

CLAIMS

1. A method of wireless communication, comprising: communicating, by a first wireless communication device with a second wireless communication device, a positioning reference signal (PRS) configuration for a set of subframes; determining, by the first wireless communication device, whether the PRS configuration includes a first indication format, a second indication format, or a combination of the first indication format and the second indication format; determining, by the first wireless communication device, a PRS time-frequency pattern for a first subframe in response to determining that the PRS configuration includes the combination of the first indication format and the second indication format; and communicating, by the first wireless communication device with the second wireless communication device in a narrowband communication frequency band, a first PRS including the determined PRS time-frequency pattern in the first subframe, wherein the first indication format includes a bitmap indicating a set of PRS subframes positioned within a group of contiguous subframes, the bitmap including a length corresponding to a number of subframes in the group of contiguous subframes, and the set of PRS subframes including the first subframe, and wherein the second indication format indicates a subset of the group of contiguous subframes by including at least one of a starting subframe for the subset, a number of subframes in the subset, or a periodicity of the subset, the subset including the first subframe.
2. The method of claim 1, wherein the first subframe includes a plurality of frequency tones in a plurality of symbols, and wherein the PRS time-frequency pattern includes time-frequency resources in a subset of the plurality of frequency tones in a subset of the plurality of symbols.
3. The method of claim 2, wherein the determining the PRS time-frequency pattern is further based on a predetermined PRS time-frequency pattern including at least one time-frequency resource in each symbol of the plurality of symbols.
4. The method of claim 2, wherein the narrowband communication frequency band is within at least one of a guard band of a wideband communication frequency band, an in-band frequency band within the wideband communication frequency band, or a standalone frequency band independent of the wideband communication frequency band.
5. The method of claim 4, wherein the wideband communication frequency band is a non-anchoring carrier frequency band of a wideband communication.
6. The method of claim 1, wherein the determining the PRS time-frequency pattern includes: determining that the PRS time-frequency pattern includes a predetermined PRS time-frequency pattern without puncturing any time-frequency resource from the predetermined PRS time-frequency pattern based on a predetermined narrowband communication reference signal when determining that the PRS configuration includes the combination of the first

indication format and the second indication format.

7. The method of claim 1, further comprising: communicating, by the first wireless communication device with the second wireless communication device in the narrowband communication frequency band, a plurality of PRSs in subframes that are within the subset of the group of contiguous subframes indicated by the second indication format and within the set of PRS subframes indicated by the first indication format when determining that the PRS configuration includes the combination of the first indication format and the second indication format, the plurality of PRSs including the first PRS.

8. The method of claim 1, further comprising: communicating, by the first wireless communication device with the second wireless communication device in the narrowband communication frequency band within a wideband communication frequency band, a plurality of PRSs by excluding a PRS transmission in one or more symbols within a subframe of at least one of the set of PRS subframes or the subset of the group of contiguous subframes, the one or more symbols associated with a wideband communication in the wideband communication frequency band, and the plurality of PRSs including the first PRS.

9. The method of claim 8, wherein the wideband communication is a Long-Term Evolution (LTE) communication, and wherein the one or more symbols include at least one of a transmission of a cell-specific reference signal (CRS) of the wideband communication or a transmission of a physical downlink control channel (PDCCH) signal of the wideband communication.

10. The method of claim 9, further comprising communicating, by the first wireless communication device with the second wireless communication device, assistance information including at least one of a LTE PRS configuration, a bandwidth of a LTE cell, a number of LTE control symbols, a maximum number of LTE control symbols, or a CSI-RS configuration for one or more serving and neighboring cells.

11. The method of claim 1, further comprising: communicating, by the first wireless communication device with the second wireless communication device in the narrowband communication frequency band, a first subset of a plurality of PRSs using a first beam during a first time period corresponding to the bitmap or the periodicity, the first subset of the plurality of PRSs including the first PRS; and communicating, by the first wireless communication device with the second wireless communication device in the narrowband communication frequency band, a second subset of the plurality of PRSs using a second beam during a repeating time period corresponding to the bitmap or the periodicity, the first beam and the second beam include different beam directions.

12. The method of claim 1, wherein the communicating includes: communicating the first PRS using a first beam, and wherein the method further comprises: communicating, by the first wireless communication device with the second wireless communication device in the narrowband communication frequency band, a second PRS in a second subframe using a

second beam, the first beam and the second beam include different beam directions.

13. The method of claim 1, further comprising communicating, by the first wireless communication device with the second wireless communication device, assistance information including at least one of a subframe offset with respect to a serving cell, a radio frame offset with respect to the serving cell, a number of cell-specific reference signal (CRS) ports, a number of narrowband reference signal (NRS) ports, or a valid subframe bitmap configuration.

14. An apparatus comprising: a transceiver configured to communicate, with a second wireless communication device, a positioning reference signal (PRS) configuration; and a processor configured to: determine whether the PRS configuration includes a first indication format, a second indication format, or a combination of the first indication format and the second indication format; and determine a PRS time-frequency pattern for a first subframe in response to determining that the PRS configuration includes the combination of the first indication format and the second indication format, wherein the transceiver is further configured to communicate, with the second wireless communication device in a narrowband communication frequency band, a first PRS including the determined PRS time-frequency pattern in the first subframe, wherein the first indication format includes a bitmap indicating a set of PRS subframes positioned within a group of contiguous subframes, the bitmap including a length corresponding to a number of subframes in the group of contiguous subframes, and the set of PRS subframes including the first subframe, and wherein the second indication format indicates a subset of the group of contiguous subframes by including at least one of a starting subframe for the subset, a number of subframes in the subset, or a periodicity of the subset, the subset including the first subframe.

15. The apparatus of claim 14, wherein the first subframe includes a plurality of frequency tones in a plurality of symbols, and wherein the PRS time-frequency pattern includes time-frequency resources in a subset of the plurality of frequency tones in a subset of the plurality of symbols.

16. The apparatus of claim 15, wherein the processor is further configured to determine the PRS time-frequency pattern further based on a predetermined PRS time-frequency pattern including at least one time-frequency resource in each symbol of the plurality of symbols.

17. The apparatus of claim 15, wherein the narrowband communication frequency band is within at least one of a guard band of a wideband communication frequency band, an in-band frequency band within the wideband communication frequency band, or a standalone frequency band independent of the wideband communication frequency band.

18. The apparatus of claim 17, wherein the wideband communication frequency band is a non-anchoring carrier frequency band of a wideband communication.

19. The apparatus of claim 14, wherein the processor is further configured to determine the

PRS time-frequency pattern by determining that the PRS time-frequency pattern includes a predetermined PRS time-frequency pattern without puncturing any time-frequency resource from the predetermined PRS time-frequency pattern based on a predetermined narrowband communication reference signal when determining that the PRS configuration includes the combination of the first indication format and the second indication format.

20. The apparatus of claim 14, wherein the transceiver is further configured to communicate, with the second wireless communication device in the narrowband communication frequency band, a plurality of PRSs in subframes that are within the subset of the group of contiguous subframes indicated by the second indication format and within the set of PRS subframes indicated by the first indication format when determining that the PRS configuration includes the combination of the first indication format and the second indication format, the plurality of PRSs including the first PRS.

21. The apparatus of claim 14, wherein the transceiver is further configured to communicate, with the second wireless communication device in the narrowband communication frequency band within the in band a wideband communication frequency band, a plurality of PRSs by excluding a PRS transmission in one or more symbols within a subframe of at least one of the set of PRS subframes or the subset of the group of contiguous subframes, the one or more symbols associated with a wideband communication in the wideband communication frequency band, and the plurality of PRSs including the first PRS.

22. The apparatus of claim 21, wherein the wideband communication is a Long-Term Evolution (LTE) communication, and wherein the one or more symbols include at least one of a transmission of a cell-specific reference signal (CRS) of the wideband communication or a transmission of a physical downlink control channel (PDCCH) signal of the wideband communication.

23. The apparatus of claim 22, wherein the transceiver is further configured to communicate, with the second wireless communication device, assistance information including at least one of a LTE PRS configuration, a bandwidth of a LTE cell, a number of LTE control symbols, a maximum number of LTE control symbols, or a CSI-RS configuration for one or more serving and neighboring cells.

24. The apparatus of claim 14, wherein the transceiver is further configured to: communicate, with the second wireless communication device in the narrowband communication frequency band, a first subset of a plurality of PRSs using a first beam during a first time period corresponding to the bitmap or the periodicity, the first subset of the plurality of PRSs including the first PRS; and communicate, with the second wireless communication device in the narrowband communication frequency band, a second subset of the plurality of PRSs using a second beam during a repeating time period corresponding to the bitmap or the periodicity, the first beam and the second beam include different beam directions.

25. The apparatus of claim 14, wherein the transceiver is further configured to: communicate,

with the second wireless communication device in the narrowband communication frequency band, the first PRS using a first beam; and communicate, with the second wireless communication device in the narrowband communication frequency band, a second PRS using a second beam, the first beam and the second beam include different beam directions.

26. The apparatus of claim 14, wherein the transceiver is further configured to communicate, with the second wireless communication device, assistance information including at least one of a subframe offset with respect to a serving cell, a radio frame offset with respect to the serving cell, a number of cell-specific reference signal (CRS) ports, a number of narrowband reference signal (NRS) ports, or a valid subframe bitmap configuration.

27. A non-transitory computer-readable medium having program code recorded thereon, the program code comprising: code for causing a first wireless communication device to communicate, with a second wireless communication device, a positioning reference signal (PRS) configuration; determining, code for causing the first wireless communication device to determine whether the PRS configuration includes a first indication format, a second indication format, or a combination of the first indication format and the second indication format; code for causing the first wireless communication device to determine a PRS time-frequency pattern for a first subframe in response to determining that the PRS configuration includes the combination of the first indication format and the second indication format; and code for causing the first wireless communication device to communicate, with the second wireless communication device in a narrowband communication frequency band, a first PRS including the determined PRS time-frequency pattern in the first subframe, wherein the first indication format includes a bitmap indicating a set of PRS subframes positioned within a group of contiguous subframes, the bitmap including a length corresponding to a number of subframes in the group of contiguous subframes, and the set of PRS subframes including the first subframe, and wherein the second indication format indicates a subset of the group of contiguous subframes by including at least one of a starting subframe for the subset, a number of subframes in the subset, or a periodicity of the subset, the subset including the first subframe.

28. The non-transitory computer-readable medium of claim 27, wherein the first subframe includes a plurality of frequency tones in a plurality of symbols, and wherein the PRS time-frequency pattern includes time-frequency resources in a subset of the plurality of frequency tones in a subset of the plurality of symbols.

29. The non-transitory computer-readable medium of claim 28, wherein the code for causing the first wireless communication device to determine the PRS time-frequency pattern is further configured to determine the PRS time-frequency pattern based on a predetermined PRS time-frequency pattern including at least one time-frequency resource in each symbol of the plurality of symbols.

30. The non-transitory computer-readable medium of claim 28, wherein the narrowband communication frequency band is within at least one of a guard band of a wideband

communication frequency band, an in-band frequency band within the wideband communication frequency band, or a standalone frequency band independent of the wideband communication frequency band.

31. The non-transitory computer-readable medium of claim 30, wherein the wideband communication frequency band is a non-anchoring carrier frequency band of a wideband communication.

32. The non-transitory computer-readable medium of claim 27, wherein the code for causing the first wireless communication device to determine the PRS time-frequency pattern is further configured to: determine that the PRS time-frequency pattern includes a predetermined PRS time-frequency pattern without puncturing any time-frequency resource from the predetermined time-frequency PRS pattern based on a predetermined narrowband communication reference signal when determining that the PRS configuration includes the combination of the first indication format and the second indication format.

33. The non-transitory computer-readable medium of claim 27, further comprising: code for causing the first wireless communication device to communicate, with the second wireless communication device in the narrowband communication frequency band, a plurality of PRSs in subframes that are within the subset of the group of contiguous subframes indicated by the second indication format and within the set of PRS subframes indicated by the first indication format when determining that the PRS configuration includes the combination of the first indication format and the second indication format, the plurality of PRSs including the first PRS.

34. The non-transitory computer-readable medium of claim 27, further comprising: code for causing the first wireless communication device to communicate, with the second wireless communication device in the narrowband communication frequency band within a wideband communication frequency band, a plurality of PRSs by excluding a PRS transmission in one or more symbols within a subframe of at least one of the set of PRS subframes or the subset of the group of contiguous subframes, the one or more symbols associated with a wideband communication in the wideband communication frequency band, and the plurality of PRSs including the first PRS.

35. The non-transitory computer-readable medium of claim 34, wherein the wideband communication is a Long-Term Evolution (LTE) communication, and wherein the one or more symbols include at least one of a transmission of a cell-specific reference signal (CRS) of the wideband communication or a transmission of a physical downlink control channel (PDCCH) signal of the wideband communication.

36. The non-transitory computer-readable medium of claim 35, further comprising code for causing the first wireless communication device to communicate, with the second wireless communication device, assistance information including at least one of a LTE PRS configuration, a bandwidth of a LTE cell, a number of LTE control symbols, a maximum

number of LTE control symbols, or a CSI-RS configuration for one or more serving and neighboring cells.

37. The non-transitory computer-readable medium of claim 27, further comprising: code for causing the first wireless communication device to communicate, with the second wireless communication device in the narrowband communication frequency band, a first subset of a plurality of PRSs using a first beam during a first time period corresponding to the bitmap or the periodicity, the first subset of the plurality of PRSs including the first PRS; and code for causing the first wireless communication device to communicate, with the second wireless communication device in the narrowband communication frequency band, a second subset of the plurality of PRSs using a second beam during a repeating time period corresponding to the bitmap or the periodicity, the first beam and the second beam include different beam directions.

38. The non-transitory computer-readable medium of claim 27, wherein the code for causing the first wireless communication device to communicate the first PRS is further configured to communicate the first PRS using a first beam, and wherein the non-transitory computer-readable medium further comprises: code for causing the first wireless communication device to communicate, with the second wireless communication device in the narrowband communication frequency band, a second PRS in a second subframe using a second beam, the first beam and the second beam include different beam directions.

39. The non-transitory computer-readable medium of claim 27, further comprising code for causing the first wireless communication device to communicate, with the second wireless communication device, assistance information including at least one of a subframe offset with respect to a serving cell, a radio frame offset with respect to the serving cell, a number of cell-specific reference signal (CRS) ports, a number of narrowband reference signal (NRS) ports, or a valid subframe bitmap configuration.