

WHAT IS CLAIMED IS:

1. A method comprising:

implementing, by a base station, BS, a grant-free uplink transmission scheme, wherein the grant-free uplink transmission scheme:

—defines a first contention transmission unit, CTU access region in a time-frequency domain;

—defines a plurality of CTUs;

—defines a default CTU mapping scheme by mapping at least some of the a plurality of CTUs to the first CTU access region; and

defines a default user equipment, UE mapping scheme by defining rules for mapping a first UE to a first CTU of the plurality of CTUs and a second UE to a second CTU of the plurality of CTUs, the second CTU being different than the first CTU;

receiving, by the BS, a uplink transmission on the first CTU from the first UE; and

decoding, by the BS, the uplink transmission blindly.

2. The method of claim 1, further comprising:

defining, by the BS, at least a portion of the grant-free uplink transmission scheme; and

transmitting the portion of the grant-free uplink transmission scheme defined by the BS using high-level signaling.

3. The method of claim 1, wherein at least a portion of the grant-free uplink transmission scheme is pre-configured on the BS in conformance with a standard.

4. The method of claim 1, wherein decoding the uplink transmission blindly comprises blindly identifying a source of the uplink transmission, and wherein implementing the grant-free transmission uplink scheme further comprisesing:

receiving, by the BS, an uplink transmission from the first UE;
~~attempting to decode the uplink transmission blindly, wherein attempting to decode the~~
~~uplink transmission blindly comprises attempting, by the BS, to blindly identify a source of the~~
~~uplink transmission; and~~
indicating, to the first UE, whether ~~the attempting to decoding~~ the uplink transmission
blindly was successful.

5. The method of claim 4, wherein the grant-free uplink transmission scheme further defines a second CTU access region in the time-frequency domain and further defines the default CTU mapping scheme by mapping the plurality of CTUs to the first and second CTU access regions, and wherein the implementing the grant-free transmission uplink scheme further comprises:

defining, by the BS, a CTU remapping scheme by remapping a portion of the plurality of CTUs to the first and second CTU access regions when the BS determines a number of collisions is too frequent, wherein the BS determines the number of collisions is too frequent when:

the BS determines a number times attempting to decode the uplink transmission blindly was unsuccessful and the number of times is over a threshold; or

the BS receives a remapping request signal from the first UE; and

sending information related to the CTU remapping scheme using high-level signaling.

6. The method of claim 4, wherein implementing the grant-free transmission uplink scheme further comprises:

defining, by the BS, a UE remapping scheme by mapping the first UE to a third CTU, the third CTU being one of the plurality of CTUs other than the first CTU, when the BS determines a number of collisions is too frequent, wherein the BS determines the number of collisions is too frequent when:

the BS determines a number times attempting to decode the uplink transmission blindly was unsuccessful and the number of times is over a threshold; or

the BS receives a remapping request signal from the first UE; and
sending information related to the UE remapping scheme using high-level signaling.

7. The method of claim 41, wherein ~~attempting to decode~~ the uplink transmission blindly comprises using a joint signature and data detection using a message passing algorithm (JMPA) method in combination with an active UE detector method, wherein the active UE detector method comprises:

receiving a list of all potential UEs;

receiving a plurality of signals transmitted over the time-frequency domain;

receiving an output, from the JMPA method, comprising an updated list of potential UEs,

wherein the updated list includes fewer potential UEs than the list of all potential UEs; and

creating an active potential UE list in accordance with the plurality of signals and the updated list of potential UEs.

8. The method of claim 1, wherein the grant-free uplink transmission scheme defines a number of unique pilots for grant-free uplink transmissions.

9. A base station, BS, comprising:

a processor; and

a computer readable storage medium storing programming for execution by the processor, the programming including instructions to:

implement a grant-free uplink transmission scheme, wherein the grant-free uplink transmission scheme:

~~defines a plurality of contention transmission units, CTUs;~~

~~defines one or more CTU access regions in a time-frequency domain;~~

~~defines~~creates a default CTU mapping scheme by mapping ~~the a~~ plurality of ~~contention transmission units~~, CTUs to the one or more CTU access regions ~~in a time-frequency domain~~; and

~~defines~~creates a default user equipment, UE, mapping scheme by defining rules for mapping a first UE to a first CTU of the plurality of CTUs and a second UE to a second CTU of the plurality of CTUs, the second CTU being different than the first CTU;

receive an uplink transmission from the first UE on the first CTU;

~~attempt to~~ decode the uplink transmission blindly; and

indicate to the first UE, whether ~~the attempt to decoding~~ the uplink transmission blindly was successful.

10. The BS of claim 9, wherein the plurality of CTUs comprises individual CTUs each defined as a time, frequency, signature, pilot, or a combination thereof element.

11. The BS of claim 10, wherein each CTU is defined as a combination of time, frequency, signature, and pilot elements, and the grant-free uplink transmission scheme maps multiple pilot elements to each signature element.

12. The BS of claim 9, wherein the grant-free uplink transmission scheme defines a plurality of CTU access regions, the plurality of CTU access regions each provide a type of service to the first UE based on quality of service, QoS, level of the first UE, configuration, subscribed level of service, geometry, or a combination thereof.

13. The BS of claim 9, wherein a size of each of the one or more CTU access regions is defined based on an estimated probability of collisions, a number of total collisions over a period of time, a number of UEs supported by the BS, or a combination thereof.

14. The BS of claim 9, wherein a size of each of the plurality of CTUs is defined based on an expected transmission threshold, a desired padding level, a modulation coding scheme (MCS) level, or a combination thereof.

15. The BS of claim 9, wherein the grant-free uplink transmissions scheme creates a default CTU mapping in accordance with goals of distributing potential UEs uniformly over the one or more CTU access regions and reducing a probability of pilot collision.

16. A method for a grant-free transmission scheme comprising:

implementing, by a first user equipment (UE), a default contention transmission unit, CTU mapping scheme by:

determining an appropriate CTU for uplink transmission in accordance with a UE mapping rule and the default CTU mapping scheme, wherein the UE mapping rule maps a second UE to a second CTU in the default CTU mapping scheme, the second CTU being different than the appropriate CTU; and

transmitting an uplink transmission, to a base station, BS, on a first the appropriate CTU;

determining, by the UE, that the uplink transmission was not successfully decoded; and the UE randomly selecting a second CTU for retransmitting the uplink transmission, the retransmitting the uplink transmission using an asynchronous hybrid automatic repeat request (HARQ) method.

17. The method of claim 16, wherein further comprising, after sending an uplink transmission:

determining, by the UE, whether a collision has occurred based on an indication from the BS that a collision has occurred; and

resolving the collision using an asynchronous hybrid automatic repeat request (HARQ) method when the UE determines a collision has occurred.

18. The method of claim 17, wherein the indication is a negative acknowledgement (NACK).

18.19. The method of claim 17, further comprising transmitting, by the UE, a remapping request to the BS using high-level signaling when the UE determines a number of collisions have occurred and the number of collisions is above a threshold.

19.20. A user equipment (UE) comprising:

a processor; and

a computer readable storage medium storing programming for execution by the processor, the programming including instructions to:

implement a default contention transmission unit (CTU) mapping scheme by:

determining an appropriate CTU for uplink transmission in accordance with a UE

mapping rule and the default CTU mapping scheme, wherein the UE mapping rule maps a second UE to a second CTU in the default CTU mapping scheme, the second CTU being different than the appropriate CTU; and

transmitting, to a base station (BS), an uplink transmission on a first the appropriate CTU;

determining, by the UE, that the uplink transmission was not successfully decoded; determine whether a collision has occurred based on an indication by the BS; and

the UE randomly selecting a second CTU for retransmitting the uplink transmission, the retransmitting re-transmit, to the BS, the uplink transmission using an asynchronous hybrid automatic repeat request (HARQ) mechanism when the UE determines a collision has occurred; method.

~~20.21.~~ The UE of claim 20, wherein the UE mapping rule includes information for determining an appropriate the first CTU in accordance with a dedicated connection signature (DCS) of the UE, a DCS index, a total number of CTUs in the default CTU mapping scheme, a subframe number, or a combination thereof.

~~21.22.~~ The UE of claim 20, wherein the UE mapping rule includes information for determining an appropriate a first CTU index corresponding to an index in the default CTU mapping scheme in accordance with:

$$I_{CTU} = DSC_i \bmod N_{CTU},$$

wherein I_{CTU} is a CTU index, DSC_i is a DCS index assigned to the UE by the BS, and N_{CTU} is a total number of CTUs in the CTU mapping scheme.

~~22.23.~~ The UE of claim 20, wherein the UE mapping rule is pre-configured on the UE.

~~23.24.~~ The UE of claim 20, wherein the UE is configured to receive the UE mapping rule from the BS.