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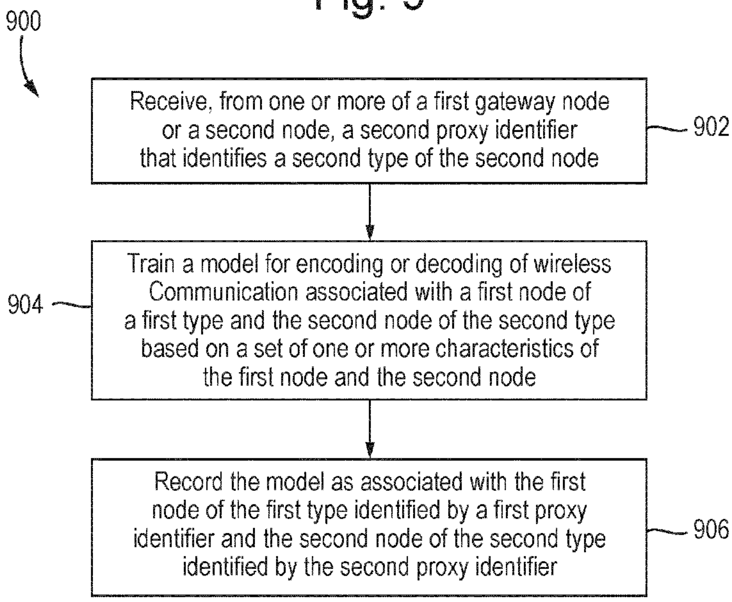
(54) Title: METHOD AND SYSTEM FOR IDENTIFICATION OF MULTIPLE MODELS IN A WIRELESS COMMUNICATION NETWORK

Fig. 9



(57) Abstract: Various aspects of the present disclosure relate to an apparatus for wireless communication, comprising: at least one memory; and at least one processor coupled with at least one memory and configured to cause the apparatus to: receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; train a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

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METHOD AND SYSTEM FOR IDENTIFICATION OF MULTIPLE MODELS IN A WIRELESS COMMUNICATION NETWORK

TECHNICAL FIELD

[0001] The subject matter disclosed herein relates generally to the field of implementing a method and a system for identification of multiple models in a wireless communication network. In particular, this document defines apparatuses and methods for wireless communication.

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, such as base stations, which may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers, or the like). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

SUMMARY

[0003] An article “a” before an element is unrestricted and understood to refer to “at least one” of those elements or “one or more” of those elements. The terms “a,” “at least one,” “one or more,” and “at least one of one or more” may be interchangeable. As used herein, including in the claims, “or” as used in a list of items (e.g., a list of items prefaced by a phrase such as “at least one of” or “one or more of” or “one or both 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 example 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. Further, as used herein, including in the claims, a “set” may include one or more elements.

[0004] There is provided an apparatus for wireless communication, comprising: at least one memory; and at least one processor coupled with at least one memory and configured to cause the apparatus to: receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; train a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0005] There is also provided an apparatus for wireless communication, comprising: at least one memory; and at least one processor coupled with at least one memory and configured to cause the apparatus to: transmit, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receive, from the second node, a second proxy identifier identifying the second type of the second node; and select, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0006] There is also provided a method for wireless communication; comprising: receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0007] There is also provided a method for wireless communication; comprising: transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receiving, from the second node, a second proxy identifier identifying the second type of the second node; and selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier

[0008] There is also provided a processor for wireless communication, comprising: at least one controller coupled with at least one memory and configured to cause the processor to: receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; train a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0009] There is also provided a processor for wireless communication, comprising: at least one controller coupled with at least one memory and configured to cause the processor to: transmit, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receive, from the second node, a second proxy identifier identifying the second type of the second node; and select, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0011] Figure 2 illustrates a further example of a wireless communications system in accordance with aspects of the present disclosure.

[0012] Figure 3 illustrates an example of a high-level structure of a two-sided model in accordance with aspects of the present disclosure.

[0013] Figure 4 illustrates an example of a high-level structure of a one-sided model in accordance with aspects of the present disclosure.

[0014] Figure 5 illustrates a further example of a high-level structure of a one-sided model in accordance with aspects of the present disclosure.

[0015] Figure 6 illustrates an example of a user equipment (UE) 600 in accordance with aspects of the present disclosure.

[0016] Figure 7 illustrates an example of a processor 700 in accordance with aspects of the present disclosure.

[0017] Figure 8 illustrates an example of a network equipment (NE) 800 in accordance with aspects of the present disclosure.

[0018] Figure 9 illustrates a flowchart of a method 900 performed by an apparatus in accordance with aspects of the present disclosure.

[0019] Figure 10 illustrates a flowchart of a method 1000 performed by an apparatus in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0020] During communication between nodes in a network, it may be desirable to maintain information regarding a type of a node as secret from other nodes. At the same time, it may be desirable to use a most appropriate means for encoding and/or decoding messages transmitted between the nodes.

[0021] Examples of the present disclosure tend to facilitate selection of a most appropriate, efficient, and/or secure encoding and/or decoding model for increasing both security and efficiency of communication.

[0022] Aspects of the present disclosure are described in the context of a wireless communications system.

[0023] Figure 1 illustrates an example of a wireless communications system 100 in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more NE 102, one or more UE 104, and a core network (CN) 106. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultrawideband (5G-UWB) network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0024] The one or more NE 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the NE 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a radio access network (RAN), a nodeB, an enodeB (eNB), a next-generation nodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g., receive signalling, transmit signalling) over a Uu interface.

[0025] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different NE 102.

[0026] The one or more UE 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0027] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0028] An NE 102 may support communications with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with other NE 102 or the CN 106 through one or more backhaul links (e.g., S1, N2, N2, or network interface). In some implementations, the NE 102 may communicate with each other directly. In some other implementations, the NE 102 may communicate with each other or indirectly (e.g., via the CN 106. In some implementations, one or more NE 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs).

[0029] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more NE 102 associated with the CN 106.

[0030] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g., via an S1, N2, N2, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the CN 106 (e.g., one or more network functions of the CN 106).

[0031] In the wireless communications system 100, the NEs 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the NEs 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0032] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., μ=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0033] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0034] Additionally, or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively.#Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols.

The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ =0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0035] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the NEs 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the NEs 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0036] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0037] Figure 2 shows a wireless network 200 with a New Generation Radio Access Network (NG-RAN) node, e.g., base station 208 gNB represented by node B_1 equipped with M antennas, and K user equipments 202, 204, 206 (UEs) denoted by $U_1, U_2, \cdots, U_K$ each having N antennas.

[0038] $\mathbf{H}_l^k(t)$ denotes a channel at time t over frequency band $l, l \in \{1,2,\ldots,L\}$, between B_1 and U_k, which is a matrix of size $N \times M$ with complex entries, i.e., $\mathbf{H}_l^k(t) \in \mathbb{C}^{N\times M}$.

[0039] At time t and in frequency band l, the gNB may want to transmit message $x_l^k(t)$ to user U_k, where $k = \{1,2,\cdots,K\}$, while it uses $\mathbf{w}_l^k(t) \in \mathbb{C}^{M\times 1}$ as the precoding vector. The received signal at U_k, $\mathbf{y}_l^k(t)$, can be written as:

$$\mathbf{y}_l^k(t) = \mathbf{H}_l^k(t)\mathbf{w}_l^k(t)x_l^k(t) + \mathbf{n}_l^k(t)$$

where $\mathbf{n}_l^k(t)$ represents the noise vector at the receiver.

[0040] To improve the achievable rate of the link, the gNB may selects $\mathbf{w}_l^k(t)$ that maximizes the received signal to noise ratio (SNR). Several schemes have been proposed for good selection of $\mathbf{w}_l^k(t)$ where most of them rely on having some knowledge about $\mathbf{H}_l^k(t)$.

[0041] The gNB may get knowledge of $\mathbf{H}_l^k(t)$ by direct measurement (e.g., in Time Division Duplex, TDD, mode and assuming reciprocity of the channel), or indirectly using the information that the UE sends to the gNB (e.g., in Frequency Division Duplex, FDD, mode). In the latter case, large amounts of feedback may be required to send accurate information about $\mathbf{H}_l^k(t)$. This becomes particularly important if there are large number of antennas or/and large frequency bands.

[0042] $\mathbf{H}^k$ denotes a matrix of size $N \times M \times L$ which may be constructed by stacking $\mathbf{H}_l^k$ for all frequency bands, i.e., the entries at $\mathbf{H}^k[n,m,l]$ is equal to $\mathbf{H}_l^k[n,m]$. In total, therefore, each UE may need to send information about $N \times M \times L$ complex numbers to the gNB.

[0043] With reference to Figure 3, a two-sided model is one of the schemes presented to reduce the required feedback information where an encoding part (at the UE) computes a quantized latent representation 310 of input data 312; and the decoding part (at the gNB) may get this latent representation 310 and use it to reconstruct the desired output 314. The input data 312 in this case may be a dataset which is based on channel measurements. For example, it could be the raw channel inputs of $\mathbf{H}^k$ or $\mathbf{H}_l^k$, or, for example, precoders that are computed from the channel matrix, e.g., the eigenvector associated with the largest eigen-vector of $\mathbf{H}^k$ for each sub-band.

[0044] Figure 3 depicts a high-level structure of a two-sided model 300 with NN-based node A 302 (e.g., UE) and node B 304 (e.g., gNB) referred to here as M_e(encoding model) 306 and M_d(decoding model) 308, respectively. Note that this is an example: the locations of the encoder 306 and decoder 308 represented in Figure 3 may be interchanged.

[0045] Models M_e 306 and M_d 308 may be logical models. This means that node A 302 may choose not to use M_e 306 directly and instead develop and use several internal models like $M_{e(1)}$, $M_{e(2)}$,…, $M_{e(k)}$ based on some private parameters and decisions. In these examples, these internal models may meet at least the performance of pairing original M_e 306 with M_d 308. In this example, node B 304 may not need to know what the actual model used at the node A 302 is. The corollary may be true for M_d 308 and internal models at node B 304.

[0046] There are several ways to train the Neural Network (NN) modules of a two-sided model, including, but not limited to: centralized training; simultaneous training; and separate training. Updating a two-sided model may be carried out centrally on one entity, on different entities but simultaneously, or separately. In separate training/model update, the NN modules of the node A 302 (e.g., UE 202) and the node B 304 (e.g., gNB 208) are trained in different training sessions (no forward or backpropagation path between the two parts). In separate training, node A 302 and node B 304 do not need to be aware of the internal structure of the NN module of the other side.

[0047] There are also some other use cases, e.g., CSI prediction or Beam Management or Positioning, wherein the model is only at one side, i.e., node A-Side, or node B-Side. Figure 4 and Figure 5 are example high-level demonstrations of these two cases.

[0048] Figure 4 illustrates a one-sided model 400 with NN-based node A 402 (e.g., a UE) and node B 404 (e.g., a gNB). node A 402 has a model M_A 406 for encoding, there being no model (indicated by 408) for decoding at node B 404. The node A 402 applies model 406 to input data 412 to get result 410 for passing to node B 404.

[0049] Figure 5 illustrates a one-sided model 500 with NN-based node A 502 (e.g., a UE) and node B 504 (e.g., a gNB). node B 504 has a model M_B 508 for decoding, there being no model (indicated by 506) for encoding at node A 502. The node B 504 applies model 508 to transmitted data 510 from node A 502 to get output 514.

[0050] To train a model for a specific use case, node A and node B may decide not to use a single Encoder-Decoder pair, and instead may construct different encode-decoder pairs which apply to different conditions of node A and/or node B since the samples of different states may have different statistics compared to other settings, and, therefore, it may be advantageous to construct two different encoder-decoder model for these two cases instead of trying to train a single model that can generalize well to different settings. For example, for CSI feedback use case, it may be advantageous to have separate encoder-decoder pairs for UMA environment and indoor environment, compared to the case of building a single encoder-decoder pair covering both environments. There it may be beneficial to design $M_e[i] - M_d[i]$, for $i = \{1,2,\dots,K\}$ where the i^{th} pair is trained based on a training data collected when node A and node B are in one or a set of conditions. Here, condition refers to when the parameters of node A and node B are in a certain state.

[0051] Having multiple models for different states of the node A and node B, during inference phase, the node A/node B may decide on which of these models should be activated based on the current node A/node B states.

[0052] Node A may be connected to different node Bs, and vice versa, i.e., one node B may be connected to different node As. For example, in case of CSI feedback, node A, could be a UE equipped with a Qualcomm chipset, and the node B could a gNB manufactured by Ericsson or Nokia.

[0053] In these scenarios where there are two-sided models and a separate training scheme (where the encoder and decoder parts are trained respectively on two nodes owned by the node A and node B sides), node A may develop a model in collaboration with each of the node Bs. In an example, Qualcomm and Ericsson collaborate to generate M_e^{Q1} (Q1 represents the first encoder model of Qualcomm chipset) and M_d^{E1} (E1 represents the first decoder model of the Ericsson gNB). In addition, Qualcomm and Ericsson may collaborate to generate M_e^{Q2} (Q2 represents the second encoder model of Qualcomm chipset) and M_d^{N1} (N1 represents the first decoder model of the Nokia gNB).

[0054] After training of the models, there may be multiple (encoder) models (at node A-side) associated with different node Bs and there may also be multiple (decoder) models (at node B-side) associated with different node As.

[0055] There may be a mechanism for node A/node B to select an appropriate model during an inference phase. During the inference phase, node A and node B may not want to reveal their identity to the other. In an example, during the inference time, the Qualcomm chipset may select between M_e^{Q1} and M_e^{Q2}, but the gNB side may not want to tell the Qualcomm chipset if is a gNB made by Ericsson or Nokia.

[0056] The following disclosure sets out examples of how node A and node B may determine an appropriate model that may be used during an inference phase in a transparent manner.

[0057] In an example, during the inference phase, node A (node B) may tell node B (node A) about its identity and then each side determines a correct model to use based on the identity of the other size. However, during the inference phase node A/node B does not want to tell/reveal its identity to the other side, so while this arrangement works, identity is revealed.

[0058] During training of a model, data may be gathered from different node As and node Bs and a single model may be generated that works with all pairs. For example, data may be collected from both Ericsson and Nokia gNBs and a model may be trained that works for both. Then, during the inference phase, the UE may not decide which model to use (as it only has one model) and therefore it may not need to know the identity of the other side. A drawback of this example may be that, based on the use-case and the model structure, the performance of one single model which is applicable to all different node A-node B pairs may be inferior to having separate models each of them for a group of node A-node B pairs, so performance may be improved by training different models and then finding a way for correct model selection during the inference phase. Another difficulty of this example may be that collaboration between different node As and node Bs (during the training phase) to train a single model, while possible, may be impractical. In the above example, it may not be practical to ask different chipset vendors and gNB vendors to collaborate together to determine a model that works for all pairing situations.

[0059] In an example, after training a model between each pair, an ID may be assigned to that model and then, during the inference phase, each node may tell the other node which of the models should be selected. In an example, there may be assigned identifiers, such as proxy identifiers denoted ID-A and ID-B, to $M_e^{Q1} - M_d^{E1}$ and $M_e^{Q1} - M_d^{N1}$, respectively. In this example, node A has two encoder models with proxy identifiers ID-A and ID-B. Ericsson has one decoder model with proxy identifier ID-A and Nokia has one decode model with proxy identifier ID-B.

[0060] In an example, during inference, the UE chipset vendor, e.g., Qualcomm chipset, may be attached to a gNB vendor, e.g., Nokia gNB but it does not know the identity of the gNB. So, the UE may query gNB as to what model the UE may use. Then, the gNB may respond (or the gNB may send this information proactively, before even the question from the node A side) that the gNB supports a decoder with Model represented by identifier ID-A (without revealing that the gNB is associated with Ericsson or Nokia). Receiving this message, the Qualcomm chipset may activate the associated encoder model for Model ID-A without actual knowledge of the gNB vendor.

[0061] This example avoids direct communication of node identities. However, when one node reveals its supported model ID, its identity may be also revealed, indirectly, to the other side.

[0062] In the above example, when the gNB side tells node A side that it supports Model ID-A, then the Qualcomm chipset may infer it the gNB is an Ericsson gNB as it has previously trained Model ID-A with Ericsson collaboration.

[0063] The following examples apply for both one-sided and two-sided models but, for conciseness, the two-sided model scenario is discussed.

[0064] In an example, a two-sided model with M_e (encoder) and M_d (decoder) parts residing at a node A and node B, respectively, is trained, in which there may be $\tilde{L}$ different types of node A and $\widetilde{K}$ different types of node Bs.

[0065] Node As may be different chipsets used in different UEs, e.g., Low-end Qualcomm chipset, high-end Qualcomm chipset, high-end MediaTek chipset, etc.

[0066] Node As may be different OEMs/UEs, e.g., Motorola g100 first gen, Motorola g100 second get, Motorola Razr40, Apple iPhone 13, etc.

[0067] Node Bs may be different gNB manufacturers/vendors, e.g., Ericsson first generation gNB, Nokia first generation gNB, Nokia second generation gNB, etc.

[0068] While specific company names are used herein for illustrative purposes, it should be understood that the UE and gNB devices could come from any UE and gNB manufacturers and that implementation of the disclosure is not dependent on or more particular manufacturer.

[0069] Depending on the use case, statistics of the data, and/or agreement between owner of different types, a few types may be grouped together for consideration as one type. For example, if for a use case there is no difference between a Low-end Qualcomm chipset and a high-end Qualcomm chipset the two may be considered as one type of UE chipset, instead of two types.

[0070] In an example, all possible such groupings may be conducted and there may be L different types of node As and K different types of node Bs.

[0071] In an example, there may be a few types of node As and a few types of node Bs who participate in the training of a two-sided model. In an example, to improve performance of the model a separate two-sided model for each pair may be trained.

[0072] Depending on the use-case and other conditions, in an example, a single model that works with all pair of node As and node Bs may be trained, or all node As and node Bs may be combined into one type ($L = 1,$ and $K = 1$), such that a single model (which is generalizable for all pairs) may be trained and there is no need for model selection.

[0073] During the inference phase, node As, and node Bs may not be willing to reveal their Types to the other side.

[0074] Node A (node B) may send an identifier (ID) to the other side with which the other side can determine the particular node B (node A) is connected to. This ID may not reveal information about the type of the other side. This ID may be referred to as a pairing identifier or pairing ID.

[0075] In an example, a current Cell-ID of a UE may show the gNB it is connected to, and it does not reveal who the manufacturer of that gNB is. In another example, an International Mobile Equipment Identity (IMEI) can be used to determine which UE a gNB is connected to, and it does not tell which chipset is used in that UE. In examples, either or both of these may therefore be useable as a pairing ID.

[0076] A model, like M_1, is trained if the nodes node A and node B participating in training are aware of each other's model types. Whenever one side selects that particular model M_1, the other side may indirectly understand the type of the first side.

[0077] Following examples set out examples in which the sides collaborating in training may not know the actual type of the other side.

[0078] In an example, for all or each group of node A types, a gateway node G_A may be designated. If there are multiple groups, then there are multiple gateway nodes G_{A1} to G_{Am}.

[0079] In examples, gateway node properties may include:

a. The node As who are associated with that gateway node may share their types with that Gateway.

b. Gateways of node As may be identified from node Bs and may be accessible at least from a node at the node-B side.

[0080] In an example, an over-the-top (OTT) server from Lenovo may be the designated gateway for all UEs manufactured by Lenovo. In this example, as these UEs are manufactured by Lenovo, Lenovo ma already knows their types, i.e., what chipset has been used in each UE, e.g., Qualcomm high-end chipset, or MediaTek chipset. Therefore, no extra information is revealed. From current defined 3GPP signalling, a network is already able to determine the manufacturer of a UE which is connected to it. Therefore, even though the network, e.g., gNB, is not able to determine the chipset used in a UE, it can determine that the gateway of the UE should be Lenovo. Note that since the gNB may not have direct access to Lenovo Gateway, it may rely on another node in NW side to communicate with Lenovo gateway.

[0081] In an example, for all or each group of the node B types, a gateway node G_B is designated. If there are multiple groups, then there are multiple gateway nodes G_{B1} to G_{Bm}.

[0082] In examples, gateway node properties may include:

a. The node Bs who are associated with that gateway may share their types with that Gateway.

b. Gateways of node Bs may be identified from node As.

[0083] In an example, an operations and management (OAM) server from an operator of the network, e.g., T-Mobile could be the designated gateway for all gNBs owned by T-Mobile. As these gNBs are owned by T-Mobile, T-Mobile may already know their types, i.e., their manufacturer, e.g., Ericsson first generation gNB, Nokia first generation gNB, Nokia second generation gNB. Therefore, no extra information is revealed. From current defined 3GPP signalling, each UE is able to determine the operator that it is connected to. Therefore, even though the UE is not able to determine the gNB manufacturer, it can determine that the gateway of that gNB should be T-Mobile. Note that since the UE may not have direct access to T-Mobile Gateway, it may rely on another node in NW side to communicate with the Lenovo gateway.

[0084] In an example, a node Type from one side, for example, node A-side, sends their request to their gateway node notifying the gateway node that they want to train a model. The gateway may associate a proxy-ID with that type. The term G_A^{ID} may be used to refer to this proxy-ID. If that type was previously assigned with an ID, it may use that ID, otherwise the gateway node may generate a new random number which has not been previously used at this gateway node for that type.

[0085] In an example, a model for Lenovo UEs of type 1, e.g., with high-end Qualcomm chipset may be trained. In this example, the Lenovo gateway assigns a number, e.g., $G_A^{ID} = 4$, to that particular node A type.

[0086] In an example, G_A and node As may collaboratively determine a proxy-ID to each of the node As and may pre-assign the proxy-ID to that node A. Following this scheme, node A does not need to receive its proxy-ID from the G_A during the data-collection phase. node A may only transmit a request to G_A notifying the gateway that they want to train the model.

[0087] In an example, G_A then may determine a pairing-ID and/or ask all node As of a particular Type to send it their pairing-IDs that the gateway may use to determine which node B they are connecting to.

[0088] In an example, Lenovo G_A may ask all UEs with high-end Qualcomm chipset to send the Cell-ID that they are associated with.

[0089] In an example, Lenovo G_A may use IMEI of the UEs with high-end Qualcomm chipset. Since the network side knows which IMEI is connected to which cell it can determine the connected gNB.

[0090] In an example, G_A may notify the G_B that the UEs with a certain G_A^{ID} want to collect data for training of their model and may send G_B their pairing-IDs.

[0091] In an example, Lenovo G_A notifies T-Mobile G_B that UEs with $G_A^{ID} = 4$ want to collect data for training of their models and may send their Cell-ID to the T-Mobile G_B.

[0092] In an example, Lenovo G_A notifies T-Mobile G_B that UEs with $G_A^{ID} = 4$ want to collect data for training of their models and may send their IMEI of that UEs to T-Mobile G_B.

[0093] In an example, using the received pairing-IDs, G_B may determine the node Bs who are connected to node As and may determine their Types. G_B, then, may associate a proxy-ID with each of the types. Term G_B^{ID} may be used to refer to this proxy-ID. If that type was previously assigned with an ID, it may use that ID, otherwise the gateway may generate a new random number which has not been previously used at this gateway for that type.

[0094] In an example, T-Mobile G_B may determine that the Cell-IDs that it has received are associated with two gNB types, one group is associated with Ericsson first generation gNB and the other group is associated with Nokia second generation gNB. It may assign two random numbers, such as $G_B^{ID} = 2$ and $G_B^{ID} = 4$ to Ericsson first generation gNB and Nokia second generation gNB, respectively.

[0095] In an example, G_B and node Bs may collaboratively determine a proxy-ID to each of the node Bs and may pre-assign the proxy-ID to that node B. Following this scheme, node B does not need to receive its proxy-ID from the G_B during the data-collection phase.

[0096] In an example, G_B may notify the G_A with the information on the G_B^{ID} of the node B that each node A with certain Pairing-ID is connected to.

[0097] In an example, T-Mobile G_B may notify Lenovo G_A that a certain set of UEs with such Cell-ID/IMEI are connected to $G_B^{ID} = 2$ and another group of them are connected to $G_B^{ID} = 4$.

[0098] At this stage, both sides may know that there are two groups of (node A, node B) pairs, for example $(G_A^{ID} = 4, G_B^{ID} = 2)$ and $(G_A^{ID} = 4, G_B^{ID} = 4)$.

[0099] In an example, data collection and model training may be carried out for each group.

[0100] In an example, node As with similar (G_A^{ID}, G_B^{ID}) may participate in data collection and may use the training dataset. The collected data may then be used for training the encoder model for (G_A^{ID}, G_B^{ID}). The dataset required for construction of the paired decoder model may be constructed.

[0101] In an example, the constructed dataset may be sent to node B-side with an indication that this dataset is for (G_A^{ID}, G_B^{ID}). The dataset may be sent to G_B (directly or via G_A) and G_B may direct it to appropriate server/node owned by the node B with that particular G_B^{ID}.

[0102] In an example, G_B may send an IP address of the server/node owned by the node B with that particular G_B^{ID}, so the data of (G_A^{ID}, G_B^{ID}) may be sent directly to that server/node.

[0103] In an example, the node B-side server/node may train the decoder model of the two-sided model associated with (G_A^{ID}, G_B^{ID}).

[0104] In an example, node As with similar G_A^{ID} may send their data to the node B-side indicating that this dataset is for G_A^{ID}. The dataset may be sent to G_B (directly or via G_A) and G_B may direct the portion of the datasets associated with a particular (G_A^{ID}, G_B^{ID}) to appropriate server/node owned by the node B with that particular G_B^{ID}.

[0105] In an example, G_B may send an IP address of the node owned by the node B with that particular G_B^{ID}, so the data of (G_A^{ID}, G_B^{ID}) may be sent directly to that server/node. Each node B type may then have the training dataset for different (G_A^{ID}, G_B^{ID}) if there are multiple G_A^{ID}s. The server/node owned by the node B with that particular G_B^{ID} may train the decoder model for (G_A^{ID}, G_B^{ID}) and may also construct the dataset required for construction of the paired encoder model.

[0106] In an example, the constructed dataset may be sent to node A-side with an indication that the dataset is for a particular (G_A^{ID}, G_B^{ID}). The dataset may be sent to G_A (directly or via G_B) and then G_A may direct it to appropriate server/node owned by the node A with that particular G_A^{ID}.

[0107] In an example, G_A may send an IP address of the server/node owned by the node A with that particular G_B^{ID}, so the data can be sent directly to that server/node.

[0108] In an example, the node A-side server/node may train the encoder model of the two-sided model associated with (G_A^{ID}, G_B^{ID}).

[0109] In an example, node A and node B may further partition the dataset into sub-datasets based on parameters of the node A, p_A, and/or parameters of node B, p_B, and may then train separate encoder/decoder models for each sub-dataset. The resulted models trained for each sub-dataset may be represented by $[(G_A^{ID}, G_B^{ID}), p_A, p_B]$.

[0110] In an example, collected data from all Lenovo UEs with high-end Qualcomm chipset connected to Ericsson first generation gNB may have $(G_A^{ID} = 4, G_B^{ID} = 2)$. Instead of trained one encoder/decoder model for the whole dataset, this data may be further partitioned based on some configuration/UE capability parameters such as #Txport/Bandwidth/carrier-frequency and different models may be trained for each group.

[0111] There may now, as a result of the above, be different pairs of encoder model and decoder model trained for different pairs of (G_A^{ID}, G_B^{ID}). The trained models may be transferred back to the node As/node Bs so they can select the appropriate model themselves. In an example, the trained models may be saved on a server/node on the node A-side/node B-side so they can be transferred to the node A/node B based on the need of the node A/node B at each state.

[0112] Node A and node B Gateways may be located in different physical/logical locations than the node A/node Bs.

[0113] In an example, the Gateways of the NW side, e.g., T-Mobile gateway, may be located at the Access and Mobility Management Function (AMF) of the core. This node may then communicate with the gNBs or with the UE-Vendor gateway. The Gateways of the UEs may also be located at an OTT server owned by the UE manufacturer.

[0114] The above examples ensure transparency between the node A and node B using, for example, Proxy-IDs assigned to node A and node B useable during the training, and data transfer being through a gateway node or with the involvement of the Gateway node such that the Type of node A/node B does not leak to the other side.

[0115] While, above, it is described that node A first initiates the data collection and model training phase, this process may in other examples instead be initiated from the node B side. In an example, a node B (node B Type) may send their request to their gateway notifying the gateway that they want to train the model. Then G_B may get pairing-information, find the node A, determine the gateway of node A, and communicate with the determined gateways to find out the proxy-ID of the node-As. G_A and G_B may further facilitate data collection and communication needed during the training.

[0116] In an example, different models each associated with a particular (G_A^{ID}, G_B^{ID}) may already have been trained. Also, the encoder/decoder part of the model may have been transferred back to node A/node B respectively, and the encoder/decoder part of the model may have been stored on a server/node owned by that particular node A/node B Type respectively.

[0117] In an example, models are stored at the node A/node B. The encoder part of $(G_A^{ID} = 4, G_B^{ID} = 2)$ and $(G_A^{ID} = 4, G_B^{ID} = 4)$ may, in an example, have been stored on all UEs with $G_A^{ID} = 4$, i.e., with high-end Qualcomm chipset.

[0118] In an example, the decoder part of $(G_A^{ID} = 4, G_B^{ID} = 2)$ may be stored at the Ericsson first generation gNB and the decoder part of $(G_A^{ID} = 4, G_B^{ID} = 4)$ may be stored at the Nokia second generation gNB.

[0119] In an example, node A may determine its associated G_A^{ID}. It may ask the node A Gateway G_A for, or G_A may proactively send, the associated a proxy-ID, G_A^{ID} (which may have been assigned during the training) to node A.

[0120] In an example, a Lenovo UE equipped with high-end Qualcomm chipset may ask a Lenovo Gateway about its proxy-ID and receive information that it $G_A^{ID} = 4$.

[0121] In an example, the Lenovo gateway may notify the Lenovo UE equipped with a high-end Qualcomm chipset that its proxy-ID is $G_A^{ID} = 4$.

[0122] In an example, each time that the node A is associated with a new node B and it wants to select one of its models, node A may ask G_A about the proxy-ID of the node B that the node A is currently associated with. In an example, if the G_A does not have the current pairing-ID of the node A, node A may send the pairing-ID to G_A .

[0123] In an example, the UE may send its current Cell-ID to the Lenovo gateway asking for the type of the connected gNB.

[0124] In cases that, for example, IMEI is the pairing-ID and assuming that Lenovo gateway knows the IMEI of each UE, the UE may ask the Lenovo gateway for the type of the connected gNB.

[0125] In an example, the UE may start this procedure after the initial connection to a gNB or after handover from one gNB to another gNB.

[0126] In an example, the UE may start this procedure after the gNB askes for the UE capabilities to check if it can support a certain AI/ML based functionality or not.

[0127] In an example, using the pairing-ID, G_A may then ask G_B about the type of the connected node B. It may send the G_A^{ID} of the current UE to the G_B .

[0128] In an example, G_A may ask G_B for the gNB proxy-ID of the gNB with that particular cell-ID and may say that G_A^{ID} of that node A is $G_A^{ID} = 4$.

[0129] In an example, G_A may ask G_B for the gNB proxy-ID of the gNB that a UE with particular IMEI is connected to and may say that G_A^{ID} of that node A is $G_A^{ID} = 4$.

[0130] In an example, G_B may use the pairing-ID to determine the actual node B and then may use its internal mapping to determine G_B^{ID} of the connected node B and may send it back to G_A . It may also send the G_A^{ID} of that node A to the gNB.

[0131] In an example, G_B may find out that the connected gNB of that UE is a Nokia second generation gNB and so feedback $G_B^{ID} = 4$ to G_B .

[0132] In an example, knowing G_A^{ID} and also its own G_B^{ID}, the node B may determine the decoder model that should be used. In an example, node B may not find a correct match among the existing models, and may declare that the model is not available, or functionality is not supported by transmitting a message back to node A.

[0133] In an example, the gNB may know $G_B^{ID} = 4$ and also]that $G_A^{ID} = 4$; therefore, it may select the decoder model of $(G_A^{ID} = 4, G_B^{ID} = 4)$.

[0134] In an example, G_A may send back the received G_B^{ID} to the node A.

[0135] In an example, G_A may send back $G_B^{ID} = 4$ to the UE.

[0136] In an example, knowing G_B^{ID} and its own G_A^{ID}, the node A may determine the encoder model that should be used. In an example, node A may not find a correct match among the existing models, and may declare that the model is not available, or functionality is not supported.

[0137] In an example, the UE may know $G_A^{ID} = 4$ and may also know that $G_B^{ID} = 4$; therefore, it may select the encoder model of $(G_A^{ID} = 4, G_B^{ID} = 4)$.

[0138] In an example, models may be stored at a server/node at the node A-side/node B-side. S_A and S_B refer to this server/node at the node A-side/node B-side, respectively.

[0139] In an example, the encoder part of $(G_A^{ID} = 4, G_B^{ID} = 2)$ and $(G_A^{ID} = 4, G_B^{ID} = 4)$ may have been stored on S_A and S_B, respectively.

[0140] In examples, S_A may first determine the G_A^{ID} associated with node A. Node A may know its G_A^{ID} and may send it to S_A, node A may ask for its G_A^{ID} from G_A and then may send it to S_A.

[0141] In an example, each time that the node A is associated with a new node B and it wants to select one of its models, node A/S_A may ask G_A about the proxy-ID of the node B that the node A is currently associated with. If G_A does not have the current pairing-ID of the node A, node A may send the pairing-ID to G_A .

[0142] In an example, using the pairing-ID, G_A then may ask G_B about the type of the connected node B. It may also send the G_A^{ID} of the current UE to the G_B .

[0143] In an example, G_B may use the pairing-ID to determine the actual node B and then using its internal mapping, may determine G_B^{ID} of the connected node B and send it back to G_A . It may send the G_A^{ID} of that node A to the gNB/S_B.

[0144] In examples, S_B may determine the G_B^{ID} associated with node B. Node B may know its G_B^{ID} and send it to S_B, Node B may ask for its G_B^{ID} from G_b and may send it to S_B,

[0145] In an example, knowing G_A^{ID} and G_B^{ID}, S_B may determine the decoder model that should be used and may send it to the node B. In an example, S_B may not find a correct match among the existing models, and may declare that the model is not available, or functionality is not supported.

[0146] In an example, G_A may send back the received G_B^{ID} to S_A.

[0147] In an example, knowing G_B^{ID} and G_A^{ID}, S_A may determine the encoder model that should be used and may send it to the node A. In an example, node A may not find a correct match among the existing models, and may declare that the model is not available, or functionality is not supported.

[0148] In an example, models are stored at the node A/node B. node A and node B may have been notified about their proxy-IDs, i.e., G_A^{ID} and G_B^{ID}, respectively.

[0149] In an example, the encoder part of $(G_A^{ID} = 4, G_B^{ID} = 2)$ and $(G_A^{ID} = 4, G_B^{ID} = 4)$ may have been stored on all UEs with $G_A^{ID} = 4$, i.e., with high-end Qualcomm chipset and these UEs may know that their proxy-ID is $G_A^{ID} = 4$.

[0150] In an example, the decoder part of $(G_A^{ID} = 4, G_B^{ID} = 2)$ may be stored on all gNBs with Ericsson first generation chipsets and these gNBs may know that they have $G_B^{ID} = 2$. Also, the decoder part of $(G_A^{ID} = 4, G_B^{ID} = 4)$ may stored at the Nokia second generation gNB and it may know that it has $G_B^{ID} = 4$.

[0151] In an example, node A may send its proxy-ID G_A^{ID} to the node B that it is associated with. This procedure may be initiated with different conditions, e.g., each time that the node A is associated with a new node B and it wants to select one of its models.

[0152] In an example, node A with a high-end Qualcomm chipset may send $G_A^{ID} = 4$ to the gNB.

[0153] In an example, G_A and node As may collaboratively determine a proxy-ID for each of the node As and pre-assign the proxy-ID to those node As. In this example, node A may not need to ask for the proxy-ID from the G_A as it has been already assigned to it.

[0154] In an example, node B, based on the received G_A^{ID}, may determine the decoder model based on its own G_B^{ID}. If there is no matching model, it may declare that the model is not available, or functionality is not supported by transmitting a message back to node A.

[0155] In an example, node B may be a Nokia second generation gNB with $G_B^{ID} = 4$, and may select the decoder part of the model associated with $(G_A^{ID} = 4, G_B^{ID} = 4)$.

[0156] In an example, the UE may start this procedure after the initial connection to a gNB or after handover from one gNB to another gNB.

[0157] In an example, the UE may start this procedure after the gNB askes for the UE capabilities to check if it can support a certain AI/ML based functionality or not.

[0158] In an example, G_B and node As may collaboratively determine a proxy-ID for each of the node Bs and pre-assign the proxy-ID to those node Bs. In this example, node B may not need to ask for the proxy-ID from the G_B as it has been already assigned to it.

[0159] In an example, node B may send back its proxy-ID G_B^{ID} to the node A.

[0160] In an example, node B may be a Nokia second generation gNB and may send $G_B^{ID} = 4$ to the UE.

[0161] In an example, node A, based on the received G_B^{ID}, may determine the encoder model based on its own G_A^{ID}. If there is no matching model, it may declare that the model is not available, or functionality is not supported.

[0162] In an example, node A may select the encoder model associated with $(G_A^{ID} = 4, G_B^{ID} = 4)$ since its $G_A^{ID} = 4$ and the received node-B proxy-ID is $G_B^{ID} = 4$.

[0163] Figure 6 illustrates an example of a UE 600 in accordance with aspects of the present disclosure. The UE 600 may include a processor 602, a memory 604, a controller 606, and a transceiver 608. The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0164] The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0165] The processor 602 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 602 may be configured to operate the memory 604. In some other implementations, the memory 604 may be integrated into the processor 602. The processor 602 may be configured to execute computer-readable instructions stored in the memory 604 to cause the UE 600 to perform various functions of the present disclosure.

[0166] The memory 604 may include volatile or non-volatile memory. The memory 604 may store computer-readable, computer-executable code including instructions when executed by the processor 602 cause the UE 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 604 or another type of memory. 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 may be accessed by a general-purpose or special-purpose computer.

[0167] In some implementations, the processor 602 and the memory 604 coupled with the processor 602 may be configured to cause the UE 600 to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604). For example, the processor 602 may support wireless communication at the UE 600 in accordance with examples as disclosed herein.

[0168] The UE 600 may be configured to support a means for receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0169] The UE may be configured to support a means for transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receiving, from the second node, a second proxy identifier identifying the second type of the second node; and selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0170] The controller 606 may manage input and output signals for the UE 600. The controller 606 may also manage peripherals not integrated into the UE 600. In some implementations, the controller 606 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 606 may be implemented as part of the processor 602.

[0171] In some implementations, the UE 600 may include at least one transceiver 608. In some other implementations, the UE 600 may have more than one transceiver 608. The transceiver 608 may represent a wireless transceiver. The transceiver 608 may include one or more receiver chains 610, one or more transmitter chains 612, or a combination thereof.

[0172] A receiver chain 610 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 610 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 610 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 610 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 610 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0173] A transmitter chain 612 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 612 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 612 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 612 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0174] Figure 7 illustrates an example of a processor 700 in accordance with aspects of the present disclosure. The processor 700 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 700 may include a controller 702 configured to perform various operations in accordance with examples as described herein. The processor 700 may optionally include at least one memory 704, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 700 may optionally include one or more arithmetic-logic units (ALUs) 706. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0175] The processor 700 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 700) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0176] The controller 702 may be configured to manage and coordinate various operations (e.g., signalling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. For example, the controller 702 may operate as a control unit of the processor 700, generating control signals that manage the operation of various components of the processor 700. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0177] The controller 702 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 704 and determine subsequent instruction(s) to be executed to cause the processor 700 to support various operations in accordance with examples as described herein. The controller 702 may be configured to track memory address of instructions associated with the memory 704. The controller 702 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 702 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 702 may be configured to manage flow of data within the processor 700. The controller 702 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 700.

[0178] The memory 704 may include one or more caches (e.g., memory local to or included in the processor 700 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 704 may reside within or on a processor chipset (e.g., local to the processor 700). In some other implementations, the memory 704 may reside external to the processor chipset (e.g., remote to the processor 700).

[0179] The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 700, cause the processor 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 702 and/or the processor 700 may be configured to execute computer-readable instructions stored in the memory 704 to cause the processor 700 to perform various functions. For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the processor 700 may include multiple processors and the memory 704 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0180] The one or more ALUs 706 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 706 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 706 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 706 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 706 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 706 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 706 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 706 to handle conditional operations, comparisons, and bitwise operations.

[0181] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 700 may be configured to or operable to support a means for receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0182] The processor 700 may be configured to support a means for transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receiving, from the second node, a second proxy identifier identifying the second type of the second node; and selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0183] Figure 8 illustrates an example of a NE 800 in accordance with aspects of the present disclosure. The NE 800 may include a processor 802, a memory 804, a controller 806, and a transceiver 808. The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0184] The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0185] The processor 802 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 802 may be configured to operate the memory 804. In some other implementations, the memory 804 may be integrated into the processor 802. The processor 802 may be configured to execute computer-readable instructions stored in the memory 804 to cause the NE 800 to perform various functions of the present disclosure.

[0186] The memory 804 may include volatile or non-volatile memory. The memory 804 may store computer-readable, computer-executable code including instructions when executed by the processor 802 cause the NE 800 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 804 or another type of memory. 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 may be accessed by a general-purpose or special-purpose computer.

[0187] In some implementations, the processor 802 and the memory 804 coupled with the processor 802 may be configured to cause the NE 800 to perform one or more of the functions described herein (e.g., executing, by the processor 802, instructions stored in the memory 804). For example, the processor 802 may support wireless communication at the NE 800 in accordance with examples as disclosed herein. The NE 800 may be configured to support a means for receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0188] The processor 802 may be configured to support a means for transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receiving, from the second node, a second proxy identifier identifying the second type of the second node; and selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0189] The controller 806 may manage input and output signals for the NE 800. The controller 806 may also manage peripherals not integrated into the NE 800. In some implementations, the controller 806 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 806 may be implemented as part of the processor 802.

[0190] In some implementations, the NE 800 may include at least one transceiver 808. In some other implementations, the NE 800 may have more than one transceiver 808. The transceiver 808 may represent a wireless transceiver. The transceiver 808 may include one or more receiver chains 810, one or more transmitter chains 812, or a combination thereof.

[0191] A receiver chain 810 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 810 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 810 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 810 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 810 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0192] A transmitter chain 812 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 812 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 812 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 812 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0193] Figure 9 illustrates a flowchart of a method 900 in accordance with aspects of the present disclosure. The operations of the method may be implemented by a UE or an NE as described herein. In some implementations, the UE or NE may execute a set of instructions to control the function elements of the UE or NE to perform the described functions.

[0194] At 902, the method 900 may include receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node. The operations of 902 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 902 may be performed by a UE or NE as described with reference to Figure 6 or Figure 8.

[0195] At 904, the method 900 may include training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node. The operations of 904 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 904 may be performed by a UE or NE as described with reference to Figure 6 or Figure 8.

[0196] At 906, the method 900 may include recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier. The operations of 906 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 906 may be performed by a UE or NE as described with reference to Figure 6 or Figure 8.

[0197] It should be noted that the method 900 described herein describes a possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0198] Figure 10 illustrates a flowchart of a method 1000 in accordance with aspects of the present disclosure. The operations of the method 1000 may be implemented by a UE or an NE as described herein. In some implementations, the NE may execute a set of instructions to control the function elements of the UE or NE to perform the described functions.

[0199] At 1002, the method 1000 may include transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node. The operations of 1002 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1002 may be performed by a UE or an NE as described with reference to Figure 6 or Figure 8.

[0200] At 1004, the method 1000 may include receiving, from the second node, a second proxy identifier identifying the second type of the second node. The operations of 1004 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1004 may be performed by a UE or an NE as described with reference to Figure 6 or Figure 8.

[0201] At 1006, the method 1000 may include selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

The operations of 1006 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1006 may be performed by a UE or an NE as described with reference to Figure 6 or Figure 8.

[0202] There is provided herein an apparatus for wireless communication, comprising: at least one memory; and at least one processor coupled with at least one memory and configured to cause the apparatus to: receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; train a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0203] The apparatus may comprise the first node. The first node may comprise a user equipment. A second apparatus may comprise the second node. The second node may comprise a base station. The model may be an encoder model or a decoder model. If the first node comprises the user equipment, the model may be the encoder model. If the second node comprises the base station, the model may be the decoder model.

[0204] The processor may be configured to cause the apparatus to receive the first proxy identifier that identifies the first type of the first node from the first gateway node.

[0205] A type, such as the first type and/or the second type, may be associated with at least one of a use case, data statistics, manufacturer, owner agreements, chipset, chipset grade, and/or any other identifying parameter capable of logically identifying, describing, labelling, and/or grouping nodes.

[0206] The first proxy identifier may be randomly generated. The first proxy identifier may be generated by the first gateway node. The first node may collaborate with the first gateway node to determine the first proxy identifier.

[0207] An encoder model may encode messages sent by the apparatus or first node to the second node. The decoder model may decode such messages.

[0208] The set of one or more characteristics may include one or more of a number of antennae of the first node, a number of antennae of the second node, a frequency band, a time, a channel, a transmit signal, a receive signal, a noise vector, a precoding vector, and/or at least one characteristic of an environment.

[0209] A plurality of the characteristics may be arranged in a matrix. A receive signal may be represented according to the following equation:

$$\mathbf{y}_l^k(t) = \mathbf{H}_l^k(t)\mathbf{w}_l^k(t)x_l^k(t) + \mathbf{n}_l^k(t)$$

where $\mathbf{y}_l^k(t)$ is the receive signal, $\mathbf{H}_l^k(t)$ denotes the channel at time t over frequency band $l, l \in \{1,2,\ldots,L\}$, $\mathbf{w}_l^k(t) \in \mathbb{C}^{M\times 1}$ is the precoding vector, $x_l^k(t)$ is the transmit message, $\mathbf{n}_l^k(t)$ represents the noise vector, which may be at the receiver, M is the number of antennae of a second node, N is the number of antennas of the first node, L is the number of frequency bands, and k is the number of possible intended recipients.

[0210] The processor may be configured to cause the apparatus to store an association or a mapping between the model and a set of proxy identifiers comprising the first proxy identifier and the second proxy identifier.

[0211] The associated/mapping may be such that, if both the first proxy identifier and second proxy identifier are subsequently known, the encoder or decoder model may be identified via the stored association or mapping.

[0212] The processor may be configured to cause the apparatus to transmit, to the first gateway node, a message that indicates an intent to train the model.

[0213] The processor may be configured to cause the apparatus to transmit a pairing identifier to the first gateway node, the pairing identifier identifying the second node.

[0214] The pairing identifier may include a Cell-ID and/or an IMEI.

[0215] The first gateway node may notify a second gateway node that the apparatus/first node wants to train an encoder or decoder model. The first gateway node may send the pairing identifier to the second gateway node. The second gateway node may determine, from the pairing identifier, which second node is an intended connection target of the first node. The second gateway node may determine the second type of the second node. The second gateway node may determine the second proxy identifier of the second node. The second proxy identifier may be randomly generated. The second proxy identifier may be generated by the second gateway node. The second node may collaborate with the second gateway node to determine the second proxy identifier. The second gateway node may notify the first gateway node of the second proxy identifier.

[0216] The processor may be configured to cause the apparatus to collect training data for training the model.

[0217] The apparatus may collect the training data and/or train the encoder model collaboratively with further nodes of the first type.

[0218] The processor may be configured to cause the apparatus to transmit, to the second node, a collected dataset of training data, via at least one of the first gateway node or a second gateway node.

[0219] The second node may subsequently train the decoder or encoder model with the sent dataset. A gateway node may provide an IP address of a second node for direct sending of the dataset.

[0220] The processor may be configured to cause the apparatus to partition the training data into multiple sub-datasets based on a first set of one or more parameters of the first node or on second set of one or more parameters of the second node. The processor may be configured to cause the apparatus to train the model for each sub-dataset of the multiple sub-datasets.

[0221] The apparatus may store one or more models on the first node and/or on a server associated with the first node.

[0222] There is provided an apparatus for wireless communication, comprising: at least one memory; and at least one processor coupled with at least one memory and configured to cause the apparatus to: transmit, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receive, from the second node, a second proxy identifier identifying the second type of the second node; and select, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0223] The processor may be configured to cause the apparatus to one or more of transmit the first proxy identifier or receive of the second proxy identifier via one or more of a first gateway node or a second gateway node.

[0224] The processor may be configured to cause the apparatus to, prior to transmitting the first proxy identifier, receive a checking message from the second node checking that the first node supports an artificial intelligence and/or machine learning capability.

[0225] The selecting an encoder or decoder model may include determining that the model is unavailable and/or that the functionality is not supported.

[0226] The first proxy identifier may be randomly generated. The first proxy identifier may be generated by the first gateway node. The first node may collaborate with the first gateway node to determine the first proxy identifier. The second proxy identifier may be randomly generated. The second proxy identifier may be generated by the second gateway node. The second node may collaborate with the second gateway node to determine the second proxy identifier.

[0227] The processor may be configured to cause the apparatus to transmit a request for the second proxy identifier to the first gateway node.

[0228] The first gateway node may send the first proxy identifier and a pairing identifier to the second gateway node. The pairing identifier may identify the second node with which the first node intends to connect. The pairing identifier may include a Cell-ID and/or an IMEI.

[0229] The second gateway node may determine, from the first proxy identifier and the pairing identifier, the second node and the second proxy identifier. The second gateway node may send the second proxy identifier to the first gateway node. The second gateway node may send the first proxy identifier to the second node. The second node may select, based the first proxy identifier and the second proxy identifier, a decoder or encoder model. The first gateway may send the second proxy identifier to the first node.

[0230] The first node may be a user equipment and the model the first node selects may be an encoder model. The first node may be a base station and the model the first node selects may be a decoder model.

[0231] The processor may be configured to cause the apparatus to encode or decode a message using the selected model. The processor may be configured to cause the apparatus to encode a message using the selected model and to transmit the encoded message.

[0232] The processor may be configured to cause the apparatus to transmit, to a first server, one or more of the first proxy identifier or the pairing identifier. The first server may send the first proxy identifier to the first gateway node. The second gateway node may send the first proxy identifier to a second server. The second server may determine, from the first proxy identifier, the second proxy identifier. The second server may select, based on the first and second proxy identifiers, the decoder or encoder model. The second server may send the selected decoder or encoder model to the second node. The first gateway node may send the second proxy identifier to the first server. The first server may select, based on the first and second proxy identifiers, the encoder or decoder model. The first server may send the selected encoder or decoder model to the first node.

[0233] Alternative to the processor being configured to cause the apparatus to receive the second proxy identifier and select the model, the processor may be configured to cause the apparatus to receive the selected model from the first server.

[0234] The first node may comprise a user equipment or a base station, and the second node may comprise respectively a base station or a user equipment.

[0235] There is provided a method for wireless communication, comprising: receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node; training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0236] There is provided a method for wireless communication, comprising: transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node; receiving, from the second node, a second proxy identifier identifying the second type of the second node; and selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

[0237] Considering a use case that the statistics of training data samples depends on type of the two nodes (e.g., node A and node B) which are involved during data collection. Thus, it is desirable to train and use different models for different pairs of (Type of node A, Type of node B). In this disclosure, procedures for data collection/model training such that the data of different pairs of (Type of node A, Type of node B) can be separated without each node (side) knowing the exact type of the other side are presented. The procedures are based on introduced gateway nodes for a group of node As and node Bs. Proxy-IDs are disclosed and example schemes explained on how a proxy-ID can be assigned to a node A and/or a node B, procedures disclosed for data collection with an indirect link between the node A and node Bs, and examples disclosed of selection of the appropriate model based on the Type of the node A and node B while keeping the exact type transparent from the other side.

[0238] There is provided a method in a first device (e.g., UE) comprising: determining a first proxy-ID associated with a first device and a set of parameters where the set of parameters comprise a plurality of current parameters/states of the first device and/or a second device, where the second device is a device that the transmit/receive data/signal to/from the first device.

[0239] The method may comprise determining a set of input samples comprising samples that at least represent the input of a model.

[0240] The method may comprise performing model selection process. The selection process may include: determining a second proxy-ID associated with the second device or a third device where the third device is a device that may transmit/receive data/signal to/from the first device at a later time; and/or determining an active encoder model from a set of encoder models based on the first proxy-ID, the second proxy-ID, and the set of parameters.

[0241] The method may comprise transmitting encoded data to the second device based on at least the set of input samples and the active encoder model. The first device may receive the information regarding the first proxy-ID from the fourth device. The first device may send a request to a fourth device to receive the first proxy-ID. The first device may receive the first proxy-ID from the fourth device or another device. The first proxy-ID may be pre-configured at the first device. The first device may send a pairing information to a fourth device where the pairing information indicates at least one of the second device or the third device. The first device may receive the second proxy-ID from the fourth device. The first device may send a request to the second device to receive the second proxy-ID and may then receive the second proxy-ID from the second device. The first device receives may receive the proxy-ID from the second device.

[0242] The first device may repeat the selection process in response to at least one of: a periodic event; receiving a triggering message from the second device or another device; observing a shift in the statistics of the set of input samples; observing a shift in the statistics of a second set of information where the second set of information reflects some internal or external parameters of the environment or the first device; and/or when the associated second device changes.

[0243] In response to the selection process, the first device may transmit a triggering message to a second indicating that the active encoder model may have been modified.

[0244] The set of input samples may be based on at least a channel data representation. The channel data representation may be determined based on reception of at least one reference signal from the second device (e.g., a gNB). The channel data representation may be based on at least one of different transmitter receiver (Tx-Rx) pairs over different frequency bands or different time slots or their transformation in other domains.

[0245] The first device may be a UE.

[0246] There is provided a method in a first device (e.g., gNB) comprising: determining a first proxy-ID associated with a first device and a set of parameters where the set of parameters comprises a plurality of current parameters/states of the first device and/or a second device, where the second device is a device that transmits/receives data/signals to/from the first device.

[0247] The method may comprise performing model selection process where the selection process includes: determining a second proxy-ID associated with the second device or a third device where the third device is a device that may transmit/receive data/signal to/from the first device at a later time; and/or determining an active decoder model from a set of encoder models based on the first proxy-ID, the second proxy-ID, and the set of parameters.

[0248] The method may comprise receiving a set of input samples from the second device where the set of input sample comprises samples that at least represent the input of a model. The method may comprise determining the output data based on at least the set of input samples and the active decoder model.

[0249] The first device may be a gNB.

[0250] It should be noted that the method described herein describes a possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0251] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill 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

1. An apparatus for wireless communication, comprising:

at least one memory; and

at least one processor coupled with at least one memory and configured to cause the apparatus to:

receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node;

train a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and

record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

2. The apparatus of claim 1, wherein the processor is configured to cause the apparatus to receive the first proxy identifier that identifies the first type of the first node from the first gateway node.

3. The apparatus of claim 1, wherein the set of one or more characteristics includes one or more of a number of antennae of the first node, a number of antennae of the second node, a frequency band, a time, a channel, a transmit signal, a receive signal, a noise vector, a precoding vector, or at least one characteristic of an environment.

4. The apparatus of claim 1, wherein the recording the model includes the processor being configured to cause the apparatus to store an association or a mapping between the model and a set of proxy identifiers comprising the first proxy identifier and the second proxy identifier.

5. The apparatus of claim 1, wherein the processor is configured to cause the apparatus to transmit, to the first gateway node, a message that indicates an intent to train the model.

6. The apparatus of claim 1, wherein the processor is configured to cause the apparatus to transmit a pairing identifier to the first gateway node, the pairing identifier identifying the second node.

7. The apparatus of claim 1, wherein the processor is configured to cause the apparatus to collect training data for training the model.

8. The apparatus of claim 1, wherein the processor is configured to cause the apparatus to transmit, to the second node, a collected dataset of training data, via at least one of the first gateway node or a second gateway node.

9. The apparatus of claim 7 or claim 8, wherein the processor is configured to cause the apparatus to partition the training data into multiple sub-datasets based on a first set of one or more parameters of the first node or on second set of one or more parameters of the second node, optionally wherein the processor is configured to cause the apparatus to train the model for each sub-dataset of the multiple sub-datasets.

10. An apparatus for wireless communication, comprising:

at least one memory; and

at least one processor coupled with at least one memory and configured to cause the apparatus to:

transmit, to a second node of a second type, a first proxy identifier identifying a first type of a first node;

receive, from the second node, a second proxy identifier identifying the second type of the second node; and

select, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

11. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to one or more of transmit the first proxy identifier or receive of the second proxy identifier via one or more of a first gateway node or a second gateway node.

12. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to, prior to transmitting the first proxy identifier, receive a checking message from the second node checking that the first node supports an artificial intelligence and/or machine learning capability.

13. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to transmit a request for the second proxy identifier to the first gateway node.

14. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to encode or decode a message using the selected model.

15. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to encode a message using the selected model and transmit the encoded message.

16. The apparatus of claim 10, wherein the processor is configured to cause the apparatus to transmit, to a first server, one or more of the first proxy identifier or the pairing identifier.

17. The apparatus of claim 10, wherein, alternative to the processor being configured to cause the apparatus to receive the second proxy identifier and select the model, the processor is configured to cause the apparatus to receive the selected model from the first server.

18. The apparatus of claim 1 or claim 11, wherein the first node comprises a user equipment or a base station, and the second node comprises respectively a base station or a user equipment.

19. A method for wireless communication, comprising:

receiving, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node;

training a model for encoding or decoding of wireless communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node; and

recording the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier.

20. A method for wireless communication, comprising:

transmitting, to a second node of a second type, a first proxy identifier identifying a first type of a first node;

receiving, from the second node, a second proxy identifier identifying the second type of the second node; and

selecting, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier.

Fig. 1

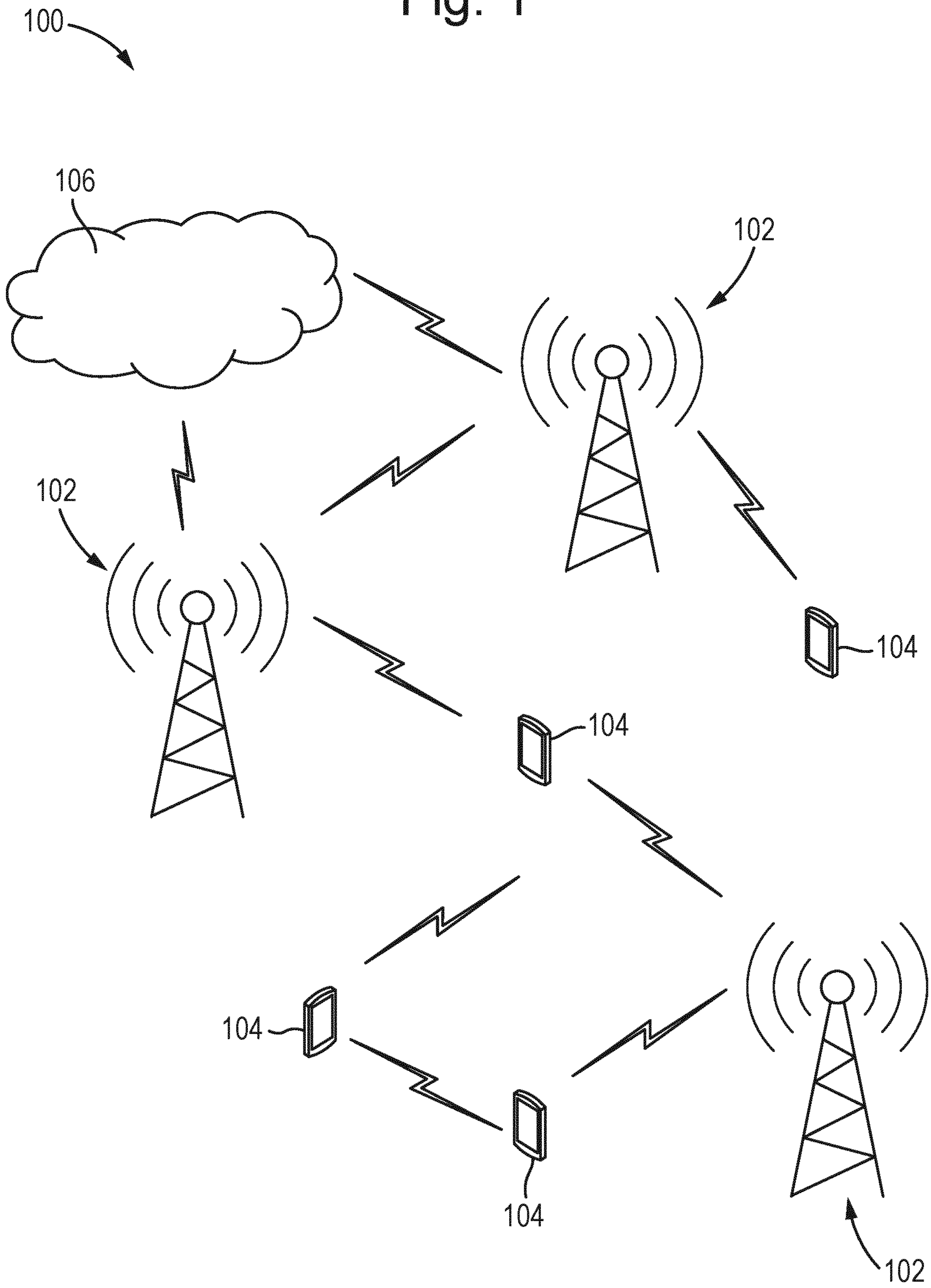


Fig. 2

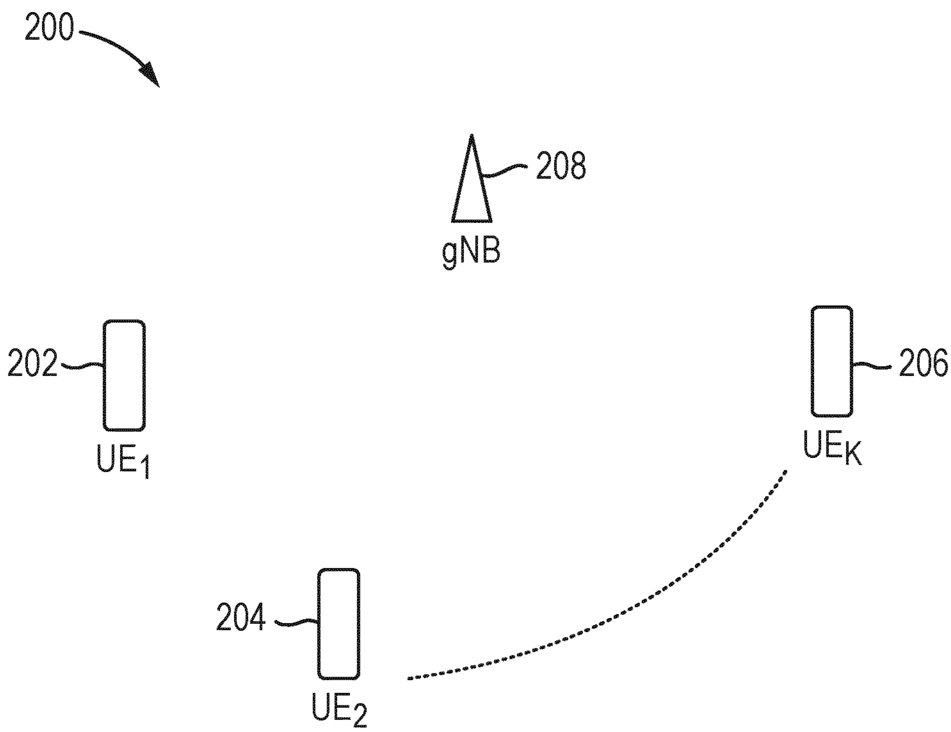

200
208
gNB
202
UE_1
206
UE_K
204
UE_2

Fig. 3

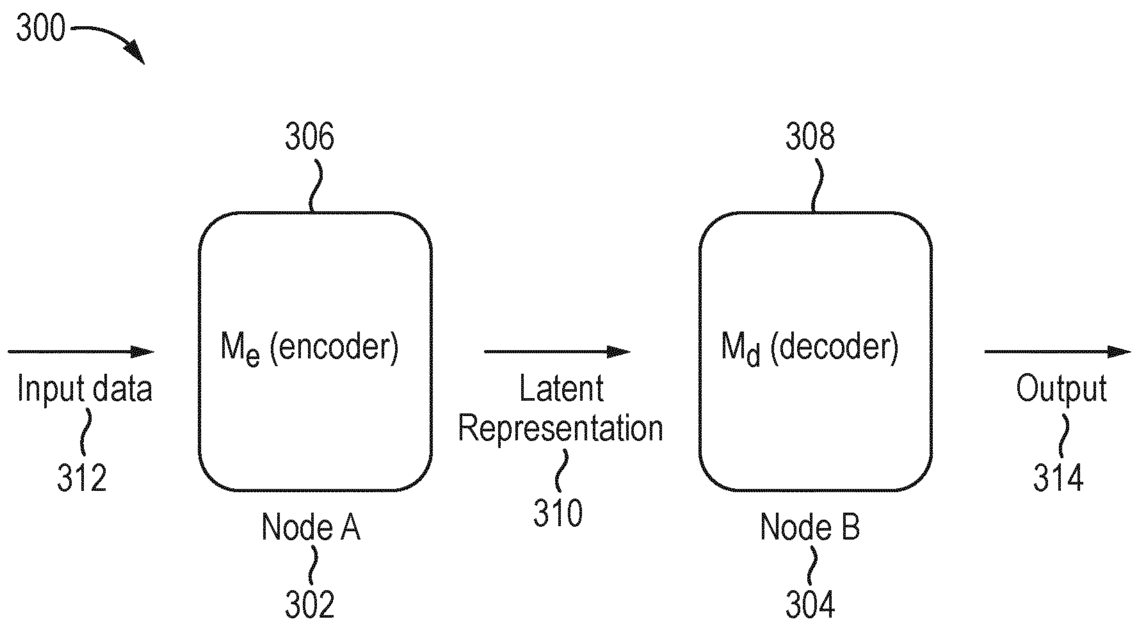

300
306
308
M_e (encoder)
M_d (decoder)
Input data
312
Latent
Representation
310
Output
314
Node A
302
Node B
304

Fig. 4

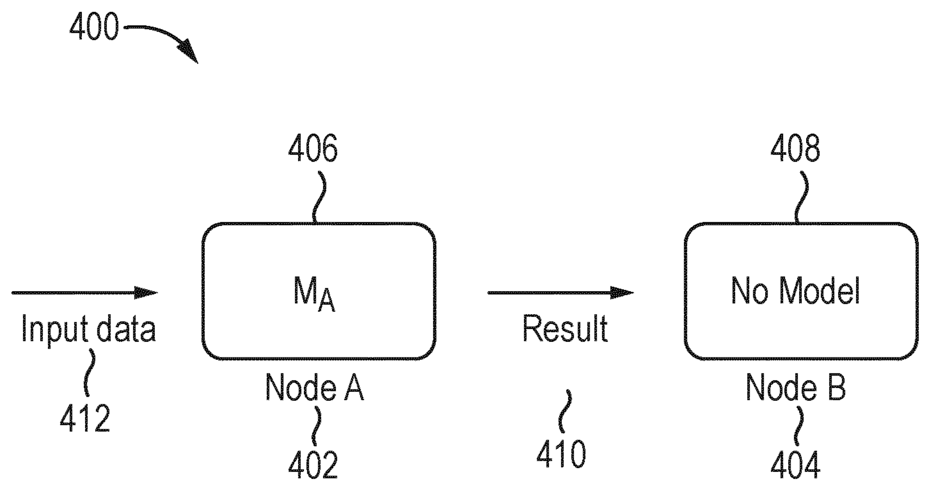

400
406
408
M_A
No Model
Input data
Result
Node A
Node B
412
402
410
404

Fig. 5

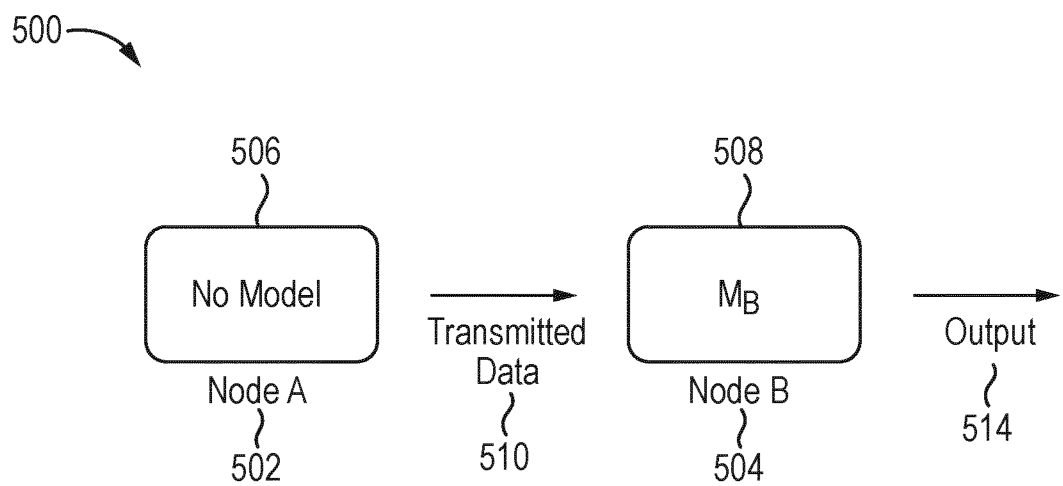

500
506
508
No Model
M_B
Transmitted Data
Output
Node A
Node B
502
510
504
514

Fig. 6

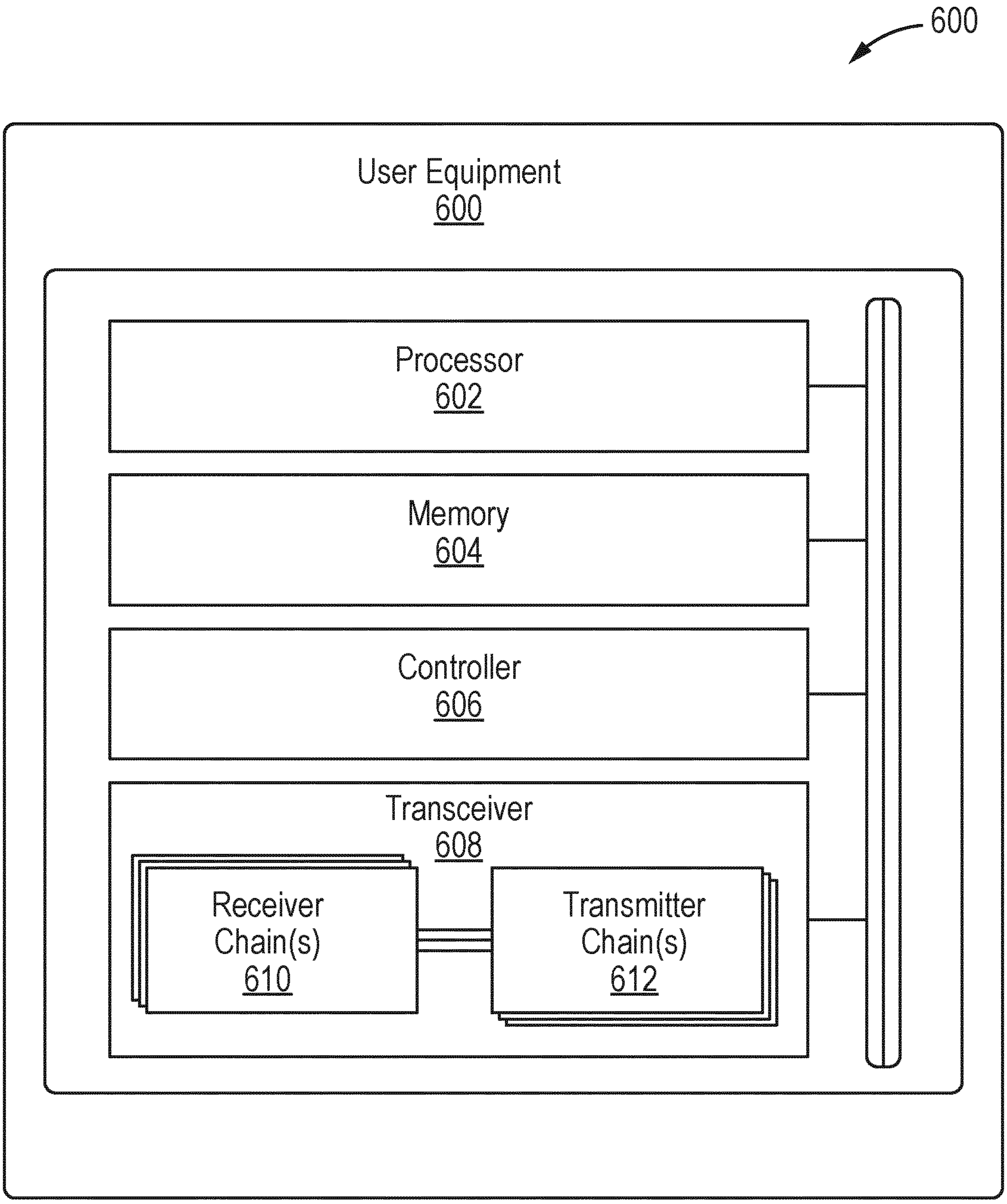

600
User Equipment
600
Processor
602
Memory
604
Controller
606
Transceiver
608
Receiver
Chain(s)
610
Transmitter
Chain(s)
612

Fig. 7

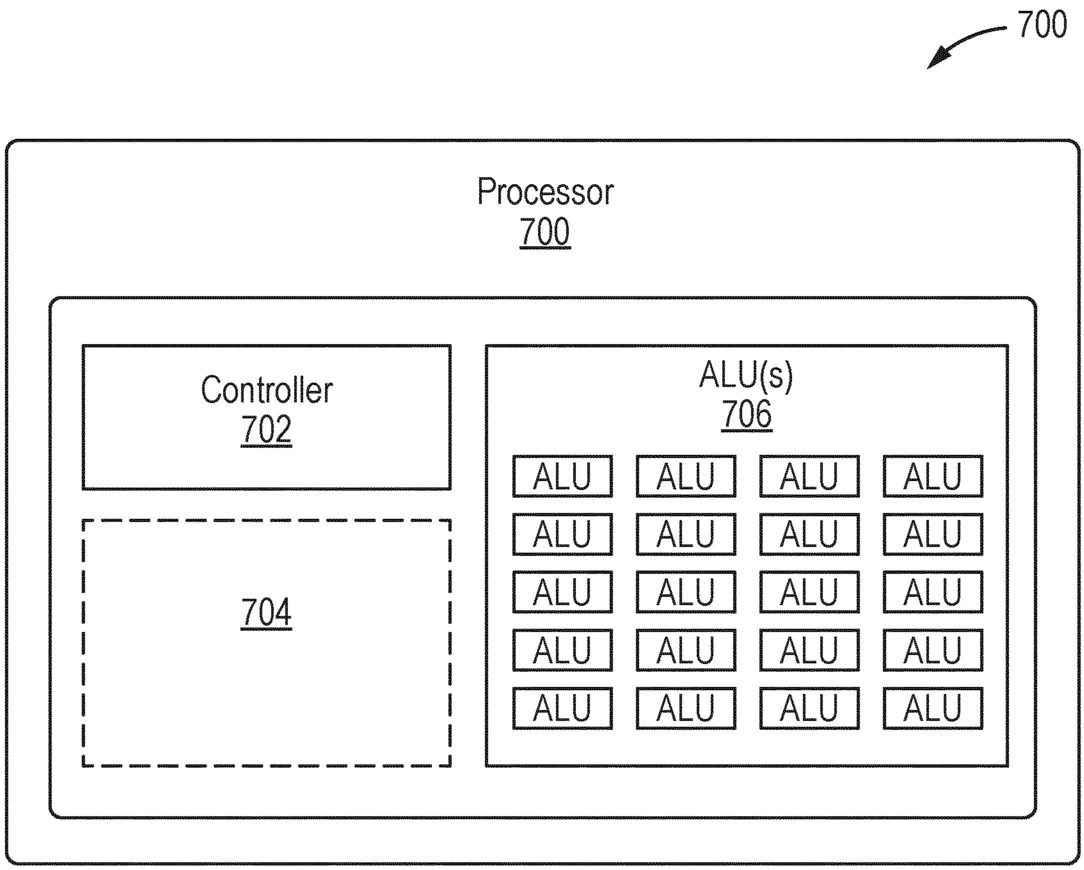

700
Processor
700
Controller
702
704
ALU(s)
706
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU

Fig. 8

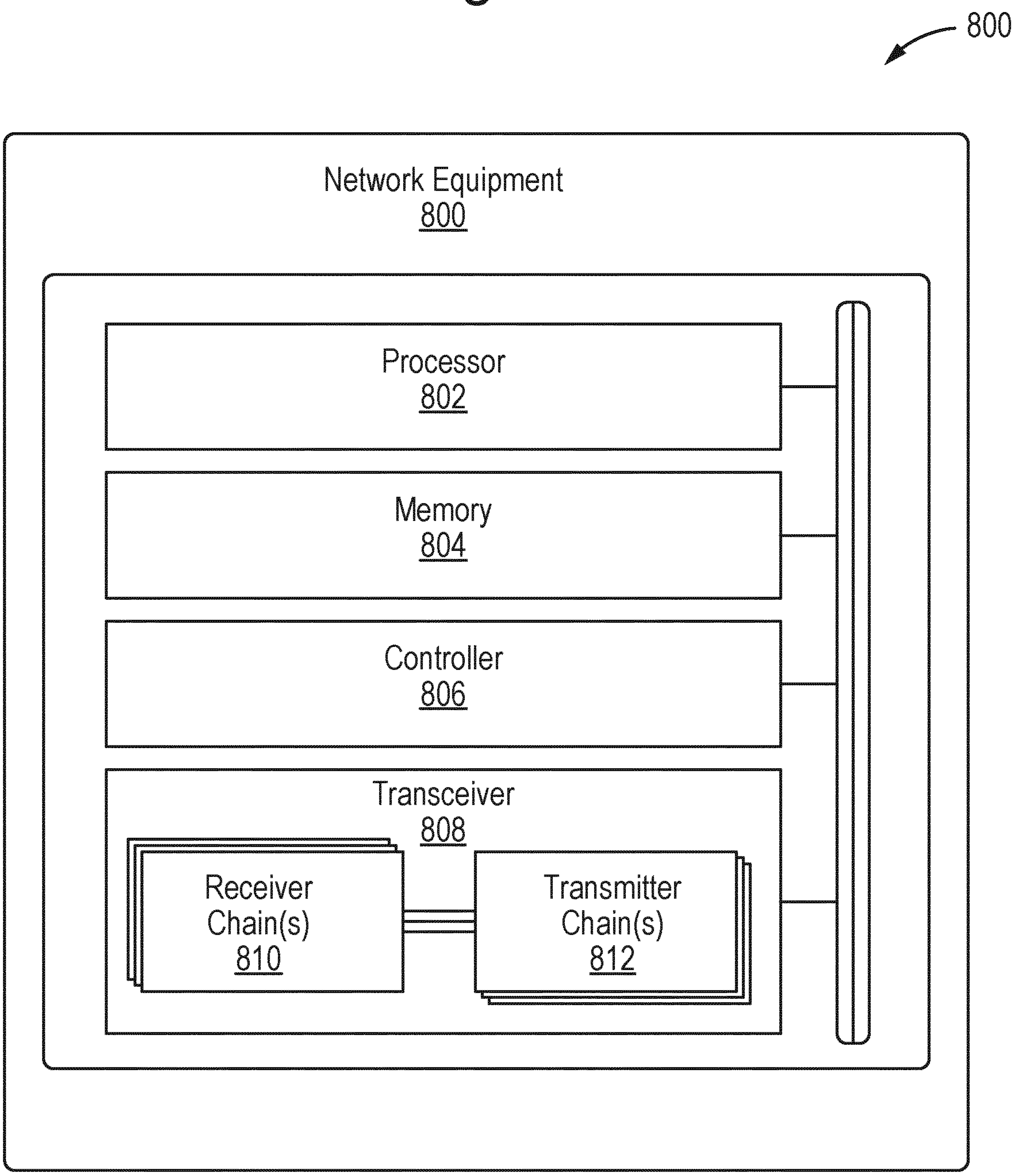

800
Network Equipment
800
Processor
802
Memory
804
Controller
806
Transceiver
808
Receiver
Chain(s)
810
Transmitter
Chain(s)
812

Fig. 9

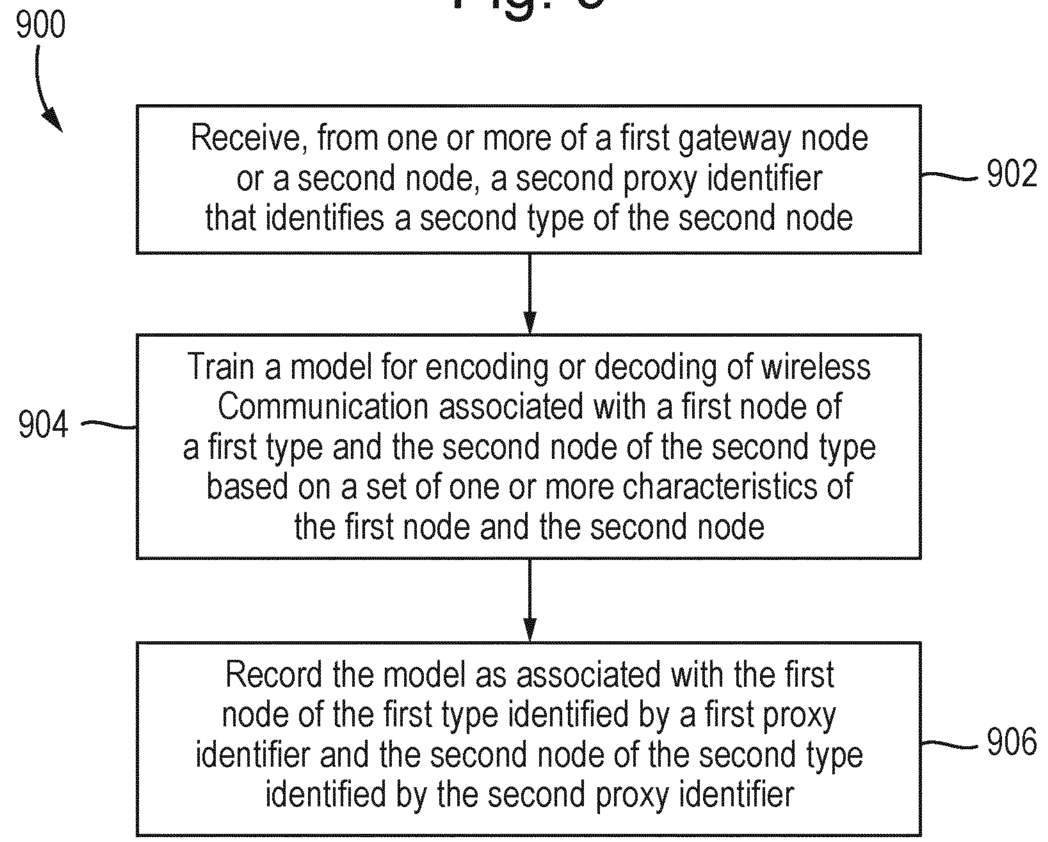
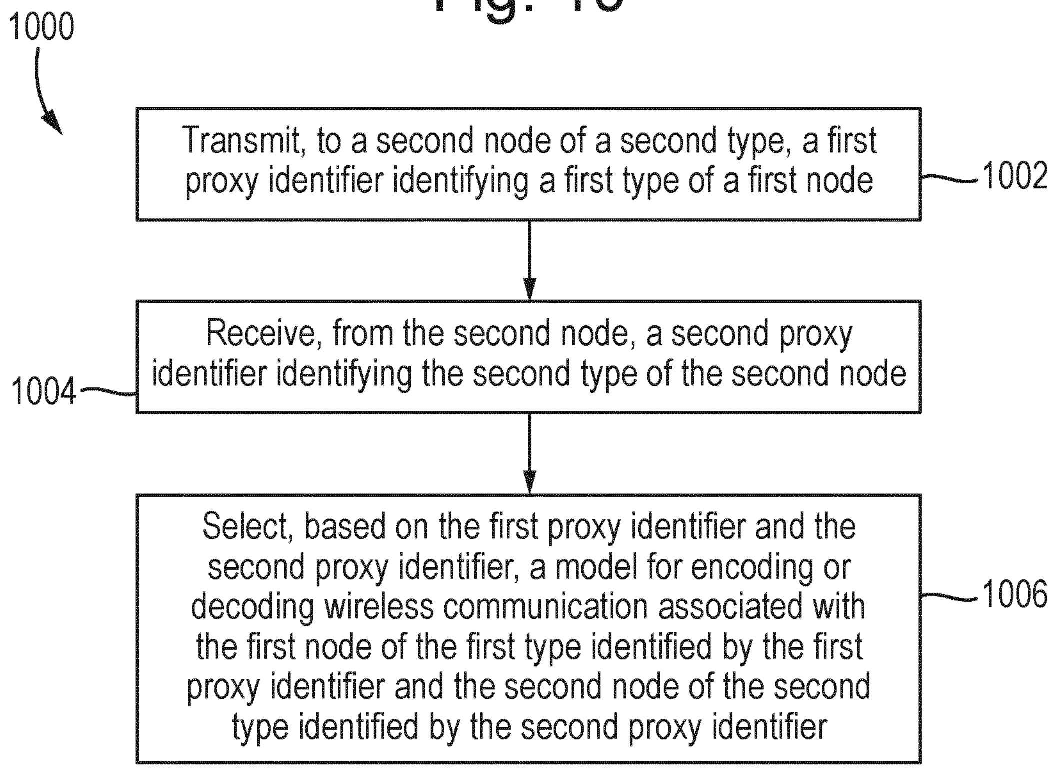

900
Receive, from one or more of a first gateway node or a second node, a second proxy identifier that identifies a second type of the second node
902
Train a model for encoding or decoding of wireless Communication associated with a first node of a first type and the second node of the second type based on a set of one or more characteristics of the first node and the second node
904
Record the model as associated with the first node of the first type identified by a first proxy identifier and the second node of the second type identified by the second proxy identifier
906

Fig. 10


1000
Transmit, to a second node of a second type, a first proxy identifier identifying a first type of a first node
1002
Receive, from the second node, a second proxy identifier identifying the second type of the second node
1004
Select, based on the first proxy identifier and the second proxy identifier, a model for encoding or decoding wireless communication associated with the first node of the first type identified by the first proxy identifier and the second node of the second type identified by the second proxy identifier
1006

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058009

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06N20/00 H04L41/16
ADD.

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)
G06N H04L

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2024/033809 A1 (LENOVO SINGAPORE PTE LTD [SG]) 15 February 2024 (2024-02-15) abstract paragraph [0032] - paragraph [0033] paragraph [0151] - paragraph [0152] -----	1-20
A	WO 2024/031647 A1 (QUALCOMM INC [US] ET AL.) 15 February 2024 (2024-02-15) abstract paragraph [0063] paragraph [0069] paragraph [0155] - paragraph [0156] -----	1-20
A	WO 2023/151989 A1 (ERICSSON TELEFON AB L M [SE]) 17 August 2023 (2023-08-17) abstract paragraph [0062] paragraph [0125] - paragraph [0126] -----	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2024	25/10/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Larcinese, Concetta

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/058009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2024033809 A1	15-02-2024	NONE	
WO 2024031647 A1	15-02-2024	WO 2024031647 A1	15-02-2024
		WO 2024031974 A1	15-02-2024
WO 2023151989 A1	17-08-2023	NONE	