COMMUNICATION METHOD, APPARATUS, AND SYSTEM

TECHNICAL FIELD

[0001] This application relates to the field of communication technologies, and in particular, to a communication method, apparatus, and system.

BACKGROUND

[0002] In ranging communication technologies, ranging signals may be wireless carrier signals with high-frequency bandwidths. The wireless carrier signal with the high-frequency bandwidth has a narrow time domain and high resolution, and therefore has a strong multipath resolution capability, and can ensure high ranging accuracy in complex multipath environments. Currently, ranging signals achieve ranging and positioning between devices by sending and receiving pulse sequences.

[0003] In related technologies, a ranging part of a ranging signal includes a plurality of ranging subsequences, each ranging subsequence includes a plurality of ranging symbols (symbol, sym), and the ranging symbol is formed by a channel code sequence. There is a gap between the ranging subsequences. A transmitter sends a signal only at the time of the ranging subsequence, and no signal is sent in the gap.

[0004] However, in the related technologies, the ranging subsequences are susceptible to interception or interference by attack signals. Consequently, ranging results of a receiver are intercepted by unauthorized users, or the ranging results are inaccurate, or even incorrect distance information is measured due to attacks.

SUMMARY

[0005] This application provides a communication method, apparatus, and system, to implement high-precision positioning and provide security protection for ranging information.

[0006] According to a first aspect, this application provides a communication method. The method includes: sending a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated in a

symmetric encryption manner, where the ranging sequence field is used to perform channel impulse response (channel impulse response, CIR) estimation.

[0007] For example, the basic duration may be configured with different values based on a service scenario of the first transmission frame. The service scenario includes at least one of the following: a ranging scenario and an angle measurement scenario.

[0008] The ranging scenario includes at least one of the following: a low-latency ranging scenario, a long-distance coverage ranging scenario, an anti-interference ranging scenario, a medium-distance ranging scenario, and a short-distance ranging scenario. The low-latency ranging scenario is a ranging scenario with a frame length less than 2 milliseconds (milliseconds, ms). The long-distance coverage ranging scenario is a ranging scenario with a coverage distance greater than 100 meters. The medium-distance ranging scenario is a ranging scenario with a ranging distance being tens of meters. The short-distance ranging scenario is a ranging scenario with a ranging distance less than or equal to 10 meters.

[0009] For example, in the low-latency ranging scenario, the basic duration may be less than or equal to 50; in the long-distance coverage ranging scenario or the anti-interference ranging scenario, the basic duration may be greater than or equal to 500; in the medium-distance ranging scenario, the basic duration may be within a range of [125, 500]; and in the short-distance ranging scenario, the basic duration may be less than 125.

[0010] The angle measurement scenario includes at least one of the following: a low-latency angle measurement scenario, a long-distance coverage angle measurement scenario, an anti-interference angle measurement scenario, a medium-distance angle measurement scenario, and a short-distance angle measurement scenario. The low-latency angle measurement scenario is an angle measurement scenario with a frame length less than 2 ms. The long-distance coverage angle measurement scenario is an angle measurement scenario with an angle measurement distance being within a range of [30 meters, 50 meters]. The medium-distance angle measurement scenario is an angle measurement scenario with an angle measurement distance being within a range of [10 meters, 30 meters]. The short-distance angle measurement scenario is an angle measurement scenario with an angle measurement distance less than or equal to 10 meters.

[0011] For example, in the low-latency angle measurement scenario, the basic duration may be less than or equal to 12; in the long-distance coverage angle measurement scenario or the anti-interference angle measurement scenario, the basic duration may be within the range of [125, 500]; in the medium-distance angle measurement scenario, the basic duration may be within a range of [50, 125]; and in the short-distance angle measurement scenario, the basic duration may be less than 50.

[0012] In the foregoing examples, a unit of the basic duration may be microseconds

(microseconds, μs) or T_{sym}, where T_{sym} is a length of one ranging symbol.

[0013] For example, after a random number within a specific range is generated in the symmetric encryption manner, the random number may be directly used as the random duration.

[0014] For another example, after a random number within a specific range is generated in the symmetric encryption manner, binary bits (bits) of the random number may be grouped to obtain a plurality of values, where each value includes at least one bit of the random number. Then, the random duration is obtained based on the plurality of values and preset coefficients respectively corresponding to the plurality of values.

[0015] Beneficial effect is as follows: The length of the gap is generated through encryption. Therefore, a duration of an interval between two adjacent ranging subsequences is encrypted, so that information about the ranging subsequence is not easily intercepted by an unauthorized user. In a time dimension, receiving and sending security control on the ranging subsequence is provided, and frequencies of interference and attack on the ranging subsequence are effectively reduced, thereby implementing high-precision positioning and providing security protection for ranging information.

[0016] When there are a plurality of ranging segments, in embodiments of this application, there are a plurality of gap length setting manners for different ranging segments. The following describes the plurality of gap length setting manners.

[0017] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

[0018] In this example, a length of the gap in the first ranging segment is the same as that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations and basic durations of gaps in any two ranging segments are the same.

[0019] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

[0020] In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations of gaps in any two ranging segments are different, and basic durations are the same.

[0021] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

[0022] In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random

durations of gaps in any two ranging segments are the same, and basic durations are different.

[0023] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

[0024] In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations and basic durations of gaps in any two ranging segments are different.

[0025] In a possible implementation, the method further includes: sending a second transmission frame, where the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[0026] In a possible implementation, the method further includes: sending a second transmission frame, where the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are the same, where $1 \le i \le M$.

[0027] In a possible implementation, the method further includes: sending a second transmission frame, where the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \le i \le M$.

[0028] In a possible implementation, the method further includes: sending a second transmission frame, where the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[0029] In a possible implementation, the gap in each ranging segment is before or after the ranging subsequence.

[0030] In a possible implementation, the gap includes a first subgap and a second subgap, the first subgap in each ranging segment is before the ranging subsequence, and the second subgap is after the ranging subsequence; and a length of the first subgap is the random duration, and a length of the second subgap is the basic duration; or the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[0031] In a possible implementation, the basic duration is greater than or equal to 0, and the

random duration is greater than or equal to 0.

[0032] In a possible implementation, there is no signal in the gap.

[0033] According to a second aspect, this application provides a communication method. The method includes: receiving a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, and each of the at least one ranging segment includes a ranging subsequence and a gap; determining a first receiving moment based on a length of a current gap, where the length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner; receiving a next ranging subsequence at the first receiving moment; and performing CIR estimation based on the received ranging subsequence.

[0034] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

[0035] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

[0036] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

[0037] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

[0038] In a possible implementation, the method further includes: receiving a second transmission frame, where the second transmission frame includes the ranging sequence field; determining a second receiving moment based on a length of a current gap, where the length of the gap includes a random duration and a basic duration, and the random duration is generated in the symmetric encryption manner; receiving a next ranging subsequence at the second receiving moment; and performing CIR estimation based on the received ranging subsequence.

[0039] In a possible implementation, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[0040] In a possible implementation, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic

durations are the same, where $1 \leq i \leq M$.

[0041] In a possible implementation, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \leq i \leq M$.

[0042] In a possible implementation, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[0043] In a possible implementation, the gap in each ranging segment is before or after the ranging subsequence.

[0044] In a possible implementation, the gap includes a first subgap and a second subgap, the first subgap in each ranging segment is before the ranging subsequence, and the second subgap is after the ranging subsequence; and

a length of the first subgap is the random duration, and a length of the second subgap is the basic duration; or the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[0045] In a possible implementation, the basic duration is greater than or equal to 0, and the random duration is greater than or equal to 0.

[0046] In a possible implementation, there is no signal in the gap.

[0047] In a possible implementation, the basic duration is determined based on a service scenario, and the service scenario includes at least one of the following: a ranging scenario and an angle measurement scenario.

[0048] In a possible implementation, the ranging scenario includes at least one of the following: a low-latency ranging scenario, a long-distance coverage ranging scenario, an anti-interference ranging scenario, a medium-distance ranging scenario, and a short-distance ranging scenario; when the service scenario is the low-latency ranging scenario, the basic duration is less than or equal to 50; when the service scenario is the long-distance coverage ranging scenario or the anti-interference ranging scenario, the basic duration is greater than or equal to 500; when the service scenario is the medium-distance ranging scenario, the basic duration belongs to [125, 500]; and when the service scenario is the short-distance ranging scenario, the basic duration is less than 125.

[0049] In a possible implementation, the angle measurement scenario includes at least one of the following: a low-latency angle measurement scenario, a long-distance coverage angle measurement scenario, an anti-interference angle measurement scenario, a medium-distance angle measurement scenario, and a short-distance angle measurement scenario; when the service

scenario is the low-latency angle measurement scenario, the basic duration is less than or equal to 12; when the service scenario is the long-distance coverage angle measurement scenario or the anti-interference angle measurement scenario, the basic duration belongs to [125, 500]; when the service scenario is the medium-distance angle measurement scenario, the basic duration belongs to [50, 125]; and when the service scenario is the short-distance angle measurement scenario, the basic duration is less than 50.

[0050] In a possible implementation, the ranging subsequence includes a plurality of ranging symbols, and a unit of the basic duration is microseconds or a length of one ranging symbol.

[0051] According to a third aspect, this application provides a transmission frame. The transmission frame includes a first transmission frame, and the first transmission frame includes: a ranging sequence field, where the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner, where the ranging sequence field is used to perform CIR estimation.

[0052] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

[0053] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

[0054] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

[0055] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

[0056] In a possible implementation, the transmission frame further includes a second transmission frame, the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[0057] In a possible implementation, the transmission frame further includes a second transmission frame, the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of

the second transmission frame, and basic durations are the same, where $1 \le i \le M$.

[0058] In a possible implementation, the transmission frame further includes a second transmission frame, the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \le i \le M$.

[0059] In a possible implementation, the transmission frame further includes a second transmission frame, the second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[0060] In a possible implementation, the gap in each ranging segment is before or after the ranging subsequence.

[0061] In a possible implementation, the gap includes a first subgap and a second subgap, the first subgap in each ranging segment is before the ranging subsequence, and the second subgap is after the ranging subsequence; and a length of the first subgap is the random duration, and a length of the second subgap is the basic duration; or the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[0062] In a possible implementation, the basic duration is greater than or equal to 0, and the random duration is greater than or equal to 0.

[0063] In a possible implementation, there is no signal in the gap.

[0064] According to a fourth aspect, this application provides a communication apparatus. The apparatus includes a module configured to send a first transmission frame. The first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner, where there is no signal in the gap, and the ranging sequence field is used to perform CIR estimation.

[0065] In a possible implementation, the apparatus further includes: a module configured to determine a service scenario; and a module configured to determine the basic duration based on the service scenario, where the service scenario includes at least one of the following: a ranging scenario and an angle measurement scenario.

[0066] In a possible implementation, the ranging scenario includes at least one of the following: a low-latency ranging scenario, a long-distance coverage ranging scenario, an anti-interference ranging scenario, a medium-distance ranging scenario, and a short-distance ranging scenario; and

the module configured to determine the basic duration based on the service scenario is specifically configured to: in response to the service scenario being the low-latency ranging scenario, determine that the basic duration is a first duration, where the first duration is less than or equal to 50; in response to the service scenario being the long-distance coverage ranging scenario or the anti-interference ranging scenario, determine that the basic duration is a second duration, where the second duration is greater than or equal to 500; in response to the service scenario being the medium-distance ranging scenario, determine that the basic duration is a third duration, where the third duration belongs to [125, 500]; and in response to the service scenario being the short-distance ranging scenario, determine that the basic duration is a fourth duration, where the fourth duration is less than 125.

[0067] In a possible implementation, the angle measurement scenario includes at least one of the following: a low-latency angle measurement scenario, a long-distance coverage angle measurement scenario, an anti-interference angle measurement scenario, a medium-distance angle measurement scenario, and a short-distance angle measurement scenario; and the module configured to determine the basic duration based on the service scenario is specifically configured to: in response to the service scenario being the low-latency angle measurement scenario, determine that the basic duration is a fifth duration, where the fifth duration is less than or equal to 12; in response to the service scenario being the long-distance coverage angle measurement scenario or the anti-interference angle measurement scenario, determine that the basic duration is a sixth duration, where the sixth duration belongs to [125, 500]; in response to the service scenario being the medium-distance angle measurement scenario, determine that the basic duration is a seventh duration, where the seventh duration belongs to [50, 125]; and in response to the service scenario being the short-distance angle measurement scenario, determine that the basic duration is an eighth duration, where the eighth duration is less than 50.

[0068] In a possible implementation, the ranging subsequence includes a plurality of ranging symbols, and a unit of the basic duration is microseconds or a length of one ranging symbol.

[0069] In a possible implementation, the communication apparatus is further configured to implement transmission of a Bluetooth signal or a wireless fidelity (wireless fidelity, Wi-Fi) signal, and at least one of a SparkLink module, a Bluetooth module, and a Wi-Fi module shares at least one of a radio frequency (radio frequency, RF) unit, a modem (Modem) unit, a medium access control (medium access control, MAC) unit, and a central processing unit (central processing unit/processor, CPU).

[0070] In a possible implementation, the communication apparatus is further configured to implement transmission of the Bluetooth signal, but does not support transmission of the Wi-Fi signal, the SparkLink module and the Bluetooth module are located in a same subsystem of the

communication apparatus, and the subsystem and a power management unit (power management unit, PMU) are integrated into the communication apparatus.

[0071] In a possible implementation, the communication apparatus is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, at least one of the Bluetooth module or the Wi-Fi module performs coexistence communication with the SparkLink module via different antennas, and a coexistence policy is channel avoidance.

[0072] In a possible implementation, the communication apparatus is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a link selection policy, a link corresponding to the peer device and/or a service to perform data transmission.

[0073] In a possible implementation, that the communication apparatus is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[0074] In a possible implementation, the link selection policy includes: when the service latency is greater than a first value, performing data transmission after establishing an asynchronous unicast link or an asynchronous multicast link; or when the service latency is less than the first value and greater than a second value, establishing the asynchronous unicast link or the asynchronous multicast link, and performing data transmission after synchronization is implemented by adding a timestamp to a data packet; or when the service latency is less than the second value, first establishing the asynchronous unicast link, and then performing data transmission after establishing a synchronous unicast link or a synchronous multicast link.

[0075] In a possible implementation, the communication apparatus is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a frame format selection policy, a frame format type corresponding to the type of the peer device and/or a service type of the peer device. The frame format type includes a SparkLink radio frame type 1, a SparkLink radio frame type 2, a SparkLink radio frame type 3, or a SparkLink radio frame type 4.

[0076] In a possible implementation, that the communication apparatus is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[0077] In a possible implementation, the frame format selection policy includes: when a

service latency requirement of the peer device is less than first duration, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 through physical layer parameter negotiation after a connected state is entered; or when the service latency requirement of the peer device is less than the first duration, and a service anti-interference capability requirement is greater than a set threshold, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation after the connected state is entered; or when the type of the peer device is a device that supports only the SparkLink radio frame type 1 or a device whose maximum transmit power is greater than a first power threshold, selecting the SparkLink radio frame type 1 to perform broadcast access; or when the service type of the peer device is an internet of things (internet of things, IOT) ultra-long-distance coverage service, when a distance between the peer device and the communication apparatus is greater than a first threshold, selecting the SparkLink radio frame type 4 to perform broadcasting and connection; or when the distance between the peer device and the communication apparatus is less than or equal to the first threshold, switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation.

[0078] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

[0079] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

[0080] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

[0081] In a possible implementation, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

[0082] In a possible implementation, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[0083] In a possible implementation, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence

field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are the same, where $1 \leq i \leq M$.

[0084] In a possible implementation, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \leq i \leq M$.

[0085] In a possible implementation, the apparatus further includes a module further configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[0086] In a possible implementation, the gap in each ranging segment is before or after the ranging subsequence.

[0087] In a possible implementation, the gap includes a first subgap and a second subgap, the first subgap in each ranging segment is before the ranging subsequence, and the second subgap is after the ranging subsequence; and a length of the first subgap is the random duration, and a length of the second subgap is the basic duration; or the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[0088] In a possible implementation, the basic duration is greater than or equal to 0, and the random duration is greater than or equal to 0.

[0089] According to a fifth aspect, this application provides a communication apparatus. The apparatus includes: a module configured to receive a first transmission frame; a module configured to determine a first receiving moment based on a length of a current gap; a module configured to receive a next ranging subsequence at the first receiving moment; and a module configured to perform CIR estimation based on the received ranging subsequence. The first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, and each of the at least one ranging segment includes a ranging subsequence and a gap. A length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner.

[0090] In a possible implementation, the apparatus further includes: a module configured to receive a second transmission frame; a module configured to determine a second receiving moment based on a length of a current gap; a module configured to receive a next ranging

subsequence at the second receiving moment; and a module configured to perform CIR estimation based on the received ranging subsequence, where the second transmission frame includes the ranging sequence field, the length of the gap includes a random duration and a basic duration, and the random duration is generated in the symmetric encryption manner.

[0091] In a possible implementation, the communication apparatus is further configured to implement transmission of a Bluetooth signal or a Wi-Fi signal, and at least one of a SparkLink module, a Bluetooth module, and a Wi-Fi module shares at least one of an RF unit, a modem unit, a MAC unit, and a CPU.

[0092] In a possible implementation, the communication apparatus is further configured to implement transmission of the Bluetooth signal, but does not support transmission of the Wi-Fi signal, the SparkLink module and the Bluetooth module are located in a same subsystem of the communication apparatus, and the subsystem and a PMU are integrated into the communication apparatus.

[0093] In a possible implementation, the communication apparatus is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, at least one of the Bluetooth module or the Wi-Fi module performs coexistence communication with the SparkLink module via different antennas, and a coexistence policy is channel avoidance.

[0094] In a possible implementation, the communication apparatus is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a link selection policy, a link corresponding to the peer device and/or a service to perform data transmission.

[0095] In a possible implementation, that the communication apparatus is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[0096] In a possible implementation, the link selection policy includes: when the service latency is greater than a first value, performing data transmission after establishing an asynchronous unicast link or an asynchronous multicast link; or when the service latency is less than the first value and greater than a second value, establishing the asynchronous unicast link or the asynchronous multicast link, and performing data transmission after synchronization is implemented by adding a timestamp to a data packet; or when the service latency is less than the second value, first establishing the asynchronous unicast link, and then performing data transmission after establishing a synchronous unicast link or a synchronous multicast link.

[0097] In a possible implementation, when the communication apparatus is a non-audio device,

the communication apparatus is further configured to perform data transmission over the asynchronous unicast link or the asynchronous multicast link.

[0098] In a possible implementation, the communication apparatus is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a frame format selection policy, a frame format type corresponding to the type of the peer device and/or a service type of the peer device. The frame format type includes a SparkLink radio frame type 1, a SparkLink radio frame type 2, a SparkLink radio frame type 3, or a SparkLink radio frame type 4.

[0099] In a possible implementation, that the communication apparatus is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[00100] In a possible implementation, the frame format selection policy includes: when a service latency requirement of the peer device is less than first duration, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 through physical layer parameter negotiation after a connected state is entered; or when the service latency requirement of the peer device is less than the first duration, and a service anti-interference capability requirement is greater than a set threshold, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation after the connected state is entered; or when the type of the peer device is a device that supports only the SparkLink radio frame type 1 or a device whose maximum transmit power is greater than a first power threshold, selecting the SparkLink radio frame type 1 to perform broadcast access; or when the service type of the peer device is an IOT ultra-long-distance coverage service, when a distance between the peer device and the communication apparatus is greater than a first threshold, selecting the SparkLink radio frame type 4 to perform broadcasting and connection; or when the distance between the peer device and the communication apparatus is less than or equal to the first threshold, switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation.

[00101] In a possible implementation, when the communication apparatus is a non-audio device, the communication apparatus is further configured to: select the SparkLink radio frame type 1 to perform broadcast access, and switch to the SparkLink radio frame type 2 through physical layer parameter negotiation for data transmission after entering the connected state.

[00102] According to a sixth aspect, this application provides a communication apparatus. The

apparatus includes one or more processors; and a memory, configured to store one or more computer programs or instructions. When the one or more computer programs or instructions are executed by the one or more processors, the one or more processors are caused to implement the method according to any one of the first aspect.

[00103] According to a seventh aspect, this application provides a communication apparatus, including a processor, configured to perform the method according to any one of the first aspect.

[00104] According to an eighth aspect, this application provides a communication apparatus. The apparatus includes one or more processors; and a memory, configured to store one or more computer programs or instructions. When the one or more computer programs or instructions are executed by the one or more processors, the one or more processors are caused to implement the method according to any one of the second aspect.

[00105] According to a ninth aspect, this application provides a communication apparatus, including a processor, configured to perform the method according to any one of the second aspect.

[00106] According to a tenth aspect, this application provides a communication apparatus. The apparatus includes a processing circuit and an interface circuit. The interface circuit is configured to: couple to a memory outside the communication apparatus, and provide a communication interface for the processing circuit to access the memory. The processing circuit is configured to execute program instructions in the memory, to implement the method according to any one of the first aspect and the second aspect.

[00107] During specific implementation, the communication apparatus may be a chip, an input circuit may be an input pin, an output circuit may be an output pin, and the processing circuit may be a transistor, a gate circuit, a trigger, various logic circuits, or the like. An input signal received by the input circuit may be received and input by, for example, but not limited to, a receiver, a signal output by the output circuit may be output to, for example, but not limited to, a transmitter and transmitted by the transmitter, and the input circuit and the output circuit may be a same circuit, where the circuit is used as the input circuit and the output circuit at different moments. Specific implementations of the processor and the various circuits are not limited in embodiments of this application.

[00108] In an implementation, the communication apparatus may be a wireless communication device, that is, a computer device supporting a wireless communication function. Specifically, the wireless communication device may be a terminal, for example, a smartphone, or may be a radio access network device, for example, a base station. A network chip may also be referred to as a system on chip (system on chip, SoC), or referred to as a SoC chip for short. A communication chip may include a baseband processing chip and a radio frequency processing chip. The baseband processing chip is also sometimes referred to as a modem (modem) or a baseband chip. The radio

frequency processing chip is also sometimes referred to as a radio frequency transceiver (transceiver) or a radio frequency chip. In a physical implementation, some or all of chips of the communication chip may be integrated into the SoC chip. For example, the baseband processing chip is integrated into the SoC chip, and the radio frequency processing chip is not integrated into the SoC chip. The interface circuit may be the radio frequency processing chip in the wireless communication device, and the processing circuit may be the baseband processing chip in the wireless communication device.

[00109] In another implementation, the communication apparatus may be a part of components in a wireless communication device, for example, an integrated circuit product like a network chip or a communication chip. The interface circuit may be an input/output interface, an interface circuit, an output circuit, an input circuit, a pin, a related circuit, or the like on the chip or a chip network. The processor may alternatively be embodied as a processing circuit or a logic circuit.

[00110] According to an eleventh aspect, this application provides a computer-readable storage medium. The computer-readable storage medium stores program code, and when the program code is executed by a processor, the method according to any one of the first aspect and the second aspect is implemented.

[00111] According to a twelfth aspect, this application provides a chip, including at least one processor. The at least one processor is configured to perform the method according to any one of the first aspect and the second aspect.

[00112] Optionally, the chip further includes a memory. The at least one processor is configured to execute code in the memory, and when the at least one processor executes the code, the chip is caused to implement the method according to any one of the first aspect and the second aspect.

[00113] Optionally, the chip may alternatively be an integrated circuit.

[00114] According to a thirteenth aspect, this application provides a computer program product including instructions. When the computer program product runs on a computer, the computer is caused to implement the method according to any one of the first aspect and the second aspect.

[00115] According to a fourteenth aspect, this application provides a communication system. The system includes a transmitter and a receiver. The transmitter includes the communication apparatus according to the fourth aspect, the sixth aspect, the seventh aspect, or the tenth aspect, and the receiver includes the communication apparatus according to the fifth aspect, the eighth aspect, the ninth aspect, or the tenth aspect.

BRIEF DESCRIPTION OF DRAWINGS

[00116] FIG. 1 is a diagram of a format of a ranging subsequence according to an embodiment

of this application;

[00117] FIG. 2 is a sending diagram of a first transmission frame according to an embodiment of this application;

[00118] FIG. 3 is a sending diagram of another first transmission frame according to an embodiment of this application;

[00119] FIG. 4 is a sending diagram of still another first transmission frame according to an embodiment of this application;

[00120] FIG. 5 is a diagram of a format of a ranging sequence field according to an embodiment of this application;

[00121] FIG. 6 is a diagram of a format of another ranging sequence field according to an embodiment of this application;

[00122] FIG. 7 is a diagram of a format of still another ranging sequence field according to an embodiment of this application;

[00123] FIG. 8 is a diagram of a format of yet another ranging sequence field according to an embodiment of this application;

[00124] FIG. 9 is a diagram of a format of still yet another ranging sequence field according to an embodiment of this application;

[00125] FIG. 10 is a diagram of a structure of a communication system according to an embodiment of this application;

[00126] FIG. 11 is a schematic flowchart of a communication method according to an embodiment of this application;

[00127] FIG. 12 is a schematic flowchart of another communication method according to an embodiment of this application;

[00128] FIG. 13 is a schematic flowchart of still another communication method according to an embodiment of this application;

[00129] FIG. 14 is a diagram of a chip architecture according to an embodiment of this application;

[00130] FIG. 15 is a diagram of another chip architecture according to an embodiment of this application;

[00131] FIG. 16 is a diagram of still another chip architecture according to an embodiment of this application;

[00132] FIG. 17 is a diagram of yet another chip architecture according to an embodiment of this application;

[00133] FIG. 18 is a diagram of a chip module framework according to an embodiment of this application;

[00134] FIG. 19 is a diagram of another chip module framework according to an embodiment of this application;

[00135] FIG. 20 is a diagram of still another chip module framework according to an embodiment of this application;

[00136] FIG. 21 is a diagram of a framework of a software static policy according to an embodiment of this application;

[00137] FIG. 22 is a diagram of a framework of a hardware arbitration time division policy according to an embodiment of this application;

[00138] FIG. 23 is a schematic flowchart of a type of link establishment according to an embodiment of this application;

[00139] FIG. 24 is a schematic flowchart of another type of link establishment according to an embodiment of this application;

[00140] FIG. 25 is a schematic flowchart of still another type of link establishment according to an embodiment of this application;

[00141] FIG. 26 is a schematic flowchart of yet another type of link establishment according to an embodiment of this application;

[00142] FIG. 27 is a schematic flowchart of still yet another type of link establishment according to an embodiment of this application;

[00143] FIG. 28 is a schematic flowchart of a further type of link establishment according to an embodiment of this application;

[00144] FIG. 29 shows four different radio frame types defined in a SparkLink protocol;

[00145] FIG. 30 is an application example of a frame format in a scenario according to an embodiment of this application;

[00146] FIG. 31 is an application example of a frame format in another scenario according to an embodiment of this application;

[00147] FIG. 32 is an application example of a frame format in still another scenario according to an embodiment of this application;

[00148] FIG. 33 is an application example of a frame format in yet another scenario according to an embodiment of this application;

[00149] FIG. 34 is a diagram of a structure of an electronic device according to an embodiment of this application;

[00150] FIG. 35 is a block diagram of a communication apparatus according to an embodiment of this application; and

[00151] FIG. 36 is a diagram of a structure of a communication apparatus according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[00152] To make objectives, technical solutions, and advantages of this application clearer, the following clearly and describes the technical solutions in this application with reference to accompanying drawings in this application. It is clear that the described embodiments are merely some rather than all of embodiments of this application. All other embodiments obtained by a person of ordinary skill in the art based on embodiments of this application without creative efforts shall fall within the protection scope of this application.

[00153] In the specification, embodiments, claims, and accompanying drawings of this application, the terms "first", "second", and the like are merely intended for distinguishing and description, and shall not be understood as indicating or implying relative importance, or indicating or implying a sequence. In addition, the terms "include", "have", and any variant thereof are intended to cover non-exclusive inclusion, for example, include a series of steps or units. A method, system, product, or device is not necessarily limited to those steps or units expressly listed, but may include other steps or units not expressly listed or inherent to such a process, method, product, or device.

[00154] It should be understood that in this application, "at least one (item)" refers to one or more and "a plurality of" refers to two or more. The term "and/or" is used for describing an association relationship between associated objects, and represents that three relationships may exist. For example, "A and/or B" may represent the following three cases: Only A exists, only B exists, and both A and B exist, where A and B may be singular or plural. The character "/" generally indicates an "or" relationship between the associated objects. The expression "at least one of the following items (pieces)" or a similar expression means any combination of these items, including a single item (piece) or any combination of a plurality of items (pieces). For example, at least one of a, b, or c may indicate a, b, c, a and b, a and c, b and c, or a, b, and c, where a, b, and c may be singular or plural.

[00155] In a ranging communication technology, a narrow impulse (impulse) signal like a nanosecond (nanosecond, ns)-level impulse signal or a picosecond (picosecond, ps)-level impulse signal is used to transmit data, for example, a narrow impulse signal of a nanosecond level is used to transmit data in an impulse radio ultra-wideband (Impulse Radio UWB, IR-UWB). The narrow impulse signal has high resolution, and therefore has a strong multipath resolution capability, and can ensure centimeter-level ranging accuracy in complex multipath environments (for example, an indoor environment).

[00156] In a current ranging communication technology, ranging between devices is implemented by sending and receiving a ranging part in a transmission frame. Embodiments of

this application provide a format of a transmission frame, to provide a security protection capability for ranging information while implementing a high-precision ranging capability, thereby implementing effective and secure high-precision ranging. The format of the transmission frame can be applied to various application technologies and devices of ranging communication systems, for example, technologies and devices including but not limited to communication, positioning, and sensing. The transmission frame may be sent based on an impulse signal, and is applicable to the current ranging communication technology.

[00157] The transmission frame provided in embodiments of this application includes a first transmission frame, the first transmission frame includes a ranging sequence field, and the ranging sequence field is used to perform CIR estimation. The ranging sequence field includes at least one ranging segment, and each of the at least one ranging segment includes a ranging subsequence and a gap (gap). The ranging subsequence includes a plurality of ranging symbols, and there is no signal in the gap. That is, in the ranging sequence field, a signal is sent only at the time of the ranging subsequence (the plurality of ranging symbols are sent), and a signal is not sent in the gap.

[00158] Each ranging symbol may include a code sequence P(0) to P(N_p−1). The code sequence may be a sequence having a good correlation property, or may be a random code sequence generated in a symmetric encryption manner. A length of the ranging symbol is determined by a length of a chip (chip) P(i) and a quantity of chips, and a length of the ranging sequence field is determined by a quantity of ranging symbols and a length of each ranging symbol. For example, a length of one ranging symbol is defined as T_{sym}, and a length of one chip is defined as T_{chip} (T_{chip} in an IR-UWB system is typically on the order of nanoseconds or hundreds of picoseconds). In this case, $T_{sym}=N_p*T_{chip}$. The quantity of ranging symbols and the length of each ranging symbol may be customized. Specific values of the quantity of ranging symbols and the length of each ranging symbol are not limited in embodiments of this application.

[00159] FIG. 1 is a diagram of a format of a ranging subsequence according to an embodiment of this application. FIG. 1 shows N_s ranging symbols S(0) to S(N_s–1) in one ranging subsequence. The ranging symbol S(i) includes a code sequence Pi=P(i, 0) to P(i, N_p–1), where $0\leq i\leq N_s-1$.

[00160] For a gap in a ranging segment, a gap position 1 is that a gap in each ranging segment is located before a ranging subsequence.

[00161] FIG. 2 is a sending diagram of a first transmission frame according to an embodiment of this application. A ranging sequence field of the first transmission frame includes M ranging segments (a ranging segment 0 to a ranging segment M–1), and the ranging segment i includes a ranging subsequence i and a gap i located before the ranging subsequence i, where $0\leq i\leq M-1$.

[00162] Specifically, as shown in FIG. 2, the ranging segment 0 includes a ranging subsequence 0 and a gap 0 located before the ranging subsequence 0, the ranging segment 1 includes a ranging

subsequence 1 and a gap 1 located before the ranging subsequence 1, the ranging segment 2 includes a ranging subsequence 2 and a gap 2 located before the ranging subsequence 2, ..., and the ranging segment M−1 includes a ranging subsequence M−1 and a gap M−1 located before the ranging subsequence M−1.

[00163] A gap position 2 is that a gap in each ranging segment is located after a ranging subsequence.

[00164] FIG. 3 is a sending diagram of another first transmission frame according to an embodiment of this application. For a signal format of the first transmission frame, refer to FIG. 2. A difference is that the gap i is located after the ranging subsequence i.

[00165] A gap position 3 is that a gap in each ranging segment includes a first subgap and a second subgap, the first subgap in each ranging segment is located before a ranging subsequence, and the second subgap is located after the ranging subsequence. A length of the first subgap is a random duration, and a length of the second subgap is a basic duration. Alternatively, the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[00166] FIG. 4 is a sending diagram of still another first transmission frame according to an embodiment of this application. A ranging sequence field of the first transmission frame includes M ranging segments (a ranging segment 0 to a ranging segment M–1), and the ranging segment i includes a ranging subsequence i, a gap i′ located before the ranging subsequence i, and a gap i′′ located after the ranging subsequence i, where $0 \le i \le M-1$.

[00167] Specifically, as shown in FIG. 4, the ranging segment 0 includes a ranging subsequence 0, a gap 0′ located before the ranging subsequence 0, and a gap 0′′ located after the ranging subsequence 0; the ranging segment 1 includes a ranging subsequence 1, a gap 1′ located before the ranging subsequence 1, and a gap 1′′ located after the ranging subsequence 1; the ranging segment 2 includes a ranging subsequence 2, a gap 2′ located before the ranging subsequence 2, and a gap 2′′ located after the ranging subsequence 2; ...; and the ranging segment M−1 includes a ranging subsequence M−1, a gap M−1′ located before the ranging subsequence M−1, and a gap M−1′′ located after the ranging subsequence M−1.

[00168] It should be noted that FIG. 2 to FIG. 4 each show only the ranging sequence field. The first transmission frame may alternatively carry another field based on definitions of frame formats in different application scenarios. All fields other than the ranging sequence field in the first transmission frame are not limited in embodiments of this application.

[00169] In embodiments of this application, a length of the gap includes a random duration and a basic duration. For example, the length of the gap may be a sum of the basic duration and the random duration, or may be a difference between the basic duration and the random duration.

[00170] The random duration is generated in the symmetric encryption manner. The basic

duration may be a pre-determined frame format configuration parameter. The basic duration is greater than or equal to 0, and the random duration is greater than or equal to 0. A transmitter determines a length of each gap in the symmetric encryption manner, to control a sending interval of each ranging subsequence.

[00171] The basic duration may be configured with different values based on a service scenario of the first transmission frame. The service scenario includes at least one of the following: a ranging scenario and an angle measurement scenario.

[00172] The ranging scenario includes at least one of the following: a low-latency ranging scenario, a long-distance coverage ranging scenario, an anti-interference ranging scenario, a medium-distance ranging scenario, and a short-distance ranging scenario. The low-latency ranging scenario is a ranging scenario with a frame length less than 2 ms. The long-distance coverage ranging scenario is a ranging scenario with a coverage distance greater than 100 meters. The medium-distance ranging scenario is a ranging scenario with a ranging distance being tens of meters. The short-distance ranging scenario is a ranging scenario with a ranging distance less than or equal to 10 meters.

[00173] For example, in the low-latency ranging scenario, the basic duration may be less than or equal to 50; in the long-distance coverage ranging scenario or the anti-interference ranging scenario, the basic duration may be greater than or equal to 500; in the medium-distance ranging scenario, the basic duration may be within a range of [125, 500]; and in the short-distance ranging scenario, the basic duration may be less than 125.

[00174] The angle measurement scenario includes at least one of the following: a low-latency angle measurement scenario, a long-distance coverage angle measurement scenario, an anti-interference angle measurement scenario, a medium-distance angle measurement scenario, and a short-distance angle measurement scenario. The low-latency angle measurement scenario is an angle measurement scenario with a frame length less than 2 ms. The long-distance coverage angle measurement scenario is an angle measurement scenario with an angle measurement distance being within a range of [30 meters, 50 meters]. The medium-distance angle measurement scenario is an angle measurement scenario with an angle measurement distance being within a range of [10 meters, 30 meters]. The short-distance angle measurement scenario is an angle measurement scenario with an angle measurement distance less than or equal to 10 meters.

[00175] For example, in the low-latency angle measurement scenario, the basic duration may be less than or equal to 12; in the long-distance coverage angle measurement scenario or the anti-interference angle measurement scenario, the basic duration may be within the range of [125, 500]; in the medium-distance angle measurement scenario, the basic duration may be within a range of [50, 125]; and in the short-distance angle measurement scenario, the basic duration may be less

than 50.

[00176] In the foregoing examples, a unit of the basic duration may be μs or T_{sym}. Refer to the foregoing descriptions. T_{sym} is a length of one ranging symbol.

[00177] Symmetric encryption is also referred to as a transmit (transmit, TX)-receive (receive, RX) symmetric key. The transmitter and a receiver may generate, by using a same key, random (random, rnd) numbers that are within a specific range and that correspond to each gap, and then obtain random durations corresponding to each gap based on the random numbers corresponding to each gap. Only when the random numbers corresponding to each gap that are generated by the transmitter and the receiver are consistent, a CIR correlation accumulator can be correctly controlled to perform effective CIR calculation, so as to correctly measure a distance and/or other positioning information.

[00178] The following describes a manner of generating the random duration in the symmetric encryption manner. For example, after the random number within the specific range is generated, the random number may be directly used as the random duration.

[00179] For another example, after the random number within the specific range is generated, binary bits of the random number may be grouped to obtain a plurality of values, where each value includes at least one bit of the random number. Then, the random duration is obtained based on the plurality of values and preset coefficients respectively corresponding to the plurality of values. For example, each value may be multiplied by a corresponding preset coefficient, and then values obtained through multiplication are accumulated, to obtain the random duration. Alternatively, the random duration may be obtained based on the plurality of values and time units of the plurality of values. For example, a time unit of each value may be preset, and then the plurality of values are accumulated based on the time units respectively corresponding to the plurality of values, to obtain the random duration. In this example, the random number is grouped based on the bits to obtain the plurality of values, and different preset coefficients or time units are set for different values. A large preset coefficient or time unit may be used to control the random duration to be within a range, and a small preset coefficient or time unit may be used to fine-tune the random duration, so that the random duration can be flexibly adjusted within a controllable range, thereby improving flexibility of generating the random duration while ensuring ranging accuracy and security.

[00180] For example, a 10-bit random number is generated in the symmetric encryption manner. In addition, bits of the random number are b0 to b9. Table 1 shows a manner of generating a random duration based on a random number. b0 to b9 are divided into two groups to obtain two values. b0 and b1 form a value N_{sym}, where a value range of N_{sym} is 0 to 3, and a preset coefficient corresponding to N_{sym} may be T_{sym}. Refer to the foregoing descriptions. T_{sym} is a length of one

ranging symbol. b2 to b9 form the other value N_{chip}, where a value range of N_{chip} is 0 to 255, and a preset coefficient corresponding to N_{chip} may be T_{chip}. Refer to the foregoing descriptions. T_{chip} is a length of one chip. The random duration $T_{rnd}=N_{sym}*T_{sym}+N_{chip}*T_{chip}$.

Table 1

Bit	b0 and b1	b2 to b9
Value	N_{sym} (a value range is 0 to 3, and a preset coefficient is T_{sym})	N_{chip} (a value range is 0 to 255, and a preset coefficient is T_{chip})
T_{rnd}	$N_{sym}*T_{sym}+N_{chip}*T_{chip}$	

[00181] Table 2 shows another manner of generating a random duration based on a random number. b0 to b9 are divided into two groups to obtain two values. b0 and b1 form a group of values N_{sym}, where a value range of N_{sym} is 0 to 3, and a time unit of N_{sym} is μs. b2 to b9 form the other group of values N_{chip}, where a value range of N_{chip} is 0 to 255, and a time unit of N_{chip} is nanoseconds (nanoseconds, ns). The random duration $T_{rnd}=N_{sym}$ μs$+N_{chip}$ ns$=(1000*N_{sym}+N_{chip})$ ns.

Table 2

Bit	b0 and b1	b2 to b9
Value	N_{sym} (a value range is 0 to 3, and a time unit is μs)	N_{chip} (a value range is 0 to 255, and a time unit is ns)
T_{rnd}	N_{sym} μs$+N_{chip}$ ns$=(1000*N_{sym}+N_{chip})$ ns	

[00182] It should be noted that Table 1 and Table 2 are merely examples for description, and do not limit a manner of obtaining a random duration based on a random number. The bits of the random number, a manner of grouping the bits of the random number, and bits forming each value may all be adjusted based on an actual application.

[00183] When there are a plurality of ranging segments, in embodiments of this application, there are a plurality of gap length setting manners for different ranging segments. The following describes the plurality of gap length setting manners.

[00184] Gap length setting manner 1: The at least one ranging segment includes a first ranging segment and a second ranging segment; and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment. In this example, a length of the gap in the first ranging segment is the same as that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations and basic durations of gaps

in any two ranging segments are the same. The first ranging segment and the second ranging segment are any ranging segments in the ranging sequence field, respectively.

[00185] Gap length setting manner 2: The at least one ranging segment includes a first ranging segment and a second ranging segment; and a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same. In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations of gaps in any two ranging segments are different, and basic durations are the same.

[00186] Gap length setting manner 3: The at least one ranging segment includes a first ranging segment and a second ranging segment; and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different. In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations of gaps in any two ranging segments are the same, and basic durations are different.

[00187] Gap length setting manner 4: The at least one ranging segment includes a first ranging segment and a second ranging segment; and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment. In this example, a length of the gap in the first ranging segment is different from that of the gap in the second ranging segment. For example, in the ranging sequence field, random durations and basic durations of gaps in any two ranging segments are different.

[00188] It may be understood that, for a plurality of gaps with a same random duration, only one random number needs to be generated in the symmetric encryption manner, and one random duration is obtained based on the random number.

[00189] The gap length setting may be combined with the foregoing gap format. For example, FIG. 5 to FIG. 9 are respectively diagrams of formats of ranging sequence fields according to embodiments of this application. FIG. 5 to FIG. 9 each show M ranging segments (a ranging segment 0 to a ranging segment M−1) included in a ranging sequence field in a first transmission frame. The ranging segment i includes a ranging subsequence i and a gap i, and a length of the gap i is T_{gapi}, where $0 \le i \le M-1$.

[00190] A ranging sequence 1 shown in FIG. 5 is a combination of the gap position 1 and the gap length setting manner 1.

[00191] As shown in FIG. 5, a gap 0 is located before a ranging subsequence 0, a gap 1 is located before a ranging subsequence 1, ..., and a gap M−1 is located before a ranging subsequence M−1. Basic durations of gaps in the M ranging segments are the same, and random durations of the gaps are the same, and a length of the gap includes a basic duration and a random duration.

Therefore, lengths T_{gap0} to T_{gapM-1} of the gaps in the M ranging segments are the same. Specifically, the basic durations of the gaps in the M ranging segments are T_{base}, and the random durations are T_{rnd}. Values of T_{gap0} to T_{gapM-1} may be $T_{base}+T_{rnd}$, or the values of T_{gap0} to T_{gapM-1} may be $T_{base}-T_{rnd}$. FIG. 5 is described by using an example in which the values of T_{gap0} to T_{gapM-1} are $T_{base}+T_{rnd}$. When sending the first transmission frame, the transmitter sends a ranging subsequence at an interval of $T_{base}+T_{rnd}$ after sending a previous field of the ranging sequence field.

[00192] For example, when generating the M ranging segments shown in FIG. 5, the transmitter generates one random number in the symmetric encryption manner, and then obtains one random duration based on the one random number, to obtain the lengths of the gaps in the M ranging segments based on one preconfigured basic duration and the one obtained random duration. For a process of determining the random duration and a configuration of the basic duration, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00193] A ranging sequence 2 shown in FIG. 6 is a combination of the gap position 1 and the gap length setting manner 2.

[00194] As shown in FIG. 6, a gap 0 is located before a ranging subsequence 0, a gap 1 is located before a ranging subsequence 1, ..., and a gap M−1 is located before a ranging subsequence M−1. Basic durations of gaps in the M ranging segments are the same, and random durations are different from each other. In addition, a length of the gap includes a basic duration and a random duration. Therefore, lengths T_{gap0} to T_{gapM-1} of the gaps in the M ranging segments are different from each other. The basic durations of the gaps in the M ranging segments are T_{base}, and a random duration of the gap i is T_{rndi}. Specifically, a random duration of the gap 0 is T_{rnd0}, a random duration of the gap 1 is T_{rnd1}, ..., and a random duration of the gap M–1 is T_{rndM-1}.

[00195] $T_{gapi}=T_{base}+T_{rndi}$, or $T_{gapi}=T_{base}-T_{rndi}$. In FIG. 6, $T_{gapi}=T_{base}+T_{rndi}$ is used as an example for description. Specifically, $T_{gap0}=T_{base}+T_{rnd0}$, $T_{gap1}=T_{base}+T_{rnd1}$, ..., and $T_{gapM-1}=T_{base}+T_{rndM-1}$. When sending the first transmission frame, the transmitter sends the ranging subsequence 0 at an interval of T_{gap0} after sending a previous field of the ranging sequence field, sends the ranging subsequence 1 at an interval of T_{gap1} after sending the ranging subsequence 0, ..., and sends the ranging subsequence M−1 at an interval of T_{gapM-1} after sending the ranging subsequence M−2.

[00196] For example, when generating the M ranging segments shown in FIG. 6, the transmitter generates M random numbers in the symmetric encryption manner, and then obtains M random durations based on the M random numbers, to obtain the lengths of the gaps in the M ranging segments based on one preconfigured basic duration and the M obtained random durations. For a process of determining the random duration and a configuration of the basic duration, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00197] A ranging sequence 3 shown in FIG. 7 is a combination of the gap position 1 and the

gap length setting manner 4.

[00198] As shown in FIG. 7, a gap 0 is located before a ranging subsequence 0, a gap 1 is located before a ranging subsequence 1, ..., and a gap M−1 is located before a ranging subsequence M−1. Basic durations of gaps in the M ranging segments are different from each other, and random durations are different from each other. In addition, a length of the gap includes a basic duration and a random duration. Therefore, lengths T_{gap0} to T_{gapM-1} of the gaps in the M ranging segments are different from each other. In the M ranging segments, a basic duration of the gap i is T_{basei}, and a random duration of the gap i is T_{rndi}. Specifically, a basic duration of the gap 0 is T_{base0}, and a random duration is T_{rnd0}; a basic duration of the gap 1 is T_{base1}, and a random duration is T_{rnd1}; ...; and a basic duration of the gap M−1 is $T_{baseM-1}$, and a random duration is T_{rndM-1}.

[00199] $T_{gapi}=T_{basei}+T_{rndi}$, or $T_{gapi}=T_{basei}-T_{rndi}$. In FIG. 7, $T_{gapi}=T_{basei}+T_{rndi}$ is used as an example for description. Specifically, $T_{gap0}=T_{base0}+T_{rnd0}$, $T_{gap1}=T_{base1}+T_{rnd1}$, ..., $T_{gapM-1}=T_{baseM-1}+T_{rndM-1}$. When sending the first transmission frame, the transmitter sends the ranging subsequence 0 at an interval of T_{gap0} after sending a previous field of the ranging sequence field, sends the ranging subsequence 1 at an interval of T_{gap1} after sending the ranging subsequence 0, ..., and sends the ranging subsequence M−1 at an interval of T_{gapM-1} after sending the ranging subsequence M−2.

[00200] For example, when generating the M ranging segments shown in FIG. 7, the transmitter generates M random numbers in the symmetric encryption manner, and then obtains M random durations based on the M random numbers, to obtain the lengths of the gaps in the M ranging segments based on M preconfigured basic durations and the M obtained random durations. For a process of determining the random duration and a configuration of the basic duration, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00201] When the gap in the ranging segment is located before the ranging subsequence, the gap length setting manners are described in embodiments of this application by using FIG. 5 to FIG. 7. When the gap in the ranging segment is located after the ranging subsequence, for gap length setting manners, refer to the related descriptions in FIG. 5 to FIG. 7. Details are not described herein again in embodiments of this application.

[00202] A ranging sequence 4 shown in FIG. 8 is a combination of the gap position 3 and the gap length setting manner 2.

[00203] As shown in FIG. 8, a gap i in each ranging segment includes a first subgap gap i′ and a second subgap gap i′′. The gap i′ in each ranging segment is located before a ranging subsequence, and the gap i′′ is located after the ranging subsequence. Specifically, a gap 0′ is located before a ranging subsequence 0, and a gap 0′′ is located after the ranging subsequence 0; a gap 1′ is located before a ranging subsequence 1, and a gap 1′′ is located after the ranging subsequence 1; ...; and a gap M−1′ is located before a ranging subsequence M−1, and a gap M−1′′

is located after the ranging subsequence M−1.

[00204] Basic durations of gaps in the M ranging segments are the same, and random durations are different from each other. FIG. 8 is described by using an example in which a length of the gap i′ is the basic duration, and a length of the gap i′′ is the random duration. Therefore, lengths $T_{gap0'}$ to $T_{gapM-1'}$ of first subgaps in the M ranging segments are the same, and lengths $T_{gap0''}$ to $T_{gapM-1''}$ of second subgaps are different from each other. The lengths of the first subgaps in the M ranging segments are T_{base}, and a length of the second subgap gap i′′ is T_{rndi}. Specifically, a length of the gap 0′′ is T_{rnd0}, a length of the gap 1′′ is T_{rnd1}, ..., and a length of the gap M−1′′ is T_{rndM-1}.

[00205] When sending the first transmission frame, the transmitter sends the ranging subsequence 0 at an interval of T_{base} after sending a previous field of the ranging sequence field, sends the ranging subsequence 1 at an interval of $T_{rnd0}+T_{base}$ after sending the ranging subsequence 0, ..., and sends the ranging subsequence M−1 at an interval of $T_{rndM-2}+T_{base}$ after sending the ranging subsequence M−2. If there is still a next field after the ranging sequence field in the first transmission frame, the next field is sent at an interval of T_{rndM-1} after the ranging subsequence M−1 is sent.

[00206] For example, when generating the M ranging segments shown in FIG. 8, the transmitter generates M random numbers in the symmetric encryption manner, and then obtains M random durations based on the M random numbers, to obtain lengths of M first subgaps based on one preconfigured basic duration, and obtain lengths of M second subgaps based on the M obtained random durations. For a process of determining the random duration and a configuration of the basic duration, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00207] A ranging sequence field 5 shown in FIG. 9 is a combination of the gap position 3 and the gap length setting manner 4.

[00208] As shown in FIG. 9, a gap gap i in each ranging segment also includes a first subgap gap i′ and a second subgap gap i′′. The gap i′ in each ranging segment is located before a ranging subsequence, and the gap i′′ is located after the ranging subsequence. Specifically, a gap 0′ is located before a ranging subsequence 0, and a gap 0′′ is located after the ranging subsequence 0; a gap 1′ is located before a ranging subsequence 1, and a gap 1′′ is located after the ranging subsequence 1; ...; and a gap M−1′ is located before a ranging subsequence M−1, and a gap M−1′′ is located after the ranging subsequence M−1.

[00209] Basic durations of gaps in the M ranging segments are different from each other, and random durations are different from each other. FIG. 9 is described by using an example in which a length of the gap i′ is the basic duration, and a length of the gap i′′ is the random duration. Therefore, lengths $T_{gap0'}$ to $T_{gapM-1'}$ of first subgaps in the M ranging segments are different from

each other, and lengths $T_{gap0''}$ to $T_{gapM-1''}$ of second subgaps are also different from each other. A length of the first subgap gap i′ in the M ranging segments is T_{basei}, and a length of the second subgap gap i′′ is T_{rndi}. Specifically, a length of the gap 0′ is T_{base0}, and a length of the gap 0′′ is T_{rnd0}; a length of the gap 1′ is T_{base1}, and a length of the gap 1′′ is T_{rnd1}; ...; and a length of the gap M−1′ is $T_{baseM-1}$, and a length of the gap M−1′′ is T_{rndM-1}.

[00210] When sending the first transmission frame, the transmitter sends the ranging subsequence 0 at an interval of T_{base1} after sending a previous field of the ranging sequence field, sends the ranging subsequence 1 at an interval of $T_{rnd0}+T_{base1}$ after sending the ranging subsequence 0, ..., and sends the ranging subsequence M−1 at an interval of $T_{rndM-2}+T_{baseM-1}$ after sending the ranging subsequence M−2. If there is still a next field after the ranging sequence field in the first transmission frame, the next field is sent at an interval of T_{rndM-1} after the ranging subsequence M–1 is sent.

[00211] For example, when generating the M ranging segments shown in FIG. 9, the transmitter generates M random numbers in the symmetric encryption manner, and then obtains M random durations based on the M random numbers, to obtain lengths of M first subgaps based on M preconfigured basic durations, and obtain lengths of M second subgaps based on the M obtained random durations. For a process of determining the random duration and a configuration of the basic duration, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00212] When the first subgap in the ranging segment is located before the ranging subsequence, the second subgap is located after the ranging subsequence, the length of the first subgap is the basic duration, and the length of the second subgap is the random duration, the gap length setting manners are described in embodiments of this application by using FIG. 8 and FIG. 9. When the first subgap in the ranging segment is located after the ranging subsequence, the second subgap is located before the ranging subsequence, the length of the first subgap is the basic duration, and the length of the second subgap is the random duration, for gap length setting manners, refer to the related descriptions in FIG. 8 and FIG. 9. Details are not described herein again in embodiments of this application.

[00213] In addition, FIG. 8 and FIG. 9 describe the length setting manner in which the basic durations of the gaps in the M ranging segments are the same, and the random durations are different from each other, and the length setting manner in which the basic durations and the random durations are different from each other. For the length setting manner in which the basic durations of the gaps in the M ranging segments are the same and the random durations of the gaps are the same, and the length setting manner in which the basic durations are different from each other and the random durations are the same, refer to the foregoing descriptions. Details are not

described herein again in embodiments of this application.

[00214] In embodiments of this application, a pulse density of the entire transmission frame is controlled by setting the length of the gap. The length of the gap may be controlled to be within a range by using the basic duration, to ensure that the pulse density of the transmission frame is within a controllable range. The length of the gap may be fine-tuned by using the random duration, so that the length of the gap can be flexibly adjusted within the controllable range, thereby improving flexibility of the length of the gap while ensuring ranging accuracy and security.

[00215] There are usually a plurality of transmission frames sent by the transmitter. There are a plurality of gap length setting manners for different transmission frames. The following describes the gap length setting manners for different transmission frames. For example, the transmission frame may further include a second transmission frame. A format of the second transmission frame is the same as that of the first transmission frame, and the second transmission frame also includes a ranging sequence field. The ranging sequence field includes at least one ranging segment. A format of the ranging segment in the second transmission frame is also the same as that of the ranging segment in the first transmission frame. For related descriptions of the ranging sequence field in the second transmission frame, refer to that in the first transmission frame. Details are not described herein again in embodiments of this application. The following uses an example in which the ranging sequence field of each of the first transmission frame and the second transmission frame includes M ranging segments for description, where $M \geq 1$.

[00216] In a first example, a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$. A gap length setting manner in the second transmission frame is completely the same as the gap length setting manner in the first transmission frame. Therefore, for the gap length setting manner in the second transmission frame, refer to the related descriptions in FIG. 5 to FIG. 9. Details are not described herein again in embodiments of this application.

[00217] In this case, one or M random numbers need to be generated for only a 1^{st} transmission frame, and a length of a gap in an i^{th} ranging segment of a subsequent transmission frame is the same as that of a gap in an i^{th} ranging segment of the transmission frame.

[00218] In a second example, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are the same, where $1 \leq i \leq M$.

[00219] For example, if the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 5, basic durations of gaps in the M ranging segments of the second transmission frame are also the

same, and random durations of the gaps in the M ranging segments of the second transmission frame are also the same. Therefore, the basic durations of the gaps in the M ranging segments of the second transmission frame are T_{base}, and the random durations of the gaps in the M ranging segments of the second transmission frame are different from T_{rnd}. In this case, for a plurality of transmission frames, only one basic duration needs to be configured. In addition, for each transmission frame, one random number needs to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00220] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 6, basic durations of gaps in the M ranging segments of the second transmission frame are also the same, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic durations of the gaps in the M ranging segments of the second transmission frame are T_{base}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for a plurality of transmission frames, only one basic duration needs to be configured. In addition, for each transmission frame, M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00221] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 7, basic durations of gaps in the M ranging segments of the second transmission frame are also different from each other, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic duration of the gap in the i^{th} ranging segment of the second transmission frame is T_{basei}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for a plurality of transmission frames, only M basic durations need to be configured. For each transmission frame, M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00222] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 8, lengths of first subgaps in the M ranging segments of the second transmission frame are also the same, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the lengths of the first subgaps in the M ranging segments of

the second transmission frame are T_{base}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for a plurality of transmission frames, only one basic duration needs to be configured. For each transmission frame, M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00223] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 9, lengths of first subgaps in the M ranging segments of the second transmission frame are also different from each other, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, a length of a first subgap in the i^{th} ranging segment of the second transmission frame is T_{basei}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for a plurality of transmission frames, only M basic durations need to be configured. For each transmission frame, M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00224] In a third example, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \leq i \leq M$.

[00225] For example, if the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 5, basic durations of gaps in the M ranging segments of the second transmission frame are also the same, and random durations of the gaps in the M ranging segments of the second transmission frame are also the same. Therefore, the basic durations of the gaps in the M ranging segments of the second transmission frame are different from T_{base}, and the random durations of the gaps in the M ranging segments of the second transmission frame are T_{rnd}. In this case, for a plurality of transmission frames, only one random number needs to be generated in the symmetric encryption manner. In addition, for each transmission frame, one basic duration needs to be reconfigured. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00226] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 6, basic durations of gaps in the M ranging segments of the second transmission frame are also the same, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic durations of the gaps in the M ranging segments

of the second transmission frame are different from T_{base}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is T_{rndi}. In this case, for a plurality of transmission frames, only M random numbers need to be generated in the symmetric encryption manner. In addition, for each transmission frame, one basic duration needs to be reconfigured. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00227] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 7, basic durations of gaps in the M ranging segments of the second transmission frame are also different from each other, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{basei}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is T_{rndi}. In this case, for a plurality of transmission frames, only M random numbers need to be generated in the symmetric encryption manner. For each transmission frame, M basic durations need to be reconfigured. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00228] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 8, lengths of first subgaps in the M ranging segments of the second transmission frame are also the same, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the lengths of the first subgaps in the M ranging segments of the second transmission frame are different from T_{base}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is T_{rndi}. In this case, for a plurality of transmission frames, only M random numbers need to be generated in the symmetric encryption manner. For each transmission frame, one basic duration needs to be reconfigured. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00229] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 9, lengths of first subgaps in the M ranging segments of the second transmission frame are also different from each other, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, a length of a first subgap in the i^{th} ranging segment of the second transmission frame is different from T_{basei}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is T_{rndi}. In this case, for a plurality of

transmission frames, only M random numbers need to be generated in the symmetric encryption manner. For each transmission frame, M basic durations need to be reconfigured. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00230] In a fourth example, a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[00231] For example, if the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 5, basic durations of gaps in the M ranging segments of the second transmission frame are also the same, and random durations of the gaps in the M ranging segments of the second transmission frame are also the same. Therefore, the basic durations of the gaps in the M ranging segments of the second transmission frame are different from T_{base}, and the random durations of the gaps in the M ranging segments of the second transmission frame are different from T_{rnd}. In this case, for each transmission frame, one basic duration needs to be reconfigured, and one random number needs to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00232] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 6, basic durations of gaps in the M ranging segments of the second transmission frame are also the same, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic durations of the gaps in the M ranging segments of the second transmission frame are different from T_{base}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for each transmission frame, one basic duration needs to be reconfigured, and M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00233] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 7, basic durations of gaps in the M ranging segments of the second transmission frame are also different from each other, and random durations of the gaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the basic duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{basei}, and the random duration of the gap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for each transmission frame, M basic durations need to be reconfigured, and M

random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00234] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 8, lengths of first subgaps in the M ranging segments of the second transmission frame are also the same, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, the lengths of the first subgaps in the M ranging segments of the second transmission frame are different from T_{base}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for each transmission frame, one basic duration needs to be reconfigured, and M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00235] If the gap length setting manner in the first transmission frame and the gap length setting manner in the second transmission frame are both the manner shown in FIG. 9, lengths of first subgaps in the M ranging segments of the second transmission frame are also different from each other, and lengths of second subgaps in the M ranging segments of the second transmission frame are also different from each other. Therefore, a length of a first subgap in the i^{th} ranging segment of the second transmission frame is different from T_{basei}, and a length of a second subgap in the i^{th} ranging segment of the second transmission frame is different from T_{rndi}. In this case, for each transmission frame, M basic durations need to be reconfigured, and M random numbers need to be re-generated in the symmetric encryption manner. For this process, refer to the foregoing descriptions. Details are not described herein again in embodiments of this application.

[00236] For example, the transmission frame (the first transmission frame or the second transmission frame) provided in embodiments of this application may further include a synchronization (synchronization, SYNC) field. The SYNC field may include at least one repeated preamble symbol, and the preamble symbol is used for time-frequency synchronization.

[00237] The transmission frame may further include a start-of-frame delimiter (start-of-frame delimiter, SFD) field after the SYNC field, and the SFD field is used to determine a start position of a subsequent field.

[00238] The transmission frame may further include a physical layer header (physical layer header, PHR) field and a payload (Payload) field. The PHR field includes rate information, at least one piece of length information, and a check code. The rate information indicates a rate of the payload field. The at least one piece of length information includes length information indicating a length of the payload field. The check code is used to check PHR information data. The payload

field is used to carry data.

[00239] The transmission frame may further include a security sequence field, and the security sequence field is used to perform security verification. For example, the security sequence field may include one code sequence, and the code sequence in the security sequence field may be a random code sequence or may be generated based on the random code sequence.

[00240] In conclusion, according to the transmission frame provided in embodiments of this application, the transmission frame includes the ranging sequence field, the ranging sequence field is used to perform CIR estimation, the ranging sequence field includes the at least one ranging segment, each of the at least one ranging segment includes the ranging subsequence and the gap, the length of the gap includes the random duration and the basic duration, the random duration is generated in the symmetric encryption manner, and there is no signal in the gap. The length of the gap in embodiments of this application is generated through encryption. Therefore, a duration of an interval between two adjacent ranging subsequences is encrypted, so that information about the ranging subsequence is not easily intercepted by an unauthorized user. In a time dimension, receiving and sending security control on the ranging subsequence is provided, and frequencies of interference and attack on the ranging subsequence are effectively reduced, thereby implementing high-precision positioning and providing security protection for ranging information.

[00241] Embodiments of this application provide a communication method, to flexibly adapt to different high-precision positioning and communication application scenarios and devices. The method may be applied to a communication system, and the communication system includes a transmitter and a receiver. The transmitter and the receiver each may include only an ultra-wideband system, and the transmitter and the receiver communicate with each other through an ultra-wideband technology. In this case, the method is applicable to the foregoing transmission frame that supports an ultra-wideband standalone operation mode. Alternatively, the transmitter and the receiver each may include an ultra-wideband system and a narrowband system, and the transmitter and the receiver may communicate with each other through an ultra-wideband technology or a narrowband technology. In this case, the method is applicable to the foregoing transmission frame that supports a narrowband-assisted ultra-wideband operation mode. The narrowband system uses a carrier signal with a narrow bandwidth to transmit data, and has advantages such as low operating power consumption and low operating costs. For example, the narrowband system may include a Wi-Fi system, a Bluetooth (Bluetooth, BT) system, and a ZigBee (ZigBee) system.

[00242] The communication system provided in embodiments of this application is applicable to a SparkLink system. The transmitter may be a grant (grant, G)-node in the SparkLink system, and the receiver may be a terminal (terminal, T)-node in the SparkLink system. Alternatively, the

transmitter may be a T-node in the SparkLink system, and the receiver may be a G-node in the SparkLink system. This is not limited in embodiments of this application.

[00243] The communication system may have a plurality of possible application scenarios. A transmitter mentioned in the following embodiments may be an initiating station in ranging communication, and a receiver is a responding station; or the transmitter is a responding station, and the receiver is an initiating station. For example, the transmitter may be a positioning device (for example, a terminal device or an anchor) in a ranging positioning scenario, and the receiver is a mobile tag (tag); or the transmitter is a mobile tag, and the receiver is a positioning device (for example, a terminal device or an anchor). In other words, the communication method provided in this application is not only applicable to a scenario in which the initiating station (the positioning device) sends a signal to the responding station (or the mobile tag) and the responding station (or the mobile tag) performs signal synchronization, but also applicable to a scenario in which the responding station (or the mobile tag) sends a signal to the initiating station (the positioning device) and the initiating station (the positioning device) performs signal synchronization. This is not limited in embodiments of this application.

[00244] For another example, both the transmitter and the receiver may be terminal devices. The terminal device may be a terminal device having receiving and sending functions, or may be a chip or a chip system disposed in the terminal device. The terminal device may also be referred to as user equipment (user equipment, UE), an access terminal, a terminal unit, a terminal station, a mobile station, a remote station, a remote terminal, a mobile device, a wireless communication device, a terminal agent, a terminal apparatus, or the like.

[00245] The terminal device may include at least one of a mobile phone (mobile phone), a cellular phone (cellular phone), a cordless phone, a session initiation protocol (session initiation protocol, SIP) phone, a wireless local loop (wireless local loop, WLL) station, a personal digital assistant (personal digital assistant, PDA), a handheld device having a wireless communication function (for example, a mobile phone, a foldable electronic device, a handheld computer, a tablet computer, a stylus, or a wireless mouse), a computing device (for example, a desktop computer, a laptop computer, a notebook computer, a super mobile personal computer, or a netbook), another processing device connected to a wireless modem, a set-top box, a router, a camera, a smart screen, a smart stereo, a remote control, a smart television, a vehicle-mounted device, a vehicle-mounted screen, a vehicle-mounted stereo, a vehicle key, a wearable device (for example, a smart watch, a smart band, or a wireless headset), an electronic conference whiteboard, an unmanned aerial vehicle, a helicopter, an aircraft, a ship, a robot, a robot arm, a terminal device in a 5G system, a terminal device in an evolved public land mobile network (public land mobile network, PLMN), an augmented reality (augmented reality, AR) device, a virtual reality (virtual reality, VR) device,

an artificial intelligence (artificial intelligence, AI) device, a smart home device (for example, a refrigerator, a television, an air conditioner, a washing machine, an electric cooker, a desk lamp, or an electric meter), a smart city device, or the like. A specific technology and a specific device form that are used by the UE are not limited in embodiments of this application.

[00246] For example, FIG. 10 is a diagram of a structure of a communication system according to an embodiment of this application. In FIG. 10, an example in which a transmitter is an anchor and a receiver is a mobile tag is used for description. The communication system includes at least one transmitter and one receiver. It should be understood that, in FIG. 10, only an example in which the communication system includes one transmitter and one receiver is used for description. The communication system is not limited to including more other devices. For example, the communication system may further include more receivers.

[00247] It should be noted that, in embodiments of this application, a device configured to send a transmission frame is referred to as a transmitter, and a device configured to receive a transmission frame is referred to as a receiver. The transmitter may alternatively receive a signal, and the receiver may alternatively send a signal. A function of the device is not limited in embodiments of this application.

[00248] FIG. 11 is a schematic flowchart of a communication method according to an embodiment of this application. The method is applied to a transmitter in a communication system, and the method may include the following procedure.

[00249] 101: Send a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner, where the ranging sequence field is used to perform CIR estimation.

[00250] For related descriptions of the ranging sequence field, refer to the foregoing embodiments. For other formats of the first transmission frame, also refer to the foregoing embodiments. Details are not described herein again in embodiments of this application.

[00251] The transmitter sends the first transmission frame in a narrow time domain signal form (for example, a narrow pulse form).

[00252] For example, when the transmitter is a source device, the transmitter first generates the first transmission frame before sending the first transmission frame. When the transmitter is a switching device (for example, a switch), the transmitter directly sends the received first transmission frame.

[00253] FIG. 12 is a schematic flowchart of another communication method according to an embodiment of this application. The method is applied to a receiver in a communication system,

and the method may include the following procedures.

[00254] 201: Receive a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, and each of the at least one ranging segment includes a ranging subsequence and a gap.

[00255] 202: Determine a first receiving moment based on a length of a current gap, where the length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner.

[00256] For a manner in which the receiver generates the random duration in the encryption manner, related descriptions of the ranging sequence field, and other formats of the first transmission frame, refer to the foregoing embodiments. Details are not described herein again in embodiments of this application.

[00257] 203: Receive a next ranging subsequence at the first receiving moment.

[00258] 204: Perform CIR estimation based on the received ranging subsequence.

[00259] FIG. 13 is a schematic flowchart of still another communication method according to an embodiment of this application. The method is applied to a communication system, and the method may include the following procedures.

[00260] 301: A transmitter sends a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated by the transmitter in a symmetric encryption manner.

[00261] 302: A receiver determines a first receiving moment based on a length of a current gap in the first transmission frame, where the length of the gap includes a random duration and a basic duration, and the random duration is generated by the receiver in the symmetric encryption manner.

[00262] 303: The receiver receives a next ranging subsequence in the first transmission frame at the first receiving moment.

[00263] 304: The receiver performs CIR estimation based on the received ranging subsequence in the first transmission frame.

[00264] 305: The transmitter sends a second transmission frame, where the second transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is generated by the transmitter in the symmetric encryption manner.

[00265] It is assumed that in the first transmission frame and the second transmission frame, the ranging sequence field includes M ranging segments. In an example, a random duration and a

basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[00266] In another example, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are the same, where $1 \le i \le M$.

[00267] In still another example, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \le i \le M$.

[00268] In yet another example, a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \le i \le M$.

[00269] For the foregoing four examples, refer to the foregoing related descriptions. Details are not described herein again in embodiments of this application.

[00270] 306: The receiver determines a second receiving moment based on a length of a current gap in the second transmission frame, where the length of the gap includes a random duration and a basic duration, and the random duration is generated by the receiver in the symmetric encryption manner.

[00271] 307: The receiver receives a next ranging subsequence in the second transmission frame at the second receiving moment.

[00272] 308: The receiver performs CIR estimation based on the received ranging subsequence in the second transmission frame.

[00273] In conclusion, according to the communication method provided in embodiments of this application, the transmitter sends the first transmission frame, where the first transmission frame includes the ranging sequence field, the ranging sequence field includes the at least one ranging segment, each of the at least one ranging segment includes the ranging subsequence and the gap, there is no signal in the gap, the length of the gap includes the random duration and the basic duration, and the random duration is generated by the transmitter in the symmetric encryption manner. In addition, the receiver receives the first transmission frame; the receiver determines the first receiving moment based on the length of the current gap in the first transmission frame, where the length of the gap includes the random duration and the basic duration, and the random duration is generated by the receiver in the symmetric encryption manner; the receiver receives the next ranging subsequence in the first transmission frame at the first receiving moment; and the receiver performs CIR estimation based on the received ranging subsequence in the first transmission frame. In embodiments of this application, the transmitter and the receiver determine the length of the gap in the symmetric encryption manner. Therefore, a duration of an interval between two adjacent

ranging subsequences is encrypted, so that information about the ranging subsequence is not easily intercepted by an unauthorized user. In a time dimension, receiving and sending security control on the ranging subsequence is provided, and frequencies of interference and attack on the ranging subsequence are effectively reduced, thereby implementing high-precision positioning and providing security protection for ranging information.

[00274] A sequence of the methods provided in embodiments of this application may be properly adjusted, and a process may alternatively be correspondingly added or deleted, and/or combined, or partially combined based on a situation. Any variation method readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. This is not limited in embodiments of this application.

[00275] For example, the solutions provided in embodiments of this application are applicable to SparkLink positioning (SparkLink positioning, SLP) or Bluetooth communication. In embodiments of this application, Bluetooth and Bluetooth low energy (Bluetooth low energy, BLE) may refer to each other. SparkLink (SparkLink or NearLink), SparkLink low energy (SparkLink low energy, SLE), SparkLink basic (SparkLink basic, SLB), or SparkLink positioning (SparkLink positioning, SLP) may also refer to each other. Therefore, the transmitter may be a G-node in the SparkLink system, and the receiver may be a T-node in the SparkLink system.

[00276] The following describes some embodiments of the solutions provided in this application.

Embodiment 1

[00277] BT and SparkLink each may be a networking mode in which a plurality of pico networks (Piconets) may be overlapped, and both may use a 2.4 GHz frequency band and use a frequency hopping technology. Due to their similarities, a part of modules may be reused. This can save chip costs, area, and power consumption. Chip resources may be highly reused, and a plurality of chips may be quickly iterated.

[00278] BLE and SLP may share a radio frequency architecture and channel. FIG. 14 is a diagram of a chip architecture according to an embodiment of this application. It can be learned from FIG. 14 that resource sharing of a CPU, an RF unit, an analog baseband (analog baseband, ABB) unit, or a modem may be implemented using a design, and a part of modules at a MAC layer may be reused. This saves a chip area and reduces chip costs and power consumption.

[00279] FIG. 15 is a diagram of another chip architecture according to an embodiment of this application. It can be learned from FIG. 15 that MAC units of BT, SLP, and Wi-Fi are separately implemented, and an RF unit and a modem unit are shared by all the modes.

[00280] FIG. 16 is a diagram of still another chip architecture according to an embodiment of this application. It can be learned from FIG. 16 that MAC units of BT, SLP, and Wi-Fi are

separately implemented, and modems of BT, SLP, and Wi-Fi are also separately implemented, and an RF unit is shared by all the modes.

[00281] FIG. 17 is a diagram of yet another chip architecture according to an embodiment of this application. It can be learned from FIG. 17 that MAC units of BT, SLP, and Wi-Fi are separately implemented, a modem is shared by some modes such as BT and SLP, and modems of other modes such as Wi-Fi are independently implemented, and RF is shared by all the modes.

Embodiment 2

[00282] An SLP chip may use a 14/28/40 nm process, may be packaged by using a chip scale package (chip size package, CSP), a ball grid array (ball grid array, BGA) package, a quad flat no-lead (quad flat no-lead, QFN) package, or the like, and may use a built-in flash memory (flash memory) or an external flash memory. Based on an application scenario, at least one of subsystems such as a PMU, a clock management unit (clock management unit, CMU), an active optical network (active optical network, AON), a wireless local area network (wireless local area network, WLAN) or BT, SLP, a global navigation satellite system (global navigation satellite system, GNSS), an application (application, APP), and an audio (audio) may be selected to be placed on one chip, to minimize an area, maximize a function, and improve performance and reliability.

[00283] Embodiments of this application provide a chip design manner. SLP and another subsystem are integrated into one chip. Subsystems of the chip may be trimmed and combined based on different products. Different subsystems are connected through a bus.

[00284] FIG. 18 is a diagram of a chip module framework according to an embodiment of this application. It can be learned from FIG. 18 that, for a product that requires a functional module like Wi-Fi or a GNSS and that needs to be connected to both a Bluetooth device and a SparkLink device, BT and SLP may be classified into different systems, and then combined with a Wi-Fi system, the GNSS system, an always-on system (Always-On System), a PMU, a CMU, and a flash memory on one chip. Different subsystems are connected through a bus.

[00285] FIG. 19 is a diagram of another chip module framework according to an embodiment of this application. It can be learned from FIG. 19 that, for an endpoint device that does not require a functional module like Wi-Fi or a GNSS but requires an audio function, to save an area and costs, BLE and SLP may be combined into one subsystem, and then combined with an APP system, an audio system, an always-on system, a PMU, a CMU, a flash, and the like on one chip. Different subsystems are connected through a bus.

[00286] FIG. 20 is a diagram of still another chip module framework according to an embodiment of this application. It can be learned from FIG. 20 that, for an endpoint device that neither requires a functional module like Wi-Fi or a GNSS nor requires an audio function, to save an area and costs, BLE and SLP may be combined into one subsystem, and then combined with

an always-on system, a CMU, a PMU, a flash, and the like on one chip. Different subsystems are connected through a bus.

Embodiment 3

[00287] A Wi-Fi 2.4 GHz frequency band ranges from 2412 MHz to 2472 MHz, and a BT/BLE/SLP frequency band ranges from 2402 MHz to 2480 MHz. Therefore, interference may occur. SLP and BT/BLE in a same core may be scheduled via software to allocate service slots. SLP and BT/BLE/Wi-Fi in different cores are not scheduled in a unified manner.

[00288] An embodiment of this application provides an SLP/BT/BLE/Wi-Fi coexistence solution. Based on whether SLP and BT/BLE/Wi-Fi share an antenna, coexistence scenarios are classified into a cross-antenna coexistence (using different antennas) scenario and a shared-antenna coexistence (using a same antenna) scenario, and different coexistence policies are provided.

[00289] For cross-antenna coexistence, if SLP and BT/BLE coexist, it may be ensured that transmit and receive frequencies of SLP and BT/BLE are different (that is, frequency division multiplexing is performed). Software may perform processing in terms of a frequency hopping sequence (that is, code division multiplexing), a service period, and an interval (that is, time division multiplexing). If SLP and Wi-Fi coexist and an isolation degree cannot meet a requirement, a channel of a WLAN needs to be avoided (that is, channel avoidance is performed) to reduce impact of the WLAN. In addition, an aggregation scheduling mechanism may be added to aggregate and send Wi-Fi data packets in bursts (that is, perform aggregation scheduling) to reduce a probability of WLAN interference.

[00290] In a case of shared-antenna coexistence, a software static policy or a hardware arbitration time division (packet traffic arbitration, PTA) policy may be used. Advantages of the software static policy are a low hardware requirement, a minimal software modification, and no dynamic RF switching (for example, an operation like RF recovery). Advantages of the PTA policy are faster service state switching and a smaller switching time granularity.

[00291] Coexistence of SLP and Wi-Fi is used as an example. FIG. 21 is a diagram of a framework of a software static policy according to an embodiment of this application. It can be learned from FIG. 21 that the software static policy may include: After SLP is enabled, software configures a host (HOST) to notify Wi-Fi to exit a current radio frequency path. In this scenario, Wi-Fi may view an SLP enable flag, and the software may set switching from the current radio frequency path to another radio frequency path. A chip needs to support software setting switching.

[00292] For example, FIG. 22 is a diagram of a framework of a hardware arbitration time division (PTA) policy according to an embodiment of this application. It can be learned from FIG. 22 that the hardware arbitration time division (PTA) policy includes: Time division is performed

by any combination of a transmitter (TX) and a receiver (RX) of each party. A PTA module transmits an occupation status of a radio frequency channel to each party, uses different level signals to indicate that the radio frequency channel is occupied by SLP/BT/BLE/Wi-Fi, and notifies, via this signal, software or hardware to perform corresponding processing. Different services may alternatively be configured with different PTA priorities. A service with a high priority may preempt an air interface resource.

Embodiment 4

[00293] Asynchronous and synchronous data links are defined in a SparkLink standard. Asynchronous links are classified into asynchronous unicast and multicast links, and synchronous links are classified into synchronous unicast, multicast, and broadcast links. In embodiments of this application, a set of SLP link selection solutions is designed based on different data real-time requirements of different products. Different data links may be used for connections between different devices in different scenarios, to support requirements of different product application scenarios.

[00294] FIG. 23 is a schematic flowchart of a type of link establishment according to an embodiment of this application. As shown in FIG. 23, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an asynchronous unicast link, and perform data transmission over the established asynchronous unicast link.

[00295] FIG. 24 is a schematic flowchart of another type of link establishment according to an embodiment of this application. As shown in FIG. 24, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an asynchronous multicast link, and perform data transmission over the established asynchronous multicast link.

[00296] For a product (for example, a non-audio device like a keyboard, a mouse, or a stylus) or a service that has no data real-time requirement (that is, a latency requirement (or a service latency) of the product or the service is greater than a first value), the asynchronous unicast link shown in FIG. 23 or the asynchronous multicast link shown in FIG. 24 may be established for data transmission.

[00297] FIG. 25 is a schematic flowchart of still another type of link establishment according to an embodiment of this application. As shown in FIG. 25, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an

asynchronous unicast link, then establish a synchronous unicast link, and perform data transmission over the established synchronous unicast link.

[00298] FIG. 26 is a schematic flowchart of yet another type of link establishment according to an embodiment of this application. As shown in FIG. 26, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an asynchronous unicast link, then establish a synchronous multicast link, and perform data transmission over the established synchronous multicast link.

[00299] For a product (for example, an audio device like a headset or a microphone) or a service that has a data real-time requirement (that is, a latency requirement of the product or the service is less than a second value), as shown in FIG. 25 or FIG. 26, the asynchronous unicast link may be first established, and the synchronous unicast link or the synchronous multicast link is then established for data transmission.

[00300] FIG. 27 is a schematic flowchart of still yet another type of link establishment according to an embodiment of this application. As shown in FIG. 27, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an asynchronous unicast link, and perform data transmission after synchronization is implemented by adding a timestamp to a data packet.

[00301] FIG. 28 is a schematic flowchart of a further type of link establishment according to an embodiment of this application. As shown in FIG. 28, a T-node sends a broadcast packet to a G-node, and then the G-node sends a scanning access request to the T-node. Further, the T-node sends a scanning access response to the G-node, and then the G-node and the T-node establish an asynchronous multicast link, and perform data transmission after synchronization is implemented by adding a timestamp to a data packet.

[00302] For a product (for example, an audio device like a headset or a live microphone) or a service that has a data real-time requirement but does not have a particularly high real-time requirement (that is, a latency requirement of the product or the service is less than a first value and greater than a second value), the asynchronous unicast link or the asynchronous multicast link may alternatively be established, and synchronization is implemented by adding the timestamp to the data packet.

Embodiment 5

[00303] FIG. 29 shows four different radio frame types defined in a SparkLink protocol. Each frame format corresponds to a different sensitivity, frame length, modulation scheme, and synchronization sequence. In different scenarios, different frame formats may be selected through

physical layer parameter negotiation to maximize a performance gain. The following provides several examples of selecting different frame formats in different scenarios.

[00304] FIG. 30 is an application example of a frame format in a scenario according to an embodiment of this application. For a low-latency product (for example, a keyboard, a mouse, a stylus, a toothbrush, or a microphone) or a service scenario (that is, a latency requirement of a product or a service is less than first duration), a frame format 1 is selected to perform broadcast access, and the frame format 1 is switched to a frame format 2 through physical layer parameter negotiation after a connected state is entered.

[00305] FIG. 31 is an application example of a frame format in another scenario according to an embodiment of this application. For a product (for example, a mobile phone or a headset audio) or a service scenario that has both a low latency (that is, a latency requirement of the product or a service is less than first duration) and an anti-interference requirement (that is, an anti-interference capability requirement of the product or the service is greater than a specified threshold), a frame format 1 is selected to perform broadcast access, and the frame format 1 is switched to a frame format 2 or a frame format 3 through physical layer parameter negotiation after a connected state is entered.

[00306] FIG. 32 is an application example of a frame format in still another scenario according to an embodiment of this application. For an extremely low-cost device that supports only a Gaussian frequency shift keying (Gaussian frequency shift keying, GFSK) frame format (a maximum transmit power of the GFSK is higher than that of phase shift keying (phase shift keying, PSK)), or a device that is sensitive to the maximum transmit power (that is, the maximum transmit power is greater than a first power threshold), a frame format 1 is selected to perform broadcast access, and frame format switching is not performed subsequently.

[00307] FIG. 33 is an application example of a frame format in yet another scenario according to an embodiment of this application. In an IoT ultra-long-distance coverage scenario, a frame format 4 is selected to perform broadcasting and connection. After a distance is shortened, the frame format 4 may be switched to a frame format 2 or a frame format 3 through physical layer parameter negotiation. Otherwise, the frame format 4 is maintained.

[00308] It should be noted that the frame format 1 in embodiments of this application may also be referred to as a frame format corresponding to a SparkLink radio frame type 1, the frame format 2 in embodiments of this application may also be referred to as a frame format corresponding to a SparkLink radio frame type 2, the frame format 3 in embodiments of this application may also be referred to as a frame format corresponding to a SparkLink radio frame type 3, and the frame format 4 in embodiments of this application may also be referred to as a frame format corresponding to a SparkLink radio frame type 4.

[00309] FIG. 34 is a diagram of a structure of an electronic device according to an embodiment of this application. The electronic device 400 may be a transmitter or a chip or a functional module in the transmitter, or may be a receiver or a chip or a functional module in the receiver. As shown in FIG. 34, the electronic device 400 includes a processor 401, a transceiver 402, and a communication line 403.

[00310] The processor 401 is configured to perform any step in the method embodiments shown in FIG. 11 to FIG. 13, and when performing processes such as sending a transmission frame, the processor 401 may choose to invoke the transceiver 402 and the communication line 403 to complete a corresponding operation.

[00311] Further, the electronic device 400 may include a memory 404. The processor 401, the memory 404, and the transceiver 402 may be connected through the communication line 403.

[00312] The transceiver 402 is configured to communicate with another device or another communication network. The another communication network may be the Ethernet, a radio access network (radio access network, RAN), a wireless local area network (wireless local area network, WLAN), or the like. The transceiver 402 may be a module, a circuit, a transceiver, or any apparatus that can implement communication.

[00313] The transceiver 402 is mainly configured to receive and send a transmission frame and the like, and may include a transmitter and a receiver, which respectively send and receive the transmission frame and the like. An operation other than receiving and sending the transmission frame and the like is implemented by the processor, for example, generating the transmission frame.

[00314] The communication line 403 is configured to transmit information between components included in the electronic device 400.

[00315] In a design, the processor may be considered as a logic circuit, and the transceiver may be considered as an interface circuit.

[00316] The memory 404 is configured to store instructions. The instructions may be a computer program.

[00317] It should be noted that the memory 404 may be independent of the processor 401, or may be integrated into the processor 401. The memory 404 may be configured to store instructions, program code, some data, or the like. The memory 404 may be located in the electronic device 400, or may be located outside the electronic device 400. This is not limited. The processor 401 is configured to execute the instructions stored in the memory 404, to implement the methods provided in the foregoing embodiments of this application.

[00318] In an example, the processor 401 may include one or more processors, for example, a processor 0 and a processor 1 in FIG. 34.

[00319] In an optional implementation, the electronic device 400 includes a plurality of

processors. For example, in addition to the processor 401 in FIG. 34, the electronic device 400 may further include a processor 407.

[00320] In an optional implementation, the electronic device 400 further includes an output device 405 and an input device 406. For example, the input device 406 is a keyboard, a mouse, a microphone, a joystick, or another device, and the output device 405 is a display, a speaker (speaker), or another device.

[00321] It should be noted that the electronic device 400 may be a chip system or a device having a structure similar to that in FIG. 34. The chip system may include a chip, or may include a chip and another discrete device. Actions, terms, and the like in embodiments of this application may be mutually referenced. This is not limited. In embodiments of this application, names of messages exchanged between devices, names of parameters in the messages, or the like are merely examples. Other names may alternatively be used during specific implementation. This is not limited. In addition, a composition structure shown in FIG. 34 does not constitute a limitation on the electronic device 400. In addition to the components shown in FIG. 34, the electronic device 400 may include more or fewer components than those shown in FIG. 34, or some components may be combined, or different component arrangements may be used.

[00322] The processor and the transceiver described in this application may be implemented in an integrated circuit (integrated circuit, IC), an analog IC, a radio frequency integrated circuit, a mixed signal IC, an application-specific integrated circuit (application-specific integrated circuit, ASIC), a printed circuit board (printed circuit board, PCB), an electronic device, or the like. The processor and the transceiver may alternatively be produced by using various IC technologies, for example, a complementary metal-oxide-semiconductor (complementary metal-oxide - semiconductor, CMOS), an N-channel metal-oxide-semiconductor (N-channel metal-oxide-semiconductor, NMOS), a P-channel metal-oxide-semiconductor (positive channel metal-oxide-semiconductor, PMOS), a bipolar junction transistor (bipolar junction transistor, BJT), a bipolar CMOS (BiCMOS), silicon germanium (SiGe), and gallium arsenide (GaAs).

[00323] The transmission frame provided in embodiments of this application is described above, and the communication method provided in embodiments of this application is mainly described from a perspective of a device. It may be understood that, to implement the foregoing functions, the device includes corresponding hardware structures and/or software modules for executing the functions. A person of ordinary skill in the art should easily be aware that, in combination with algorithms and steps in the examples described in embodiments disclosed in this specification, this application can be implemented by hardware or a combination of hardware and computer software. Whether a function is performed by hardware or hardware driven by computer software depends on particular applications and design constraints of the technical solutions. A person skilled in the

art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[00324] In embodiments of this application, a device may be divided into functional modules based on the foregoing method examples. For example, functional modules may be obtained through division based on corresponding functions, or two or more functions may be integrated into one transmitter or receiver. The integrated module may be implemented in a form of hardware, or may be implemented in a form of a software functional module. It should be noted that, in embodiments of this application, division into modules is an example, and is merely a logical function division. In actual implementation, another division manner may be used.

[00325] FIG. 35 is a block diagram of a communication apparatus according to an embodiment of this application. When the functional modules are obtained through division based on the corresponding functions, the communication apparatus 500 may include a transceiver module 501 and a processing module 502. For example, the communication apparatus may be a transmitter or a receiver, or may be a chip in the transmitter or the receiver, or another combined component or part that has a function of the communication apparatus. When the communication apparatus 500 is a transmitter or a receiver, the transceiver module 501 may be a transceiver, where the transceiver may include an antenna, a radio frequency circuit, and the like; and the processing module 502 may be a processor (or a processing circuit), for example, a baseband processor, where the baseband processor may include one or more CPUs. When the communication apparatus 500 is a component or a part having the foregoing functions, the transceiver module 501 may be a radio frequency unit, and the processing module 502 may be a processor (or a processing circuit), for example, a baseband processor. When the communication apparatus 500 is a chip system, the transceiver module 501 may be an input/output interface of a chip (for example, a baseband chip), and the processing module 502 may be a processor (or a processing circuit) of the chip system and may include one or more central processing units. It should be understood that the transceiver module 501 in this embodiment of this application may be implemented by a transceiver or a transceiver-related circuit component; and the processing module 502 may be implemented by a processor or a processor-related circuit component (or referred to as a processing circuit).

[00326] In some examples, this application further provides a communication apparatus 600. The communication apparatus 600 is configured to implement transmission of a SparkLink signal. The communication apparatus 600 may include:

a module configured to send a first transmission frame, where the first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, each of the at least one ranging segment includes a ranging subsequence and a gap, a length of the gap includes a random duration and a basic duration, and the random duration is

generated in a symmetric encryption manner, where the ranging sequence field is used to perform CIR estimation.

[00327] Optionally, the module configured to send the first transmission frame may be the transceiver module 501. The transceiver module 501 may be configured to perform all sending and receiving operations performed by the transmitter in the embodiment shown in FIG. 9, and/or configured to support another process of the technology described in this specification.

[00328] The transceiver module 501 may include a sending module and/or a receiving module, respectively configured to perform sending and receiving operations performed by the transmitter in the embodiments shown in FIG. 11 and FIG. 13. For example, the communication apparatus includes: with reference to the foregoing solution, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

[00329] With reference to the foregoing solution, the apparatus further includes: a module configured to determine a service scenario; and a module configured to determine the basic duration based on the service scenario, where the service scenario includes at least one of the following: a ranging scenario and an angle measurement scenario.

[00330] Optionally, the module configured to determine the service scenario and the module configured to determine the basic duration based on the service scenario may be the processing module 502.

[00331] With reference to the foregoing solution, the ranging scenario includes at least one of the following: a low-latency ranging scenario, a long-distance coverage ranging scenario, an anti-interference ranging scenario, a medium-distance ranging scenario, and a short-distance ranging scenario; and the module configured to determine the basic duration based on the service scenario is specifically configured to: in response to the service scenario being the low-latency ranging scenario, determine that the basic duration is a first duration, where the first duration is less than or equal to 50; in response to the service scenario being the long-distance coverage ranging scenario or the anti-interference ranging scenario, determine that the basic duration is a second duration, where the second duration is greater than or equal to 500; in response to the service scenario being the medium-distance ranging scenario, determine that the basic duration is a third duration, where the third duration belongs to [125, 500]; and in response to the service scenario being the short-distance ranging scenario, determine that the basic duration is a fourth duration, where the fourth duration is less than 125.

[00332] With reference to the foregoing solution, the angle measurement scenario includes at least one of the following: a low-latency angle measurement scenario, a long-distance coverage angle measurement scenario, an anti-interference angle measurement scenario, a medium-distance

angle measurement scenario, and a short-distance angle measurement scenario; and the module configured to determine the basic duration based on the service scenario is specifically configured to: in response to the service scenario being the low-latency angle measurement scenario, determine that the basic duration is a fifth duration, where the fifth duration is less than or equal to 12; in response to the service scenario being the long-distance coverage angle measurement scenario or the anti-interference angle measurement scenario, determine that the basic duration is a sixth duration, where the sixth duration belongs to [125, 500]; in response to the service scenario being the medium-distance angle measurement scenario, determine that the basic duration is a seventh duration, where the seventh duration belongs to [50, 125]; and in response to the service scenario being the short-distance angle measurement scenario, determine that the basic duration is an eighth duration, where the eighth duration is less than 50.

[00333] With reference to the foregoing solution, the ranging subsequence includes a plurality of ranging symbols, and a unit of the basic duration is microseconds or a length of one ranging symbol.

[00334] Both the transceiver module and the processing module in this embodiment of this application may be deployed in a SparkLink module, a Bluetooth module, or a Wi-Fi module. Alternatively, the transceiver module in this embodiment of this application may be deployed in the SparkLink module, the Bluetooth module, or the Wi-Fi module, and the processing module in this embodiment of this application may be deployed in another module of a module in which the processing module is located. Alternatively, the processing module in this embodiment of this application may be deployed in the SparkLink module, the Bluetooth module, or the Wi-Fi module, and the transceiver module in this embodiment of this application may be deployed in another module of a module in which the processing module is located. This is not specifically limited in embodiments of this application.

[00335] With reference to the foregoing solution, the communication apparatus 600 is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, and at least one of the SparkLink module, the Bluetooth module, and the Wi-Fi module shares at least one of an RF unit, a modem unit, a MAC unit, and a CPU.

[00336] With reference to the foregoing solution, the communication apparatus 600 is further configured to implement transmission of the Bluetooth signal, but does not support transmission of the Wi-Fi signal, the SparkLink module and the Bluetooth module are located in a same subsystem of the communication apparatus 600, and the subsystem and a PMU are integrated into the communication apparatus 600.

[00337] With reference to the foregoing solution, the communication apparatus 600 is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, at least one of

the Bluetooth module or the Wi-Fi module performs coexistence communication with the SparkLink module via different antennas, and a coexistence policy is channel avoidance.

[00338] With reference to the foregoing solution, the communication apparatus 600 is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a link selection policy, a link corresponding to the peer device and/or a service to perform data transmission.

[00339] With reference to the foregoing solution, that the communication apparatus 600 is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[00340] With reference to the foregoing solution, the link selection policy includes: when the service latency is greater than a first value, performing data transmission after establishing an asynchronous unicast link or an asynchronous multicast link; or when the service latency is less than the first value and greater than a second value, establishing the asynchronous unicast link or the asynchronous multicast link, and performing data transmission after synchronization is implemented by adding a timestamp to a data packet; or when the service latency is less than the second value, first establishing the asynchronous unicast link, and then performing data transmission after establishing a synchronous unicast link or a synchronous multicast link.

[00341] With reference to the foregoing solution, the communication apparatus 600 is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a frame format selection policy, a frame format type corresponding to the type of the peer device and/or a service type of the peer device. The frame format type includes a SparkLink radio frame type 1, a SparkLink radio frame type 2, a SparkLink radio frame type 3, or a SparkLink radio frame type 4.

[00342] With reference to the foregoing solution, that the communication apparatus 600 is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[00343] With reference to the foregoing solution, the frame format selection policy includes: when a service latency requirement of the peer device is less than first duration, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 through physical layer parameter negotiation after a connected state is entered; or when the service latency requirement of the peer device is less than the first duration, and a service

anti-interference capability requirement is greater than a set threshold, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation after the connected state is entered; or when the type of the peer device is a device that supports only the SparkLink radio frame type 1 or a device whose maximum transmit power is greater than a first power threshold, selecting the SparkLink radio frame type 1 to perform broadcast access; or when the service type of the peer device is an IOT ultra-long-distance coverage service, when a distance between the peer device and the communication apparatus is greater than a first threshold, selecting the SparkLink radio frame type 4 to perform broadcasting and connection; or when the distance between the peer device and the communication apparatus is less than or equal to the first threshold, switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation.

[00344] With reference to the foregoing solution, the at least one ranging segment includes a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

[00345] With reference to the foregoing solution, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

[00346] With reference to the foregoing solution, the at least one ranging segment includes a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

[00347] With reference to the foregoing solution, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[00348] With reference to the foregoing solution, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are the same, where $1 \leq i \leq M$.

[00349] With reference to the foregoing solution, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, where $1 \leq i \leq M$.

[00350] With reference to the foregoing solution, the apparatus further includes a module configured to send a second transmission frame. The second transmission frame includes the ranging sequence field, the at least one ranging segment includes M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, where $1 \leq i \leq M$.

[00351] Optionally, the module configured to send the second transmission frame may be the transceiver module 501.

[00352] With reference to the foregoing solution, the gap in each ranging segment is before or after the ranging subsequence.

[00353] With reference to the foregoing solution, the gap includes a first subgap and a second subgap, the first subgap in each ranging segment is before the ranging subsequence, and the second subgap is after the ranging subsequence; and

a length of the first subgap is the random duration, and a length of the second subgap is the basic duration; or the length of the first subgap is the basic duration, and the length of the second subgap is the random duration.

[00354] With reference to the foregoing solution, the basic duration is greater than or equal to 0, and the random duration is greater than or equal to 0.

[00355] In some examples, this application further provides a communication apparatus 700. The communication apparatus 700 is configured to implement transmission of a SparkLink signal. The communication apparatus 700 may include:

a module configured to receive a first transmission frame; a module configured to determine a first receiving moment based on a length of a current gap; a module configured to receive a next ranging subsequence at the first receiving moment; and a module configured to perform CIR estimation based on the received ranging subsequence. The first transmission frame includes a ranging sequence field, the ranging sequence field includes at least one ranging segment, and each of the at least one ranging segment includes a ranging subsequence and a gap. A length of the gap includes a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner.

[00356] Optionally, the module configured to receive the first transmission frame may be the transceiver module 501; and the module configured to determine the first receiving moment based on the length of the current gap, the module configured to receive the next ranging subsequence at the first receiving moment, and the module configured to perform CIR estimation based on the received ranging subsequence may be the processing module 502.

[00357] With reference to the foregoing solution, the apparatus further includes: a module configured to receive a second transmission frame; a module configured to determine a second receiving moment based on a length of a current gap; a module configured to receive a next ranging subsequence at the second receiving moment; and a module configured to perform CIR estimation based on the received ranging subsequence, where the second transmission frame includes the ranging sequence field, the length of the gap includes a random duration and a basic duration, and the random duration is generated in the symmetric encryption manner.

[00358] Optionally, the module configured to receive the second transmission frame may be the transceiver module 501; and the module configured to determine the second receiving moment based on the length of the current gap, the module configured to receive the next ranging subsequence at the second receiving moment, and the module configured to perform CIR estimation based on the received ranging subsequence may be the processing module 502.

[00359] The transceiver module 501 may be configured to perform all receiving and sending operations performed by the receiver in embodiments shown in FIG. 12 and FIG. 13, and/or configured to support another process of the technology described in this specification. The processing module 502 may be configured to perform all operations other than the receiving and sending operations performed by the receiver in the embodiments shown in FIG. 12 and FIG. 13, and/or configured to support another process of the technology described in this specification.

[00360] The transceiver module 501 may include a sending module and/or a receiving module, respectively configured to perform sending and receiving operations performed by the receiver in the embodiments shown in FIG. 12 and FIG. 13.

[00361] Both the communication module and the processing module in this embodiment of this application may be deployed in a SparkLink module, a Bluetooth module, or a Wi-Fi module. Alternatively, the communication module in this embodiment of this application may be deployed in the SparkLink module, the Bluetooth module, or the Wi-Fi module, and the processing module in this embodiment of this application may be deployed in another module of a module in which the processing module is located. Alternatively, the processing module in this embodiment of this application may be deployed in the SparkLink module, the Bluetooth module, or the Wi-Fi module, and the communication module in this embodiment of this application may be deployed in another module of a module in which the processing module is located. This is not specifically limited in

embodiments of this application.

[00362] With reference to the foregoing solution, the communication apparatus 700 is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, and at least one of the SparkLink module, the Bluetooth module, and the Wi-Fi module shares at least one of an RF unit, a modem unit, a MAC unit, and a CPU.

[00363] With reference to the foregoing solution, the communication apparatus 700 is further configured to implement transmission of the Bluetooth signal, but does not support transmission of the Wi-Fi signal, the SparkLink module and the Bluetooth module are located in a same subsystem of the communication apparatus 700, and the subsystem and a PMU are integrated into the communication apparatus 700.

[00364] With reference to the foregoing solution, the communication apparatus 700 is further configured to implement transmission of the Bluetooth signal or the Wi-Fi signal, at least one of the Bluetooth module or the Wi-Fi module performs coexistence communication with the SparkLink module via different antennas, and a coexistence policy is channel avoidance.

[00365] With reference to the foregoing solution, the communication apparatus 700 is further configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a link selection policy, a link corresponding to the peer device and/or a service to perform data transmission.

[00366] With reference to the foregoing solution, that the communication apparatus 700 is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[00367] With reference to the foregoing solution, the link selection policy includes: when the service latency is greater than a first value, performing data transmission after establishing an asynchronous unicast link or an asynchronous multicast link; or when the service latency is less than the first value and greater than a second value, establishing the asynchronous unicast link or the asynchronous multicast link, and performing data transmission after synchronization is implemented by adding a timestamp to a data packet; or when the service latency is less than the second value, first establishing the asynchronous unicast link, and then performing data transmission after establishing a synchronous unicast link or a synchronous multicast link.

[00368] With reference to the foregoing solution, when the communication apparatus 700 is a non-audio device, the communication apparatus 700 is further configured to perform data transmission over the asynchronous unicast link or the asynchronous multicast link.

[00369] With reference to the foregoing solution, the communication apparatus 700 is further

configured to: determine a type of a peer device and/or a service latency of the peer device, and determine, according to a frame format selection policy, a frame format type corresponding to the type of the peer device and/or a service type of the peer device. The frame format type includes a SparkLink radio frame type 1, a SparkLink radio frame type 2, a SparkLink radio frame type 3, or a SparkLink radio frame type 4.

[00370] With reference to the foregoing solution, that the communication apparatus 700 is further configured to determine the type of the peer device and/or the service latency of the peer device includes: determining the type of the peer device, where the type of the peer device includes an audio device type or a non-audio device type; and determining the service latency of the peer device when the type of the peer device is the audio device type.

[00371] With reference to the foregoing solution, the frame format selection policy includes: when a service latency requirement of the peer device is less than first duration, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 through physical layer parameter negotiation after a connected state is entered; or when the service latency requirement of the peer device is less than the first duration, and a service anti-interference capability requirement is greater than a set threshold, selecting the SparkLink radio frame type 1 to perform broadcast access, and switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation after the connected state is entered; or when the type of the peer device is a device that supports only the SparkLink radio frame type 1 or a device whose maximum transmit power is greater than a first power threshold, selecting the SparkLink radio frame type 1 to perform broadcast access; or when the service type of the peer device is an IOT ultra-long-distance coverage service, when a distance between the peer device and the communication apparatus is greater than a first threshold, selecting the SparkLink radio frame type 4 to perform broadcasting and connection; or when the distance between the peer device and the communication apparatus is less than or equal to the first threshold, switching to the SparkLink radio frame type 2 or the SparkLink radio frame type 3 through physical layer parameter negotiation.

[00372] With reference to the foregoing solution, when the communication apparatus 700 is a non-audio device, the communication apparatus 700 is further configured to: select the SparkLink radio frame type 1 to perform broadcast access, and switch to the SparkLink radio frame type 2 through physical layer parameter negotiation for data transmission after entering the connected state.

[00373] In another possible implementation, the transceiver module 501 in FIG. 35 may be replaced with the transceiver 402 in FIG. 34, and a function of the transceiver module 501 may be integrated into the transceiver 402; and the processing module 502 may be replaced with the

processor 407, and a function of the processing module 502 may be integrated into the processor 407. Further, the communication apparatus 500 shown in FIG. 35 may further include a memory (not shown in the figure). When the transceiver module 501 is replaced with the transceiver 402, and the processing module 502 is replaced with the processor 407, the communication apparatus 500 in this embodiment of this application may be the electronic device 400 shown in FIG. 34.

[00374] FIG. 36 is a diagram of a structure of a communication apparatus according to an embodiment of this application. The communication apparatus is applicable to the scenario shown in the foregoing method embodiment. For ease of description, FIG. 36 shows only main parts of the communication apparatus, including a processor, a memory, a control circuit, and an input/output apparatus. The processor is mainly configured to: process a communication protocol and communication data, execute a software program, and process data of the software program. The memory is mainly configured to store the software program and data. The control circuit is mainly configured to supply power and transmit various electrical signals. The input/output apparatus is mainly configured to: receive data input by a user, and output data to the user.

[00375] When the communication apparatus is a transmitter or a receiver, the control circuit may be a main board; the memory includes a medium having a storage function, for example, a hard disk, a RAM, or a ROM; the processor may include a baseband processor and a central processing unit, the baseband processor is mainly configured to process the communication protocol and the communication data, and the central processing unit is mainly configured to: control the entire communication apparatus, execute the software program, and process the data of the software program; the input/output apparatus includes a display, a keyboard, a mouse, and the like; and the control circuit may further include or be connected to a transceiver circuit or a transceiver, for example, a network cable interface, and is configured to send or receive data or a signal, for example, perform data transmission and communication with another device. Further, the control circuit may further include an antenna, configured to receive and send a transmission frame, and configured to perform data/request transmission with another device.

[00376] According to the methods provided in embodiments of this application, this application further provides a computer program product. The computer program product includes computer program code, and when the computer program code is run on a computer, the computer is caused to perform the method according to any one of embodiments of this application.

[00377] An embodiment of this application further provides a computer-readable storage medium. All or some of the procedures in the foregoing method embodiments may be completed by a computer or an apparatus having a communication capability by executing a computer program or instructions, to control related hardware. The computer program or the group of instructions may be stored in the computer-readable storage medium. When the computer program

or the group of instructions are executed, the procedures of the foregoing method embodiments may be included. The computer-readable storage medium may be an internal storage unit of the transmitter or the receiver in any one of the foregoing embodiments, for example, a hard disk or a memory of the transmitter or the receiver. The computer-readable storage medium may alternatively be an external storage device of the transmitter or the receiver, for example, a plug-in hard disk, a smart media card (smart media card, SMC), a secure digital (secure digital, SD) card, or a flash card (flash card), configured for the transmitter or the receiver. Further, the computer-readable storage medium may further include both the internal storage unit and the external storage device of the transmitter or the receiver. The computer-readable storage medium is configured to store the computer program or the instructions and another program and data that are required by the transmitter or the receiver. The computer-readable storage medium may be further configured to temporarily store data that has been output or is to be output.

[00378] A person of ordinary skill in the art may be aware that, in combination with the examples described in embodiments disclosed in this specification, units and algorithm steps can be implemented by electronic hardware or a combination of computer software and electronic hardware. Whether the functions are performed by hardware or software depends on particular applications and design constraints of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[00379] It may be clearly understood by a person skilled in the art that, for the purpose of convenient and brief description, for a detailed working process of the foregoing apparatus, refer to a corresponding process in the foregoing method embodiments. Details are not described herein again.

[00380] In the several embodiments provided in this application, it should be understood that the disclosed apparatus and method may be implemented in other manners. For example, the described apparatus embodiments are merely examples. For example, division into units is merely logical function division and may be other division in actual implementation. For example, a plurality of units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections may be implemented through some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electronic, mechanical, or other forms.

[00381] The units described as separate parts may or may not be physically separate, and parts displayed as units may or may not be physical units, may be located in one position, or may be distributed on a plurality of network units. Some or all of the units may be selected based on actual

requirements to achieve the objectives of the solutions of embodiments.

[00382] In addition, functional units in embodiments of this application may be integrated into one processing unit, each of the units may exist alone physically, or two or more units are integrated into one unit.

[00383] When the functions are implemented in a form of a software functional unit and sold or used as an independent product, the functions may be stored in a computer-readable storage medium. Based on such an understanding, the technical solutions in this application essentially, or the part contributing to the conventional technology, or a part of the technical solutions may be implemented in a form of a software product. The computer software product is stored in a storage medium and includes several instructions for instructing a computer device (a personal computer, a server, a network device, or the like) to perform all or some of the steps of the methods in embodiments of this application. The foregoing storage medium includes any medium that can store program code, for example, a USB flash drive, a removable hard disk, a ROM, a RAM, a magnetic disk, or an optical disc.

[00384] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

CLAIMS

1. A communication method, wherein the method comprises:

generating a first transmission frame, wherein the first transmissionframe comprises a ranging sequence field, the ranging sequence field comprises a plurality of ranging segments, each of the plurality of ranging segments comprises a ranging subsequence and a gap, a length of the gap is determined based on a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner, wherein

the ranging sequence field is used to perform channel impulse response, CIR, estimation;

sending the first transmission frame.

2. The method according to claim 1, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

3. The method according to claim 1, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

4. The method according to claim 1, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

5. The method according to claim 1, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are different from those of a gap in the second ranging segment.

6. The method according to any one of claims 1 to 5, wherein the method further comprises:

sending a second transmission frame, wherein the second transmission frame comprises M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are the same as those of a gap in an i^{th} ranging segment of the second transmission frame, wherein $1 \leq i \leq M$.

7. The method according to any one of claims 1 to 5, wherein the method further comprises:

sending a second transmission frame, wherein the second transmission frame comprises M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is different from that of a gap in an i^{th} ranging segment of the second transmissionframe, and basic durations are the same, wherein $1 \leq i \leq M$.

8. The method according to any one of claims 1 to 5, wherein the method further comprises:

sending a second transmission frame, wherein the second transmission frame comprises M ranging segments, a random duration of a gap in an i^{th} ranging segment of the first transmission frame is the same as that of a gap in an i^{th} ranging segment of the second transmission frame, and basic durations are different, wherein $1 \leq i \leq M$.

9. The method according to any one of claims 1 to 5, wherein the method further comprises:

sending a second transmission frame, wherein the second transmission frame comprises M ranging segments, and a random duration and a basic duration of a gap in an i^{th} ranging segment of the first transmission frame are different from those of a gap in an i^{th} ranging segment of the second transmission frame, wherein $1 \leq i \leq M$.

10. A communication method, wherein the method comprises:

receiving a first transmission frame, wherein the first transmission frame comprises a ranging sequence field, the ranging sequence field comprises a plurality of ranging segments, and each of the plurality of ranging segments comprises a ranging subsequence and a gap;

determining a first receiving moment based on a length of a current gap, wherein the length of the gap is determined based on a random duration and a basic duration, and the random duration is generated in a symmetric encryption manner;

receiving a next ranging subsequence at the first receiving moment; and

performing channel impulse response, CIR, estimation based on the received ranging subsequence.

11. The method according to claim 10, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, and a random duration and a basic duration of a gap in the first ranging segment are the same as those of a gap in the second ranging segment.

12. The method according to claim 10, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, a random duration of a gap in the first ranging segment is different from that of a gap in the second ranging segment, and basic durations are the same.

13. The method according to claim 10, wherein the plurality of ranging segments comprise a first ranging segment and a second ranging segment, and a random duration of a gap in the first ranging segment is the same as that of a gap in the second ranging segment, and basic durations are different.

14. A communication apparatus, wherein the apparatus comprises:

one or more processors; and

a memory, configured to store one or more computer programs or instructions, wherein

when the one or more computer programs or instructions are executed by the one or more processors, the one or more processors are caused to implement the method according to any one

of claims 1 to 9 or the method according to any one of claims 10 to 13.

15. A computer-readable storage medium, wherein

the computer-readable storage medium stores program code, and when the program code is executed by a processor, the method according to any one of claims 1 to 9 or the method according to any one of claims 10 to 13 is implemented.