

CLAIMS

1. — A method for wireless communications by a wireless device, comprising:

- assigning a continuous set of numbers to a plurality of communication resources of a communication channel in order by frequency, the communication channel comprising a plurality of frequency resources and a plurality of time resources, wherein the plurality of communication resources are discontinuous in frequency and assigned to frequency resources associated with indices that are discontinuous;
- ~~— mapping uplink control information to the plurality of communication resources based on the continuous set of numbers assigned to the plurality of communication resources; and~~
- , wherein a first communication resource of the plurality of communication resources is separated in frequency by one or more communication resources from a second communication resource of the plurality of communication resources, wherein the first communication resource is assigned a first index, the second communication resource is assigned a second index, and the first index and second index are discontinuous, and where the first communication resource is assigned a first number of the set of numbers, the second communication resource is assigned a second number of the set of numbers, and the first number and second number are continuous, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one frequency resource of the plurality of frequency resources and one time resource of the plurality of time resources; determining if a first number of resource elements needed for communicating uplink control information during a first time resource is greater than or equal to a second number of resource elements included in the first time resource; when the first number is greater than or equal to the second number, mapping the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a first separation amount; and when the first number is not greater than or equal to the second number, mapping the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource

elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount; and one of transmitting or receiving the uplink control information in the plurality of communication resources based on the mapping.

2.——~~The method of claim 1, wherein the plurality of frequency resources comprise a plurality of subcarriers, wherein the plurality of time resources comprise a plurality of symbols, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one subcarrier and one symbol.~~

3.——~~The method of claim 2, wherein mapping uplink control information to the plurality of communication resources comprises mapping uplink control information to a first symbol of the plurality of symbols comprising:~~

——~~determining if a first number of resource elements needed for communicating the uplink control information during the first symbol is greater than or equal to a second number of resource elements included in the first symbol;~~

——~~when the first number is greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a 1, wherein the first separation amount; and~~

——~~when the first number is not greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount. is equal to one resource element.~~

4.——~~The method of claim 3, wherein the first separation amount is equal to one resource element.~~

5. ~~The method of claim 31~~, wherein the second separation is equal to the floor of the second number divided by the first number.

6. ~~5.~~ The method of claim 1, wherein the communication channel comprises a physical uplink shared channel (PUSCH).

7. ~~6.~~ The method of claim 1, further comprising modulating the uplink control information into a plurality of modulated uplink control information symbols, wherein mapping the uplink control information comprises mapping each of the plurality of modulated uplink control information symbols to a different resource element of the plurality of communication resources.

8. ~~7.~~ A wireless device comprising:

~~a memory; and~~

~~a processor coupled to the memory, the processor being configured to:~~

~~assign a continuous set of numbers to a plurality of communication resources of a communication channel in order by frequency, the communication channel comprising a plurality of frequency resources and a plurality of time resources, wherein the plurality of communication resources are discontinuous in frequency and assigned to frequency resources associated with indices that are discontinuous;~~

~~map uplink control information to, wherein a first communication resource of the plurality of communication resources based on the continuous set of numbers assigned to is separated in frequency by one or more communication resources from a second communication resource of the plurality of communication resources; wherein the first communication resource is assigned a first index, the second communication resource is assigned a second index, and~~

~~the first index and second index are discontinuous, and where the first communication resource is assigned a first number of the set of numbers, the second communication resource is assigned a second number of the set of numbers, and the first number and second number are continuous, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time,~~

wherein each resource element corresponds to one frequency resource of the plurality of frequency resources and one time resource of the plurality of time resources; determine if a first number of resource elements needed for communicating uplink control information during a first time resource is greater than or equal to a second number of resource elements included in the first time resource; when the first number is greater than or equal to the second number, map the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a first separation amount; and when the first number is not greater than or equal to the second number, map the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount; and one of transmit or receive the uplink control information in the plurality of communication resources based on the mapping.

9.—~~8.~~ The wireless device of claim ~~8~~7, wherein the plurality of frequency resources comprise a plurality of subcarriers, wherein the plurality of time resources comprise a plurality of symbols;

~~9. The wireless device of claim 7, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one subcarrier and one symbol.~~

~~10.— The wireless device of claim 9, wherein mapping uplink control information to the plurality of communication resources comprises mapping uplink control information to a first symbol of the plurality of symbols comprising:~~

~~—determining if a first number of resource elements needed for communicating the uplink control information during the first symbol is greater than or equal to a second number of resource elements included in the first symbol;~~

~~—when the first number is greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a first separation amount; and~~

~~—when the first number is not greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount. is equal to one resource element.~~

~~11.—10.~~ The wireless device of claim ~~10~~, wherein the first separation amount is equal to one resource element.

~~12.—The wireless device of claim 10,~~ wherein the second separation is equal to the floor of the second number divided by the first number.

~~13.—11.~~ The wireless device of claim ~~8~~, wherein the communication channel comprises a physical uplink shared channel (PUSCH).

~~14.—12.~~ The wireless device of claim ~~8~~, wherein the processor is further configured to modulate the uplink control information into a plurality of modulated uplink control information symbols, wherein mapping the uplink control information comprises mapping each of the plurality of modulated uplink control information symbols to a different resource element of the plurality of communication resources.

~~15.—13.~~ A wireless device comprising:

~~_means for assigning a continuous set of numbers_~~ to a plurality of communication resources of a communication channel in order by frequency, the communication channel comprising a plurality of frequency resources and a plurality of time resources, wherein the

plurality of communication resources are discontinuous in frequency and assigned to frequency resources associated with indices that are discontinuous;

———, wherein a first communication resource of the plurality of communication resources is separated in frequency by one or more communication resources from a second communication resource of the plurality of communication resources, wherein the first communication resource is assigned a first index, the second communication resource is assigned a second index, and the first index and second index are discontinuous, and where the first communication resource is assigned a first number of the set of numbers, the second communication resource is assigned a second number of the set of numbers, and the first number and second number are continuous, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one frequency resource of the plurality of frequency resources and one time resource of the plurality of time resources;

means for mapping uplink control information to the plurality of communication resources based on the continuous set of numbers assigned to the plurality of communication resources; and

———, the means for mapping configured to: determine if a first number of resource elements needed for communicating the uplink control information during a first time resource is greater than or equal to a second number of resource elements included in the first time resource; when the first number is greater than or equal to the second number, map the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a first separation amount; and when the first number is not greater than or equal to the second number, map the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount; and one of means for transmitting or means for receiving the uplink control information in the plurality of communication resources based on the mapping.

~~16.~~—14. The wireless device of claim ~~15~~13, wherein the plurality of frequency resources comprise a plurality of subcarriers, wherein the plurality of time resources comprise a plurality of symbols, ~~wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one subcarrier and one symbol.~~

~~17.~~—15. The wireless device of claim ~~16~~, wherein means for mapping uplink control information to the plurality of communication resources comprises means for mapping uplink control information to a first symbol of the plurality of symbols configured to:

———~~determine if a first number of resource elements needed for communicating the uplink control information during the first symbol is greater than or equal to a second number of resource elements included in the first symbol;~~

———~~when the first number is greater than or equal to the second number, map the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a 13, wherein the first separation amount;~~ and

———~~when the first number is not greater than or equal to the second number, map the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount. is equal to one resource element.~~

~~18.~~—16. The wireless device of claim ~~17~~, wherein the first separation amount is equal to one resource element.

~~19.~~—The wireless device of claim ~~17~~13, wherein the second separation is equal to the floor of the second number divided by the first number.

~~20.~~—17. The wireless device of claim ~~15~~13, wherein the communication channel comprises a physical uplink shared channel (PUSCH).

~~21.~~—18. The wireless device of claim ~~15~~13, further comprising means for modulating the uplink control information into a plurality of modulated uplink control information symbols, wherein means for mapping the uplink control information comprises means for mapping each of the plurality of modulated uplink control information symbols to a different resource element of the plurality of communication resources.

~~22.~~—19. A non-transitory computer readable storage medium that stores instructions that when executed by a wireless device, causes the wireless device to perform a method for wireless communications, the method comprising:

assigning a continuous set of numbers to a plurality of communication resources of a communication channel in order by frequency, the communication channel comprising a plurality of frequency resources and a plurality of time resources, wherein the plurality of communication resources are discontinuous in frequency and assigned to frequency resources associated with indices that are discontinuous;

~~mapping uplink control information to the plurality of communication resources based on the continuous set of numbers assigned to the plurality of communication resources; and~~

, wherein a first communication resource of the plurality of communication resources is separated in frequency by one or more communication resources from a second communication resource of the plurality of communication resources, wherein the first communication resource is assigned a first index, the second communication resource is assigned a second index, and the first index and second index are discontinuous, and where the first communication resource is assigned a first number of the set of numbers, the second communication resource is assigned a second number of the set of numbers, and the first number and second number are continuous, wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one frequency resource of the plurality of frequency resources and one time resource of the plurality of time resources; determining if a first number of resource elements needed for communicating uplink control

information during a first time resource is greater than or equal to a second number of resource elements included in the first time resource; when the first number is greater than or equal to the second number, mapping the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a first separation amount; and when the first number is not greater than or equal to the second number, mapping the uplink control information to resource elements in the first time resource such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount; and one of transmitting or receiving the uplink control information in the plurality of communication resources based on the mapping.

23.—20. The non-transitory computer readable storage medium of claim 2219, wherein the plurality of frequency resources comprise a plurality of subcarriers, wherein the plurality of time resources comprise a plurality of symbols,~~wherein the plurality of communication resources comprise a plurality of resource elements or a plurality of resource blocks, wherein each resource block comprises multiple resource elements in frequency and time, wherein each resource element corresponds to one subcarrier and one symbol.~~

24.—21. The non-transitory computer readable storage medium of claim 23,~~wherein mapping uplink control information to the plurality of communication resources comprises mapping uplink control information to a first symbol of the plurality of symbols comprising:~~
~~——determining if a first number of resource elements needed for communicating the uplink control information during the first symbol is greater than or equal to a second number of resource elements included in the first symbol;~~
~~——when the first number is greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in a continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a~~19, wherein the first separation amount; and

~~—when the first number is not greater than or equal to the second number, mapping the uplink control information to resource elements in the first symbol such that when the resource elements are ordered in the continuous ordering based on the continuous set of numbers, adjacent resource elements, according to the continuous ordering, that carry the uplink control information are separated by a second separation amount, is equal to one resource element.~~

25.—~~22.~~ The non-transitory computer readable storage medium of claim 24, ~~wherein the first separation amount is equal to one resource element.~~

26.—~~The non-transitory computer readable storage medium of claim 24~~19, wherein the second separation is equal to the floor of the second number divided by the first number.

27.—~~23.~~ The non-transitory computer readable storage medium of claim ~~22~~19, wherein the communication channel comprises a physical uplink shared channel (PUSCH).

28.—~~24.~~ The non-transitory computer readable storage medium of claim ~~22~~19, wherein the method further comprises modulating the uplink control information into a plurality of modulated uplink control information symbols, wherein mapping the uplink control information comprises mapping each of the plurality of modulated uplink control information symbols to a different resource element of the plurality of communication resources.