

WHAT IS CLAIMED IS:

CLAIMS

1. A method of wireless communication performed by a user equipment (UE), ~~of a cellular network,~~ comprising:

 receiving, while the UE is using a first modulation order for a physical uplink control channel, ~~(PUCCH),~~ a signaling message from a base station of the cellular network that identifies a second modulation order, for the physical uplink control channel,

 wherein the second modulation order is different from the first modulation order; determining one of a PUCCH format 3 and
~~providing the physical a PUCCH format 4, when the second modulation order comprises a $\pi/2$ BPSK modulation, upon receiving the signaling message and based in part on the received signaling message; and transmitting an uplink control channel using the second modulation order and the determined PUCCH format.~~

2. The method of claim 1, wherein the signaling message is a radio resource control message or a dynamic signaling message.

3. The method of claim 1, further comprising:

 providing a power headroom report,
 —wherein the power headroom report includes information for identifying —the link budget.

4. The method of claim 1, wherein the first modulation order is a quadrature phase shift keying format.

5. The method of claim 1, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~6. The method of claim 1, wherein the second modulation order is one of:~~

~~a $\pi/2$ binary phase shift keying (BPSK) format,~~

~~an 8-phase shift keying (8PSK) format, or~~

~~a 16 quadrature amplitude modulation (16-QAM) format.~~

~~7~~6. The method of claim 1, wherein the UE is associated with less than a threshold power headroom, and

wherein the UE is configured to switch from the first modulation order to the second modulation order to reduce a modulation order of the UE.

~~8~~7. The method of claim 1, wherein the UE is associated with greater than or equal to a threshold power headroom, and

wherein the UE is configured to switch from the first modulation order to the second modulation order to increase a modulation order of the UE.

~~9~~8. The method of claim 1, wherein the UE is associated with a particular power headroom, and

wherein the UE is configured to maintain the second modulation order to maintain a modulation order of the UE.

~~10~~9. The method of claim 1, wherein the second modulation order is selected based at least in part on a link budget of the UE.

~~11~~10. A method of wireless communication performed by a base station (BS) ~~of a cellular network~~, comprising:

determining one of a physical uplink control channel (PUCCH) format 3 and a PUCCH format 4, and a second modulation order comprising a $\pi/2$ BPSK modulation for a physical uplink control channel; providing, while a user equipment (UE) is using a first modulation order for a physical uplink control channel, a signaling message that identifies a second modulation order, for the physical uplink control channel,

wherein a signaling message of the cellular network to the UE that indicates the second modulation order is, upon determining the PUCCH format and the second modulation order, for the physical uplink control channel, wherein the second modulation order is different from the first modulation order; and

receiving the physical uplink control channel using the second modulation order and the determined PUCCH format.

~~12~~11. The method of claim ~~11~~10, wherein the signaling message is a radio resource control message or a dynamic signaling message.

~~13~~12. The method of claim ~~11~~10, further comprising:

_receiving a power headroom report,

_wherein the power headroom report includes information for identifying the link budget.

~~14~~13. The method of claim ~~11~~10, wherein the first modulation order is a quadrature phase shift keying format.

~~15~~14. The method of claim ~~11~~10, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~16~~15. The method of claim ~~11~~, ~~wherein the second modulation order is one of:~~

~~a $\pi/2$ binary phase shift keying (BPSK) format,~~

~~an 8-phase shift keying (8PSK) format, or~~

~~a 16-quadrature amplitude modulation (16-QAM) format.~~

~~17. The method of claim ~~11~~10, further comprising:~~

~~_identifying the link budget of the UE; and~~

~~_selecting the second modulation order, for the physical uplink control channel of the UE, based at least in part on the link budget of the UE.~~

~~18~~16. The method of claim ~~11~~10, further comprising:

_determining, based at least in part on the link budget of the UE, that the UE is operating with less than a threshold power headroom;

_determining to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with less than the threshold power headroom,

_wherein the second modulation order is less than the first modulation order;

and

_wherein provide the signaling message comprises:

_providing the signaling message to cause the switch from the first modulation order to the second modulation order.

~~19~~17. The method of claim ~~11~~10, further comprising:

_determining, based at least in part on the link budget of the UE, that the UE is operating with greater than or equal to a threshold power headroom;

_determining to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with greater than or equal to the threshold power headroom,

_wherein the second modulation order is greater than the first modulation order;

and

_wherein providing the signaling message comprises:

_providing the signaling message to cause the switch from the first modulation order to the second modulation order.

~~20~~18. The method of claim ~~11~~10, further comprising:

_determining, based at least in part on the link budget of the UE and after receiving the physical uplink control channel using the second modulation order, that the UE is operating with a particular power headroom; and causing the UE to maintain the second modulation order.

~~causing the UE to maintain the second modulation order.~~

~~21~~19. The method of claim ~~11~~10, wherein the second modulation order is selected based at least in part on a link budget of the UE.

~~22~~20. A user equipment (UE) of a cellular network for wireless communication, comprising:

a memory; and one or more processors operatively coupled to the memory, the memory and the one or more processors configured to:

_receive, while the UE is using a first modulation order for a physical uplink control channel, (PUCCH), a signaling message from a base station of the cellular network that identifies a second modulation order, for the physical uplink control channel,

_wherein the second modulation order is different from the first modulation order; determine one of a PUCCH format 3 and

~~provide the physical~~ a PUCCH format 4, when the second modulation order comprises $\pi/2$ BPSK modulation upon receiving the signaling message and based in part on the received signaling message; and transmit an uplink control channel using the second modulation order and the determined PUCCH format.

~~23~~21. The UE of claim ~~22~~,20, wherein the signaling message is a radio resource control message or a dynamic signaling message.

~~24~~22. The UE of claim ~~22~~,20, wherein the one or more processors are further configured to:
 provide a power headroom report,
 wherein the power headroom report includes information for identifying the link budget.

~~25~~23. The UE of claim ~~22~~,20, wherein the first modulation order is a quadrature phase shift keying format.

~~26~~24. The UE of claim ~~22~~,20, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~27~~25. The UE of claim ~~22~~, wherein the second modulation order is one of:
 a $\pi/2$ binary phase shift keying (BPSK) format,
 an 8 phase shift keying (8PSK) format, or
 a 16 quadrature amplitude modulation (16 QAM) format.

~~28~~. The UE of claim ~~22~~,20, wherein the UE is associated with less than a threshold power headroom, and
 wherein the UE is configured to switch from the first modulation order to the second modulation order to reduce a modulation order of the UE.

~~29~~26. The UE of claim ~~22~~,20, wherein the UE is associated with greater than or equal to a threshold power headroom, and
 wherein the UE is configured to switch from the first modulation order to the second modulation order to increase a modulation order of the UE.

~~30~~27. The UE of claim ~~22~~,20, wherein the UE is associated with a particular power headroom, and
 wherein the UE is configured to maintain the second modulation order to maintain a modulation order of the UE.

~~3128~~. The UE of claim ~~22,20~~, wherein the second modulation order is selected based at least in part on a link budget of the UE.

~~3229~~. A base station (BS) of a cellular network for wireless communication, comprising:
a memory; and one or more processors operatively coupled to the memory, the memory and the one or more processors configured to:

determine one of a physical uplink control channel (PUCCH) format 3 and a PUCCH format 4, and a second modulation order comprising a $\pi/2$ BPSK modulation for a physical uplink control channel; provide, while a user equipment (UE) is using a first modulation order for a ~~physical uplink control channel~~, ~~a signaling message that identifies a second modulation order, for the physical uplink control channel,~~

wherein a signaling message of the cellular network to the UE that indicates the second modulation order is, upon determining the PUCCH format and the second modulation order, for the physical uplink control channel, wherein the second modulation order is different from the first modulation order; and

~~receive~~ receiving the physical uplink control channel using the second modulation order and the determined PUCCH format.

~~3330~~. The BS of claim ~~32,29~~, wherein the signaling message is a radio resource control message or a dynamic signaling message.

~~3431~~. The BS of claim ~~32,29~~, wherein the one or more processors are further configured to:
_receive a power headroom report,
_wherein the power headroom report includes information for identifying the link budget.

~~3532~~. The BS of claim ~~32,29~~, wherein the first modulation order is a quadrature phase shift keying format.

~~3633~~. The BS of claim ~~32,29~~, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~3734. The BS of claim 32, wherein the second modulation order is one of:~~

~~a $\pi/2$ binary phase shift keying (BPSK) format,~~

~~an 8-phase shift keying (8PSK) format, or~~

~~a 16-quadrature amplitude modulation (16-QAM) format.~~

~~38. The BS of claim 32,29, wherein the one or more processors are further configured to:~~

~~_identify the link budget of the UE; and~~

~~_select the second modulation order, for the physical uplink control channel of the UE, based at least in part on the link budget of the UE.~~

~~3935. The BS of claim 32,29, wherein the one or more processors are further configured to:~~

~~_determine, based at least in part on the link budget of the UE, that the UE is operating with less than a threshold power headroom;~~

~~_determine to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with less than the threshold power headroom, wherein the second modulation order is less than the first modulation order; and wherein the one or more processors, when configured to provide the signaling message, are configured to: provide the signaling message to cause the switch from the first modulation order to the second modulation order.~~

~~wherein the second modulation order is less than the first modulation order;~~

~~and~~

~~wherein the one or more processors, when configured to provide the signaling message, are configured to:~~

~~provide the signaling message to cause the switch from the first modulation order to the second modulation order.~~

~~4036. The BS of claim 32,29, wherein the one or more processors are further configured to:~~

~~_determine, based at least in part on the link budget of the UE, that the UE is operating with greater than or equal to a threshold power headroom;~~

~~_determine to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with greater than or equal to the threshold power headroom,~~

~~_wherein the second modulation order is greater than the first modulation order;~~

~~and~~

wherein the one or more processors, when configured to provide the signaling message, are configured to:

provide the signaling message to cause the switch from the first modulation order to the second modulation order.

4137. The BS of claim ~~32~~,29, wherein the one or more processors are further configured to:

determine, based at least in part on the link budget of the UE and after receiving the physical uplink control channel using the second modulation order, that the UE is operating with a particular power headroom; and cause the UE to maintain the second modulation order.

~~cause the UE to maintain the second modulation order.~~

4238. The BS of claim ~~32~~,29, wherein the second modulation order is selected based at least in part on a link budget of the UE.

4339. A non-transitory computer-readable medium storing one or more instructions for wireless communication, the one or more instructions comprising: one or more instructions that, when executed by one or more processors of a user equipment (UE) of a cellular network, cause the one or more processors to: receive, while the UE is using a first modulation order for a physical uplink control channel (PUCCH), a signaling message from a base station of the cellular network that identifies a second modulation order, for the physical uplink control channel, wherein the second modulation order is different from the first modulation order; determine one of a PUCCH format 3 and a PUCCH format 4, when the second modulation order comprises $\pi/2$ BPSK modulation upon receiving the signaling message and based in part on the received signaling message; and transmit an uplink control channel using the second modulation order and the determined PUCCH format.

~~one or more instructions that, when executed by one or more processors of a user equipment (UE), cause the one or more processors to:~~

~~receive, while the UE is using a first modulation order for a physical uplink control channel, a signaling message that identifies a second modulation order, for the physical uplink control channel,~~

~~wherein the second modulation order is different from the first modulation order; and~~

~~provide the physical uplink control channel using the second modulation order.~~

4440. The non-transitory computer-readable medium of claim ~~43~~,39, wherein the signaling message is a radio resource control message or a dynamic signaling message.

~~4541.~~ The non-transitory computer-readable medium of claim ~~43,39~~, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:

 provide a power headroom report,
 wherein the power headroom report includes information for identifying the link budget.

~~4642.~~ The non-transitory computer-readable medium of claim ~~43,39~~, wherein the first modulation order is a quadrature phase shift keying format.

~~4743.~~ The non-transitory computer-readable medium of claim ~~43,39~~, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~4844.~~ The non-transitory computer-readable medium of claim ~~43~~, ~~wherein the second modulation order is one of:~~

~~a $\pi/2$ binary phase shift keying (BPSK) format,~~
 ~~an 8 phase shift keying (8PSK) format, or~~
 ~~a 16 quadrature amplitude modulation (16-QAM) format.~~

~~49.~~ ~~The non-transitory computer-readable medium of claim 43,39,~~ wherein the UE is associated with less than a threshold power headroom, and
 wherein the UE is configured to switch from the first modulation order to the second modulation order to reduce a modulation order of the UE.

~~5045.~~ The non-transitory computer-readable medium of claim ~~43,39~~, wherein the UE is associated with greater than or equal to a threshold power headroom, and
 wherein the UE is configured to switch from the first modulation order to the second modulation order to increase a modulation order of the UE.

~~5146.~~ The non-transitory computer-readable medium of claim ~~43,39~~, wherein the UE is associated with a particular power headroom, and
 wherein the UE is configured to maintain the second modulation order to maintain a modulation order of the UE.

5247. The non-transitory computer-readable medium of claim 43,39, wherein the second modulation order is selected based at least in part on a link budget of the UE.

5348. A non-transitory computer-readable medium storing one or more instructions for wireless communication, the one or more instructions comprising:

one or more instructions that, when executed by one or more processors of a base station (BS), of a cellular network, cause the one or more processors to:

determine one of a physical uplink control channel (PUCCH) format 3 and a PUCCH format 4, and a second modulation order comprising a $\pi/2$ BPSK modulation for a physical uplink control channel; provide, while a user equipment (UE) is using a first modulation order for a physical uplink control channel, ~~a signaling message that identifies a second modulation order, for the physical uplink control channel,~~

~~wherein a signaling message of the cellular network to the UE that a~~
indicates the second modulation order is, upon determining the PUCCH format and the second modulation order, for the physical uplink control channel, wherein the second modulation order is different from the first modulation order; and

receive the physical uplink control channel using the second modulation order and the determined PUCCH format.

5449. The non-transitory computer-readable medium of claim 53,48, wherein the signaling message is a radio resource control message or a dynamic signaling message.

5550. The non-transitory computer-readable medium of claim 53,48, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:

receive a power headroom report,
wherein the power headroom report includes information for identifying the link budget.

5651. The non-transitory computer-readable medium of claim 53,48, wherein the first modulation order is a quadrature phase shift keying format.

~~57~~52. The non-transitory computer-readable medium of claim ~~53~~,48, wherein the physical uplink control channel supports greater than 2 bits of payload.

~~58~~53. The non-transitory computer-readable medium of claim ~~53~~,~~wherein the second modulation order is one of:~~

- ~~a $\pi/2$ binary phase shift keying (BPSK) format,~~
- ~~an 8-phase shift keying (8PSK) format, or~~
- ~~a 16-quadrature amplitude modulation (16-QAM) format.~~

~~59~~. ~~The non-transitory computer-readable medium of claim ~~53~~,48, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:~~

- ~~_identify the link budget of the UE; and~~
- ~~_select the second modulation order, for the physical uplink control channel of the UE, based at least in part on the link budget of the UE.~~

~~60~~54. The non-transitory computer-readable medium of claim ~~53~~,48, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:

~~_determine, based at least in part on the link budget of the UE, that the UE is operating with less than a threshold power headroom;~~

~~_determine to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with less than the threshold power headroom,~~

~~_wherein the second modulation order is less than the first modulation order;~~

~~and~~

~~_wherein the one or more instructions, that cause the one or more processors to provide the signaling message, cause the one or more processors to: provide the signaling message to cause the switch from the first modulation order to the second modulation order.~~

~~provide the signaling message to cause the switch from the first modulation order to the second modulation order.~~

6155. The non-transitory computer-readable medium of claim 53,48, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:

- _determine, based at least in part on the link budget of the UE, that the UE is operating with greater than or equal to a threshold power headroom;

- _determine to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with greater than or equal to the threshold power headroom,

- _wherein the second modulation order is greater than the first modulation order;

- and

- _wherein the one or more instructions, that cause the one or more processors to provide the signaling message, cause the one or more processors to:

- _provide the signaling message to cause the switch from the first modulation order to the second modulation order.

6256. The non-transitory computer-readable medium of claim 53,48, wherein the one or more instructions, when executed by the one or more processors, further cause the one or more processors to:

- _determine, based at least in part on the link budget of the UE and after receiving the physical uplink control channel using the second modulation order, that the UE is operating with a particular power headroom; and cause the UE to maintain the second modulation order.

- ~~cause the UE to maintain the second modulation order.~~

6357. The non-transitory computer-readable medium of claim 53,48, wherein the second modulation order is selected based at least in part on a link budget of the UE.

64. ~~An apparatus for wireless communication, comprising:~~

- ~~means for receiving, while the apparatus is using a first modulation order for a physical uplink control channel, a signaling message that identifies a second modulation order, for the physical uplink control channel;~~

- ~~wherein the second modulation order is different from the first modulation order; and~~

- ~~means for providing the physical uplink control channel using the second modulation order.~~

65. The apparatus of claim 64, wherein the signaling message is a radio resource control message or a dynamic signaling message.

66. The apparatus of claim 64, further comprising:

means for providing a power headroom report,

wherein the power headroom report includes information for identifying the link budget.

67. The apparatus of claim 64, wherein the first modulation order is a quadrature phase shift keying format.

68. The apparatus of claim 64, wherein the physical uplink control channel supports greater than 2 bits of payload.

69. The apparatus of claim 64, wherein the second modulation order is one of:

a $\pi/2$ binary phase shift keying (BPSK) format,

an 8-phase shift keying (8PSK) format, or

a 16 quadrature amplitude modulation (16-QAM) format.

70. The apparatus of claim 64, wherein the apparatus is associated with less than a threshold power headroom, and

wherein the apparatus is configured to switch from the first modulation order to the second modulation order to reduce a modulation order of the apparatus.

71. The apparatus of claim 64, wherein the apparatus is associated with greater than or equal to a threshold power headroom, and

wherein the apparatus is configured to switch from the first modulation order to the second modulation order to increase a modulation order of the apparatus.

72. The apparatus of claim 64, wherein the apparatus is associated with a particular power headroom, and

wherein the apparatus is configured to maintain the second modulation order to maintain a modulation order of the apparatus.

73. The apparatus of claim 64, wherein the second modulation order is selected based at least in part on a link budget of the apparatus.

74. An apparatus for wireless communication, comprising:

means for providing, while a user equipment (UE) is using a first modulation order for a physical uplink control channel, a signaling message that identifies a second modulation order, for the physical uplink control channel;

wherein the second modulation order is different from the first modulation order; and

means for receiving the physical uplink control channel using the second modulation order.

75. The apparatus of claim 74, wherein the signaling message is a radio resource control message or a dynamic signaling message.

76. The apparatus of claim 74, further comprising:

means for receiving a power headroom report;

wherein the power headroom report includes information for identifying the link budget.

77. The apparatus of claim 74, wherein the first modulation order is a quadrature phase shift keying format.

78. The apparatus of claim 74, wherein the physical uplink control channel supports greater than 2 bits of payload.

79. The apparatus of claim 74, wherein the second modulation order is one of:

a $\pi/2$ binary phase shift keying (BPSK) format,

an 8-phase shift keying (8PSK) format, or

a 16 quadrature amplitude modulation (16-QAM) format.

80. The apparatus of claim 74, further comprising:

means for identifying the link budget of the UE; and

means for selecting the second modulation order, for the physical uplink control channel of the UE, based at least in part on the link budget of the UE.

81. The apparatus of claim 74, further comprising:

means for determining, based at least in part on the link budget of the UE, that the UE is operating with less than a threshold power headroom;

means for determining to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with less than the threshold power headroom,

wherein the second modulation order is less than the first modulation order;

and

wherein the means for providing the signaling message comprises:

means for providing the signaling message to cause the switch from the first modulation order to the second modulation order.

82. The apparatus of claim 74, further comprising:

means for determining, based at least in part on the link budget of the UE, that the UE is operating with greater than or equal to a threshold power headroom;

means for determining to cause a switch from the first modulation order to the second modulation order based at least in part on determining that the UE is operating with greater than or equal to the threshold power headroom,

wherein the second modulation order is greater than the first modulation order;

and

wherein the means for providing the signaling message comprises:

means for providing the signaling message to cause the switch from the first modulation order to the second modulation order.

83. The apparatus of claim 74, further comprising:

means for determining, based at least in part on the link budget of the UE and after receiving the physical uplink control channel using the second modulation order, that the UE is operating with a particular power headroom; and

means for causing the UE to maintain the second modulation order.

The apparatus of claim 74, wherein the second modulation order is selected based at least in part on a link budget of the UE.