US 20240214858A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2024/0214858 A1
(43) Pub. Date: Jun. 27, 2024
CHOI

(54) **ELECTRONIC DEVICE AND TRAFFIC CONTROL METHOD**

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(21) Appl. No.: **18/598,247**

(22) Filed: **Mar. 7, 2024**

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/010890, filed on Jul. 25, 2022.

(30) **Foreign Application Priority Data**

Sep. 7, 2021 (KR) 10-2021-0119328

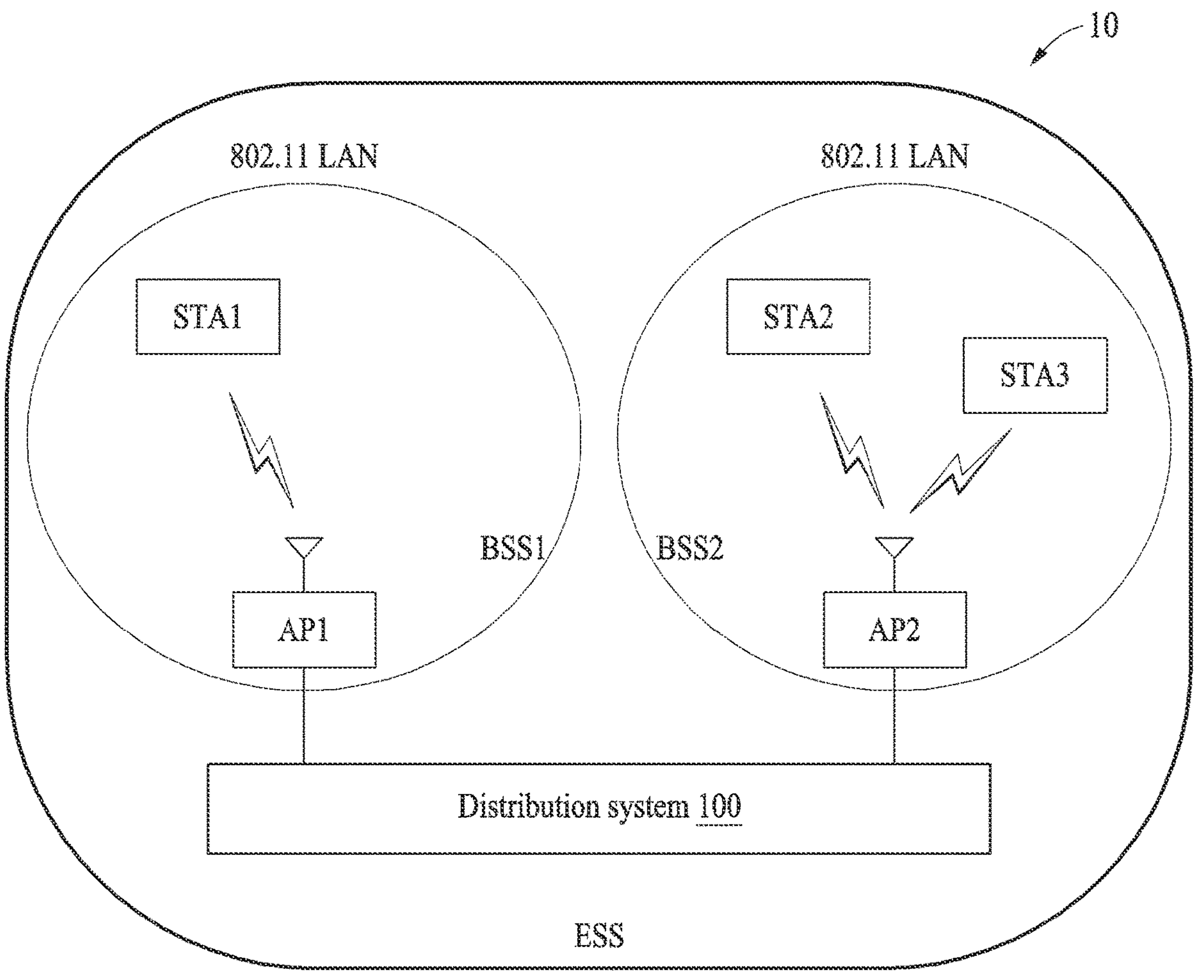
Publication Classification

(51) **Int. Cl.**
H04W 28/02 (2006.01)
H04W 52/02 (2006.01)
H04W 84/12 (2006.01)

(52) **U.S. Cl.**
CPC ... ***H04W 28/0215*** (2013.01); ***H04W 52/0251*** (2013.01); *H04W 84/12* (2013.01)

(57) **ABSTRACT**

An electronic device includes a temperature sensor located in the electronic device; a wireless communication module configured to transmit and receive a wireless signal; a processor operatively connected to the wireless communication module; and a memory electrically connected to the processor and storing instructions executable by the processor. The instructions, when executed by the processor, cause the electronic device to determine a target wake time (TWT) parameter differently according to a heat state of the electronic device based on a temperature of the electronic device, and use the TWT parameter to perform a TWT negotiation with an external electronic device through the wireless communication module.



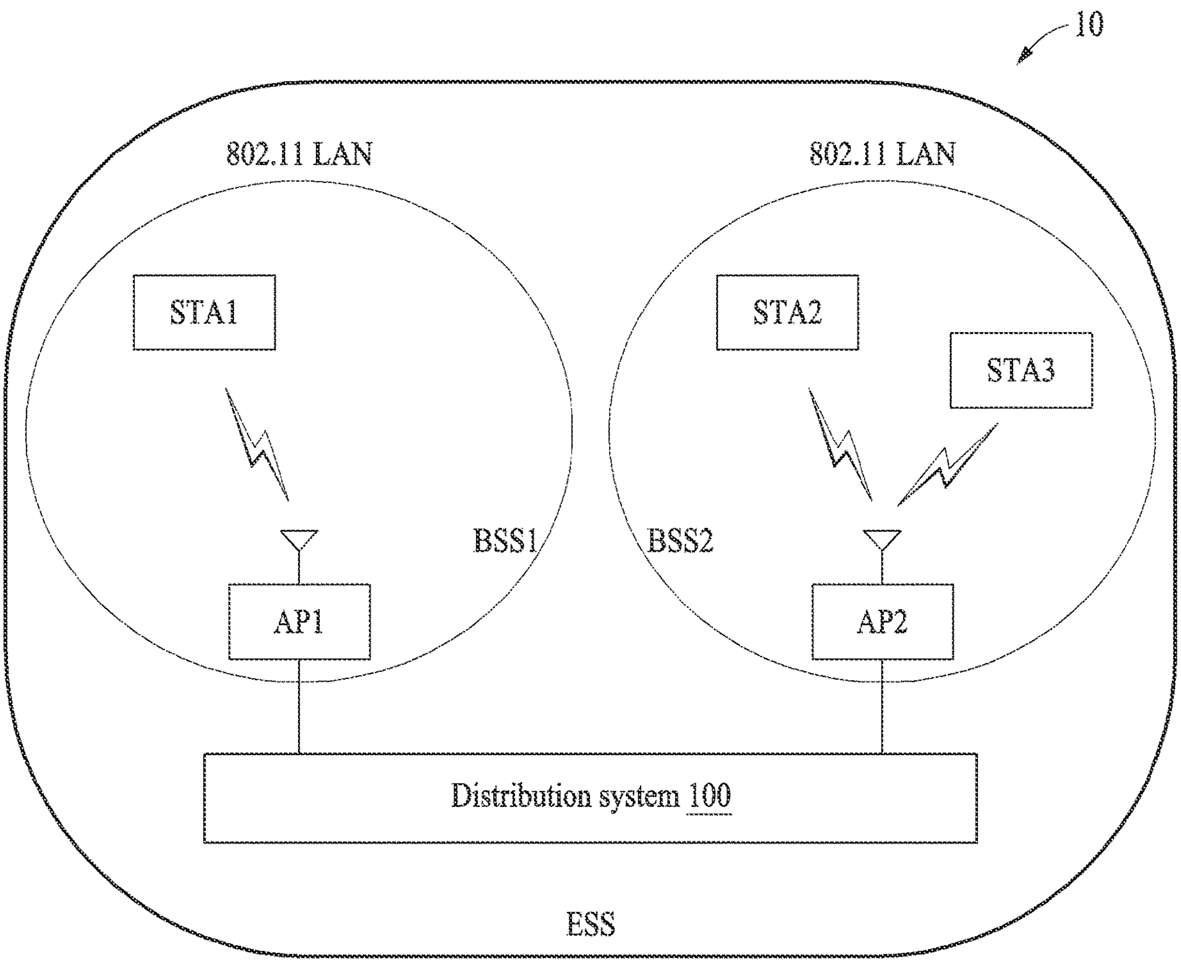

10
802.11 LAN
802.11 LAN
STA1
STA2
STA3
BSS1
BSS2
AP1
AP2
Distribution system 100
ESS

FIG. 1

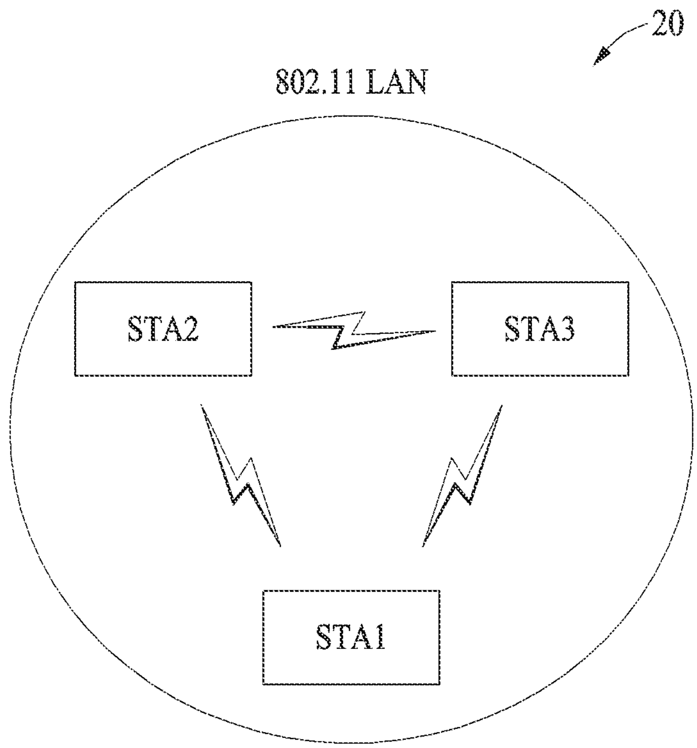


FIG. 2

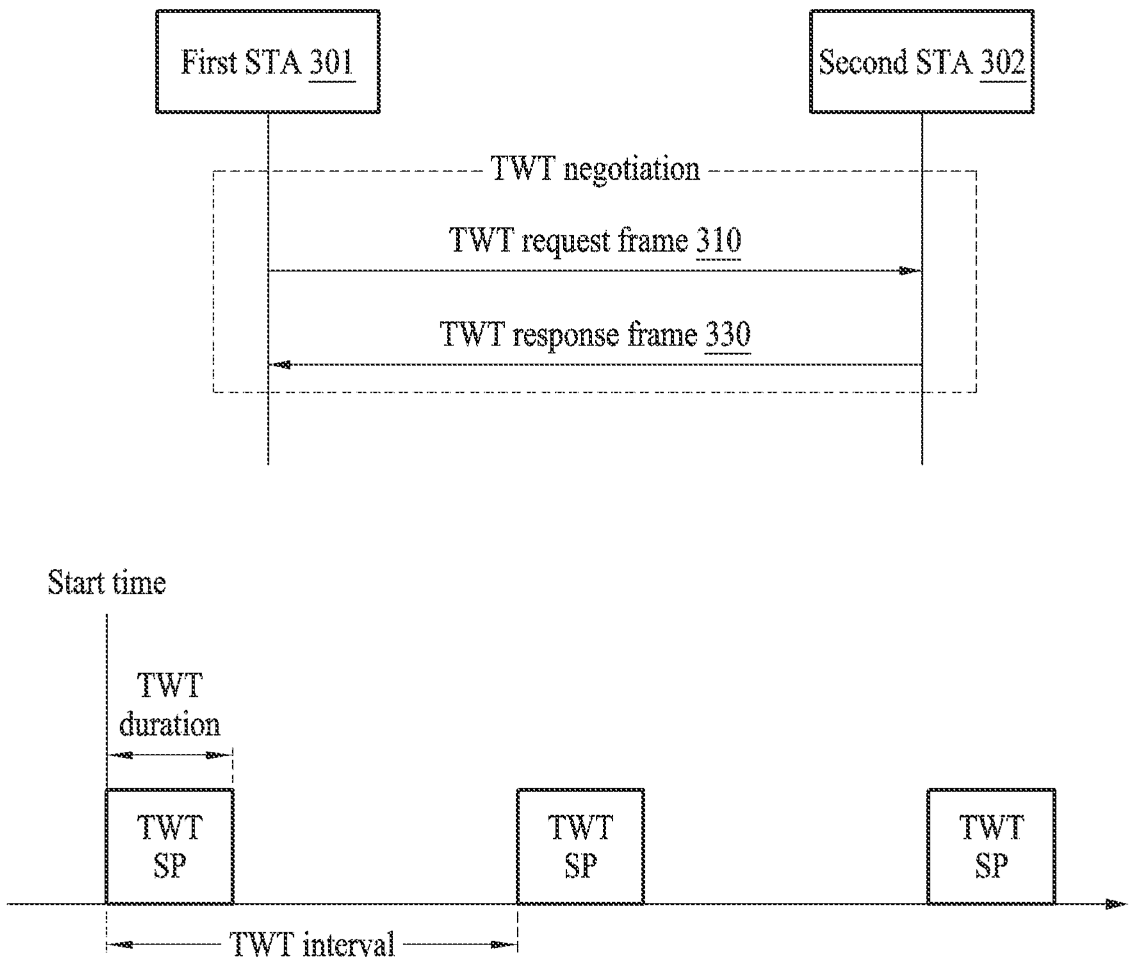

First STA 301
Second STA 302
TWT negotiation
TWT request frame 310
TWT response frame 330
Start time
TWT
duration
TWT
SP
TWT
SP
TWT
SP
TWT interval

FIG. 3

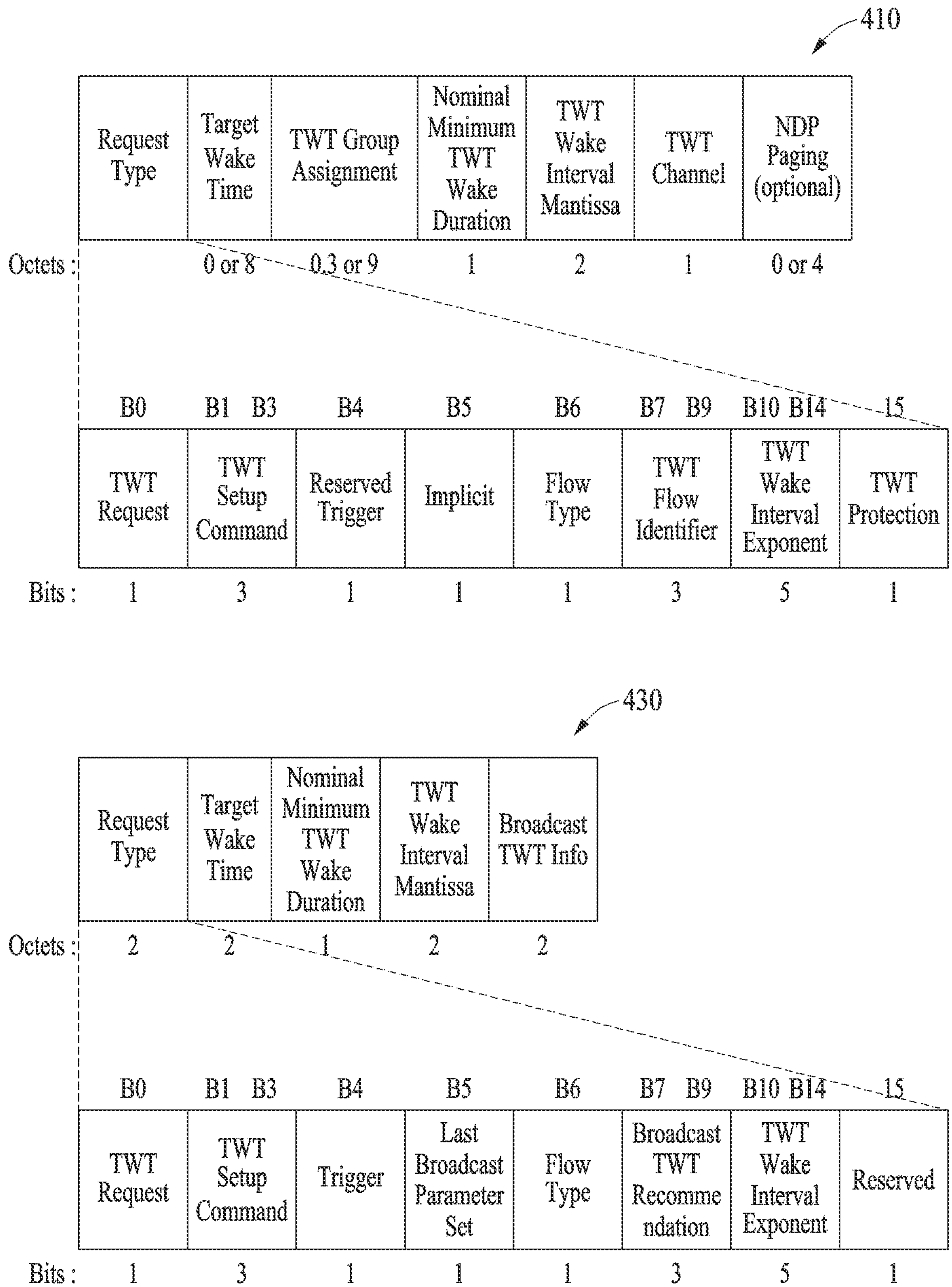

410
Request Type
Target Wake Time
TWT Group Assignment
Nominal Minimum TWT Wake Duration
TWT Wake Interval Mantissa
TWT Channel
NDP Paging (optional)
Octets :
0 or 8
0,3 or 9
1
2
1
0 or 4
B0
B1 B3
B4
B5
B6
B7 B9
B10 B14
15
TWT Request
TWT Setup Command
Reserved Trigger
Implicit
Flow Type
TWT Flow Identifier
TWT Wake Interval Exponent
TWT Protection
Bits :
1
3
1
1
1
3
5
1
430
Request Type
Target Wake Time
Nominal Minimum TWT Wake Duration
TWT Wake Interval Mantissa
Broadcast TWT Info
Octets :
2
2
1
2
2
B0
B1 B3
B4
B5
B6
B7 B9
B10 B14
15
TWT Request
TWT Setup Command
Trigger
Last Broadcast Parameter Set
Flow Type
Broadcast TWT Recommendation
TWT Wake Interval Exponent
Reserved
Bits :
1
3
1
1
1
3
5
1

FIG. 4

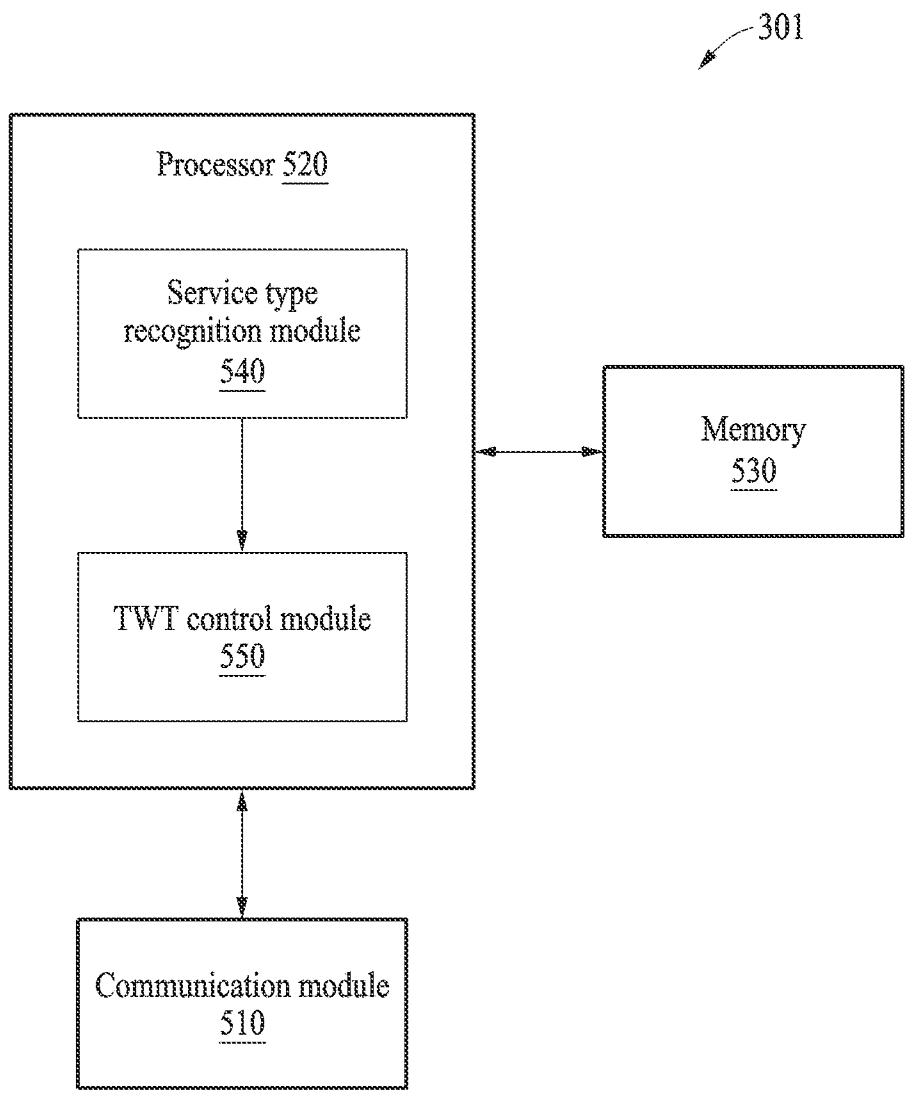

301
Processor 520
Service type recognition module 540
TWT control module 550
Memory 530
Communication module 510

FIG. 5

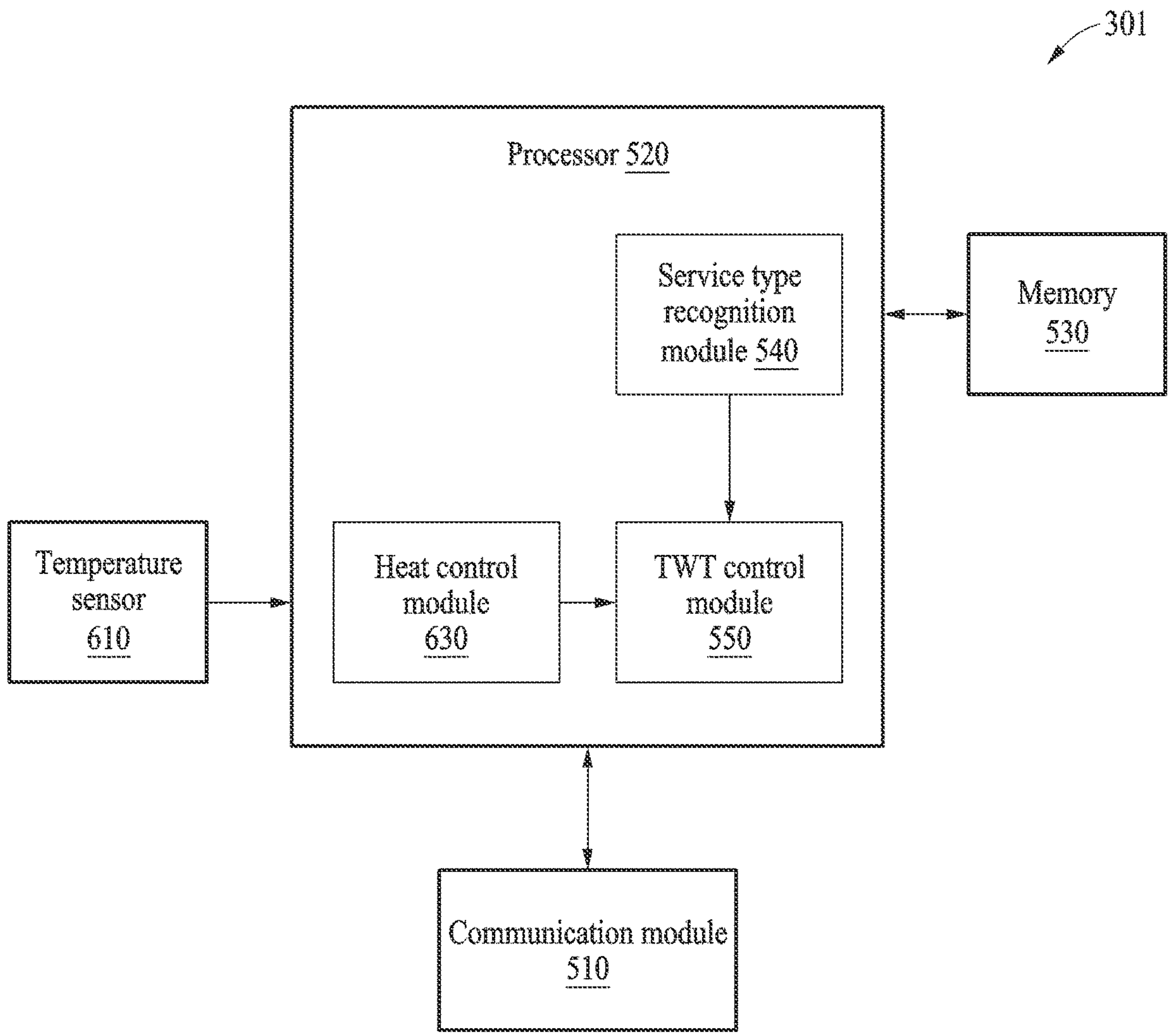

301
Processor 520
Service type recognition module 540
Memory 530
Temperature sensor 610
Heat control module 630
TWT control module 550
Communication module 510

FIG. 6

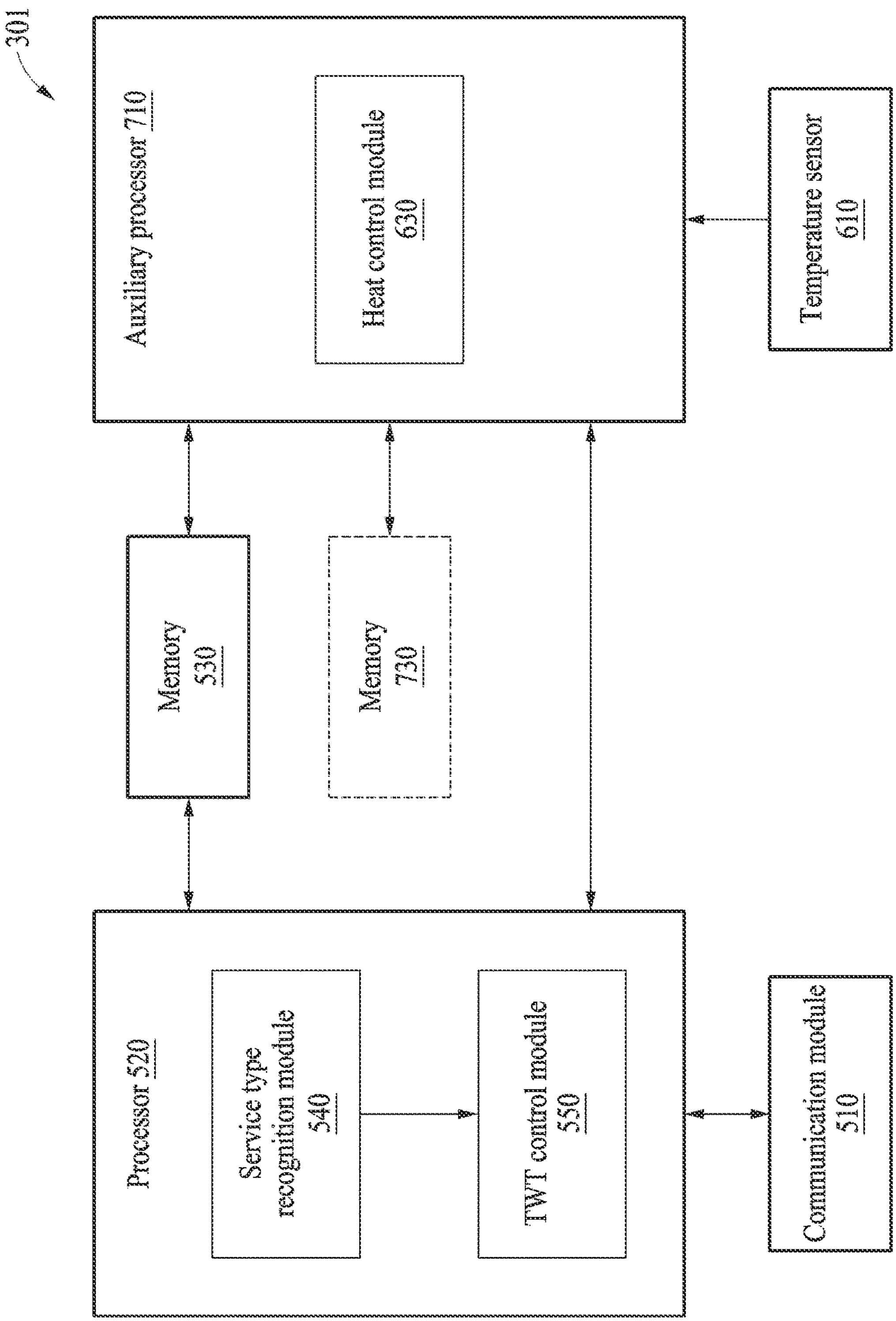

301
Auxiliary processor 710
Heat control module
630
Temperature sensor
610
Memory
530
Memory
730
Processor 520
Service type
recognition module
540
TWT control module
550
Communication module
510

FIG. 7

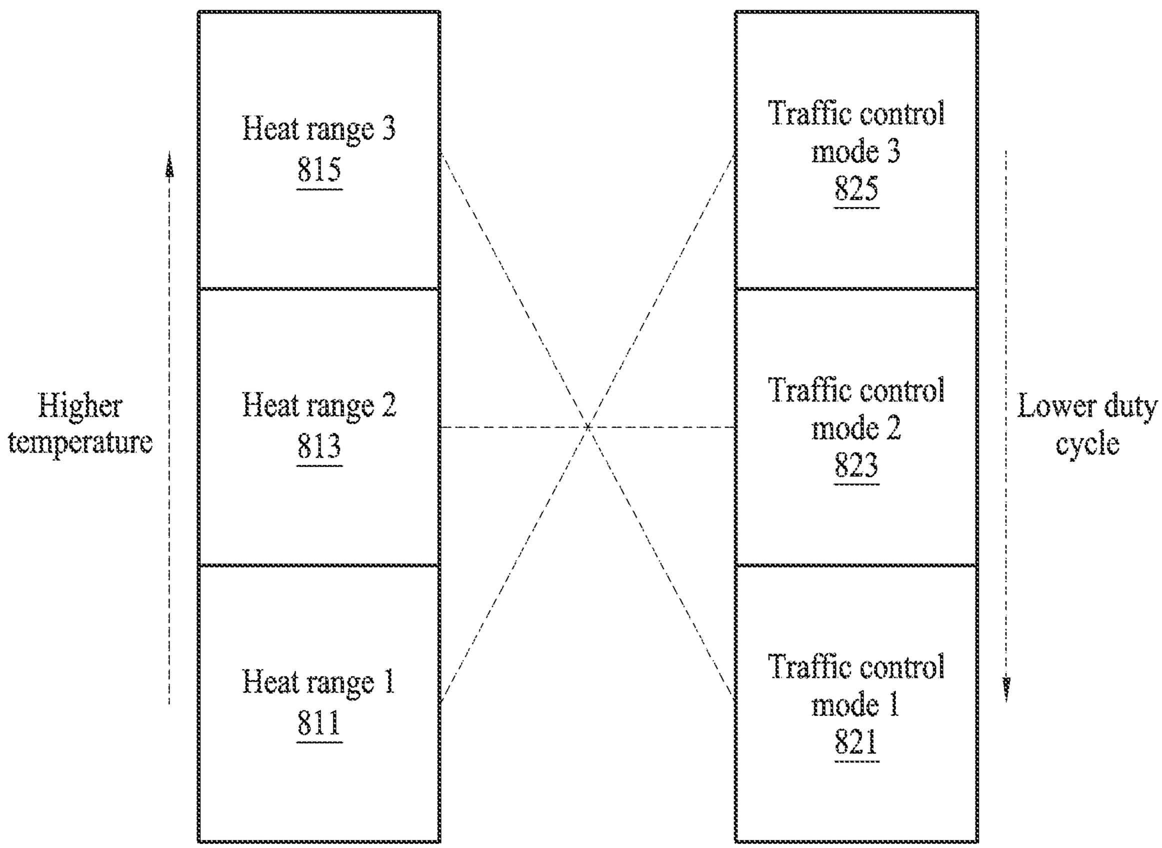

Heat range 3
815
Heat range 2
813
Heat range 1
811
Higher temperature
Traffic control mode 3
825
Traffic control mode 2
823
Traffic control mode 1
821
Lower duty cycle

FIG. 8A

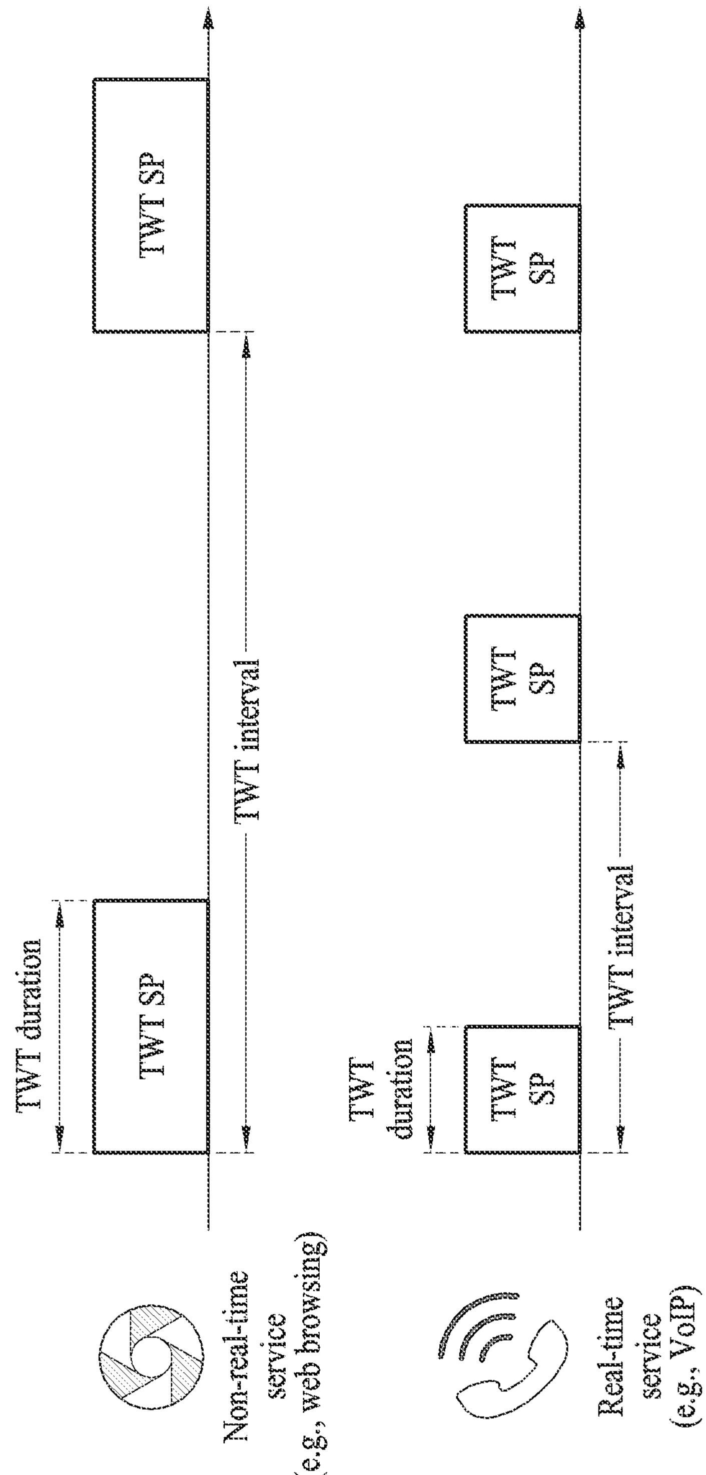

Non-real-time service (e.g., web browsing)
TWT duration
TWT SP
TWT interval
TWT SP
Real-time service (e.g., VoIP)
TWT duration
TWT SP
TWT interval
TWT SP
TWT SP

FIG. 8B

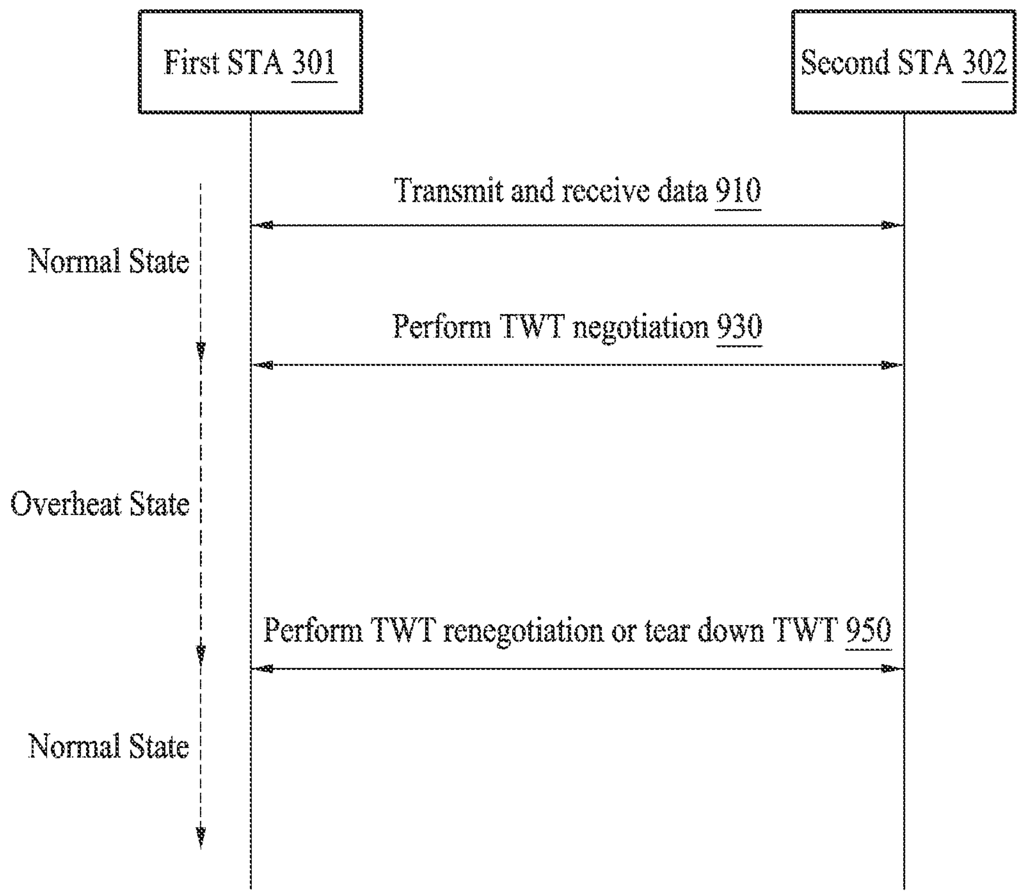

First STA 301
Second STA 302
Transmit and receive data 910
Normal State
Perform TWT negotiation 930
Overheat State
Perform TWT renegotiation or tear down TWT 950
Normal State

FIG. 9

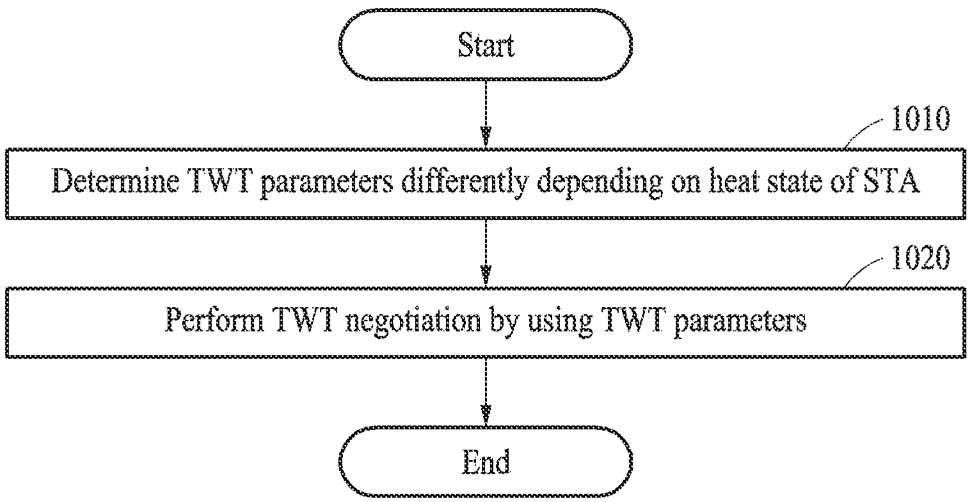


FIG. 10A

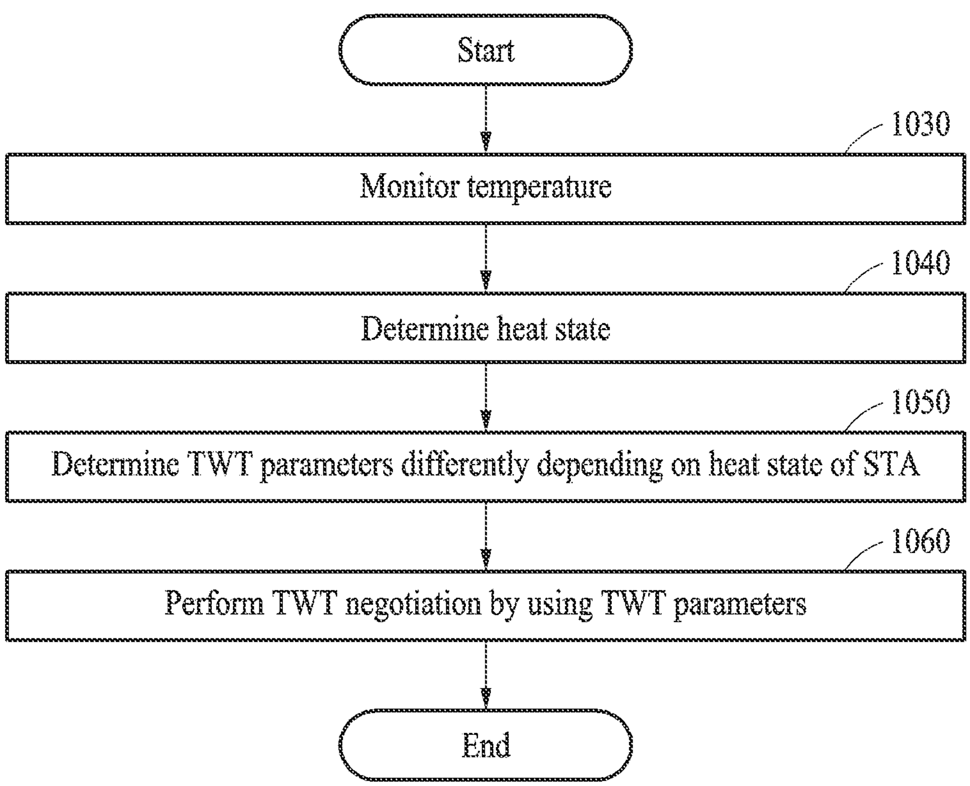


FIG. 10B

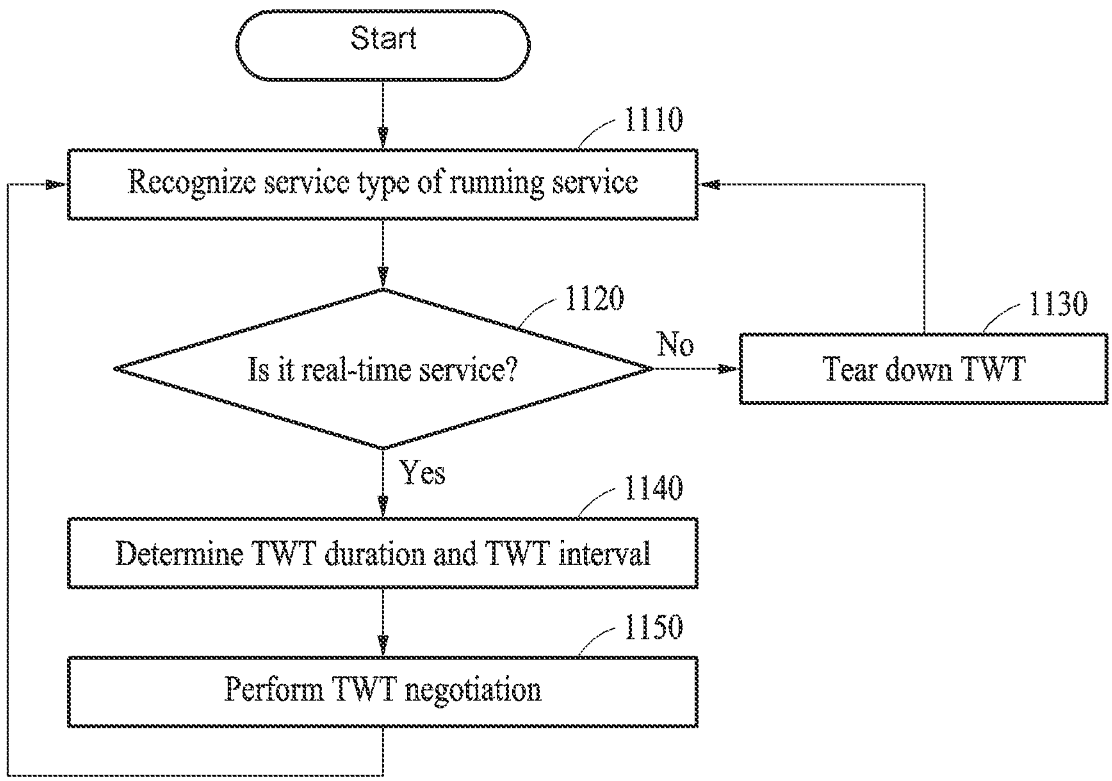

Start
1110
Recognize service type of running service
1120
Is it real-time service?
No
1130
Tear down TWT
Yes
1140
Determine TWT duration and TWT interval
1150
Perform TWT negotiation

FIG. 11

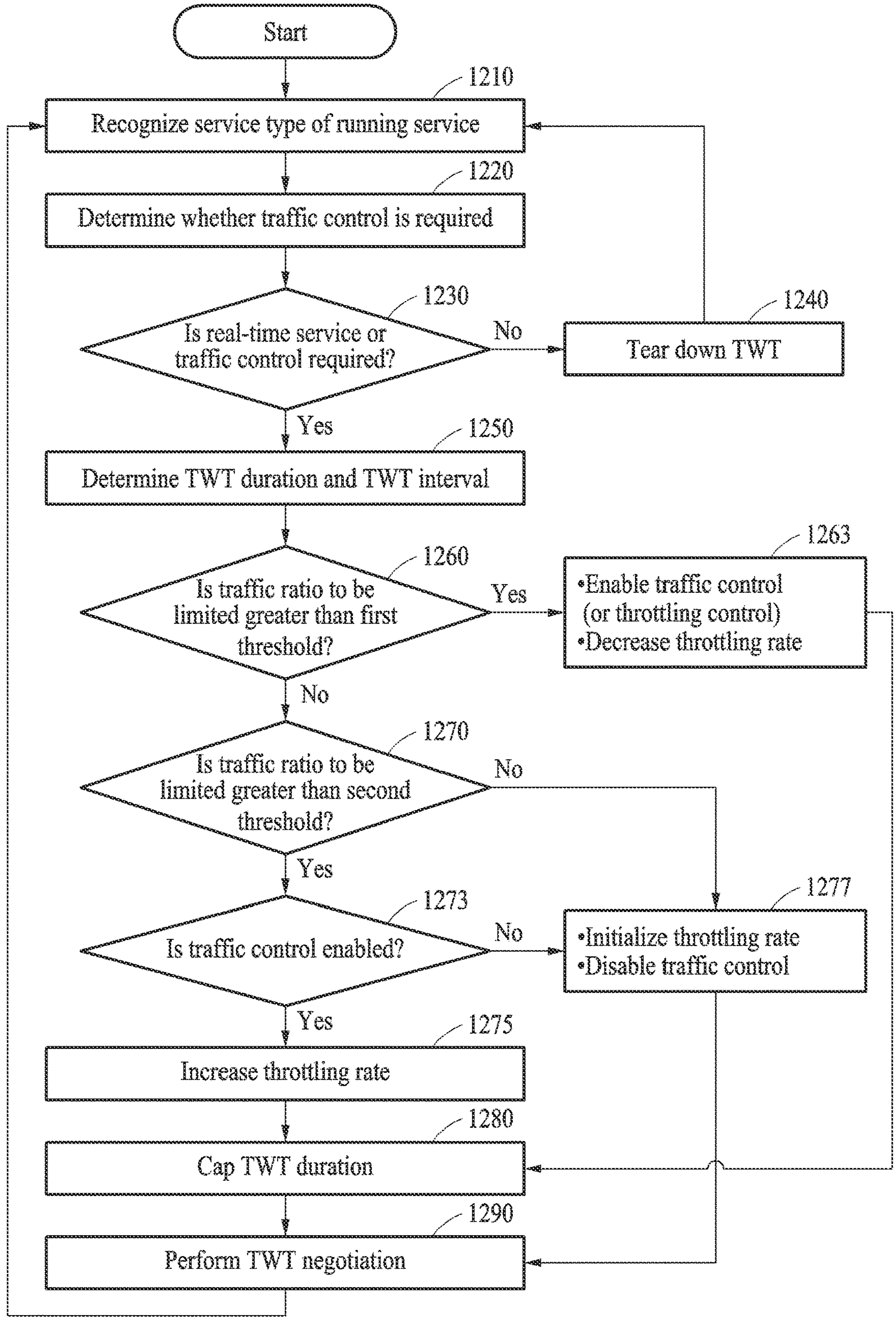

Start
1210
Recognize service type of running service
1220
Determine whether traffic control is required
1230
Is real-time service or traffic control required?
No
1240
Tear down TWT
Yes
1250
Determine TWT duration and TWT interval
1260
Is traffic ratio to be limited greater than first threshold?
Yes
1263
•Enable traffic control (or throttling control)
•Decrease throttling rate
No
1270
Is traffic ratio to be limited greater than second threshold?
No
Yes
1273
Is traffic control enabled?
No
1277
•Initialize throttling rate
•Disable traffic control
Yes
1275
Increase throttling rate
1280
Cap TWT duration
1290
Perform TWT negotiation

FIG. 12

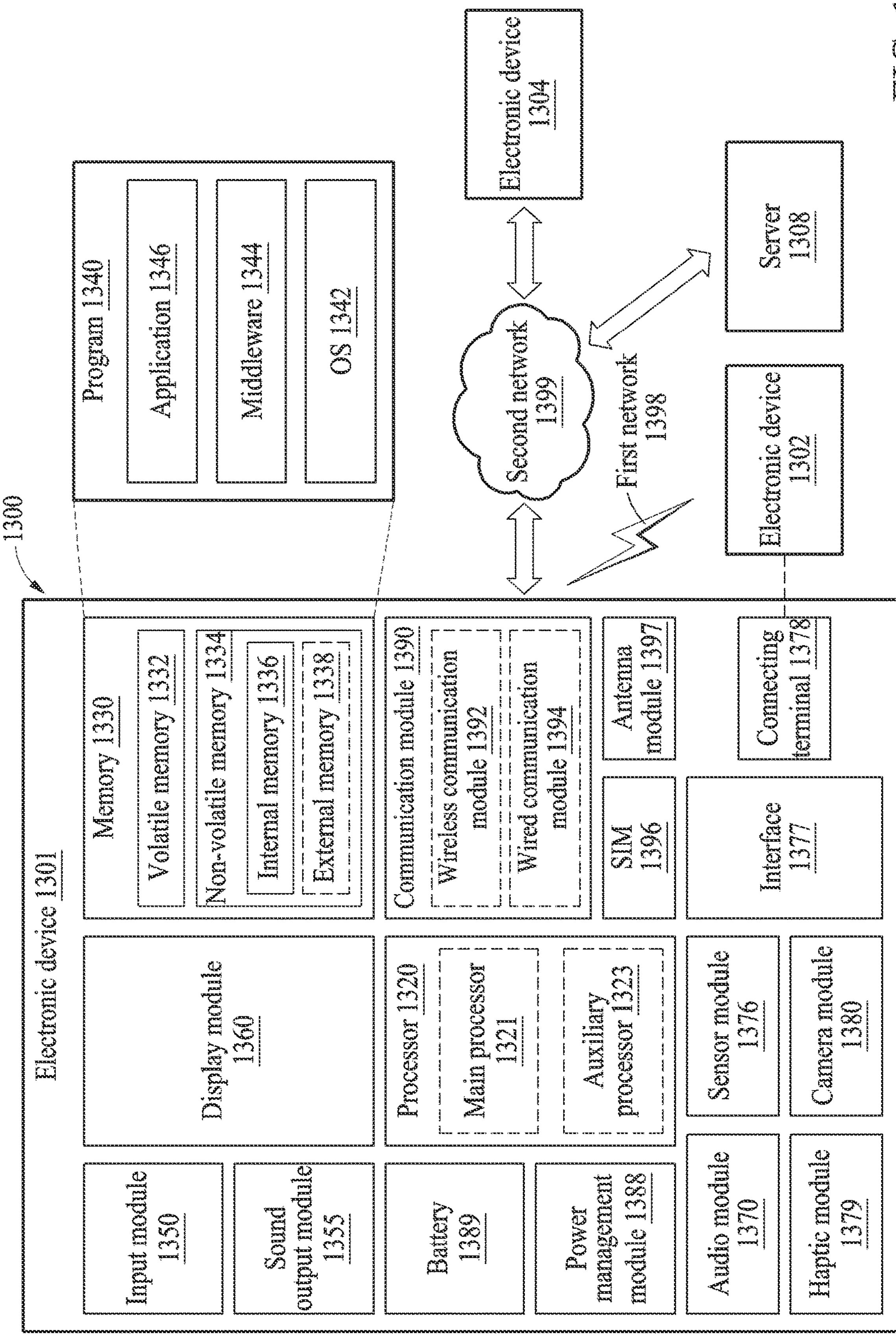

1300
Electronic device 1301
Input module 1350
Sound output module 1355
Battery 1389
Power management module 1388
Audio module 1370
Haptic module 1379
Display module 1360
Processor 1320
Main processor 1321
Auxiliary processor 1323
Sensor module 1376
Camera module 1380
Memory 1330
Volatile memory 1332
Non-volatile memory 1334
Internal memory 1336
External memory 1338
Communication module 1390
Wireless communication module 1392
Wired communication module 1394
SIM 1396
Antenna module 1397
Interface 1377
Connecting terminal 1378
Program 1340
Application 1346
Middleware 1344
OS 1342
Second network 1399
First network 1398
Electronic device 1304
Server 1308
Electronic device 1302

FIG. 13

ELECTRONIC DEVICE AND TRAFFIC CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of International Application No. PCT/KR2022/010890 designating the United States, filed on Jul. 25, 2022, in the Korean Intellectual Property Receiving Office and claiming priority to Korean Patent Application No. 10-2021-0119328, filed on Sep. 7, 2021, in the Korean Intellectual Property Office, the disclosures of which are incorporated by reference herein in their entireties.

BACKGROUND

1. Field

[0002] The disclosure relates to an electronic device and a traffic control method.

2. Description of Related Art

[0003] Electronic devices, such as smartphones, tablets, PCs, or laptops, have continued to provide users with various services and user experiences. Electronic devices have been playing a pivotal role in various activities, such as shopping, education, medical service, work, or leisure, and, today, they are so deeply entangled in our lives that they are considered necessities.

[0004] In implementations, such as calls, games, or video streaming, in which an electronic device is used while being turned on for a long time, a temperature of the electronic device increases as the electronic device heats up, and thus, a user may be exposed to heat for a long time.

SUMMARY

[0005] According to an embodiment, an electronic device includes a temperature sensor positioned in the electronic device, a wireless communication module configured to transmit and receive a wireless signal, a processor connected operatively to the wireless communication module, and a memory connected electrically to the processor and configured to store instructions executable by the processor. The instructions, when executed by the processor, cause the electronic device to determine a target wake time (TWT) parameter differently depending on a heat state of the electronic device based on a temperature of the electronic device, and perform a TWT negotiation with an external electronic device through the wireless communication module by using the TWT parameter.

[0006] According to an embodiment, an operating method of an electronic device includes monitoring a temperature of the electronic device, determining a heat state of the electronic device based on the monitored temperature, determining a target wake time (TWT) parameter differently depending on the heat state of the electronic device, and performing a TWT negotiation with an external electronic device by using the TWT parameter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The above and other aspects, features, and advantages of certain embodiments of the present disclosure will be more apparent from the following detailed description, taken in conjunction with the accompanying drawings, in which:

[0008] FIG. **1** illustrates an example of a wireless local area network (WLAN) system according to an embodiment.

[0009] FIG. **2** illustrates another example of the WLAN system according to an embodiment.

[0010] FIG. **3** is a diagram illustrating a protocol for traffic transmission according to an embodiment.

[0011] FIG. **4** is a diagram illustrating a TWT element used in the protocol for traffic transmission according to an embodiment.

[0012] FIG. **5** is a schematic block diagram illustrating a station (STA) according to an embodiment.

[0013] FIG. **6** is another schematic block diagram illustrating the STA according to an embodiment.

[0014] FIG. **7** is yet another schematic block diagram illustrating the STA according to an embodiment.

[0015] FIG. **8**A is a diagram illustrating an example of an operation of determining a TWT parameter according to an embodiment.

[0016] FIG. **8**B is a diagram illustrating another example of the operation of determining a TWT parameter according to an embodiment.

[0017] FIG. **9** is a diagram illustrating a TWT negotiation according to an embodiment.

[0018] FIG. **10**A is a flowchart illustrating an operating method of the STA according to an embodiment.

[0019] FIG. **10**B is another flowchart illustrating the operating method of the STA according to an embodiment.

[0020] FIG. **11** is a flowchart illustrating a TWT-based traffic control according to an embodiment.

[0021] FIG. **12** is another flowchart illustrating the TWT-based traffic control according to an embodiment.

[0022] FIG. **13** is a block diagram illustrating an electronic device in a network environment according to an embodiment.

DETAILED DESCRIPTION

[0023] Hereinafter, embodiments are described in detail with reference to the accompanying drawings. When describing the embodiments with reference to the accompanying drawings, like reference numerals refer to like elements and a repeated description related thereto will be omitted.

[0024] An electronic device may be equipped with a mechanism for preventing additional overheating of the electronic device and lowering a temperature in an overheat state. An application processor may lower a temperature by reducing an operation clock speed and thereby reducing an overall task processing speed and a traffic amount.

[0025] A processor (e.g., a Wi-Fi chipset) processing network traffic, instead of reducing a task processing amount by simply reducing a clock speed, may dissipate an overheat state by intentionally dropping acknowledgement (ACK) without transmitting the ACK for traffic transmitted by a counterpart (e.g., a counterpart electronic device that the electronic device is communicating with) to reduce a traffic amount transmitted by the counterpart according to a flow control mechanism, which results in a reduction of a network traffic throughput. The processor processing network traffic may need to process all incoming data despite not intending to transmit the ACK. Thus, it may be inefficient in lowering a temperature of the processor processing network traffic. Retransmission for dropped traffic may be performed on packets not receiving the ACK. First, time and frequency resources required for transmitting normally transmitted packets may be wasted, and, additionally, network resources may be wasted when the packets are retransmitted. When the traffic amount itself transmitted by the counterpart decreases over time according to the flow control mechanism, an overhead may only decrease to a certain extent. The flow control mechanism may once reduce a buffer size for a while to respond to a network environment change but may soon increase a buffer gradually until a timeout occurs again. Thus, network resources may be wasted. In addition, the method described above may not be applied to a transport layer protocol, such as a user datagram protocol (UDP), not having a separate flow control mechanism. Accordingly, a technology for performing a traffic control (e.g., traffic throttling) efficiently on network traffic in a device overheat state may be required.

[0026] An embodiment may provide a technology for adjusting a duty cycle of transmission and reception with a counterpart differently depending on a heat state of a device by using a target wake time (TWT).

[0027] The technical goals to be achieved are not limited to those described above or below, and other technical goals not mentioned are clearly understood by one of ordinary skill in the art from the following description.

[0028] An embodiment may perform a traffic control efficiently without wasting time and frequency resources by adjusting a duty cycle of transmission and reception with a counterpart differently by using a TWT depending on a heat state of a device when performing traffic control on network traffic in a device overheat state.

[0029] An embodiment may reduce a traffic throughput for a transport layer protocol not having a flow control mechanism.

[0030] An embodiment may rapidly lower a temperature of a processor (e.g., a wireless communication module) processing network traffic by adjusting a reception and transmission duty cycle itself.

[0031] In addition, various effects directly or indirectly ascertained through the present disclosure may be provided.

[0032] FIG. **1** illustrates an example of a wireless local area network (WLAN) system according to an embodiment.

[0033] Referring to FIG. **1**, according to an embodiment, a WLAN system **10** may be an infrastructure mode in which an AP is in a WLAN structure of an Institute of Electrical and Electronic Engineers (IEEE) 802.11. The WLAN system **10** may include at least one basic service set (BSS) (e.g., BSS1 or BSS2). The BSS (e.g., BSS1 or BSS2) may be a set of an AP and a station (STA) (e.g., an electronic device **1301**, **1302**, or **1304** of FIG. **13**) that may be successfully synchronized with each other to communicate with each other. BSS1 may include AP1 and STA1, and BSS2 may include two or more STAs (e.g., STA2 and STA3) that may be combined with one AP (e.g., AP2).

[0034] According to an embodiment, the WLAN system **10** may include at least one STA (e.g., STA1 to STA3), an AP (e.g., AP1 or AP2) that provides a distribution service, and a distribution system **100** that connects a plurality of APs (e.g., AP1 and AP2). The distribution system **100** may implement an extended service set (ESS) by connecting a plurality of BSSs (e.g., BSS 1 and BSS 2). The ESS may be used as a term to refer to one network including at least one AP (e.g., AP1 or AP2) connected via the distribution system **100**. APs (e.g., AP1 and AP2) included in one ESS may have the same service set identification (SSID).

[0035] According to an embodiment, the STAs (e.g., STA1 to STA3) may be an arbitrary functional medium including a wireless-medium physical layer interface and a medium access control (MAC) conforming to the IEEE 802.11 standard. The term "STA" (e.g., STA1 to STA3) may be used to include both an AP STA and a non-AP STA. The STA (e.g., STA1 to STA3) may also be referred to as various terms, such as an "electronic device", a "mobile terminal", a "wireless device", a "wireless transmit/receive unit (WTRU)", a "user equipment (UE)", a "mobile station (MS)", and a "mobile subscriber unit", or, simply, a "user".

[0036] FIG. **2** illustrates another example of the WLAN system according to an embodiment.

[0037] Referring to FIG. **2**, according to an embodiment, a WLAN system **20** may be an ad-hoc mode in which communication is performed by setting a network between STAs without an AP in a WLAN structure of the IEEE 802.11, unlike the WLAN system **10** of FIG. **1**. The WLAN system **20** may include a BSS operating in an ad-hoc mode, that is, an independent BSS (IBSS).

[0038] According to an embodiment, since the IBSS does not include an AP, there may not be a centralized management entity that performs a management function at a center. In the IBSS, STAs may be managed in a distributed manner. In the IBSS, all STAs may be mobile STAs, and access to a distribution system may not be allowed, thus, the IBSS may form a self-contained network.

[0039] FIG. **3** is a diagram illustrating a protocol for traffic transmission according to an embodiment.

[0040] Referring to FIG. **3**, according to an embodiment, in a wireless communication system (e.g., the WLAN system **10** of FIG. **1** or the WLAN system **20** of FIG. **2**), a first STA **301** (e.g., an electronic device **1301** of FIG. **13**) and/or a second STA **302** (e.g., an AP or an electronic device **1302** or **1304** of FIG. **13**) may perform wireless communication according to a target wake time (TWT) protocol in a BSS. A TWT may be a time resource set to manage an activity of an STA (e.g., the first STA **301** or the second STA **302**) in the BSS and may be defined to minimize an operation of a wake state (or an awake state) (e.g., a wake mode) of the STA (e.g., the first STA **301** or the second STA **302**). A TWT setting may be used for the STA (e.g., the first STA **301** or the second STA **302**) to perform data transmission and reception during a certain TWT duration at a certain TWT interval, and a plurality of STAs (the first STA **301** and the second STA **302**) may operate at a set time according to the TWT setting. Contention between the STAs (the first STA **301** and the second STA **302**) may decrease.

[0041] According to an embodiment, the first STA **301** may perform wireless communication with the second STA **302**, which is an external electronic device, according to the TWT protocol. The first STA **301** and the second STA **302** may perform a TWT negotiation to transmit and receive data to and from each other according to the TWT protocol. The TWT negotiation may be performed between the first STA **301** and the second STA **302**, in which the first STA **301** may transmit, to the second STA **302**, a TWT request frame **310** for requesting the TWT setting, and, in response to the TWT request frame **310**, the second STA **302** may transmit, to the first STA **301**, a TWT response frame **330** for responding to the TWT setting. The first STA **301** requesting the TWT may be referred to as a TWT request STA, and the second STA

302 that performs communication with the TWT request STA, based on the request for the TWT, may be referred to as a TWT response STA. For example, the TWT request STA may be a first user STA, and the TWT response STA may be an AP or a second user STA.

[0042] According to an embodiment, the TWT request frame **310** and/or the TWT response frame **330** may include a TWT element (e.g., a TWT element **410** or **430** of FIG. **4**) for setting a TWT parameter (or TWT parameter information). A TWT element included in the TWT request frame **310** may be referred to as a TWT request element, and a TWT element included in the TWT response frame **330** may be referred to as a TWT response element. The TWT request element and the TWT response element may be the same format or different formats in which some of the included fields are different.

[0043] According to an embodiment, the first STA **301** and the second STA **302** may perform wireless communication according to the TWT setting, for example, the TWT parameter, based on the TWT negotiation. The TWT parameter may be an operational parameter (e.g., a periodic parameter and/or an aperiodic parameter) for communication between the first STA **301** and the second STA **302**, based on the TWT protocol. For example, the TWT parameter may include start time information of a TWT service period (SP), duration information of the TWT SP, and/or TWT interval information of the TWT SP.

[0044] According to an embodiment, the first STA **301** may switch periodically between a wake state (or an awake state) (e.g., a wake mode) and a doze state (e.g., a doze mode), based on the TWT parameter. For example, a wireless communication module of the first STA **301** for performing communication with the second STA **302** may switch periodically between the wake state and the doze state, based on the TWT parameter.

[0045] According to an embodiment, the first STA **301** may transmit and receive data by switching from the doze state to the wake state during the TWT SP and may switch from the wake state to the doze state during a period other than the TWT SP. For example, the doze state may be a state in which data transmission and reception may not be performed by the STA (e.g., the first STA **301**) for power saving. The wake state may be a state in which data transmission and reception may be performed by the STA (e.g., the first STA **301**).

[0046] FIG. **4** is a diagram illustrating a TWT element used in the protocol for traffic transmission according to an embodiment.

[0047] Referring to FIG. **4**, according to an embodiment, a TWT request frame (e.g., the TWT request frame **310** of FIG. **3**) and/or a TWT response frame (e.g., the TWT response frame **330** of FIG. **3**) may include a TWT element **410** or **430** to set a TWT parameter (or TWT parameter information). The TWT element **410** may be an individual TWT parameter set field format according to IEEE 802.11 (e.g., IEEE 802.11ax), and the TWT element **430** may be a broadcast TWT parameter set field format according to IEEE 802.11 (e.g., IEEE 802.11ax). A TWT element included in the TWT request frame **310** and/or the TWT response frame **330** may be the TWT element **410** or **430**.

[0048] According to an embodiment, the TWT element **410** may include a request type field, a target wake time field, a TWT group assignment field, a nominal minimum TWT wake duration field, a TWT wake interval mantissa field, a TWT channel field (an N field), and an NDP paging field. In this case, the request type field may include a plurality of sub-fields, for example, a TWT request field, a TWT setup command field, a trigger field, an implicit field, a flow type field, a TWT flow identifier field, a TWT wake interval exponent field, and a TWT protection field.

[0049] According to an embodiment, the TWT element **430** may include a request type field, a target wake time field, a nominal minimum TWT wake duration field, a TWT wake interval mantissa field, and a broadcast TWT information field. In this case, the request type field may include a plurality of sub-fields, for example, a TWT request field, a TWT setup command field, a trigger field, a last broadcast parameter set field, a flow type field, a broadcast TWT recommendation field, a TWT wake interval exponent field, and a reserved field.

[0050] According to an embodiment, the TWT parameter (e.g., start time information of a TWT SP, duration information of the TWT SP, and/or TWT interval information of the TWT SP) may be determined by setting a value of at least one field of the plurality of fields included in the TWT element **410** or **430**. A time from which the TWT SP starts may be set in the target wake time field of the TWT element **410** or **430**, and a TWT duration for which the TWT SP continues (or is maintained) may be set in the nominal minimum TWT wake duration field of the TWT element **410** or **430**. A TWT interval (e.g., a value of an interval) of the TWT SP may be determined by a value set in the TWT wake interval mantissa field of the TWT element **410** or **430** and the TWT wake interval exponent field of the TWT element **410** or **430**. Information on a mantissa to determine the TWT interval in the TWT wake interval mantissa field may be set, and information on an exponent value of which a base is 2 to determine the TWT interval in the TWT wake interval exponent field may be set. The size of the TWT interval may be determined based on TWT wake interval mantissa$\times 2^{(TWT\ wake\ interval\ exponent)}$.

[0051] According to an embodiment, a TWT negotiation between the first STA **301** and the second STA **302** for setting a TWT may be performed, in which the first STA **301** may transmit, to the second STA **302**, the TWT request frame **310** including the TWT element **410** or **430**, and, in response to the TWT request frame **310**, the second STA **302** may transmit, to the first STA **301**, the TWT response frame **330** including the TWT element **410** or **430**. The TWT response frame **330** may include information indicating an accept TWT or a reject TWT. The accept TWT may indicate accepting a value of a TWT parameter requested by the first STA **301**, that is, a TWT request STA, and the reject TWT may indicate not accepting the value of the TWT parameter requested by the first STA **301**, that is, the TWT request STA.

[0052] FIG. **5** is a schematic block diagram illustrating an STA according to an embodiment.

[0053] Referring to FIG. **5**, according to an embodiment, the first STA **301** may perform a TWT negotiation, to set a TWT (e.g., set an initial TWT or renew a TWT setting), with the second STA **302**, that is, an external electronic device to and from which data on a running service is transmitted and received. The TWT setting may be used for the first STA **301** or the second STA **302** to perform data transmission and reception during a certain TWT duration at a certain TWT interval or may be used for a traffic control (e.g., traffic throttling) over a wireless communication module **510** included in the first STA **301**.

[0054] According to an embodiment, the first STA **301** may include at least one wireless communication module **510** (e.g., a wireless communication module **1392** of FIG. **13**) configured to transmit and receive a wireless signal, at least one processor **520** (e.g., a processor **1320** of FIG. **13**) connected operatively to the wireless communication module **510**, and a memory **530** (e.g., a memory **1330** of FIG. **13**) connected electrically to the processor **520**. The wireless communication module **510** may be a Wi-Fi chipset. A service type recognition module **540** included in the first STA **301** and a TWT control module **550** included in the first STA **301** may be executable by the processor **520** and may include one or more of program code, an application, an algorithm, a routine, a set of instructions, and an artificial intelligence learning model, which include instructions that may be stored in the memory **530**. In addition, at least one of the service type recognition module **540** and the TWT control module **550** may be implemented through hardware or a combination of hardware and software.

[0055] According to an embodiment, the service type recognition module **540** may recognize a service type (e.g., a real-time service or a non-real-time service) of a running service (e.g., a currently running service in the processor **520**) in the first STA **301**. The service type recognition module **540** may output the recognized service type of the running service to the TWT control module **550**.

[0056] According to an embodiment, the TWT control module **550** may determine whether to perform a TWT setting on the second STA **302**, based on the recognized service type of the running service. For example, the TWT control module **550** may determine to perform the TWT setting on the second STA **302** when the recognized service type is a real-time service and may determine not to perform the TWT setting (e.g., tear down a TWT) on the second STA **302** when the recognized service type is a non-real-time service.

[0057] According to an embodiment, the TWT control module **550** may determine TWT parameters (e.g., a TWT interval and a TWT duration) based on the real-time service, which is the service type of the running service. The TWT control module **550** may set at least one value of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent field in a TWT element (e.g., the TWT element **410** or **430** of FIG. **4**) according to the determined TWT parameters. Accordingly, the TWT control module **550** may adjust a TWT duty cycle that is defined based on the TWT interval and the TWT duration to match the service type of the running service.

[0058] According to an embodiment, the TWT control module **550** may control the wireless communication module **510** such that the wireless communication module **510** may perform a TWT negotiation with the second STA **302** by using the determined TWT parameters. The wireless communication module **510** may transmit, to the second STA **302**, a TWT request frame (e.g., the TWT request frame **310** of FIG. **3**) including the TWT element **410** or **430** of which a value is set by the TWT control module **550**. In response to the TWT request frame **310**, the second STA **302** may transmit a TWT response frame (e.g., the TWT response frame **330** of FIG. **3**) to the wireless communication module **510**.

[0059] According to an embodiment, when the TWT response frame **330** includes an accept TWT, the wireless communication module **510** may perform wireless communication with the second STA **302** according to the TWT setting, for example, a TWT parameter, based on the TWT negotiation. The wireless communication module **510** may transmit and receive data by switching from a doze state to a wake state during a TWT SP and may switch from the wake state to the doze state during a period other than the TWT SP. The wireless communication module **510** may perform a traffic control (e.g., traffic throttling) efficiently by using the TWT setting by the TWT negotiation.

[0060] FIG. **6** is another schematic block diagram illustrating the STA according to an embodiment.

[0061] Referring to FIG. **6**, according to an embodiment, the first STA **301** may perform a TWT negotiation with the second STA **302** to set a TWT (e.g., set an initial TWT or renew a TWT setting) for the second STA **302**, that is, an external electronic device, to and from which data on a running service is transmitted and received according to a heat state (e.g., high heat state) of the first STA **301** based on a temperature (e.g., a temperature monitored in the first STA **301**) of the first STA **301**. The TWT setting may be used for the first STA **301** and the second STA **302** to perform data transmission and reception during a certain TWT duration at a certain TWT interval and may also be used to lower a temperature of the wireless communication module **510** by performing a traffic control (e.g., traffic throttling) on the wireless communication module **510** included in the first STA **301** according to a heat state (e.g., a high heat state) of the first STA **301**.

[0062] According to an embodiment, the first STA **301** may further include at least one temperature sensor **610** (e.g., a sensor module **1376** of FIG. **13**) other than at least one wireless communication module **510**, at least one processor **520**, and at least one memory **530**. The temperature sensor **610** may be in a proximity to various components (e.g., the processor **520**, the wireless communication module **510**, and/or an antenna (now shown)) in the first STA **301** and may monitor the temperature of the first STA **301**. A position, in which the temperature sensor **610** is, may not be limited to the foregoing example, but the temperature sensor **610** may be adjacent to various components related to a heat source (e.g., a main heat source of Wi-Fi communication) for the wireless communication module **510**.

[0063] According to an embodiment, the first STA **301** may further include a heat control module **630** other than the service type recognition module **540** and the TWT control module **550**. The heat control module **630** may be executable by the processor **520** and may include one or more of program code, an application, an algorithm, a routine, a set of instructions, and an artificial intelligence learning model, which include instructions that may be stored in the memory **530**. In addition, the heat control module **630** may be implemented through hardware or a combination of hardware and software.

[0064] According to an embodiment, the service type recognition module **540** may recognize a service type (e.g., a real-time service or a non-real-time service) of a running service (e.g., a currently running service in the processor **520**) in the first STA **301**. The service type recognition module **540** may output the recognized service type of the running service to the TWT control module **550**.

[0065] According to an embodiment, the heat control module **630** may determine a heat state based on the temperature monitored by the temperature sensor **610** in the first STA **301**. The heat control module **630** may determine whether the heat state of the first STA **301** is a high heat state, based on the temperature monitored in the first STA **301**. The heat control module **630** may notify the TWT control module **550** that the first STA **301** is in a high heat state. In this case, the heat control module **630** may output, to the TWT control module **550**, a maximum throughput (e.g., a throughput limit) of the wireless communication module **510** based on the high heat state of the first STA **301**. The maximum throughput that is output by the heat control module **630** may be determined according to a degree (a monitored temperature range) of the high heat state and may be used to notify the TWT control module **550** that the first STA **301** is in a high heat state. The maximum throughput may be an upper limit to lower the temperature of the wireless communication module **510**.

[0066] According to an embodiment, the TWT control module **550** may determine whether to perform the TWT setting on the second STA **302** in response to an output (e.g., the recognized service type of the running service) of the service type recognition module **540** and/or an output (e.g., the maximum throughput) of the heat control module **630**. An operation that the TWT control module **550** performs the TWT setting by using the output of the service type recognition module **540** may be substantially the same as the operation of performing the TWT setting described with reference to FIG. **5**.

[0067] According to an embodiment, the TWT control module **550** may determine TWT parameters differently depending on a heat state (e.g., a high heat state) of the first STA **301**. The TWT control module **550** may determine the TWT parameters (e.g., a TWT interval and a TWT duration) differently such that a TWT duty cycle may operate (e.g., be adjusted) differently depending on the maximum throughput, which is an output of the heat control module **630**. The maximum throughput, which is an output of the heat control module **630**, may be an upper limit of the TWT duty cycle. For example, the TWT control module **550** may determine the TWT parameters such that the TWT duty cycle decreases as the temperature (e.g., the monitored temperature) of the first STA **301** increases.

[0068] According to an embodiment, the TWT control module **550** may determine the TWT parameters to be a combination of a TWT duration and a different TWT wake interval, which satisfies the same TWT duty cycle, with respect to the TWT duty cycle based on a heat state (e.g., a high heat state) of the first STA **301**. In this case, the TWT control module **550** may determine the combination of a TWT duration and a different TWT wake interval, which satisfies the same TWT duty cycle, according to the service type, recognized by the service type recognition module **540**, of the running service. For example, the TWT control module **550** may determine the combination of a TWT duration and a first TWT wake interval, which satisfies the same TWT duty cycle, when the service type is a real-time service, and may determine the combination of a TWT duration and a second TWT wake interval, which satisfies the same TWT duty cycle, when the service type is a non-real-time service. The first TWT wake interval may be less than the second TWT wake interval. The TWT control module **550** may determine the combination of a TWT duration and a TWT wake interval, which satisfies a user experience, by using the recognized service type of the running service with respect to the same TWT duty cycle.

[0069] According to an embodiment, the TWT control module **550** may determine a TWT duty cycle based on a heat state (e.g., a high heat state) of the first STA **301** and may determine the TWT parameters to be a combination of a TWT duration and a TWT wake interval, which satisfies the same (or determined) TWT duty cycle, based on the recognized service type of the running service. The TWT control module **550** may set at least one value of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent duration field in a TWT element (e.g., the TWT element **410** or **430** of FIG. **4**) according to the determined TWT parameters. Accordingly, the TWT control module **550** may adjust the TWT duty cycle defined based on a TWT duration and a TWT interval depending on a heat state (e.g., a high heat state) of the first STA **301**. For example, when the heat state of the first STA **301** is the high heat state, the TWT control module **550** may increase the TWT interval and/or decrease the TWT duration.

[0070] According to an embodiment, the TWT control module **550** may control the wireless communication module **510** such that the wireless communication module **510** may perform a TWT negotiation with the second STA **302** by using the determined TWT parameters. The wireless communication module **510** may transmit, to the second STA **302**, a TWT request frame (e.g., the TWT request frame **310** of FIG. **3**) including the TWT element **410** or **430** of which a value is set by the TWT control module **550**. In response to the TWT request frame **310**, the second STA **302** may transmit a TWT response frame (e.g., the TWT response frame **330** of FIG. **3**) to the wireless communication module **510**.

[0071] According to an embodiment, when the TWT response frame **330** includes an accept TWT, the wireless communication module **510** may perform wireless communication with the second STA **302** according to the TWT setting, for example, a TWT parameter, based on the TWT negotiation. The wireless communication module **510** may transmit and receive data by switching from a doze state to a wake state during a TWT SP and may switch from the wake state to the doze state during a period other than the TWT SP. The wireless communication module **510** may perform a traffic control (e.g., traffic throttling) efficiently by using the TWT setting by the TWT negotiation according to the heat state (e.g., the high heat state) of the first STA **301**. Accordingly, the temperature of the wireless communication module **510** may be lowered.

[0072] FIG. **7** is yet another schematic block diagram illustrating the STA according to an embodiment.

[0073] Referring to FIG. **7**, according to an embodiment, the first STA **301** may further include an auxiliary processor **710** (e.g., an auxiliary processor **1323** of FIG. **13** or a sensor hub processor) other than at least one wireless communication module **510**, at least one processor **520**, at least one memory **530**, and at least one temperature sensor **610**. In addition, the first STA **301** may further include a memory **730** connected electrically to the auxiliary processor **710**. The auxiliary processor **710** may also be connected electrically to the memory **530**.

[0074] According to an embodiment, the heat control module **630** may be executable by the auxiliary processor

710 and may include one or more of program code, an application, an algorithm, a routine, a set of instructions, and an artificial intelligence learning model, which include instructions that may be stored in the memory **530** or **730**. In addition, the heat control module **630** may be implemented through hardware or a combination of hardware and software.

[0075] According to an embodiment, the description of each component (e.g., the wireless communication module **510**, the processor **520**, the memory **530**, the service type recognition module **540**, the TWT control module **550**, the temperature sensor **610**, or the heat control module **630**) of FIG. **7** may be substantially the same as the operation of each component (e.g., the wireless communication module **510**, the processor **520**, the memory **530**, the service type recognition module **540**, the TWT control module **550**, the temperature sensor **610**, or the heat control module **630**) described with reference to FIG. **5** and/or FIG. **6**. Accordingly, further description thereof is not repeated herein.

[0076] FIG. **8**A is a diagram illustrating an example of an operation of determining a TWT parameter according to an embodiment.

[0077] Referring to FIG. **8**A, according to an embodiment, heat states **811** to **815** (e.g., an overheat state) of the first STA **301** may be classified into a plurality of heat states according to a monitored temperature (e.g., a temperature range) in the first STA **301**. A first heat state **811** may have a first temperature range, a second heat state **813** may have a second temperature range, and a third heat state **815** may have a third temperature range. An upper limit of a TWT duty cycle may vary depending on each of the heat states **811** to **815**. The heat states **811** to **815** may correspond respectively to traffic control modes (or throttling modes) **821** to **825** to which different upper limits of the TWT duty cycle are assigned. The traffic control modes **821** to **825** may be an operation mode in which an STA (e.g., the first STA **301**) performs a TWT negotiation not to exceed an upper limit of the TWT duty cycle assigned to a traffic control mode. Although a heat state and a traffic control mode are each divided into three states/modes for ease of description in FIG. **8**A, examples are not limited thereto. The heat state and the traffic control mode may each be divided into one or more states/modes as a temperature (e.g., a temperature range) monitored in the STA (e.g., the first STA **301**) may be divided in various methods.

[0078] According to an embodiment, the first STA **301** may perform a TWT negotiation in different TWT duty cycles depending on the heat states **811** to **815** of the first STA **301**. For example, the first STA **301** may perform a TWT negotiation in a traffic control mode (e.g., a first traffic control mode **821**) in which traffic throttling may be performed tighter as a heat state (e.g., a third heat state **815**) corresponding to a higher temperature. In other words, the first STA **301** may perform a TWT negotiation by setting TWT parameters (e.g., a TWT interval and a TWT duration) to have a lower TWT duty cycle. Although traffic control (e.g., traffic throttling) is accompanied by the degradation of a user experience, such as an increase of network latency and a decrease of a speed, an embodiment may resolve a heat state efficiently and may alleviate the degradation of a user experience by varying the traffic control (e.g., traffic throttling) depending on the heat state.

[0079] FIG. **8**B is a diagram illustrating another example of the operation of determining a TWT parameter according to an embodiment.

[0080] Referring to FIG. **8**B, according to an embodiment, in a TWT duty cycle based on a heat state (a high heat state) (e.g., the heat states **811**, **813**, or **815** of FIG. **8**A) of the first STA **301**, the first STA **301** may determine TWT parameters to be a combination of a TWT duration and a different (or various) TWT wake interval, which satisfies the same TWT duty cycle. For example, a combination satisfying a TWT duty cycle upper limit (e.g., a 30% duty cycle) may include a combination of a TWT interval (e.g., 100 ms) and a TWT duration (e.g., 30 ms) and a combination of a TWT interval (e.g., 50 ms) and a TWT duration (e.g., 15 ms). TWT duty cycles that are substantially the same (or similar) may dissipate a heat state to a similar degree. Accordingly, the first STA **301** may determine the TWT parameters by applying different combinations of TWT intervals and TWT durations, which satisfies the same TWT duty cycle limit, according to a service type of a running service and may thereby minimize user experience degradation while maintaining the same heat dissipation performance.

[0081] For example, in a real-time service, such as VoIP, using a combination of a short TWT interval and TWT duration, which satisfies the TWT duty cycle limit, may minimize user experience degradation while maintaining the same heat dissipation performance. In a non-real-time service, such as web browsing, using a combination of a long TWT interval and TWT duration, which satisfies the same TWT duty cycle limit, may have an advantageous effect in handling burst traffic and may minimize user experience degradation while maintaining the same heat dissipation performance.

[0082] FIG. **9** is a diagram illustrating a TWT negotiation according to an embodiment.

[0083] Referring to FIG. **9**, in operation **910**, the first STA **301** may transmit and receive data on a service running in the first STA **301** to and from the second STA **302**, which is an external electronic device. The first STA **301** may monitor a temperature in the first STA **301** and may determine that a heat state of the first STA **301** is an overheat state according to the monitored temperature. The first STA **301** may determine that a state of the first STA **301** switches from a normal state to an overheat state.

[0084] In operation **930**, the first STA **301** may perform a TWT negotiation with the second STA **302** according to the heat state of the first STA **301**. The first STA **301** may determine that a network traffic control (e.g., traffic throttling) is required in an overheat state and may control the wireless communication module **510** to perform the TWT negotiation with a combination of a TWT interval and a TWT duration, which has a TWT duty cycle that may dissipate the overheat state, for the wireless communication module **510** included in the first STA **301**. The wireless communication module **510** and the second STA **302** may perform the TWT negotiation by transmitting and receiving a TWT request frame and a TWT response frame. The wireless communication module **510** may transmit and receive data by switching from a doze state to a wake state during a TWT SP according to a TWT setting by the TWT negotiation and may switch from the wake state to the doze state during a period other than the TWT SP.

[0085] In operation **950**, a certain time has passed after the TWT negotiation, the first STA **301** may determine that the heat state is dissipated according to the monitored temperature and may perform the TWT negotiation again normally with a combination of a TWT interval and a TWT duration, which is suitable for QoS, or may not use the TWT negotiation at all (e.g., tear down a TWT). Accordingly, the first STA **301** may be released from a traffic control state (e.g., a traffic throttling state). According to an embodiment, the first STA **301** may periodically monitor the temperature of the first STA **301**.

[0086] FIG. **10**A is a flowchart illustrating an operating method of the STA according to an embodiment.

[0087] Referring to FIG. **10**A, operations **1010** and **1020** may be performed in a situation where the first STA **301** may transmit and receive data on a service running in the first STA **301** to and from the second STA **302**, which is an external electronic device.

[0088] In operation **1010**, the first STA **301** may determine TWT parameters differently depending on a heat state (e.g., a high heat state) of the first STA **301**, based on a temperature of the first STA **301**.

[0089] In operation **1020**, the first STA **301** may perform a TWT negotiation with the second STA **302**, which is an external electronic device, through the wireless communication module **510** by using the TWT parameters.

[0090] FIG. **10**B is another flowchart illustrating the operating method of the STA according to an embodiment.

[0091] Referring to FIG. **10**B, operations **1030** to **1060** may be performed in a situation where the first STA **301** may transmit and receive data on a service running in the first STA **301** to and from the second STA **302**, which is an external electronic device.

[0092] In operation **1030**, the first STA **301** may monitor a temperature of the first STA **301**.

[0093] In operation **1040**, the first STA **301** may determine a heat state (e.g., an overheat state) of the first STA **301**, based on the temperature monitored in the first STA **301**.

[0094] In operation **1050**, the first STA **301** may determine TWT parameters differently depending on the heat state (e.g., the overheat state) of the first STA **301**, based on the temperature of the first STA **301**.

[0095] In operation **1060**, the first STA **301** may perform a TWT negotiation with the second STA **302**, which is an external electronic device, through the wireless communication module **510** by using the TWT parameters.

[0096] FIG. **11** is a flowchart illustrating a TWT-based traffic control according to an embodiment.

[0097] Referring to FIG. **11**, operations **1110** to **1150** may be performed in a situation where the first STA **301** may transmit and receive data on a service running in the first STA **301** to and from the second STA **302**, which is an external electronic device. Operations **1110** to **1150** may be performed sequentially but may not necessarily be performed sequentially. For example, the order of operations **1110** to **1150** may be changed, and at least two of operations **1110** to **1150** may be performed in parallel.

[0098] In operation **1110**, the first STA **301** may recognize a service type (e.g., a real-time service or a non-real-time service) of a running service (e.g., a currently running service in the processor **520**) in the first STA **301**.

[0099] In operation **1120**, the first STA **301** may determine whether a TWT-based traffic control (e.g., TWT-based traffic throttling) is required according to whether the recognized service type is a real-time service. The first STA **301** may determine that the TWT-based traffic control is required when the recognized service type is a real-time service.

[0100] In operation **1130**, when the recognized service type is not a real-time service, the first STA **301** may not use a TWT (or a TWT negotiation). The first STA **301** may not perform the TWT negotiation on the second STA **302**.

[0101] In operation **1140**, when the recognized service type is a real-time service, the first STA **301** may determine TWT parameters (e.g., a TWT interval and a TWT duration) based on the real-time service, which is the service type of the running service. The TWT control module **550** may set at least one value of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent duration field in a TWT element (e.g., the TWT element **410** or **430** of FIG. **4**) according to the determined TWT parameters.

[0102] In operation **1150**, the first STA **301** may perform the TWT negotiation with the second STA **302** by using the TWT parameters.

[0103] According to an embodiment, operations **1110** to **1150** may be performed repeatedly in a designated cycle. The first STA **301**, through operations **1110** to **1150**, may perform a traffic control (e.g., traffic throttling) efficiently by using a TWT setting by the TWT negotiation.

[0104] According to an embodiment, a cycle of performing operations **1110** to **1150** may be determined based on a temperature of the first STA **301**. For example, when the temperature of the first STA **301** is in a high temperature state, the cycle of performing operations **1110** to **1150** may be short.

[0105] FIG. **12** is another flowchart illustrating the TWT-based traffic control according to an embodiment.

[0106] Referring to FIG. **12**, operations **1210** to **1280** may be performed in a situation where the first STA **301** may transmit and receive data on a service running in the first STA **301** to and from the second STA **302**, which is an external electronic device. Operations **1210** to **1280** may be performed sequentially but may not necessarily be performed sequentially. For example, the order of operations **1210** to **1280** may be changed, and at least two of operations **1210** to **1280** may be performed in parallel.

[0107] In operation **1210**, the first STA **301** may recognize a service type (e.g., a real-time service or a non-real-time service) of a running service (e.g., a currently running service in the processor **520**) in the first STA **301**.

[0108] In operation **1220**, the first STA **301** may monitor a temperature in the first STA **301** and may determine whether a traffic control (e.g., traffic throttling) is required for the wireless communication module **510** included in the first STA **301** according to a heat state of the first STA **301** based on the monitored temperature.

[0109] In operation **1230**, the first STA **301** may determine whether a TWT-based traffic control (e.g., TWT-based traffic throttling) is required according to whether the recognized service type is a real-time service or whether the traffic control according to the heat state of the first STA **301** is required. The first STA **301** may transmit and receive data based on a TWT when the recognized service type is a real-time service or the traffic control according to the heat state of the first STA **301** is required. The first STA **301** may transmit and receive data based on the TWT if the traffic control according to the heat state of the first STA **301** is required even when the recognized service type is a non-real-time service.

[0110] In operation **1240**, the first STA **301** may not use the TWT (or a TWT negotiation) when the recognized service type is not a real-time service and the traffic control according to the heat state of the first STA **301** is not required. The first STA **301** may not perform the TWT negotiation on the second STA **302**.

[0111] In operation **1250**, the first STA **301** may determine TWT parameters (e.g., a TWT interval and a TWT duration) corresponding to the recognized service type (e.g., a real-time service or a non-real-time service) of the running service.

[0112] In operations **1260** to **1280**, the first STA **301** may maintain the TWT parameters (e.g., the TWT interval and the TWT duration) determined in operation **1250** or may cap a value of the TWT duration of the TWT parameters (e.g., the TWT interval and the TWT duration) determined in operation **1250**. For example, when the TWT-based traffic control according to the heat state of the first STA **301** is enabled, the first STA **301** may cap the value of the TWT duration of the TWT parameters (e.g., the TWT interval and the TWT duration) determined in operation **1250**. The capping of the value of the TWT duration may be performed through Equation 1.

$$\text{duration} = \text{wake interval} * \text{throttling rate} \qquad \text{(Equation 1)}$$

[0113] In Equation 1, the wake interval may be a value of the TWT interval determined in operation **1250**. The value of the TWT interval may be maintained at a value (e.g., a value determined in operation **1250**) determined to correspond to the recognized service type of the running service, and the value (e.g., an upper value) of the TWT duration may be determined (e.g., adjusted or modified) through Equation 1 to satisfy a TWT duty cycle based on the heat state of the first STA **301**.

[0114] In operation **1260**, the first STA **301** may determine whether a traffic ratio to be limited is greater than a first threshold. The traffic ratio to be limited may be a ratio of a currently (or actually) used throughput to a maximum throughput (e.g., an output of the heat control module **630**) for the wireless communication module **510** included in the first STA **301**. The traffic ratio to be limited may be used to determine whether to enable the TWT-based traffic control based on the heat state.

[0115] In operation **1263**, when the traffic ratio to be limited is greater than the first threshold, the TWT-based traffic control based on the heat state may be enabled in the first STA **301**, and the first STA **301** may decrease a throttling rate (e.g., an initial throttling rate). In operation **1280**, the first STA **301** may cap the value of the TWT duration determined in operation **1250** based on the throttling rate less than the initial throttling rate. In this case, when the TWT-based traffic control based on the heat state may be enabled, the first STA **301** may maintain an enabled state while performing operations **1210** to **1290** repeatedly in a designated cycle until disabled.

[0116] In operation **1270**, the first STA **301** may determine whether the traffic ratio to be limited is greater than a second threshold when the traffic ratio to be limited is not greater than the first threshold. In operation **1273**, the first STA **301** may determine whether the TWT-based traffic control based on the heat state is enabled when the traffic ratio to be limited is greater than the second threshold. In operation **1275**, when the traffic ratio to be limited is not greater than the first threshold but is greater than the second threshold, and the TWT-based traffic control based on the heat state is enabled, the first STA **301** may increase the throttling rate that has been decreased in operation **1263**. The throttling rate increased in operation **1275** may still be less than the initial throttling rate. In operation **1280**, the first STA **301** may cap the value of the TWT duration determined in operation **1250** based on the throttling rate greater than the throttling rate decreased in operation **1263**. In operations **1275** and **1280**, the first STA **301** may improve performance by increasing the throttling rate that has been decreased in operation **1263** after determining that the temperature (e.g., a temperature of the wireless communication module **510**) of the first STA **301** is lowered than an initial high temperature state through the TWT-based traffic control based on the heat state of the first STA **301**.

[0117] In operation **1277**, when the traffic ratio to be limited is less than the first and second thresholds or the traffic ratio to be limited is 0 (e.g., when there is no output of the heat control module **630**) or the TWT-based traffic control based on the heat state is not enabled, the first STA **301** may initialize the throttling rate to the initial throttling rate. In addition, the TWT-based traffic control based on the heat state that has been enabled may be disabled.

[0118] In operation **1290**, the first STA **301** may perform the TWT negotiation with the second STA **302** by using the TWT parameters (e.g., the TWT parameters determined in operation **1250** or the TWT parameters capped in operation **1280**).

[0119] According to an embodiment, operations **1210** to **1290** may be performed repeatedly in a designated cycle. The first STA **301**, through operations **1210** to **1290**, may perform a traffic control (e.g., traffic throttling) efficiently by using a TWT setting by the TWT negotiation according to the heat state (e.g., the high heat state) of the first STA **301**. Accordingly, the first STA **301** may lower the temperature of the wireless communication module **510**.

[0120] FIG. **13** is a block diagram illustrating an electronic device in a network environment according to an embodiment. Referring to FIG. **13**, the electronic device **1301** in the network environment **1300** may communicate with an electronic device **1302** via a first network **1398** (e.g., a short-range wireless communication network), or communicate with at least one of an electronic device **1304** or a server **1308** via a second network **1399** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **1301** may communicate with the electronic device **1304** via the server **1308**. According to an embodiment, the electronic device **1301** may include a processor **1320**, a memory **1330**, an input module **1350**, a sound output module **1355**, a display module **1360**, an audio module **1370**, a sensor module **1376**, an interface **1377**, a connecting terminal **1378**, a haptic module **1379**, a camera module **1380**, a power management module **1388**, a battery **1389**, a communication module **1390**, a subscriber identification module (SIM) **1396**, or an antenna module **1397**. In an embodiment, at least one of the components (e.g., the connecting terminal **1378**) may be omitted from the electronic device **1301**, or one or more other components may be added to the electronic device **1301**. In an embodiment, some of the components (e.g., the sensor module **1376**, the camera module **1380**, or the antenna module **1397**) may be integrated as a single component (e.g., the display module **1360**).

[0121] The processor **1320** may execute, for example, software (e.g., a program **1340**) to control at least one other component (e.g., a hardware or software component) of the electronic device **1301** connected to the processor **1320** and may perform various data processing or computation. According to an embodiment, as at least a part of data processing or computation, the processor **1320** may store a command or data received from another component (e.g., the sensor module **1376** or the communication module **1390**) in a volatile memory **1332**, process the command or the data stored in the volatile memory **1332**, and store resulting data in a non-volatile memory **1334**. According to an embodiment, the processor **1320** may include the main processor **1321** (e.g., a CPU or an AP), or an auxiliary processor **1323** (e.g., a GPU, a neural processing unit (NPU), an ISP, a sensor hub processor, or a CP) that is operable independently from, or in conjunction with the main processor **1321**. For example, when the electronic device **1301** includes the main processor **1321** and the auxiliary processor **1323**, the auxiliary processor **1323** may be adapted to consume less power than the main processor **1321** or to be specific to a specified function. The auxiliary processor **1323** may be implemented separately from the main processor **1321** or as a part of the main processor **1321**.

[0122] The auxiliary processor **1323** may control at least some of functions or states related to at least one (e.g., the display module **1360**, the sensor module **1376**, or the communication module **1390**) of the components of the electronic device **1301** instead of the main processor **1321** while the main processor **1321** is in an inactive (e.g., sleep) state or along with the main processor **1321** while the main processor **1321** is an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **1323** (e.g., an ISP or a CP) may be implemented as a portion of another component (e.g., the camera module **1380** or the communication module **1390**) that is functionally related to the auxiliary processor **1323**. According to an embodiment, the auxiliary processor **1323** (e.g., an NPU) may include a hardware structure specifically for artificial intelligence model processing. An artificial intelligence (AI) model may be generated by machine learning. Such learning may be performed by, for example, the electronic device **1301** in which AI is performed or performed via a separate server (e.g., the server **1308**). Learning algorithms may include, but are not limited to, for example, supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The AI model may include a plurality of artificial neural network layers. An artificial neural network may include, for example, a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted Boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), and a deep Q-network or a combination of two or more thereof but is not limited thereto. The AI model may additionally or alternatively include a software structure other than the hardware structure.

[0123] The memory **1330** may store various pieces of data used by at least one component (e.g., the processor **1320** or the sensor module **1376**) of the electronic device **1301**. The various pieces of data may include, for example, software (e.g., the program **1340**) and input data or output data for a command related thereto. The memory **1330** may include the volatile memory **1332** or the non-volatile memory **1334**.

[0124] The program **1340** may be stored as software in the memory **1330**, and may include, for example, an operating system (OS) **1342**, middleware **1344**, or an application **1346**.

[0125] The input module **1350** may receive a command or data to be used by another component (e.g., the processor **1320**) of the electronic device **1301**, from the outside (e.g., a user) of the electronic device **1301**. The input module **1350** may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

[0126] The sound output module **1355** may output a sound signal to the outside of the electronic device **1301**. The sound output module **1355** may include, for example, a speaker or receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used to receive an incoming call. According to an embodiment, the receiver may be implemented separately from the speaker or as a portion of the speaker.

[0127] The display module **1360** may visually provide information to the outside (e.g., a user) of the electronic device **1301**. The display module **1360** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, the hologram device, and the projector. According to an embodiment, the display module **1360** may include a touch sensor adapted to sense a touch, or a pressure sensor adapted to measure an intensity of a force incurred by the touch.

[0128] The audio module **1370** may convert a sound into an electrical signal or vice versa. According to an embodiment, the audio module **1370** may obtain the sound via the input module **1350** or output the sound via the sound output module **1355** or an external electronic device (e.g., the electronic device **1302** such as a speaker or a headphone) directly or wirelessly connected to the electronic device **1301**.

[0129] The sensor module **1376** may detect an operational state (e.g., power or temperature) of the electronic device **1301** or an environmental state (e.g., a state of a user) external to the electronic device **1301** and may generate an electric signal or data value corresponding to the detected state. According to an embodiment, the sensor module **1376** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

[0130] The interface **1377** may support one or more specified protocols to be used for the electronic device **1301** to be coupled with the external electronic device (e.g., the electronic device **1302**) directly or wirelessly. According to an embodiment, the interface **1377** may include, for example, an HDMI, a USB interface, an SD card interface, or an audio interface.

[0131] The connecting terminal **1378** may include a connector via which the electronic device **1301** may physically connect to an external electronic device (e.g., the electronic device **1302**). According to an embodiment, the connecting terminal **1378** may include, for example, an HDMI connector, a USB connector, an SD card connector, or an audio connector (e.g., a headphone connector).

[0132] The haptic module **1379** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or an electrical stimulus which may be recognized by a user via his or her tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **1379** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

[0133] The camera module **1380** may capture a still image and moving images. According to an embodiment, the camera module **1380** may include one or more lenses, image sensors, ISPs, or flashes.

[0134] The power management module **1388** may manage power supplied to the electronic device **1301**. According to an embodiment, the power management module **1388** may be implemented as, for example, at least a part of a power management integrated circuit (PMIC).

[0135] The battery **1389** may supply power to at least one component of the electronic device **1301**. According to an embodiment, the battery **1389** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

[0136] The communication module **1390** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **1301** and the external electronic device (e.g., the electronic device **1302**, the electronic device **1304**, or the server **1308**) and performing communication via the established communication channel. The communication module **1390** may include one or more communication processors that operate independently of the processor **1320** (e.g., an application processor) and support direct (e.g., wired) communication or wireless communication. According to an embodiment, the communication module **1390** may include a wireless communication module **1392** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **1394** (e.g., a local area network (LAN) communication module, or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device **1304** via the first network **1398** (e.g., a short-range communication network, such as Bluetooth™ wireless-fidelity (Wi-Fi) direct, or IR data association (IrDA)) or the second network **1399** (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., a LAN or a wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip) or may be implemented as multi-components (e.g., multi-chips) separate from each other. The wireless communication module **1392** may identify and authenticate the electronic device **1301** in a communication network, such as the first network **1398** or the second network **1399**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the SIM **1396**.

[0137] The wireless communication module **1392** may support a 5G network after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **1392** may support a high-frequency band (e.g., a mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module **1392** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (MIMO), full dimensional MIMO (FD-MIMO), an array antenna, analog beam-forming, or a large scale antenna. The wireless communication module **1392** may support various requirements specified in the electronic device **1301**, an external electronic device (e.g., the electronic device **1304**), or a network system (e.g., the second network **1399**). According to an embodiment, the wireless communication module **1392** may support a peak data rate (e.g., 20 Gbps or more) for implementing eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

[0138] The antenna module **1397** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **1301**. According to an embodiment, the antenna module **1397** may include an antenna including a radiating element including a conductive material or a conductive pattern formed in or on a substrate (e.g., a PCB). According to an embodiment, the antenna module **1397** may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in a communication network, such as the first network **1398** or the second network **1399**, may be selected by, for example, the communication module **1390** from the antennas. The signal or power may be transmitted or received between the communication module **1390** and the external electronic device via the at least one selected antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as a part of the antenna module **1397**.

[0139] According to an embodiment, the antenna module **1397** may form a mm Wave antenna module. According to one embodiment, the mmWave antenna module may include a PCB, an RFIC on a first surface (e.g., the bottom surface) of the PCB, or adjacent to the first surface of the PCB and capable of supporting a designated high-frequency band (e.g., a mm Wave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the PCB, or adjacent to the second surface of the PCB and capable of transmitting or receiving signals of the designated high-frequency band.

[0140] At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

[0141] According to an embodiment, commands or data may be transmitted or received between the electronic device **1301** and the external electronic device **1304** via the server **1308** coupled with the second network **1399**. Each of the external electronic devices **1302** or **1304** may be a device of the same type as or a different type from the electronic device **1301**. According to an embodiment, all or some of operations to be executed by the electronic device **1301** may be executed at one or more external electronic devices (e.g., the external electronic devices **1302** and **1304**, and the server **1308**). For example, if the electronic device **1301** needs to perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **1301**, instead of, or in addition to, executing the function or the service, may request one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request and may transfer an outcome of the performing to the electronic device **1301**. The electronic device **1301** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **1301** may provide ultra-low-latency services using, e.g., distributed computing or MEC. In an example, the external electronic device **1304** may include an Internet-of-things (IOT) device. The server **1308** may be an intelligent server using machine learning and/or a neural network. According to one embodiment, the external electronic device (e.g., the electronic device **1304**) or the server **1308** may be included in the second network **1399**. The electronic device **1301** may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

[0142] The electronic device according to the embodiments disclosed herein may be one of various types of electronic devices. The electronic device may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance device. According to an embodiment, the electronic device is not limited to those described above.

[0143] It should be appreciated that embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. In connection with the description of the drawings, like reference numerals may be used for similar or related components. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things unless the relevant context clearly indicates otherwise. As used herein, "A or B", "at least one of A and B", "at least one of A or B", "A, B or C", "at least one of A, B and C", and "A, B, or C," each of which may include any one of the items listed together in the corresponding one of the phrases, or all possible combinations thereof. Terms such as "first", "second", or "first" or "second" may simply be used to distinguish the component from other components in question, and do not limit the components in other aspects (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively," as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), the element may be coupled with the other element directly (e.g., by wire), wirelessly, or via a third element.

[0144] As used in connection with embodiments of the disclosure, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic", "logic block", "part", or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

[0145] Embodiments as set forth herein may be implemented as software (e.g., the program **1340**) including one or more instructions that are stored in a storage medium (e.g., an internal memory **1336** or an external memory **1338**) that is readable by a machine (e.g., the electronic device **1301**). For example, a processor (e.g., the processor **1320**) of the machine (e.g., the electronic device **1301**) may invoke at least one of the one or more instructions stored in the storage medium and execute it. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include code generated by a compiler or code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Here, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

[0146] According to an embodiment, a method according to embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read-only memory (CD-ROM)) or may be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smartphones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a transmit server.

[0147] According to embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities, and some of the multiple entities may be separately disposed in different components. According to embodiments, one or more of the above-described components or operations may be omitted, or one or more other components or operations may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to an embodiment, the integrated component may still perform one or more functions of each of the components in the same or similar manner as they are performed by a corresponding one among the components before the integration. According to embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

[0148] According to an embodiment, an electronic device (e.g., the first STA **301** of FIG. **6** or the electronic device **1301** of FIG. **13**) includes at least one temperature sensor (e.g., the temperature sensor **610** of FIG. **7** or the sensor module **1376** of FIG. **13**) positioned in the electronic device, at least one wireless communication module (e.g., the wireless communication module **510** of FIG. **6** or the wireless communication module **1392** of FIG. **13**) configured to transmit and receive a wireless signal, at least one processor (e.g., the processor **520** of FIG. **6** or the processor **1320** of FIG. **13**) connected operatively to the wireless communication module, and a memory (e.g., the memory **530** of FIG. **6** or the memory **1330** of FIG. **13**) connected electrically to the processor and configured to store instructions executable by the processor, in which, when the instructions are executed by the processor, the electronic device may determine (e.g., operation **1010** of FIG. **10**A) a target wake time (TWT) parameter differently depending on a heat state of the electronic device based on a temperature of the electronic device and may perform (e.g., operation **1020** of FIG. **10**A) a TWT negotiation with an external electronic device (e.g., the second STA **302** of FIG. **3** or the electronic device **1302** or **1304** of FIG. **13**) through the wireless communication module by using the TWT parameter.

[0149] According to an embodiment, the processor may execute instructions to determine the TWT parameter such that a TWT duty cycle operates differently depending on a heat state of the electronic device (refer to FIG. **8**A).

[0150] According to an embodiment, the processor may execute instructions to determine the TWT parameter such that the TWT duty cycle decreases as a temperature of the electronic device increases (refer to FIG. **8**A).

[0151] According to an embodiment, the processor may execute instructions to determine the TWT parameter to be a combination of a TWT duration and a different TWT wake interval, which satisfies the same TWT duty cycle, with respect to the TWT duty cycle based on a heat state of the electronic device (refer to FIG. **8**B).

[0152] According to an embodiment, the processor may execute instructions to determine the combination of the TWT duration and the different TWT wake interval, which satisfies the same TWT duty cycle, according to a service type of a service that is running (refer to FIG. **8**B).

[0153] According to an embodiment, the processor may execute instructions to determine the combination to be a combination of the TWT duration and a first TWT wake interval, which satisfies the same TWT duty cycle, when the service type is a real-time service, and may determine the combination to be a combination of the TWT duration and a second TWT wake interval, which satisfies the same TWT duty cycle, when the service type is a non-real-time service, in which the first TWT wake interval is less than the second TWT wake interval (refer to FIG. **8**B).

[0154] According to an embodiment, the processor may execute instructions to set the TWT parameter differently by setting at least one value differently of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent field of a TWT element (e.g., the TWT element **410** or **430** of FIG. **4**) depending on a heat state of the electronic device.

[0155] According to an embodiment, the processor may execute instructions to recognize (e.g., operation **1210** of FIG. **12**) the service type of a running service, may determine (e.g., operation **1250** of FIG. **12**) a TWT duration and a TWT interval corresponding to the recognized service type, and may cap (operation **1270** of FIG. **12**) a value of the TWT duration to satisfy the TWT duty cycle based on a heat state of the electronic device.

[0156] According to an embodiment, the processor may execute instructions to monitor a temperature of the electronic device through the temperature sensor and determine a heat state of the electronic device.

[0157] According to an embodiment, the electronic device may further include an auxiliary processor (e.g., the auxiliary processor **710** of FIG. **7** or the auxiliary processor **1323** of FIG. **13**) configured to execute instructions to monitor a temperature of the electronic device through the temperature sensor and determine a heat state of the electronic device.

[0158] According to an embodiment, an operating method of an electronic device (e.g., the first STA **301** of FIG. **6** or the electronic device **1301** of FIG. **13**) includes an operation (e.g., operation **1030** of FIG. **10**B) of monitoring a temperature of the electronic device, an operation (e.g., operation **1040** of FIG. **10**B) of determining a heat state of the electronic device based on the monitored temperature, an operation (e.g., operation **1050** of FIG. **10**B) of determining a target wake time (TWT) parameter differently depending on a heat state of the electronic device, and an operation (e.g., operation **1060** of FIG. **10**B) of performing a TWT negotiation with an external electronic device (e.g., the second STA **302** of FIG. **3** or the electronic device **1302** or **1304** of FIG. **13**) by using the TWT parameter.

[0159] According to an embodiment, the operation of determining may include an operation of determining the TWT parameter such that a TWT duty cycle operates differently depending on a heat state of the electronic device (refer to FIG. **8**A).

[0160] According to an embodiment, the operation of determining the TWT parameter may include an operation of determining the TWT parameter such that the TWT duty cycle decreases as a temperature of the electronic device increases (refer to FIG. **8**A).

[0161] According to an embodiment, the operation of determining the TWT parameter may include an operation of determining the TWT parameter to be a combination of a TWT duration and a different TWT wake interval, which satisfies the same TWT duty cycle, with respect to the TWT duty cycle based on a heat state of the electronic device (refer to FIG. **8**B).

[0162] According to an embodiment, the operation of determining the TWT parameter to be the combination may include an operation of determining the combination of the TWT duration and the different TWT wake interval satisfying the same TWT duty cycle according to a service type of a service that is running (refer to FIG. **8**B).

[0163] According to an embodiment, the operation of determining the combination of the TWT duration and the different TWT wake interval satisfying the same TWT duty cycle according to a service type of a service that is running may include an operation of determining the combination to be a combination of the TWT duration and a first TWT interval, which satisfies the same TWT duty cycle, when the service type is a real-time service, and an operation of determining the combination to be a combination of the

TWT duration and a second TWT interval, which satisfies the same TWT duty cycle, when the service type is a non-real-time service, in which the first TWT interval is less than the second TWT interval (refer to FIG. 8B).

[0164] According to an embodiment, the operation of determining may include an operation of setting the TWT parameter differently by setting at least one value differently of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent field of a TWT element (e.g., the TWT element **410** or **430** of FIG. **4**) depending on a heat state of the electronic device.

[0165] According to an embodiment, the operation of determining may include an operation of determining (e.g., operation **1250** of FIG. **12**) a TWT duration and a TWT interval corresponding to a recognized service type of a service that is running and an operation of capping (operation **1270** of FIG. **12**) a value of the TWT duration to satisfy the TWT duty cycle based on a heat state of the electronic device.

[0166] According to an embodiment, the operating method may further include an operation (e.g., operation **1210** of FIG. **12**) of recognizing the service type of the service that is running.

[0167] According to an embodiment, the operating method may further include an operation (e.g., operation **950** of FIG. **9**) of performing a TWT negotiation again or tearing down a TWT when the heat state is dissipated.

[0168] According to an embodiment, the temperature of the electronic device may be monitored through a temperature sensor and the heat state of the electronic device may be determined by a processor or an auxiliary processor of the electronic device.

[0169] According to an embodiment, a computer program product can include a storage medium storing instructions configured to be executed by at least one processor of an electronic device to perform a plurality of operations. The operations can include determining a target wake time (TWT) parameter differently depending on a heat state of the electronic device such that a TWT duty cycle operates differently depending on the heat state of the electronic device, where the TWT duty cycle is based on a combination of a TWT duration and a TWT interval. The operations can also include performing a TWT negotiation with an external electronic device by using the TWT parameter.

What is claimed is:

1. An electronic device comprising:

a temperature sensor positioned in the electronic device;

a wireless communication module configured to transmit and receive a wireless signal;

a processor connected operatively to the wireless communication module; and

a memory connected electrically to the processor and configured to store instructions executable by the processor, wherein the instructions, when executed by the processor, cause the electronic device to:

determine a target wake time (TWT) parameter differently depending on a heat state of the electronic device based on a temperature of the electronic device, and perform a TWT negotiation with an external electronic device through the wireless communication module by using the TWT parameter.

2. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to determine the TWT parameter such that a TWT duty cycle operates differently depending on the heat state of the electronic device.

3. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to determine the TWT parameter such that a TWT duty cycle decreases as the temperature of the electronic device increases.

4. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to determine the TWT parameter to be a combination of a TWT duration and a different TWT interval, which satisfies a same TWT duty cycle, with respect to a TWT duty cycle based on the heat state of the electronic device.

5. The electronic device of claim **4**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to determine the combination of the TWT duration and the different TWT interval, which satisfies the same TWT duty cycle, according to a service type of a service that is running.

6. The electronic device of claim **5**, wherein the instructions are configured to, when executed by the processor, cause the electronic device is further configured to:

determine the combination to be a combination of the TWT duration and a first TWT interval, which satisfies the same TWT duty cycle, when the service type is a real-time service, and

determine the combination to be a combination of the TWT duration and a second TWT interval, which satisfies the same TWT duty cycle, when the service type is a non-real-time service, wherein

the first TWT interval is less than the second TWT interval.

7. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to set the TWT parameter differently by setting at least one value differently of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent field of a TWT element depending on the heat state of the electronic device.

8. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to:

recognize a service type of a running service,

determine a TWT duration and a TWT interval corresponding to the recognized service type, and

cap a value of the TWT duration to satisfy a TWT duty cycle based on the heat state of the electronic device.

9. The electronic device of claim **1**, wherein the instructions are configured to, when executed by the processor, cause the electronic device to monitor the temperature of the electronic device through the temperature sensor and determine the heat state of the electronic device.

10. The electronic device of claim **1**, further comprising:

an auxiliary processor configured to monitor a temperature of the electronic device through the temperature sensor and determine the heat state of the electronic device.

11. An operating method of an electronic device, the operating method comprising:

monitoring a temperature of the electronic device;

determining a heat state of the electronic device based on the monitored temperature;

determining a target wake time (TWT) parameter differently depending on the heat state of the electronic device; and

performing a TWT negotiation with an external electronic device by using the TWT parameter.

12. The operating method of claim **11**, wherein the determining the TWT parameter comprises:

determining the TWT parameter such that a TWT duty cycle operates differently depending on the heat state of the electronic device.

13. The operating method of claim **12**, wherein the determining the TWT parameter comprises:

determining the TWT parameter such that the TWT duty cycle decreases as the temperature of the electronic device increases.

14. The operating method of claim **13**, wherein the determining the TWT parameter comprises:

determining the TWT parameter to be a combination of a TWT duration and a different TWT interval, which satisfies the same TWT duty cycle, with respect to the TWT duty cycle based on a heat state of the electronic device.

15. The operating method of claim **14**, wherein the determining the TWT parameter to be the combination comprises:

determining the combination of the TWT duration and the different TWT interval satisfying the same TWT duty cycle according to a service type of a service that is running.

16. The operating method of claim **15**, further comprising:

determining the combination to be a combination of the TWT duration and a first TWT interval, which satisfies the same TWT duty cycle, when the service type is a real-time service; and

determining the combination to be a combination of the TWT duration and a second TWT interval, which satisfies the same TWT duty cycle, when the service type is a non-real-time service, wherein

the first TWT interval is less than the second TWT interval.

17. The operating method of claim **11**, wherein the TWT parameter is set differently by setting at least one value differently of a TWT wake interval mantissa field, a nominal minimum TWT duration field, and a TWT wake interval exponent field of a TWT element depending on the heat state of the electronic device.

18. The operating method of claim **11**, further comprising:

recognizing a service type of a running service;

determining a TWT duration and a TWT interval corresponding to the recognized service type; and

capping a value of the TWT duration to satisfy a TWT duty cycle based on the heat state of the electronic device.

19. The operating method of claim **11**, wherein the temperature of the electronic device is monitored through a temperature sensor and the heat state of the electronic device is determined by a processor or an auxiliary processor of the electronic device.

20. A computer program product comprising a storage medium storing instructions configured to be executed by at least one processor of an electronic device to perform a plurality of operations comprising:

determining a target wake time (TWT) parameter differently depending on a heat state of the electronic device such that a TWT duty cycle operates differently depending on the heat state of the electronic device, wherein the TWT duty cycle is based on a combination of a TWT duration and a TWT interval; and

performing a TWT negotiation with an external electronic device by using the TWT parameter.

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