

CLAIMS

1. A communication apparatus, comprising:

a receiver, which, in operation, receives a reference signal (RS) and first data mapped to a first shortened transmission time interval (TTI), a second shortened TTI, and a third shortened TTI within 14 consecutive symbols and receives second data mapped to a fourth shortened TTI and a fifth shortened TTI within the 14 consecutive symbols, no RS being mapped to the fourth shortened TTI and the fifth shortened TTI; and

circuitry, which is coupled to the receiver and which, in operation, demodulates the first and second data based on the RS,

wherein the RS is mapped to non-consecutive symbols within the 14 consecutive symbols,

wherein a first number of shortened TTIs having no RS between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs having no RS between the second shortened TTI and the third shortened TTI, and

wherein a difference between the first number and the second number is one.

2. The communication apparatus according to claim 1, wherein the RS is mapped on a symbol and is used for some or all of a plurality of shortened TTIs.

3. The communication apparatus according to claim 1, wherein a position of the RS is indicated by downlink control information (DCI).

4. The communication apparatus according to claim 1, wherein RS port numbers of the first shortened TTI, the second shortened TTI, and the third shortened TTI are indicated by Radio Resource Control (RRC) signaling.

5. The communication apparatus according to claim 1, wherein the second shortened TTI is between the fourth shortened TTI and the fifth shortened TTI.

6. The communication apparatus according to claim 1, wherein no RS is between the first shortened TTI and the second shortened TTI, and no RS is between the second shortened TTI and the third shortened TTI.

7. A communication method, comprising:

receiving a reference signal (RS) and first data mapped to a first shortened transmission time interval (TTI), a second shortened TTI, and a third shortened TTI within 14 consecutive symbols and receives second data mapped to a fourth shortened TTI and a fifth shortened TTI within the 14 consecutive symbols, no RS being mapped to the
 5 fourth shortened TTI and the fifth shortened TTI; and

demodulating the first and second data based on the RS,

wherein the RS is mapped to non-consecutive symbols within the 14 consecutive symbols,

10 wherein a first number of shortened TTIs having no RS between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs having no RS between the second shortened TTI and the third shortened TTI, and

wherein a difference between the first number and the second number is one.

15 8. The communication method according to claim 7, wherein the RS is mapped on a symbol and is used for some or all of a plurality of shortened TTIs.

9. The communication method according to claim 7, wherein a position of the RS is indicated by downlink control information (DCI).

10. The communication method according to claim 7, wherein RS port
 20 numbers of the first shortened TTI, the second shortened TTI, and the third shortened TTI are indicated by Radio Resource Control (RRC) signaling.

11. The communication method according to claim 7, wherein the second shortened TTI is between the fourth shortened TTI and the fifth shortened TTI.

12. The communication method according to claim 7, wherein no RS is
 25 between the first shortened TTI and the second shortened TTI, and no RS is between the second shortened TTI and the third shortened TTI.

13. A communication apparatus, comprising:

circuitry, which, in operation, maps a reference signal (RS) and first data to a first shortened transmission time interval (TTI), a second shortened TTI, and a third
 30 shortened TTI within 14 consecutive symbols and maps second data to a fourth

shortened TTI and a fifth shortened TTI within the 14 consecutive symbols, no RS being mapped to the fourth shortened TTI and the fifth shortened TTI; and

a transmitter, which is coupled to the circuitry and which, in operation, transmits the first and second data and the RS,

5 wherein the RS is mapped to non-consecutive symbols within the 14 consecutive symbols,

wherein a first number of shortened TTIs having no RS between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs having no RS between the second shortened TTI and the third shortened
10 TTI, and

wherein a difference between the first number and the second number is one.

14. The communication apparatus according to claim 13, wherein the RS is mapped on a symbol and is used for some or all of a plurality of shortened TTIs.

15 15. The communication apparatus according to claim 13, wherein a position of the RS is indicated by downlink control information (DCI).

16. The communication apparatus according to claim 13, wherein RS port numbers of the first shortened TTI, the second shortened TTI, and the third shortened TTI are indicated by Radio Resource Control (RRC) signaling.

20 17. The communication apparatus according to claim 13, wherein the second shortened TTI is between the fourth shortened TTI and the fifth shortened TTI.

18. The communication apparatus according to claim 13, wherein no RS is between the first shortened TTI and the second shortened TTI, and no RS is between the second shortened TTI and the third shortened TTI.

25 19. A communication method, comprising:
mapping a reference signal (RS) and first data to a first shortened transmission time interval (TTI), a second shortened TTI, and a third shortened TTI within 14 consecutive symbols and mapping second data to a fourth shortened TTI and a fifth shortened TTI within the 14 consecutive symbols, no RS being mapped to the fourth shortened TTI and the fifth shortened TTI; and

30 transmitting the first and second data based on the RS,

wherein the RS is mapped to non-consecutive symbols within the 14 consecutive symbols,

wherein a first number of shortened TTIs having no RS between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs having no RS between the second shortened TTI and the third shortened TTI, and

wherein a difference between the first number and the second number is one.

20. The communication method according to claim 19, wherein the RS is mapped on a symbol and is used for some or all of a plurality of shortened TTIs.

10 21. The communication method according to claim 19, wherein a position of the RS is indicated by downlink control information (DCI).

22. The communication method according to claim 19, wherein RS port numbers of the first shortened TTI, the second shortened TTI, and the third shortened TTI are indicated by Radio Resource Control (RRC) signaling.

15 23. The communication method according to claim 19, wherein the second shortened TTI is between the fourth shortened TTI and the fifth shortened TTI.

24. The communication method according to claim 19, wherein no RS is between the first shortened TTI and the second shortened TTI, and no RS is between the second shortened TTI and the third shortened TTI.