[00156] The following numbered paragraphs describe further aspects of the invention

1. A cellular base station, comprising: a plurality of antennas;

a radio operably coupled to the plurality of antennas; and a processor operably coupled to the radio;

wherein the cellular base station is configured to:

establish a first radio resource control (RRC) connection with a user equipment (UE) of a cellular network;

generate and transmit a single channel state information (CSI) report configuration to the UE, wherein the single CSI report configuration comprises information for configuring a plurality of concurrent CSI processing reports and further comprises a plurality of codebook configuration parameters specifying different codebook types, wherein the CSI report configuration is useable for configuring the UE with a plurality of concurrent CSI processing requests, wherein two or more of the plurality of concurrent CSI processing requests use the different codebook types.

2. A user equipment (UE), comprising: a plurality of antennas

a radio operably coupled to the plurality of antennas; and a processor operably coupled to the radio;

wherein the UE is configured to:

receive a channel state information (CSI) report configuration from the base station on a downlink channel, wherein the CSI report configuration comprises information for configuring a plurality of concurrent CSI processing reports, wherein the CSI report configuration comprises a plurality of codebook configuration parameters specifying different codebook types, wherein two or more of the plurality of concurrent CSI processing requests use the different codebook types;

configure a first channel measurement resource and a first interference measurement resource on the UE to perform CSI measurements on the downlink channel;

generate a plurality of CSI reports based on the first channel measurement resource and the first interference measurement resource resources; and

transmit the plurality of CSI reports to the base station.

3. A user equipment (UE), comprising: a plurality of antennas;

a radio operably coupled to the plurality of antennas; and a processor operably coupled to the radio;

wherein the UE is configured to:

receive at least one channel state information (CSI) report configuration from the base station on a downlink channel, wherein the at least one CSI report configuration comprises information for configuring a plurality of concurrent CSI processing reports;
receive a plurality of CSI reference signals for concurrent CSI reporting; wherein the at least one CSI report configuration specifies a first minimum time offset between a last symbol of a last downlink control information (DCI) containing a CSI report configuration and a CSI reference signal and a second minimum time offset between a last symbol of a last one of the CSI reference signals and an uplink channel;
perform at least one measurement on the each of the CSI reference signals to generate CSI;
transmit the CSI in the uplink channel;
wherein the UE performs the at least one measurement based on the first minimum time offset;
wherein the UE transmits the CSI in the uplink channel based on the second minimum time offset.

It is well understood that the use of personally identifiable information should follow privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining the privacy of users. In particular, personally identifiable information data should be managed and handled so as to minimize risks of unintentional or unauthorized access or use, and the nature of authorized use should be clearly indicated to users.

[00157] Embodiments of the present invention may be realized in any of various forms. For example, in some embodiments, the present invention may be realized as a computer-implemented method, a computer-readable memory medium, or a computer system. In other embodiments, the present invention may be realized using one or more custom-designed hardware devices such as ASICs. In other embodiments, the present invention may be realized using one or more programmable hardware elements such as FPGAs.

[00158] In some embodiments, a non-transitory computer-readable memory medium (e.g., a non-transitory memory element) may be configured so that it stores program instructions and/or data, where the program instructions, if executed by a computer system, cause the computer system to perform a method, e.g., any of a method embodiments described herein, or, any combination of the method embodiments described herein, or, any subset of any of the method embodiments described herein, or, any combination of such subsets.

[00159] In some embodiments, a device (e.g., a UE) may be configured to include a processor (or a set of processors) and a memory medium (or memory element), where the memory medium stores program instructions, where the processor is configured to read and execute the program instructions from the memory medium, where the program instructions are executable to implement any of the various method embodiments described herein (or, any combination of the method embodiments herein, or, any subset of any of the method embodiments described herein, or, any combination of such subsets). The device may be realized in any of various forms.

[00160] Although the embodiments above have been described in considerable detail, numerous variations and modifications will become apparent to those skilled in the art once the above disclosure is fully appreciated. It is intended that the following claims be interpreted to embrace all such variations and modifications.

CLAIMS

1. A wireless device, comprising:

a plurality of antennas;

a radio operably coupled to the plurality of antennas; and

a processor operably coupled to the radio;

wherein the wireless device is configured to:

establish a first radio resource control (RRC) connection with a base station of a cellular network;

transmit channel state information (CSI) capability information to the base station, wherein the capability information comprises information on concurrent CSI processing capability of the wireless device;

wherein the CSI capability information specifies a first type of capability when concurrent CSI processing is requested for two or more different component carriers, and wherein the capability information specifies a second type of capability when concurrent CSI processing is requested for a single component carrier using multiple codebook types.

2. The wireless device of claim 1,

wherein the CSI capability information is useable by the base station in formulating concurrent CSI processing requests to the wireless device.

3. The wireless device of claim 1,

wherein the CSI capability information indicates that the wireless device supports concurrent CSI reporting when multiple concurrent instances of CSI processing are requested for two or more different component carriers; and

wherein the CSI capability information indicates that the wireless device does not support concurrent CSI reporting when multiple concurrent instances of CSI processing are requested for a single component carrier using multiple codebook types.

4. The wireless device of claim 1,

wherein the CSI capability information specifies separate concurrent CSI reporting capability for each of the following scenarios:

1) multiple concurrent instances of CSI processing are requested for a single component carrier;

2) multiple concurrent instances of CSI processing are requested for multiple component carriers, and the multiple component carriers are in a same operating frequency band.

3) multiple concurrent instances of CSI processing are requested for multiple component carriers, and the multiple component carriers are in different operating frequency bands.

5. The wireless device of claim 1,

wherein the capability information includes a maximum number of CSI resources for all codebook types.

6. The wireless device of claim 5,

wherein the capability information includes one or both of 1) a maximum number of ports per CSI-RS resource or 2) a maximum total number of ports across all CSI-RS resources.

7. The wireless device of claim 1,

wherein the capability information includes specific codebook type combinations that are supported for concurrent CSI processing.

8. The wireless device of claim 7,

wherein the capability information includes a maximum number of CSI resources for each codebook type combination that is supported for concurrent CSI processing.

9. The wireless device of claim 1,

wherein the capability information includes weighting factors for each of a plurality of codebook types, wherein the weighting factors are usable by the base station in assessing usage of CSI resources in CSI processing requests.

10. The wireless device of claim 1,

wherein the capability information includes a plurality of maximum CSI resource configurations for each of one or more codebook types.

11. The wireless device of claim 10,

wherein each maximum CSI resource configuration comprises 1) a maximum number of ports per CSI reference signal, 2) a maximum number of CSI reference signals, and 3) a maximum total number of ports.

12. The wireless device of claim 1,

wherein the wireless device is further configured to:

receive multiple CSI requests from the base station on a downlink channel, wherein the multiple CSI requests include a first CSI request that specifies configuration of first CSI resources on the wireless device to generate a first CSI report and a second CSI request that specifies configuration of second CSI resources on the wireless device to generate a second CSI report;

configure the first CSI resources on the wireless device to perform measurements on the downlink channel;

generate the first CSI report and the second CSI report based on the configured first CSI resources; and

transmit the first CSI report and the second CSI report to the base station.

13. The wireless device of claim 1,

wherein the wireless device is further configured to:

receive multiple CSI requests from the base station on a downlink channel;

generate one or more CSI reports based on the requests, wherein the wireless device is further configured to report only a first subset of rank indicators for a first type of CSI reporting and to report only a second subset of rank indicators for a second type of CSI reporting.

14. The wireless device of claim 13,

wherein the wireless device is configured to generate rank indicators 1 or 2 for Type II CSI reporting, and wherein the wireless device is configured to generate rank indicators 3 or 4 for Type I CSI reporting.

15. The wireless device of claim 1,

wherein the wireless device is further configured to:

receive multiple CSI requests from the base station on a downlink channel requesting concurrent CSI processing;

generate at least one CSI report based on the requests, wherein the CSI report includes a CSI payload having a determined size, wherein CSI data generated in response to the concurrent CSI processing is larger than the determined size of the CSI payload;

wherein the wireless device is configured to prioritize inclusion of CSI data in the CSI payload based on a predetermined priority of codebook types.

16. A user equipment (UE), comprising:

a plurality of antennas;

a radio operably coupled to the plurality of antennas; and

a processor operably coupled to the radio;

wherein the UE is configured to:

establish a first radio resource control (RRC) connection with a base station of a cellular network;

receive a plurality of channel state information (CSI) requests from the base station, wherein

transmit channel state information (CSI) capability information to the base station, wherein the capability information comprises information on concurrent CSI processing capability of the UE;

wherein the capability information includes specific codebook type combinations that are supported for concurrent CSI processing.

17. The UE of claim 16,

wherein the capability information includes one or more of a maximum number of CSI resources for each codebook type combination, a maximum number of ports per CSI-RS resource, or a maximum total number of ports across all CSI-RS resources.

18. The UE of claim 16

wherein the plurality of CSI requests include a first CSI request that specifies configuration of first CSI resources on the UE to generate a first CSI report and a second CSI request that specifies configuration of second CSI resources on the UE to generate a second CSI report;

wherein the UE is further configured to:

configure the first CSI resources on the UE to perform measurements on the downlink channel;

generate the first CSI report and the second CSI report based on the configured first CSI resources; and

transmit the first CSI report and the second CSI report to the base station.

19. An apparatus, comprising:

a processor configured to cause a wireless device to:

establish a first radio resource control (RRC) connection with a base station of a cellular network;

transmit channel state information (CSI) capability information to the base station, wherein the capability information comprises information on concurrent CSI processing capability of the wireless device;

wherein the CSI capability information indicates that the wireless device supports concurrent CSI reporting when multiple concurrent instances of CSI processing using multiple codebook types are requested for two or more different component carriers; and

wherein the CSI capability information indicates that the wireless device does not support concurrent CSI reporting when multiple concurrent instances of CSI processing using multiple codebook types are requested for a single component carrier.

20. The apparatus of claim 19,

wherein the capability information includes specific codebook type combinations that are supported for concurrent CSI processing.