

SUMMARY OF THE INVENTION

Non-limiting and exemplary embodiments provide improved methods for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL transmissions over a sidelink interface to one or more receiving user equipments. The independent claims provide non-limiting and exemplary embodiments. Advantageous embodiments are subject to the dependent claims.

In embodiments of the disclosure, performing direct communication transmissions by a transmitting user equipment is improved (not only for but) particularly for scenarios in which data is available for transmission in the transmitting user equipment destined to more than one sidelink destination group.

An aspect of the disclosure provides a transmitting user equipment for allocating radio resources to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system. The transmitting user equipment comprises a receiver, which, in operation, receives, for a subsequent sidelink control, SC, period, a plurality of sidelink, SL, grants in different subframes before the start of the subsequent SC period. Each of the received SL grants is associated with one from among a plurality of a maximum number of SL processes on the basis of the subframe in which it is received, by applying an association scheme, wherein the allocation of radio resources within the SC period is restricted, for the SC period, by the maximum number of SL processes with which the transmitting user equipment is configured. Each of the maximum number of SL processes is associated with plural received SL grants from a set of different subframes, and each of the subframes in the set is offset from one another by a defined number of subframes. The transmitting user equipment comprises circuitry, which, in operation, associates each of the plurality of the maximum number of SL processes with that one SL grant, which is received in the respective set of different subframes and which has most recently been received before the start of the subsequent SC period and allocates, for each of the plurality of the SL processes, radio resources within the subsequent SC period according to that one SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments. The transmitting user equipment also comprises a transmitter, which, in operation, performs each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

Another aspect of the disclosure provides a method for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL, transmissions over a SL

interface to one or more receiving user equipments in a communication system. The method comprises steps performed by the transmitting user equipment. The steps comprise receiving, for a subsequent sidelink control, SC, period, a plurality of sidelink, SL, grants in different subframes before the start of the subsequent SC period. Each of the received SL grants is

5 associated with one from among a plurality of a maximum number of SL processes on the basis of the subframe in which it is received, by applying an association scheme, wherein the allocation of radio resources within a sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which the transmitting user equipment is configured. Each of the maximum number of SL processes is associated with plural received SL

10 grants from a set of different subframes, and each of the subframes in the set is offset from one another by a defined number of subframes. The steps also comprise associating each of the plurality of the maximum number of SL processes with that one SL grant, which is acquired in the respective set of different subframes and which has most recently been received before the start of the subsequent SC period, and, for each of the plurality of the SL processes, allocating radio

15 resources within the subsequent SC period according to that one SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

20 There is disclosed a transmitting user equipment for allocating radio resources to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system. The allocation of radio resources within a sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which a transmitting user equipment is configured. A processor of the transmitting user

25 equipment is adapted to acquire a plurality of SL grants for a subsequent SC period, and to select among the acquired SL grants a number of those SL grants that have most recently been acquired before the start of the subsequent SC period, wherein the number of selected SL grants does not exceed the maximum number of SL processes configured for the one SC period. Further, the processor is adapted to associate a plurality of SL processes for the subsequent SC

30 period such that each of the plurality of SL process is associated with a different one of the selected number of SL grants for allocating radio resources within the subsequent SC period. Even further, the processor is adapted, for each of the plurality of the SL processes, to allocate the radio resources within the subsequent SC period according to the selected SL grant, with which the respective SL process is associated, for performing one of the plurality of SL

35 transmissions to one of one or more of receiving user

equipments. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

5 There is disclosed a transmitting user equipment for allocating radio resources to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system. The allocation of radio resources within a sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which the transmitting user equipment is configured. A processor is adapted to acquire, for a subsequent SC period, a plurality of sidelink,

- SL, grants in different sub-frames before the start of the subsequent SC period, wherein: each of the acquired SL grants is associated with one from among the maximum number of SL processes on the basis of the sub-frame in which it is acquired, by applying an association scheme, where: each of the maximum number of SL processes is associated with SL grants
- 5 from a set of different sub-frames, and each of the sub-frames in the set is offset from one another by a pre-defined number of sub-frames. Further, the processor is adapted to associate each of a plurality of the maximum number of SL processes with that one SL grant, which is acquired in the respective set of different sub-frames and which has most recently been acquired before the start of the subsequent SC period. Even further, the processor is adapted, for each of
- 10 the plurality of the SL processes, to allocate radio resources within the subsequent SC period according to the SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.
- 15 There is disclosed a transmitting user equipment for allocating radio resources to perform a plurality of direct sidelink, SL, transmissions within a sidelink control, SC, period over a SL interface to one or more receiving user equipments in a communication system. A processor of the transmitting user equipment is adapted to autonomously select SL grants for a plurality of SL transmission from different resource pools, each being configured and made available for SL
- 20 transmissions within the communication system. The processor is adapted to associate, for each of the plurality of SL transmissions, a SL grant to a different SL process selected from the different configured resource pools. Further, the processor is adapted to perform, for each of the plurality of SL processes with an associated SL grant, a separate logical channel prioritization, LCP, procedure which only considers logical channels to different destination Group IDs. Even
- 25 further, the processor is adapted, for each of the plurality of SL processes, to allocate, within the same SC period, the radio resources according to the autonomously selected SL grant with which the respective SL process is associated for performing the plurality of SL transmissions. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.
- 30 There is disclosed a method for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system. The allocation of radio resources within a sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which a transmitting user equipment is configured. A plurality of SL grants is
- 35 acquired for a subsequent SC period. Among the acquired

SL grants a number of those SL grants is selected that have most recently been acquired before the start of the subsequent SC period, wherein the number of selected SL grants does not exceed the maximum number of SL processes configured for the one SC period. Then, a plurality of SL processes for the subsequent SC period are associated such that each of the

5 plurality of SL process is associated with a different one of the selected number of SL grants for allocating radio resources within the subsequent SC period. Thereafter, for each of the plurality of the SL processes, the radio resources are allocated within the subsequent SC period according to the selected SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one of one or more of receiving user

10 equipments. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

There is disclosed a method for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system. The allocation of radio resources within a

15 sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which the transmitting user equipment is configured. For a subsequent SC period, a plurality of sidelink, SL, grants are acquired in different sub-frames before the start of the subsequent SC period, wherein: each of the acquired SL grants is associated with one from among the maximum number of SL processes on the basis of the sub-frame in which it is

20 acquired, by applying an association scheme, where: each of the maximum number of SL processes is associated with SL grants from a set of different sub-frames, and each of the sub-frames in the set is offset from one another by a pre-defined number of sub-frames. Then, each of a plurality of the maximum number of SL processes is associated with that one SL grant, which is acquired in the respective set of different sub-frames and which has most recently been

25 acquired before the start of the subsequent SC period. Thereafter, for each of the plurality of the SL processes, radio resources are allocated within the subsequent SC period according to the SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments. Each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least

30 one data transmission over the SL interface.

There is disclosed a method for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL, transmissions within a sidelink control, SC, period over a SL interface to one or more receiving user equipments in a communication system. SL grants are autonomously selected for a plurality of SL transmission from different resource pools, each

35 being configured and made available for SL transmissions within the communication system. Then, for each of the plurality of SL

Claims

1. A transmitting user equipment for allocating radio resources to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system,

the transmitting user equipment comprising:

a receiver, which, in operation, receives, for a subsequent sidelink control, SC, period, a plurality of sidelink, SL, grants in different subframes before the start of the subsequent SC period, wherein:

- each of the received SL grants is associated with one from among a plurality of a maximum number of SL processes on the basis of the subframe in which it is received, by applying an association scheme, wherein the allocation of radio resources within the SC period is restricted, for the SC period, by the maximum number of SL processes with which the transmitting user equipment is configured,
- each of the maximum number of SL processes is associated with plural received SL grants from a set of different subframes, and each of the subframes in the set is offset from one another by a defined number of subframes;

circuitry, which, in operation, associates each of the plurality of the maximum number of SL processes with that one SL grant, which is received in the respective set of different subframes and which has most recently been received before the start of the subsequent SC period and

allocates, for each of the plurality of the SL processes, radio resources within the subsequent SC period according to that one SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments; and

a transmitter, which, in operation, performs each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

2. The transmitting user equipment according to claim 1, wherein the defined number of subframes corresponds to the maximum number of SL processes with which the transmitting user equipment is configured.

3. The transmitting user equipment according to claim 1, wherein SL grants are only received for the subsequent SC period until 4 subframes before the start of the SC period.
4. The transmitting user equipment according to claim 1, wherein each of the plurality of SL processes is re-initialized before the start of an SC period to thereafter allow its association with SL grants for a sub-subsequent SC period.
5. The transmitting user equipment according to claim 4, wherein each of the plurality of SL processes is re-initialized 3 subframes before the start of an SC period.
6. The transmitting user equipment according to claim 1, wherein the circuitry, in operation, performs, for each of the plurality of SL processes associated with a SL grant, a logical channel prioritization, LCP, procedure.
7. The transmitting user equipment according to claim 6 wherein performing each of the plurality of LCP procedures includes identifying different destination Group IDs used for performing the plurality of SL transmissions to one or more receiving user equipments.
8. A method for allocating radio resources for a transmitting user equipment to perform a plurality of direct sidelink, SL, transmissions over a SL interface to one or more receiving user equipments in a communication system,

the method comprising the following steps performed by the transmitting user equipment:

receiving, for a subsequent sidelink control, SC, period, a plurality of sidelink, SL, grants in different subframes before the start of the subsequent SC period, wherein:

- each of the received SL grants is associated with one from among a plurality of a maximum number of SL processes on the basis of the subframe in which it is received, by applying an association scheme, wherein the allocation of radio resources within a sidelink control, SC, period is restricted, for the SC period, by a maximum number of SL processes with which the transmitting user equipment is configured,
- each of the maximum number of SL processes is associated with plural received SL grants from a set of different subframes, and each of the subframes in the set is offset from one another by a defined number of subframes;

associating each of the plurality of the maximum number of SL processes with that one SL grant, which is acquired in the respective set of different subframes and which has most recently been received before the start of the subsequent SC period;

and, for each of the plurality of the SL processes, allocating radio resources within the subsequent SC period according to that one SL grant, with which the respective SL process is associated, for performing one of the plurality of SL transmissions to one or more receiving user equipments,

wherein each of the plurality of SL transmissions comprises at least one sidelink control information, SCI, transmission and at least one data transmission over the SL interface.

9. The method according to claim 8, wherein the defined number of subframes corresponds to the maximum number of SL processes with which the transmitting user equipment is configured.
10. The method according claim 8, wherein SL grants are only acquired for the subsequent SC period until 4 subframes before the start of the SC period.
11. The method according to claim 8, wherein each of the plurality of SL processes is re-initialized before the start of an SC period to thereafter allow its association with SL grants for a sub-subsequent SC period.
12. The method according to claim 11, wherein each of the plurality of SL processes is re-initialized 3 subframes before the start of an SC period.
13. The method according to claim 8, wherein the steps include a step of performing, for each of the plurality of SL processes associated with a SL grant, a logical channel prioritization, LCP, procedure.
14. The method according to claim 13, wherein performing each of the plurality of LCP procedures includes identifying different destination Group IDs used for performing the plurality of SL transmissions to one or more receiving user equipments.