

CLAIMS

1. A wireless communication device comprising:
 - 5 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
 - 10 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
 - 15 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
 - 20 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
 - 25 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
 - 30

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
5 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
10 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
15 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
20 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
25 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.

13. A wireless communication device comprising:

a receiver operative to receive at least a first type of reference signals (RSs) and receive a physical channel in a shortened transmission time interval (TTI) which comprises 1-7 orthogonal frequency division multiplexing (OFDM) symbols; and

5 circuitry operative to demodulate the physical channel based on at least the first type of RSs, wherein

the first type of RSs are mapped onto OFDM symbol(s) onto which no shortened TTIs are mapped.

14. A wireless communication method comprising:

10 receiving at least a first type of reference signals (RSs) and receiving a physical channel in a shortened transmission time interval (TTI) which comprises 1-7 orthogonal frequency division multiplexing (OFDM) symbols; and

demodulating the physical channel based on at least the first type of RSs, wherein

15 the first type of RSs are mapped onto OFDM symbol(s) onto which no shortened TTIs are mapped.

15. A wireless communication device comprising:

20 circuitry operative to map at most one type of reference signals (RSs) from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) in each shorten transmission time interval (TTI) in a subframe, each shortened TTI comprising 1-7 orthogonal frequency division multiplexing (OFDM) symbols; and

a transmitter operative to transmit 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.

25 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;

30 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. A wireless communication method comprising:

5 mapping at most one type of reference signals (RSs) from cell-specific reference signals (CRSs) and demodulation reference signals (DMRSs) in each shorten transmission time interval (TTI) in a subframe, each shortened TTI comprising 1-7 orthogonal frequency division multiplexing (OFDM) symbols; and

10 transmitting 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.

19. A wireless communication device comprising:

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

15 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

20 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

25 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.