

CLAIMS

What is claimed is:

- 1 1. A method for wireless communication at a user equipment (UE),
2 comprising:
3 receiving a downlink (DL) signal from a base station on one or more DL
4 beams;
5 identifying a selected DL beam of the one or more DL beams for
6 communications from the base station to the UE; and
7 transmitting a beam recovery or beam tracking message to the base station
8 using at least one of a resource or a waveform selected based at least in part on the selected
9 DL beam.
- 1 2. The method of claim 1, wherein the waveform comprises one of a
2 scheduling request or a random access channel (RACH) waveform.
- 1 3. The method of claim 1, wherein the DL signal comprises a
2 synchronization signal or a reference signal.
- 1 4. The method of claim 1, further comprising:
2 selecting the resource or waveform based at least in part on an index of the
3 selected DL beam or a symbol of a subframe of the DL signal of the selected DL beam.
- 1 5. The method of claim 1, wherein transmitting the beam recovery or
2 beam tracking message comprises: transmitting the beam recovery or beam tracking message
3 during an entire duration of a corresponding random access subframe.
- 1 6. The method of claim 1, wherein identifying the selected DL beam
2 comprises: identifying a preferred DL beam based at least in part on a signal strength of the
3 DL signal on the one or more DL beams, a signal quality of the DL signal on the one or more
4 DL beams, or combinations thereof.
- 1 7. The method of claim 1, wherein identifying the selected DL beam
2 comprises: identifying the DL beam based at least in part on the DL signal on the one or more
3 DL beams meeting a transmit power condition.

- 1 **8.** The method of claim 1, further comprising:
2 selecting at least one of the resource or the waveform for transmission of the
3 beam recovery or beam tracking message to the base station, the resource or the waveform
4 being selected based at least in part on the selected DL beam.
- 1 **9.** The method of claim 1, wherein a correspondence is absent between
2 the one or more DL beams and one or more uplink (UL) receive beams at the UE, wherein
3 the absent correspondence is associated with the one or more DL beams having different
4 beam directions than the one or more UL beams.
- 1 **10.** The method of claim 1, further comprising:
2 identifying that correspondence is absent between the one or more DL beams
3 from the base station and one or more uplink (UL) receive beams at the base station by
4 receiving information from the base station in a master information block (MIB) or a system
5 information block (SIB).
- 1 **11.** The method of claim 10, further comprising:
2 transmitting the beam recovery or beam tracking message to the base station
3 during an entire duration of a random access channel (RACH) subframe based at least in part
4 on the identification of the absent correspondence.
- 1 **12.** The method of claim 10, further comprising:
2 selecting the resource or waveform based at least in part on the identification
3 of the absent correspondence.
- 1 **13.** The method of claim 1, further comprising:
2 transmitting an indication that correspondence is absent between the one or
3 more DL beams from the base station and one or more uplink (UL) beams at the UE; and
4 transmitting the indication of the absent correspondence in a random access
5 channel (RACH) message 3, a physical uplink control channel (PUCCH), or a physical uplink
6 shared channel (PUSCH).
- 1 **14.** The method of claim 13, further comprising:

2 transmitting the beam recovery or beam tracking message to the base station
3 during a first symbol of a first random access subframe and a second symbol of a second
4 random access subframe.

1 **15.** The method of claim 1, further comprising:
2 receiving an indication of a nature of correspondence between the one or more
3 DL beams at the base station and one or more uplink (UL) beams at the base station, wherein
4 the nature of correspondence corresponds to one of: full correspondence, partial
5 correspondence, or no correspondence.

1 **16.** The method of claim 15, further comprising:
2 determining that correspondence is present based on the indication of the
3 nature of correspondence; and
4 selecting a transmission time for transmitting the beam recovery or beam
5 tracking message to the base station based on the present correspondence, wherein the
6 transmission time comprises a symbol of a corresponding random access subframe.

1 **17.** The method of claim 15, further comprising:
2 determining that there is partial correspondence based on the indication of the
3 nature of correspondence; and
4 selecting a transmission time for transmitting the beam recovery or beam
5 tracking message to the base station based on the partial correspondence, wherein the
6 transmission time comprises multiple symbols of a corresponding random access subframe.

1 **18.** The method of claim 15, further comprising:
2 selecting the resource or waveform based at least in part on a symbol
3 associated with the DL signal and the indication of the nature of correspondence.

1 **19.** The method of claim 15, further comprising:
2 receiving the indication of the nature of correspondence over a physical
3 broadcast channel (PBCH) or an extended PBCH (ePBCH), or in a master information block
4 (MIB) or a system information block (SIB).

1 **20.** The method of claim 1, wherein the selected DL beam from the base
2 station is different from a selected uplink (UL) beam from the UE.

1 **21.** The method of claim 1, wherein the one or more DL beams are within
2 a single symbol of a synchronization subframe, wherein selecting the resource or the
3 waveform for transmission of the beam recovery or beam tracking message comprises:
4 selecting the resource or the waveform based at least in part on the symbol of the selected DL
5 beam.

1 **22.** The method of claim 1, wherein the resource is associated with one or
2 more tones in a component carrier, or a component carrier, or a combination thereof.

1 **23.** The method of claim 1, further comprising:
2 selecting a combination of the resource and the waveform to transmit the
3 scheduling request to the base station.

1 **24.** A method for wireless communication at a base station, comprising:
2 transmitting a downlink (DL) signal on one or more DL beams;
3 receiving, on at least one of a resource or a waveform, a beam recovery or
4 beam tracking message from a user equipment (UE);
5 identifying, based at least in part on the resource or the waveform, a selected
6 DL beam of the one or more DL beams for communications from the base station to the UE;
7 and
8 transmitting one or more subsequent messages to the UE using the selected
9 DL beam.

1 **25.** The method of claim 24, wherein identifying the selected DL beam
2 comprises: associating the resource or the waveform with an index of the selected DL beam
3 or with a symbol of a subframe of the DL signal of the selected DL beam.

1 **26.** The method of claim 24, wherein receiving the beam recovery or beam
2 tracking message comprises: receiving the beam recovery or beam tracking message on a
3 plurality of uplink (UL) beams.

1 **27.** The method of claim 26, further comprising:
2 measuring a quality of the beam recovery or beam tracking message received
3 on the plurality of UL beams; and

4 determining a selected UL beam for communications from the UE to the base
5 station based at least in part on the quality.

1 **28.** The method of claim 27, wherein measuring the quality of the beam
2 recovery or beam tracking message comprises: measuring one or more of a reference signal
3 received power (RSRP), a received signal strength indicator (RSSI), a reference signal
4 received quality (RSRQ), a signal to noise ratio (SNR), or a signal to interference plus noise
5 ratio (SINR).

1 **29.** The method of claim 24, wherein a correspondence is absent between
2 the one or more DL beams from the base station and one or more uplink (UL) beams at the
3 base station, wherein the absent correspondence is associated with the one or more DL beams
4 having different beam directions than the one or more UL receive beams.

1 **30.** The method of claim 24, further comprising:
2 identifying that correspondence is absent between the one or more DL beams
3 from the base station and one or more uplink (UL) beams at the base station; and
4 transmitting the indication of the absent correspondence in a master
5 information block (MIB) or a system information block (SIB).

1 **31.** An apparatus for wireless communication at a user equipment (UE),
2 comprising:
3 means for receiving a downlink (DL) signal from a base station on one or
4 more DL beams;
5 means for identifying a selected DL beam of the one or more DL beams for
6 communications from the base station to the UE; and
7 means for transmitting a beam recovery or beam tracking message to the base
8 station using at least one of a resource or a waveform selected based at least in part on the
9 selected DL beam.

1 **32.** The apparatus of claim 31, further comprising:
2 means for selecting the resource or waveform based at least in part on an index
3 of the selected DL beam or a symbol of a subframe of the DL signal of the selected DL beam.

1 **33.** The apparatus of claim 31, wherein the means for transmitting the
2 beam recovery or beam tracking message comprises: means for transmitting the beam

3 recovery or beam tracking message during an entire duration of a corresponding random
4 access subframe.

1 **34.** The apparatus of claim 31, wherein the means for identifying the
2 selected DL beam comprises: means for identifying a preferred DL beam based at least in
3 part on a signal strength of the DL signal on the one or more DL beams, a signal quality of
4 the DL signal on the one or more DL beams, or combinations thereof.

1 **35.** The apparatus of claim 31, wherein the means for identifying the
2 selected DL beam comprises: means for identifying the DL beam based at least in part on the
3 DL signal on the one or more DL beams meeting a transmit power condition.

1 **36.** The apparatus of claim 31, further comprising:
2 means for selecting at least one of the resource or the waveform for
3 transmission of the beam recovery or beam tracking message to the base station, the resource
4 or the waveform being selected based at least in part on the selected DL beam.

1 **37.** The apparatus of claim 31, further comprising:
2 means for identifying that correspondence is absent between the one or more
3 DL beams from the base station and one or more uplink (UL) receive beams at the base
4 station by receiving information from the base station in a master information block (MIB) or
5 a system information block (SIB).

1 **38.** The apparatus of claim 37, further comprising:
2 means for transmitting the beam recovery or beam tracking message to the
3 base station during an entire duration of a random access channel (RACH) subframe based at
4 least in part on the identification of the absent correspondence.

1 **39.** The apparatus of claim 37, further comprising:
2 means for selecting the resource or waveform based at least in part on the
3 identification of the absent correspondence.

1 **40.** The apparatus of claim 31, further comprising:
2 means for transmitting an indication that correspondence is absent between the
3 one or more DL beams from the base station and one or more uplink (UL) beams at the UE;
4 and

5 means for transmitting the indication of the absent correspondence in a
6 random access channel (RACH) message 3, a physical uplink control channel (PUCCH), or a
7 physical uplink shared channel (PUSCH).

1 **41.** The apparatus of claim 40, further comprising:
2 means for transmitting the beam recovery or beam tracking message to the
3 base station during a first symbol of a first random access subframe and a second symbol of a
4 second random access subframe.

1 **42.** The apparatus of claim 31, further comprising:
2 means for receiving an indication of a nature of correspondence between the
3 one or more DL beams at the base station and one or more uplink (UL) beams at the base
4 station, wherein the nature of correspondence corresponds to one of: full correspondence,
5 partial correspondence, or no correspondence.

1 **43.** The apparatus of claim 42, further comprising:
2 means for determining that correspondence is present based on the indication
3 of the nature of correspondence; and
4 means for selecting a transmission time for transmitting the beam recovery or
5 beam tracking message to the base station based on the present correspondence, wherein the
6 transmission time comprises a symbol of a corresponding random access subframe.

1 **44.** The apparatus of claim 42, further comprising:
2 means for determining that there is partial correspondence based on the
3 indication of the nature of correspondence; and
4 means for selecting a transmission time for transmitting the beam recovery or
5 beam tracking message to the base station based on the partial correspondence, wherein the
6 transmission time comprises multiple symbols of a corresponding random access subframe.

1 **45.** The apparatus of claim 42, further comprising:
2 means for selecting the resource or waveform based at least in part on a
3 symbol associated with the DL signal and the indication of the nature of correspondence.

1 **46.** The apparatus of claim 42, further comprising:

2 means for receiving the indication of the nature of correspondence over a
3 physical broadcast channel (PBCH) or an extended PBCH (ePBCH), or in a master
4 information block (MIB) or a system information block (SIB).

1 **47.** The apparatus of claim 31, further comprising:

2 means for selecting a combination of the resource and the waveform to
3 transmit the scheduling request to the base station.

1 **48.** An apparatus for wireless communication at a base station, comprising:

2 means for transmitting a downlink (DL) signal on one or more DL beams;

3 means for receiving, on at least one of a resource or a waveform, a beam
4 recovery or beam tracking message from a user equipment (UE);

5 means for identifying, based at least in part on the resource or the waveform, a
6 selected DL beam of the one or more DL beams for communications from the base station to
7 the UE; and

8 means for transmitting one or more subsequent messages to the UE using the
9 selected DL beam.

1 **49.** The apparatus of claim 48, wherein the means for identifying the

2 selected DL beam comprises: means for associating the resource or the waveform with an
3 index of the selected DL beam or with a symbol of a subframe of the DL signal of the
4 selected DL beam.

1 **50.** The apparatus of claim 48, wherein the means for receiving the beam

2 recovery or beam tracking message comprises: means for receiving the beam recovery or
3 beam tracking message on a plurality of uplink (UL) beams.

1 **51.** The apparatus of claim 50, further comprising:

2 means for measuring a quality of the beam recovery or beam tracking message
3 received on the plurality of UL beams; and

4 means for determining a selected UL beam for communications from the UE
5 to the base station based at least in part on the quality.

1 **52.** The apparatus of claim 51, wherein the means for measuring the

2 quality of the beam recovery or beam tracking message comprises: means for measuring one
3 or more of a reference signal received power (RSRP), a received signal strength indicator

4 (RSSI), a reference signal received quality (RSRQ), a signal to noise ratio (SNR), or a signal
5 to interference plus noise ratio (SINR).

1 **53.** The apparatus of claim 48, further comprising:
2 means for identifying that correspondence is absent between the one or more
3 DL beams from the base station and one or more uplink (UL) beams at the base station; and
4 means for transmitting the indication of the absent correspondence in a master
5 information block (MIB) or a system information block (SIB).