

INTERFERENCE MEASUREMENT REFERENCE SIGNAL

TECHNICAL FIELD

[0001] This disclosure is directed generally to digital wireless communications.

BACKGROUND

[0002] Mobile telecommunication technologies are moving the world toward an increasingly connected and networked society. In comparison with the existing wireless networks, next generation systems and wireless communication techniques will need to support a much wider range of use-case characteristics and provide a more complex and sophisticated range of access requirements and flexibilities.

[0003] Long-Term Evolution (LTE) is a standard for wireless communication for mobile devices and data terminals developed by 3rd Generation Partnership Project (3GPP). LTE Advanced (LTE-A) is a wireless communication standard that enhances the LTE standard. The 5th generation of wireless system, known as 5G, advances the LTE and LTE-A wireless standards and is committed to supporting higher data-rates, large number of connections, ultra-low latency, high reliability and other emerging business needs.

SUMMARY

[0004] Techniques are disclosed for configuration and/or transmission of reference signals that can enable a network device (e.g., base station) to reduce interference.

[0005] In an aspect, the present disclosure provides a wireless communication method, comprising: transmitting, by a first network device, a first reference signal to a second network device, wherein the first reference signal includes an identifier of the first network device or of a cell of the first network device, wherein the first reference signal is transmitted on N occasions, wherein each of the N occasions is based on a first set of time domain resources and a first set of frequency domain resources of the first reference signal, where each of the N occasions includes X time units in time domain and Y frequency units in frequency domain, and where N, X, and Y are integers greater than or equal to 1; and receiving, by the first network device from the second network device, a measurement report in response to the transmitting the first reference signal.

[0006] In some examples, the first reference signal includes an identifier of the first network device or of a cell of the first network device. In some embodiments, each of the N occasions is mapped to or is associated with a second reference signal that is transmitted by the first network device. In some examples, the second reference signal includes a channel state information reference signal (CSI-RS) or a synchronization signal block (SSB). In some examples, each of the N occasions is mapped to or is associated with: a transmission power for the transmitting the first reference signal, and/or a sub-band within which an occasion is located. In some examples, the first set of time domain resources associated with an occasion of the N occasions are based on a second set of time domain

resources of a second reference signal that is transmitted by the first network device, and the second reference signal is mapped to the occasion for the first reference signal.

[0007] In some examples, time domain resources for an occasion for the first reference signal is based on an offset from a second reference signal to which the occasion for the first reference signal is mapped. In some examples, the first set of time domain resources for the N occasions are based on a second set of time domain resources of a plurality of second reference signals that are transmitted by the first network device, a plurality of occasions for the first reference signal are mapped with a same second reference signal, and the plurality of occasions for the first reference signal are in a same time slot. In some examples, the plurality of second reference signals or the second reference signal includes a channel state information reference signal (CSI-RS) or a synchronization signal block (SSB). In some examples, the first set of frequency domain resources associated with an occasion of the N occasions are based on a second set of frequency domain resources of a second reference signal that is transmitted by the first network device, and the second reference signal is mapped to the occasion for the first reference signal.

[0008] In some examples, the first set of frequency domain resources associated with an occasion of the N occasions are based on a frequency domain offset to a second reference signal that is transmitted by the first network device, and the second reference signal is mapped to the occasion for the first reference signal. In some examples, the first network device determines an index for each occasion of the N occasions based on: the first set of time domain resources and the first set of frequency domain resources; or an index of a second reference signal transmitted by the first network device, the first set of time domain resources and the first set of frequency domain resources; or a transmission

power for the transmitting the first reference signal, the first set of time domain resources and the first set of frequency domain resources; or the index of the second reference signal, the transmission power, the first set of time domain resources and the first set of frequency domain resources.

[0009] In some examples, one or more indexes of the N occasions are mapped in a first increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal and then in a second increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal. In some examples, indexes of a plurality of second reference signals transmitted by the first network device are mapped to the N occasions associated with the first reference signal in the following order: first, in a first order of a transmission power of the first reference signal on the N occasions, second, in increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal on the N occasions, and third, in an increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal on the N occasion. In some examples, the measurement report includes an index corresponding to an occasion associated with a transmission of the first reference signal, a measured interference strength of the first reference signal in the occasion is smaller than an interference strength measured of a second reference signal mapped to the occasion, and the second reference signal is transmitted by the first network device.

[0010] In some examples, the measurement report includes an index corresponding to an occasion associated with a transmission of the first reference signal, a measured interference strength of the first reference signal in the occasion is smaller than a threshold, the threshold is configured by or determined by the first network device, the second network device, or an operation, administration and management (OAM) device.

[0011] In a second aspect, the present disclosure provides a wireless communication method, comprising: receiving, by a second network device, a first reference signal from a first network device, wherein the first reference signal includes an identifier of the first network device or of a cell of the first network device, wherein the first reference signal is transmitted on N occasions, wherein each of the N occasions is based on a first set of time domain resources and a first set of frequency domain resources of the first reference signal, wherein each of the N occasions includes X time units in time domain and Y frequency units in frequency domain, and where N, X, and Y are integers greater than or equal to 1; and transmitting, by the second network device to the first network device, a measurement report in response to the receiving the first reference signal.

[0012] In some examples, the first reference signal includes an identifier of the first network device or of a cell of the first network device. In some examples, each of the N occasions is mapped to or is associated with a second reference signal. In some examples, the second reference signal includes a channel state information reference signal (CSI-RS) or a synchronization signal block (SSB). In some examples, each of the N occasions is mapped to or is associated with: a transmission power for transmission of the first reference signal, and/or a sub-band within which an occasion is located. In some examples, the first set of time domain resources

associated with an occasion of the N occasions are based on a second set of time domain resources of a second reference signal, and the second reference signal is mapped to the occasion for the first reference signal.

[0013] In some examples, time domain resources for an occasion for the first reference signal is based on an offset from a second reference signal to which the occasion for the first reference signal is mapped. In some examples, the first set of time domain resources for the N occasions are based on a second set of time domain resources of a plurality of second reference signals, a plurality of occasions for the first reference signal are mapped with a same second reference signal, and the plurality of occasions for the first reference signal are in a same time slot. In some examples, the plurality of second reference signals or the second reference signal includes a channel state information reference signal (CSI-RS) or a synchronization signal block (SSB). In some examples, the first set of frequency domain resources associated with an occasion of the N occasions are based on a second set of frequency domain resources of a second reference signal, and wherein the second reference signal is mapped to the occasion for the first reference signal.

[0014] In some examples, the first set of frequency domain resources associated with an occasion of the N occasions are based on a frequency domain offset to a second reference signal, and the second reference signal is mapped to the occasion for the first reference signal. In some examples, the an index for each occasion of the N occasions is based on: the first set of time domain resources and the first set of frequency domain resources; or an index of a second reference signal, the first set of time domain resources and the first set of frequency domain resources; or a transmission power for the transmitting the first reference signal, the first set of time domain resources and the first set of frequency domain resources; or the index of the second reference signal, the transmission power, the first set of time domain resources and the first set of frequency domain resources. In some examples, one or more indexes of the N occasions are mapped in a first increasing order of one or more frequency resource indexes for the first set of frequency domain

resources of the first reference signal and then in a second increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal.

[0015] In some examples, indexes of a plurality of second reference signals are mapped to the N occasions associated with the first reference signal in the following order: first, in a first order of a transmission power of the first reference signal on the N occasions, second, in increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal on the N occasions, and third, in an increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal on the N occasion. In some examples, the measurement report includes an index corresponding to an occasion associated with the first reference signal, a measured interference strength of the first reference signal in the occasion is smaller than an interference strength measured of a second reference signal mapped to the occasion, and the second reference signal is received by the second network device. In some examples, the measurement report includes an index corresponding to an occasion associated with the first reference signal, a measured interference strength of the first reference signal in the occasion is smaller than a threshold. In some examples, the first network device includes an aggressor base station that causes an interference experienced by the second network device that includes a victim base station.

[0016] In yet another exemplary example, the above-described methods are embodied in the form of processor-executable code and stored in a non-transitory computer-readable storage medium. The code included in the computer readable storage medium when executed by a processor, causes the processor to implement the methods described in this patent document.

[0017] In a third aspect, the present disclosure provides an apparatus for wireless communication comprising a processor, configured to implement a method according to the first or second aspect.

[0018] The above and other aspects and their implementations are described in greater detail in the drawings, the descriptions, and the claims.

BRIEF DESCRIPTION OF THE DRAWING

[0019] FIG. 1 shows an example mapping between two reference signal 0 (RS0) and two reference signal 2 (RS2).

[0020] FIG. 2 shows an example mapping between two RS2 and a RS0 in a same time slot.

[0021] FIG. 3 shows an example mapping between two RS2 and a RS0 in one time slot, and two other RS2 and RS0 in another time slot.

[0022] FIG. 4 shows an example mapping between three RS2 occasions and RS0 in a first slot, where the three RS2 occasions occupy same frequency resources as RS0 in the first slot.

[0023] FIG. 5 shows an example mapping between two RS2 occasions and RS0 in a first time slot, and two RS2 occasions and RS0 in a third time slot, where two of the RS2 (RS2#0 and RS2#2) use same first frequency resources, and where the remaining two of the RS2 (RS2#1 and RS2#3) use same second frequency resources.

[0024] FIG. 6 shows an example of wireless communication including a base station (BS) and user equipment (UE) based on some implementations of the disclosed technology.

[0025] FIG. 7 shows an exemplary block diagram of a hardware platform that may be a part of a network device or a communication device.

[0026] FIG. 8 shows an exemplary flowchart for transmitting a reference signal and receiving a measurement report.

[0027] FIG. 9 shows an exemplary flowchart for receiving a reference signal and transmitting a measurement report.

DETAILED DESCRIPTION

[0028] In the existing NR system, various reference signals have been specified for measuring the interference between base station and User Equipment (UE) or between UE and UE, e.g., Channel State Information Reference Signal (CSI-RS) and Sounding Reference Signal (SRS). For interference measurement between base stations, only Remote Interference Management Reference Signal (RIM-RS) is defined. However, RIM-RS is mainly used for atmospheric

CLAIMS

What is claimed is:

1. A wireless communication method, comprising:
 - transmitting, by a first network device, a first reference signal to a second network device,
 - wherein the first reference signal includes an identifier of the first network device or of a cell of the first network device,
 - wherein the first reference signal is transmitted on N occasions,
 - wherein each of the N occasions is based on a first set of time domain resources and a first set of frequency domain resources of the first reference signal,
 - wherein each of the N occasions includes X time units in time domain and Y frequency units in frequency domain, and
 - wherein N, X, and Y are integers greater than or equal to 1; and
 - receiving, by the first network device from the second network device, a measurement report in response to the transmitting the first reference signal.
2. The method of claim 1, wherein each of the N occasions is mapped to or is associated with:
 - a transmission power for the transmitting the first reference signal, and/or
 - a sub-band within which an occasion is located.
3. The method of claim 1,
 - wherein the first set of time domain resources for the N occasions are based on a second set of time domain resources of a plurality of second reference signals that are transmitted by the first network device,
 - wherein a plurality of occasions for the first reference signal are mapped with a same second reference signal, and
 - wherein the plurality of occasions for the first reference signal are in a same time slot.

4. The method of claim 1,
wherein the first set of frequency domain resources associated with an occasion of the N occasions are based on a frequency domain offset to a second reference signal that is transmitted by the first network device, and
wherein the second reference signal is mapped to the occasion for the first reference signal.
5. The method of claim 1, wherein one or more indexes of the N occasions are mapped in a first increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal and then in a second increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal.
6. The method of claim 1, wherein indexes of a plurality of second reference signals transmitted by the first network device are mapped to the N occasions associated with the first reference signal in the following order:
first, in a first order of a transmission power of the first reference signal on the N occasions,
second, in increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal on the N occasions,
and
third, in an increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal on the N occasion.
7. The method of claim 1,
wherein the measurement report includes an index corresponding to an occasion associated with a transmission of the first reference signal,
wherein a measured interference strength of the first reference signal in the occasion is smaller than an interference strength measured of a second reference

- signal mapped to the occasion, and
wherein the second reference signal is transmitted by the first network device.
8. A wireless communication method, comprising:
receiving, by a second network device, a first reference signal from a first network device,
wherein the first reference signal includes an identifier of the first network device or of a cell of the first network device,
wherein the first reference signal is transmitted on N occasions,
wherein each of the N occasions is based on a first set of time domain resources and a first set of frequency domain resources of the first reference signal,
wherein each of the N occasions includes X time units in time domain and Y frequency units in frequency domain, and
wherein N, X, and Y are integers greater than or equal to 1; and
transmitting, by the second network device to the first network device, a measurement report in response to the receiving the first reference signal.
9. The method of claim 8, wherein each of the N occasions is mapped to or is associated with:
a transmission power for transmission of the first reference signal, and/or
a sub-band within which an occasion is located.
10. The method of claim 8,
wherein the first set of time domain resources for the N occasions are based on a second set of time domain resources of a plurality of second reference signals,
wherein a plurality of occasions for the first reference signal are mapped with a same second reference signal, and
wherein the plurality of occasions for the first reference signal are in a same time slot.

11. The method of claim 8,
 - wherein the first set of frequency domain resources associated with an occasion of the N occasions are based on a frequency domain offset to a second reference signal, and
 - wherein the second reference signal is mapped to the occasion for the first reference signal.
12. The method of claim 8, wherein one or more indexes of the N occasions are mapped in a first increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal and then in a second increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal.
13. The method of claim 8, wherein indexes of a plurality of second reference signals are mapped to the N occasions associated with the first reference signal in the following order:
 - first, in a first order of a transmission power of the first reference signal on the N occasions,
 - second, in increasing order of one or more frequency resource indexes for the first set of frequency domain resources of the first reference signal on the N occasions, and
 - third, in an increasing order of one or more time resource indexes for the first set of time domain resources of the first reference signal on the N occasion.
14. The method of claim 8,
 - wherein the measurement report includes an index corresponding to an occasion associated with the first reference signal,
 - wherein a measured interference strength of the first reference signal in the occasion is smaller than an interference strength measured of a second reference

signal mapped to the occasion, and

wherein the second reference signal is received by the second network device.

15. An apparatus for wireless communication comprising a processor, configured to implement a method recited in one or more of claims 1-14.