

CLAIMS

1. A method for configuring timing advance, comprising:
 - providing a timing advance command for a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein providing the timing advance command comprises configuring a number of bits used to express a timing advance duration to a user equipment (UE), wherein the number of bits is a first number of bits when the UE is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the UE is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size;
 - determining a timing advance step size for the UE when the UE is in communication with the radio access network, the timing advance step size being associated with one or more subcarrier spacings defined for the radio access network, wherein the timing advance step size is scaled in accordance with the one or more subcarrier spacings defined for the radio access network and used to calculate the timing advance duration included in the timing advance command; and
 - transmitting the timing advance command to the UE, wherein the timing advance command includes the first number of bits used to express the timing advance duration when the UE is in the initial access procedure with the radio access network, and wherein the timing advance command includes the second number of bits used to express the timing advance duration when the UE is in the connected state in the radio access network.
2. The method of claim 1, wherein providing the timing advance command comprises:
 - configuring timing advance step sizes for all subcarrier spacings defined for the radio access network.
3. The method of claim 1, wherein the timing advance step size is associated with a group of two or more subcarrier spacings defined for the radio access network.
4. The method of claim 3, wherein the group of two or more subcarrier spacings includes

subcarrier spacings of at least two of 15 kHz, 30 kHz, or 60 kHz.

5. The method of claim 3, wherein the group of two or more subcarrier spacings includes subcarrier spacings of at least one of 120 kHz or 240 kHz.

6. The method of claim 1, wherein a group of cyclic prefix lengths is defined for the radio access network, and wherein providing the timing advance command comprises:

configuring a timing advance step size for each cyclic prefix length in the group of cyclic prefix lengths.

7. The method of claim 1, wherein providing the timing advance command comprises:

configuring respective timing advance step sizes for the one or more subcarrier spacings defined for the radio access network, wherein the timing advance step size for the UE and at least one of the first number of bits or the second number of bits are selected to obtain a maximum timing advance duration or a maximum range of the radio access network with a desired timing advance granularity.

8. The method of claim 7, wherein the desired timing advance granularity is determined by a hybrid automatic repeat request (HARQ) time line.

9. The method of claim 1, wherein at least one of the first number of bits or the second number of bits are each based on the timing advance step size for the one or more subcarrier spacings defined for the radio access network.

10. The method of claim 1, wherein providing the timing advance command comprises:

configuring a third number of bits used to express the timing advance duration when the UE is configured to operate as an enhanced mobile broadband (eMBB) UE; and

configuring a fourth number of bits used to express the timing advance duration when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.

11. The method of claim 1, wherein providing the timing advance command comprises:

configuring a first timing advance step size when the UE is configured to operate as an enhanced mobile broadband (eMBB) UE; and

configuring a second timing advance step size when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.

12. The method of claim 1, wherein providing the timing advance command comprises:

configuring one or more timing advance step sizes for the one or more subcarrier spacings based on frequency ranges used by the radio access network, wherein the radio access network is configurable to use bandwidths associated with sub-6 GHz frequencies and millimeter wavelengths.

13. An apparatus for wireless communication, comprising:

means for providing a timing advance command for a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein providing the timing advance command comprises configuring a number of bits used to express a timing advance duration to a user equipment (UE), wherein the number of bits is a first number of bits when the UE is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the UE is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size;

means for determining a timing advance step size for the UE when the UE is in communication with the radio access network, the timing advance step size being associated with one or more subcarrier spacings defined for the radio access network, wherein the timing advance step size is scaled in accordance with the one or more subcarrier spacings defined for the radio access network and used to calculate the timing advance duration included in the timing advance command; and

means for transmitting the timing advance command to the UE, wherein the timing advance command includes the first number of bits used to express the timing advance duration when the UE is in the initial access procedure with the radio access network, and wherein the timing advance command includes the second number of bits used to express the timing advance duration when

the UE is in the connected state in the radio access network.

14. The apparatus of claim 13, wherein the means for providing the timing advance command is adapted to:

configure timing advance step sizes for all subcarrier spacings defined for the radio access network.

15. The apparatus of claim 13, wherein a group of cyclic prefix lengths is defined for the radio access network, and wherein the means for providing the timing advance command is adapted to:

configure a timing advance step size for subcarrier spacings in the group of cyclic prefix lengths.

16. The apparatus of claim 13, wherein a group of cyclic prefix lengths is defined for the radio access network, and wherein the means for providing the timing advance command is adapted to:

configure a timing advance step size for each cyclic prefix length in the group of cyclic prefix lengths.

17. The apparatus of claim 13, wherein the first number of bits and the second number of bits are based on the timing advance step size associated with the one or more subcarrier spacings defined for the radio access network.

18. The apparatus of claim 13, wherein the means for providing the timing advance command is adapted to:

configure a third number of bits used to express the timing advance duration when the UE is configured to operate as an enhanced mobile broadband (eMBB) UE; and

configure a fourth number of bits used to express the timing advance duration when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.

19. The apparatus of claim 13, wherein the means for providing the timing advance command is adapted to:

configure a first timing advance step size when the UE is configured to operate as an

enhanced mobile broadband (eMBB) UE; and

configure a second timing advance step size when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.

20. The apparatus of claim 13, wherein the means for providing the timing advance command is adapted to:

configure one or more timing advance step sizes for the one or more subcarrier spacings based on frequency ranges used by the radio access network, wherein the radio access network is configurable to use bandwidths associated with sub-6 GHz frequencies and millimeter wavelengths.

21. The apparatus of claim 13, wherein the timing advance step size is associated with a group of two or more subcarrier spacings defined for the radio access network.

22. An apparatus for wireless communication, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to:

provide a timing advance command for a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein providing the timing advance command comprises configuring a number of bits used to express a timing advance duration to a user equipment (UE), wherein the number of bits is a first number of bits when the UE is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the UE is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size;

determine a timing advance step size for the UE when the UE is in communication with the radio access network, the timing advance step size being associated with one or more subcarrier spacings defined for the radio access network, wherein the timing advance

step size is scaled in accordance with the one or more subcarrier spacings defined for the radio access network and used to calculate the timing advance duration included in the timing advance command; and

transmit the timing advance command to the UE, wherein the timing advance command includes the first number of bits used to express the timing advance duration when the UE is in the initial access procedure with the radio access network, and wherein the timing advance command includes the second number of bits used to express the timing advance duration when the UE is in the connected state in the radio access network.

23. The apparatus of claim 22, wherein a group of cyclic prefix lengths is defined for the radio access network, and wherein the at least one processor is configured to:

configure a timing advance step size for each cyclic prefix length in the group of cyclic prefix lengths.

24. The apparatus of claim 22, wherein the timing advance step size is associated with a group of two or more subcarrier spacings defined for the radio access network.

25. A non-transitory computer-readable medium storing computer-executable code, comprising code for causing a computer to:

provide a timing advance command for a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein providing the timing advance command comprises configuring a number of bits used to express a timing advance duration to a user equipment (UE), wherein the number of bits is a first number of bits when the UE is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the UE is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size;

determine a timing advance step size for the UE when the UE is in communication with the radio access network, the timing advance step size being associated with the one or more subcarrier spacings defined for the radio access network, wherein the timing advance step size is

scaled in accordance with the one or more subcarrier spacings defined for the radio access network and used to calculate the timing advance duration included in the timing advance command; and

transmit the timing advance command to the UE, wherein the timing advance command includes the first number of bits used to express the timing advance duration when the UE is in the initial access procedure with the radio access network, , and wherein the timing advance command includes the second number of bits used to express the timing advance duration when the UE is in the connected state in the radio access network.

26. The non-transitory computer-readable medium of claim 25, wherein the timing advance step size is associated with a group of two or more subcarrier spacings defined for the radio access network.

27. An apparatus for wireless communication, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to:

receive a timing advance command from a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein the timing advance command comprises a number of bits used to express a timing advance duration, wherein the number of bits is a first number of bits when the apparatus is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the apparatus is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size, wherein the timing advance duration is based on a timing advance step size that is associated with one or more subcarrier spacings defined for the radio access network and is scaled in accordance with the one or more subcarrier spacings defined for the radio access network; and

communicate with the radio access network based on the timing advance command.

28. The apparatus of claim 27, wherein:

the timing advance command comprises a third number of bits used to express the timing advance duration when the apparatus is configured to operate as an enhanced mobile broadband (eMBB) apparatus; and

the timing advance command comprises a fourth number of bits used to express the timing advance duration when the apparatus is configured to operate as an ultra-reliable-low latency communications (URLLC) apparatus.

29. The apparatus of claim 27, wherein:

the timing advance duration is based on a first timing advance step size when the apparatus is configured to operate as an enhanced mobile broadband (eMBB) apparatus; and

the timing advance duration is based on a second timing advance step size when the apparatus is configured to operate as an ultra-reliable-low latency communications (URLLC) apparatus.

30. A method for wireless communication at a user equipment (UE), comprising:

receiving a timing advance command from a radio access network that employs a modulation scheme with a scalable numerology, wherein the timing advance command accommodates the scalable numerology used by the radio access network, wherein the timing advance command comprises a number of bits used to express a timing advance duration, wherein the number of bits is a first number of bits when the apparatus is in an initial access procedure with the radio access network, wherein the number of bits is a second number of bits when the apparatus is in a connected state in the radio access network, and wherein the first number of bits is greater than the second number of bits for a common timing advance step size, wherein the timing advance duration is based on a timing advance step size that is associated with one or more subcarrier spacings defined for the radio access network and is scaled in accordance with the one or more subcarrier spacings defined for the radio access network; and

communicating with the radio access network based on the timing advance command.

31. The method of claim 30, wherein:

the timing advance command comprises a third number of bits used to express the timing

advance duration when the UE is configured to operate as an enhanced mobile broadband (eMBB) UE; and

the timing advance command comprises a fourth number of bits used to express the timing advance duration when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.

32. The method of claim 30, wherein:

the timing advance duration is based on a first timing advance step size when the UE is configured to operate as an enhanced mobile broadband (eMBB) UE; and

the timing advance duration is based on a second timing advance step size when the UE is configured to operate as an ultra-reliable-low latency communications (URLLC) UE.