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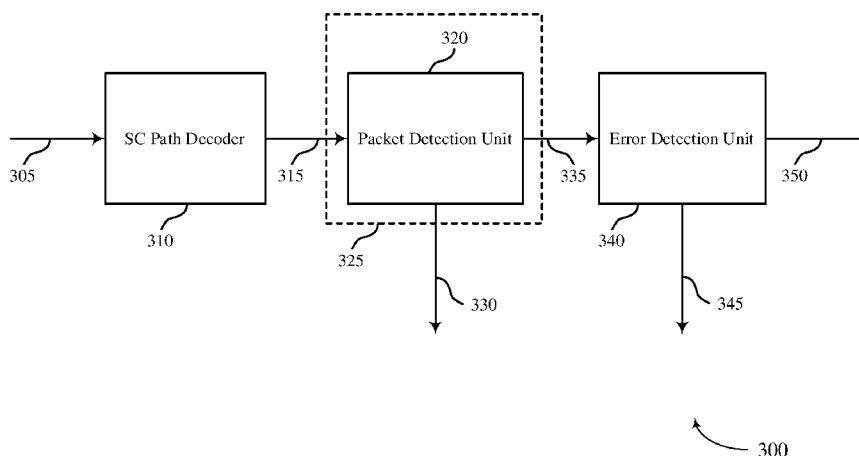


FIG. 3

(57) Abstract: Methods, systems, and devices for wireless communication are described. The described techniques include monitoring a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits, decoding the codeword to obtain a plurality of candidate information bits, re-encoding the plurality of candidate information bits to obtain a hypothesized codeword, computing a correlation metric based at least in part on the hypothesized codeword and the set of symbols, and determining whether the candidate information bits contain valid information based at least in part on the correlation metric. In some cases, computing the correlation metric includes re-modulating the hypothesized codeword to obtain a second set of symbols. In such cases, the correlation metric may be generated based on a correlation between the set of symbols and the second set of symbols.



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FALSE ALARM RATE SUPPRESSION FOR POLAR CODES

BACKGROUND

[0001] The following relates generally to wireless communication, and more specifically to false alarm rate (FAR) suppression for polar codes.

[0002] Wireless communications systems are widely deployed to provide various types of communication content such as voice, video, packet data, messaging, broadcast, and so on. These systems may be capable of supporting communication with multiple users by sharing the available system resources (e.g., time, frequency, and power). Examples of such multiple-access systems include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, and orthogonal frequency division multiple access (OFDMA) systems, (e.g., a Long Term Evolution (LTE) system, or a New Radio (NR) system). A wireless multiple-access communications system may include a number of base stations or access network nodes, each simultaneously supporting communication for multiple communication devices, which may be otherwise known as user equipment (UE).

[0003] Information transmitted between devices in wireless multiple-access communications systems may be encoded into a codeword in order to improve the reliability of successfully decoding the transmitted information. In some cases, codewords may provide redundancy, which may be used to correct errors that result from the transmission environment (e.g., path loss, obstacles, etc.). Some examples of encoding algorithms with error correcting codes include convolutional codes (CCs), low-density parity-check (LDPC) codes, and polar codes. A polar code is an example of a linear block error correcting code and has been shown to asymptotically approach the theoretical channel capacity as the code length increases. Polar codes are based on polarization of sub-channels used for information bits or frozen bits (e.g., predetermined bits set to a '0' or a '1'), with information bits generally assigned to the higher reliability sub-channels. In some cases, the nature of polar decoder operations may result in false acceptance of a signal (e.g., noise treated as a signal, an incorrectly decoded signal treated as being correctly decoded, etc.). Techniques for high-performance polar codes that reduce FAR of decoding are desired.

SUMMARY

[0004] The described techniques relate to improved methods, systems, devices, or apparatuses that support false alarm rate (FAR) suppression for polar codes. Generally, the described techniques provide for improvements in decoding operation through the validation of a decoding hypothesis. Of concern for a decoder may be false acceptance of a received signal. For example, a receiver may in some cases treat ambient noise as a signal and output the noise to one or more receive chains, which may unnecessarily (or detrimentally) decode the noise as a valid signal. Alternatively, the receiver may in some cases receive a valid signal which is decoded improperly, resulting in subsequent processing errors (e.g., at a higher layer of the communication protocol stack). Techniques are described herein to suppress the rate of such errors (e.g., below an acceptable level).

[0005] A method of wireless communication is described. The method may include monitoring a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits, decoding the codeword to obtain a plurality of candidate information bits, re-encoding the plurality of candidate information bits to obtain a hypothesized codeword, computing a correlation metric based at least in part on the hypothesized codeword and the set of symbols, and determining whether the candidate information bits contain valid information based at least in part on the correlation metric.

[0006] An apparatus for wireless communication is described. The apparatus may include means for monitoring a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits, means for decoding the codeword to obtain a plurality of candidate information bits, means for re-encoding the plurality of candidate information bits to obtain a hypothesized codeword, means for computing a correlation metric based at least in part on the hypothesized codeword and the set of symbols, and means for determining whether the candidate information bits contain valid information based at least in part on the correlation metric.

[0007] Another apparatus for wireless communication is described. The apparatus may include a processor, memory in electronic communication with the processor, and instructions stored in the memory. The instructions may be operable to cause the processor to monitor a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits, decode the codeword to

obtain a plurality of candidate information bits, re-encode the plurality of candidate information bits to obtain a hypothesized codeword, compute a correlation metric based at least in part on the hypothesized codeword and the set of symbols, and determine whether the candidate information bits contain valid information based at least in part on the correlation metric.

[0008] A non-transitory computer readable medium for wireless communication is described. The non-transitory computer-readable medium may include instructions operable to cause a processor to monitor a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits, decode the codeword to obtain a plurality of candidate information bits, re-encode the plurality of candidate information bits to obtain a hypothesized codeword, compute a correlation metric based at least in part on the hypothesized codeword and the set of symbols, and determine whether the candidate information bits contain valid information based at least in part on the correlation metric.

[0009] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the computing the correlation metric further comprises re-modulating the hypothesized codeword according to a modulation rate of the decoding candidate to obtain a second set of symbols. Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for generating the correlation metric based on a correlation between the set of symbols and the second set of symbols.

[0010] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the decoding the codeword further comprises determining path metrics for a set of decoding hypotheses. Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for selecting a decoding hypothesis corresponding to the plurality of candidate information bits from the set of decoding hypotheses based at least in part on the path metrics.

[0011] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, each path metric may be based at least in part on a set of parity check bits for the decoding candidate.

[0012] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the computing the correlation metric further comprises generating the correlation metric based at least in part on a correlation between the hypothesized codeword and logarithmic likelihood ratio (LLR) values for the decoding candidate of the codeword.

[0013] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the decoding the codeword further comprises performing an error detecting check (EDC) operation for each decoding hypothesis of a set of decoding hypotheses. Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for selecting a decoding hypothesis corresponding to the plurality of candidate information bits based at least in part on a result of the EDC operation for the each decoding hypothesis.

[0014] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the computing the correlation metric further comprises determining a first correlation value associated with the decoding hypothesis. Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for determining respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis. Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for determining the correlation metric as a ratio of the first correlation value and a highest correlation value of the respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis.

[0015] In some examples of the method, apparatus, and non-transitory computer-readable medium described above, the correlation metric comprises a ratio of a correlation value to a power normalization factor, the power normalization factor based at least in part on an aggregation of symbol power over the set of symbols.

[0016] Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for comparing the correlation metric to a detection threshold, wherein the determining whether the candidate information bits contain valid information may be based at least in part on the comparison.

[0017] Some examples of the method, apparatus, and non-transitory computer-readable medium described above may further include processes, features, means, or instructions for determining the detection threshold based at least in part on a type of communication associated with the codeword, a type of transmitting device, a number of error check bits for the decoding candidate, or some combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 illustrates an example of a system for wireless communication that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0019] FIG. 2 illustrates an example of a device that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0020] FIG. 3 illustrates an example of a decoding structure that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0021] FIG. 4 illustrates an example of a process flow that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0022] FIGs. 5 and 6 show block diagrams of a device that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0023] FIG. 7 illustrates a block diagram of a system including a wireless device that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

[0024] FIG. 8 illustrates a method for false alarm rate suppression for polar codes in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0025] Some wireless communications systems may support the use of polar codes, which are a type of linear block error correcting code that has been shown to approach the theoretical channel capacity as the code length increases. The number of sub-channels for polar codes follows a power function (*e.g.*, 2^X), where a number of information bits are mapped to different polarized sub-channels (*e.g.*, polar channel indices). The capacity of a given polar channel index may be a function of a reliability metric of the polar channel index.

Information bits may be loaded on a set of polar channel indices, and the remaining indices may be loaded with known bits (*e.g.*, parity check (PC) bits or frozen bits). Error detection performance of the polar code may be improved through an increased number of supporting bits (*e.g.*, which may refer to cyclic redundancy check (CRC) bits and/or PC bits). However, the redundancy provided by these supporting bits may reduce the throughput of the system (*e.g.*, because the supporting bits may be included at the expense of additional information bits). The described techniques are directed to false alarm rate (FAR) suppression for polar codes. These techniques may support the use of polar codewords with a decreased number of supporting bits while minimizing the effect on the FAR of a decoder.

[0026] Aspects of the disclosure are initially described in the context of a wireless communications system. Aspects of the disclosure are then illustrated by and described with reference to various decoding schemes and process flows. Aspects of the disclosure are further illustrated by and described with reference to apparatus diagrams, system diagrams, and flowcharts that relate to nominal complexity and weighted combinations for polar code construction.

[0027] FIG. 1 illustrates an example of a wireless communications system 100 in accordance with various aspects of the present disclosure. The wireless communications system 100 includes base stations 105, UEs 115, and a core network 130. In some examples, the wireless communications system 100 may be a Long Term Evolution (LTE), LTE-Advanced (LTE-A) network, or a New Radio (NR) network. In some cases, wireless communications system 100 may support enhanced broadband communications, ultra-reliable (*i.e.*, mission critical) communications, low latency communications, and communications with low-cost and low-complexity devices. Base stations 105 and UEs 115 may use a polar code design to encode information bits of an input vector to obtain a codeword for transmission. In some cases, the base stations 105 and UEs 115 may reduce overhead (*e.g.*, at the expense of decoding reliability) for these transmissions by including fewer supporting bits. For example, in accordance with the described techniques, a codeword may be generated using fewer CRC bits without significantly affecting the decoding reliability. That is, the reduction in decoding reliability may be mitigated through the use of techniques described herein.

[0028] Base stations 105 may wirelessly communicate with UEs 115 via one or more base station antennas. In some cases, the transmissions may be encoded using a polar code

design. Each base station 105 may provide communication coverage for a respective geographic coverage area 110. Communication links 125 shown in wireless communications system 100 may include uplink transmissions from a UE 115 to a base station 105, or downlink transmissions from a base station 105 to a UE 115. Control information and data may be multiplexed on an uplink channel or downlink according to various techniques. Control information and data may be multiplexed on a downlink channel, for example, using time division multiplexing (TDM) techniques, frequency division multiplexing (FDM) techniques, or hybrid TDM-FDM techniques. In some examples, the control information transmitted during a transmission time interval (TTI) of a downlink channel may be distributed between different control regions in a cascaded manner (e.g., between a common control region and one or more UE-specific control regions).

[0029] UEs 115 may be dispersed throughout the wireless communications system 100, and each UE 115 may be stationary or mobile. A UE 115 may also be referred to as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable terminology. A UE 115 may also be a cellular phone, a personal digital assistant (PDA), a wireless modem, a wireless communication device, a handheld device, a tablet computer, a laptop computer, a cordless phone, a personal electronic device, a handheld device, a personal computer, a wireless local loop (WLL) station, an Internet of Things (IoT) device, an Internet of Everything (IoE) device, a machine type communication (MTC) device, an appliance, an automobile, or the like.

[0030] In some cases, a UE 115 may also be able to communicate directly with other UEs (e.g., using a peer-to-peer (P2P) or device-to-device (D2D) protocol). One or more of a group of UEs 115 utilizing D2D communications may be within the coverage area 110 of a cell. Other UEs 115 in such a group may be outside the coverage area 110 of a cell, or otherwise unable to receive transmissions from a base station 105. In some cases, groups of UEs 115 communicating via D2D communications may utilize a one-to-many (1:M) system in which each UE 115 transmits to every other UE 115 in the group. In some cases, a base station 105 facilitates the scheduling of resources for D2D communications. In other cases, D2D communications are carried out independent of a base station 105.

[0031] Some UEs 115, such as MTC or IoT devices, may be low cost or low complexity devices, and may provide for automated communication between machines, i.e., Machine-to-Machine (M2M) communication. M2M or MTC may refer to data communication technologies that allow devices to communicate with one another or a base station without human intervention. For example, M2M or MTC may refer to communications from devices that integrate sensors or meters to measure or capture information and relay that information to a central server or application program that can make use of the information or present the information to humans interacting with the program or application. Some UEs 115 may be designed to collect information or enable automated behavior of machines. Examples of applications for MTC devices include smart metering, inventory monitoring, water level monitoring, equipment monitoring, healthcare monitoring, wildlife monitoring, weather and geological event monitoring, fleet management and tracking, remote security sensing, physical access control, and transaction-based business charging.

[0032] In some cases, an MTC device may operate using half-duplex (one-way) communications at a reduced peak rate. MTC devices may also be configured to enter a power saving “deep sleep” mode when not engaging in active communications. In some cases, MTC or IoT devices may be designed to support mission critical functions and wireless communications system may be configured to provide ultra-reliable communications for these functions.

[0033] Base stations 105 may communicate with the core network 130 and with one another. For example, base stations 105 may interface with the core network 130 through backhaul links 132 (e.g., S1, etc.). Base stations 105 may communicate with one another over backhaul links 134 (e.g., X2, etc.) either directly or indirectly (e.g., through core network 130). Base stations 105 may perform radio configuration and scheduling for communication with UEs 115, or may operate under the control of a base station controller (not shown). In some examples, base stations 105 may be macro cells, small cells, hot spots, or the like. Base stations 105 may also be referred to as evolved NodeBs (eNBs) 105 or next generation NodeBs (gNBs) 105.

[0034] A base station 105 may be connected by an S1 interface to the core network 130. The core network may be an evolved packet core (EPC), which may include at least one mobility management entity (MME), at least one serving gateway (S-GW), and at least one Packet Data Network (PDN) gateway (P-GW). The MME may be the control node that

processes the signaling between the UE 115 and the EPC. All user Internet Protocol (IP) packets may be transferred through the S-GW, which itself may be connected to the P-GW. The P-GW may provide IP address allocation as well as other functions. The P-GW may be connected to the network operators IP services. The operators IP services may include the Internet, the Intranet, an IP Multimedia Subsystem (IMS), and a Packet-Switched (PS) Streaming Service.

[0035] The core network 130 may provide user authentication, access authorization, tracking, Internet Protocol (IP) connectivity, and other access, routing, or mobility functions. At least some of the network devices, such as base station 105 may include subcomponents such as an access network entity, which may be an example of an access node controller (ANC). Each access network entity may communicate with a number of UEs 115 through a number of other access network transmission entities, each of which may be an example of a smart radio head, or a transmission/reception point (TRP). In some configurations, various functions of each access network entity or base station 105 may be distributed across various network devices (e.g., radio heads and access network controllers) or consolidated into a single network device (e.g., a base station 105).

[0036] Wireless communications system 100 may operate in an ultra-high frequency (UHF) frequency region using frequency bands from 700 MHz to 2600 MHz (2.6 GHz), although some networks (e.g., a wireless local area network (WLAN)) may use frequencies as high as 4 GHz. This region may also be known as the decimeter band, since the wavelengths range from approximately one decimeter to one meter in length. UHF waves may propagate mainly by line of sight, and may be blocked by buildings and environmental features. However, the waves may penetrate walls sufficiently to provide service to UEs 115 located indoors. Transmission of UHF waves is characterized by smaller antennas and shorter range (e.g., less than 100 km) compared to transmission using the smaller frequencies (and longer waves) of the high frequency (HF) or very high frequency (VHF) portion of the spectrum. In some cases, wireless communications system 100 may also utilize extremely high frequency (EHF) portions of the spectrum (e.g., from 30 GHz to 300 GHz). This region may also be known as the millimeter band, since the wavelengths range from approximately one millimeter to one centimeter in length. Thus, EHF antennas may be even smaller and more closely spaced than UHF antennas. In some cases, this may facilitate use of antenna arrays within a UE 115 (e.g., for directional beamforming). However, EHF transmissions

may be subject to even greater atmospheric attenuation and shorter range than UHF transmissions.

[0037] Thus, wireless communications system 100 may support millimeter wave (mmW) communications between UEs 115 and base stations 105. Devices operating in mmW or EHF bands may have multiple antennas to allow beamforming. That is, a base station 105 may use multiple antennas or antenna arrays to conduct beamforming operations for directional communications with a UE 115. Beamforming (which may also be referred to as spatial filtering or directional transmission) is a signal processing technique that may be used at a transmitter (e.g., a base station 115) to shape and/or steer an overall antenna beam in the direction of a target receiver (e.g., a UE 115). This may be achieved by combining elements in an antenna array in such a way that transmitted signals at particular angles experience constructive interference while others experience destructive interference.

[0038] Multiple-input multiple-output (MIMO) wireless systems use a transmission scheme between a transmitter (e.g., a base station 105) and a receiver (e.g., a UE 115), where both transmitter and receiver are equipped with multiple antennas. Some portions of wireless communications system 100 may use beamforming. For example, base station 105 may have an antenna array with a number of rows and columns of antenna ports that the base station 105 may use for beamforming in its communication with UE 115. Signals may be transmitted multiple times in different directions (e.g., each transmission may be beamformed differently). A mmW receiver (e.g., a UE 115) may try multiple beams (e.g., antenna subarrays) while receiving the synchronization signals.

[0039] In some cases, the antennas of a base station 105 or UE 115 may be located within one or more antenna arrays, which may support beamforming or MIMO operation. One or more base station antennas or antenna arrays may be collocated at an antenna assembly, such as an antenna tower. In some cases, antennas or antenna arrays associated with a base station 105 may be located in diverse geographic locations. A base station 105 may multiple use antennas or antenna arrays to conduct beamforming operations for directional communications with a UE 115.

[0040] In some cases, wireless communications system 100 may be a packet-based network that operate according to a layered protocol stack. In the user plane, communications at the bearer or Packet Data Convergence Protocol (PDCP) layer may be IP-based. A Radio Link Control (RLC) layer may in some cases perform packet segmentation and reassembly to

communicate over logical channels. A Medium Access Control (MAC) layer may perform priority handling and multiplexing of logical channels into transport channels. The MAC layer may also use Hybrid Automatic Repeat Request (HARQ) to provide retransmission at the MAC layer to improve link efficiency. In the control plane, the Radio Resource Control (RRC) protocol layer may provide establishment, configuration, and maintenance of an RRC connection between a UE 115 and a network device such as a base station 105, or core network 130 supporting radio bearers for user plane data. At the Physical (PHY) layer, transport channels may be mapped to physical channels.

[0041] A shared radio frequency spectrum band may be utilized in an NR shared spectrum system. For example, an NR shared spectrum may utilize any combination of licensed, shared, and unlicensed spectrums, among others. The flexibility of eCC symbol duration and subcarrier spacing may allow for the use of eCC across multiple spectrums. In some examples, NR shared spectrum may increase spectrum utilization and spectral efficiency, specifically through dynamic vertical (e.g., across frequency) and horizontal (e.g., across time) sharing of resources.

[0042] In some cases, wireless system 100 may utilize both licensed and unlicensed radio frequency spectrum bands. For example, wireless system 100 may employ LTE License Assisted Access (LTE-LAA) or LTE Unlicensed (LTE U) radio access technology or NR technology in an unlicensed band such as the 5Ghz Industrial, Scientific, and Medical (ISM) band. When operating in unlicensed radio frequency spectrum bands, wireless devices such as base stations 105 and UEs 115 may employ listen-before-talk (LBT) procedures to ensure the channel is clear before transmitting data. In some cases, operations in unlicensed bands may be based on a CA configuration in conjunction with CCs operating in a licensed band. Operations in unlicensed spectrum may include downlink transmissions, uplink transmissions, or both. Duplexing in unlicensed spectrum may be based on frequency division duplexing (FDD), time division duplexing (TDD) or a combination of both.

[0043] FIG. 2 illustrates an example of a device 200 that supports FAR suppression for polar codes in accordance with various aspects of the present disclosure. The device 200 may be any device within a wireless communications system 100 that performs an encoding or decoding process. For example, the device 200 may be a UE 115 or base station 105, as described in FIG. 1.

[0044] As shown, device 200 includes a memory 205, an encoder/decoder 210, and a transmitter/receiver 215. Bus 220 may connect memory 205 to encoder/decoder 210 and bus 225 may connect encoder/decoder 210 to transmitter/receiver 215. In some instances, device 200 may have data stored in memory 205 to be transmitted to another device, such as a UE 115 or base station 105. Additionally or alternatively, memory 205 may store signals or portions thereof received from another device (e.g., for processing).

[0045] To initiate the transmission process, device 200 may retrieve from memory 205 data (e.g., in the form of an input vector) for transmission. The data may include a number of information bits provided from memory 205 to encoder/decoder 210 via bus 220. The number of information bits may be represented as a value 'k,' as shown. The encoder/decoder 210 may encode the number of information bits and output a codeword having a length 'N.' The bits that are not allocated as information bits (i.e., $N - k$ bits) may be assigned as frozen bits or parity check (PC) bits. Frozen bits may be bits of a value (e.g., 0) known to both the encoder and decoder (i.e., the encoder encoding information bits at a transmitter and the decoder decoding the codeword received at a receiver). PC bits represent a simple form of error detecting codes and are used to indicate, for example, the total number of 1-bits in a given binary string. In some cases, the length 'N' codeword may be generated using CRC bits appended to the information bits. For example, the input data vector (i.e., the 'k' information bits) may be encoded with CRC. The encoded vector may then undergo a polar transform to generate the length 'N' codeword. Like PC bits, CRC bits represent an example of an error-detecting code. CRC bits are determined based on inputting a data vector into a linear feedback shift register (LFSR) or polynomial division of the data vector and are included within the k information bits to provide an error check for the data vector. From the receiving device perspective, device 200 may receive a representation of the codeword via receiver 215, and decode the codeword using decoder 210 to obtain candidate bits for the information bits, which may be checked for decoding errors using the CRC value.

[0046] Various polar codeword structures are considered within the scope of the present disclosure. One such structure may be referred to as a PC-polar code (e.g., a codeword which contains PC bits as well as information bits and frozen bits). Another such structure may be referred to as a CRC-aided (CA)-polar code (e.g., a data vector encoded with CRC bits). In some cases, CA-polar codes may be an example of PC-polar codes (i.e., a CA-polar codeword may be generated using PC bits and CRC bits).

[0047] One consideration in implementation of polar codewords is the FAR at a decoder. In aspects of the present disclosure, FAR may refer to false detection of a signal when no signal is present (which may be referred to herein as FAR 1) as well as treatment of an incorrectly decoded signal as being correct (which may be referred to herein as FAR 2). To support practical implementation of polar codewords, decoders may in some cases be designed to provide sufficiently low FAR 1 and/or FAR 2 rates for PC-polar codes and/or CA-polar codes.

[0048] For CA-polar codes, FAR constraints at a decoder may easily be met with a large number of CRC bits. For example, FAR (e.g., FAR 1) may be generally given by $1/2^j$, where j is the number of CRC bits. That is, increasing the number of CRC bits is one way to provide sufficient suppression of FAR. However, this redundancy decreases throughput for the system and may, in some cases, increase the complexity of a decoding operation. Accordingly, improved techniques for FAR suppression that complement the use of a limited (e.g., less than j for an FAR of $1/2^j$) CRC bits may be desired. Furthermore, for PC-polar codes without CRC, the FAR for j PC bits may be higher than $1/2^j$, and thus achieving a low FAR using PC-polar codes may present further challenges. Communication devices that operate in accordance with the described techniques may be able to support communications with fewer error checking (e.g., PC or CRC) bits than would otherwise be possible for a given FAR.

[0049] In some wireless systems, the decoder 210 may be an example of a successive cancellation list (SCL) decoder. A UE 115 or base station 105 may receive a transmission including a codeword at the receiver 215, and may decode the codeword (e.g., using the decoder 210). The SCL decoder may determine input logarithmic-likelihood ratios (LLRs) for the bit channels of the received codeword. During decoding, the SCL decoder may determine decoded LLRs based on these input LLRs, where the decoded LLRs correspond to each bit channel of the polar code. These decoded LLRs may be referred to as bit metrics. In some cases, if the LLR is zero or a positive value, the SCL decoder may determine the corresponding bit is a 0 bit, and a negative LLR may correspond to a 1 bit. The SCL decoder may use the bit metrics to determine the decoded bit values.

[0050] The SCL decoder may employ multiple concurrent successive cancellation (SC) decoding processes. Each SC decoding process may decode the codeword sequentially (e.g., in order of the bit channel indices). Due to the combination of multiple SC decoding

processes, the SCL decoder may calculate multiple decoding path candidates. For example, an SCL decoder of list size 'L' (*i.e.*, the SCL decoder has L SC decoding processes) may calculate L decoding path candidates, and a corresponding reliability metric (*e.g.*, a path metric) for each decoding path candidate. The path metric may represent a reliability of a decoding path candidate or a probability that the corresponding decoding path candidate is the correct set of decoded bits. The path metric may be based on the determined bit metrics and the bit values selected at each bit channel. The SCL decoder may have a number of levels equal to the number of bit channels in the received codeword. At each level, each decoding path candidate may select either a 0 bit or a 1 bit based on a path metric of the 0 bit and the 1 bit. The SCL decoder may select a decoding path candidate based on the path metrics, and may output the bits corresponding to the selected decoding path as the decoded sets of bits. For example, the SCL decoder may select the L decoding paths with the highest path metrics at each bit channel. One or more decoding paths may be checked using error checking functions including PC or CRC in the decoding process.

[0051] FIG. 3 illustrates an example of a decoding structure 300 that supports FAR suppression for polar codes in accordance with various aspects of the present disclosure. The decoding structure 300 may be implemented at any device within a wireless communications system 100 that performs a polar decoding process (*e.g.*, a UE 115 or base station 105).

[0052] The decoding structure 300 may receive an input signal 305. The SC path decoder 310 may determine decoding candidate for one or more codewords in the signal. A decoding candidate may correspond to a set of resources of the input signal 305 (*e.g.*, a number of resource elements), a polar codeword length N, a number of information bits k, and a codeword length (which may be the same as the polar code length N or may be greater than or equal to N if rate matching is used). For example, the SC path decoder 310 may determine a decoding candidate of a set of decoding candidates for blind decoding of a channel (*e.g.*, a control channel). Thus, for a given decoding candidate, the input signal 305 may include a codeword that matches the decoding candidate, a codeword that matches some parameters of the decoding candidate but not others (*e.g.*, a codeword encoded using the same N but a different k), or no codeword (*e.g.*, random data or noise). The input signal 305 may be demodulated and decoded by SC path decoder 310 (*e.g.*, using the SCL decoding techniques described above) according to the decoding candidate to obtain a set of information bits 315. For example, decoding may include computing and sorting of path metrics for various branches of a decoding tree (*i.e.*, where the node of each branch is associated with an

information bit) based at least in part on input LLRs of the received symbols. Accordingly, multiple decoding hypotheses may be determined for each decoding candidate based on the associated path metrics.

[0053] The set of information bits 315 may be fed to a packet detection unit 320. In some cases, the input LLRs may also be passed to the packet detection unit 320. The packet detection unit 320 may employ one or more of the FAR suppression techniques described herein to determine whether the decoding hypothesis represents a valid transmission or noise. As indicated by the dashed box at 325, in some cases the decoding structure 300 may not include or bypass the packet detection unit 320 (e.g., if the signal received 305 is associated with a scheduled transmission).

[0054] If the set of information bits 315 for the decoding hypothesis is determined by the packet detection unit 320 to not be valid, the packet detection unit 320 may output packet detection failure indicator 330 to terminate decoding of the decoding candidate. That is, packet detection failure indicator 330 may indicate that the decoding candidate does not correspond to a valid decoding candidate. Based on the indicator 330, the decoding structure 300 may restart the decoding process for the signal 305 using a different decoding candidate (e.g., different resources, N, k, or rate matching). If the packet detection unit 320 determines that the set of information bits 315 corresponds to a valid decoding candidate, the packet detection unit 320 may output the set of information bits 335 (e.g., and the associated input LLRs) to an error detection unit 340. The error detection unit 340 may employ one or more of the FAR suppression techniques described herein to determine whether the decoding candidate represents a valid transmission or an improperly decoded transmission. In various examples, the operations performed by the packet detection unit 320 and the error detection unit 340 may be the same (e.g., may use a same set of algorithms to compute metrics and a same set of thresholds with which to compare the metrics). Alternatively, the operations performed by the packet detection unit 320 and the error detection unit 340 may be different (e.g., may use different algorithms to compute metrics and/or different thresholds with which to compare the metrics). For example, the thresholds may be based on a target FAR for packet detection, a target FAR for error detection, a channel condition, an estimated signal-to-noise ratio (SNR), a noise power, etc.

[0055] If the error detection unit 340 determines that the set of information bits 335 for the decoding candidate does not correspond to a correctly decoded codeword, the error

detection unit 340 may output packet error signal 345. Based on the packet error signal 345, the decoding structure 300 may restart the decoding process for the signal 305 using a different decoding candidate. Alternatively, the error detection unit 340 may determine that the set of information bits 335 corresponds to a correctly decoded codeword and may output a data vector 350 corresponding to data bits of the information bits to other components of the receiving device for higher level processing.

[0056] FIG. 4 illustrates an example of a process flow 400 that supports FAR suppression for polar codes in accordance with various aspects of the present disclosure. The process flow 400 may be implemented at any device within a wireless communications system 100 that performs a polar decoding process (e.g., a UE 115 or base station 105). Further, the operations of process flow 400 may be implemented at a packet detection unit 320 and/or an error detection unit 340 as described with reference to FIG. 3. As further described above, the operations of the packet detection unit may be referred to as FAR 1 operations and the operations of the error detection unit may be referred to as FAR 2 operations. Accordingly, process flow 400 is initially described in terms of FAR 1 operations and subsequently described in terms of FAR 2 operations. A device may perform operations associated with FAR 1 and/or FAR 2 in a given decoding operation.

[0057] At 405, a receiver may monitor a set of symbols according to a decoding candidate for a codeword. The received signal may be decoded according to the decoding candidate at 410 to obtain a set of information bits. For example, each symbol of the set of symbols may be associated with one or more input LLRs. These LLRs may be used in an SCL decoder (e.g., or any other suitable polar decoder such as an SC decoder) to compute a set of path metrics, which may in turn be used to select the set of information bits. In some cases, the path metrics may be based at least in part on PC bits for the decoding candidate (e.g., for a PC-polar codeword). For example, path metrics may be computed for each of a plurality of decoding hypotheses. The decoding hypothesis having the best path metric (e.g., the path metric associated with the lowest penalty based on the input LLRs and any PC bits) may be selected and the associated information bits for the decoding hypothesis and any relevant metrics may be output at 415. In some cases (e.g., for a CA-polar codeword), the decoding hypothesis may be selected based on passing a CRC operation (e.g., an error check operation using CRC bits of the decoding hypothesis).

[0058] At 420, the information bits may be re-encoded to obtain a hypothesized codeword $\hat{x}$. For example, a device performing process flow 400 may contain an encoder and decoder, as described with reference to FIG. 2. The re-encoding may be performed by the encoder or may be performed separately by an encoding unit associated with the decoder (e.g., in the case that the encoder is reserved for encoding transmissions to be sent to another device). In some cases, an encoding unit associated with the decoder may share circuitry with an encoder.

[0059] In some examples, the hypothesized codeword $\hat{x}$ may be output at 425 and used to compute a correlation metric m_0 at 445. Various techniques for computing the correlation metric m_0 at 445 are considered within the scope of the present disclosure. For example, the correlation metric m_0 may be computed at the packet detection unit described with reference to FIG. 3 (e.g., may be associated with FAR 1 operations) according to:

$$m_0 = \frac{c_0}{p} \quad (1)$$

[0060] Various techniques for computing the correlation value c_0 are considered within the scope of the present disclosure. For example, in one technique the correlation is computed according to:

$$c_0 = \sum_{i=0}^{N-1} LLR_i \hat{x}_i \quad (2)$$

in which the index i refers to a bit channel index of the received codeword and the hypothesized codeword. Accordingly, LLR_i represents the estimated LLR of the i -th bit channel of the received codeword and $\hat{x}_i$ represents the corresponding bit value of the hypothesized codeword. Accordingly, the correlation value c_0 may be computed based on a correlation between the hypothesized codeword and LLR values for the received codeword.

[0061] In some examples, the output of the re-encoding operation at 420 may be fed to a re-modulating component at 430. At 435, the re-modulating component may modulate the hypothesized codeword $\hat{x}$ (e.g., according to a given modulation rate used for the communications) to obtain a set of symbols $\hat{s}_i$. In such examples, the correlation value c_0 may be computed at 445 as

$$c_0 = \sum_{i=0}^{Q-1} y_i^* \hat{s}_i \quad (3)$$

where y_i^* represents the complex conjugate of the received input symbols of the input signal with length Q (i.e., the input signal which spans Q symbols) and $\hat{s}_i$ represents the symbols of the re-encoded hypothesized codeword $\hat{x}$. For example, if an input symbol $y_i = a + b * j$, then $y_i^* = a - b * j$. Accordingly, the correlation value c_0 may represent a correlation of symbols of the received codeword and corresponding symbols of the hypothesized codeword.

[0062] The power normalization factor may be computed as

$$p = \sqrt{\sum_{i=0}^{Q-1} y_i^2} \quad (4)$$

Alternative techniques for normalizing the correlation value c_0 are considered within the scope of the present disclosure (e.g., based on an SNR of the received signal or some other suitable metric).

[0063] At 450, the correlation metric m_0 may be fed to a validation component (e.g., to determine whether the decoding hypothesis represents a valid transmission or noise in the case of FAR 1). At 455, the validation component may compare the correlation metric m_0 to a threshold. If the correlation metric m_0 satisfies the threshold, a positive decision (e.g., for a valid transmission) may be output at 460. Alternatively, if the correlation metric m_0 fails to satisfy the threshold, a negative decision (e.g., for an invalid transmission) may be output at 465. In some cases, the output at 465 may influence future operations of the packet detection unit (e.g., as indicated by the dashed arrow). For example, after a certain number of consecutive negative decisions, the decoding device may enter a low-power mode before continuing to monitor symbol periods at a subsequent point in time. Validation of the decoded information bits according to the decoding candidate reduces FAR 1 for a given number of error checking bits by detecting situations in which the re-encoded information bits do not correlate with the received codeword at least a threshold level above a level determined to be consistent with noise or random data correlation. In some cases, the threshold with which the correlation metric m_0 is compared may be semi-statically or dynamically updated (e.g., based on some signaling from a network entity, an SNR of the received signal, a type of communication associated with the codeword, a type of transmitting device, a number of error check bits for the decoding candidate, or some combination thereof). Additionally or alternatively, the threshold may be selected or adjusted

based on some desired FAR 1. For example, a higher threshold may be associated with scenarios in which a lower FAR 1 is desired or necessary.

[0064] As described above, in some cases, a decoding device may skip the operations of process flow 400 for a packet detection unit (e.g., for FAR 1) in the case that a transmission is known to have occurred (e.g., is scheduled). Alternatively, upon identifying a valid transmission at 460, the operations of process flow 400 may be repeated in whole or in part at an error detection unit (e.g., for FAR 2). In some cases, operations performed for FAR 1 may not be repeated for FAR 2 (e.g., the output of such operations may be re-used for FAR 2). In some cases, the described FAR 2 operations may be performed for a CA-polar codeword (e.g., but not for a PC-polar codeword without CRC bits).

[0065] At 405, a receiver may perform a decoding operation on a set of symbols for a decoding candidate for a codeword, as described above. The received signal may be decoded according to the decoding candidate at 410 to obtain a set of information bits. For example, each symbol of the set of symbols may be associated with one or more input LLRs. These LLRs may be used in an SCL decoder (e.g., or any other suitable polar decoder such as an SC decoder) to compute a set of path metrics, which may in turn be used to select the set of information bits. In some cases, the path metrics may be based at least in part on PC bits for the decoding candidate (e.g., for a PC-polar codeword). For example, path metrics may be computed for each of a plurality of decoding hypotheses. The decoding hypothesis having the best path metric (e.g., the path metric associated with the lowest penalty based on the input LLRs and any PC bits) may be selected and the associated information bits for the decoding hypothesis and any relevant metrics may be output at 415. In some cases (e.g., for a CA-polar codeword), the decoding hypothesis may be selected based on passing a CRC operation (e.g., an error check operation using CRC bits of decoding hypothesis).

[0066] At 420, the information bits may be re-encoded to obtain a hypothesized codeword $\hat{x}$. For example, a device performing process flow 400 may contain an encoder and decoder, as described with reference to FIG. 2. The re-encoding may be performed by the encoder or may be performed separately by an encoding unit associated with the decoder (e.g., in the case that the encoder is reserved for encoding transmissions to be sent to another device).

[0067] In some examples, the hypothesized codeword $\hat{x}$ may be output at 425 and used to compute a correlation metric m_0 at 445. Various techniques for computing the correlation

metric m_0 at 445 are considered within the scope of the present disclosure. For example, the correlation metric m_0 may be computed at the error detection unit described with reference to FIG. 3 (e.g., may be associated with FAR 2 operations) according to:

$$m_0 = \frac{c_k}{c_1} \quad (5)$$

where c_k represents a correlation value for the decoding candidate that passes a CRC operation and c_1 represents the best (e.g., largest) correlation value of the remaining decoding hypotheses. Various techniques for computing the correlation values c_k and c_1 are considered within the scope of the present disclosure. For example, in one technique the correlation is computed according to:

$$c_k = \sum_{i=0}^{N-1} LLR_i \hat{x}_{k,i} \quad (6)$$

in which the index i refers to a bit channel index of the received codeword and the hypothesized codeword. Accordingly, LLR_i represents the estimated LLR of the i -th bit channel of the received codeword and $\hat{x}_{k,i}$ represents the corresponding bit value of the hypothesized codeword corresponding to the k -th decoding path (i.e., the decoding path which passes the CRC operation). Thus, the correlation value c_k may be computed based on a correlation between the hypothesized codeword and LLR values for the received codeword.

[0068] In this example, c_1 may be computed using analogous operations for each decoding path that does not pass the CRC operation. The various correlation values c_l may then be compared to select the maximum value according to

$$c_1 = \max_{l, l \neq k, \hat{o}_l \neq \hat{o}_k} \left(\sum_{i=0}^{N-1} LLR_i \hat{x}_{l,i} \right) \quad (7)$$

Accordingly, c_1 may be selected as the best correlation value of $\hat{x}_l$ for the various decoding hypotheses l with the input LLRs (e.g., except for the decoding hypothesis that passes the CRC operation). In this equation, $\hat{o}$ refers to the information bit set associated with a given decoding hypothesis.

[0069] Alternatively, in some examples, the output of the re-encoding operation at 420 may be fed to a re-modulating component at 430. At 435, the re-modulating component may modulate the hypothesized codeword $\hat{x}_k$ and the other decoding hypotheses $\hat{x}_l$ (e.g., with the CRC bits included and according to a given modulation rate used for the communications) to

obtain respective sets of symbols $\hat{s}_l$. In such examples, the correlation value c_k may be computed at 445 as

$$c_k = \sum_{l=0}^{Q-1} y_l^* \hat{s}_{k,l} \quad (8)$$

where y_l^* represents the complex conjugate of the received input symbols of the input signal with length Q (i.e., the input signal which spans Q symbols) and $\hat{s}_{k,l}$ represents the symbols of the re-encoded hypothesized codeword $\hat{x}_k$. Accordingly, the correlation value c_0 may represent a correlation of symbols of the received codeword and corresponding symbols of the hypothesized codeword (i.e., the codeword that passes the CRC operation).

[0070] In this example, c_l may be computed using analogous operations for each decoding hypothesis that does not pass the CRC operation. The various correlation values c_l may then be compared to select the maximum value according to

$$c_1 = \max_{l, l \neq k, \hat{o}_l \neq \hat{o}_k} \left(\sum_{l=0}^{Q-1} y_l^* \hat{s}_{l,i} \right) \quad (9)$$

which is the best correlation value of $\hat{s}_l$ with the symbols of the input signal (e.g., except for the decoding hypothesis which passes the CRC operation).

[0071] At 450, the correlation metric m_0 may be fed to a validation component (e.g., to determine whether the information bits determined for the decoding candidate represents a valid transmission). At 455, the validation component may compare the correlation metric m_0 to a threshold. If the correlation metric m_0 satisfies the threshold, a positive decision (e.g., for a valid transmission) may be output at 460. Alternatively, if the correlation metric m_0 fails to satisfy the threshold, a negative decision (e.g., for an invalid transmission) may be output at 465. In some cases, the output at 465 may influence future operations of the packet detection unit (e.g., as indicated by the dashed arrow). For example, after a certain number of consecutive negative decisions, the decoding device may enter a low-power mode before continuing to monitor symbol periods at a subsequent point in time. Validation of the decoded information bits according to the decoding candidate reduces FAR 2 for a given number of error checking bits by detecting situations in which the re-encoded information bits that pass the error check do not correlate with the received codeword at least a threshold level above other decoding paths which do not pass the error check. In some cases, the threshold with which the correlation metric m_0 is compared may be semi-statically or dynamically updated (e.g., based on some signaling from a network entity, an SNR of the

received signal, a type of communication associated with the codeword, a type of transmitting device, a number of error check bits for the decoding candidate, or some combination thereof). Additionally or alternatively, the threshold may be selected or adjusted based on some desired FAR 2. For example, a higher threshold may be associated with scenarios in which a lower FAR 2 is desired or necessary.

[0072] FIG. 5 shows a block diagram 500 of a wireless device 505 that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure. Wireless device 505 may be an example of aspects of a UE 115 or base station 105 as described herein (e.g., with reference to FIGs. 1 and 2). Wireless device 505 may include receiver 510, communications manager 515, and transmitter 520. Wireless device 505 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0073] Receiver 510 may receive information such as packets, user data, or control information associated with various information channels (e.g., control channels, data channels, and information related to false alarm rate suppression for polar codes, etc.). Information may be passed on to other components of the device. The receiver 510 may be an example of aspects of the transceiver 735 described with reference to FIG. 7. The receiver 510 may utilize a single antenna or a set of antennas. Receiver 510 may monitor a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits.

[0074] Communications manager 515 and/or at least some of its various sub-components may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions of the communications manager 515 and/or at least some of its various sub-components may be executed by a general-purpose processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), an field-programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described in the present disclosure. The communications manager 515 and/or at least some of its various sub-components may be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations by one or more physical devices. In some examples, communications manager 515 and/or at least some of its

various sub-components may be a separate and distinct component in accordance with various aspects of the present disclosure. In other examples, communications manager 515 and/or at least some of its various sub-components may be combined with one or more other hardware components, including but not limited to an I/O component, a transceiver, a network server, another computing device, one or more other components described in the present disclosure, or a combination thereof in accordance with various aspects of the present disclosure. Communications manager 515 may also include decoder 525, encoding unit 530, correlator 535, and validation component 540.

[0075] Decoder 525 may decode the codeword to obtain a set of candidate information bits, select a decoding hypothesis corresponding to the set of candidate information bits from the set of decoding hypotheses based on the path metrics, and select a decoding hypothesis corresponding to the set of candidate information bits based on a result of the error detecting check (EDC) operation for each decoding hypothesis. In some cases, decoding the codeword further includes determining path metrics for a set of decoding hypotheses. In some cases, each path metric is based on a set of parity check bits for the decoding candidate. In some cases, decoding the codeword further includes performing an EDC operation (e.g., a CRC operation) for each decoding hypothesis of a set of decoding hypotheses.

[0076] Encoding unit 530 may re-encode the set of candidate information bits to obtain a hypothesized codeword. As described above, in some cases encoding unit 530 may alternatively be referred to as (e.g., or share circuitry with) an encoder as described with reference to FIG. 2.

[0077] Correlator 535 may compute a correlation metric based on the hypothesized codeword and the set of symbols, generate the correlation metric based on a correlation between the set of symbols and the second set of symbols, determine respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis, and determine the correlation metric as a ratio of the first correlation value and a highest correlation value of the respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis. In some cases, computing the correlation metric further includes re-modulating the hypothesized codeword according to a modulation rate of the decoding candidate to obtain a second set of symbols. In some cases, the computing the correlation metric further includes: generating the correlation metric based on a correlation between the hypothesized codeword and LLR values for the decoding candidate

of the codeword. In some cases, the computing the correlation metric further includes: determining a first correlation value associated with the decoding hypothesis. In some cases, the correlation metric includes a ratio of a correlation value to a power normalization factor, the power normalization factor based on an aggregation of symbol power over the set of symbols.

[0078] Validation component 540 may determine whether the candidate information bits contain valid information based on the correlation metric (e.g., comparing the correlation metric to a detection threshold). In some cases, validation component 540 may determine the detection threshold based on a type of communication associated with the codeword, a type of transmitting device, a number of error check bits for the decoding candidate, or some combination thereof.

[0079] Transmitter 520 may transmit signals generated by other components of the device. In some examples, the transmitter 520 may be collocated with a receiver 510 in a transceiver module. For example, the transmitter 520 may be an example of aspects of the transceiver 735 described with reference to FIG. 7. The transmitter 520 may utilize a single antenna or a set of antennas.

[0080] FIG. 6 shows a block diagram 600 of a communications manager 615 that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure. The communications manager 615 may be an example of aspects of a communications manager 515, or a communications manager 715 described with reference to FIGs. 5 and 7. The communications manager 615 may include decoder 620, encoding unit 625, correlator 630, and validation component 635. Each of these modules may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0081] Decoder 620 may decode the codeword to obtain a set of candidate information bits, select a decoding hypothesis corresponding to the set of candidate information bits from the set of decoding hypotheses based on the path metrics, and select a decoding hypothesis corresponding to the set of candidate information bits based on a result of the EDC operation for the each decoding hypothesis. In some cases, decoding the codeword further includes determining path metrics for a set of decoding hypotheses. In some cases, each path metric is based on a set of parity check bits for the decoding candidate. In some cases, decoding the codeword further includes performing an EDC operation for each decoding hypothesis of a set of decoding hypotheses.

[0082] Encoding unit 625 may re-encode the set of candidate information bits to obtain a hypothesized codeword. As described above, in some cases encoding unit 625 may alternatively be referred to as (e.g., or share circuitry with) an encoder as described with reference to FIG. 2.

[0083] Correlator 630 may compute a correlation metric based on the hypothesized codeword and the set of symbols, generate the correlation metric based on a correlation between the set of symbols and the second set of symbols, determine respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis, and determine the correlation metric as a ratio of the first correlation value and a highest correlation value of the respective correlation values associated with the set of decoding hypotheses excluding the decoding hypothesis. In some cases, computing the correlation metric further includes re-modulating the hypothesized codeword according to a modulation rate of the decoding candidate to obtain a second set of symbols. In some cases, computing the correlation metric further includes generating the correlation metric based on a correlation between the hypothesized codeword and LLR values for the decoding candidate of the codeword. In some cases, computing the correlation metric further includes determining a first correlation value associated with the decoding hypothesis. In some cases, the correlation metric includes a ratio of a correlation value to a power normalization factor, the power normalization factor based on an aggregation of symbol power over the set of symbols.

[0084] Validation component 635 may determine whether the candidate information bits contain valid information based on the correlation metric and compare the correlation metric to a detection threshold, where the determining whether the candidate information bits contain valid information is based on the comparison. In some cases, validation component 635 may determine the detection threshold based on a type of communication associated with the codeword, a type of transmitting device, a number of error check bits for the decoding candidate, or some combination thereof.

[0085] FIG. 7 shows a diagram of a system 700 including a device 705 that supports false alarm rate suppression for polar codes in accordance with aspects of the present disclosure. Device 705 may be an example of or include the components of wireless device 505, wireless device 605, a base station 105, or a UE 115 as described above, e.g., with reference to FIGs. 1, 5, and 6. Device 705 may include components for bi-directional voice and data communications including components for transmitting and receiving

communications, including communications manager 715, processor 720, memory 725, software 730, transceiver 735, antenna 740, and I/O controller 745. These components may be in electronic communication via one or more buses (e.g., bus 710).

[0086] Processor 720 may include an intelligent hardware device, (e.g., a general-purpose processor, a DSP, a central processing unit (CPU), a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some cases, processor 720 may be configured to operate a memory array using a memory controller. In other cases, a memory controller may be integrated into processor 720. Processor 720 may be configured to execute computer-readable instructions stored in a memory to perform various functions (e.g., functions or tasks supporting false alarm rate suppression for polar codes).

[0087] Memory 725 may include random access memory (RAM) and read only memory (ROM). The memory 725 may store computer-readable, computer-executable software 730 including instructions that, when executed, cause the processor to perform various functions described herein. In some cases, the memory 725 may contain, among other things, a basic input/output system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0088] Software 730 may include code to implement aspects of the present disclosure, including code to support false alarm rate suppression for polar codes. Software 730 may be stored in a non-transitory computer-readable medium such as system memory or other memory. In some cases, the software 730 may not be directly executable by the processor but may cause a computer (e.g., when compiled and executed) to perform functions described herein.

[0089] Transceiver 735 may communicate bi-directionally, via one or more antennas, wired, or wireless links as described above. For example, the transceiver 735 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 735 may also include a modem to modulate the packets and provide the modulated packets to the antennas for transmission, and to demodulate packets received from the antennas.

[0090] In some cases, the wireless device may include a single antenna 740. However, in some cases the device may have more than one antenna 740, which may be capable of concurrently transmitting or receiving multiple wireless transmissions.

[0091] I/O controller 745 may manage input and output signals for device 705. I/O controller 745 may also manage peripherals not integrated into device 705. In some cases, I/O controller 745 may represent a physical connection or port to an external peripheral. In some cases, I/O controller 745 may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In other cases, I/O controller 745 may represent or interact with a modem, a keyboard, a mouse, a touchscreen, or a similar device. In some cases, I/O controller 745 may be implemented as part of a processor. In some cases, a user may interact with device 705 via I/O controller 745 or via hardware components controlled by I/O controller 745.

[0092] FIG. 8 shows a flowchart illustrating a method 800 for false alarm rate suppression for polar codes in accordance with aspects of the present disclosure. The operations of method 800 may be implemented by a wireless device or its components as described herein. For example, the operations of method 800 may be performed by a communications manager as described with reference to FIGs. 5 through 7. In some examples, a wireless device may execute a set of codes to control the functional elements of the device to perform the functions described below. Additionally or alternatively, the wireless device may perform aspects of the functions described below using special-purpose hardware.

[0093] At block 805 the wireless device may monitor a set of symbols for a decoding candidate of a codeword, wherein the decoding candidate is based at least in part on a plurality of information bits. The operations of block 805 may be performed according to the methods described herein. In certain examples, aspects of the operations of block 805 may be performed by a receiver as described with reference to FIGs. 2 through 7.

[0094] At block 810 the wireless device may decode the codeword to obtain a plurality of candidate information bits. The operations of block 810 may be performed according to the methods described herein. In certain examples, aspects of the operations of block 810 may be performed by a decoder as described with reference to FIGs. 2 through 7.

[0095] At block 815 the wireless device may re-encode the plurality of candidate information bits to obtain a hypothesized codeword. The operations of block 815 may be performed according to the methods described herein. In certain examples, aspects of the operations of block 815 may be performed by an encoding unit as described with reference to FIGs. 2 through 7.

[0096] At block 820 the wireless device may compute a correlation metric based at least in part on the hypothesized codeword and the set of symbols. The operations of block 820 may be performed according to the methods described herein. In certain examples, aspects of the operations of block 820 may be performed by a correlator as described with reference to FIGs. 2 through 7.

[0097] At block 825 the wireless device may determine whether the candidate information bits contain valid information based at least in part on the correlation metric. The operations of block 825 may be performed according to the methods described herein. In certain examples, aspects of the operations of block 825 may be performed by a validation component as described with reference to FIGs. 2 through 7.

[0098] It should be noted that the methods described above describe possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Furthermore, aspects from two or more of the methods may be combined.

[0099] Techniques described herein may be used for various wireless communications systems such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal frequency division multiple access (OFDMA), single carrier frequency division multiple access (SC-FDMA), and other systems. The terms “system” and “network” are often used interchangeably. A code division multiple access (CDMA) system may implement a radio technology such as CDMA2000, Universal Terrestrial Radio Access (UTRA), etc. CDMA2000 covers IS-2000, IS-95, and IS-856 standards. IS-2000 Releases may be commonly referred to as CDMA2000 1X, 1X, etc. IS-856 (TIA-856) is commonly referred to as CDMA2000 1xEV-DO, High Rate Packet Data (HRPD), etc. UTRA includes Wideband CDMA (WCDMA) and other variants of CDMA. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM).

[0100] An OFDMA system may implement a radio technology such as Ultra Mobile Broadband (UMB), Evolved UTRA (E-UTRA), Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, etc. UTRA and E-UTRA are part of Universal Mobile Telecommunications System (UMTS). LTE and LTE-A are releases of UMTS that use E-UTRA. UTRA, E-UTRA, UMTS, LTE, LTE-A, NR, and GSM are described in documents from the organization named “3rd

Generation Partnership Project” (3GPP). CDMA2000 and UMB are described in documents from an organization named “3rd Generation Partnership Project 2” (3GPP2). The techniques described herein may be used for the systems and radio technologies mentioned above as well as other systems and radio technologies. While aspects of an LTE or an NR system may be described for purposes of example, and LTE or NR terminology may be used in much of the description, the techniques described herein are applicable beyond LTE or NR applications.

[0101] In LTE/LTE-A networks, including such networks described herein, the term evolved node B (eNB) may be generally used to describe the base stations. The wireless communications system or systems described herein may include a heterogeneous LTE/LTE-A or NR network in which different types of eNBs provide coverage for various geographical regions. For example, each eNB, next generation NodeB (gNB), or base station may provide communication coverage for a macro cell, a small cell, or other types of cell. The term “cell” may be used to describe a base station, a carrier or component carrier associated with a base station, or a coverage area (e.g., sector, etc.) of a carrier or base station, depending on context.

[0102] Base stations may include or may be referred to by those skilled in the art as a base transceiver station, a radio base station, an access point, a radio transceiver, a NodeB, eNodeB (eNB), gNB, Home NodeB, a Home eNodeB, or some other suitable terminology. The geographic coverage area for a base station may be divided into sectors making up only a portion of the coverage area. The wireless communications system or systems described herein may include base stations of different types (e.g., macro or small cell base stations). The UEs described herein may be able to communicate with various types of base stations and network equipment including macro eNBs, small cell eNBs, gNBs, relay base stations, and the like. There may be overlapping geographic coverage areas for different technologies.

[0103] A macro cell generally covers a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs with service subscriptions with the network provider. A small cell is a lower-powered base station, as compared with a macro cell, that may operate in the same or different (e.g., licensed, unlicensed, etc.) frequency bands as macro cells. Small cells may include pico cells, femto cells, and micro cells according to various examples. A pico cell, for example, may cover a small geographic area and may allow unrestricted access by UEs with service subscriptions with the network provider. A femto cell may also cover a small geographic area (e.g., a home) and may

provide restricted access by UEs having an association with the femto cell (e.g., UEs in a closed subscriber group (CSG), UEs for users in the home, and the like). An eNB for a macro cell may be referred to as a macro eNB. An eNB for a small cell may be referred to as a small cell eNB, a pico eNB, a femto eNB, or a home eNB. An eNB may support one or multiple (e.g., two, three, four, and the like) cells (e.g., component carriers).

[0104] The wireless communications system or systems described herein may support synchronous or asynchronous operation. For synchronous operation, the base stations may have similar frame timing, and transmissions from different base stations may be approximately aligned in time. For asynchronous operation, the base stations may have different frame timing, and transmissions from different base stations may not be aligned in time. The techniques described herein may be used for either synchronous or asynchronous operations.

[0105] The downlink transmissions described herein may also be called forward link transmissions while the uplink transmissions may also be called reverse link transmissions. Each communication link described herein—including, for example, wireless communications system 100 and 200 of FIGs. 1 and 2—may include one or more carriers, where each carrier may be a signal made up of multiple sub-carriers (e.g., waveform signals of different frequencies).

[0106] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term “exemplary” used herein means “serving as an example, instance, or illustration,” and not “preferred” or “advantageous over other examples.” The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0107] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description

is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0108] Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0109] The various illustrative blocks and modules described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

[0110] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described above can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations. Also, as used herein, including in the claims, “or” as used in a list of items (for example, a list of items prefaced by a phrase such as “at least one of” or “one or more of”) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an exemplary step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as

used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on.”

[0111] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, non-transitory computer-readable media may comprise RAM, ROM, electrically erasable programmable read only memory (EEPROM), compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that can be used to carry or store desired program code means in the form of instructions or data structures and that can be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0112] The description herein is provided to enable a person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein, but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

- 1 1. A method for wireless communication, comprising:
2 monitoring a set of symbols for a decoding candidate of a codeword, wherein
3 the decoding candidate is based at least in part on a plurality of information bits;
4 decoding the codeword to obtain a plurality of candidate information bits;
5 re-encoding the plurality of candidate information bits to obtain a
6 hypothesized codeword;
7 computing a correlation metric based at least in part on the hypothesized
8 codeword and the set of symbols; and
9 determining whether the candidate information bits contain valid information
10 based at least in part on the correlation metric.
- 1 2. The method of claim 1, wherein:
2 the computing the correlation metric further comprises: re-modulating the
3 hypothesized codeword according to a modulation rate of the decoding candidate to obtain a
4 second set of symbols; and
5 the method further comprising generating the correlation metric based on a
6 correlation between the set of symbols and the second set of symbols.
- 1 3. The method of claim 1, wherein:
2 the decoding the codeword further comprises: determining path metrics for a
3 set of decoding hypotheses; and
4 the method further comprising selecting a decoding hypothesis corresponding
5 to the plurality of candidate information bits from the set of decoding hypotheses based at
6 least in part on the path metrics.
- 1 4. The method of claim 3, wherein:
2 each path metric is based at least in part on a set of parity check bits for the
3 decoding candidate.
- 1 5. The method of claim 1, wherein:

2 the computing the correlation metric further comprises: generating the
3 correlation metric based at least in part on a correlation between the hypothesized codeword
4 and logarithmic likelihood ratio (LLR) values for the decoding candidate of the codeword.

1 6. The method of claim 1, wherein:
2 the decoding the codeword further comprises: performing an error detecting
3 check (EDC) operation for each decoding hypothesis of a set of decoding hypotheses; and
4 the method further comprising selecting a decoding hypothesis corresponding
5 to the plurality of candidate information bits based at least in part on a result of the EDC
6 operation for the each decoding hypothesis.

1 7. The method of claim 6, wherein:
2 the computing the correlation metric further comprises: determining a first
3 correlation value associated with the decoding hypothesis;
4 the method further comprising determining respective correlation values
5 associated with the set of decoding hypotheses excluding the decoding hypothesis; and
6 determining the correlation metric as a ratio of the first correlation value and a
7 highest correlation value of the respective correlation values associated with the set of
8 decoding hypotheses excluding the decoding hypothesis.

1 8. The method of claim 1, wherein:
2 the correlation metric comprises a ratio of a correlation value to a power
3 normalization factor, the power normalization factor based at least in part on an aggregation
4 of symbol power over the set of symbols.

1 9. The method of claim 1, further comprising:
2 comparing the correlation metric to a detection threshold, wherein the
3 determining whether the candidate information bits contain valid information is based at least
4 in part on the comparison.

1 10. The method of claim 9, further comprising:
2 determining the detection threshold based at least in part on a type of
3 communication associated with the codeword, a type of transmitting device, a number of
4 error check bits for the decoding candidate, or some combination thereof.

1 11. An apparatus for wireless communication, comprising:

2 means for monitoring a set of symbols for a decoding candidate of a
3 codeword, wherein the decoding candidate is based at least in part on a plurality of
4 information bits;
5 means for decoding the codeword to obtain a plurality of candidate
6 information bits;
7 means for re-encoding the plurality of candidate information bits to obtain a
8 hypothesized codeword;
9 means for computing a correlation metric based at least in part on the
10 hypothesized codeword and the set of symbols; and
11 means for determining whether the candidate information bits contain valid
12 information based at least in part on the correlation metric.

1 **12.** The apparatus of claim 11, wherein the means for computing the
2 correlation metric further comprises:
3 means for re-modulating the hypothesized codeword according to a
4 modulation rate of the decoding candidate to obtain a second set of symbols; and
5 means for generating the correlation metric based on a correlation between the
6 set of symbols and the second set of symbols.

1 **13.** The apparatus of claim 11, wherein the means for decoding the
2 codeword further comprises:
3 means for determining path metrics for a set of decoding hypotheses; and
4 means for selecting a decoding hypothesis corresponding to the plurality of
5 candidate information bits from the set of decoding hypotheses based at least in part on the
6 path metrics.

1 **14.** The apparatus of claim 13, wherein:
2 each path metric is based at least in part on a set of parity check bits for the
3 decoding candidate.

1 **15.** The apparatus of claim 11, wherein the means for computing the
2 correlation metric further comprises:
3 means for generating the correlation metric based at least in part on a
4 correlation between the hypothesized codeword and logarithmic likelihood ratio (LLR)
5 values for the decoding candidate of the codeword.

1 **16.** The apparatus of claim 11, wherein the means for decoding the
2 codeword further comprises:
3 means for performing an error detecting check (EDC) operation for each
4 decoding hypothesis of a set of decoding hypotheses; and
5 means for selecting a decoding hypothesis corresponding to the plurality of
6 candidate information bits based at least in part on a result of the EDC operation for the each
7 decoding hypothesis.

1 **17.** The apparatus of claim 16, wherein the means for computing the
2 correlation metric further comprises:
3 means for determining a first correlation value associated with the decoding
4 hypothesis;
5 means for determining respective correlation values associated with the set of
6 decoding hypotheses excluding the decoding hypothesis; and
7 means for determining the correlation metric as a ratio of the first correlation
8 value and a highest correlation value of the respective correlation values associated with the
9 set of decoding hypotheses excluding the decoding hypothesis.

1 **18.** The apparatus of claim 11, wherein:
2 the correlation metric comprises a ratio of a correlation value to a power
3 normalization factor, the power normalization factor based at least in part on an aggregation
4 of symbol power over the set of symbols.

1 **19.** The apparatus of claim 11, further comprising:
2 means for comparing the correlation metric to a detection threshold, wherein
3 the determining whether the candidate information bits contain valid information is based at
4 least in part on the comparison.

1 **20.** The apparatus of claim 19, further comprising:
2 means for determining the detection threshold based at least in part on a type
3 of communication associated with the codeword, a type of transmitting device, a number of
4 error check bits for the decoding candidate, or some combination thereof.

1 **21.** An apparatus for wireless communication, comprising:
2 a processor;

memory in electronic communication with the processor; and
instructions stored in the memory and operable, when executed by the
processor, to cause the apparatus to:
monitor a set of symbols for a decoding candidate of a codeword,
wherein the decoding candidate is based at least in part on a plurality of information
bits;
decode the codeword to obtain a plurality of candidate information
bits;
re-encode the plurality of candidate information bits to obtain a
hypothesized codeword;
compute a correlation metric based at least in part on the hypothesized
codeword and the set of symbols; and
determine whether the candidate information bits contain valid
information based at least in part on the correlation metric.

22. The apparatus of claim 21, wherein the instructions are further
executable by the processor to:
re-modulate the hypothesized codeword according to a modulation rate of the
decoding candidate to obtain a second set of symbols; and
generate the correlation metric based on a correlation between the set of
symbols and the second set of symbols.

23. The apparatus of claim 21, wherein the instructions are further
executable by the processor to:
determine path metrics for a set of decoding hypotheses; and
select a decoding hypothesis corresponding to the plurality of candidate
information bits from the set of decoding hypotheses based at least in part on the path
metrics.

24. The apparatus of claim 23, wherein:
each path metric is based at least in part on a set of parity check bits for the
decoding candidate.

25. The apparatus of claim 21, wherein the instructions are further
executable by the processor to:

3 generate the correlation metric based at least in part on a correlation between
4 the hypothesized codeword and logarithmic likelihood ratio (LLR) values for the decoding
5 candidate of the codeword.

1 **26.** The apparatus of claim 21, wherein the instructions are further
2 executable by the processor to:
3 perform an error detecting check (EDC) operation for each decoding
4 hypothesis of a set of decoding hypotheses; and
5 select a decoding hypothesis corresponding to the plurality of candidate
6 information bits based at least in part on a result of the EDC operation for the each decoding
7 hypothesis.

1 **27.** The apparatus of claim 26, wherein the instructions are further
2 executable by the processor to:
3 determine a first correlation value associated with the decoding hypothesis;
4 determine respective correlation values associated with the set of decoding
5 hypotheses excluding the decoding hypothesis; and
6 determine the correlation metric as a ratio of the first correlation value and a
7 highest correlation value of the respective correlation values associated with the set of
8 decoding hypotheses excluding the decoding hypothesis.

1 **28.** The apparatus of claim 21, wherein:
2 the correlation metric comprises a ratio of a correlation value to a power
3 normalization factor, the power normalization factor based at least in part on an aggregation
4 of symbol power over the set of symbols.

1 **29.** The apparatus of claim 21, wherein the instructions are further
2 executable by the processor to:
3 compare the correlation metric to a detection threshold, wherein the
4 determining whether the candidate information bits contain valid information is based at least
5 in part on the comparison.

1 **30.** The apparatus of claim 29, wherein the instructions are further
2 executable by the processor to:

3 determine the detection threshold based at least in part on a type of
4 communication associated with the codeword, a type of transmitting device, a number of
5 error check bits for the decoding candidate, or some combination thereof.

1 **31.** A non-transitory computer readable medium storing code for wireless
2 communication, the code comprising instructions executable by a processor to:

3 monitor a set of symbols for a decoding candidate of a codeword, wherein the
4 decoding candidate is based at least in part on a plurality of information bits;

5 decode the codeword to obtain a plurality of candidate information bits;

6 re-encode the plurality of candidate information bits to obtain a hypothesized
7 codeword;

8 compute a correlation metric based at least in part on the hypothesized
9 codeword and the set of symbols; and

10 determine whether the candidate information bits contain valid information
11 based at least in part on the correlation metric.

1 **32.** The non-transitory computer-readable medium of claim 31, wherein
2 the instructions are further executable by the processor to:

3 re-modulate the hypothesized codeword according to a modulation rate of the
4 decoding candidate to obtain a second set of symbols; and

5 generate the correlation metric based on a correlation between the set of
6 symbols and the second set of symbols.

1 **33.** The non-transitory computer-readable medium of claim 31, wherein
2 the instructions are further executable by the processor to:

3 determine path metrics for a set of decoding hypotheses; and

4 select a decoding hypothesis corresponding to the plurality of candidate
5 information bits from the set of decoding hypotheses based at least in part on the path
6 metrics.

1 **34.** The non-transitory computer-readable medium of claim 33, wherein:

2 each path metric is based at least in part on a set of parity check bits for the
3 decoding candidate.

1 **35.** The non-transitory computer-readable medium of claim 31, wherein

2 the instructions are further executable by the processor to:

3 generate the correlation metric based at least in part on a correlation between
4 the hypothesized codeword and logarithmic likelihood ratio (LLR) values for the decoding
5 candidate of the codeword.

1 **36.** The non-transitory computer-readable medium of claim 31, wherein
2 the instructions are further executable by the processor to:
3 perform an error detecting check (EDC) operation for each decoding
4 hypothesis of a set of decoding hypotheses; and
5 select a decoding hypothesis corresponding to the plurality of candidate
6 information bits based at least in part on a result of the EDC operation for the each decoding
7 hypothesis.

1 **37.** The non-transitory computer-readable medium of claim 36, wherein
2 the instructions are further executable by the processor to:
3 determine a first correlation value associated with the decoding hypothesis;
4 determine respective correlation values associated with the set of decoding
5 hypotheses excluding the decoding hypothesis; and
6 determine the correlation metric as a ratio of the first correlation value and a
7 highest correlation value of the respective correlation values associated with the set of
8 decoding hypotheses excluding the decoding hypothesis.

1 **38.** The non-transitory computer-readable medium of claim 31, wherein:
2 the correlation metric comprises a ratio of a correlation value to a power
3 normalization factor, the power normalization factor based at least in part on an aggregation
4 of symbol power over the set of symbols.

1 **39.** The non-transitory computer-readable medium of claim 31, wherein
2 the instructions are further executable by the processor to:
3 compare the correlation metric to a detection threshold, wherein the
4 determining whether the candidate information bits contain valid information is based at least
5 in part on the comparison.

1 **40.** The non-transitory computer-readable medium of claim 39, wherein
2 the instructions are further executable by the processor to:

- 3 determine the detection threshold based at least in part on a type of
4 communication associated with the codeword, a type of transmitting device, a number of
5 error check bits for the decoding candidate, or some combination thereof.

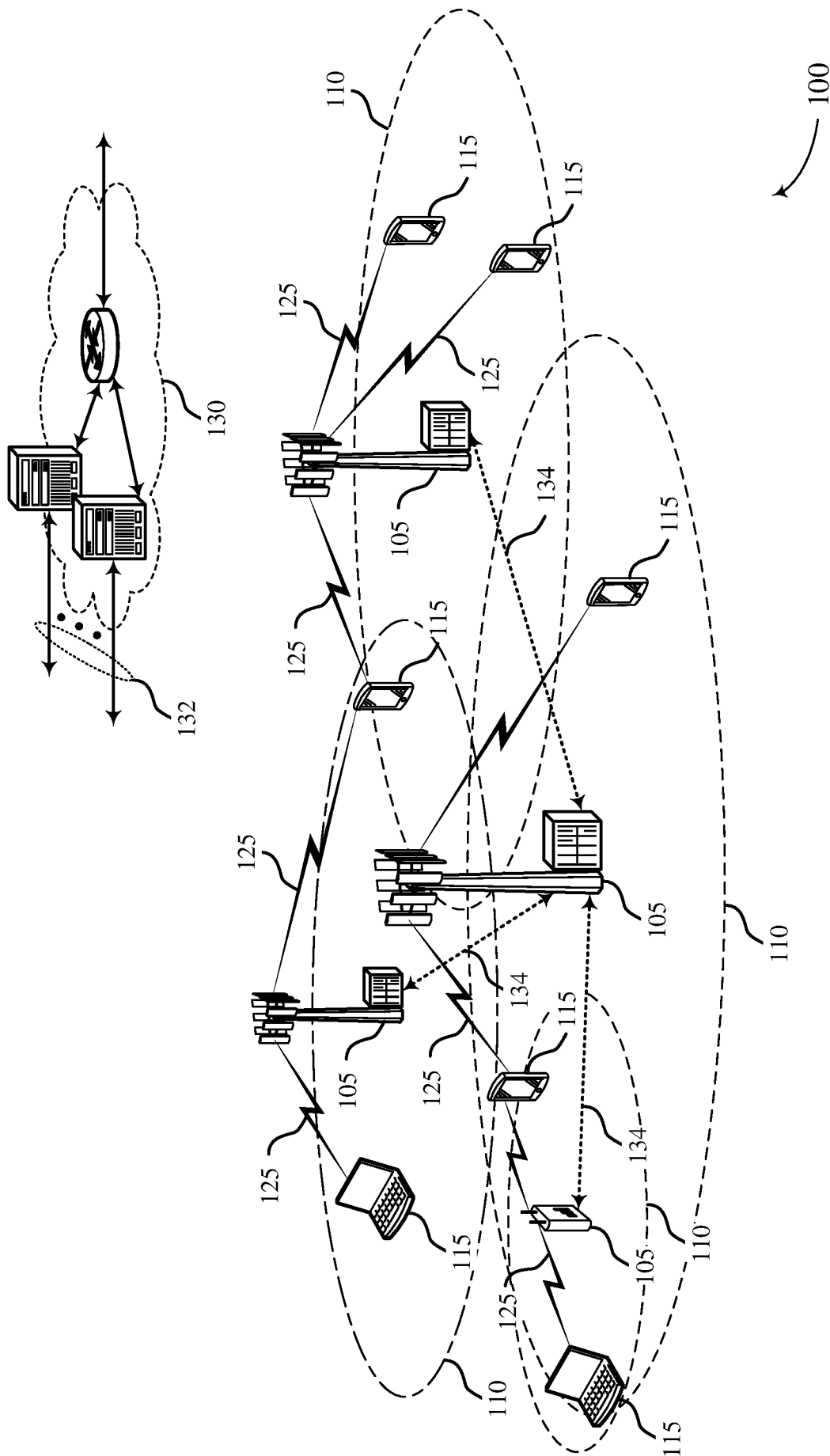


FIG. 1

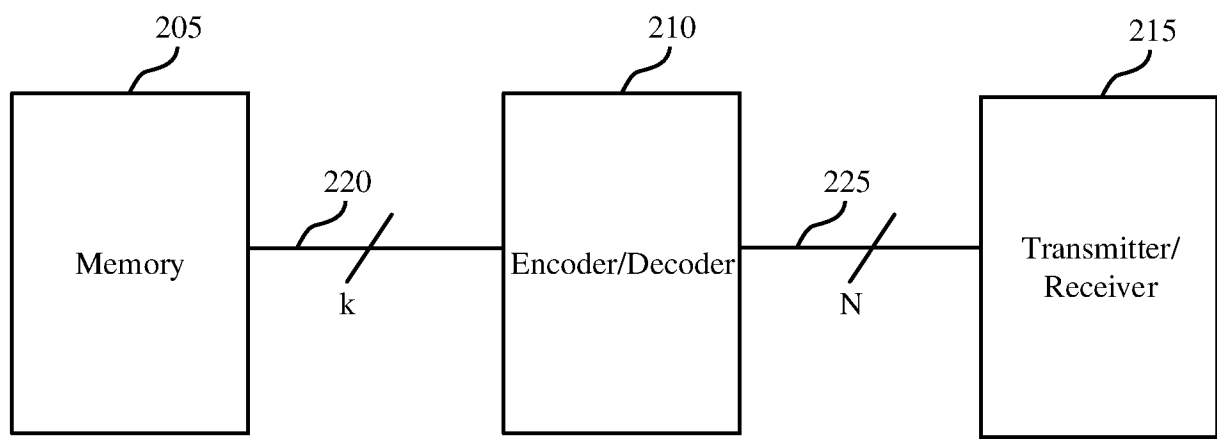


FIG. 2

200

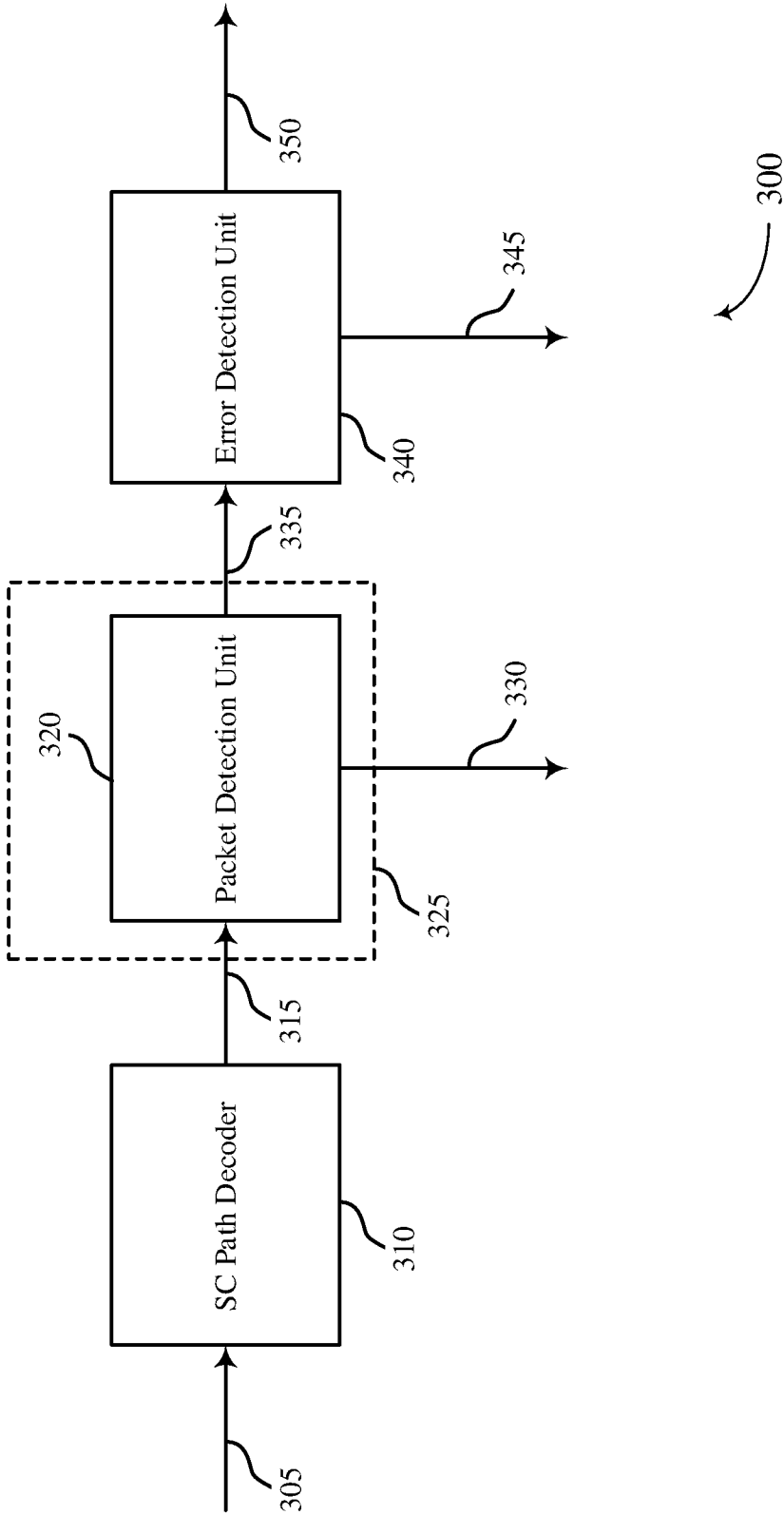


FIG. 3

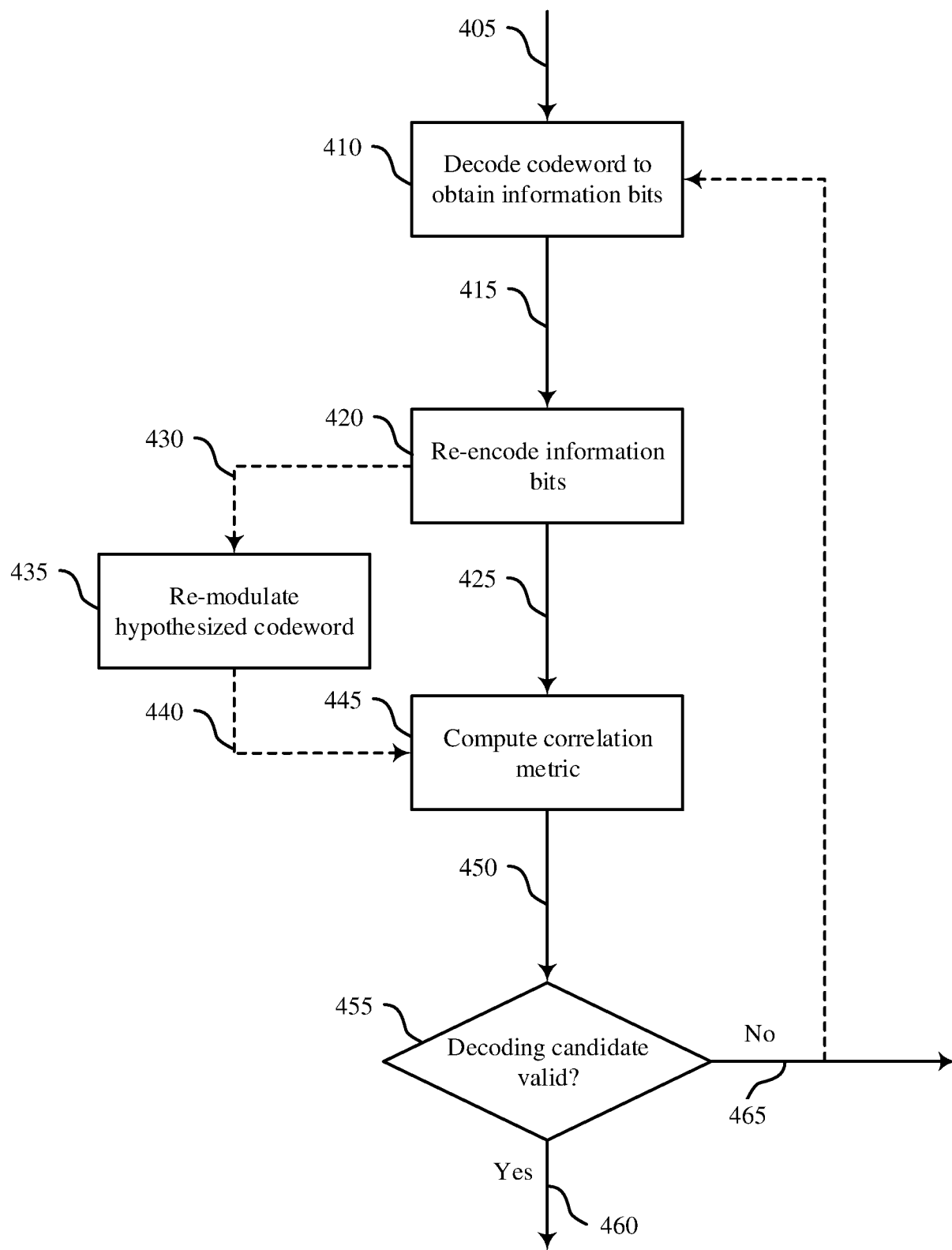


FIG. 4

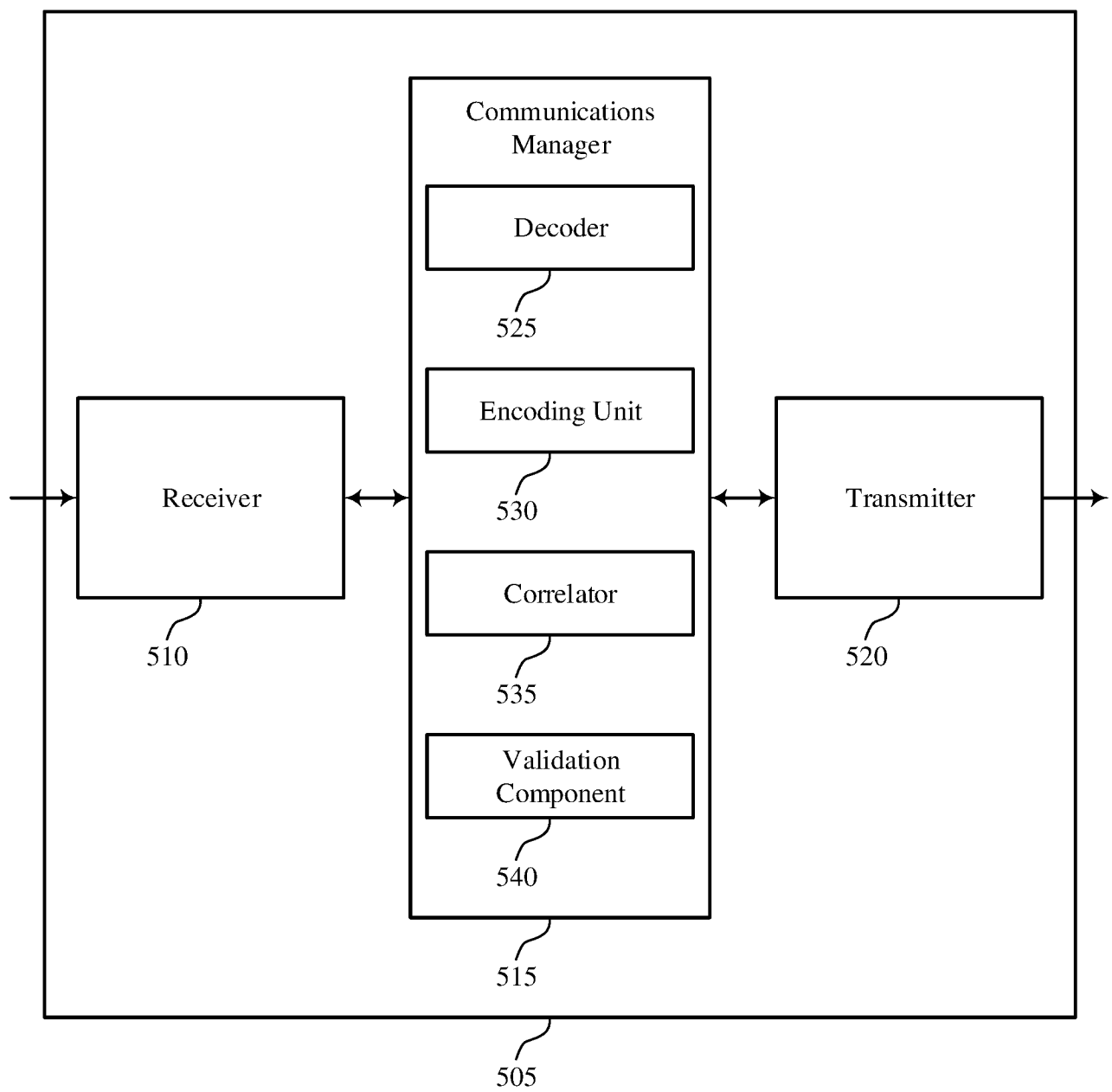


FIG. 5

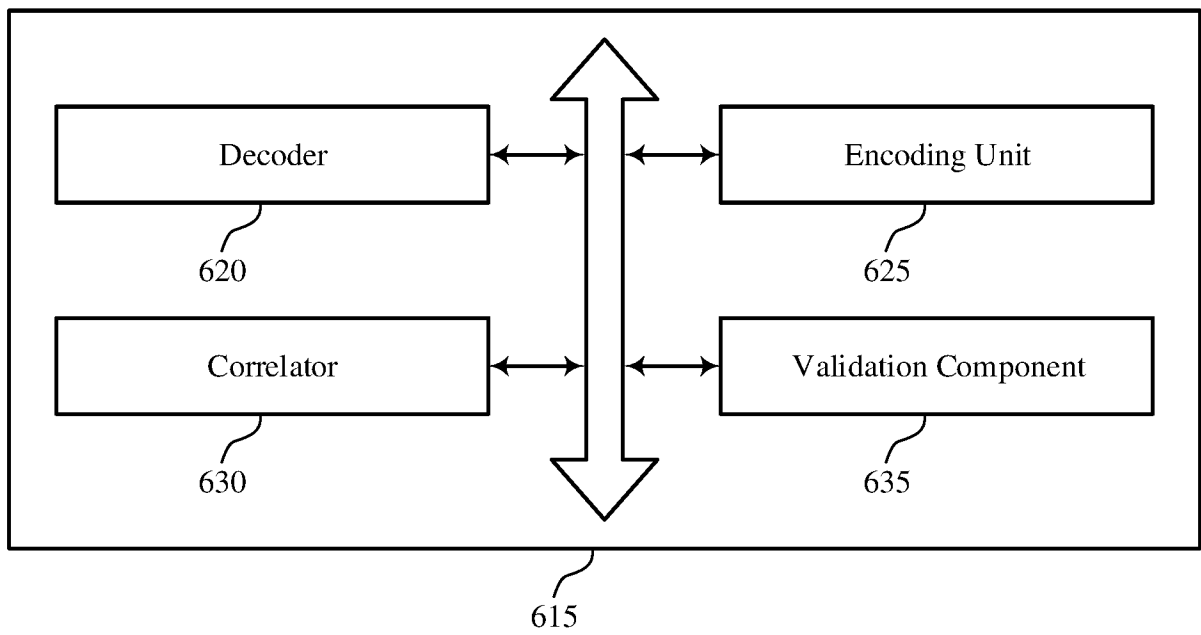


FIG. 6

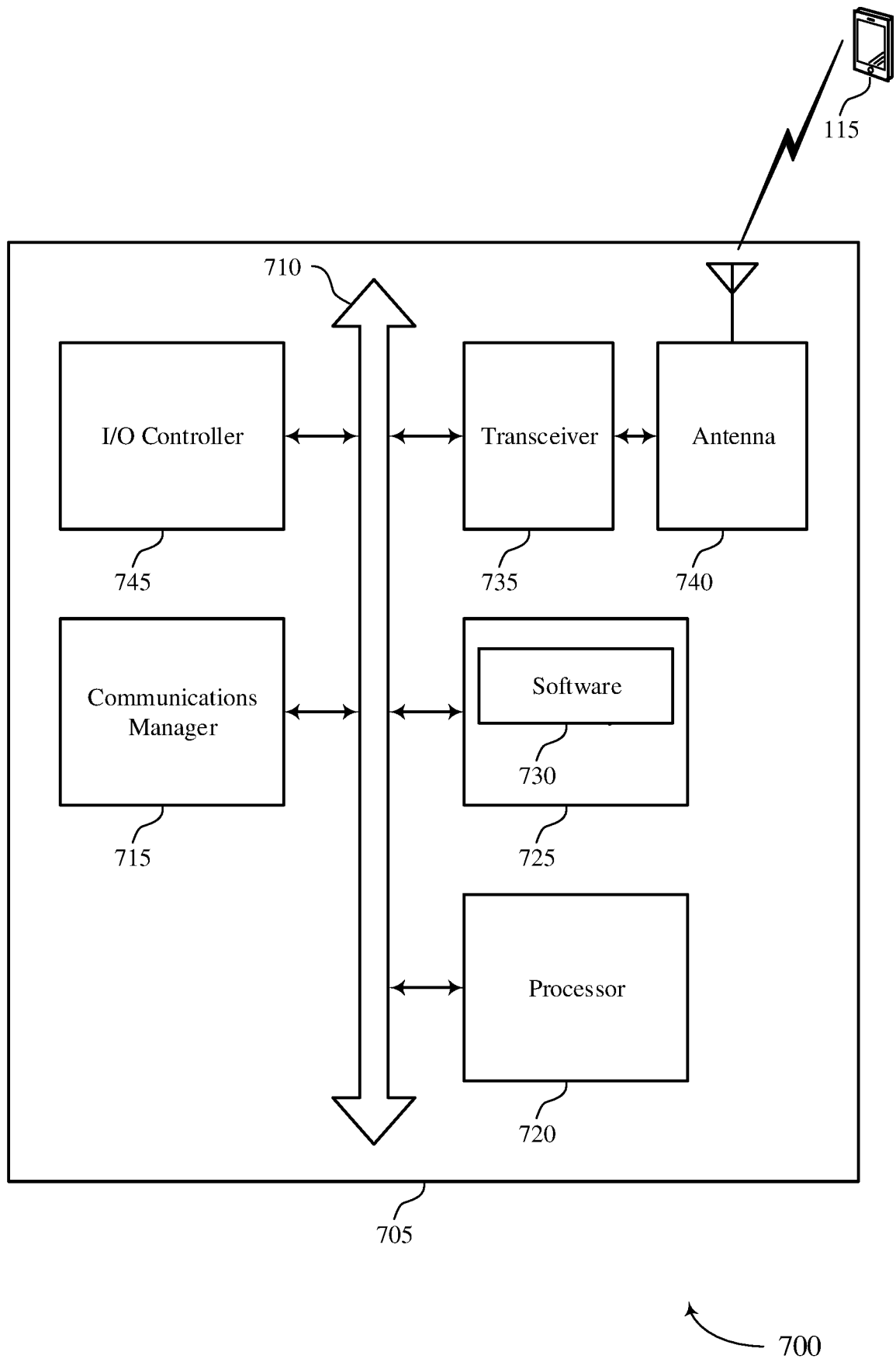
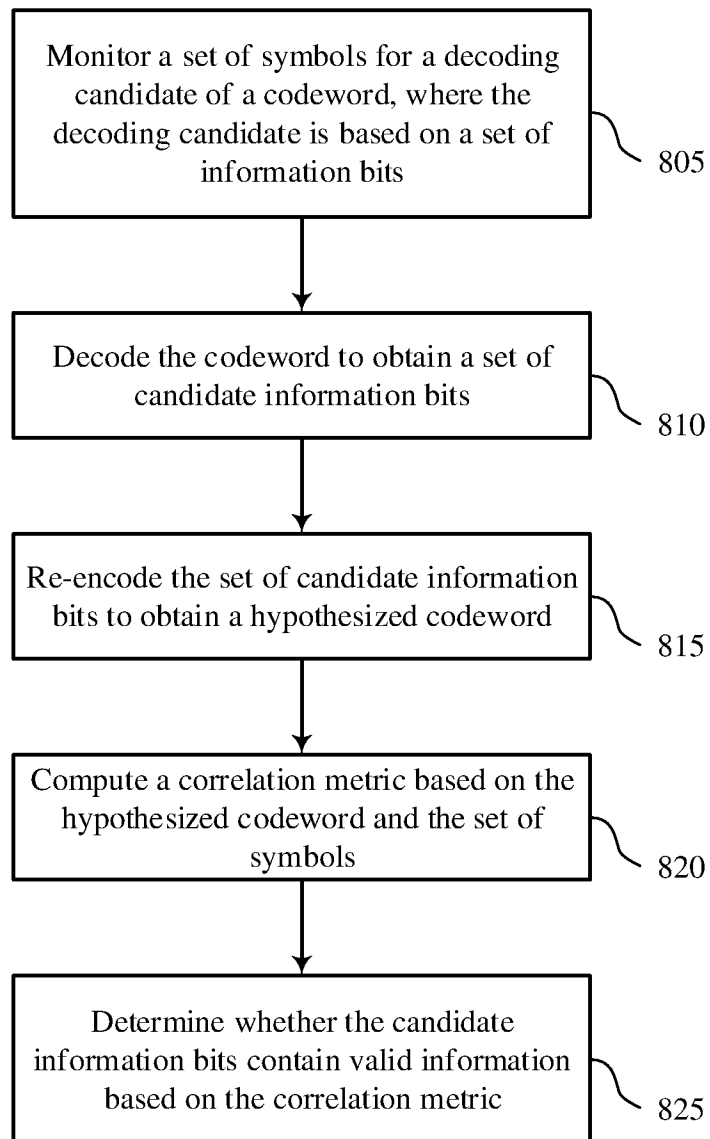


FIG. 7



800

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/085931

A. CLASSIFICATION OF SUBJECT MATTER

H04L 1/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L; H04W; H04B

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

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

CNABS;CNTXT;CNKI;VEN;USTXT;WOTXT;EPTXT;JPTXT:FAR, false alarm rate, suppres+, polar code, monitor+, symbol?, candidate, codeword, information bit?, hypothesized, correlation metric

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2017054164 A1 (HUAWEI TECH CO., LTD. ET AL.) 06 April 2017 (2017-04-06) Claims 1-12	1-40
A	US 2017033894 A1 (SAMSUNG ELECTRONICS CO., LTD.) 02 February 2017 (2017-02-02) The whole documents	1-40
A	CN 106452460 A (UNIV HUAZHONG SCIENCE TECH.) 22 February 2017 (2017-02-22) The whole documents	1-40
A	JP 2006292597 A (NEC CORP.) 26 October 2006 (2006-10-26)	1-40
A	KR 101546421 B1 (STXENGINE CO., LTD.) 24 August 2015 (2015-08-24) The whole documents	1-40
A	US 2009268803 A1 (NEWPORT MEDIA INC.) 29 October 2009 (2009-10-29) The whole documents	1-40

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

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

07 February 2018

Date of mailing of the international search report

14 February 2018

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2017/085931

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2017054164	A1	06 April 2017	None			
US	2017033894	A1	02 February 2017	WO	2017018859	A1	02 February 2017
				KR	20170014610	A	08 February 2017
CN	106452460	A	22 February 2017	None			
JP	2006292597	A	26 October 2006	JP	4670446	B2	13 April 2011
KR	101546421	B1	24 August 2015	None			
US	2009268803	A1	29 October 2009	US	7940864	B2	10 May 2011