(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 August 2015 (13.08.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/119623 A2

(51) **International Patent Classification:** Not classified

(21) **International Application Number:**
PCT/US2014/015378

(22) **International Filing Date:**
7 February 2014 (07.02.2014)

(25) **Filing Language:** English

(26) **Publication Language:** English

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2015/119623 A2

(54) Title: POWER SOURCING EQUIPMENT

(57) Abstract: Example implementations relate to supplying power based on a power over Ethernet protocol. For example, a first apparatus may include a first PSE and a second PSE at one end of an Ethernet cable and a second apparatus may include a first PD and a second PD at the other end of the Ethernet cable. In response to a detection of a presence of at least one PD, the first apparatus may inquire the second apparatus about the at least one PD regarding power requirements, number, and type of PDs requesting power. Based on that information, the first apparatus may supply at least one power source using either the single pair delivery method, the two pair delivery method, or a combination thereof. In some examples, a central controller may instruct the first apparatus to modify the power delivery configuration based on changing PD needs of the second apparatus.

POWER SOURCING EQUIPMENT

BACKGROUND

[0001] Power over Ethernet (PoE) is a technology to supply power over a network cable, such as a Category 5 Ethernet cable. A device that implements PoE to supply power to another device is called a power sourcing equipment (PSE). A device that implements PoE to receive power from a PSE is called a powered device (PD).

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Some examples of the present application are described with respect to the following figures:

[0003] FIG. 1 is a block diagram of an example multi-PSE for selectively supplying power via various PSEs;

[0004] FIG. 2 is a block diagram of an example network node having a multi-PSE for selectively supplying power via various PSEs;

[0005] FIG. 3 is flowchart illustrating an example method of a multi-PSE selectively supplying power via various PSEs;

[0006] FIG. 4 is a block diagram of an example muiti-PD for selectively drawing power via various PDs;

[0007] FIG. 5 is a block diagram of another example muiti-PD for selectively drawing power via various PDs;

[0008] FIG. 6 is a block diagram of an example network node having a multi-PD for selectively drawing power via various PDs;

[0009] FIG. 7 is a block diagram of an example PoE system including a multi-PSE and a multi-PD;

[0010] FIG. 8 is a flowchart illustrating an example method of determining a power delivery method at a PSE;

[0011] FIG. 9 is a flowchart illustrating an example method of a PSE signaling to determine whether a PD is a multi-PD; and

[0012] FIG. 10 is a flowchart illustrating an example method of a PD signaling to identify that the PD is a multi-PD.

DETAILED DESCRIPTION

[0013] As described above, a power sourcing equipment (PSE) implements power over Ethernet (PoE) to supply power, such as electrical power, to a powered device over an Ethernet cable. Under currently PoE protocols, such as Institute of Electrical and Electronics Engineers (IEEE) 802.3af protocol and IEEE 802.3at protocol, a PSE may supply power to a PD using either the signal pair delivery method or the spare pair delivery method. When a PSE supplies power to a PD using the signal pair delivery method, the PSE supplies power using two pairs of conductors in a network cable that are used for data transmission. For example, pins 1 and 2 of a Category (Cat) 5 Ethernet cable may be the first pair of conductors and pins 3 and 6 of the Cat 5 Ethernet cable may be the second pair of conductors. When a PSE supplies power using the spare pair method, the PSE supplies power using two pairs of conductors in a network cable that are not used for data transmission. For example, pins 4 and 5 of a Cat 5 Ethernet cable may be the first pair of conductors and pins 7 and 8 of the Cat 5 Ethernet cable may be the second pair of conductors.

[0014] Accordingly, a PSE may have limited delivery methods to supply power to a PD. Examples described herein address the above challenge by providing a multi-PSE that may selectively supply power to a PD via various methods and a multi-PD that may selectively receive power from a PSE and/or another PD via various methods. For example, a multi-PSE may include first circuitry and second circuitry. The first circuitry may selectively draw power from a set of power sources. The second circuitry may be coupled to the first circuitry. The second circuitry may selectively supply power to a PD via a single pair delivery method, a two pair delivery method (e.g., via center taps of two corresponding transformers), or a combination thereof.

[0015] A multi-PD may include first circuitry and second circuitry. The first circuitry may selectively receive power via a single pair of conductors in a network connector, two pairs of conductors in the network connector (e.g., via

center taps of two corresponding transformers), or a combination thereof. The second circuitry may include a plurality of power outputs. The second circuitry may receive first power from the first circuitry via a first connection and second power from the first circuitry via a second connection. The second circuitry may output the first power and the second power via different power outputs or via a single power output. In this manner, examples described herein may increase available delivery methods to supply power from a PSE to a PD.

[0016] Referring now to the figures, FIG. 1 is a block diagram of an example multi-PSE 100 for selectively supplying power via various PSEs. As used herein, a multi-PSE may be a PSE that includes multiple PSEs. A PSE may be any device that supplies power to another device over a network cable and/or based on a power over Ethernet (PoE) protocol, such as the IEEE 802.3af protocol and the IEEE 802.3at protocol.

[0017] Multi-PSE 100 may be a network switch, a network server, a computing device, a midspan device, an endspan device, or any devices suitable to supply power over a network cable. Multi-PSE 100 may include first circuitry 102, second circuitry 104, a network connector 108, a first transformer 108, and a second transformer 110. First circuitry 102 may be any circuits suitable to draw power from a power source, such as a voltage source or a current source, and supply the power to another circuit. Second circuitry 104 may be any circuits suitable to supply power using a single pair delivery method, a two pair delivery method, or a combination thereof as is described in more detail below. Transformers 108 and 110 may be any circuits suitable to transfer power from one circuit to another. Network connector 108 may be any interfaces that are compatible with an Ethernet cable. For example, network connector 106 may be an RJ45 connector standardized as the IEC 60603-7 8 position 8 contact (8P8C) modular connector with different categories of performance, with all eight conductors present. The 8P8C connector may be a modular connector used to terminate twisted pairs, and may be used for Ethernet over twisted pair and other applications involving unshielded twisted pair, and shielded twisted pair. The 8P8C connector may two paired components: the male plug and the female

jack, each with eight equally-spaced conducting channels. When an 8P8C plug is mated with an 8P8C jack, the contacts meet and create an electrical connection.

[0018] Second circuitry 104 may include a first PSE 112 and a second PSE 114. Network connector 106 may include a plurality pairs of conductors, such as a first pair of conductors 118, a second pair of conductors 118, and a third pair of conductors 120. Each pair of conductors 116-120 may correspond to two pins of an Ethernet connector. For example, the first pair of conductors 116 may correspond to pins 1 and 2 of the Ethernet connector.

[0019] First circuitry 102 may be coupled to second circuitry 104. For example, first circuitry 102 may be coupled to first PSE 112 and/or second PSE 114. First PSE 112 may be coupled to first pair of conductors 116. Second PSE 114 may be coupled to second pair of conductors 118 via first transformer 108. Second PSE 114 may also be coupled to third pair of conductors 120 via second transformer 110.

[0020] During operation, first circuitry 102 may draw power from a set of power sources, such as a power source 122. Power source 122 may be a current source or a voltage source. First circuitry 102 may transfer the power to second circuitry 104. For example, first circuitry 102 may transfer the power to first PSE 112 and/or second PSE 114. Second circuitry 104 may supply the power to a PD using a single pair delivery method, a two pair delivery method, or a combination thereof. When second circuitry 104 supplies the power using the single pair delivery method, first PSE 112 may supply the power via first pair of conductors 116.

[0021] When second circuitry 104 supplies the power using the two pair delivery method, second PSE 114 may supply the power using second pair of conductors 118 and third pair of conductors 120 via first transformer 108 and second transformer 110, respectively. When second circuitry 104 supplies the power using both the single pair delivery method and the two pair delivery method, first PSE 112 may supply a portion of the power via first pair of conductors 116 and second PSE 114 may supply a remaining portion of the power using second pair of conductors 118 and third pair of conductors 120 via center taps of first transformer 108 and second transformer 110,

respectively. Thus, multi-PSE 100 may have multiple ways to supply power to a PD.

[0022] FIG. 2 is a block diagram of an example network node 200 having a multi-PSE for selectively supplying power via various PSEs. Network node 200 may be a network switch, a network server, a midspan device, or a computing device. Network node 200 may include a first multi-PSE 202, a first network connector 280, a first transformer 234, a second transformer 238, a third transformer 238, and a fourth transformer 240. First multi-PSE 202 may include first circuitry 204, second circuitry 212, and a controller 232. First circuitry 204 may include an input circuit 208, a filter circuit 208, and an output circuit 210. Input circuit 206, filter circuit 208, and output circuit 210 may correspond to a power distribution circuit. Second circuitry 212 may include a first PSE 214, a second PSE 216, a third PSE 218, a fourth PSE 220, a fifth PSE 222, and a sixth PSE 224. PSEs 214-224 may be similar. For example, first PSE 214 may include an input circuit 228, a filter circuit 228, and an output circuit 230. Input circuit 228 may draw power from first circuitry 204. The power drawn by input circuit 228 may be filtered by filter circuit 228 and may be output by output circuit 230. Filter circuit 228 may filter noise and may provide surge protection by filtering spikes. Each of PSE 218-224 may include corresponding input circuits, filter circuits, and output circuits.

[0023] First network connector 280 may include a plurality of pins, such as pins 1-8. Each of pins 1-8 may be a conductor. Each pair of pins may correspond to a pair of conductors. For example, pins 1 and 2 may correspond to a first pair of conductors 262, pins 3 and 8 may correspond to a second pair of conductors 284, pins 4 and 5 may correspond to a third pair of conductors 268, and pins 7 and 8 may correspond to a fourth pair of conductors 268.

[0024] First circuitry 204 may be any circuits suitable to draw power from a power source, such as a voltage source or a current source, and supply the power to another circuit. Second circuitry 212 may be any circuits suitable to supply power using a single pair delivery method, a two pair delivery method, or a combination thereof as is described in more detail below. Controller 232 may be a central processing unit (CPU), a semiconductor-based microprocessor, and/or other hardware devices suitable for controlling an

operation of a circuit. Transformers 234-240 may be circuits suitable to transfer power from one circuit to another. First network connector 260 may be any interfaces that are compatible with an Ethernet cable. For example, first network connector 260 may be similar to network connector 106 of FIG. 1.

[0025] First circuitry 204 may be coupled to second circuitry 212. For example, output circuit 210 may be coupled to each of PSEs 214-220. Controller 232 may be coupled to first circuitry 204 and to second circuitry 212. For example, controller 232 may be coupled to input circuit 206 and to each of PSEs 214-220. Each PSE 214-220 may be coupled to a corresponding pair of conductors 262-268, respectively. Fifth PSE 222 may be coupled to first pair of conductors 262 via first transformer 234 and to second pair of conductors 264 via second transformer 236. Sixth PSE 224 may be coupled to third pair of conductors 266 via third transformer 238 and to fourth pair of conductors 268 via fourth transformer 240.

[0026] During operation, controller 232 may direct first circuitry 204 to draw power from a set of power sources 270, such as a first power source 242 and/or a second power source 244. Set of power sources 270 may be a voltage source or a current source. For example, controller 232 may direct input circuit 206 to selectively draw power from first power source 242, second power source 244, or a combination thereof via commands. Controller 232 may direct input circuit 206 to selectively draw power based on a plurality of factors, such as the number of available power sources, power demand from second circuitry 212, etc. Power drawn by input circuit 206 may be filtered by filter circuit 208 and may be drawn by second circuitry 212 via output circuit 210.

[0027] Controller 232 may direct PSEs 214-224 to selectively draw power from first circuitry 204, such as from output circuit 210. Controller 232 may direct PSEs 214-224 to selectively draw power based on a plurality of factors, such as power demand of a PD, availability of PSEs 214-224, availability of pins in first network connector 260, etc. By controlling PSEs 214-224 to selectively draw power from first circuitry 204, first muiti-PSE 202 may supply power using a plurality of delivery methods, such as the single pair delivery method, the two pair delivery method, or a combination thereof.

[0028] When first muiti-PSE 202 supplies power using the single pair delivery method, controller 232 may direct power delivery using any of PSEs 214-220. Each PSE 214-220 may correspond to a distinct source of power. Each PSE 214-220 may supply power via a corresponding power channel. As used herein, a power channel may correspond to a transfer path to send and/or receive electrons. For example, when two distinct sources of power are needed, controller 232 may direct first PSE 214 to draw power from first circuitry 204 using input circuit 226 and supply the power via first pair of conductors 262 using output circuit 230. Controller 232 may also direct second PSE 216 to draw power from first circuitry 204 and supply the power via second pair of conductors 264. First network connector 260 may be coupled to a first network cable 246, thus power supplied from first PSE 214 may be transported to a PD via a power channel of first PSE 214 that corresponds to the first pair of conductors 262 and/or a first twisted wire pair 248 in first network cable 246 based on a PoE protocol. Power supplied from second PSE 216 may be transported to the PD or another PD based on a PoE protocol via a power channel of second PSE 216 that corresponds to second pair of conductors 264 and/or a second twisted wire pair 250 in first network cable 246. Thus, first muiti-PSE 202 may supply up to four distinct sources of power when using the single pair delivery method.

[0029] When first muiti-PSE 202 supplies power using the two pair delivery method, controller 232 may direct power delivery using any of PSEs 222-224. Each PSE 222-224 may correspond to a distinct source of power. For example, when a single distinct source of power is needed, controller 232 may direct fifth PSE 222 to draw power from first circuitry 204 and supply the power to a PD via a power channel of fifth PSE 222. The power channel of fifth PSE 222 may correspond to first pair of conductors 262, second pair of conductors 264, first twisted wire pair 248, and/or second twisted wire pair 250. The power may be supplied to first pair of conductors 262 and second pair of conductors 264 using a center tap of first transformer 234 and a center tap of second transformer 236, respectively. The power may then be transported to the PD via first twisted wire pair 248 and second twisted wire pair 250 based on a PoE protocol. First twisted wire pair 248 may be the plus path and second twisted wire pair 250 may be the minus path.

[0030] As another example, controller 232 may direct sixth PSE 224 to draw power from first circuitry 204 and supply the power via the PD or another PD via a power channel of sixth PSE 224. The power channel of sixth PSE 224 may correspond to third pair of conductors 266, fourth pair of conductors 268, a third twisted pair 252 in first network cable 246, and/or fourth twisted wire pair 254 in first network cable 246. For example, power may be supplied to third pair of conductors 266 and fourth pair of conductors 268 using a center tap of third transformer 238 and a center tap of fourth transformer 240, respectively. The power may then be transported to the PD or the other PD via third twisted wire pair 252 and fourth twisted wire pair 254 based on a PoE protocol. When two distinct sources of power are needed, controller 232 may direct both PSE 222 and PSE 224 to supply power. Thus, first muiti-PSE 202 may supply up to two distinct sources of power when using the two pair delivery method.

[0031] When a combination of the single pair delivery method and the two pair delivery method are used, controller 232 may direct one of PSEs 222-224 to supply power and at least one of PSEs 214-220 to supply power. For example, controller 232 may direct fifth PSE 222 and third PSE 218 to supply power. As another example, controller 232 may direct sixth PSE 224, first PSE 214, and second PSE 216 to supply power. Thus, first multi~PSE 202 may supply up to four distinct sources of power when using the single pair delivery method and the two pair delivery method.

[0032] In some examples, network node 200 may also include a second multi-PSE 256 that is similar to first muiti-PSE 202, a set of transformers 274, and a second network connector 272. Second multi-PSE 256 may be coupled to second network connector 272 similar to first muiti-PSE 202 coupling to first network connector 260. Second multi-PSE 256 may draw power from a power source 276. During operation, controller 232 may direct first circuitry 204 to draw power from second muiti-PSE 256 in addition to drawing power from set of power sources 270.

[0033] FIG. 3 is flowchart illustrating an example method 300 of a muiti-PSE selectively supplying power via various PSEs. Method 300 includes selectively drawing power, at first circuitry of a network node, from a set of power sources, where the network node includes second circuitry, a first

network connector having multiple conductors, a first transformer, and a second transformer, where the second circuitry includes a first power sourcing equipment (PSE) and a second PSE, where the first PSE is coupled to a first pair of conductors of the multiple conductors, where the first transformer is coupled to the second PSE, and where the second transformer is coupled to the second PSE, at 302. For example, first circuitry 102 of FIG. 1 may selectively draw power from power source 122. As another example, first circuitry 204 may selectively draw power from set of power sources 270.

[0034] Method 300 also includes selectively supplying the power, at second circuitry of the network node coupled to the first circuitry, via the first PSE, the second PSE, or a combination thereof, where the power is supplied based on a power over Ethernet (PoE) protocol, at 304. For example, second circuitry 104 may selectively supply power using first PSE 112 and/or second PSE 114 as requested by a corresponding PD. As another example, second circuitry 212 may selectively supply power using any of PSEs 214-224 as requested by at least one corresponding PD.

[0035] FIG. 4 is a block diagram of an example multi-PD 400 for selectively drawing power via various PDs. As used herein, a multi-PD may be a PD that includes multiple PDs. A PD may be any circuits and/or devices that receive power over a network cable and/or based on a PoE protocol. Multi-PD 400 may be a network node, a circuit, a light-emitting diode (LED), or any devices suitable to receive power over a network cable. For example, multi-PD 400 may be an internet protocol (IP) telephone, a network camera, a wireless access point, etc.

[0036] Multi-PD 400 may include first circuitry 402, a network connector 404, a first transformer 410, and a second transformer 412. First circuitry 402 may be any circuits suitable to draw power from a PSE via a network connector based on a PoE protocol. Transformers 410-412 may be similar to transformers 112-114 of FIG. 1 and/or transformers 234-240 of FIG. 2. Network connector 404 may be similar to network connector 108 and/or first network connector 280. First circuitry 402 may include first PD 406 and second PD 408.

[0037] During operation, first circuitry 402 may selectively draw power from conductors in network connector 404 based on a plurality of factors,

such as power demand of first PD 406, power demand of second PD 408, power demand of a power consuming component, etc. For example, first PD 408 may selectively draw power that is delivered using the single pair method from a first pair of conductors 414 in network connector 404. As another example, second PD 408 may selectively draw power that is delivered using the two pair method from a second pair of conductors 416 via a center tap of first transformer 410 and from a third pair of conductors 418 via a center tap of second transformer 412. Thus, muiti-PD 400 may receive power delivered using the single pair method, the two pair method, or a combination thereof.

[0038] FIG. 5 is a block diagram of another example muiti-PD 500 for selectively drawing power via various PDs. Muiti-PD 500 may include first circuitry 502, second circuitry 504, a network connector 512, a first transformer 518, and a second transformer 520. First circuitry 502 may be similar to first circuitry 402 of FIG. 4. Network connector 512 may be similar to network connector 404. Transformers 518-520 may be similar to transformers 410-412.

[0039] During operation, first circuitry 502 may supply first power to second circuitry 504 via a first connection 506 and second power to second circuitry 504 via a second connection 508. Based on a plurality of factors, such as a power demand of a power consuming device 510, second circuitry 504 may supply the first power and the second power as combined power or as separate power using distinct power outputs. For example, second circuitry 504 may supply the first power and the second power as combined power via a first power output 522 of second circuitry 504. As another example, second circuitry 504 may provide isolation between the first power and the second power by supplying the first power via first power output 522 and the second power via a second power output 524 of second circuitry 504. Thus, mu!ti-PD 500 may selectively supply power to a power consuming device using a single power output or multiple power outputs.

[0040] FIG. 6 is a block diagram of an example network node 600 having a multi-PD for selectively drawing power via various PDs. Network node 600 may be a circuit or device that is suitable to communicate using a network connection. Network node 600 may be an IP camera, a wireless access point, an IP telephone, a iight-emitting diode (LED), etc. Network node 600

may include a first muiti-PD 602, a power consuming device 678, a first network connector 656, a first transformer 634, a second transformer 636, a third transformer 638, and a fourth transformer 640. Transformers 634-640 may be similar to transformers 518-520 of FIG. 5. First network connector 656 may be similar to network connector 512.

[0041] First muiti-PD 602 may include first circuitry 604, second circuitry 606, and a controller 608. First circuitry 604 may any circuits suitable to receive power delivered using the single pair method, the two pair method, or a combination thereof. First circuitry 604 may include a first PD 610, a second PD 618, a third PD 620, a fourth PD 622, a fifth PD 624, and a sixth PD 626. Each PD 610, 618-626 may be similar. For example, first PD 610 may include an input circuit 612, a filter circuit 614, and an output circuit 616. Input circuit 612 may selectively draw power from a single pair of conductors in first network connector 656. Filter circuit 614 may filter the power drawn by input circuit 612 and output circuit 616 may output the power filtered by filter circuit 614 to second circuitry 606.

[0042] Each PD 618-626 may include corresponding input circuits, filter circuits, and output circuits. Each input circuit of PDs 610, 618-622 may selectively draw power from a single pair of conductors in first network connector 656. Each input circuit of PD 624-626 may selectively draw power from two pairs of conductors in first network connector 656 via corresponding transformers 634-640. Second circuitry 606 may be any circuits suitable to supply power using a single power output or multiple power outputs. Second circuitry 606 may include an input circuit 628, a filter circuit 630, and an output circuit 632.

[0043] During operation, controller 608 may receive a power demand 666 from power consuming device 678. Power demand 666 may correspond to an amount of power needed at power consuming device 678. Based on power demand 666, controller 608 may direct first circuitry 604 to selectively draw power delivered to conductors in first network connector 656 from a PSE, such as multi-PSE 100 of FIG. 1 or multi-PSE 202 and/or 256 of FIG. 2.

[0044] When the power is delivered to conductors in first network connector 656 using the single pair method, controller 608 may instruct any of PDs 610, 618-622 to selectively draw power from corresponding pairs of

conductors in first network connector 856. For example, first PD 610 may draw power from a first pair of conductors 658 in first network connector 856. First pair of conductors 658 may correspond to pins 1-2 in first network connector 656. Power may be delivered to first pair of conductors 658 from a power channel of a PSE, such as the power channel of first PSE 214 of FIG. 2, using the single pair method via a first twisted wire pair 848 in a first network cable 646. First twisted wire pair 648 may be part of the power channel.

[0045] As another example, second PD 618 may draw power from a second pair of conductors 660 in first network connector 656. Second pair of conductors 660 may correspond to pins 3 and 6 in first network connector 658. Power may be delivered to second pair of conductors 660 from a power channel of a PSE using the single pair method via a second twisted wire pair 650 in first network cable 646. Second twisted wire pair 650 may be part of the power channel. As another example, third PD 620 may draw power from a third pair of conductors 682 in first network connector 856. Power may be delivered to third pair of conductors 662 from a power channel of a PSE using the single pair method via a third twisted wire pair 652 in first network cable 648. Third twisted wire pair 652 may be part of the power channel. As another example, fourth PD 622 may draw power from a fourth pair of conductors 664 in first network connector 656. Power may be delivered to fourth pair of conductors 664 from a power channel of a PSE using the single pair method via a fourth twisted wire pair 654 in first network cable 646. Fourth twisted wire pair 854 may be part of the power channel. Thus, first multi-PD 602 may selectively draw power from up to four distinct sources of power.

[0046] When the power is delivered to conductors in first network connector 656 using the two pair method, controller 608 may instruct any of PDs 624-826 to selectively draw power from corresponding pairs of conductors in first network connector 856. For example, controller 608 may instruct fifth PD 624 to draw power from first pair of conductors 858 via a center tap of first transformer 634 and from second pair of conductors 660 via a center tap of second transformer 638. The power may be delivered to first pair of conductors 858 and second pair of conductors 860 via a power

channel of a PSE. For example, the power channel may be the power channel of fifth PSE 222 of FIG. 2.

[00471] As another example, controller 608 may instruct sixth PD 626 to draw power from third pair of conductors 662 via a center tap of third transformer 638 and from fourth pair of conductors 664 via a center tap of fourth transformer 640. The power may be delivered to third pair of conductors 662 and fourth pair of conductors 664 via a power channel of a PSE, such as the power channel of sixth PSE 224 of FIG. 2. As another example, controiler 608 may instruct PDs 624-626 to draw power from corresponding pairs of conductors in first network connector 656 via center taps of corresponding transformers. The power may be delivered via corresponding power channels of PSEs. Thus, first multi-PD 602 may selectively draw power from up to two distinct sources of power.

[004SJ] When the power is delivered to conductors in first network connector 656 using the single pair method and the two pair method, controller 608 may instruct any of PDs 610, 618-626 to selectively draw power from corresponding pairs of conductors in first network connector 656. For example, controller 608 may instruct first PD 610 to draw power from first pair of conductors 658 as power delivered to first pair of conductors 658 may be delivered using the single pair method via a power channel of a PSE. Controiler 608 may also instruct PDs 620-622 to draw power from third pair of conductors 662 and fourth pair of conductors 664 via center taps of transformers 638-640, respectively as power delivered to third pair of conductors 662 and fourth pair of conductors 664 is delivered using the two pair method via a power channel of a PSE. Thus, first multi-PD 602 may selectively draw power from up to three distinct sources of power.

[0049] Each PD 610, 618-624 may be coupled to second circuitry 606 via a corresponding connection, such as a connection 672. Second circuitry 606 may draw power from each PD 610, 618-624 using input circuit 628 via the corresponding connection. Input circuit 628 may combine the power drawn from each PD 610, 618-624 or keep the power separate (e.g., by using staging circuits). Input circuit 628 may transmit the power drawn to filter circuit 630. Filter circuit 630 may transmit the filtered power to output circuit 632. Output circuit 632 may supply the power to power consuming device

678 using at least one of power outputs of second circuitry 606, such as a first power output 674 or a second power output 676. For example, when input circuit 628 keeps the power drawn from each PD 610, 618-624 separate, output circuit 632 may supply the power using multiple power outputs. As another example, when input circuit 628 combines the power drawn, output circuit 632 may supply the combined power using a single power output.

[0050] In some examples, network node 600 may also include a second multi-PD 644, a set of transformers 668, and a second network connector 670. Second multi-PD 644 may be similar to first multi-PD 602. Second multi-PD 644 may be coupled to second network connector 670 similar to first multi-PD 602 coupling to first network connector 656. During operation, power may be delivered to second network connector 670 via a second network cable 642. Second multi-PD 644 may draw the power delivered to second network connector 670 directly or via set of transformers 668. Second circuitry 606 may draw power from second multi-PD 644 in addition to drawing power from first network connector 656.

[0051] FIG. 7 is a block diagram of an example PoE system 700 including a multi-PSE and a multi-PD. PoE system 700 may include a PSE 702 and a PD 704. PSE 702 may be similar to multi-PSE 100 of FIG. 1, first multi-PSE 202 of FIG. 2, or second multi-PSE 256. PD 704 may be similar to multi-PD 400 of FIG. 4, multi-PD 500 of FIG. 5, first multi-PD 602 of FIG. 6, or second multi-PD 644. PSE 702 may be coupled to PD 704 via a network cable 706. Network cable 706 may be a Category 5 Ethernet cable. Network cable 706 may include a plurality of twisted wire pairs, such a first twisted wire pair 708, a second twisted wire pair 710, a third twisted wire pair 712, and a fourth twisted wire pair 714.

[0052] During operation, PSE 702 may exchange signaling messages with PD 704 to determine information associated with PD 704. For example, PSE 702 may transmit a first discovery message 718 via network cable 706 to PD 704. In response to receiving first discovery message 718, PD 704 may generate a first response to indicate that PD 704 is PoE capable. For example, PD 704 may generate a particular response in response to receiving first discovery message 718. The particular response may correspond to a resistance value, a particular current value, or a particular voltage value. PSE

702 may detect the particular response and determine that PD 704 is PoE capable. After determining that PD 704 is PoE capable, PSE 702 may determine type information of PD 704 using a plurality of mechanisms as described in more detail below. The type information of PD 704 may identify whether PD 704 is a type 1 PD that is compliant with the IEEE 802.3af protocol, a type 2 PD that is compliant with the IEEE 802.3at protocol, and a multi-PD similar to any of multi-PDs in FIGs. 4-6.

[0053] In some examples, PSE 702 may determine the type information via a controller. For example, PSE 702 and PD 704 may be coupled to a controller 728. Controller 726 may be any devices suitable to centrally manage a PoE system, such as a software-defined network (SDN) controller. Controller 726 may manage PSE 702 and PD 704. PSE 702 may communicate information associated with PSE 702 via a first controller message 728. For example, PSE 702 may communicate a type of PSE 702 in first controller message 728. The type of PSE 702 may include a PSE that is compliant with the IEEE 802.3af protocol and/or the IEEE 802.3at protocol and a multi-PSE similar to any of multi-PSEs in FIGs. 1-2. PD 704 may also communicate information associated with PD 704 via a second controller message 730. For example, PD 704 may communicate the type of PD 704 in second controller message 730. In some examples, prior to PD 704 being power up, a network administrator may send an initial controller message to controller 726. Once PD 704 is powered up, PD 704 may transmit up-to-date power needs and PD capabilities to controller 726 via second controller message 730.

[0054] Controller 726 may configure power delivery method from PSE 702 to PD 704 based on a plurality of factors, such as network equipment power demands, network equipment configuration, a capability of PSE 702, the type of PSE 702, a capability of PD 704, the type of PD 704, etc. Controller 726 may also turn on and off PSE 702 and/or PD 704 based on the plurality of factors.

[0055] Controller 726 may transit a first configuration message 732 to PSE 702 to configure PSE 702. First configuration message 732 may configure a distinct power delivery method associated with each PSE of PSE 702. For

example, first configuration message 732 may instruct PSE 702 to supply power to PD 704 using the single pair delivery method via a particular PSE of PSE 702. As another example, first configuration message 732 may instruct PSE 702 to supply power to PD 704 using the single pair delivery method and the two pair delivery method via appropriate PSEs of PSE 702. First configuration message 732 may also instruct an amount of power needed from each PSE of PSE 702. Controller 726 may generate first configuration message 732 based on first controller message 728.

[0056] PD 704 may be initially configured to factory default configuration via a local interface using switches, jumpers, etc. During operation, messages may be exchanged between PD 704 and controller 728 to dynamically adjust power requested from each PD of PD 704 and/or methods to receive the requested power. For example, controller 726 may transit a second configuration message 734 to PD 704 to configure PD 704. Second configuration message 734 may configure a distinct power delivery method associated with each PD of PD 704. For example, second configuration message 734 may instruct PD 704 to receive power from PSE 702 using a particular PD of PD 704 that is compatible with the single pair delivery method. As another example, second configuration message 734 may instruct PD 704 to receive power from PSE 702 using a particular PD compatible with the single pair delivery method and a particular pair of PDs compatible with the two pair delivery method. Controller 726 may generate second configuration message 734 based on second controller message 730. Second configuration message 734 may also adjust power requested by each PD of PD 704. Controller 726 may also reconfigure PSE 702 and/or PD 704 dynamically via subsequent configuration messages as network condition changes, such as when controller 726 receives updated information from PSE 702 and/or PD 704.

[0057] In some example, PSE 702 may determine the type information using alternating signals. For example, PSE 702 may transmit alternating signals over twisted wire pairs 708-714 to PD 704 to determine the type of PD 704. For example, PSE 702 may transmit a first signal 720 over first twisted wire pair 708 and second twisted wire pair 710 to PD 704. PSE 702 may also

transmit a second signal 722 over third twisted wire pair 712 and fourth twisted wire pair 714 to PD 704. First signal 720 and second signal 722 may be alternating pulses. In response to receiving the first signal 720 and the second signal 722, PD 704 may generate a response having a particular characteristic that may be detected by PSE 702. PSE 702 may determine the type of PD 704 based on the response. When the type of PD 704 is the type 1 PD or the type 2 PD, PD 704 may generate a response having a first characteristic. For example, the first characteristic may be a steady current. When the type of PD 704 is the multi-PD, PD 704 may generate a response having a second characteristic. For example, the second characteristic may be a choppy or unsteady current.

[0058] In some examples, to determine the type information, PSE 702 may initially engage in a discovery process that is compliant with the IEEE 802.3at protocol with PD 704. PD 704 may initially identify the type of PD 704 as a type 2 PD. When link layer protocol starts between PSE 702 and PD 704, PSE 702 and PD 704 may exchange corresponding type information using link layer discovery protocol frames. Based on the type information, PSE 702 may update the type of PD 704. PSE 702 may supply power using the single pair delivery method, the two pair delivery method, or a combination thereof to PD 704 based on the type information.

[0059] In some examples, PSE 702 may determine the type information of PD 704 and configure power delivery method using classification inquiry messages and classification signatures. As used herein, a classification inquiry message may be any messages suitable to cause a PD to generate a response that may identify an amount of power consumption of the PD. A classification signature may be any responses generated by a PD that are suitable to identify an amount of power consumption of the PD.

[0060] For example, after detecting the presence of PD 704, PSE 702 may transmit a first classification inquiry message 724 to PD 704. In response to receiving first ciassification inquiry message 724, PD 704 may generate a first classification signature that may be detected by PSE 702. The first classification signature may correspond to a first particular resistance value, a first particular voltage value, or a first particular current value. In response to

detecting the first classification signature, PSE 702 may transmit subsequent classification inquiry messages to PD 704. PD 704 may generate corresponding classification signatures based on the subsequent classification inquiry messages. Based on classification signatures, PSE 702 may determine information associated with PD 704, such as the type information of PD 704. PSE 702 may also configure power delivery method based on classification signatures. PSE 702 and PD 704 signaling using classification inquiry messages and classification signatures are described in more detail in FIGs. 8-10. When PSE 702 determines that PD 704 is a multi-PD, PSE 702 may determine a corresponding power parameter of each PD of PD 704 in series or in parallel via any of the techniques described herein.

[0061] FIG. 8 is a flowchart illustrating an example method 800 of determining a power delivery method at a PSE. At 802, a PSE, such as multi-PSE 100 of FIG. 1, first multi-PSE 202 of FIG. 2, second multi-PSE 256, or PSE 702 of FIG. 7 may determine a presence of a PD, such as multi-PD 400 of FIG. 4, multi-PD 500 of FIG. 5, first multi-PD 802 of FIG. 6, second multi-PD 644, or PD 704 of FIG. 7. For example, the PSE may determine the presence of the PD using a discovery message.

[0062] At 804, when the PSE detects the presence of the PD, the PSE may transmit a first classification inquiry message, such as first classification inquiry message 724 of FIG. 7, to the PD. In response to receiving the first classification inquiry message, the PD may generate a first classification signature that is detected by the PSE. When the PD is a type 1 PD, the first classification signature correspond to a class 4 signature that is compliant with the IEEE 802.3af protocol and/or the IEEE 802.3at protocol. For example, the first classification signature may correspond to a current value between 38-44 milliamps (mAs). When the PD is not a type 1 PD, the first classification signature may correspond to a class signature that is compliant with the IEEE 802.3af protocol and/or the IEEE 802.3at protocol but not the class 4 signature. For example, the first classification signature may correspond to a class 1 signature. The class 1 signature may correspond to a current value between 9-12 mAs.

[0063] At 806, the PSE may determine whether the first classification signature corresponds to the class 4 signature. At 808, the PSE may determine that the PD is a type 1 PD when the first classification signature does not correspond to the class 4 signature. In response to determining that the first classification signature corresponds to the class 4 signature, the PSE may transmit a second classification inquiry message to the PD. The PD may generate a second classification signature in response to receiving the second classification inquiry message.

[0064] At 810, the PSE may determine whether the second classification signature corresponds to the class 4 signature. When the second classification signature does not correspond to the class 4 signature, the PSE may determine that the PD is a multi-PD, at 812. When the second classification signature corresponds to the class 4 signature, the PSE may determine that the PD is type 2 PD, at 814. When the PSE determines that the PD is a muiti-PD, the PSE may determine power delivery method based on subsequent classification signatures detected from the PD, which is described in more detail in a power delivery method look-up table.

[0065]

	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
R1	0	0-3	2	4						
R2	1	0-3	2	4						
R3	2	0-3	3	0	2	4				
R4	2	0-3	3	1	2	4				
R5	2	0-3	3	2	2	4				
R6	2	0-3	3	3	2	4				
R7	0	0-3	1	0-3	2	4				
R8	2	0-3	3	0	2	0-3	3	1	2	0-3
R9	2	0-3	3	0	2	0-3	3	1	2	0-3

Power Delivery Method Look-up Table

	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23
R8	3	2	2	0-3	3	3	2	4				
R9	3	2	2	0-3	3	3	0	0-3	1	0-3	2	4

Power Delivery Method Look-up Table (continued)

[0066] Power delivery method look-up table may include a plurality of columns C2-C23 and rows R1-R9. Each column may correspond to a sequence number of a particular classification signature. For example, column C2 may correspond to the second classification signature at 810. Column C3 may correspond to a third classification signature generated subsequent to the second classification signature in column C2.

[0067] Entries in each row may correspond to a particular classification signature generated by the PD and defected by the PSE. The PD may generate each classification signature in response to receiving a corresponding classification inquiry message from the PSE. Each row may correspond to a sequence of classification signatures that the PD may generate to request a particular delivery method and to identify a power parameter of the PD and a particular circuit of the PD where power is drawn. The power parameter may correspond to an amount of power that the PD may request. The PSE may compare a particular sequence to the power delivery method look-up table to determine the particular delivery method requested, the power parameter, and the particular circuit.

[0068] Rows R1 and R2 may correspond to sequences of classification signatures generated by the PD to request the PSE to deliver power using the two pair method via two pairs of conductors. For example, in row R1, entry "0" under column C2 may correspond to a class 0 signature. The class 0 signature may identify two particular pairs of conductors that the PD may use to draw power via center taps of corresponding transformers, such as first pair of conductors 658 and second pair of conductors 860 in FIG. 6. In row R2, entry "1" under column C2 may correspond to a class 1 signature that identifies two other particular pairs of conductors different from the two particular pairs of conductors, such as third pair of conductors 662 and fourth pair of conductors 664.

[0069] Entry under column C3 may correspond to the power parameter. For example, a class 1 signature under column C3 may indicate that the PD is requesting the PSE to supply 4 watts of power. As another example, a class 2 signature under column C3 may indicate that the PD is requesting the PSE to supply 7 watts of power. Entries under columns C4 and C5 may correspond to an ending sequence. A class 2 signature follow by a class 4 signature may indicate that the sequence of classification signatures has ended and the PSE may use the sequence to determine the power delivery method, the power parameter, and the particular circuit of the PD requested.

[0070] Rows R3-R6 may correspond to sequences of classification signatures generated by the PD to request the PSE to deliver power using the

single pair method. Each sequence of rows R3-R8 may identify a distinct pair of conductor from which the PD may draw power. In rows R3-R6, entry under column C2 may identify that the two pair delivery method is requested; entry under column C3 may identify a power parameter of the PD; entry under column C4 may indicate that the power parameter is to be associated with a particular pair of conductor in an immediate subsequent classification signature and power is to be supplied using the particular of conductor; entry under column C5 may indicate the particular pair of conductor; and entries under columns C6-C7 may be the ending sequence.

[0071] Row R7 may correspond to a sequence of classification signatures generated by the PD to request the PSE to deliver power using the two pair methods via four pairs of conductors. Even though entries of R7 under columns C2-C3 are the same as entries of R1 under columns C2-C3, the PSE may identify the sequence in row R7 from the sequence in row R1 by the placement of the ending sequence. In row R7, entry under column C2 may identify first two pairs of conductors from which the PD may draw power, such as first pair of conductors 658 and second pair of conductors 860; entry under column C3 may identify a first power parameter of the PD with respect to the first two pairs of conductors; entry under column C4 may identify second two pairs of conductors from which the PD may draw power, such as third pair of conductors 662 and fourth pair of conductors 684; entry under column C5 may identify a second power parameter of the PD with respect to the second two pairs of conductors; and entries under columns C8-C7 may identify the ending sequence.

[0072] Row R8 may correspond to a sequence of classification signatures generated by four PDs of a multi-PD, such as first PD 610, second PD 818, third PD 620, and fourth PD 822, to request the PSE to deliver power to each of the four PDs using the single pair method via four distinct pairs of conductors. Entries under columns C2, C6, C10, and C14 may serve as a starting indication for power delivery method request of each PD.

[0073] Entries under columns C3, C7, C11, and C15 may indicate power parameters of the four PDs, respectively; entries under column C4, C8, C2, and C16 may indicate that each respective power parameter is to be

associated with a distinct pair of conductor coupled to a corresponding PD in an immediate subsequent classification signature; entries under columns C5, C9, C13, and C17 may indicate each distinct pair of conductors. Entries under columns C18 and C19 may correspond to the ending sequence.

[0074] Row R9 may correspond to a sequence of classification signatures generated by six PDs of a multi-PD, such as first PD 610, second PD 618, third PD 620, and fourth PD 622, to request the PSE to supply power using a combination of the single pair method and the two pair method via four pairs of conductors. In row R9, entries under columns C2 to C17 may correspond to the same information as entries in row R8 under the same columns. In row R9, entry under column C18 may identify first two pairs of conductors that a first particular PD may draw power from using the two pair method, such as fifth PD 624. Entry under column C19 may identify a power parameter of the first particular PD. Entry under column C20 may identify second two pairs of conductors that a second particular PD may draw power from using the two pair method, such as sixth PD 626. Entry under column C21 may identify a power parameter of the second particular PD. Entries under columns C22-C23 may correspond to the ending sequence.

[0075] When the PSE receives the sequence in row R9, the PSE may determine which four of the six PDs may receive power since a pair of conductor may not be used for the single pair method and the two pair method concurrently. For example, the PSE may not supply power to first pair of conductor 658 using the single pair method and the two pair method concurrently. The PSE may determine the four PDs based on a plurality of factors, such as power parameters of each of the six PDs, availability of power sources, etc.

[0076] *FIG.* 9 is a flowchart illustrating an example method 900 of a PSE signaling to determine whether a PD is a multi-PD. Method 900 includes in response to a detection of a presence of a powered device (PD), transmitting a first classification inquiry message from a power sourcing equipment (PSE) to the PD, at 902. For example, referring to FIG. 7, after detecting the presence of PD 704, PSE 702 may transmit a first classification inquiry message 724 to PD 704.

[0077] Method 900 also includes in response to receiving a first classification signature compliant with a class four signature of a power over Ethernet (PoE) protocol, transmitting a second classification inquiry message from the PSE to the PD, at 904. For example, in response to defecting the first classification signature, PSE 702 may transmit subsequent classification inquiry messages to PD 704.

[0078] Method 900 further includes in response to receiving a second classification signature compliant with a class signature of the PoE protocol other than the class four signature, determining that a type of the PD is a multi-PD. For example, referring to FIG. 8, when the second classification signature does not correspond to the class 4 signature, the PSE may determine that the PD is a multi-PD.

[0079] FIG. 10 is a flowchart illustrating an example method 1000 of a PD signaling to identify that the PD is a multi-PD. Method 1000 includes in response to receiving a first classification inquiry message from a power sourcing equipment (PSE), generating, at a powered device (PD), a first classification signature compliant with a class four signature of a power over Ethernet (PoE) standard, at 1002. For example, referring to FIG. 8, in response to receiving the first classification inquiry message, the PD may generate a first classification signature that is detected by the PSE.

[0080] Method 1000 also includes in response to receiving a second classification inquiry message from the PSE, generating a second classification signature compliant with a class signature of the power over Ethernet standard other than the class four signature, where the second classification inquiry is subsequent to the first classification inquiry, and where the first classification signature and the second classification signature identify a type of the PD, at 1004. For example, referring to FIG. 8, the PD may generate a second classification signature in response to receiving the second classification inquiry message. The PSE may determine whether the second classification signature corresponds to the class 4 signature. When the second classification signature does not correspond to the class 4 signature, the PSE may determine that the PD is a multi-PD.

[0081] The use of "comprising", "including" or "having" are synonymous and variations thereof herein are meant to be inclusive or open-ended and do not exclude additional unrecited elements or method steps.

Claims

What is claimed is:

1. An apparatus comprising:

first circuitry to selectively draw power from a set of power sources;

second circuitry coupled to the first circuitry, wherein the second circuitry includes a first power sourcing equipment (PSE) and a second PSE;

a first transformer coupled to the second PSE;

a second transformer coupled to the second PSE; and

a first network connector coupled to the second circuitry, wherein the first network connector includes multiple conductors, wherein the first PSE is coupled to a first pair of conductors of the multiple conductors, wherein the second circuitry, based on a power over Ethernet (PoE) protocol, to selectively supply the power via the first PSE, the second PSE, or a combination thereof.

2. The apparatus of claim 1, further comprising:

a third transformer; and

a fourth transformer, wherein the multiple conductors include a second pair of conductors, a third pair of conductors, and a fourth pair of conductors, wherein the first circuitry include a power distribution circuit, wherein the second circuitry include a third PSE, a fourth PSE, a fifth PSE, and a sixth PSE, wherein the second PSE to couple with the first pair via the first transformer, wherein the second PSE to couple with the second pair via the second transformer, wherein the third PSE to couple with the second pair, wherein the fourth PSE to couple with the third pair, wherein the fifth PSE to couple with fourth pair, wherein the sixth PSE to couple with the third pair via the third transformer, and wherein the sixth PSE to couple with the fourth pair via the fourth transformer.

3. The apparatus of claim 1, wherein the set of power sources includes a first power source and a multi-power source equipment (mulfi-PSE), and wherein the multi-PSE is associated with a second network connector.

4. The apparatus of claim 1, further comprising a controller to:

transmit alternating signals to a powered device (PD); and

determine a type of the PD based on a response that is generated based on the alternating signals, wherein the type of the PD includes a single powered device (PD) and a multi-PD.

5. A method comprising:

selectively drawing power, at first circuitry of a network node, from a set of power sources, wherein the network node includes second circuitry, a first network connector having multiple conductors, a first transformer, and a second transformer, wherein the second circuitry includes a first power sourcing equipment (PSE) and a second PSE, wherein the first PSE is coupled to a first pair of conductors of the multiple conductors, wherein the first transformer is coupled to the second PSE, and wherein the second transformer is coupled to the second PSE; and

selectively supplying the power, at second circuitry of the network node coupled to the first circuitry, via the first PSE, the second PSE, or a combination thereof, wherein the power is supplied based on a power over Ethernet (PoE) protocol.

8. The method of claim 5, further comprising:

transmitting alternating signals to a powered device (PD); and

determining a type of the PD based on a response that is generated based on the alternating signals, wherein the type of the PD includes a single powered device (PD) and a multi-PD.

7. The method of claim 8, further comprising determining power delivery methods of PDs of the mu!ti-PD in response to a determination that the type of the PD is the muiti-PD.

8. An apparatus comprising:

a network connector having multiple conductors;

first circuitry having a first powered device (PD) and a second PD, wherein the first PD is coupled to a first pair of conductors of the multiple conductors;

a first transformer coupled to the second PD; and

a second transformer coupled to the second PD, wherein the first circuitry to selectively draw power, based on a power over Ethernet (PoE) protocol, from the first PD, the second PD, or a combination thereof.

9. The apparatus of claim 8, further comprising a fourth transformer and a fifth transformer, wherein the multiple conductors include a second pair, a third pair, and a fourth pair, wherein the second PD is coupled to the first pair via the first transformer, wherein the second PD is coupled to the second pair via the second transformer, wherein the first circuitry further includes a third PD, a fourth PD, a fifth PD, and a sixth PD, wherein the third PD is coupled to the second pair, wherein the fourth PD is coupled to the third pair, wherein the fifth PD is coupled to the fourth pair, wherein the sixth PD is coupled to the third pair via the third transformer, and wherein the sixth PD is coupled to the fourth pair via the fourth transformer.

10. The apparatus of claim 8, further comprising a controller, wherein the first circuitry to selectively draw the power based on a command from the controller, and wherein the controller to generate the command based on a power demand of a power consuming device.

11. An apparatus comprising:

first circuitry;

a first network connector coupled to the first circuitry, wherein the first network connector includes a plurality of conductors;

a set of transformers coupled to the first circuitry, wherein the first circuitry to selectively draw power from the plurality of conductors, the set of transformers, or a combination thereof, based on a power over Ethernet (PoE) protocol; and

second circuitry coupled to the first circuitry, wherein the second circuitry includes a plurality of power outputs, wherein the first circuitry to transmit first power to the second circuitry via a first connection and to transmit second power to the second circuitry via a second connection, and wherein the second circuitry to selectively supply the first power and the second power to a power consuming device via a single power output of the plurality of power outputs or via multiple power outputs of the plurality of power outputs.

12. The apparatus of claim 11, wherein the second circuitry to combine the first power and the second power when the second circuitry to supply the first power and the second power via the single power output, and wherein the second circuitry to supply the first power and the second power via distinct power outputs when the second circuitry to supply the first power and the second power via the multiple power outputs.

13. The apparatus of claim 11, wherein the second circuitry to receive third power from a multi-powered device (muiti-PD) that is associated with a second network connector, and wherein the second circuitry to selectively supply the first power, the second power, and the third power via the set of power outputs to the power consuming device.

14. A method comprising:

in response to a detection of a presence of a powered device (PD), transmitting a first classification inquiry message from a power sourcing equipment (PSE) to the PD;

in response to defecting a first classification signature compliant with a class four signature of a power over Ethernet (PoE) protocol, transmitting a second classification inquiry message from the PSE to the PD; and

in response to detecting a second classification signature compliant with a class signature of the PoE protocol other than the class four signature, determining that a type of the PD is a multi-PD.

15. The method of claim 14, further comprising in response to a determination that the type of the PD is the multi-PD, determining a power delivery method of the PD.

16. A method comprising:

in response to receiving a first classification inquiiy message from a power sourcing equipment (PSE), generating, at a powered device (PD), a first classification signature compiiant with a class four signature of a power over Ethernet (PoE) standard; and

in response to receiving a second classification inquiry message from the PSE, generating a second classification signature compliant with a class signature of the power over Ethernet standard other than the class four signature, wherein the second classification inquiry is subsequent to the first classification inquiry, and wherein the first classification signature and the second classification signature identify a type of the PD.

17. The method of claim 16, further comprising generating a third classification signature in response to receiving a third classification inquiry, wherein the third classification signature identifies a power parameter of the PD, and wherein the second classification signature identifies a particular circuit of the PD.

18. The method of claim 18, further comprising:

generating a third classification signature in response to receiving a third classification inquiry;

generating a fourth classification signature in response to receiving a fourth classification inquiry; and

generating a fifth classification signature in response to receiving a fifth classification inquiry, wherein the second classification signature indicates that the PD is to receive power via a single pair of conductors of a network cable, wherein the third classification signature identifies a power parameter of the PD, wherein the fourth classification signature associates the power parameter with the single pair of conductors, and wherein the fifth classification signature identifies the single pair of conductors.

19. A method comprising:

receiving first information associated with a power sourcing equipment (PSE) from the PSE;

receiving second information associated with a powered device (PD) from the PD;

configuring the PSE based on the first information and the second information via a first configuration message;

configuring the PD based on the first information and the second information via a second configuration message; and

reconfiguring the PSE, the PD, or a combination thereof via subsequent configuration messages based on updated information received from the PSE, the PD, or a combination thereof.

20. The method of claim 19, wherein the PSE is a multi-PSE having a plurality of PSEs, wherein configuring the PSE includes determining a distinct power delivery method associated with each PSE of the multi-PSE, and wherein the distinct power delivery method includes a single pair method, a two pair method, and a combination thereof.

21. The method of claim 19, wherein the PD is a multi-PD having a plurality of PDs, wherein configuration the PD includes determining a distinct power delivery method associated with each PD of the muiti-PD, and wherein the distinct power delivery method includes a single pair method, a two pair method, and a combination thereof.

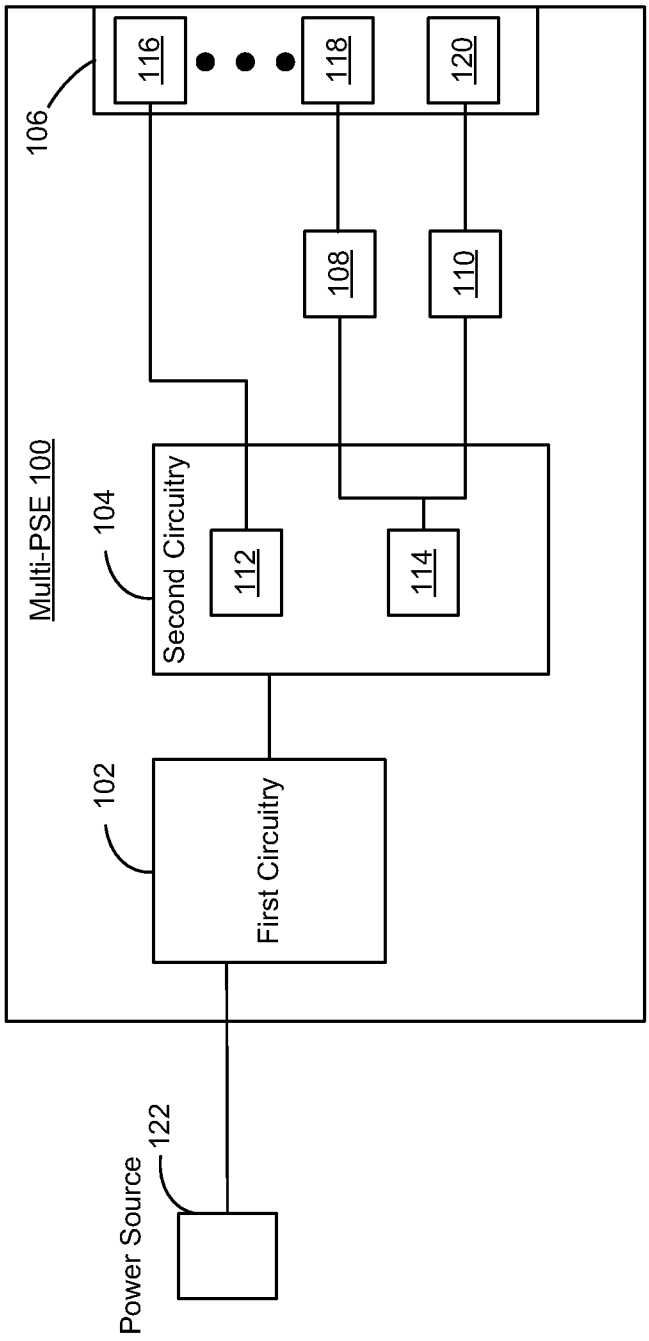
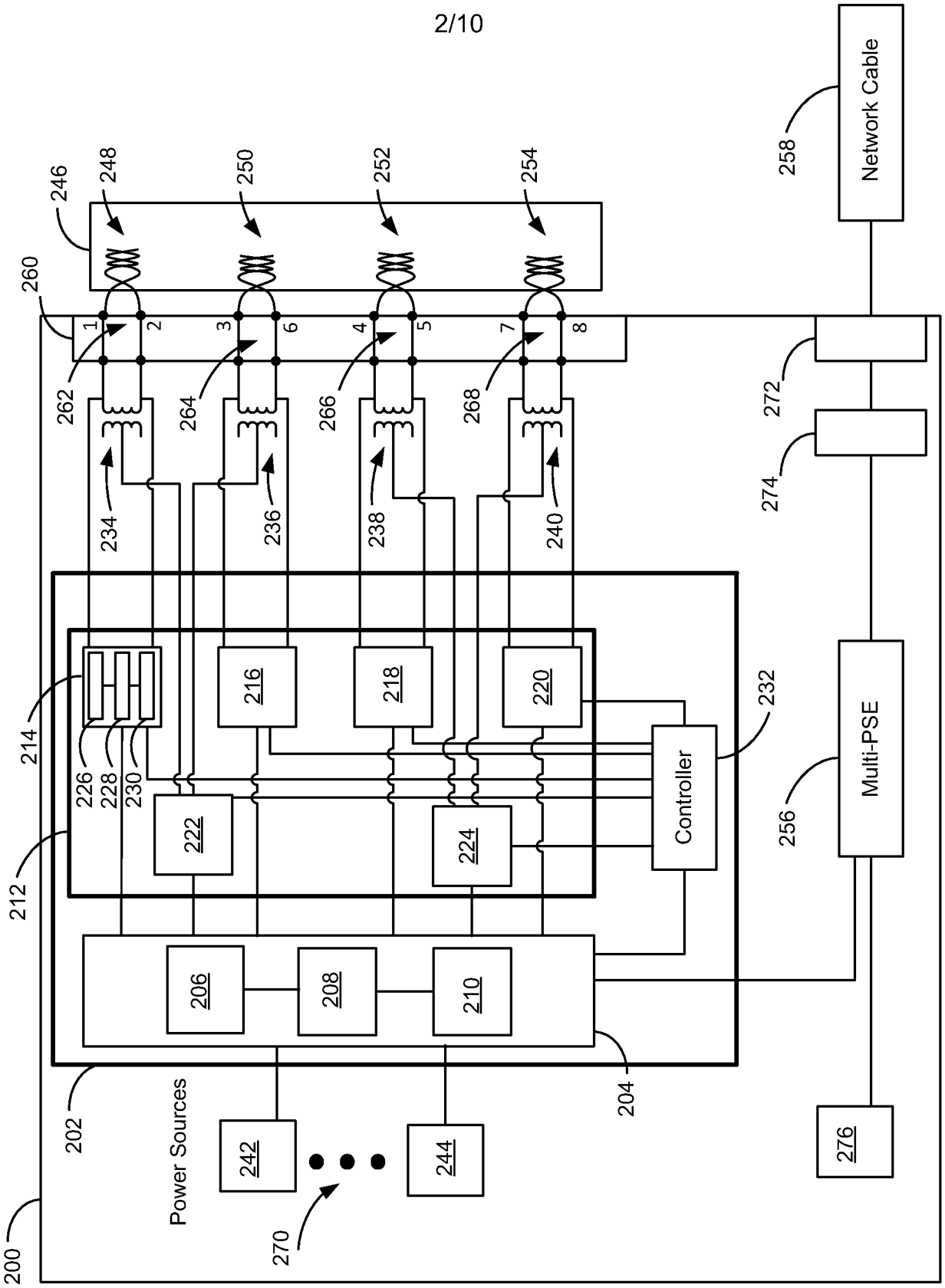

106
116
118
120
108
110
Multi-PSE 100
104
Second Circuitry
112
114
102
First Circuitry
122
Power Source

FIG. 1


Network Cable
Multi-PSE
Controller
Power Sources
200
202
204
206
208
210
212
214
216
218
220
222
224
226
228
230
232
234
236
238
240
242
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248
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252
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264
266
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270
272
274
276

FIG. 2

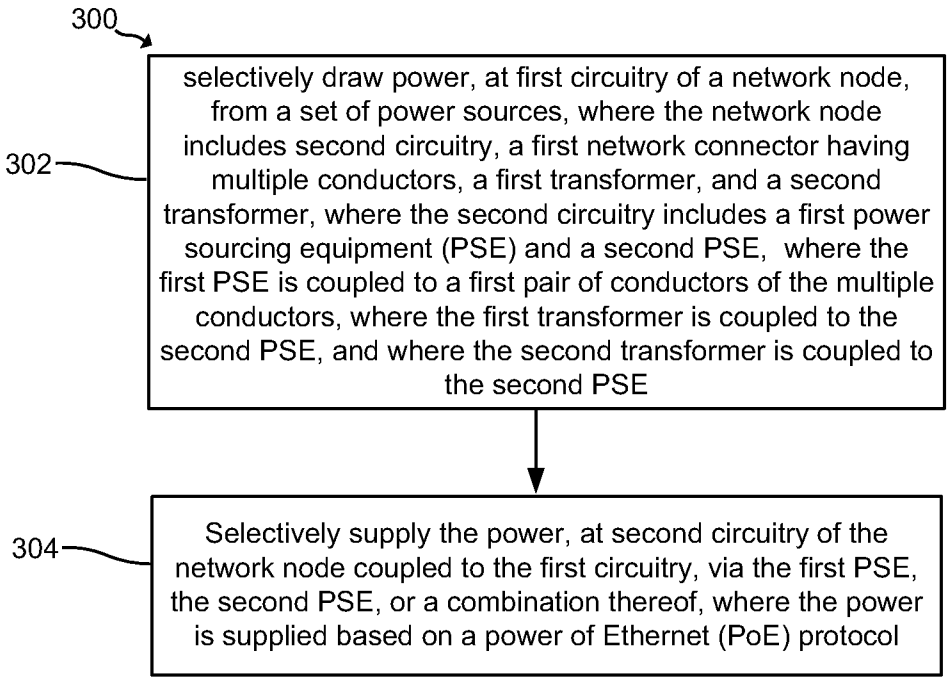
300
selectively draw power, at first circuitry of a network node, from a set of power sources, where the network node includes second circuitry, a first network connector having multiple conductors, a first transformer, and a second transformer, where the second circuitry includes a first power sourcing equipment (PSE) and a second PSE, where the first PSE is coupled to a first pair of conductors of the multiple conductors, where the first transformer is coupled to the second PSE, and where the second transformer is coupled to the second PSE
302
Selectively supply the power, at second circuitry of the network node coupled to the first circuitry, via the first PSE, the second PSE, or a combination thereof, where the power is supplied based on a power of Ethernet (PoE) protocol
304

FIG. 3

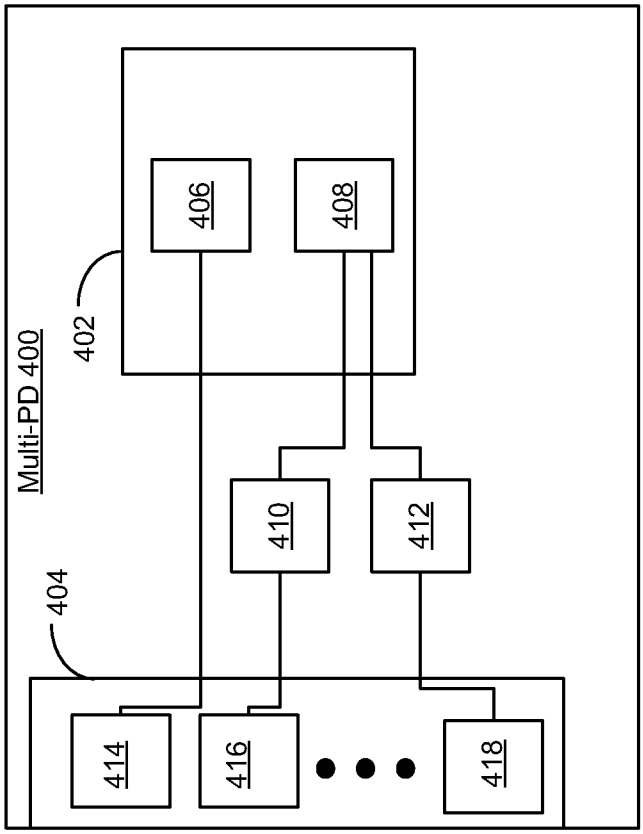

FIG. 4

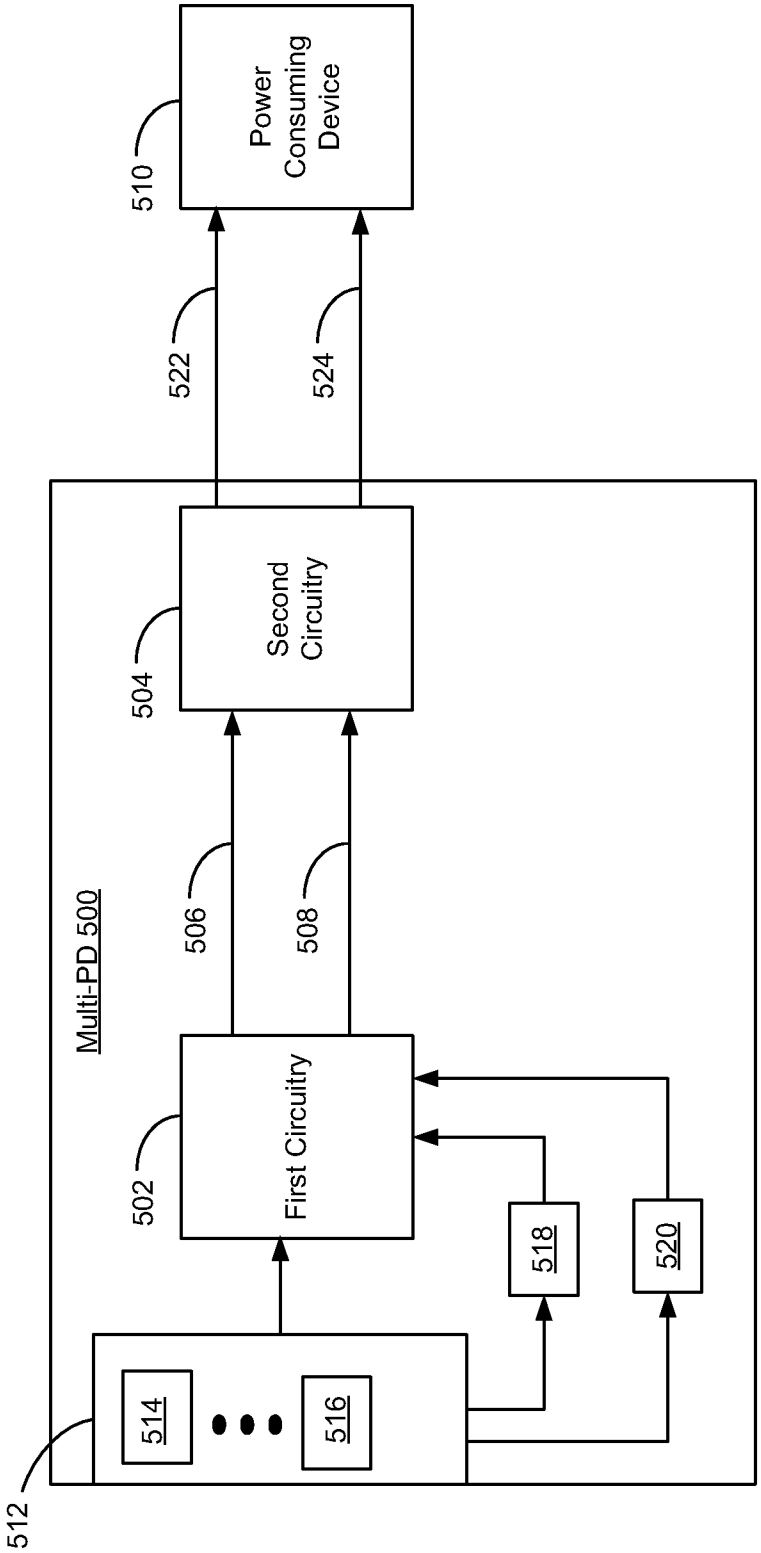
Power Consuming Device
510
522
524
Second Circuitry
504
506
508
Multi-PD 500
First Circuitry
502
518
520
514
516
512

FIG. 5

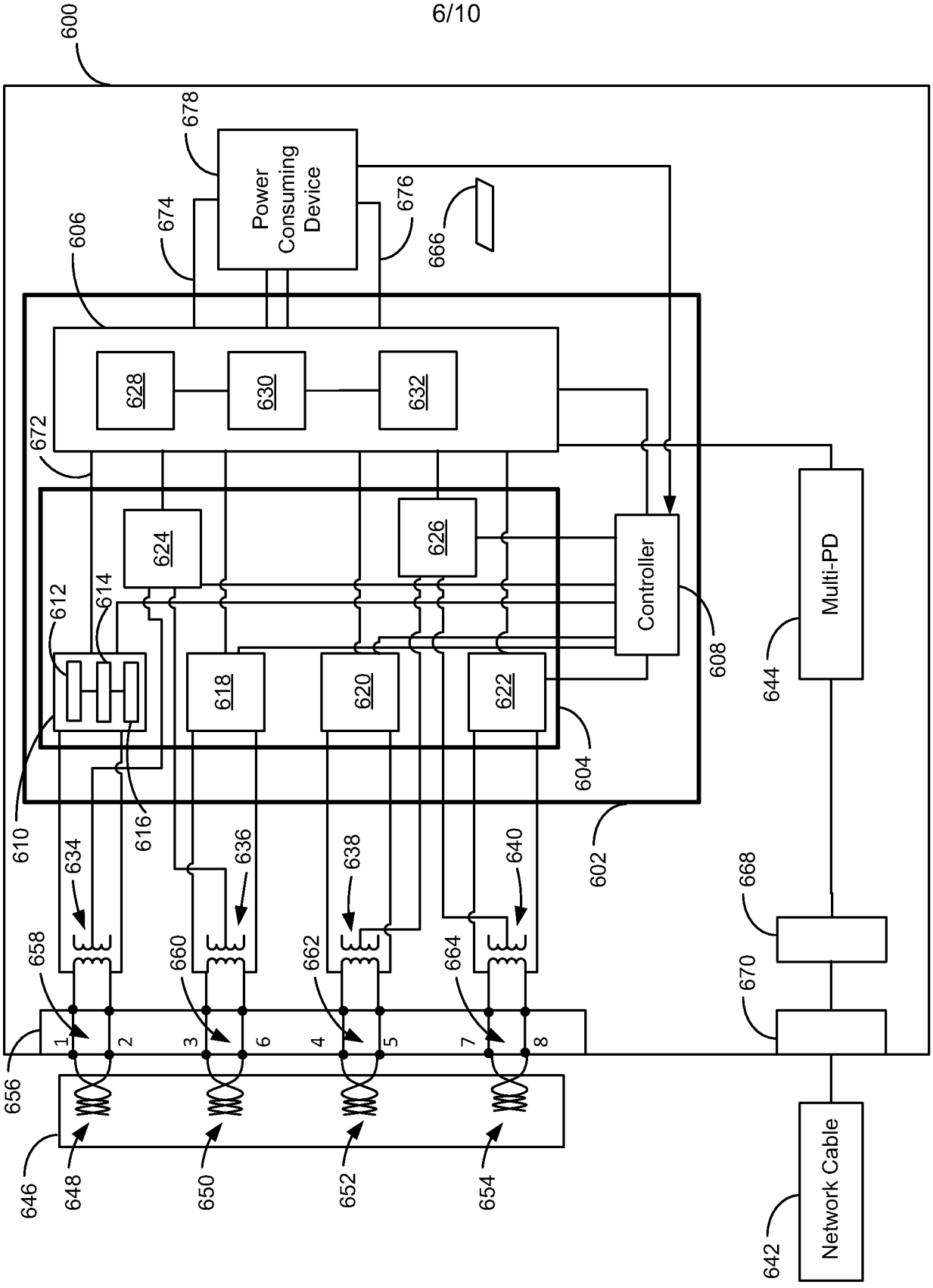
600
678
Power Consuming Device
674
676
666
606
628
630
632
672
624
626
Controller
612
614
618
620
622
608
644
Multi-PD
610
616
604
602
634
636
638
640
668
658
660
662
664
670
1
2
3
6
4
5
7
8
656
646
648
650
652
654
642
Network Cable

FIG. 6

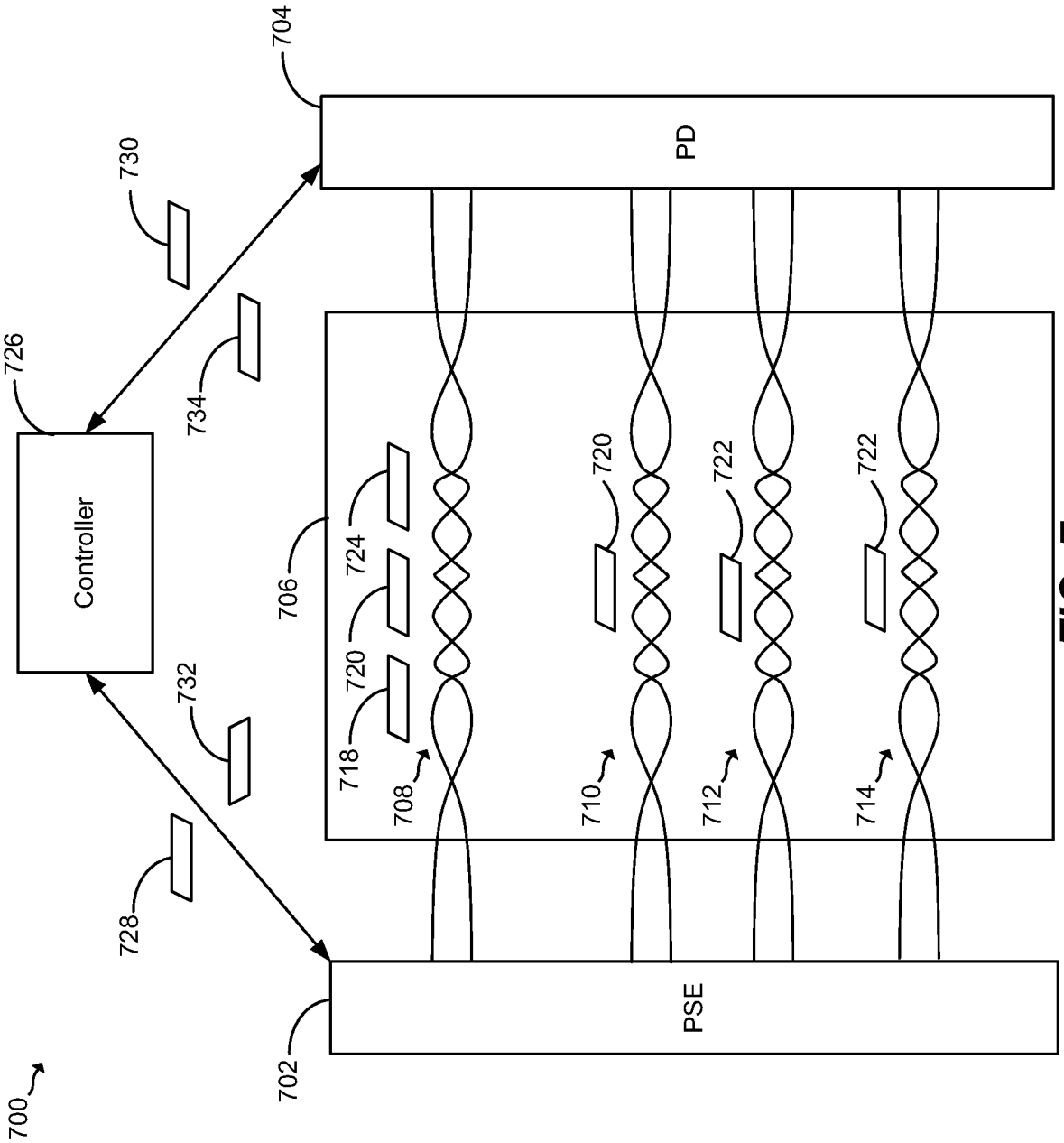
700
702
PSE
704
PD
706
708
710
712
714
718
720
720
722
722
724
726
Controller
728
730
732
734

FIG. 7

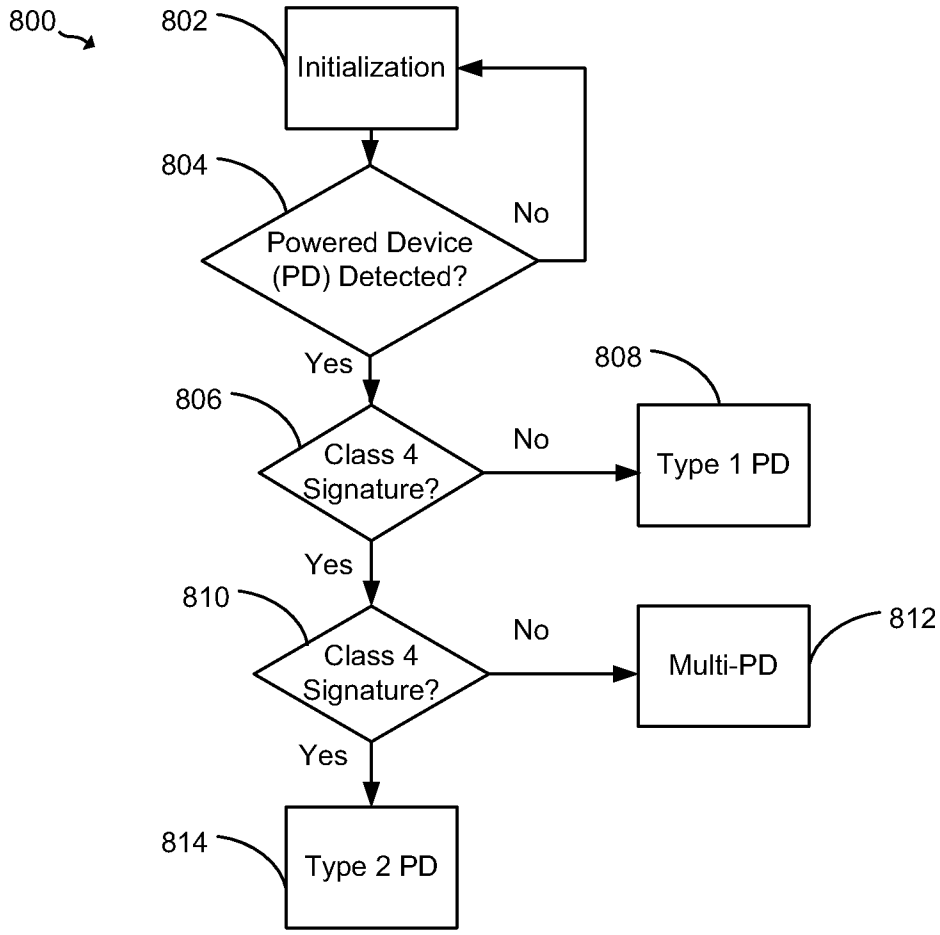
800
802
Initialization
804
Powered Device (PD) Detected?
No
Yes
808
806
Class 4 Signature?
No
Type 1 PD
Yes
810
Class 4 Signature?
No
Multi-PD
812
Yes
814
Type 2 PD

FIG. 8

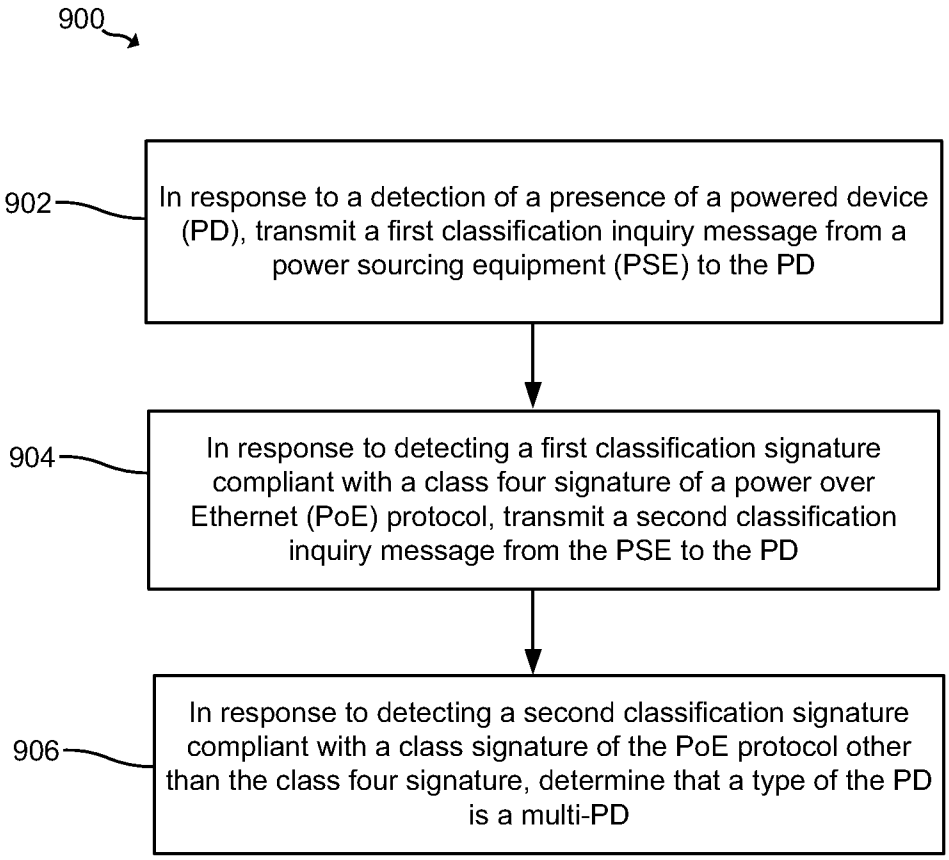
900
902
In response to a detection of a presence of a powered device (PD), transmit a first classification inquiry message from a power sourcing equipment (PSE) to the PD
904
In response to detecting a first classification signature compliant with a class four signature of a power over Ethernet (PoE) protocol, transmit a second classification inquiry message from the PSE to the PD
906
In response to detecting a second classification signature compliant with a class signature of the PoE protocol other than the class four signature, determine that a type of the PD is a multi-PD

FIG. 9

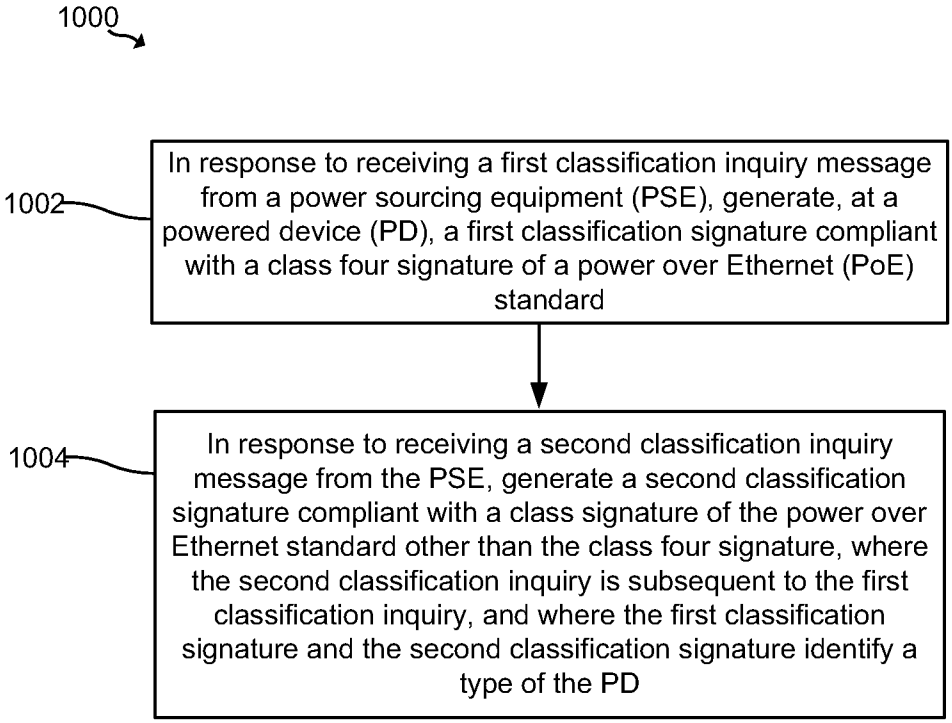
1000
1002
In response to receiving a first classification inquiry message from a power sourcing equipment (PSE), generate, at a powered device (PD), a first classification signature compliant with a class four signature of a power over Ethernet (PoE) standard
1004
In response to receiving a second classification inquiry message from the PSE, generate a second classification signature compliant with a class signature of the power over Ethernet standard other than the class four signature, where the second classification inquiry is subsequent to the first classification inquiry, and where the first classification signature and the second classification signature identify a type of the PD

FIG. 10