with the same first length that the sensing device decides, while the sensing device may tokenize the sensing semantic into the second sensing token and the second query semantic into the second query token, both tokens of which are with the same second length that the sensing device decides, wherein the sensing device may use the first tokenization model to tokenize the sensing semantic into the first sensing token and the second tokenization model to tokenize the sensing semantic into the second sensing token (FIG. 31), or may use a common tokenization model to tokenize the sensing semantic into both the first sensing token and the second sensing token (FIG. 32); the sensing device may score the relevance between the first query token and the first sensing token and the relevance between the second query token and the second sensing token; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query token if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query token if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

Alternative #2: the sensing device may convert the sensed data into the first sensing semantic by one LLM or LLMs and convert the same sensed data into the second sensing semantic by one LLM or LLMs; and tokenize the first sensing semantic into the first sensing token and the first query semantic into the first query token, both tokens of which are with the same first length that the sensing device decides, while the sensing device may tokenize the second sensing semantic into the second sensing token and the second query semantic into the second query token, both tokens of which are with the same second length that the sensing device decides, wherein the sensing device may use the first tokenization model to tokenize the first sensing semantic into the first sensing token and the second tokenization model to tokenize the second sensing semantic into the second sensing token (FIG. 33), or may use a common tokenization model (FIG. 34) to tokenize the first and second sensing semantics into both the first sensing token and the second sensing token; the sensing device may score the relevance between the first query token and the first sensing token and the relevance between the second query token and the second sensing token; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query token if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query token if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, the first sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, the second sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

Alternative #3 (FIG. 35): the sensing device may convert the sensed data into one common sensing semantic by one LLM or LLMs; and then the sensing device may score the relevance between the first query semantic and the sensing semantic and the relevance between the second query semantic and the sensing semantic; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query semantic if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query semantic if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, the sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, the sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

Alternative #4 (FIG. 36): the sensing device may convert the sensed data into the first sensing semantic by one LLM or LLMs and convert the same sensed data into the second sensing semantic by one LLM or LLMs; and then the sensing device may score the relevance between the first query semantic and the first sensing semantic and the relevance between the second query semantic and the second sensing semantic; the sensing device may tell whether or not the sensed data provides an enough relevance to the first query semantic if the first score of the relevance is greater than or equal to the first threshold, and the sensing device may tell whether or not the sensed data provides an enough relevance to the second query semantic if the second score of the relevance is greater than or equal to the second threshold; the sensing device may transmit at least one of the sensed data, the first sensing semantic or the first score of relevance if deciding the first score of relevance is high enough; the sensing device may transmit at least one of the sensed data, the second sensing semantic or the second score of relevance if deciding the second score of relevance is high enough.

[0259] FIG. 37 is a schematic illustration of processing two sensing semantics independently, which shows how a central device processes the two sensing semantics independently in a possible implementation.

[0260] If the central device receives a number of the first sensing semantics plus the first scores of relevance and a number of the second sensing semantics plus the second scores of relevance, the central device may fuse these first sensing semantics according to their first scores of relevance into the first fused sensing semantic and the central device may fuse these second sensing semantics according to their second scores of relevance into the second fused sensing semantic; the central device may score the first fused sensing semantic by measuring the relevance between the first fused semantic and the first query semantic, and score the second fused sensing semantic by measuring the relevance between the second fused sensing semantic and the second query semantic; the central device may transmit the first fused sensing semantic with the first score of relevance to the first GPT device and transmit the second fused sensing semantic with the second score of relevance to the second GPT device; as shown in FIG. 37.

[0261] FIG. 38 is a schematic illustration of processing one sensing semantic but with two tasks independently, which shows how a central device processes the one sensing semantics but with two tasks independently in a possible implementation.

[0262] If the central device receives a number of the sensing semantics plus the first scores of relevance and the second scores of relevance, the central device may fuse these sensing semantics according to their first scores of relevance into the first fused sensing semantic and the central device may fuse the second sensing semantics according to their second scores of relevance into the second fused sensing semantic; the central device may score the first fused sensing semantic by measuring the relevance between the first fused semantic and the first query semantic, and score the second fused sensing semantic by measuring the relevance between the second fused sensing semantic and the second query semantic; the central device may transmit the first fused sensing semantic with the first score of relevance to the first GPT device and transmit the second fused sensing semantic with the second score of relevance to the second GPT device; as shown in FIG. 38.

[0263] The first GPT device may receive the first fused sensing semantic and the first score of relevance to the first query semantic; the first GPT device may de-semantize the first fused sensing semantic into the first sensing message; the first GPT device may input the first sensing message into the LLM(s) to inference to generate the next first query message; optionally, the first GPT device may input the first sensing message plus the first score of relevance to the LLM(s).

[0264] The second GPT device may receive the second fused sensing semantic and the second score of relevance to the second query semantic; the second GPT device may de-semantize the second fused sensing semantic into the second sensing message; the second GPT device may input the second sensing message into the LLM(s) to inference to generate the next second query message; optionally, the second GPT device may input the second sensing message plus the second score of relevance to the LLM(s).

[0265] Next, examples of products related to the methods for semantic communications will be described.

[0266] FIG. 39 is a schematic structural diagram of a first apparatus 3900 according to one or more example embodiments of the present disclosure.

[0267] As shown in FIG. 39, the first apparatus 3900 may include:

an obtaining module 3910, configured to obtain at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area; and

a selecting module 3920, configured to select, based on an interested task type and the at least one piece of task indication information, an area from the at least one area.

[0268] In a possible implementation, each of the at least one task indication includes a reference signal for measurement.

[0269] In a possible implementation, the first apparatus further includes a determining module 3930 configured to determine the interested task type based on a capability of the first apparatus and/or a current status of the first apparatus.

[0270] In a possible implementation, the selecting module 3920 is configured to:

perform measurement for the interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, where a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type; and

select an area from the one or more of the at least one area, where a measurement result corresponding to the selected area has a value higher than a threshold.

[0271] In a possible implementation, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

[0272] In a possible implementation, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

[0273] In a possible implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

[0274] In a possible implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

[0275] In a possible implementation, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area.

[0276] In a possible implementation, the at least one task indication is represented by at least one pattern for at least one task type.

[0277] In a possible implementation, different patterns are defined for different task types.

[0278] In a possible implementation, the at least one task indication is configurable.

[0279] In a possible implementation, the different patterns are pre-defined in a specification and selectable depending on a current scenario.

[0280] In a possible implementation, the different patterns are broadcast, multicast or unicast through signaling.

[0281] In a possible implementation, the signaling is carried in radio resource control (RRC) signaling.

[0282] In a possible implementation, different task types correspond to different task indications.

[0283] In a possible implementation, a message for a task type is scrambled with a task identifier of the task type.

[0284] In a possible implementation, the at least one task indication belongs to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type.

[0285] In a possible implementation, each of the at least one area is a cell, or each of the at least one area is a paging area.

[0286] In a possible implementation, the first apparatus is a sensing apparatus.

[0287] The first apparatus may be applied to the above first device such as the sensing device as described in the above possible method implementations. It should be understood by a person skilled in the art that, the relevant description of the above modules in these possible implementations of the present disclosure may be understood with reference to the relevant description of the communication method in these possible implementations of the present disclosure. The technical effect achieved by the above first apparatus is similar as that achieved by the above possible method implementation, which is not repeated herein.

[0288] FIG. 40 is a schematic structural diagram of a second apparatus 4000 according to one or more example embodiments of the present disclosure.

[0289] As shown in FIG. 40, the second apparatus 4000 may include:

a sending module 4010, configured to send, in at least one area, at least one piece of task indication information, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area.

[0290] In a possible implementation, each of the at least one task indication includes a reference signal for measurement.

[0291] In a possible implementation, the at least one area includes a first area and a second area, and the at least one piece of task indication information includes a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, where at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

[0292] In a possible implementation, the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

[0293] In a possible implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

[0294] In a possible implementation, the at least one area includes a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

[0295] In a possible implementation, the time-frequency resources of the one or more first task indications for the task type in the first area include time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area include time-frequency resources of one or more second reference signals for the same task type in the second area.

[0296] In a possible implementation, the at least one task indication is represented by at least one pattern for at least one task type.

[0297] In a possible implementation, different patterns are defined for different task types.

[0298] In a possible implementation, the at least one task indication is configurable.

[0299] In a possible implementation, the different patterns are pre-defined in a specification and selectable depending on a current scenario.

[0300] In a possible implementation, the different patterns are broadcast, multicast or unicast through signaling.

[0301] In a possible implementation, the signaling is carried in radio resource control (RRC) signaling.

[0302] In a possible implementation, different task types correspond to different task indications.

[0303] In a possible implementation, a message for a task type is scrambled with a task identifier of the task type.

[0304] In a possible implementation, the at least one task indication belongs to at least one group, where each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and includes one or more task indications indicating the respective different task type.

[0305] In a possible implementation, each of the at least one area is a cell, or each of the at least one area is a paging area.

[0306] In a possible implementation, the at least one piece of task indication information is sent by a central apparatus.

[0307] The second apparatus may be applied to the above second device such as the central device as described in the above possible method implementations. It should be understood by a person skilled in the art that, the relevant description of the above modules in these possible implementations of the present disclosure may be understood with reference to the relevant description of the communication method in these possible implementations of the present disclosure. The technical effect achieved by the above second apparatus is similar as that achieved by the above possible method implementations, which is not repeated herein.

[0308] A possible implementation of the present disclosure provides a third apparatus including a processing circuitry for executing any of the above corresponding methods for semantic communications at the first device side, which is not repeated herein.

[0309] A possible implementation of the present disclosure provides a fourth apparatus including a processing circuitry for executing any of the above corresponding methods for semantic communications at the second device side, which is not repeated herein.

[0310] A possible implementation of the present disclosure provides a wireless communication system which includes: at least one first apparatus for executing any of the above corresponding methods for semantic communications at the first device side or at least one third apparatus for executing any of the above corresponding methods for semantic communications at the first device side; and at least one second apparatus for executing any of the above corresponding methods for semantic communications at the second device side or at least one fourth apparatus for executing any of the above corresponding methods for semantic communications at the second device side. The above method is not repeated herein.

[0311] A possible implementation of the present disclosure provides a wireless communication system which includes: a first processing circuitry for executing any of the above corresponding methods for semantic communications at the first device side; and a second processing circuitry for executing any of the above corresponding methods for semantic communications at the second device side. The above method is not repeated herein.

[0312] A possible implementation of the present disclosure provides a computer-readable medium storing computer execution instructions which, when executed by a processor, cause the processor to execute any of the above methods for semantic communications, which is not repeated herein.

[0313] A possible implementation of the present disclosure provides a computer program product including computer execution instructions which, when executed by a processor, cause the processor to execute any of the above methods for semantic communications, which is not repeated herein.

[0314] A method, apparatus and system for semantic/task-oriented cell selection is provided in the present disclosure.

[0315] Some aspects of the present disclosure relate to a scheme of a semantic-based communication to manage and schedule a large number of sensing devices, in which the sensing devices may belong to different types. The query semantics are goal-oriented and only the sensing device whose sensed data has sufficient relevance with the semantic message(s) would response and transmit their sensed data that are preferably in semantic form too.

[0316] Some aspects of the present disclosure relate to a scheme of a collective semantic token-based scheduling over a large number of sensing devices rather than one-to-one individual scheduling.

[0317] Some aspects of the present disclosure relate to a scheme of using the large-Language-model (LLM) to turn query and sensed data into a common semantic domain on which they can be easily compared to each other and fused.

[0318] The above one or more aspects of the present disclosure may have at least one of the following benefits:

scheduling may be task-oriented or goal-oriented; only the sensing devices that has contributions to a scheduled task or goal will response and transmit their sensed data;

privacy may be protected: both the task, goal, or query and sensed data are well protected; no raw data or minimum raw data or message is transmitted over the air;

forward compatible: semantic-based sensing system in this disclosure may be forward compatible in a sense that any new sensing mechanism can be supported.

[0319] In some aspects of the present disclosure, there is provided a computer program including instructions. The instructions, when executed by a processor, may cause the processor to implement the method of the present disclosure.

[0320] In some aspects of the present disclosure, there is provided a non-transitory computer-readable medium storing instructions, the instructions, when executed by a processor, may cause the processor to implement the method of the present disclosure.

[0321] In some aspects of the present disclosure, there is provided an apparatus/chipset system including means to implement the method implemented by the sensing device of the present disclosure.

[0322] In some aspects of the present disclosure, there is provided an apparatus/chipset system including means to implement the method implemented by the central device of the present disclosure.

[0323] In some aspects of the present disclosure, there is provided an apparatus/chipset system including means to implement the method implemented by the GPT device of the present disclosure.

[0324] In some aspects of the present disclosure, there is provided a system comprising at least two of an apparatus in the sensing device of the present disclosure, an apparatus in the central device of the present disclosure and an apparatus in the GPT device of the present disclosure.

[0325] In some aspects of the present disclosure, there is provided an apparatus/chipset system including at least one processor executing instructions stored in a computer-readable medium to implement the method implemented by the sensing device of the present disclosure.

[0326] In some aspects of the present disclosure, there is provided an apparatus/chipset system including at least one processor executing instructions stored in a computer-readable medium to implement the method implemented by the central device of the present disclosure.

[0327] In some aspects of the present disclosure, there is provided an apparatus/chipset system including at least one processor executing instructions stored in a computer-readable medium to implement the method implemented by the GPT device of the present disclosure.

[0328] **Example concepts of some terms**

Message: a payload in a natural language, e.g. English, French, or Chinese …;

Query message: a query sentence in a natural language;

Sensing message: a description about an observation or sensed data in a natural language;

Semantic: a vector, a matrix, a tensor of scalars to embed a message;

Query semantic: a semantic that embeds a query message;

Sensing semantic: a semantic that embeds a sensing message;

Token: a vector of scalars encoded from a semantic;

Query token: a token that is encoded from a query semantic;

Sensing token: a token that is encoded from a sensing semantic;

GPT device: a device that runs over generative AI model or models to generate one query message or messages given a sensing message or messages;

Central device: a device as BS that connects a plurality of terminal devices via radio access in DL and UL, and connects with the core network via backbone network;

Sensing device: a device as terminal that connects to one BS or BSs and that is equipped with the sensing gadget to measure data of interest near it.

[0329] Please note that the different embodiments may be implemented separately or combined. Although a combination of features is shown in the illustrated embodiments, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system or method designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0330] Although this disclosure has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments, as well as other embodiments of the disclosure, will be apparent to persons skilled in the art upon reference to the description. It is therefore intended that the appended claims encompass any such modifications or embodiments.

[0331] Although the present disclosure describes methods and processes with steps in a certain order, one or more steps of the methods and processes may be omitted or altered as appropriate. One or more steps may take place in an order other than that in which they are described, as appropriate.

[0332] Note that the expression "at least one of A or B", as used herein, is interchangeable with the expression "A and/or B". It refers to a list in which you may select A or B or both A and B. Similarly, "at least one of A, B, or C", as used herein, is interchangeable with "A and/or B and/or C" or "A, B, and/or C". It refers to a list in which you may select: A or B or C, or both A and B, or both A and C, or both B and C, or all of A, B and C. The same principle applies for longer lists having a same format.

[0333] Although the present disclosure is described, at least in part, in terms of methods, a person of ordinary skill in the art will understand that the present disclosure is also directed to the various components for performing at least some of the aspects and features of the described methods, be it by way of hardware components, software or any combination of the two. Accordingly, the technical solution of the present disclosure may be embodied in the form of a software product. A suitable software product may be stored in a pre-recorded storage device or other similar non-volatile or non-transitory computer readable medium, including DVDs, CD-ROMs, USB flash disk, a removable hard disk, or other storage media, for example. The software product includes instructions tangibly stored thereon that enable a processing device (e.g., a personal computer, a server, or a network device) to execute examples of the methods disclosed herein. The machine-executable instructions may be in the form of code sequences, configuration information, or other data, which, when executed, cause a machine (e.g., a processor or other processing device) to perform steps in a method according to examples of the present disclosure.

[0334] All values and sub-ranges within disclosed ranges are also disclosed. Also, although the systems, devices and processes disclosed and shown herein may include a specific number of elements/components, the systems, devices and assemblies could be modified to include additional or fewer of such elements/components. For example, although any of the elements/components disclosed may be referenced as being singular, the possible implementations disclosed herein could be modified to include a plurality of such elements/components. The subject matter described herein intends to cover and embrace all suitable changes in technology.

CLAIMS

1. A communication method, comprising:

obtaining at least one piece of task indication information sent in at least one area, wherein each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area; and

selecting, based on an interested task type and the at least one piece of task indication information, an area from the at least one area.

2. The method according to claim 1, wherein each of the at least one task indication comprises a reference signal for measurement.

3. The method according to claim 1 or 2, further comprising:

determining the interested task type based on a capability of a first device and/or a current status of the first device.

4. The method according to any one of claims 1 to 3, wherein the selecting, based on the interested task type and the at least one piece of task indication information, an area from the at least one area comprises:

performing measurement for the interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, wherein a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type; and

selecting an area from the one or more of the at least one area, wherein a measurement result corresponding to the selected area has a value higher than a threshold.

5. The method according to any one of claims 1 to 4, wherein the at least one area comprises a first area and a second area, and the at least one piece of task indication information comprises a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, wherein at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

6. The method according to any one of claims 1 to 5, wherein the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task

indication is sent.

7. The method according to any one of claims 1 to 6, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

8. The method according to any one of claims 1 to 6, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

9. The method according to claim 7 or 8, wherein the time-frequency resources of the one or more first task indications for the task type in the first area comprise time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area comprise time-frequency resources of one or more second reference signals for the same task type in the second area.

10. The method according to any one of claims 1 to 9, wherein the at least one task indication is represented by at least one pattern for at least one task type.

11. The method according to claim 10, wherein different patterns are defined for different task types.

12. The method according to claim 11, wherein the at least one task indication is configurable.

13. The method according to claim 12, wherein the different patterns are pre-defined in a specification and selectable depending on a current scenario.

14. The method according to claim 12, wherein the different patterns are broadcast, multicast or unicast through signaling.

15. The method according to claim 14, wherein the signaling is carried in radio resource control (RRC) signaling.

16. The method according to any one of claims 1 to 15, wherein different task types correspond to different task indications.

17. The method according to claim 16, wherein a message for a task type is scrambled with a task identifier of the task type.

18. The method according to claim 16, wherein the at least one task indication belongs to at least one group, wherein each of the at least one task indication belongs to one of the at least one group, each of the at least one

group corresponds to a respective different task type and comprises one or more task indications indicating the respective different task type.

19. The method according to any one of claims 1 to 18, wherein each of the at least one area is a cell, or each of the at least one area is a paging area.

20. The method according to claim 3, wherein the first device is a sensing device.

21. A communication method, comprising:

sending, in at least one area, at least one piece of task indication information, wherein each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area.

22. The method according to claim 21, wherein each of the at least one task indication comprises a reference signal for measurement.

23. The method according to claim 21 or 22, wherein the at least one area comprises a first area and a second area, and the at least one piece of task indication information comprises a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, wherein at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

24. The method according to any one of claims 21 to 23, wherein the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

25. The method according to any one of claims 21 to 24, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

26. The method according to any one of claims 21 to 24, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

27. The method according to claim 25 or 26, wherein the time-frequency resources of the one or more first task indications for the task type in the first area comprise time-frequency resources of one or more first reference

signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area comprise time-frequency resources of one or more second reference signals for the same task type in the second area.

28. The method according to any one of claims 21 to 27, wherein the at least one task indication is represented by at least one pattern for at least one task type.

29. The method according to claim 28, wherein different patterns are defined for different task types.

30. The method according to claim 29, wherein the at least one task indication is configurable.

31. The method according to claim 30, wherein the different patterns are pre-defined in a specification and selectable depending on a current scenario.

32. The method according to claim 30, wherein the different patterns are broadcast, multicast or unicast through signaling.

33. The method according to claim 32, wherein the signaling is carried in radio resource control (RRC) signaling.

34. The method according to any one of claims 21 to 33, wherein different task types correspond to different task indications.

35. The method according to claim 34, wherein a message for a task type is scrambled with a task identifier of the task type.

36. The method according to claim 34, wherein the at least one task indication belongs to at least one group, wherein each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and comprises one or more task indications indicating the respective different task type.

37. The method according to any one of claims 21 to 36, wherein each of the at least one area is a cell, or each of the at least one area is a paging area.

38. The method according to any one of claims 21 to 37, wherein the at least one piece of task indication information is sent by a central device.

39. A first apparatus, comprising:

an obtaining module, configured to obtain at least one piece of task indication information sent in at least one area, wherein each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area; and a selecting module, configured to select, based on an interested task type and the at least one piece of task indication information, an area from the at least one area.

40. The first apparatus according to claim 39, wherein each of the at least one task indication comprises a reference signal for measurement.

41. The first apparatus according to claim 39 or 40, further comprising:

a determining module, configured to determine the interested task type based on a capability of the first apparatus and/or a current status of the first apparatus.

42. The first apparatus according to any one of claims 39 to 41, wherein the selecting module is configured to:

perform measurement for the interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, wherein a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type; and

select an area from the one or more of the at least one area, wherein a measurement result corresponding to the selected area has a value higher than a threshold.

43. The first apparatus according to any one of claims 39 to 42, wherein the at least one area comprises a first area and a second area, and the at least one piece of task indication information comprises a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, wherein at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

44. The first apparatus according to any one of claims 39 to 43, wherein the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

45. The first apparatus according to any one of claims 39 to 44, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

46. The first apparatus according to any one of claims 39 to 44, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area

are different.

47. The first apparatus according to claim 45 or 46, wherein the time-frequency resources of the one or more first task indications for the task type in the first area comprise time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area comprise time-frequency resources of one or more second reference signals for the same task type in the second area.

48. The first apparatus according to any one of claims 39 to 47, wherein the at least one task indication is represented by at least one pattern for at least one task type.

49. The first apparatus according to claim 48, wherein different patterns are defined for different task types.

50. The first apparatus according to claim 49, wherein the at least one task indication is configurable.

51. The first apparatus according to claim 50, wherein the different patterns are pre-defined in a specification and selectable depending on a current scenario.

52. The first apparatus according to claim 50, wherein the different patterns are broadcast, multicast or unicast through signaling.

53. The first apparatus according to claim 52, wherein the signaling is carried in radio resource control (RRC) signaling.

54. The first apparatus according to any one of claims 39 to 53, wherein different task types correspond to different task indications.

55. The first apparatus according to claim 54, wherein a message for a task type is scrambled with a task identifier of the task type.

56. The first apparatus according to claim 54, wherein the at least one task indication belongs to at least one group, wherein each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and comprises one or more task indications indicating the respective different task type.

57. The first apparatus according to any one of claims 39 to 56, wherein each of the at least one area is a cell, or each of the at least one area is a paging area.

58. The first apparatus according to claim 41, wherein the first apparatus is a sensing apparatus.

59. A second apparatus, comprising:

a sending module, configured to send, in at least one area, at least one piece of task indication information, wherein each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area.

60. The second apparatus according to claim 59, wherein each of the at least one task indication comprises a reference signal for measurement.

61. The second apparatus according to claim 59 or 60, wherein the at least one area comprises a first area and a second area, and the at least one piece of task indication information comprises a first piece of task indication information which is sent in the first area and a second piece of task indication information which is sent in the second area, wherein at least one first task indication indicated by the first piece of task indication information indicates a different task type from at least one second task indication indicated by the second piece of task indication information.

62. The second apparatus according to any one of claims 59 to 61, wherein the at least one task indication is scrambled with an identifier of an area in which a piece of task indication information indicating the at least one task indication is sent.

63. The second apparatus according to any one of claims 59 to 62, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are same.

64. The second apparatus according to any one of claims 59 to 62, wherein the at least one area comprises a first area and a second area, and time-frequency resources of one or more first task indications for a task type in the first area and time-frequency resources of one or more second task indications for the same task type in the second area are different.

65. The second apparatus according to claim 63 or 64, wherein the time-frequency resources of the one or more first task indications for the task type in the first area comprise time-frequency resources of one or more first reference signals for the task type in the first area, and the time-frequency resources of the one or more second task indications for the same task type in the second area comprise time-frequency resources of one or more second reference signals for the same task type in the second area.

66. The second apparatus according to any one of claims 59 to 65, wherein the at least one task indication is represented by at least one pattern for at least one task type.

67. The second apparatus according to claim 66, wherein different patterns are defined for different task types.

68. The second apparatus according to claim 67, wherein the at least one task indication is configurable.

69. The second apparatus according to claim 68, wherein the different patterns are pre-defined in a specification and selectable depending on a current scenario.

70. The second apparatus according to claim 68, wherein the different patterns are broadcast, multicast or unicast through signaling.

71. The second apparatus according to claim 70, wherein the signaling is carried in radio resource control (RRC) signaling.

72. The second apparatus according to any one of claims 59 to 71, wherein different task types correspond to different task indications.

73. The second apparatus according to claim 72, wherein a message for a task type is scrambled with a task identifier of the task type.

74. The second apparatus according to claim 72, wherein the at least one task indication belongs to at least one group, wherein each of the at least one task indication belongs to one of the at least one group, each of the at least one group corresponds to a respective different task type and comprises one or more task indications indicating the respective different task type.

75. The second apparatus according to any one of claims 59 to 74, wherein each of the at least one area is a cell, or each of the at least one area is a paging area.

76. The second apparatus according to any one of claims 59 to 75, wherein the at least one piece of task indication information is sent by a central apparatus.

77. A third apparatus, comprising:

a processing circuitry for executing the method according to any one of claims 1 to 20.

78. A fourth apparatus, comprising:

a processing circuitry for executing the method according to any one of claims 21 to 38.

79. A wireless communication system, comprising:

at least one first apparatus according to any one of claims 39 to 58 or at least one third apparatus according to claim 77; and

at least one second apparatus according to any one of claims 59 to 76 or at least one fourth apparatus according to claim 78.

80. A wireless communication system, comprising:

a first processing circuitry for executing the method according to any one of claims 1 to 20; and a second processing circuitry for executing the method according to any one of claims 21 to 38.

81. A computer-readable medium storing computer execution instructions which, when executed by a processor, cause the processor to execute the method according to any one of claims 1 to 38.

82. A computer program product comprising computer execution instructions which, when executed by a processor, cause the processor to execute the method according to any one of claims 1 to 38.

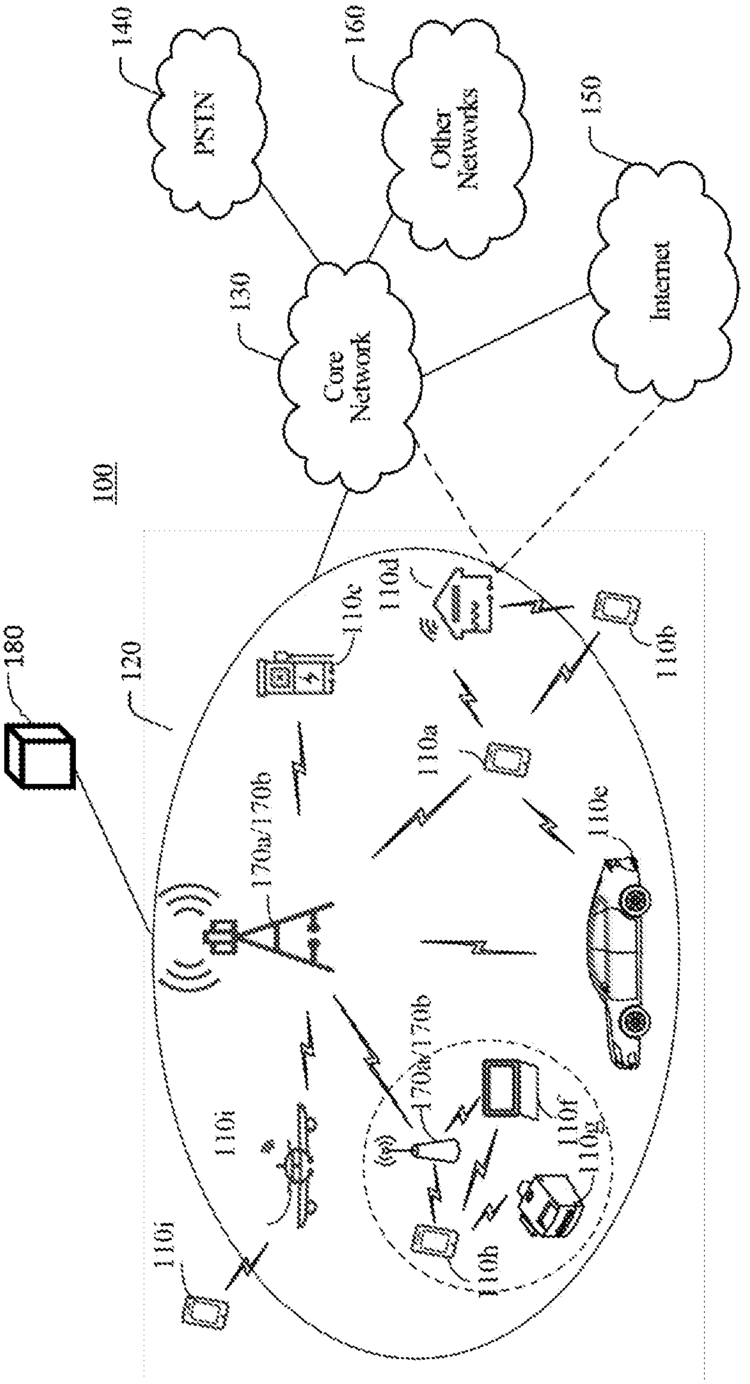
100
140
PSTN
160
Other Networks
150
Internet
130
Core Network
180
120
110a
110b
110c
110d
110e
110f
110g
110h
110i
110j
170a/170b
170a/170b

FIG. 1

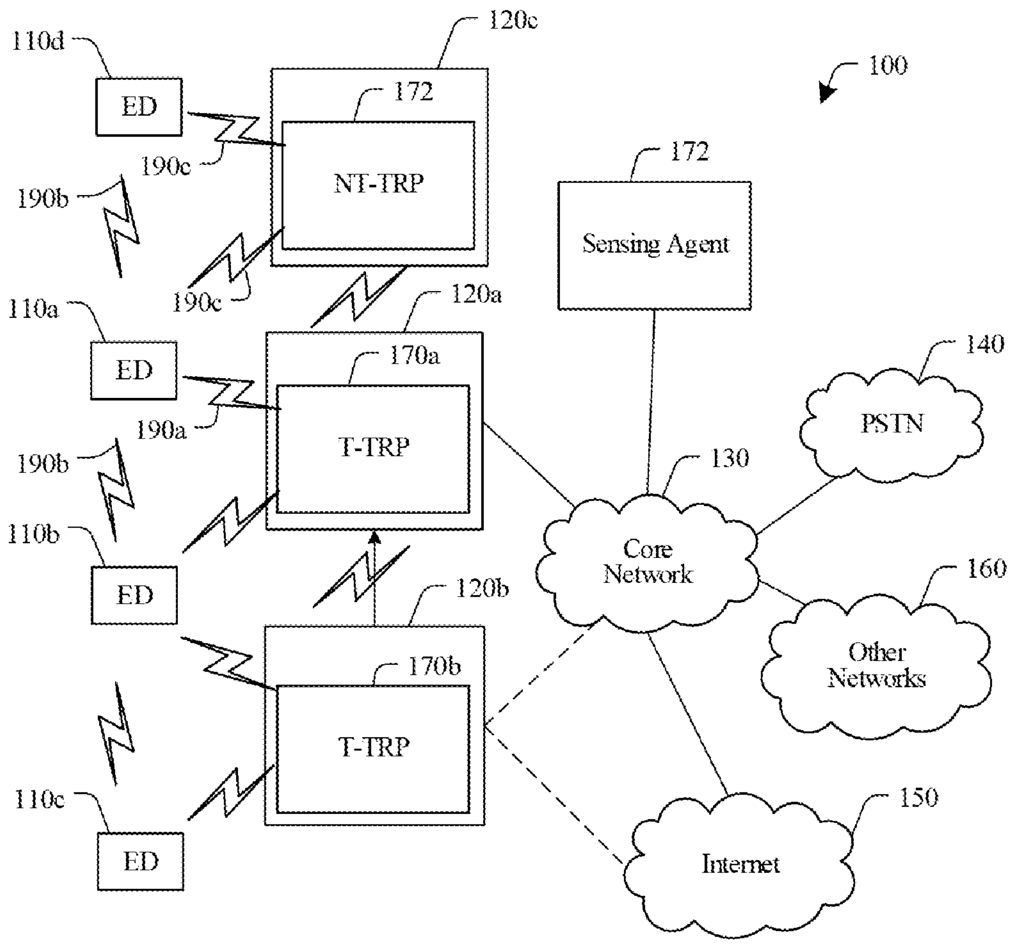
120c
110d
100
ED
172
190c
NT-TRP
172
190b
Sensing Agent
190c
110a
120a
170a
140
ED
PSTN
190a
T-TRP
190b
130
110b
Core
Network
160
ED
120b
170b
Other
Networks
T-TRP
110c
150
ED
Internet

FIG. 2

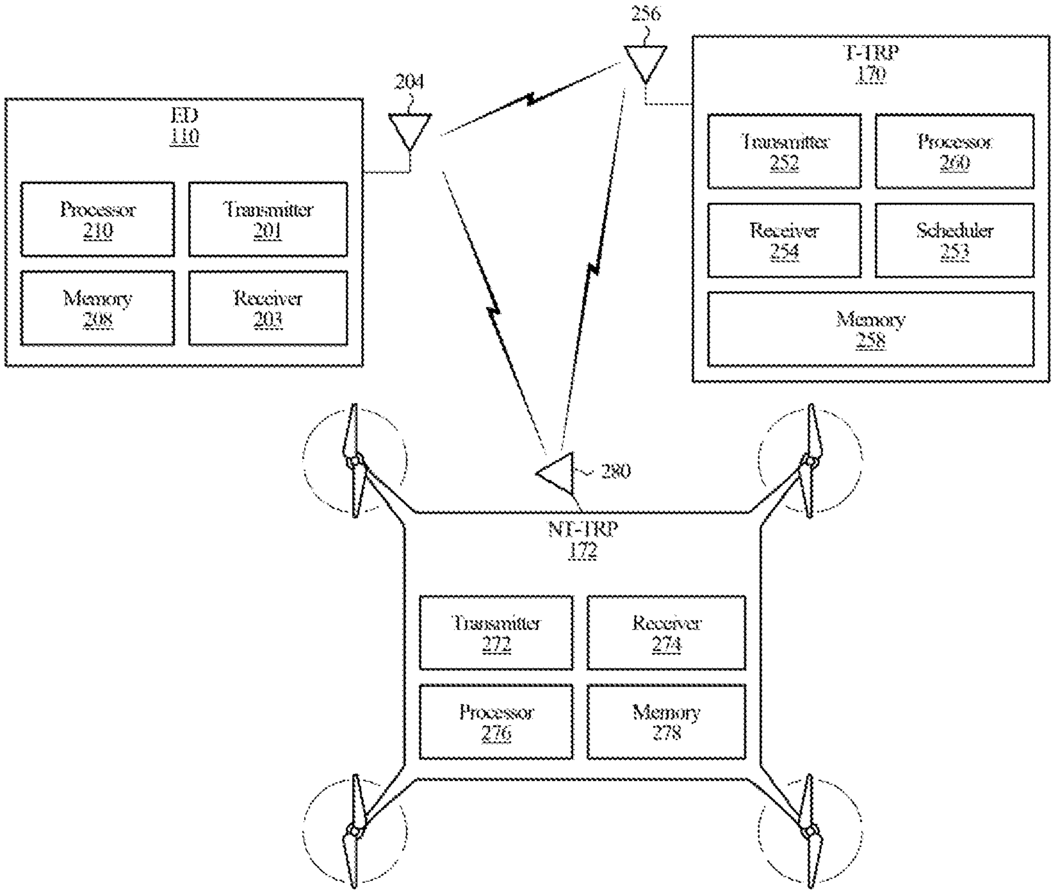
256
204
T-TRP
170
ED
110
Transmitter
252
Processor
260
Processor
210
Transmitter
201
Receiver
254
Scheduler
253
Memory
208
Receiver
203
Memory
258
280
NT-TRP
172
Transmitter
272
Receiver
274
Processor
276
Memory
278

FIG. 3

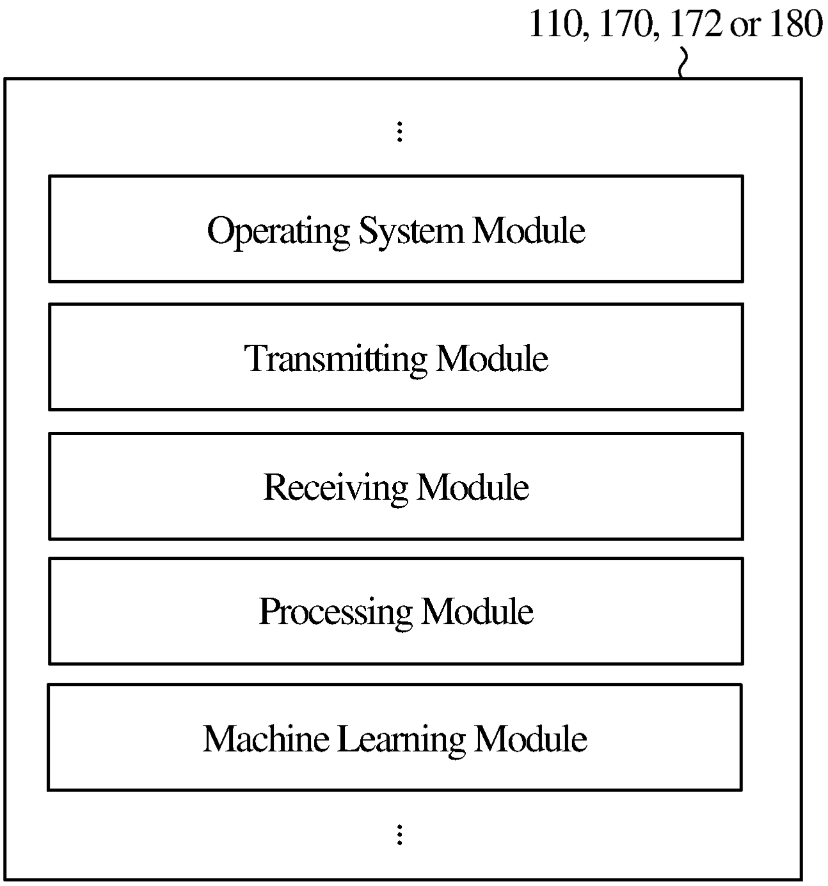
110, 170, 172 or 180
⋮
Operating System Module
Transmitting Module
Receiving Module
Processing Module
Machine Learning Module
⋮

FIG. 4

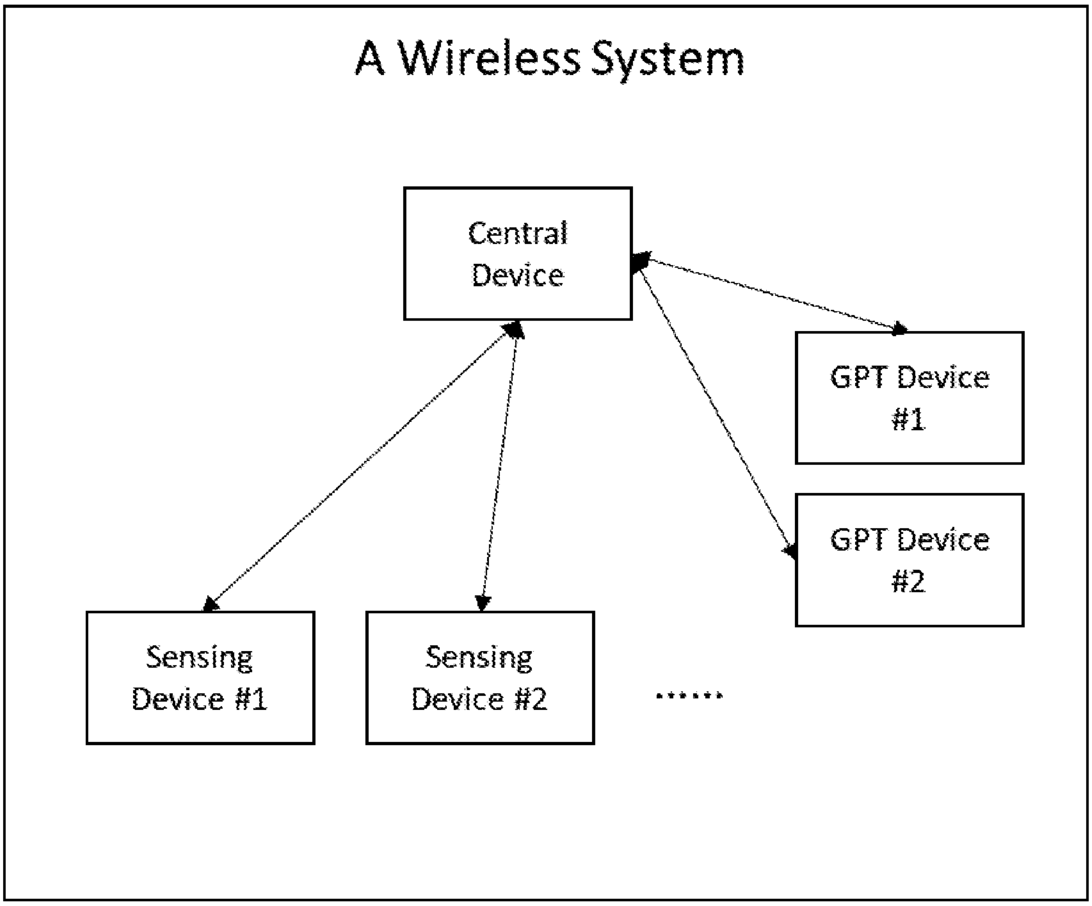
A Wireless System
Central Device
GPT Device #1
GPT Device #2
Sensing Device #1
Sensing Device #2
......

FIG. 5

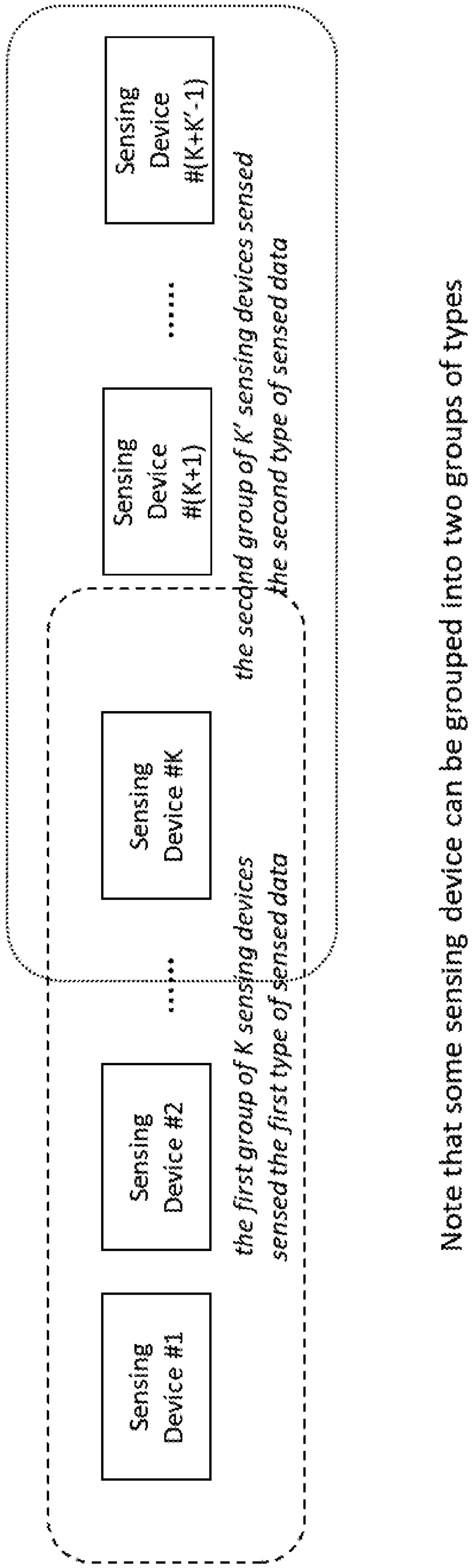
Sensing Device #1
Sensing Device #2
......
Sensing Device #K
Sensing Device #(K+1)
......
Sensing Device #(K+K′-1)
the first group of K sensing devices sensed the first type of sensed data
the second group of K′ sensing devices sensed the second type of sensed data
Note that some sensing device can be grouped into two groups of types

FIG. 6

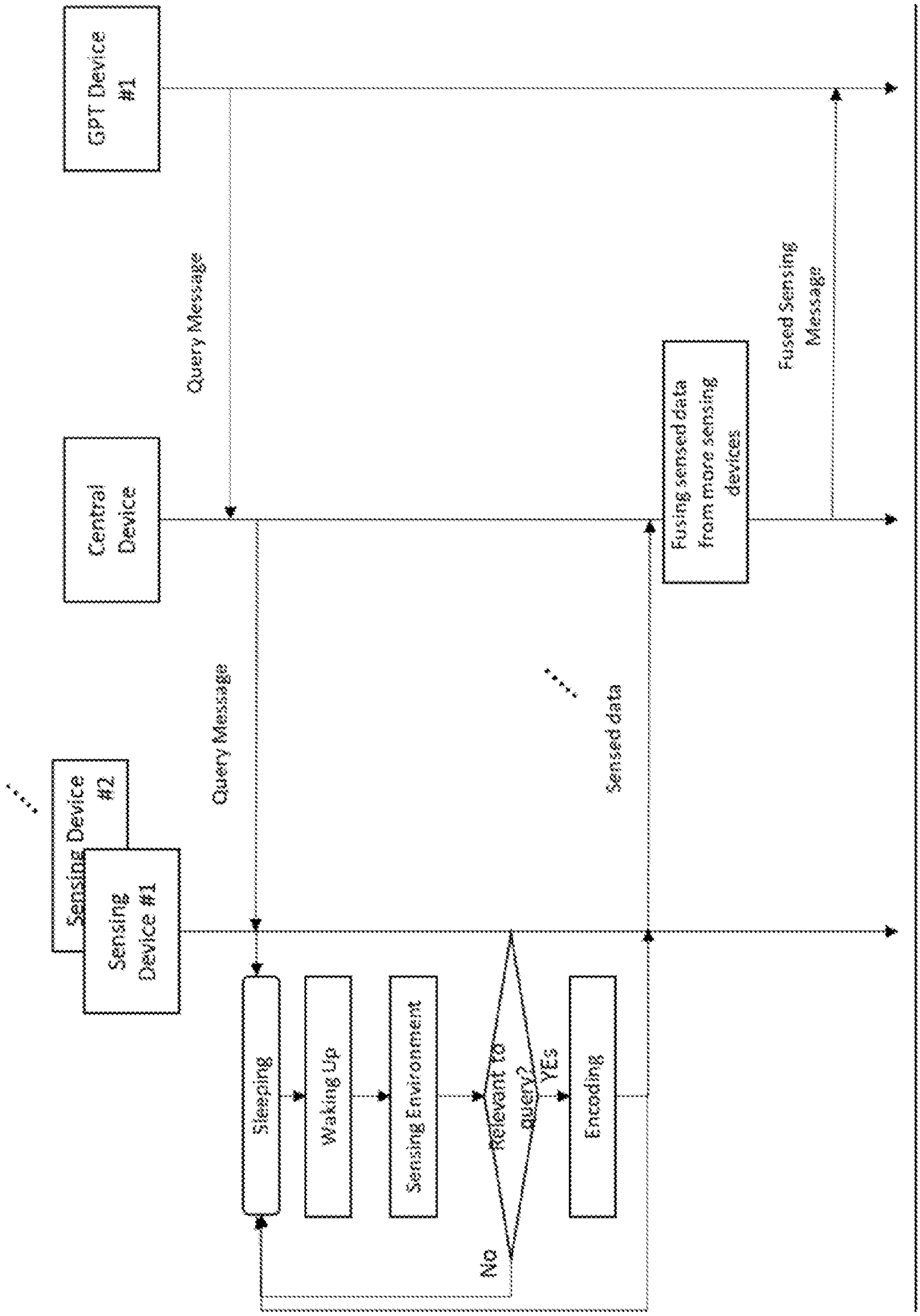
GPT Device #1
Central Device
Sensing Device #2
Sensing Device #1
Query Message
Query Message
Sleeping
Waking Up
Sensing Environment
Relevant to query?
YEs
No
Encoding
Sensed data
Fusing sensed data from more sensing devices
Fused Sensing Message

FIG. 7

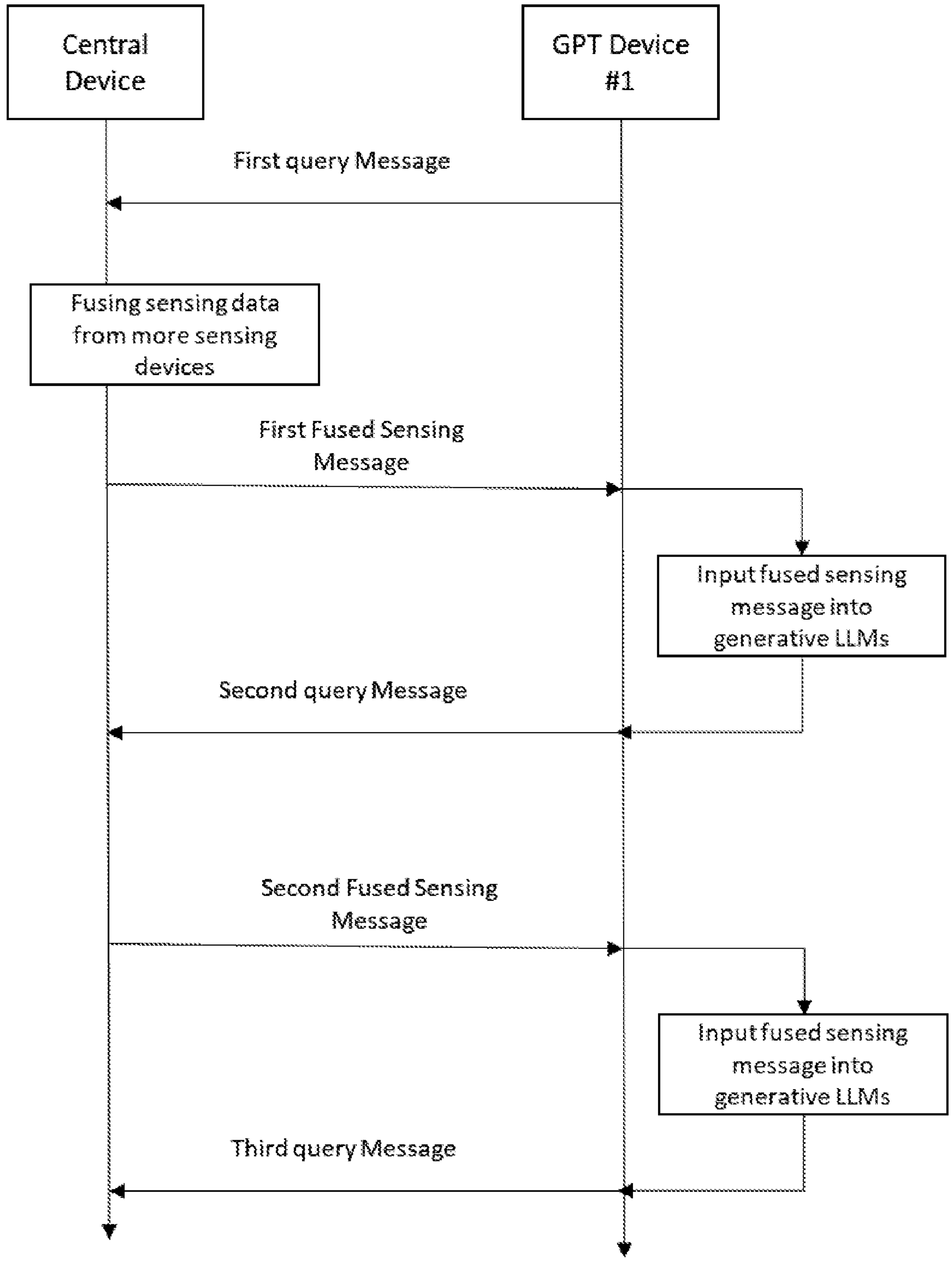
Central Device
GPT Device #1
First query Message
Fusing sensing data from more sensing devices
First Fused Sensing Message
Input fused sensing message into generative LLMs
Second query Message
Second Fused Sensing Message
Input fused sensing message into generative LLMs
Third query Message

FIG. 8

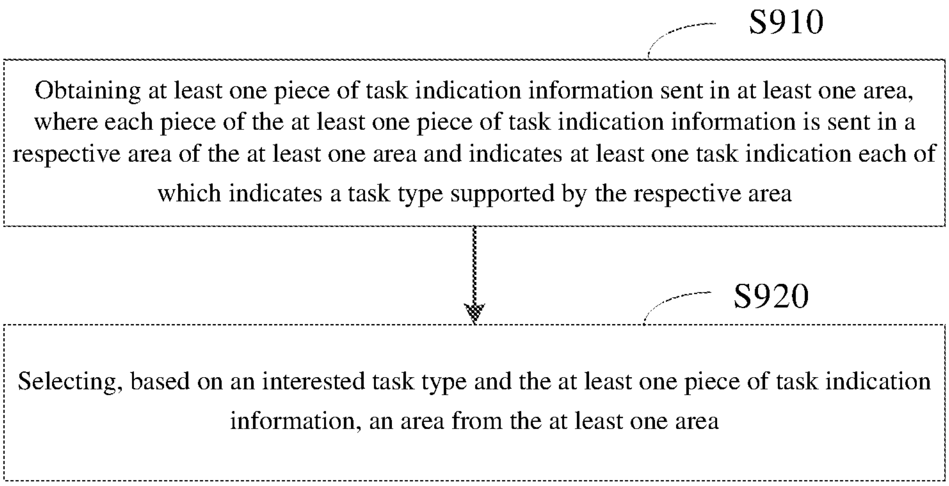
S910
Obtaining at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area
S920
Selecting, based on an interested task type and the at least one piece of task indication information, an area from the at least one area

FIG. 9

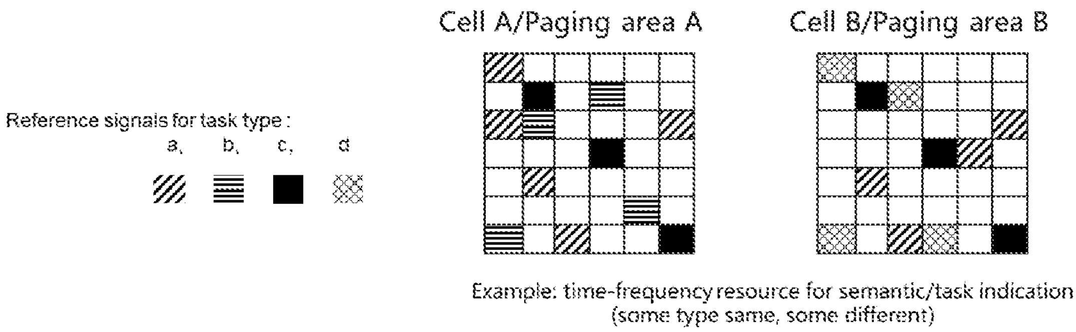
Reference signals for task type :
a、 b、 c、 d
Cell A/Paging area A
Cell B/Paging area B
Example: time-frequency resource for semantic/task indication
(some type same, some different)

FIG. 10

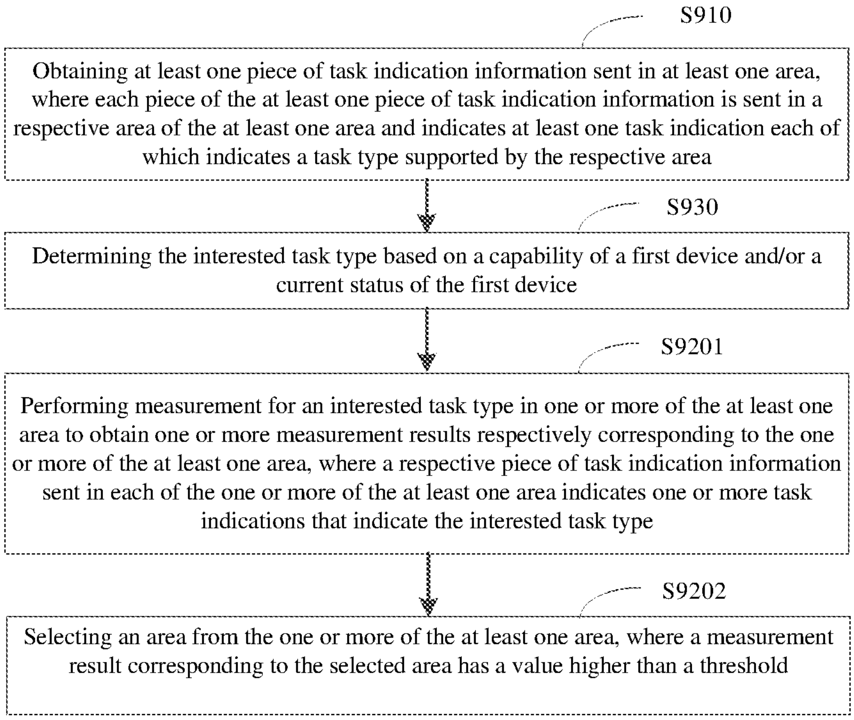
S910
Obtaining at least one piece of task indication information sent in at least one area, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area and indicates at least one task indication each of which indicates a task type supported by the respective area
S930
Determining the interested task type based on a capability of a first device and/or a current status of the first device
S9201
Performing measurement for an interested task type in one or more of the at least one area to obtain one or more measurement results respectively corresponding to the one or more of the at least one area, where a respective piece of task indication information sent in each of the one or more of the at least one area indicates one or more task indications that indicate the interested task type
S9202
Selecting an area from the one or more of the at least one area, where a measurement result corresponding to the selected area has a value higher than a threshold

FIG. 11

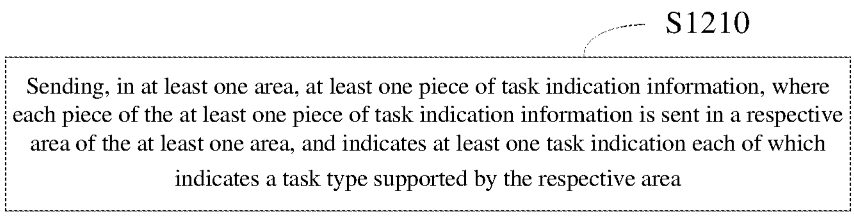
S1210
Sending, in at least one area, at least one piece of task indication information, where each piece of the at least one piece of task indication information is sent in a respective area of the at least one area, and indicates at least one task indication each of which indicates a task type supported by the respective area

FIG. 12

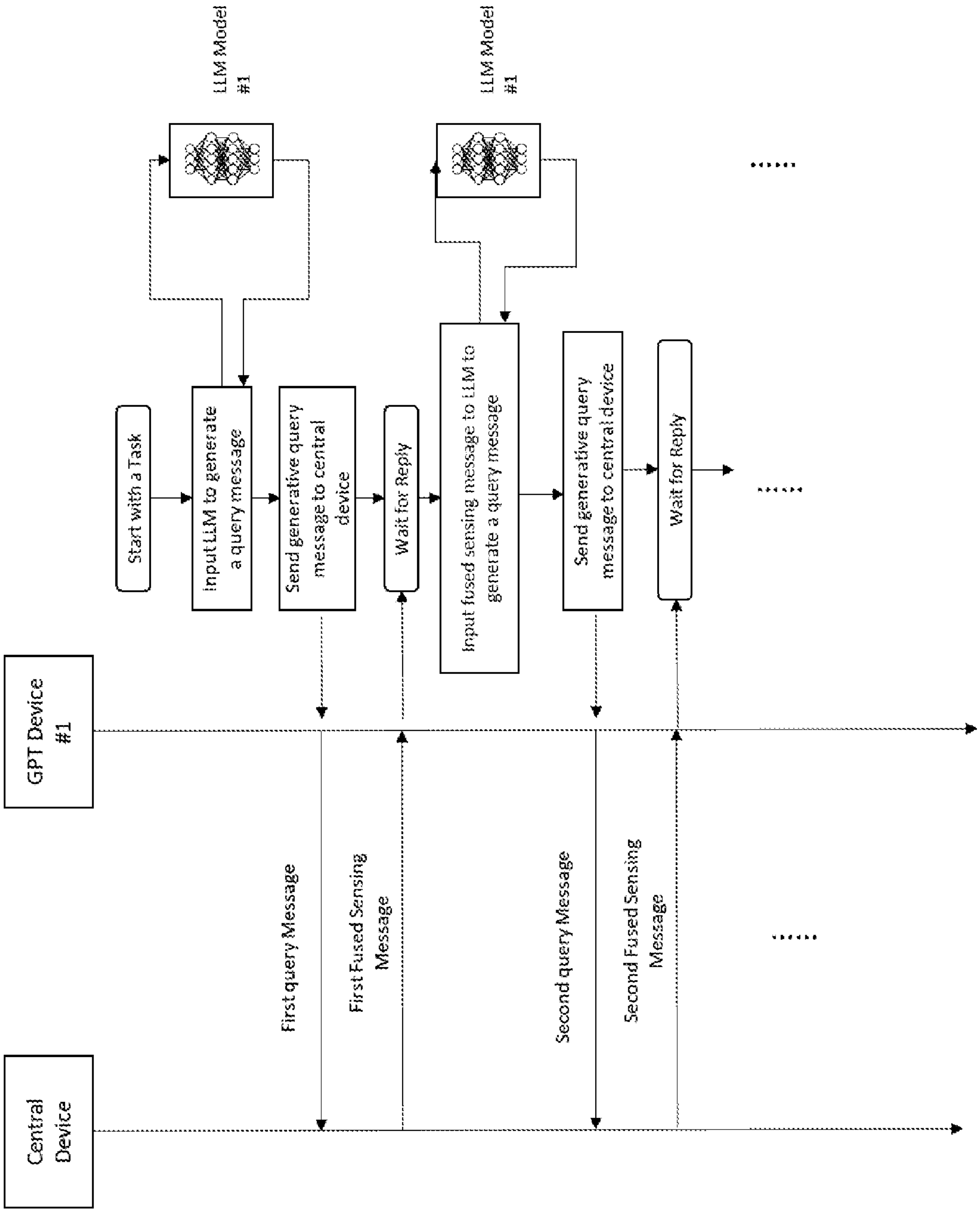
Central Device
GPT Device #1
LLM Model #1
LLM Model #1
Start with a Task
Input LLM to generate a query message
Send generative query message to central device
Wait for Reply
Input fused sensing message to LLM to generate a query message
Send generative query message to central device
Wait for Reply
First query Message
First Fused Sensing Message
Second query Message
Second Fused Sensing Message
......
......
......

FIG. 13

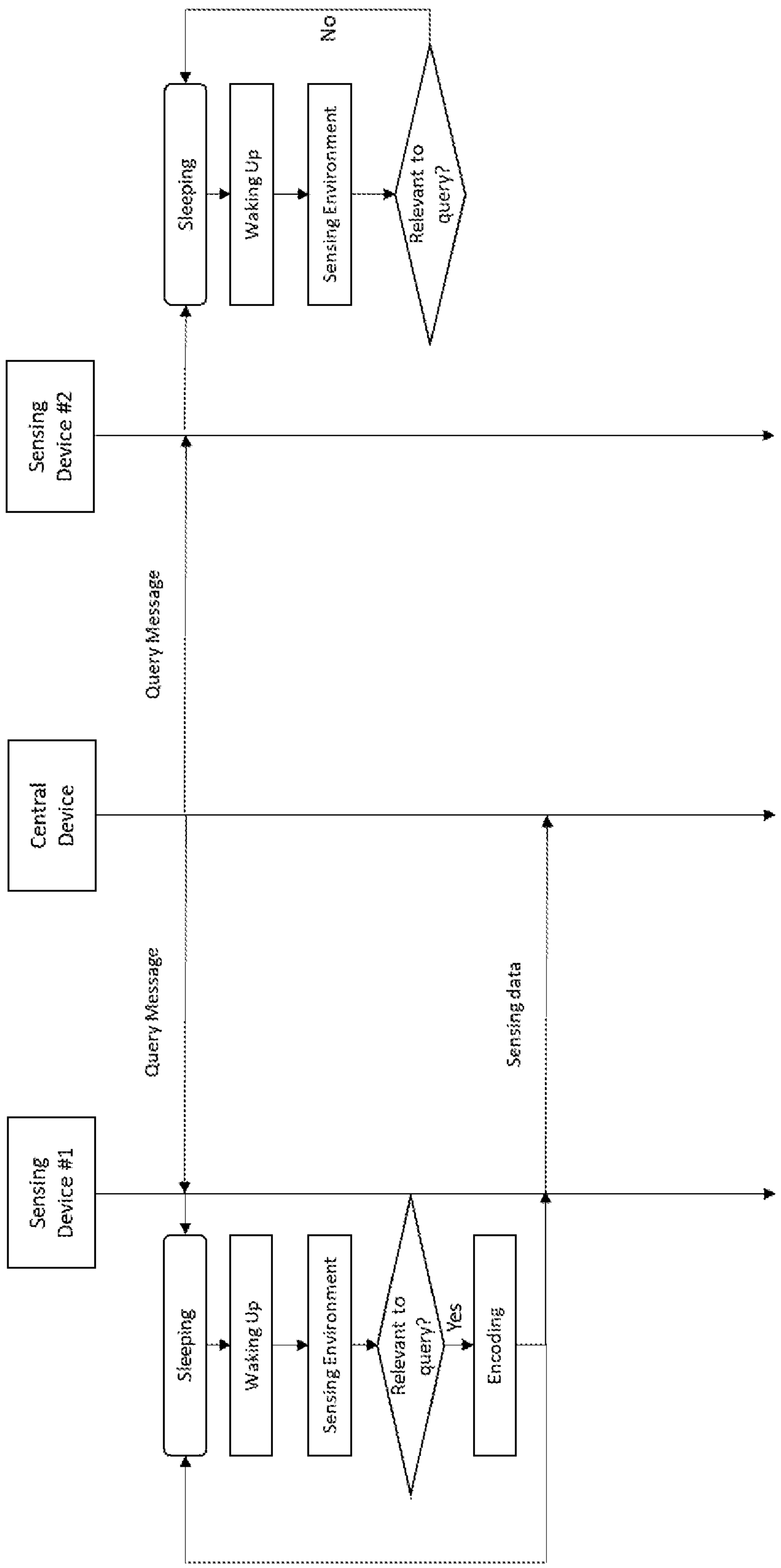
Sensing Device #1
Central Device
Sensing Device #2
Query Message
Query Message
Sensing data
Sleeping
Waking Up
Sensing Environment
Relevant to query?
Yes
Encoding
Sleeping
Waking Up
Sensing Environment
Relevant to query?
No

FIG. 14

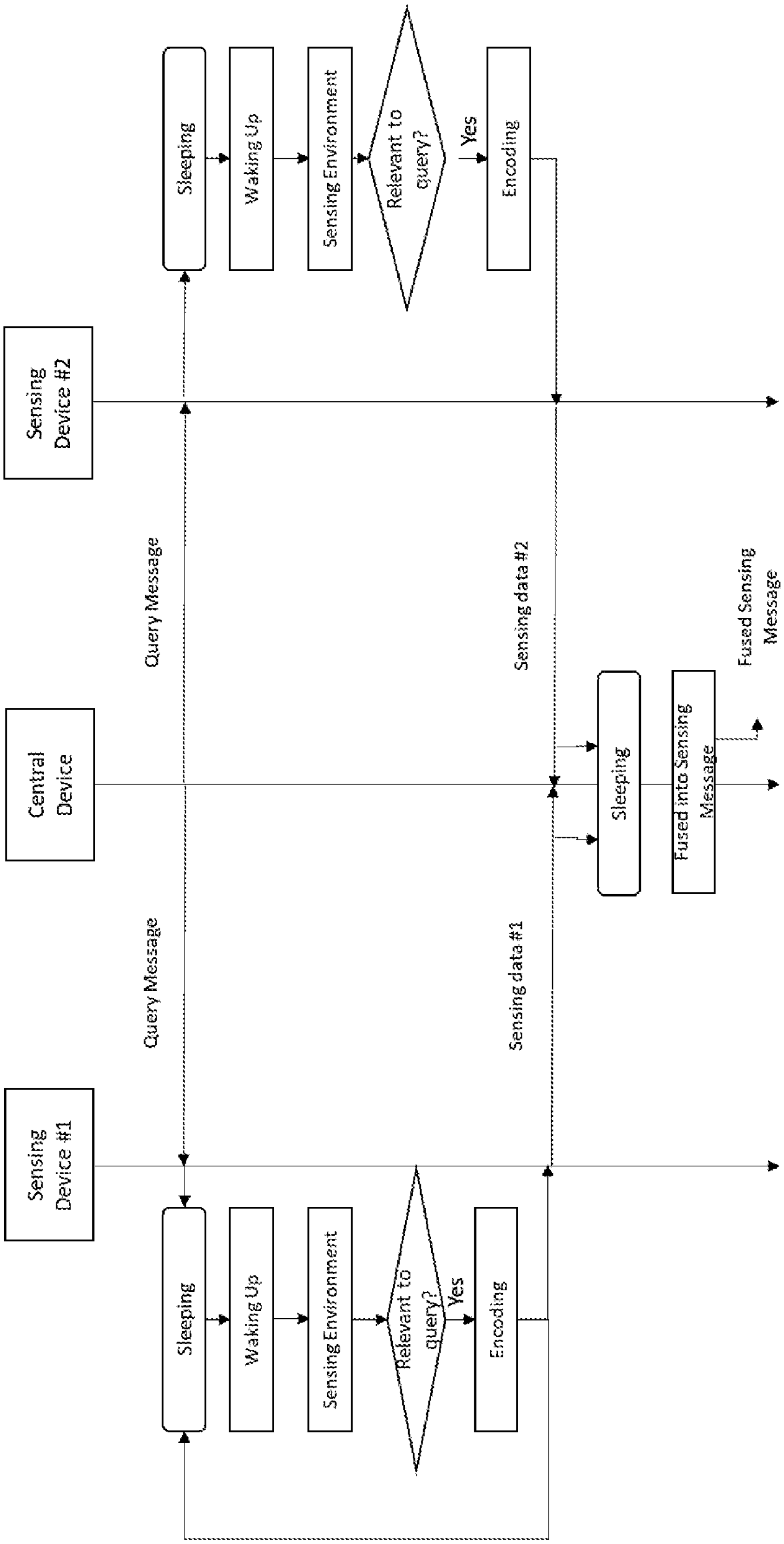
Sensing Device #2
Sleeping
Waking Up
Sensing Environment
Relevant to query?
Yes
Encoding
Query Message
Sensing data #2
Central Device
Sleeping
Fused into Sensing Message
Fused Sensing Message
Query Message
Sensing data #1
Sensing Device #1
Sleeping
Waking Up
Sensing Environment
Relevant to query?
Yes
Encoding

FIG. 15

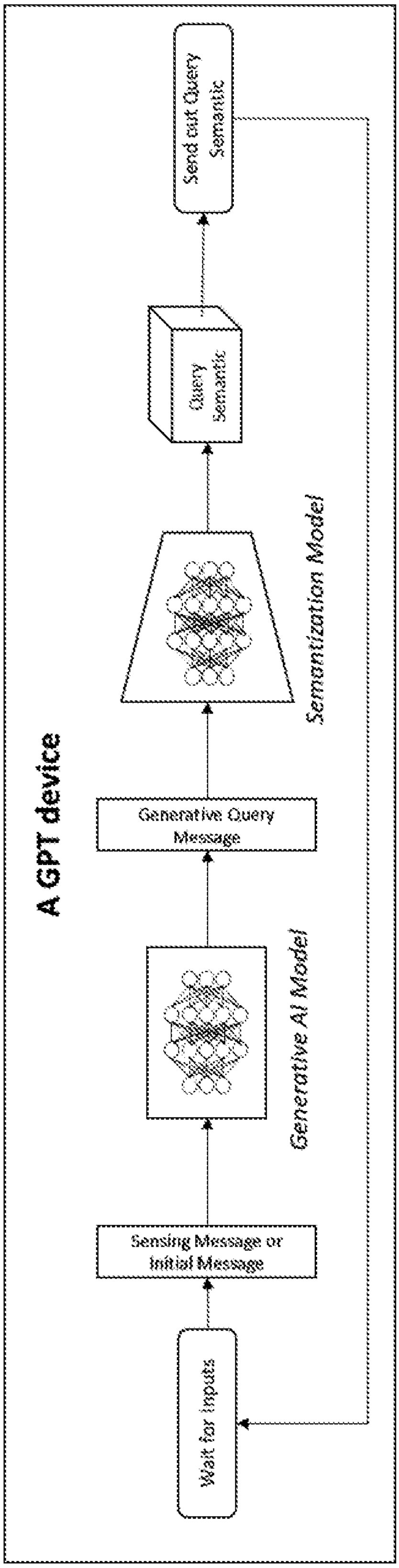
A GPT device
Wait for Inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Send out Query Semantic

FIG. 16

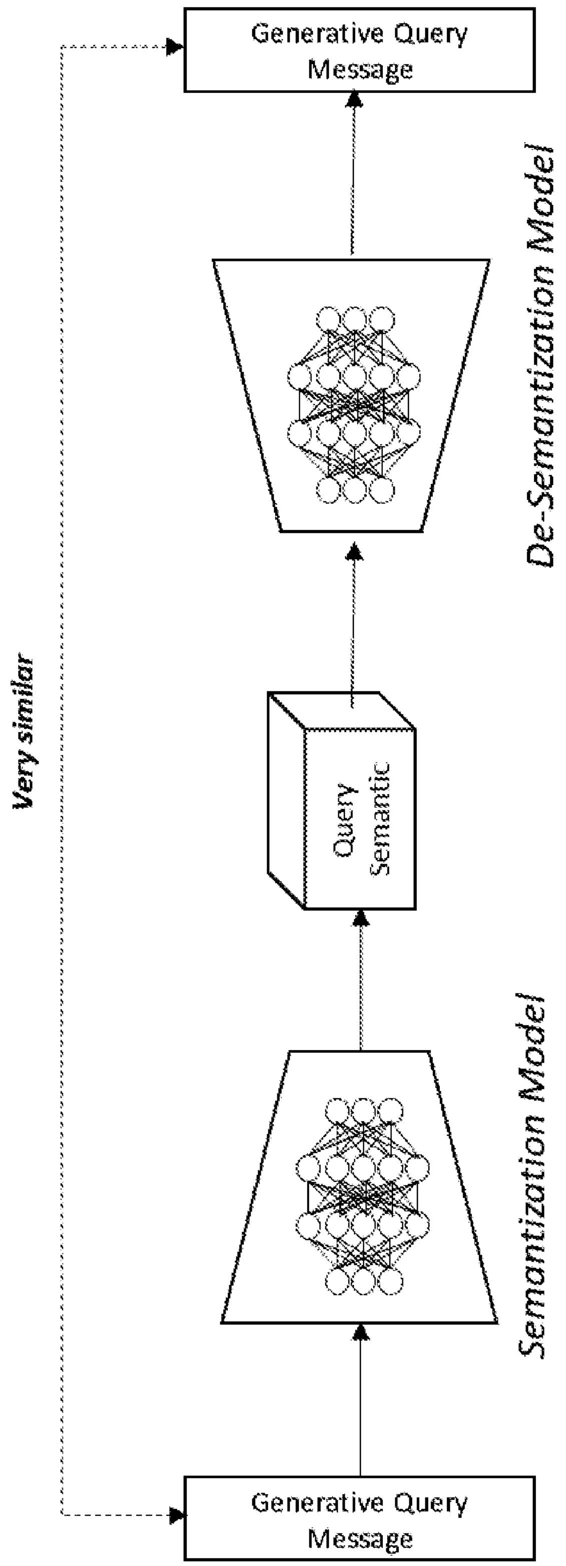
Generative Query Message
De-Semantization Model
Query Semantic
Semantization Model
Generative Query Message
Very similar

FIG. 17

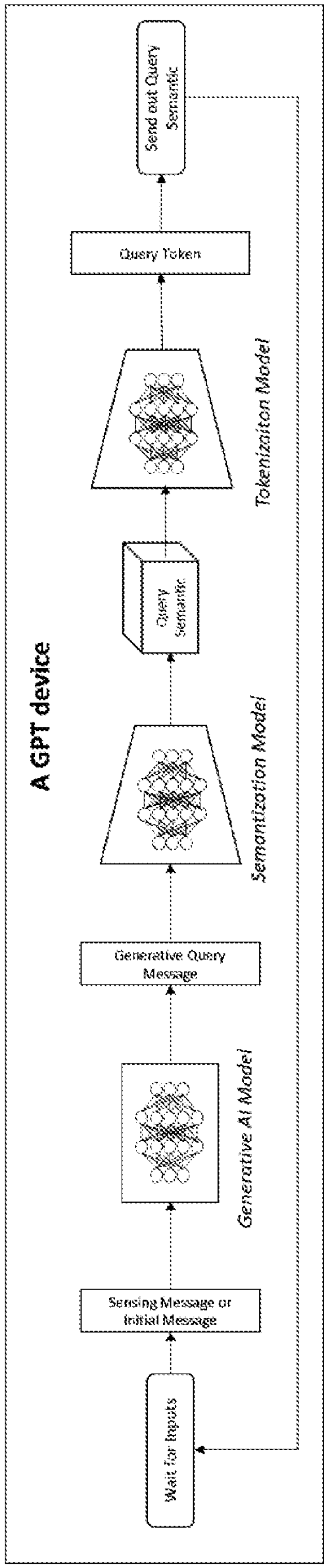
A GPT device
Wait for Inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Tokenizaiton Model
Query Token
Send out Query Semantic

FIG. 18

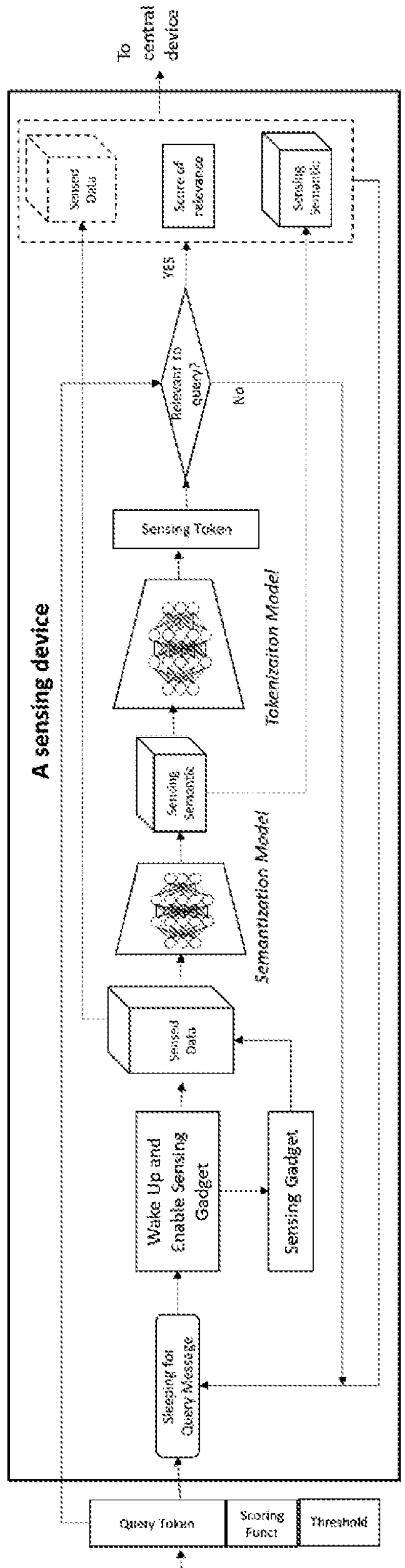
To central device
A sensing device
Sensed Data
Score of relevance
Sensing Semantic
YES
Relevant to query?
No
Sensing Token
Tokenizaiton Model
Sensing Semantic
Semantization Model
Sensed Data
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
Query Token
Scoring Funct
Threshold
from central device

FIG. 19

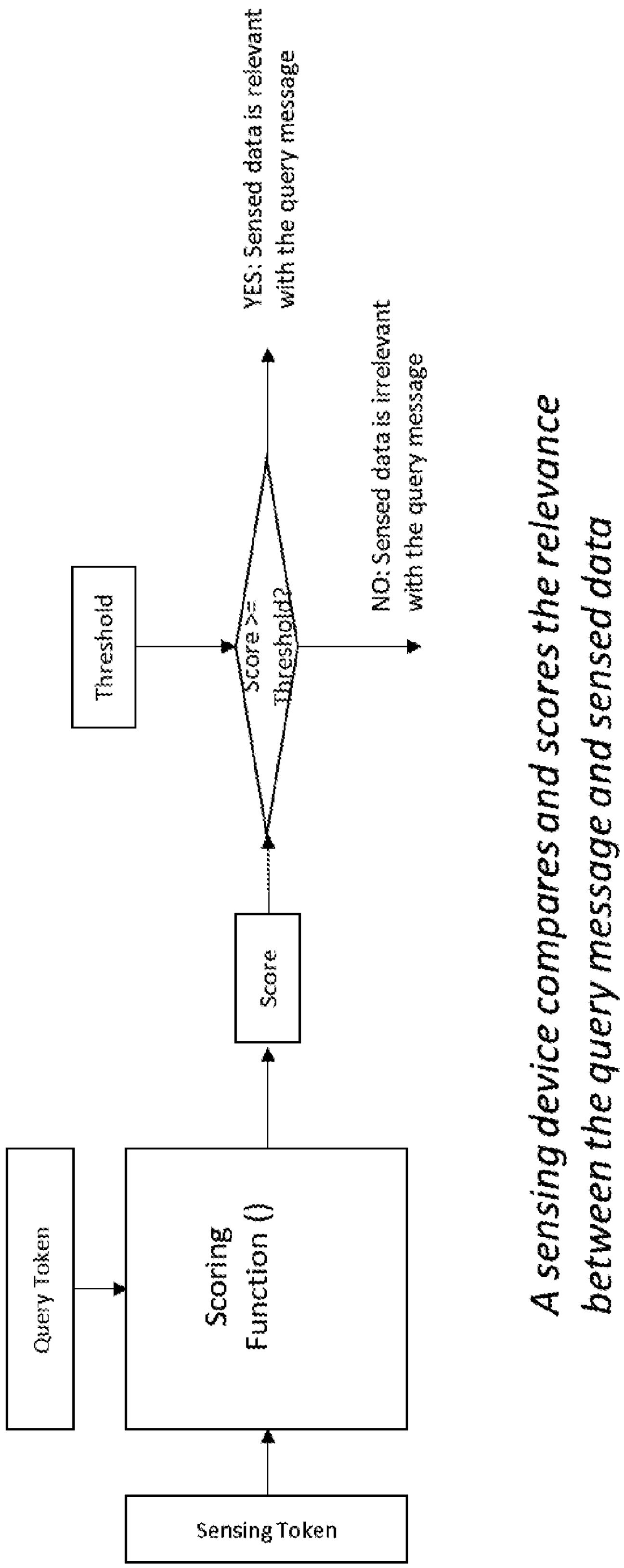
Sensing Token
Query Token
Scoring Function ()
Score
Threshold
Score >= Threshold?
YES: Sensed data is relevant with the query message
NO: Sensed data is irrelevant with the query message
A sensing device compares and scores the relevance between the query message and sensed data

FIG. 20

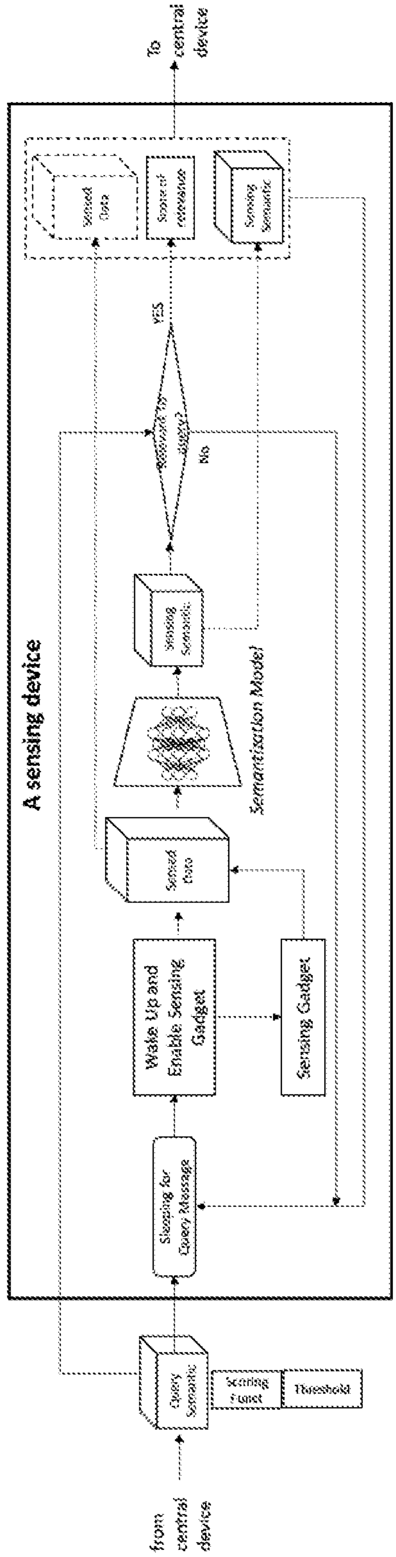
A sensing device
from central device
Query Semantic
Threshold
Sleeping for Query Message
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
Semantisation Model
Sensing Semantic
YES
No
Sensed Data
Sensing Semantic
To central device

FIG. 21

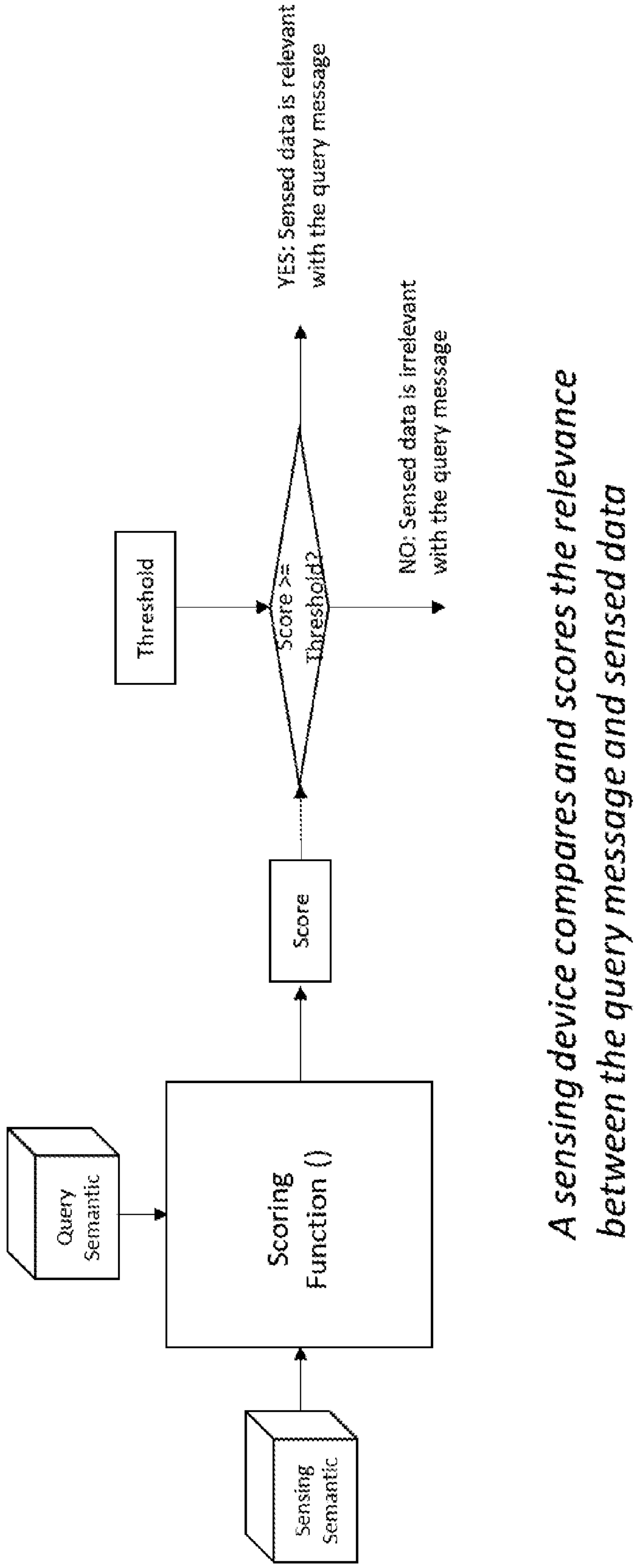
Sensing Semantic
Query Semantic
Scoring Function ()
Score
Threshold
Score >= Threshold?
YES: Sensed data is relevant with the query message
NO: Sensed data is irrelevant with the query message
A sensing device compares and scores the relevance between the query message and sensed data

FIG. 22

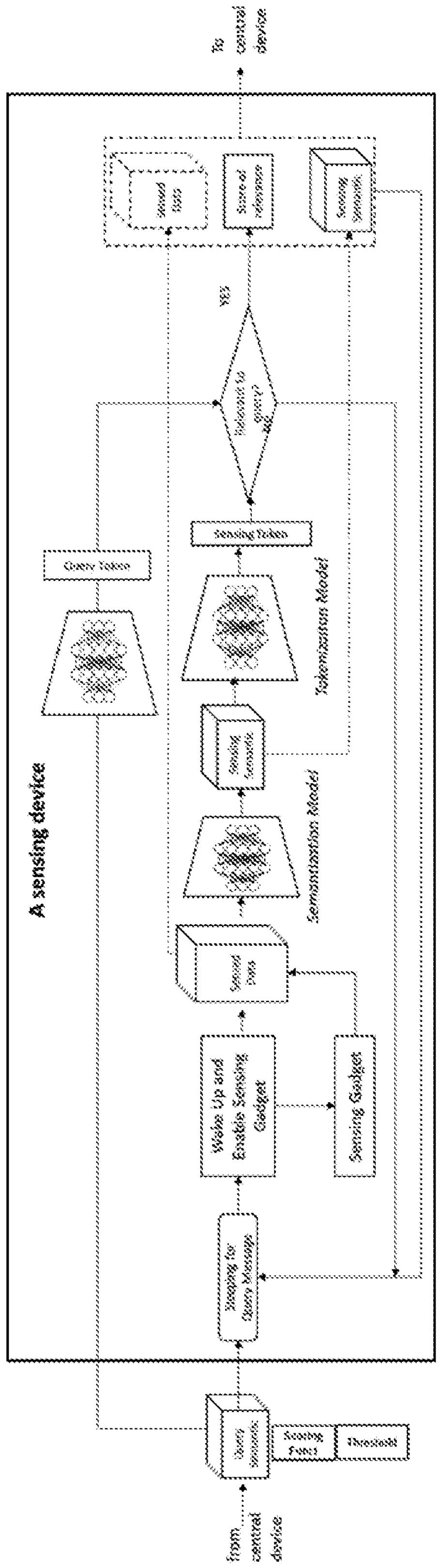
To central device
A sensing device
Query Token
Sensing Token
Relevant to query?
YES
NO
Tokenization Model
Semantization Model
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
Scoring Funct
Threshold
from central device

FIG. 23

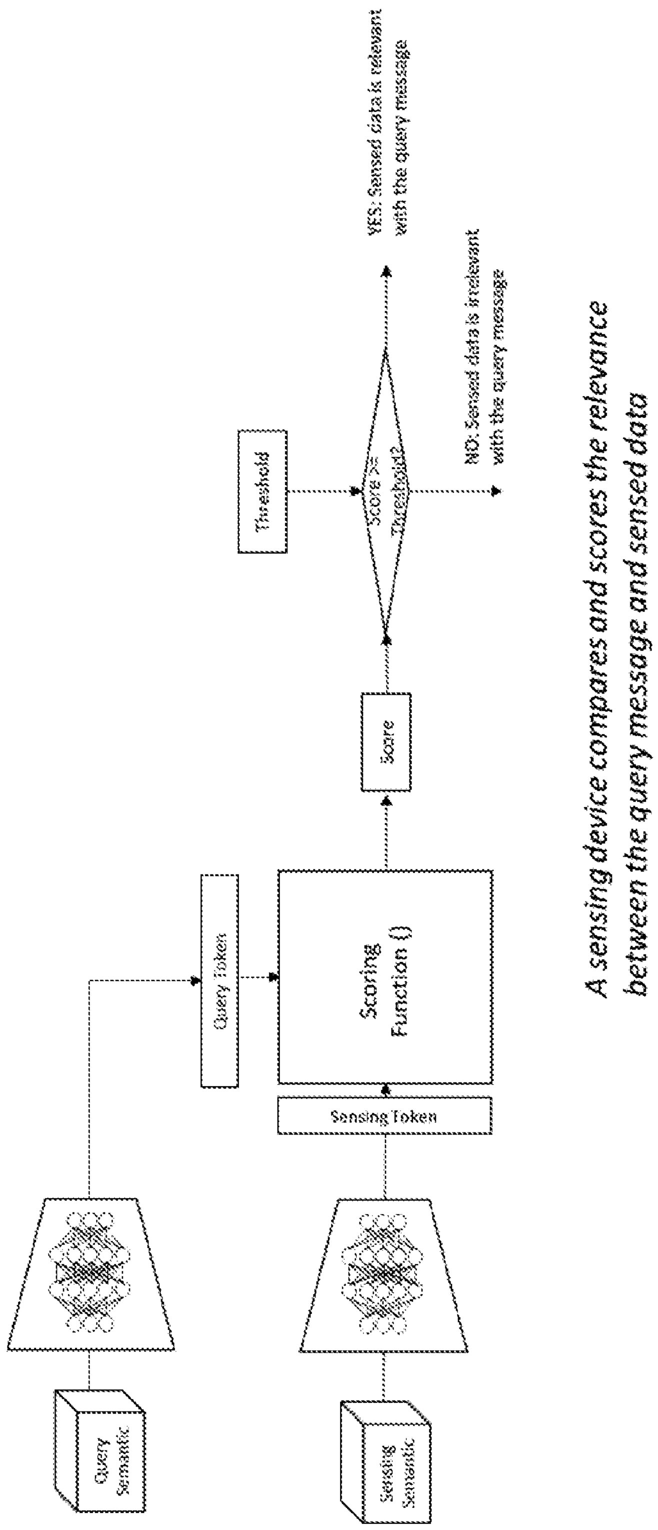
YES: Sensed data is relevant with the query message
NO: Sensed data is irrelevant with the query message
Threshold
Score >= Threshold?
Score
Query Token
Scoring Function ()
Sensing Token
Query Semantic
Sensing Semantic
A sensing device compares and scores the relevance between the query message and sensed data

FIG. 24

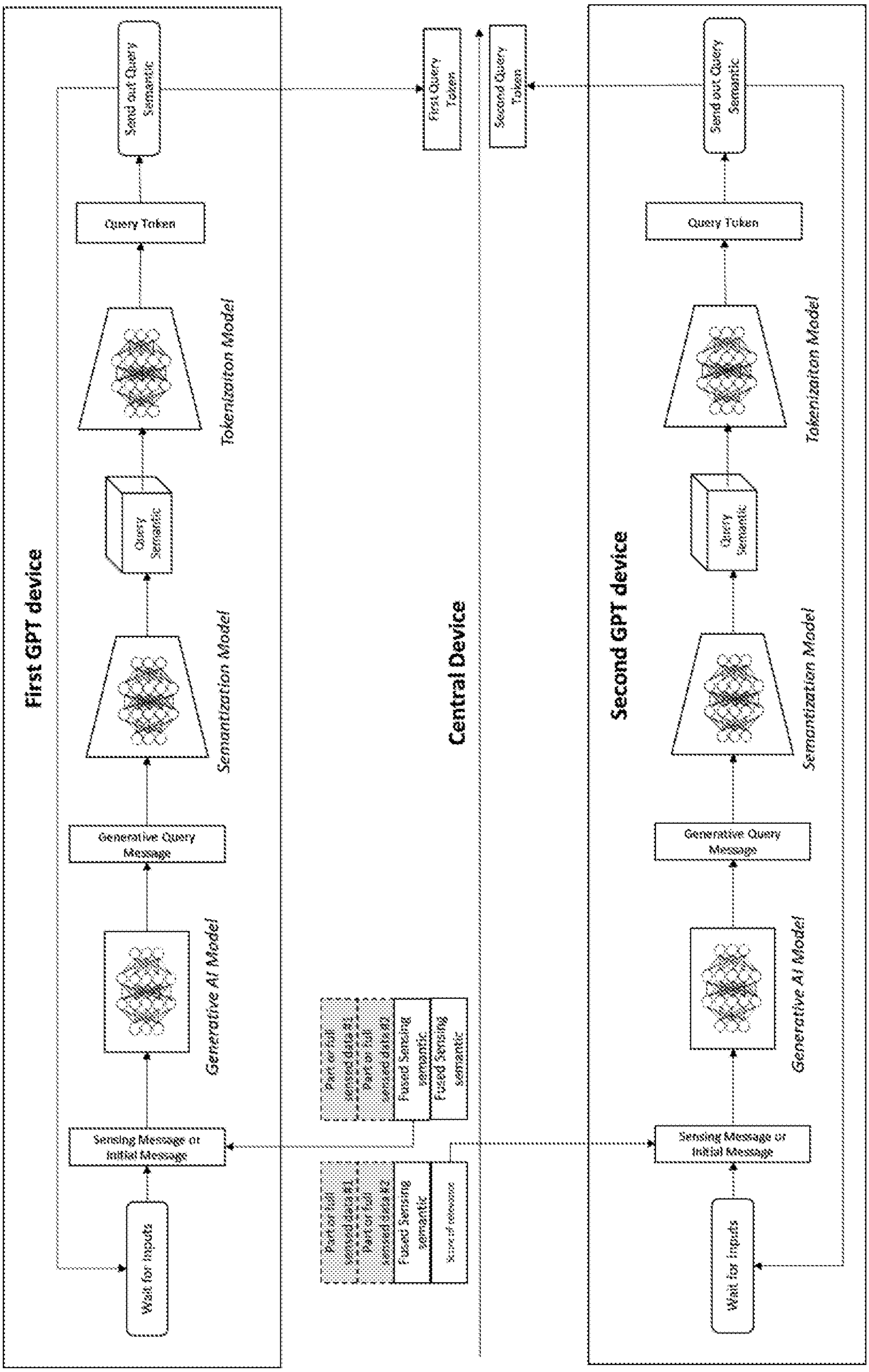
First GPT device
Wait for inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Tokenizaiton Model
Query Token
Send out Query Semantic
Central Device
Part or full sensed data #1
Part or full sensed data #2
Fused Sensing semantic
Score of relevance
Fused Sensing semantic
First Query Token
Second Query Token
Second GPT device
Wait for inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Tokenizaiton Model
Query Token
Send out Query Semantic

FIG. 25

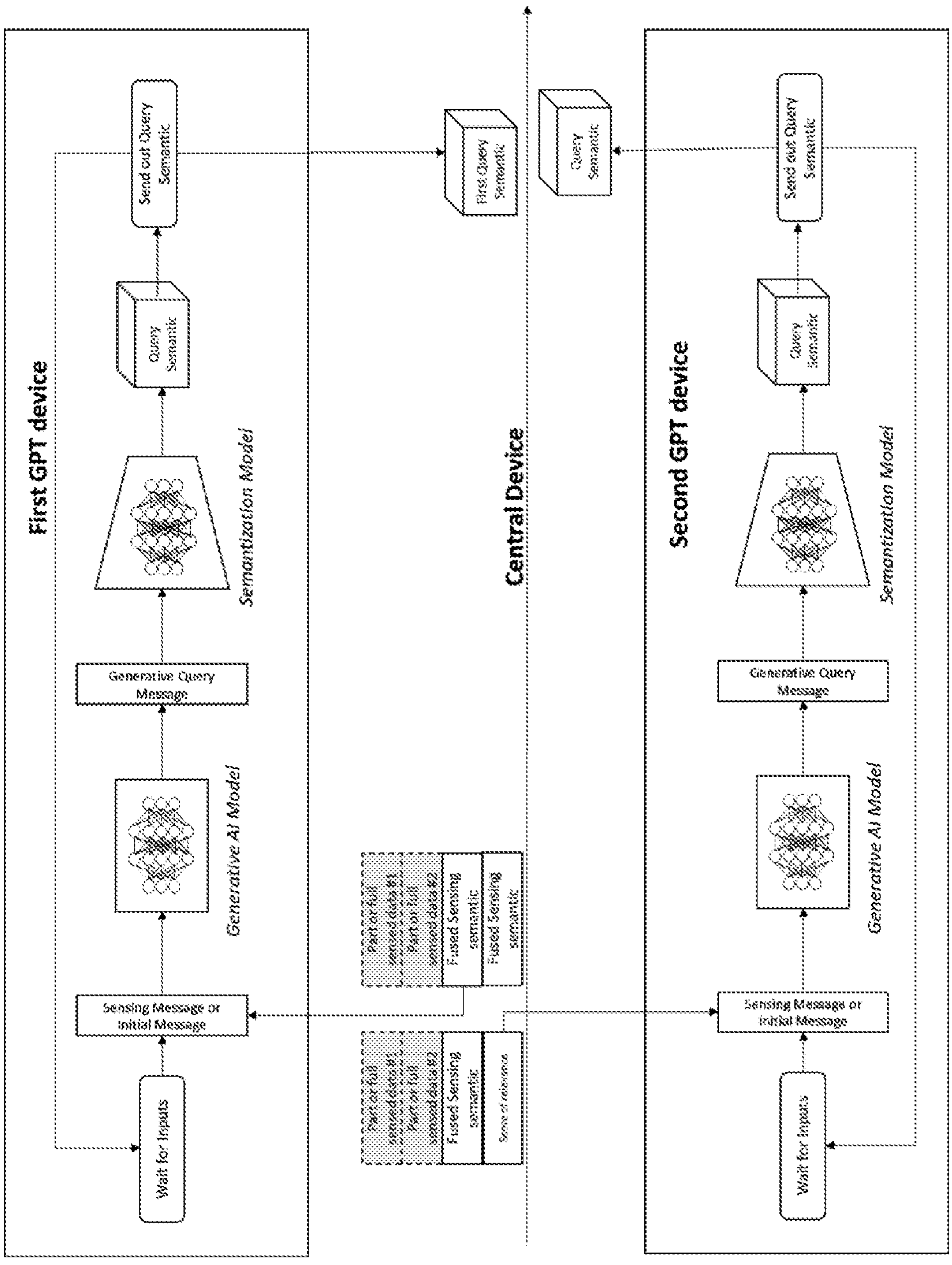
First GPT device
Wait for Inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Send out Query Semantic
Central Device
First Query Semantic
Query Semantic
Fused Sensing semantic
Second GPT device
Wait for Inputs
Sensing Message or Initial Message
Generative AI Model
Generative Query Message
Semantization Model
Query Semantic
Send out Query Semantic

FIG. 26

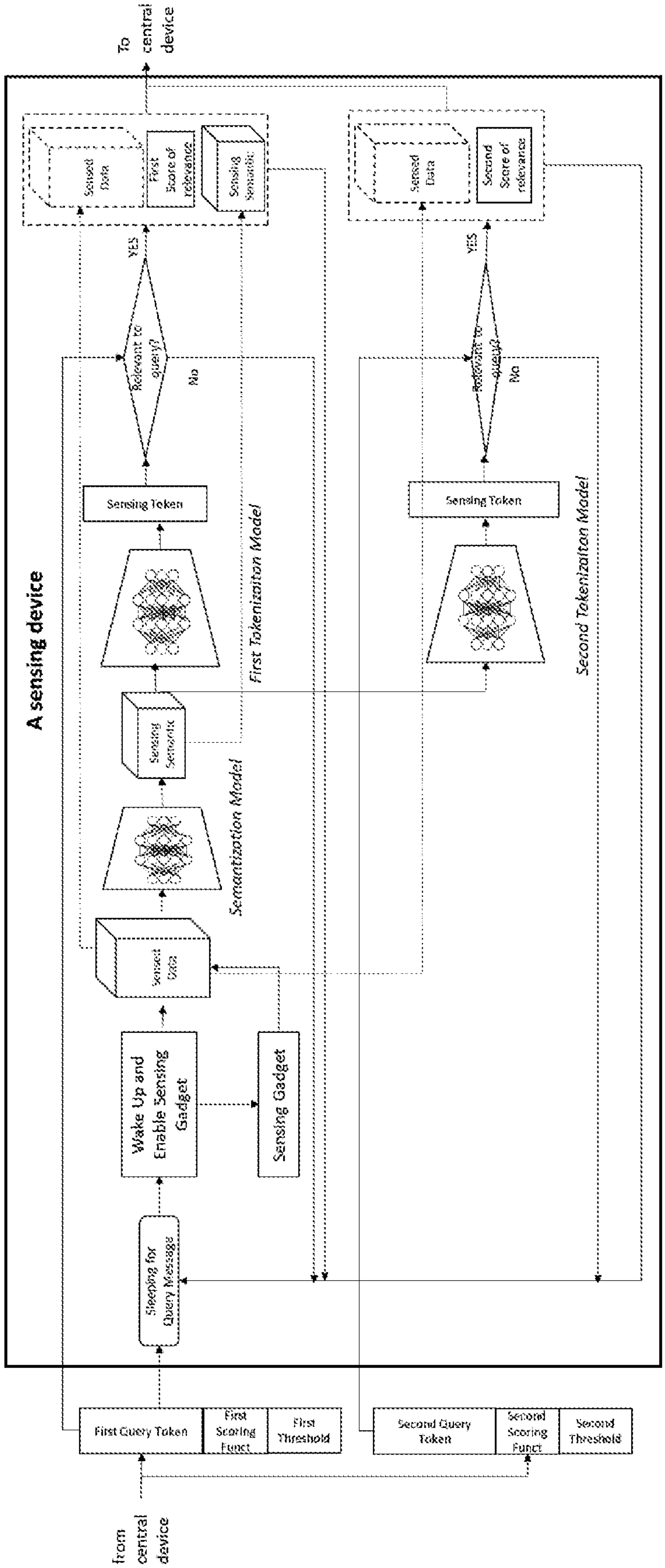
To central device
A sensing device
Sensed Data
First Score of relevance
Sensing Semantic
Second Score of relevance
YES
Relevant to query?
No
Sensing Token
First Tokenizaiton Model
Second Tokenizaiton Model
Semantization Model
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
First Query Token
First Scoring Funct
First Threshold
Second Query Token
Second Scoring Funct
Second Threshold
from central device

FIG. 27

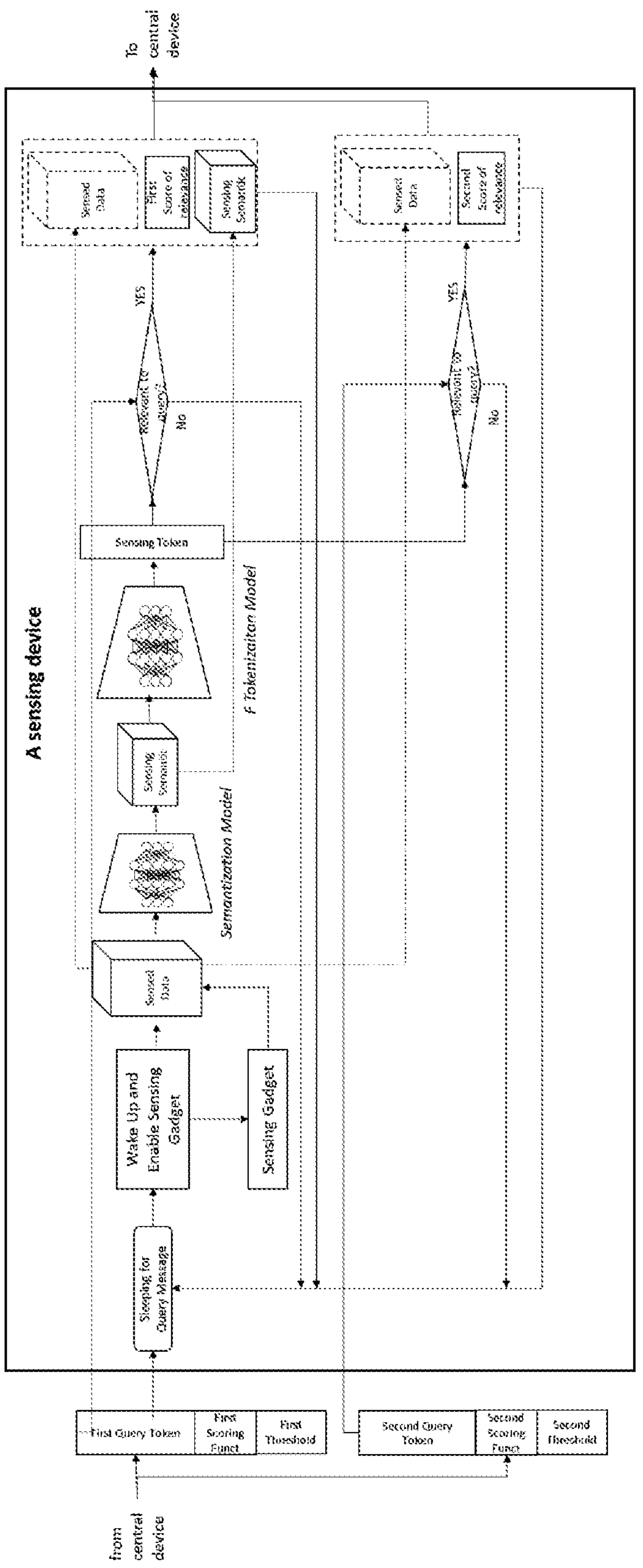
To central device
A sensing device
Sensed Data
First Score of relevance
Sensing Semantic
YES
Relevant to query1
No
Sensing Token
f Tokenizaiton Model
Sensing Semantic
Semantization Model
Sensed Data
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
Sensed Data
Second Score of relevance
YES
Relevant to query2
No
First Query Token
First Scoring Funct
First Threshold
Second Query Token
Second Scoring Func
Second Threshold
from central device

FIG. 28

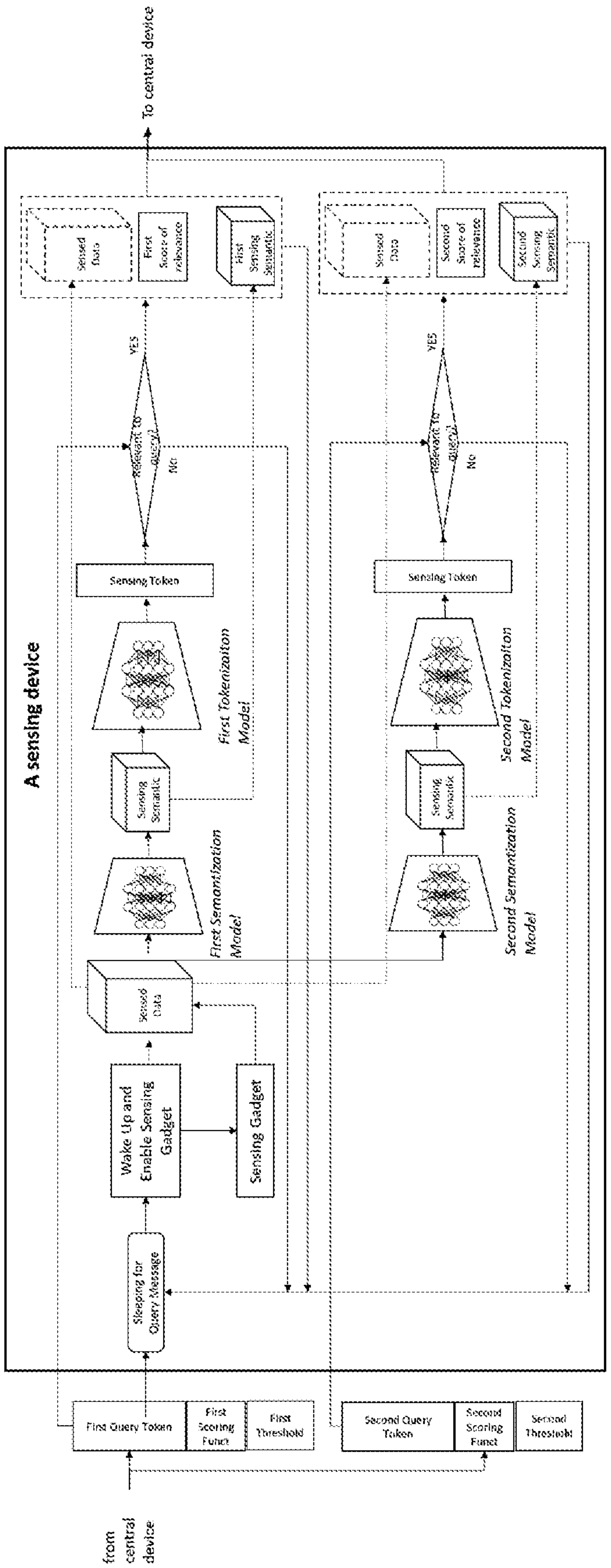
To central device
A sensing device
Sleeping for Query Message
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
First Semantization Model
Sensing Semantic
First Tokenizaiton Model
Sensing Token
Relevant to query?
YES
No
Sensed Data
First Score of relevance
First Sensing Semantic
Second Semantization Model
Sensing Semantic
Second Tokenizaiton Model
Sensing Token
Relevant to query?
YES
No
Sensed Data
Second Score of relevance
Second Sensing Semantic
First Query Token
First Scoring Funct
First Threshold
Second Query Token
Second Scoring Funct
Second Threshold
from central device

FIG. 29

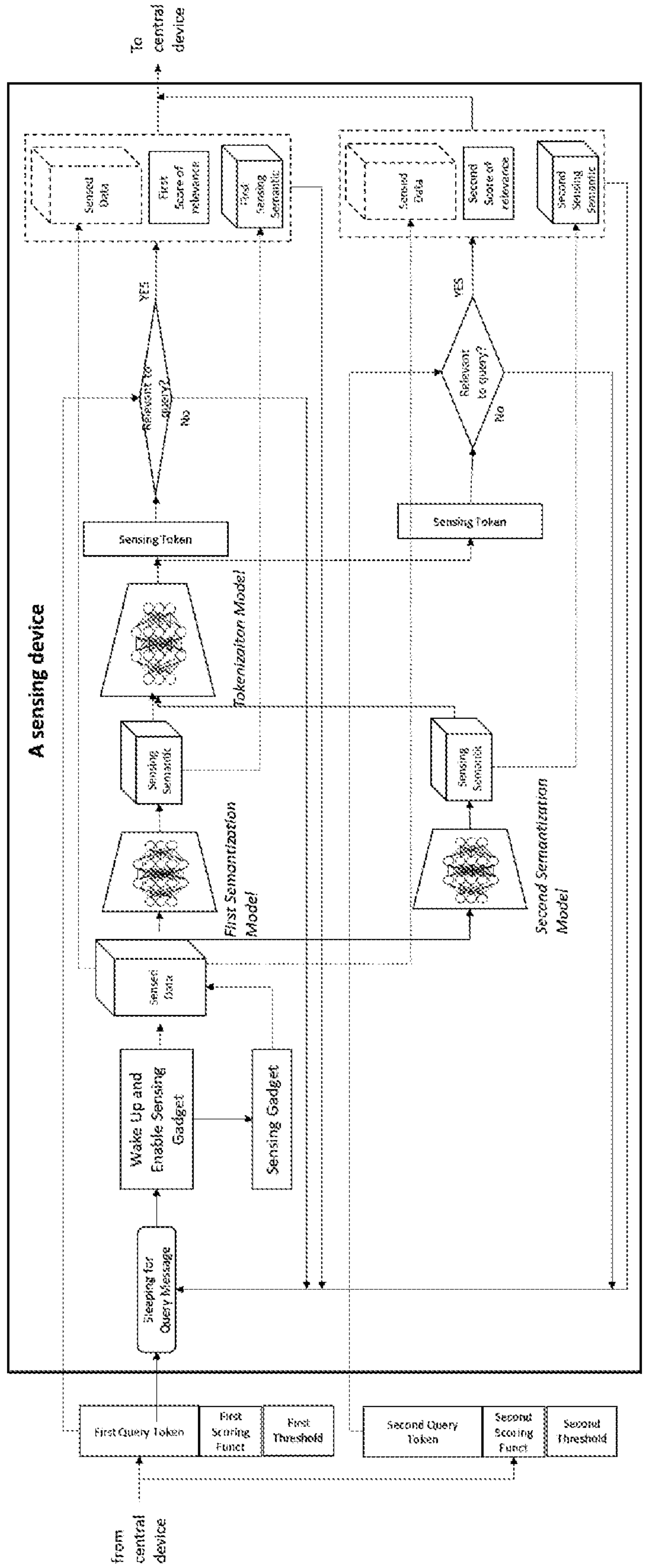
To central device
A sensing device
Sensed Data
First Score of relevance
First Sensing Semantic
Sensed Data
Second Score of relevance
Second Sensing Semantic
YES
Relevant to query?
No
YES
Relevant to query?
No
Sensing Token
Sensing Token
Tokenizaiton Model
Sensing Semantic
Sensing Semantic
First Semantization Model
Second Semantization Model
Sensed Data
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
First Query Token
First Scoring Funct
First Threshold
Second Query Token
Second Scoring Funct
Second Threshold
from central device

FIG. 30

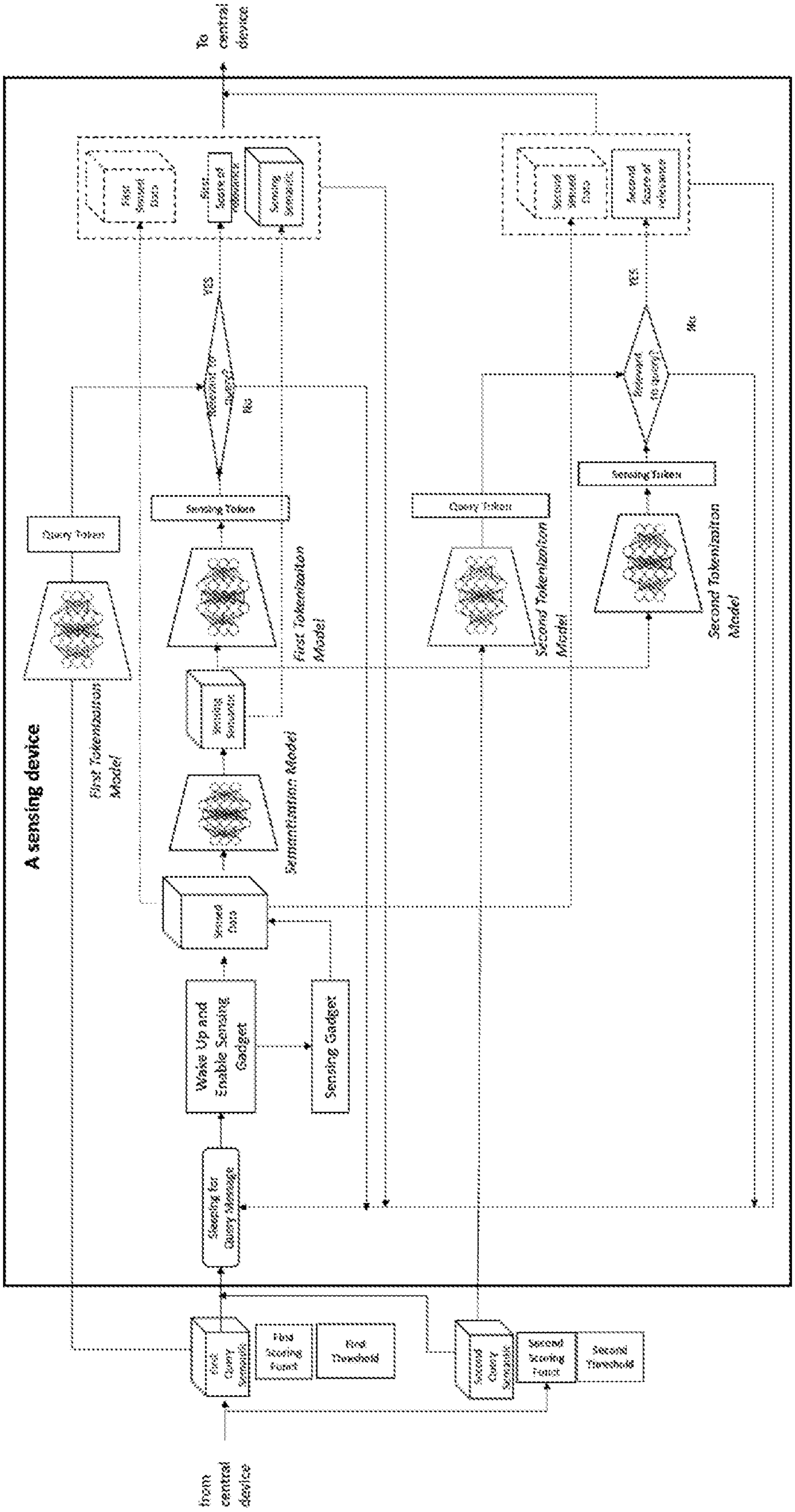
To central device
A sensing device
Query Token
First Tokenization Model
Sensing Token
YES
No
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
Sensing Semantic
Second Tokenization Model
First Threshold
Second Threshold
from central device

FIG. 31

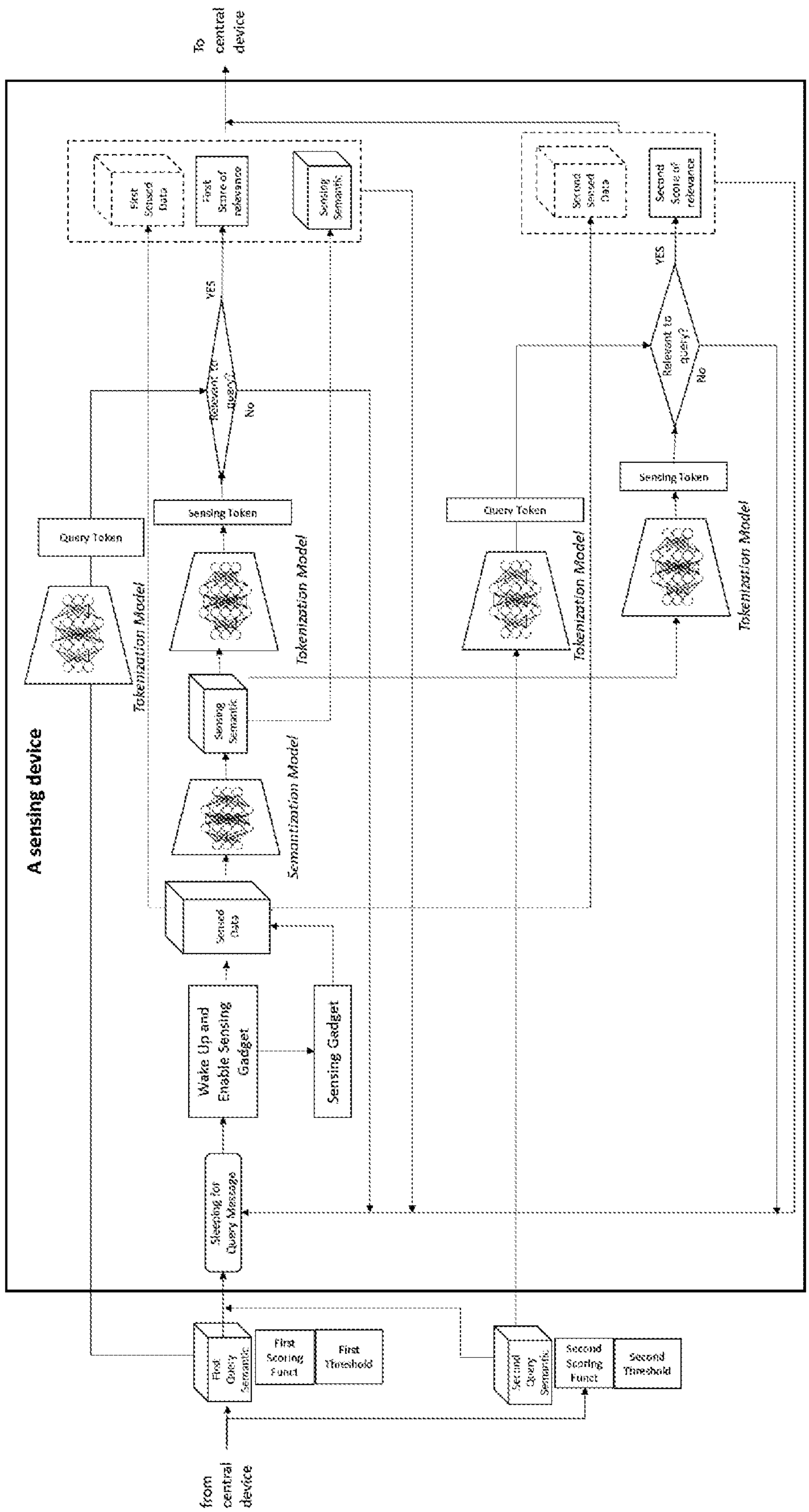
To central device
A sensing device
First Sensed Data
First Score of relevance
Sensing Semantic
Second Sensed Data
Second Score of relevance
YES
Relevant to query?
No
Query Token
Sensing Token
Tokenization Model
Sensing Semantic
Semantization Model
Sensed Data
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sleeping for Query Message
First Query Semantic
First Scoring Funct
First Threshold
Second Query Semantic
Second Scoring Funct
Second Threshold
from central device

FIG. 32

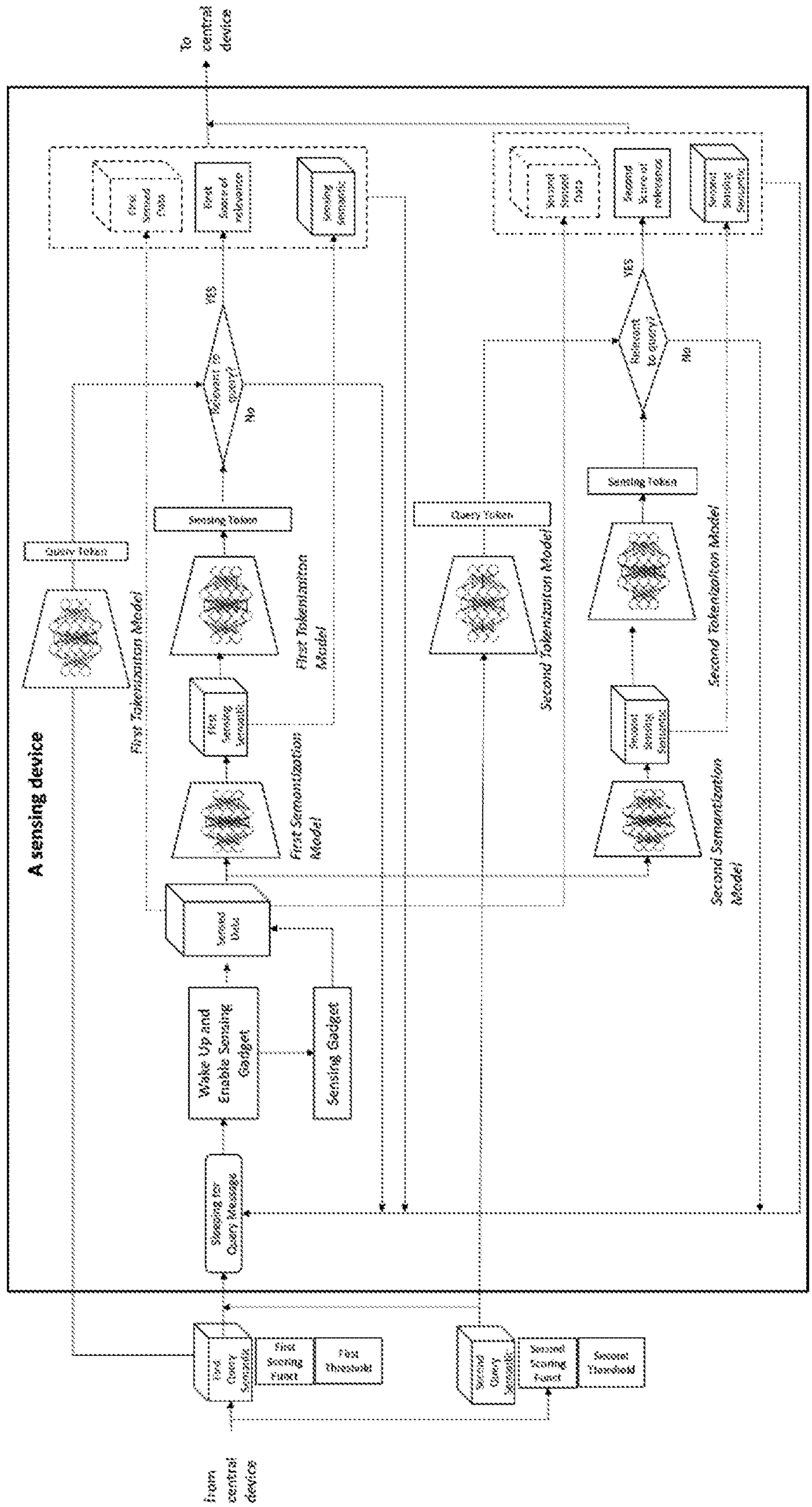
To central device
A sensing device
from central device
Sleeping for Query Message
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
First Semantization Model
First Sensing Semantic
First Tokenization Model
Sensing Token
Query Token
Relevant to query?
YES
No
Second Semantization Model
Second Sensing Semantic
Second Tokenization Model
Second Threshold
First Threshold

FIG. 33

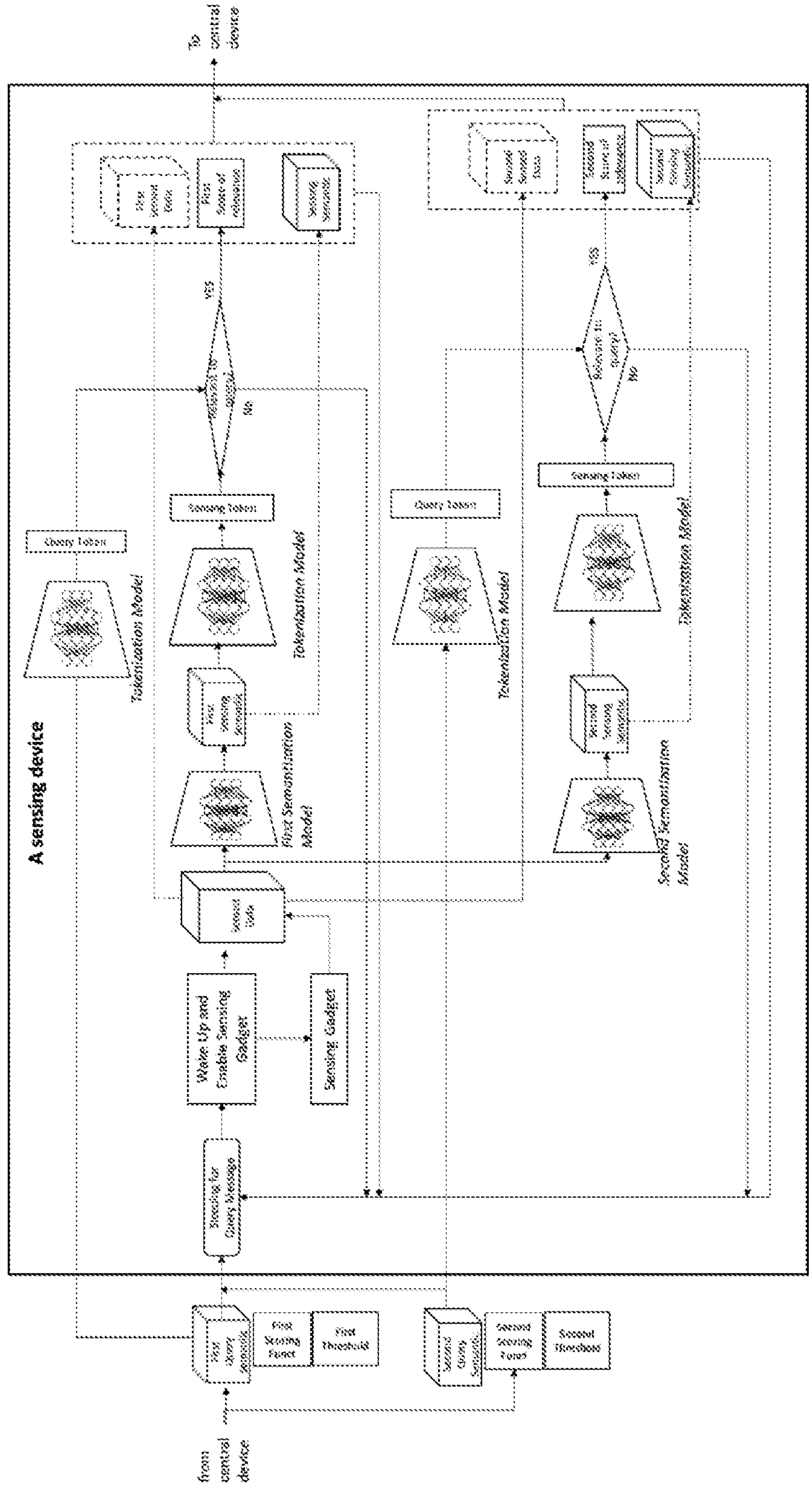
to central device
A sensing device
Wake Up and Enable Sensing Gadget
Sensing Gadget
Query Token
Sensing Token
Tokenization Model
First Semantization Model
Second Semantization Model
YES
NO
First Threshold
Second Threshold
from central device

FIG. 34

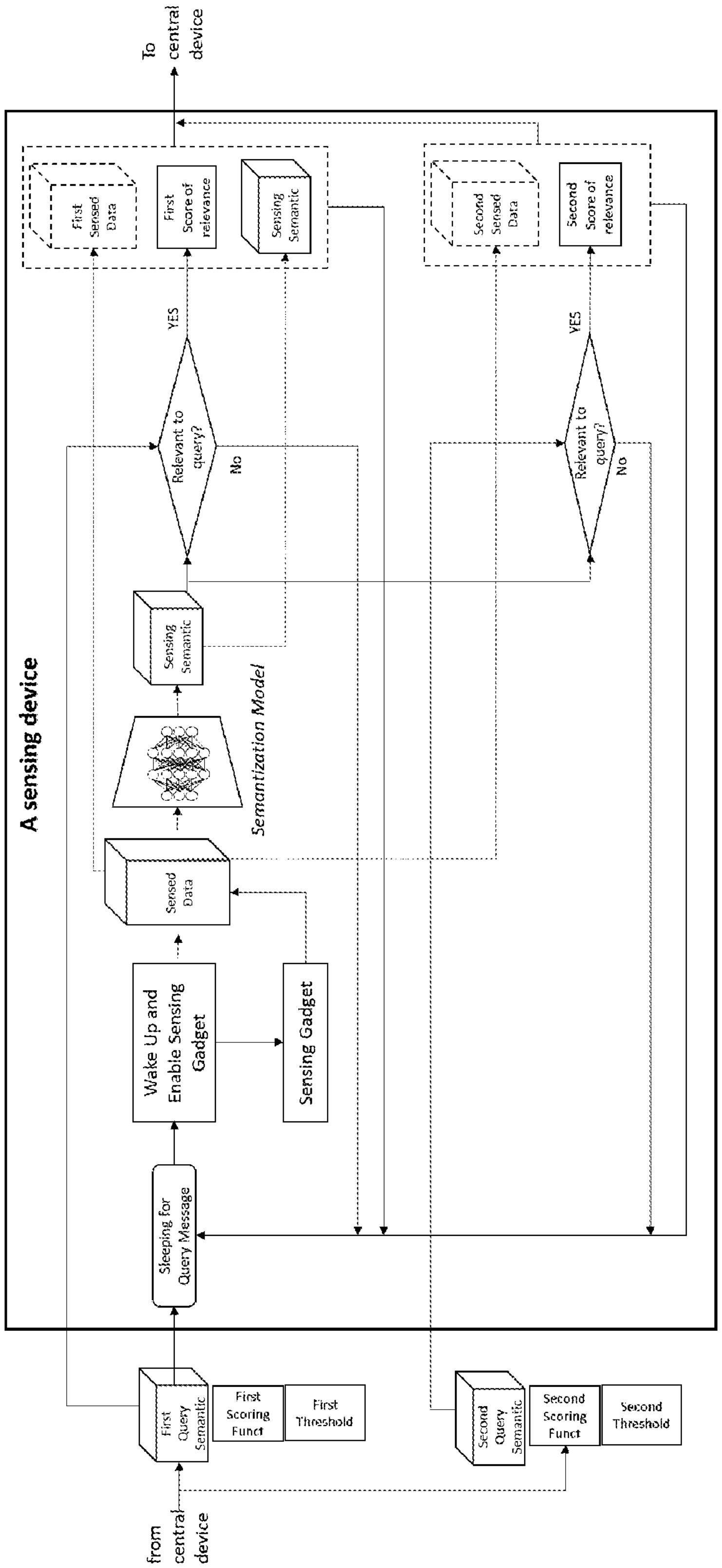
To central device
A sensing device
Sleeping for Query Message
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
Semantization Model
Sensing Semantic
Relevant to query?
YES
No
First Sensed Data
First Score of relevance
Sensing Semantic
Relevant to query?
YES
No
Second Sensed Data
Second Score of relevance
First Query Semantic
First Scoring Funct
First Threshold
Second Query Semantic
Second Scoring Funct
Second Threshold
from central device

FIG. 35

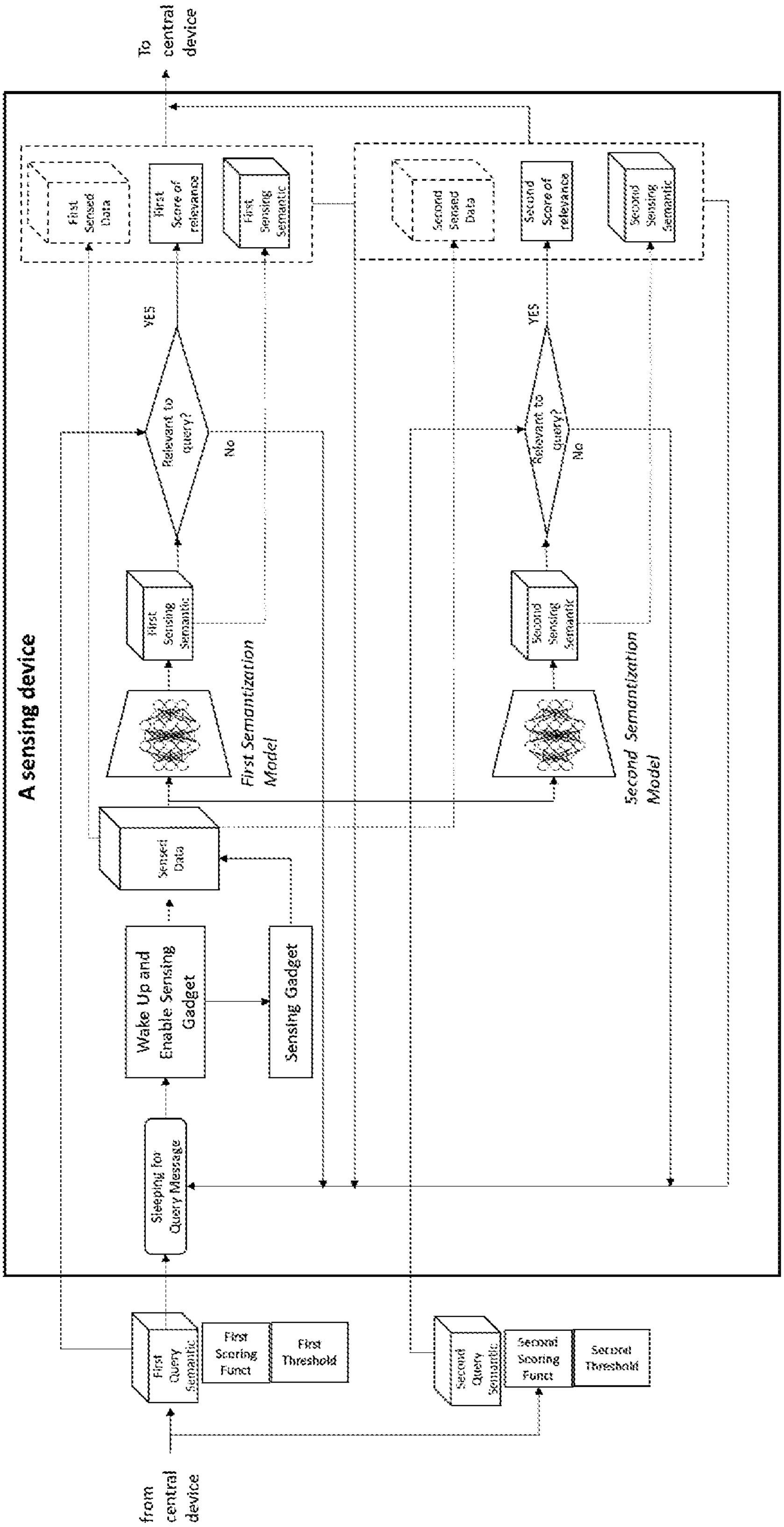
To central device
A sensing device
Sleeping for Query Message
Wake Up and Enable Sensing Gadget
Sensing Gadget
Sensed Data
First Semantization Model
First Sensing Semantic
Relevant to query?
YES
No
First Sensed Data
First Score of relevance
First Sensing Semantic
Second Semantization Model
Second Sensing Semantic
Second Sensed Data
Second Score of relevance
Second Sensing Semantic
First Query Semantic
First Scoring Funct
First Threshold
Second Query Semantic
Second Scoring Funct
Second Threshold
from central device

FIG. 36

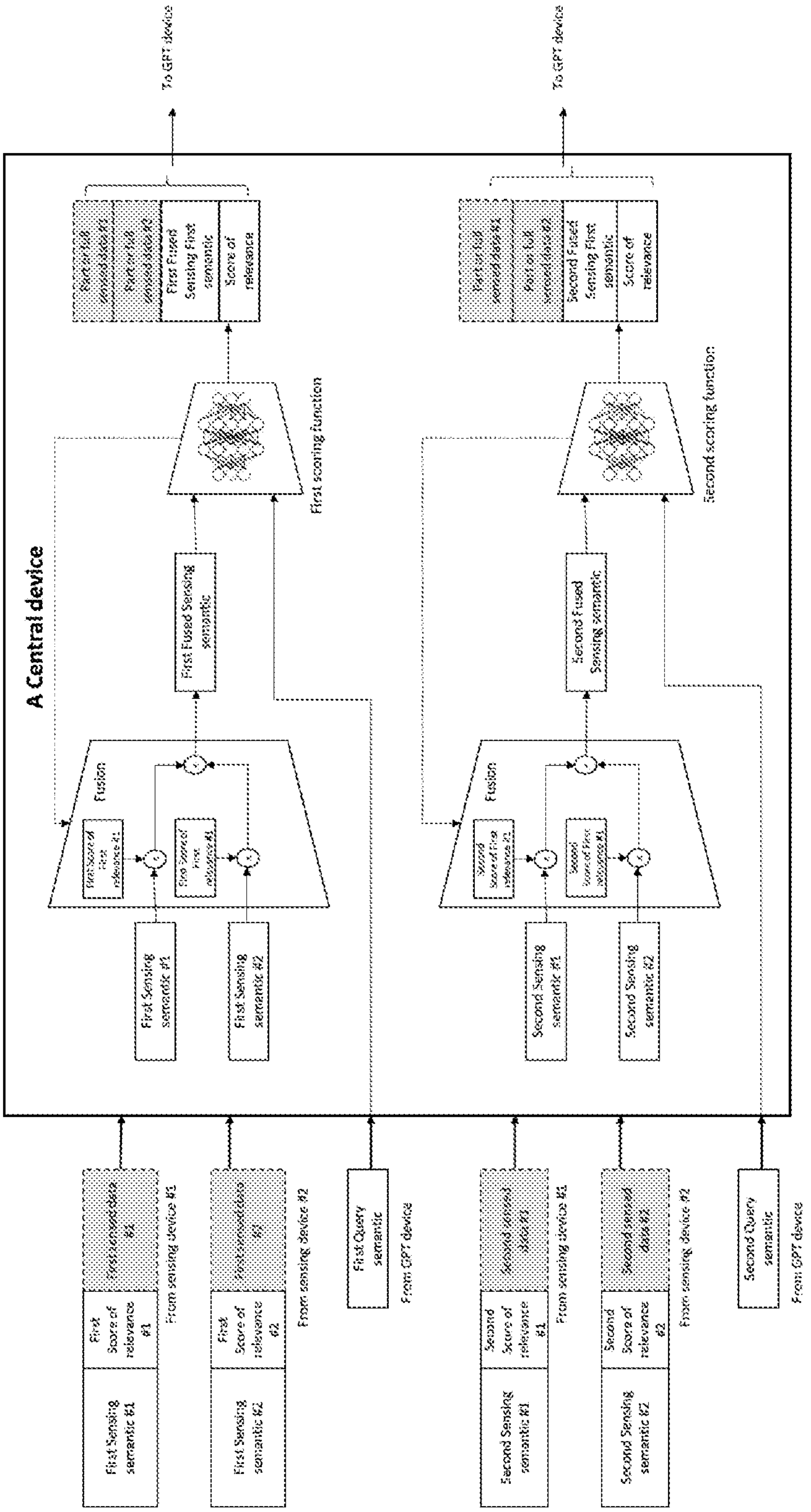
A Central device
Fusion
First scoring function
Second scoring function
To GPT device
To GPT device
First Fused Sensing semantic
Second Fused Sensing semantic
First Sensing semantic #1
First Sensing semantic #2
Second Sensing semantic #1
Second Sensing semantic #2
First Score of relevance #1
First Score of relevance #2
Second Score of relevance #1
Second Score of relevance #2
From sensing device #1
From sensing device #2
From sensing device #1
From sensing device #2
First Query semantic
Second Query semantic
From GPT device
From GPT device
Score of relevance
Score of relevance

FIG. 37

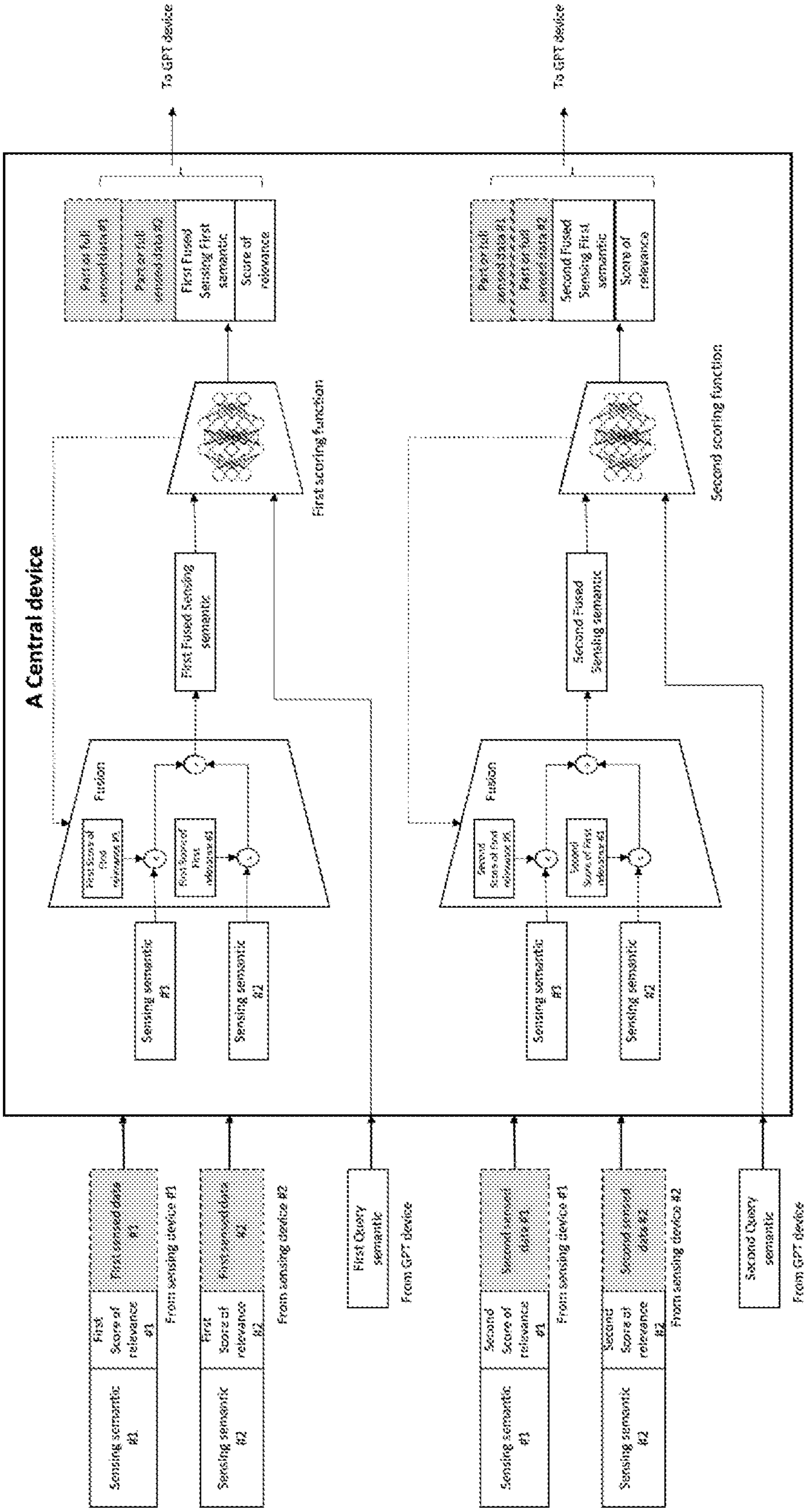
A Central device
To GPT device
To GPT device
First Fused Sensing First semantic
Score of relevance
Second Fused Sensing First semantic
Score of relevance
First scoring function
Second scoring function
First Fused Sensing semantic
Second Fused Sensing semantic
Fusion
Fusion
Sensing semantic #1
Sensing semantic #2
Sensing semantic #1
Sensing semantic #2
First Score of relevance #1
First Score of relevance #2
Second Score of relevance #1
Second Score of relevance #2
From sensing device #1
From sensing device #2
From sensing device #1
From sensing device #2
First Query semantic
From GPT device
Second Query semantic
From GPT device

FIG. 38

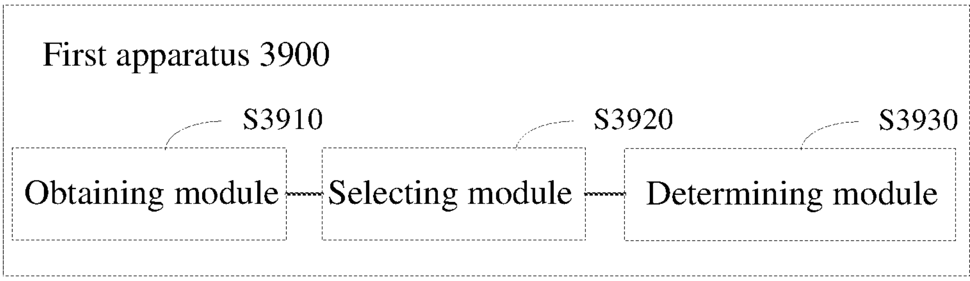
First apparatus 3900
S3910
S3920
S3930
Obtaining module
Selecting module
Determining module

FIG. 39

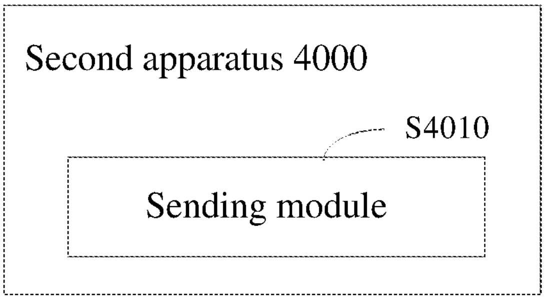
Second apparatus 4000
S4010
Sending module

FIG. 40

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/128893

A. CLASSIFICATION OF SUBJECT MATTER

H04W4/021(2018.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04W,H04Q

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

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

3GPP,CNTXT,ENTXT,ENTXTC,DWPI,WPABS:task,indication,indicator,support,type,area,cell,interested,semantic,sensing, measure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2021159307 A1 (APPLE INC.) 19 August 2021 (2021-08-19) description, paragraphs [0015], [0031]-[0062]	1-82
A	CN 115735380 A (QUALCOMM INCORPORATED) 03 March 2023 (2023-03-03) the whole document	1-82
A	CN 116134896 A (SHARP KABUSHIKI KAISHA) 16 May 2023 (2023-05-16) the whole document	1-82
A	US 2014341116 A1 (ZTE CORPORATION) 20 November 2014 (2014-11-20) the whole document	1-82
A	US 2023007503 A1 (QUALCOMM INCORPORATED) 05 January 2023 (2023-01-05) the whole document	1-82
A	US 2023171020 A1 (LENOVO (SINGAPORE) PTE. LTD.) 01 June 2023 (2023-06-01) the whole document	1-82
A	HUAWEI et al. "R2-1911084,Cell reselection for V2X SL communication in NR" *3GPP TSG-RAN WG2 Meeting#106,* 30 August 2019 (2019-08-30), the whole document	1-82

☐ 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
- "D" document cited by the applicant in the international application
- "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
31 January 2024	**07 February 2024**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**FENG,Ji** Telephone No. **(+86) 010-53961610**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/128893

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2021159307	A1	19 August 2021	EP	4104510	A1	21 December 2022
				BR	112022015612	A2	27 September 2022
				CL	2022002172	A1	03 March 2023
				KR	20220124239	A	13 September 2022
				US	2022377659	A1	24 November 2022
				CN	115088303	A	20 September 2022
CN	115735380	A	03 March 2023	WO	2021223204	A1	11 November 2021
				EP	4147485	A1	15 March 2023
CN	116134896	A	16 May 2023	WO	2022030523	A1	10 February 2022
				US	2023308963	A1	28 September 2023
				EP	4193687	A1	14 June 2023
US	2014341116	A1	20 November 2014	EP	2793505	A1	22 October 2014
				JP	2015511420	A	16 April 2015
				WO	2013107155	A1	25 July 2013
				CN	103220711	A	24 July 2013
US	2023007503	A1	05 January 2023	None			
US	2023171020	A1	01 June 2023	WO	2023100116	A1	08 June 2023