TRANSMISSION CONFIGURATION INDICATOR (TCI) ACTIVATION

FIELD

[0001] Various example embodiments relate generally to wireless networking and, more particularly, to transmission configuration indicator (TCI) states for mobility in wireless networking.

BACKGROUND

[0002] Wireless networking provides significant advantages for user mobility. A user's ability to remain connected while on the move provides advantages not only for the user, but also provides greater efficiency and productivity for society as a whole. As user expectations for connection reliability, data speed, and device battery life, become more demanding, technology for wireless networking must also keep pace with such expectations. Accordingly, there is continuing interest in improving wireless networking technology. For that purpose, the cellular standards have developed cell switching on various protocol layers: conventional Layer 3 handovers have been present for several generations. On top of that, a conditional handover was introduced to improve the reliability of handovers. Recent development has contemplated lower-layer handovers known as Layer1/Layer 2 triggered mobility (LTM). Efforts to reduce latency during handovers may therefore be valuable.

SUMMARY

[0002A] In a first aspect, the present disclosure provides a method, comprising: receiving, by a user equipment (UE) connected to a first cell, an activation for a first transmission configuration indicator (TCI) state of a first configured TCI state list associated with a second cell, the TCI states of the first configured TCI state list being configured under serving cell configurations for beam management (BM); receiving, by the UE, a configuration of a second TCI state of a second TCI state list associated with the second cell, the second TCI state list being a lower-layer triggered mobility (LTM) TCI state list and the second TCI state of the second TCI state list being a target TCI state associated with an LTM configuration for the second cell; receiving, by the UE, a message for activating the second TCI state; determining, by the UE, that the target TCI state is already active in the first configured TCI state list; based upon the determining, activating, by the

UE, the target TCI state of the second TCI state list with a reduced activation delay compared to when the target TCI state is not already active in another TCI state list; and performing, by the UE, a cell switch to the second cell, maintaining the activated second TCI state of the second cell.

[0002B] In a second aspect, the present disclosure provides a user equipment (UE), comprising: at least one processor; and at least one memory storing instructions which, when executed by the at least one processor, cause the apparatus at least to perform at least the following: receiving, by the user equipment (UE) connected to a first cell, an activation for a first transmission configuration indicator (TCI) state of a first configured TCI state list associated with a second cell , the TCI states of the first configured TCI state list being configured under serving cell configurations for beam management (BM); receiving a configuration of a second TCI state of a second TCI state list associated with the second cell, the second TCI state list being a lower-layer triggered mobility (LTM) TCI state list and the second TCI state of the second TCI state list being a target TCI state associated with an LTM configuration for the second cell; receiving, by the UE, a message for activating the second TCI state; determining, by the UE, that the target TCI state is already active in the first configured TCI state list; based upon the determining, activating, by the UE, the target TCI state of the second TCI state list with a reduced activation delay compared to when the target TCI state is not already active in another TCI state list; and performing, by the UE, a cell switch to the second cell, maintaining the activated second TCI state of the second cell.

[0003] In an example of the present disclosure, a method includes receiving, by a user equipment (UE) connected to a first cell, an activation for a first transmission configuration indicator (TCI) state of a first configured TCI state pool associated with a second cell and further receiving a configuration of a second TCI state of a second TCI state pool associated with the second cell. The UE determines that the first activated TCI state and the second TCI state share one or more properties, and based upon the determining, activates the second TCI state of the second cell. The UE performs a cell switch to the second cell, maintaining the activated second TCI state of the second cell.

[0004] In an example of the method, the UE maintains the activated second TCI state of the second cell upon switching to the second cell.

[0005] In an example of the method, the activation of the second TCI state of the second cell is determined after switching to the second cell.

[0006] In an example of the method, the activation of the second TCI state of the second cell is determined after reception of a cell switch command that switches The UE to the second cell.

[0007] In an example of the method, the activation of the second TCI state of the second cell is determined after reception and acknowledging of the cell switch command that switches the UE to the second cell.

[0008] In an example of the method, the activation of the second TCI state of the second cell is determined after processing of the cell switch command that switches the UE to the second cell.

[0009] In an example of the method, the first activated TCI state of the first TCI state pool is associated with a beam management configuration for the second cell and the second TCI state of the second TCI state pool is associated with a lower-layer triggered mobility (LTM) configuration for the second cell.

[0010] In an example of the method, the first activated TCI state of the first TCI state pool is associated with a lower-layer triggered mobility (LTM) configuration for the second cell and the second TCI state of the second TCI state pool is associated with a beam management configuration for the second cell.

[0011] In an example of the method, the second cell is configured as an LTM candidate cell.

[0012] In an example of the method, the second cell is configured as a serving cell.

[0013] In an example of the method, the determination of the first activated TCI state and the second TCI sharing one or more properties includes determining that a quasi-colocation (QCL) reference signal of the first activated TCI state is equivalent to the QCL reference signal of the second TCI state.

[0014] In an example of the method, the determination of the first activated TCI state and the second TCI sharing one or more properties includes determining that a quasi-colocation (QCL) reference signal of the first activated TCI state shares one or more properties with the QCL reference signal of the second TCI state.

[0015] In an example of the method, the one or more QCL properties include one or more of the following: doppler spread, doppler shift, delay spread, or average delay.

[0016] In an example of the method, the QCL reference signal of the first activated TCI state sharing one or more properties with the QCL reference signal of the second TCI state includes the

QCL reference signal of the first activated TCI state including a same QCL source reference signal (RS).

[0017] In an example of the method, the activation for the first TCI state of the first TCI state pool associated with a second cell and the second TCI state of the second TCI state pool associated with the second cell is included in a media access control (MAC) control element (CE) message.

[0018] In an example of the present disclosure, a user equipment (UE) includes at least one processor, and at least one memory storing instructions which, when executed by the at least one processor, cause the apparatus at least to perform any of the foregoing methods.

[0019] In an example of the present disclosure, a processor-readable medium storing instructions which, when executed by at least one processor of an apparatus, causes the apparatus at least to perform any of the foregoing methods.

[0020] In an example of the present disclosure, a method includes transmitting, by a first cell, a first message to a user equipment (UE) that includes at least a first activated transmission configuration indicator (TCI) state of a first TCI state pool associated with a second cell and a second TCI state of a second TCI state pool associated with the second cell, based upon the first activated TCI state and the second TCI state sharing one or more properties. The first cell performs beam management using the first TCI state, and transmits, to a user equipment, an instruction for a lower-layer triggered mobility (LTM) cell switch to the second cell, the instruction including the second TCI state for the second cell.

[0021] In an example of the method, the instruction for the LTM cell switch includes a command for LTM cell switch to the second cell.

[0022] In an example of the method, a determination of the first activated TCI state and the second TCI state sharing one or more properties includes determining that a quasi-colocation (QCL) reference signal of the first activated TCI state is equivalent to the QCL reference signal of the second TCI state.

[0023] In an example of the method, a determination of the first activated TCI state and the second TCI sharing one or more properties includes determining that a quasi-colocation (QCL) reference signal of the first activated TCI state shares one or more properties with the QCL reference signal of the second TCI state.

[0024] In an example of the method, the one or more QCL properties include one or more of the following: doppler spread, doppler shift, delay spread, or average delay.

[0025] In an example of the method, the QCL reference signal of the first activated TCI state sharing one or more properties with the QCL reference signal of the second TCI state includes the QCL reference signal of the first activated TCI state including a same QCL source reference signal (RS).

[0026] In an example of the method, the first activated TCI state of the first TCI state pool is associated with a lower-layer triggered mobility (LTM) configuration for the second cell and the second TCI state of the second TCI state pool is associated with a beam management configuration for the second cell.

[0027] In an example of the method, the second cell is configured as an LTM candidate cell.

[0028] In an example of the method, the second cell is configured as a serving cell.

[0029] In an example of the method, the first message is a media access control (MAC) control element (CE) message.

[0030] In an example of the present disclosure, an apparatus includes at least one processor, and at least one memory storing instructions which, when executed by the at least one processor, cause the apparatus at least to perform any of the foregoing methods.

[0031] In an example of the present disclosure, a processor-readable medium storing instructions which, when executed by at least one processor of an apparatus, causes the apparatus at least to perform any of the foregoing methods.

[0032] According to some examples, there is provided the subject matter of the independent claims. Some further examples are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] Some example embodiments will now be described with reference to the accompanying drawings.

[0034] FIG. 1 is a diagram of an example embodiment of wireless networking between a network system and a user equipment apparatus (UE), according to one illustrated aspect of the disclosure;

[0035] FIG. 2 is a diagram of an example embodiment of transmit and receive beams for wireless networking between a network apparatus and a user equipment apparatus (UE), according to one illustrated aspect of the present disclosure;

WHAT IS CLAIMED IS:

1. A method, comprising:

receiving, by a user equipment (UE) connected to a first cell, an activation for a first transmission configuration indicator (TCI) state of a first configured TCI state list associated with a second cell, the TCI states of the first configured TCI state list being configured under serving cell configurations for beam management (BM);

receiving, by the UE, a configuration of a second TCI state of a second TCI state list associated with the second cell, the second TCI state list being a lower-layer triggered mobility (LTM) TCI state list and the second TCI state of the second TCI state list being a target TCI state associated with an LTM configuration for the second cell;

receiving, by the UE, a message for activating the second TCI state;

determining, by the UE, that the target TCI state is already active in the first configured TCI state list;

based upon the determining, activating, by the UE, the target TCI state of the second TCI state list with a reduced activation delay compared to when the target TCI state is not already active in another TCI state list; and

performing, by the UE, a cell switch to the second cell, maintaining the activated second TCI state of the second cell.

2. The method of claim 1, wherein the reduced activation delay is realized by not considering, as a delay in the activation of the second TCI state, synchronization with a synchronization signal block that has a quasi-co-location relationship to the second TCI state.

3. The method of claim 1 or 2, wherein the reduced activation delay is based on omitting synchronization with the synchronization signal block.

4. The method of any preceding claim, wherein the reduced activation delay is based on that parameters $T_{first\text{-}SSB}$ and $T_{SSB\text{-}proc}$ are omitted in the activation delay, if the target TCI state is already active.

5. The method of any preceding claim, wherein the UE activates the second TCI state after receiving the activation for the first TCI state and before the cell switch and maintains the activated second TCI state of the second cell upon switching to the second cell.

6. The method of any preceding claim, wherein the activation of the second TCI state of the second cell is determined after switching to the second cell.

7. The method of any preceding claim, wherein the second cell is configured as a serving cell.

8. The method of any preceding claim, wherein a quasi-colocation (QCL) reference signal of the first activated TCI state is equivalent to the QCL reference signal of the second TCI state.

9. The method of any of claims 1-7, wherein a quasi-colocation (QCL) reference signal of the first activated TCI state shares one or more properties with the QCL reference signal of the second TCI state.

10. The method of claim 9, wherein the one or more QCL properties include one or more of the following: doppler spread, doppler shift, delay spread, or average delay.

11. The method of claim 9, wherein the QCL reference signal of the first activated TCI state sharing one or more properties with the QCL reference signal of the second TCI state includes the QCL reference signal of the first activated TCI state including a same QCL source reference signal (RS).

12. The method of any of claims 1-11, wherein the activation for the first TCI state of the first TCI state pool associated with a second cell and the second TCI state of the second TCI state pool associated with the second cell is included in a media access control (MAC) control element (CE) message.

13. A user equipment (UE), comprising:

at least one processor; and

at least one memory storing instructions which, when executed by the at least one processor, cause the apparatus at least to perform at least the following:

receiving, by the user equipment (UE) connected to a first cell, an activation for a first transmission configuration indicator (TCI) state of a first configured TCI state list associated with a second cell , the TCI states of the first configured TCI state list being configured under serving cell configurations for beam management (BM);

receiving a configuration of a second TCI state of a second TCI state list associated with the second cell, the second TCI state list being a lower-layer triggered mobility (LTM) TCI state list and the second TCI state of the second TCI state list being a target TCI state associated with an LTM configuration for the second cell;

receiving, by the UE, a message for activating the second TCI state;

determining, by the UE, that the target TCI state is already active in the first configured TCI state list;

based upon the determining, activating, by the UE, the target TCI state of the second TCI state list with a reduced activation delay compared to when the target TCI state is not already active in another TCI state list; and

performing, by the UE, a cell switch to the second cell, maintaining the activated second TCI state of the second cell.

14. The UE of claim 13, configured to realize the reduced activation delay by not considering, as a delay in the activation of the second TCI state, synchronization with a synchronization signal block that has a quasi-co-location relationship to the second TCI state.

15. The UE of claim 13 or 14, wherein the reduced activation delay is based on omitting synchronization with the synchronization signal block.

16. The UE of any of claims 13 to 15, wherein the reduced activation delay is based on that parameters $T_{first\text{-}SSB}$ and $T_{SSB\text{-}proc}$ are omitted in the activation delay, if the target TCI state is already active.

17. The UE of any of claims 13 to 16, further configured to activate the second TCI state after receiving the activation for the first TCI state and before the cell switch and maintains the activated second TCI state of the second cell upon switching to the second cell.

18. The UE of any of claims 13 to 17, configured to determine the activation of the second TCI state of the second cell after switching to the second cell.

19. The UE of any preceding claim 13 to 18, wherein the second cell is configured as a serving cell.

20. The UE of any of claims 13 to 19, wherein the a quasi-colocation (QCL) reference signal of the first activated TCI state is equivalent to the QCL reference signal of the second TCI state.

21. The UE of any of claims 13 to 20, wherein a quasi-colocation (QCL) reference signal of the first activated TCI state shares one or more properties with the QCL reference signal of the second TCI state.

22. The UE of claim 21, wherein the one or more QCL properties include one or more of the following: doppler spread, doppler shift, delay spread, or average delay.

23. The UE of claim 22, wherein the QCL reference signal of the first activated TCI state sharing one or more properties with the QCL reference signal of the second TCI state includes the QCL reference signal of the first activated TCI state including a same QCL source reference signal (RS).

24. The UE of any of claims 13 to 23, wherein the activation for the first TCI state of the first TCI state pool associated with a second cell and the second TCI state of the second TCI state pool associated with the second cell is included in a media access control (MAC) control element (CE) message.

25. A processor-readable medium storing instructions which, when executed by at least one processor of an apparatus, causes the apparatus at least to perform a method as in any one of claims 1-12.