CLAIMS

~~1. A wireless communication device comprising:~~

~~circuitry operative to map at least a first type of reference signals (RSs) onto orthogonal frequency division multiplexing (OFDM) symbol(s) other than the OFDM symbols onto which shortened transmission time intervals (TTIs) are mapped in a subframe, each of the shortened TTIs comprising 1-7 OFDM symbols; and~~

~~a transmitter operative to transmit a physical channel in one of the shortened TTIs and transmit at least the first type of RSs~~

~~2. The wireless communication device according to claim 1, wherein~~

~~same OFDM symbol(s) are shared by multiple shortened TTIs to map their associated RSs of the first type.~~

~~3. The wireless communication device according to claim 1, wherein~~

~~each shortened TTI is placed after the OFDM symbol(s) with the first type of RSs associated with said shortened TTI.~~

~~4. The wireless communication device according to any one of claims 1-3, wherein~~

~~two or more OFDM symbols in the subframe are used to map the first type of RSs; and~~

~~the two or more OFDM symbols are spaced from each other.~~

~~5. The wireless communication device according to any one of claims 1-3, wherein the position of the OFDM symbol(s) to transmit the first type of RSs depends on the length of the physical downlink control channel (PDCCH) region in the subframe.~~

~~6. The wireless communication device according to claim 2, wherein~~

~~the first type of RSs are demodulation reference signals (DMRSs); and~~

~~the DMRSs in the OFDM symbol(s) shared by the multiple shortened TTIs are used to multiplex multiple DMRS ports each of which is associated with one or more of the multiple shortened TTIs.~~

~~7. The wireless communication device according to claim 6, wherein~~

~~the position and/or the usage of the DMRS ports are indicated in downlink channel information (DCI) transmitted in a physical downlink control channel (PDCCH).~~

~~8. The wireless communication device according to claim 6, wherein~~

~~the position and the usage of the DMRS ports are fixed by specification or configured by the medium access control (MAC) or radio resource control (RRC) layer.~~

~~9. The wireless communication device according to claim 6, wherein~~

~~the position of the DMRS ports is fixed by specification or configured by the MAC or RRC layer;~~

~~DCI is transmitted in a shortened TTI whose associated DMRS port is fixed by specification or configured by MAC or RRC layer; and~~

~~the usage of the DMRS ports other than the DMRS port that is associated with the DCI is indicated in the DCI.~~

~~10. The wireless communication device according to any of claims 1-3, wherein~~

~~the first type of RSs are demodulation reference signals (DMRSs); and~~

~~a second type of RSs which are channel status information-reference signals (CSI-RSs) are mapped onto the same OFDM symbol(s) as the DMRSs.~~

~~11. The wireless communication device according to claim 1, wherein~~

~~the transmission performed by the transmitter is uplink transmission; and~~

~~the first type of RSs are always mapped onto the start OFDM symbol of the subframe, or the first type of RSs associated with each shortened TTI are mapped onto the OFDM symbol(s) adjacent to said shortened TTI.~~

~~12. A wireless communication method comprising:~~

~~mapping at least a first type of reference signals (RSs) onto orthogonal frequency division multiplexing (OFDM) symbol(s) other than the OFDM symbols onto which shortened transmission time intervals (TTIs) are mapped in a subframe, each of the shortened TTIs comprising 1-7 OFDM symbols; and~~

~~transmitting a physical channel in one of the shortened TTIs and transmitting at least the first type of RSs.~~

1~~3~~. A ~~wireless~~ communication ~~device~~ apparatus comprising:

a receiver, which, in operation, ~~operative to~~ receives ~~at least~~ a ~~first type of~~ reference signal~~s~~ (RS~~s~~) and first data mapped to ~~and receive a physical channel in~~ 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~~which comprises1-7 orthogonal frequency division multiplexing (OFDM) symbols~~; and

circuitry, which is coupled to the receiver and which, in operation, ~~operative to~~ demodulates the ~~physical channel~~first and second data based on ~~at least~~ the ~~first type of~~ RS~~s~~, ~~wherein~~

wherein the ~~first type of~~ RS~~s~~ ~~are~~ is mapped ~~on~~to ~~OFDM symbol(s) onto which no shortened TTIs are mapped~~ non-consecutive symbols within the 14 consecutive symbols,

wherein a first number of shortened TTIs between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs 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 the 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.

~~147~~. A ~~wireless~~ communication method comprising:

receiving ~~at least~~ a ~~first type of~~ reference signal~~s~~ (RS~~s~~) and first data mapped to ~~and receiving a physical channel in~~ a first shortened transmission time interval (TTI) ~~which comprises 1-7 orthogonal frequency division multiplexing (OFDM) symbols~~, 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

demodulating the first and second data based on the ~~physical channel based on at least the first type of~~ RS~~s~~, ~~wherein~~

wherein the ~~first type of~~ RS~~s~~ ~~are~~ is mapped ~~on~~to ~~OFDM symbol(s) onto which no shortened TTIs are mapped~~non-consecutive symbols within the 14 consecutive symbols,

wherein a first number of shortened TTIs between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs between the second shortened TTI and the third shortened TTI, and

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

8. The communication method according to claim 7, wherein the RS is mapped on a symbol and is used for some or all of the 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 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 between the first shortened TTI and the second shortened TTI, and no RS is between the second shortened TTI and the third shortened TTI.

~~15~~13. A ~~wireless~~ communication ~~device~~ apparatus comprising:

circuitry, which, in operation, ~~operative to~~ maps ~~at most one type of~~ a reference signal~~s~~ (RS~~s~~) ~~from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) in~~and first data to ~~each~~ a first shortened transmission time interval (TTI), a second shortened TTI, and a third shortened TTI within 14 consecutive symbols and maps 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 ~~in a subframe, each shortened TTI comprising 1-7 orthogonal frequency division multiplexing (OFDM) symbols~~; and

a transmitter, which is coupled to the circuitry and which, in operation, ~~operative to~~ transmits ~~a physical channel in a shorten TTI, the RSs within the OFDM symbol(s) of or before the shorten TTI transmitting the physical channel being used to demodulate the physical channel at a receiving side~~the first and second data and the RS,

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

wherein a first number of shortened TTIs between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs between the second shortened TTI and the third shortened 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 the plurality of shortened TTIs.

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.

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.

~~16. The wireless communication device according to claim 15, wherein~~

~~either CRSs or DMRSs are mapped in each shorten TTI, and~~

~~the CRSs or DMRSs in the shorten TTI transmitting the physical channel is used to demodulate the physical channel.~~

~~17. The wireless communication device according to claim 15, wherein~~

~~CRSs are mapped in some shorten TTIs;~~

~~neither CRSs nor DMRSs are mapped in the other shorten TTIs; and~~

~~the CRSs in one OFDM symbol are used to demodulate multiple OFDM symbols which are not earlier than said one OFDM symbol, or all CRSs that are not later than each shorten TTI are used to demodulate said shorten TTI.~~

~~18~~19. A ~~wireless~~ communication method comprising:

mapping ~~at most one type of~~ a reference signal~~s~~ (RS~~s~~) ~~from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) in each~~and first data to a first shorten~~ed~~ transmission time interval (TTI), a second shortened TTI, and a third shortened TTI within 14 consecutive symbols and maps 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 ~~in a subframe, each shortened TTI comprising 1-7 orthogonal frequency division multiplexing (OFDM) symbols~~; and

transmitting ~~a physical channel in a shorten TTI,~~the first and second data based on the RS~~s within the OFDM symbol(s) of or before the shorten TTI transmitting the physical channel being used to demodulate the physical channel at a receiving side~~,

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

wherein a first number of shortened TTIs between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs 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 the plurality of shortened TTIs.

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.

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.25. An integrated circuit, comprising:

reception circuitry, which, in operation, controls of 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 fourth shortened TTI and the fifth shortened TTI; and

demodulation circuitry, which, in operation, controls of demodulating 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 between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs between the second shortened TTI and the third shortened TTI, and

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

26. An integrated circuit, comprising:

mapping circuitry, which, in operation, controls of 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 maps 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

transmission circuitry, which, in operation, controls of transmitting the first and second data and the RS,

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

wherein a first number of shortened TTIs between the first shortened TTI and the second shortened TTI is different from a second number of shortened TTIs between the second shortened TTI and the third shortened TTI, and

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

~~19. A wireless communication device comprising:~~

~~a receiver operative to receive a physical channel in a shorten transmission time interval (TTI); and~~

~~circuitry operative to demodulate the physical channel based on reference signals (RSs) within orthogonal frequency division multiplexing (OFDM) symbol(s) of or before the shorten TTI, wherein~~

~~at most one type of RSs from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) are mapped in each shorten TTI in a subframe, and each shortened TTI comprises 1-7 OFDM symbols.~~

~~20. A wireless communication method comprising:~~

~~receiving a physical channel in a shorten transmission time interval (TTI); and~~

~~demodulating the physical channel based on reference signals (RSs) within orthogonal frequency division multiplexing (OFDM) symbol(s) of or before the shorten TTI, wherein~~

~~at most one type of RSs from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) are mapped in each shorten TTI in a subframe, and each shortened TTI comprises 1-7 OFDM symbols.~~