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Enabling a terminal device to perform efficient communication in a stand-by state

Abstract

A terminal comprises a function capable of operating in a plurality of states that include a first state in which a connection with a base station has been established, and a second state in which a connection with a base station has not been established, but the base station holds information regarding the terminal device. After starting operation in the second state from a state in which the terminal operates with a first base station in the first state, if predetermined information that enables communication with the first base station in the second state and that has been acquired from the first base station in the first state is held, the terminal determines whether a signal transmission target has changed from the first base station to a second base station device, and performs communication according to a result of the determination.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) (1) This application is a continuation of U.S. patent application Ser. No. 17/198,620 filed on Mar. 11, 2021, which is a continuation of International Patent Application No. PCT/JP2019/030157 filed on Aug. 1, 2019, which claims priority to and the benefit of Japanese Patent Application No. 2018-175780 filed on Sep. 20, 2018, the entire disclosures of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION
Field of the Invention
(1) The present invention relates to a terminal device, a method for controlling the same, and a computer-readable storage medium, and specifically relates to a control technique used by a terminal device in a stand-by state to transmit a signal.
Description of the Related Art
(2) In 3GPP, NR (New Radio) has been standardized as the 5.sup.th generation wireless communication method (see NPL 1). A terminal device conforming to NR can transition to an RRC_INACTIVE state in addition to two states that a terminal device conforming to LTE (Long Term Evolution) can take, namely an RRC_CONNECTED state and an RRC_IDLE state. Here, RRC_CONNECTED is a state in which the terminal device is connected to a base station device and is performing communication, and RRC_INACTIVE and RRC_IDLE are stand-by states. Note that the RRC_INACTIVE state is a state in which context information (regarding a terminal device) that is to be used by the terminal device to communicate with a core network is held by a base station device (a last connected base station) to which the terminal device has been connected until the state transitions to the RRC_INACTIVE state, and the RRC_IDLE state is a state in which such information is not held by the base station device.
(3) NPL 2 discloses that studies have been carried out to enable a terminal device in the RRC_INACTIVE state to transmit data, and that an MA (Multiple Access) signature is assigned to the terminal device to realize such data transmission. An MA signature may be, for example, a time/frequency radio resource block, a modulation coding method (MCS), a demodulation reference signal (DMRS) that is used to identify a terminal device, or information that identifies a data transmission pattern that is unique to a terminal device such as an interleave pattern. A terminal device transmits data by using an MA signature, and a base station device can separate and identify the data transmitted from the terminal device, by using the MA signature.
CITATION LIST
Non-patent Literature
(4) NPL1: 3GPP TS 38.300, V15.2.0, June 2018 NPL2: 3GPP written contribution, RP-171043
(5) A terminal device in the RRC_INACTIVE state can move in an RNA (RAN-based Notification Area) without notifying the network. Therefore, it can be conceived that the terminal device moves to, although within the RNA, an area expanded by a base station device that is different from the last connected base station. In such a case, the base station device at the destination does not hold the MA signature for the terminal device, and may be unable to extract data transmitted from the terminal device in the RRC_INACTIVE state. On the other hand, the terminal device can reliably transmit data by transitioning to the RRC_CONNECTED state each time the terminal device transmits data. However, it is necessary to perform processing to transition to the RRC_CONNECTED state each time, and therefore efficiency may degrade.

SUMMARY OF THE INVENTION
(6) The present invention enables a terminal device to perform efficient communication in a stand-by state.
(7) A terminal device according to one aspect of the present invention includes: a communication circuit capable of operating in a plurality of states that include a first state in which a connection with a base station device has been established, and a second state in which a connection with a base station device has not been established, but the base station device holds information regarding the terminal device; and a controller configured to, after the communication circuit that has been operating with a first base station device in the first state starts operating in the second state, if predetermined information that enables the communication circuit to perform communication with the first base station device in the second state and that has been acquired from the first base station device in the first state is held, determine whether or not a target to which a signal is to be transmitted has changed from the first base station device to the second base station device, and control the communication circuit so that the communication circuit performs communication according to a result of the determination.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain principles of the invention.
(2) FIG. **1** is a diagram showing an example of a configuration of a wireless communication system.
(3) FIG. **2** is a diagram showing an example of a hardware configuration of a device.
(4) FIG. **3** is a diagram showing an example of a functional configuration of a terminal device.
(5) FIG. **4** is a diagram showing an example of a functional configuration of a base station device.
(6) FIG. **5** is a diagram showing an example of the flow of processing performed by the wireless communication system.
(7) FIG. **6** is a diagram showing an example of the flow of processing performed by the terminal device.
(8) FIG. **7** is a diagram showing an example of the flow of processing performed by the wireless communication system.
(9) FIG. **8** is a diagram showing an example of a flow of processing performed by the wireless communication system.
DESCRIPTION OF THE EMBODIMENTS
(10) The following describes an embodiment in detail with reference to the accompanying drawings. Note that the following embodiment does not limit the invention according to the scope of claims, and the invention does not necessarily require all of the combinations of features described in the embodiment. Two or more of the plurality of features described in the embodiment may be combined together in any manner. In addition, the same or similar components will be given the same reference numbers, and duplicate descriptions will be omitted.
Configuration of Wireless Communication System
(11) FIG. **1** shows an example of a configuration of a wireless communication system according to the present embodiment. The wireless communication system includes, for example, a first base station device **101**, a second base station device **102**, and a terminal device **103**. Although FIG. **1** shows two base station devices and one terminal device to simplify the descriptions thereof, a large number of base station devices and a large number of terminal devices may be present as in a common cellular communication system. Also, although the following describes a case in which

NR, which is the 5.sup.th generation wireless communication method, is employed, the present invention is not limited to such a case. For example, the following discussion can be applied to any other systems including a 5.sup.th generation or later cellular communication system, and a terminal device (a communication device) that can communicate a certain amount of data in a standby state such as the RRC_INACTIVE state specified by NR. That is to say, the base station devices described below may be any base station devices that can perform communication not only with a terminal device with which a connection has been established, but also with a terminal device with which a connection has not been established, but that can perform certain amount of data communication. Also, the terminal device described below is configured to be able to operate in a first state in which a connection with a base station device has been established, and a second state in which a connection with a base station device has not been established, but the terminal device can perform a certain amount of data communication with the base station device.
(12) The first base station device **101** and the second base station device **102** are, for example, base station devices that can operate in conformity with NR (gNB). The first base station device **101** and the second base station device **102** provide a communication service in a cell **104** and a cell **105**, respectively. Note that the first base station device **101** and the second base station device **102** may form two or more cells/beams. The terminal device **103** is a terminal device that can operate in conformity with NR, and can communicate with a base station device that conforms to NR.
(13) The terminal device **103** can acquire an MA signature from the first base station device **101**, and use the MA signature in communication with the first base station device **101**, for example. Note that the MA signature is predetermined information for realizing data communication in the RRC_INACTIVE state, and other information may be used instead of, or in addition to, the MA signature. Note that the MA signature may also be used in the RRC_CONNECTED state, for example. After receiving the MA signature, upon receiving an RRCRelease message with suspendConfig from the first base station device **101**, for example, the terminal device **103** may transition to the RRC_INACTIVE state. Note that a base station device with which the terminal device **103** has been establishing a connection until the terminal device **103** transitions to the RRC_INACTIVE state, such as the first base station device **101**, may be referred to as a last connected base station (last serving gNB).
(14) NR defines an RNA that includes at least one cell, and a terminal device can move within the RNA (RAN-based Notification Area) in the RRC_INACTIVE state without notifying the network. In FIG. **1**, for example, one RNA **106** that includes the cell **104** and the cell **105** formed by the first base station device **101** and the second base station device **102** has been set. Therefore, after transitioning to the RRC_INACTIVE state, the terminal device **103** can move to the cell **104** formed by the first base station device **101** to the cell **105** formed by the second base station device **102**, without notifying the network.
(15) Note that, when moving to the outside of the RNA, the terminal device **103** can establish a connection with the base station device at the destination, transition to the RRC_CONNECTED state, and transition to the RRC_INACTIVE state again in response to an RRCRelease message that includes “suspendConfig” from the base station device at the destination. In such a case, the terminal device **103** can receive an MA signature from the base station device at the destination, and therefore can transmit a data signal to the base station device in the RRC_INACTIVE state.
(16) On the other hand, the terminal device **103** does not need to communicate with a base station device as long as it moves within the RNA. Therefore, when the terminal device **103** has moved from the cell **104** to the cell **105**, it is possible that the second base station device **102** has not received a notification from the terminal device **103**. In such a case, the second base station device **102** does not know the MA signature provided from the first base station device **101** to the terminal device **103**, and the second base station device **102** has not provided an MA signature to the terminal device **103**. Therefore, even if the terminal device **103** in the RRC_INACTIVE state transmits a data signal by using an MA signature provided from the first base station device **101**,

the second base station device **102** cannot separate the data signal from the received signal.
(17) In contrast, the terminal device **103** can transition to the RRC_CONNECTED state each time it transmits data. As a result, the terminal device **103** can reliably transmit data even if it stays in a cell formed by a base station device that is different from the last connected base station. On the other hand, in order for the terminal device **103** in the RRC_INACTIVE state to transition to the RRC_CONNECTED state, the terminal device **103** needs to transmit an I-RNTI (Inactive Radio Network Temporary Identifier) for identifying a terminal device in the RRC_INACTIVE state, provided from the last connected base station, to a base station device to which the terminal device is to connect. That is to say, a certain signaling overhead occurs. At this time, the terminal device **103** transitions to the RRC_CONNECTED state even though the terminal device **103** has not moved from the cell formed by the first base station device **101**, and performs signaling that is originally unnecessary. Thus, the communication efficiency of the wireless communication system may degrade.
(18) Therefore, in the present embodiment, if the terminal device **103** holds an MA signature acquired from the last connected base station, the terminal device **103** monitors for whether or not the base station device to which a signal is to be transmitted has been changed from the last connected base station. That is to say, in the RRC_INACTIVE state, the terminal device **103** monitors a movement within the RNA on the condition that it holds an MA signature, in addition to monitoring regarding whether or not it has moved across an RNA. For example, when operating in the RRC_CONNECTED state, the terminal device **103** acquires an MA signature from the first base station device **101** to which the terminal device **103** is connected, and if the terminal device **103** thereafter transitions to the RRC_INACTIVE state, it monitors for whether or not it has moved from the cell **104** formed by the first base station device **101** to the cell **105** formed by the second base station device **102**. As a result, the terminal device **103** can determine whether or not it can perform communication while staying in the RRC_INACTIVE state, using the MA signature held by the terminal device **103**. Therefore, if the terminal device **103** holds an MA signature and the base station device to which a signal is to be transmitted has not changed from the last connected base station, the terminal device **103** transmits a data signal to the last connected base station by using the same MA signature while staying in the RRC_INACTIVE state.
(19) On the other hand, even if the terminal device **103** holds an MA signature, if the base station device to which a signal is to be transmitted has changed from the last connected base station, the terminal device **103** cannot transmit a signal by using the MA signature. Therefore, when transmitting a signal, the terminal device **103** establishes a connection with the base station device to which the signal is to be transmitted, transitions to the RRC_CONNECTED state, and thereafter transmits a signal. As described above, when holding an MA signature, the terminal device **103** can avoid unnecessarily transitioning to the RRC_CONNECTED state by monitoring whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station.
(20) Note that the terminal device **103** can determine whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station by acquiring an identifier of a cell (Physical Cell ID, PCI) from a synchronization signal (SS) or a notification signal (Physical Broadcast Channel, PBCH) transmitted from each base station device, and detecting whether or not there is a change in the PCI acquired from the received signal. However, the present invention is not limited to such a configuration, and the terminal device **103** may determine whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station based on any information that the terminal device **103** can acquire in the RRC_INACTIVE state and that can distinguish between a plurality of base station devices.
(21) If the terminal device **103** does not hold an MA signature, the terminal device **103** may refrain from such monitoring regarding whether or not the base station device to which a signal is to be

transmitted has changed from the last connected base station. As a result, the terminal device **103** can avoid unnecessarily performing monitoring, and, for example, it is possible to reduce the power consumption of the terminal device **103**. However, while the terminal device **103** is in the RRC_INACTIVE state, even in the case where the terminal device **103** does not monitor whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station, the terminal device **103** regularly checks whether or not the terminal device **103** has moved across an RNA. If the terminal device **103** has moved across an RNA, the terminal device **103** establishes a connection with a base station device at the destination, transitions to the RRC_CONNECTED state, and updates an RNA. Note that the procedures for updating an RNA are known as a conventional technique, and therefore the details thereof will not be described.

(22) Note that the terminal device **103** may invariably (regularly) perform such monitoring, or, when the terminal device **103** holds an MA signature, the terminal device **103** may determine whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station, each time data to be transmitted is generated, for example. If the terminal device **103** invariably performs monitoring, the terminal device **103** can swiftly determine whether or not it is possible to transmit a signal when data to be transmitted is generated, while staying in the RRC_INACTIVE state. Therefore, it is possible to reduce the time from the generation of the data to the completion of the transmission of the signal. On the other hand, if the terminal device **103** determines whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station after data to be transmitted is generated, it is unnecessary to perform monitoring processing from when it is determined that a signal is not to be transmitted. Therefore, it is possible to reduce the power consumption of the terminal device **103**.

(23) If it is determined that the base station device to which a signal is to be transmitted has changed from the last connected base station (for example, if the terminal device **103** has moved from the cell **104** formed by the first base station device **101** to the cell **105** formed by the second base station device), the terminal device **103** may discard the MA signature held by the terminal device **103**. Also, if the terminal device **103** enters the RRC_CONNECTED state and transmits a signal to the base station device to which a signal is to be transmitted, the terminal device **103** may attempt to acquire an MA signature from the base station device. In the case where the terminal device **103** does not hold an MA signature, for example, the terminal device **103** may acquire an MA signature from the first base station device **101** if the terminal device **103** has transmitted a signal to the first base station device **101** in the RRC_CONNECTED state, and may acquire an MA signature from the second base station device **102** if the terminal device **103** has transmitted a signal to the second base station device **102** in the RRC_CONNECTED state. Even if the terminal device **103** holds an MA signature, the terminal device **103** may newly acquire an MA signature. In such a case, the terminal device **103** may overwrite the MA signature held thereby, or hold the MA signature held in the past as a history. Note that the terminal device **103** may acquire an MA signature while staying in the RRC_INACTIVE state. Generally, the terminal device **103** transmits an RRCConnectionResumeRequest message to the base station device to which a signal is to be transmitted, receives an RRCConnectionResume message from the base station device, and thus transitions to the RRC_CONNECTED state. Thereafter, the terminal device **103** may acquire an MA signature from the base station device that is in the connected state in such a case. On the other hand, for example, the terminal device **103** may transmit an RRCConnectionResumeRequest message in which an information element that requests for the issuance of an MA signature is included, and if the base station device receives the RRCConnectionResumeRequest message that includes the information element, the base station device may notify the terminal device **103** of the MA signature without making the terminal device **103** transition to the RRC_CONNECTED state. Note that this is an example, and the terminal device **103** may acquire an MA signature through other procedures. Note that the terminal device **103** performs processing corresponding to the

message from the base station device, and may be unable to acquire an MA signature.

(24) The base station device may acquire an MA signature held by the terminal device **103** from the last connected base station, for example, and continuously use the MA signature held by the terminal device **103**, without change. In this case, for example, the base station device may transmit an RRCConnectionResume message that includes a bit indicating that the MA signature held by the terminal device **103** is to be continuously used, in response to the RRCConnectionResumeRequest message from the terminal device **103**. For example, a bit indicating that the terminal device **103** is denied transition to the RRC_CONNECTED state may be included in the RRCConnectionResume message so as to indicate that the MA signature held by the terminal device **103** is to be continuously used. In the case where the base station device transmits an RRCConnectionResume message that includes a bit indicating that the terminal device **103** is to transition to the RRC_CONNECTED state, the base station device may subsequently transmit a separate message notifying the terminal device **103** of the MA signature. The base station device may use an information element separate from the bit indicating that the terminal device **103** is denied transition to the RRC_CONNECTED state, to notify the terminal device **103** that the MA signature held thereby is to be used continuously. In this case, the terminal device **103** can continuously use the MA signature held thereby, without transitioning to the RRC_CONNECTED state.

Device Configuration

(25) Next, examples of hardware configurations of the base station devices (the first base station device **101** and the second base station device **102**) and the terminal device **103** that perform the above-described processing will be described with reference to FIG. **2**. In one example, these devices include a processor **201**, a ROM **202**, a RAM **203**, a storage device **204**, and a communication circuit **205**. The processor **201** is a computer that includes at least one processing circuit such as a general-purpose CPU (Central Processing Unit) or an ASIC (Application Specific Integrated Circuit), and performs the overall processing for the devices and each kind of processing described above by reading out and executing a program stored in the ROM **202** or the storage device **204**. The ROM **202** is a read-only memory that stores a program related to processing to be performed by the devices and information such as various parameters, for example. The RAM **203** functions as a work space when the processor **201** executes a program, and is a random access memory that stores temporary information. The storage device **204** is constituted by a removable external storage device or the like, for example. The communication circuit **205** is constituted by a circuit for wireless communication or wired communication, for example. The base station device includes, for example, a baseband circuit for NR, an RF circuit, etc., and an antenna as a communication circuit **205** for communication with the terminal device **103**. The communication circuit **205** of the base station device may include a circuit for performing (wired or wireless) communication with another base station device or a network node, for example. Also, the terminal device **103** and the communication circuit **205** include a baseband circuit for NR, RF circuit, etc., and an antenna. The terminal device **103** may also include a communication circuit **205** for performing communication in conformity with wireless LAN or other communication standards. Although FIG. **2** shows one communication circuit **205**, each device may have a plurality of communication circuits.

(26) FIG. **3** shows a schematic example of a functional configuration of the terminal device **103**. In one example, the terminal device **103** includes a communication unit **301**, a control unit **302**, and an information holding unit **303**. The communication unit **301** communicates with a base station device. Note that the communication unit **301** is configured to be able to operate in any of three states, namely the RRC_CONNECTED state, the RRC_INACTIVE state, and the RRC_IDLE state, under the control of the base station device, and transmit and receive data to and from the base station device to which the communication unit **301** is connected, in the RRC_CONNECTED state. Even in the RRC_INACTIVE state, the communication unit **301** can transmit a small amount of data to the base station device by using an MA signature held by the information holding unit

303 described below. The control unit **302** may perform various kinds of processing of the terminal device **103** as described above by controlling the communication unit **301**. That is to say, the control unit **302** controls the communication unit **301** to perform processing such as determination regarding whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station while the communication unit **301** has been operating in the RRC_INACTIVE state, on the condition that an MA signature is held by the information holding unit **303**. The information holding unit **303** holds an MA signature that has been set by the base station device that is in the RRC_CONNECTED state. Note that the information holding unit **303** may hold the history of MA signatures set in the past. In such a case, the information holding unit **303** may discard the entire history information when a trigger is detected such as when the terminal device **103** moves across an RNA in the RRC_INACTIVE state.

(27) FIG. **4** shows a schematic example of a functional configuration of the base station devices (the first base station device **101** and the second base station device **102**). In one example, each base station device includes a communication unit **401**, a control unit **402**, a signature acquisition unit **403**, and a signature setting unit **404**. The communication unit **401** communicates with the terminal device **103** and another base station device. Note that a communication unit for wireless communication with the terminal device **103** and communication unit for communication with another base station device may separately be provided. However, for example, when another base station device is operated according to the NR standards, only one communication unit **401** may be provided. The control unit **402** may perform various kinds of processing of the base station device as described above by controlling the communication unit **401**. For example, the control unit **402** may acquire information regarding an MA signature from the last connected base station of the terminal device **103** by controlling the signature acquisition unit **403**, and set the MA signature to the terminal device **103** by controlling the signature setting unit **404**. For example, the control unit **402** determines whether or not to use the MA signature acquired by the signature acquisition unit **403** without change, and controls the signature setting unit **404** to use the acquired MA signature, use a new MA signature, or hold the MA signature. Furthermore, the control unit **402** may control the communication unit **401** so that the data signal transmitted from the terminal device **103** in the RRC_INACTIVE state is separated from the received signal by using the MA signature held by the signature setting unit **404**. The signature acquisition unit **403** acquires the MA signature from the last connected base station of the terminal device **103**. The signature setting unit **404** sets the MA signature to the terminal device **103** under the control of the control unit **402**.

Processing Flow

(28) FIG. **5** shows an example of the flow of processing performed by the wireless communication system according to the present embodiment. In FIG. **5**, the terminal device **103** is communicating with the first base station device **101** in the RRC_CONNECTED state (S**501**). In this state, an MA signature is set to the terminal device **103** by the first base station device **101** to which the terminal device **103** is connected, and the terminal device **103** acquires the set MA signature (S**502**). Thereafter, upon receiving an RRCRelease message that includes “suspendConfig” (S**503**), the terminal device **103** transitions to the RRC_INACTIVE state (S**504**). In this way, the first base station device **101** that the terminal device **103** has been communicating with in the RRC_CONNECTED state immediately before transitioning to the RRC_INACTIVE state is the last connected base station for the terminal device **103**.

(29) If data to be transmitted is generated while the terminal device **103** is operating in the RRC_INACTIVE state (S**505**), the terminal device **103** transmits a signal that includes the data to the first base station device **101** by using the MA signature acquired in S**502** while staying in the RRC_INACTIVE state (S**506**), and the first base station device **101** can separate and extract the data signal transmitted by the terminal device **103**, from the received signal, using the MA signature set to the terminal device **103**. Note that, when the terminal device **103** is operating in the RRC_INACTIVE state while holding the MA signature, the terminal device **103** determines

whether or not the base station device to which a signal is to be transmitted on the assumption that the signal is to be transmitted at the time has been changed from the last connected base station (the first base station device **101**), based on a synchronization signal (SS) or a notification signal (PBCH) received from a base station device around the terminal device **103** (S**507**). Note that, if the terminal device **103** in the RRC_INACTIVE state is not holding an MA signature, the terminal device **103** may only perform determination regarding movement across an RNA, without performing determination regarding movement including movement within an RNA as performed in S**507**. The period of cycles in which the determination regarding movement within an RNA is performed may be set to be shorter than the period of cycles in which determination regarding movement across an RNA is performed. That is to say, in the present embodiment, when the terminal device **103** is operating in the RRC_INACTIVE state while holding an MA signature, the terminal device **103** may more frequently perform determination regarding movement than when not holding an MA signature.

(30) Upon determining that the base station device to which a signal is to be transmitted has changed from the last connected base station (S**508**), the terminal device **103** does not perform data transmission using the MA signature held thereby (S**509**). At this time, the terminal device **103** may discard the MA signature. However, the present invention is not limited to such a configuration, and the terminal device **103** may discard the MA signature only if the base station device to which a signal is to be transmitted has not returned to the last connected base station even when data to be transmitted is actually generated, and may keep holding the MA signature until then. In such a case, upon determining that the base station device to which a signal is to be transmitted has changed from the last connected base station, the terminal device **103** may transition to a mode in which data transmission using an MA signature is not permitted, instead of discarding the MA signature, and transition to a mode in which data transmission using an MA signature is permitted upon determining that the base station device to which a signal is to be transmitted has returned to the last connected base station.

(31) For example, upon detecting that the base station device to which a signal is to be transmitted is different from the last connected base station or upon the generation of data to be transmitted, the terminal device **103** performs predetermined processing with the base station device to which a signal is to be transmitted (the second base station device **102**) at the destination. For example, after performing RACH (Random Access Channel) processing with the second base station device, the terminal device **103** transmits an RRCConnectionResumeRequest message to establish a connection with the second base station device **102**, and transitions to the RRC_CONNECTED state (S**510**, S**511**). An example of such predetermined processing will be described later.

(32) In the above-described example, the terminal device **103** periodically monitors SS and PBCH to monitor whether or not the base station device to which a signal is to be transmitted has been changed from the last connected base station, and setting is performed regarding whether or not the transmission of a data signal using an MA signature is to be allowed. However, the present invention is not limited to such an example. For example, the terminal device **103** may determine whether or not to use the MA signature held thereby upon data to be transmitted being generated. FIG. **6** shows an example of the processing performed by the terminal device **103** in such a case. As shown in FIG. **6**, upon data to be transmitted being generated (YES in S**601**), the terminal device **103** determines whether or not the terminal device **103** is in the RRC_INACTIVE state (S**602**), whether or not the terminal device **103** holds an MA signature (S**603**), and whether or not the base station device to which a signal is to be transmitted is the last connected base station (S**604**). Thereafter, if the terminal device **103** is operating in the RRC_INACTIVE state (YES in S**602**), the terminal device **103** holds an MA signature (YES in S**603**), and the base station device to which a signal is to be transmitted has not changed from the last connected base station (YES in S**604**), the terminal device **103** determines to transmit data while staying in the RRC_INACTIVE state, using the MA signature held thereby (S**605**). On the other hand, if the terminal device **103** is

operating in the RRC_CONNECTED state (NO in S**602**), the terminal device **103** may transmit a data signal while maintaining the connection (S**606**). If the terminal device **103** is operating in the RRC_IDLE state, (NO in S**602**), or the terminal device **103** does not hold an MA signature despite the terminal device **103** operating in the RRC_INACTIVE state (NO in S**603**), or the base station device to which a signal is to be transmitted has changed from the last connected base station (NO in S**604**), the terminal device **103**, for example, transmits an RRCConnectionSetupRequest message to the base station device to which a signal is to be transmitted to transition to the RRC_CONNECTED state, and thereafter transmits a data signal (S**606**). Note that if the terminal device **103** holds an MA signature, but the base station device to which a signal is to be transmitted has changed from the last connected base station (NO in S**604**), the terminal device **103** may discard the MA signature (S**607**).
(33) As described above, by performing determination upon data to be transmitted being generated, it is possible to reduce the power consumption of the terminal device **103** compared to the case in which regular monitoring is performed. On the other hand, if regular monitoring is performed, the state at the time data to be transmitted is generated is the same as the state at the completion of the processing shown in FIG. **6**. Therefore, a data signal can be swiftly transmitted. Therefore, different types of control may be performed for different terminal devices **103**. For example, a terminal device **103** for which suppression of a delay is given priority over reduction of a power consumption may perform periodical monitoring, and a terminal device **103** for which reduction of a power consumption is given priority over suppression of a delay may perform the processing in FIG. **6** when a data signal is to be transmitted.
(34) Next, an example of the above-described predetermined processing performed between the terminal device **103** and the base station device to which a signal is to be transmitted (the second base station device **102**) when the terminal device **103** determines that the base station device to which a signal is to be transmitted is different from the last connected base station.
(35) FIG. **7** is a diagram showing an example of the flow of such processing. Upon determining that the base station device to which a signal is to be transmitted is different from the last connected base station, the terminal device **103** transmits an RRCConnectionResumeRequest message that includes “I-RNTI” to perform communication with the base station device to which a signal is to be transmitted, which is the second base station device **102**. Upon receiving the message, the second base station device **102** specifies the last connected base station (the first base station device **101**) based on I-RNTI, and requests that UE context data be provided. Upon acquiring the UE context data, the second base station device **102** transmits an RRCConnectionResume message to the terminal device **103** to make the terminal device **103** transition to the RRC_CONNECTED state. If an MA signature has been set to the terminal device **103**, the first base station device **101** transmits the MA signature to the second base station device **102** to which the terminal device **103** is to be connected. Also, after notifying the second base station device **102** of information regarding the MA signature set to the terminal device **103**, the first base station device **101** discards this information. The second base station device **102** determines whether or not to continuously use the received MA signature, notifies the terminal device **103** of an MA signature that has been newly set. Thereafter, the second base station device **102** transmits an RRCRelease message that includes “suspendConfig” to the terminal device **103** to make the terminal device **103** transition to the RRC_INACTIVE state. As a result, the terminal device **103** returns to the RRC_INACTIVE state.
(36) Note that, in one example, the notification regarding the MA signature may include one-bit (or few-bit) information indicating whether or not the MA signature set by the first base station device **101** is to be used without change. For example, if the MA signature set by the first base station device **101** is to be used without change, only such one-bit (or few-bit) information is transmitted to the terminal device **103**, and the terminal device **103** keeps holding the MA signature held thereby. As a result, information regarding the MA signature itself is not transmitted, and it is possible to reduce the amount of signaling. If an MA signature that is different from the MA

signature set by the first base station device **101** is to be set, information regarding a newly set MA signature may also be transmitted in addition to the one-bit (or few-bit) information.

(37) In the example shown in FIG. **7**, the first base station device **101** notifies the second base station device **102** of information regarding the MA signature after the terminal device **103** enters the RRC_CONNECTED state. However, the present invention is not limited to this example. For example, the second base station device **102** may acquire an MA signature from the first base station device **101** before transmitting an RRCConnectionResume message. In this case, the second base station device **102** may determine whether or not to make the terminal device **103** transition to the RRC_CONNECTED state, based on the acquired MA signature. For example, if the second base station device **102** determines that the MA signature set by the first base station device **101** is to be used without change, the second base station device **102** may transmit an RRCConnectionResume message that includes “reject”, which indicates that transition to the RRC_CONNECTED state is rejected. In this case, the terminal device **103** may recognize that the MA signature held thereby is to be continuously used, by receiving the RRCConnectionResume message including “reject”. Note that, in the RRCConnectionResume message, a one-bit (or a few-bit) information element that is different from the information element indicating “reject” may be used to notify the terminal device **103** that the MA signature set by the first base station device **101** is to be used without change. In such cases, the terminal device **103** can recognize that the MA signature held thereby can be continuously used without transitioning to the RRC_CONNECTED state. When setting a new MA signature instead of using the MA signature of which the second base station device **102** has been notified by the first base station device **101**, the second base station device **102** may transmit an RRCConnectionResume message to make the terminal device **103** transition to the RRC_CONNECTED state. Note that the MA signature may be set without making the terminal device **103** transition to the RRC_CONNECTED state, using a message or procedures that the terminal device **103** in the RRC_INACTIVE state can receive, other than the RRCConnectionResume message.

(38) FIG. **8** shows another example of the flow of the above-described predetermined processing. FIG. **7** shows an example in which the second base station device **102** sets an MA signature to the terminal device **103** without a request from the terminal device **103**, where FIG. **8** shows an example in which the terminal device **103** requests for an MA signature. In FIG. **8**, the terminal device **103** transmits a message that includes information indicating a request for an MA signature, to the second base station device **102** that is the base station device to which a signal is to be transmitted. Although the message used here as an example is an RRCConnectionResumeRequest, any message that can specify that the terminal device **103** requests that the base station device to which a signal is to be transmitted sets an MA signature may be used. Upon receiving this message, the second base station device **102** transmits a request for acquiring UE context data, to the first base station device **101**. At this time, the second base station device **102** may include information indicating a request for an MA signature, in the message that is requesting to acquire UE context data. Note that the information indicating a request for an MA signature may be transmitted separate from the request for acquiring UE context data.

(39) Upon receiving information indicating a request for an MA signature, the first base station device **101** notifies the second base station device **102** of information regarding the MA signature set to the terminal device **103**. Thereafter, the second base station device **102** determines whether or not to use the acquired MA signature without change, and sets an MA signature to the terminal device **103** according to the result of the determination. This setting may be performed by using, for example, an RRCConnectionResume message, after the terminal device **103** has transitioned to the RRC_CONNECTED state, or, as described above, for example, by notifying that the MA signature held by the terminal device **103** is to be continuously used, using an RRCConnectionResume message including “reject”, while the terminal device **103** stays in the RRC_INACTIVE state. Alternatively, the second base station device **102** may transmit an

RRCRelease message that includes "suspendConfig", instead of transmitting an RRCConnectionResume message, to notify that the MA signature held by the terminal device **103** is to be continuously used. Alternatively, the second base station device **102** may set a new MA signature that is different from the MA signature held by the terminal device **103** by using a message or procedures that can be used to transmit a certain amount of data signal to the terminal device **103** in the RRC_INACTIVE state. In such cases, the terminal device **103** can set the MA signature that can be used in communication with the second base station device **102** while staying the RRC_INACTIVE state without transitioning to the RRC_CONNECTED state.

(40) As described above, the terminal device **103** according to the present embodiment determines whether or not the base station device to which a signal is to be transmitted has changed from the last connected base station while holding the MA signature and operating in the RRC_INACTIVE state, and if the base station device has not changed, the terminal device **103** can transmit a certain amount (a small amount) of data to the last connected base station by using the MA signature held thereby. On the other hand, if the base station device to which a signal is to be transmitted has changed from the last connected base station while the terminal device **103** is holding the MA signature and is operating in the RRC_INACTIVE state, the terminal device **103** acquires a new MA signature so that the terminal device **103** can perform communication in the RRC_INACTIVE state, or transitions to the RRC_CONNECTED state, to transmit a data signal to the base station device to which a signal is to be transmitted. As a result, the terminal device **103** can appropriately recognize whether or not the MA signature is available, and transmit a data signal to a base station device (a network) without unnecessarily transitioning to the RRC_CONNECTED state.

(41) With the present invention, it is possible to enable a terminal device to perform efficient communication in a stand-by state.

(42) While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

Claims

1. A base station device comprising: one or more processors; and one or more memories that store computer-readable instruction for causing, when executed by the one or more processors, the base station device to: obtain predetermined information from another base station device, wherein the predetermined information enables a terminal device, that operates in a second state, to perform communication with the another base station device, after the terminal device, that has been operating with the another base station device in the first state, starts to operate in the second state, wherein the first state is a state in which a connection between the terminal device and the another base station device has been established, and wherein the second state is a state in which a connection between the terminal device and the another base station device has not been established, but the another base station device holds information regarding the terminal device; and perform, in a case where a target to which a signal is to be transmitted from the terminal device has been changed from the another base station device to the base station device, communication with the terminal device in the second state using the predetermined information, wherein the base station device obtains the predetermined information, in a case where the base station device receives a first signal requesting, from the terminal device operating in the second state, to start operating in the first state and to issue the predetermined information; and wherein the base station device transmits a second signal indicating to the terminal device to continue, in the second state, the communication with the base station device, and communicates with the terminal device in the second state using the predetermined information obtained from the another base station device.
2. The base station device according to claim 1, wherein, the second signal includes information

indicating that the predetermined information is to be used continuously.
3. The base station device according to claim 1, wherein the base station device determines whether or not to continuously use the predetermined information obtained from the another base station device, wherein, the base station device performs, in a case where the base station device decides to use the predetermined information continuously, communication with the terminal device operating in the second state using the predetermined information.
4. The base station device according to claim 3, wherein the base station device issues, in a case where the base station device decides not to continuously use the predetermined information, the predetermined information, to the terminal device, for communication between the base station device and the terminal device operating in the second state.
5. The base station device according to claim 1, the predetermined information is Multiple Access signatures.
6. A control method for controlling a base station device, the control method comprising: obtaining predetermined information from another base station device, wherein the predetermined information enables a terminal device, that operates in a second state, to perform communication with the another base station device, after the terminal device, that has been operating with the another base station device in the first state, starts to operate in the second state, wherein the first state is a state in which a connection between the terminal device and the another base station device has been established, and wherein the second state is a state in which a connection between the terminal device and the another base station device has not been established, but the another base station device holds information regarding the terminal device; and performing, in a case where a target to which a signal is to be transmitted from the terminal device has been changed from the another base station device to the base station device, communication with the terminal device in the second state using the predetermined information, wherein the base station device obtains the predetermined information, in a case where the base station device receives a first signal requesting, from the terminal device operating in the second state, to start operating in the first state and to issue the predetermined information; and wherein the base station device transmits a second signal indicating to the terminal device to continue, in the second state, the communication with the base station device, and communicates with the terminal device in the second state using the predetermined information obtained from the another base station device.
7. A non-transitory computer-readable storage medium that stores program instructions that when executed by one or more processors included in a base station device, cause the one or more processors to: obtain predetermined information from another base station device, wherein the predetermined information enables a terminal device, that operates in a second state, to perform communication with the another base station device, after the terminal device, that has been operating with the another base station device in the first state, starts to operate in the second state, wherein the first state is a state in which a connection between the terminal device and the another base station device has been established, and wherein the second state is a state in which a connection between the terminal device and the another base station device has not been established, but the another base station device holds information regarding the terminal device; and perform, in a case where a target to which a signal is to be transmitted from the terminal device has been changed from the another base station device to the base station device, communication with the terminal device in the second state using the predetermined information, wherein the base station device obtains the predetermined information, in a case where the base station device receives a first signal requesting, from the terminal device operating in the second state, to start operating in the first state and to issue the predetermined information; and wherein the base station device transmits a second signal indicating to the terminal device to continue, in the second state, the communication with the base station device, and communicates with the terminal device in the second state using the predetermined information obtained from the another base station device.