

C L A I M S

1. A method for paging using adaptively allocated paging resource, performed by a first network element in a network, the method comprising:

receiving a first message from a second network element of the network;

deriving a User Equipment (UE) specific paging resource configuration associated with a UE based on the first message;

selecting a paging radio resource based on the UE specific paging resource configuration and based on a radio resource specific paging configuration pre-defined in the first network element; and

sending a paging message over the selected paging radio resource to the UE.

2. The method of claim 1, wherein the UE specific paging resource configuration comprises at least one of following parameters associated with the UE:

coverage enhancement level (CEL);

CEL based paging indication;

CEL based paging deactivating indication;

maximum numbers of repetitions for NPDCCH common search space for paging (Rmax-paging);

Rmax-paging based paging indication;

Rmax-paging based paging deactivating indication;

DRX cycle based paging radio resource selection capability;

WUS Assistance Information;

Paging Probability Information;

paging extended Discontinuous Reception (eDRX) Information;

Radio Access Network (RAN) paging cycle;

UE specific Discontinuous Reception (DRX); or

Core Network Assistance Information for the UE in the RRC inactive state.

3. The method of claim 1, wherein the paging radio resource includes at least one of:

paging carrier;

paging narrowband;

paging physical resource block (PRB);

paging bandwidth part (BWP);

paging control-resource set (CORESET);

paging occasion (PO); or

GWUS resource.

4. The method of claim 1, wherein the radio resource specific paging configuration comprises at least one of:

carrier specific paging configuration configured per paging carrier;

narrow band specific paging configuration configured per paging narrowband;

paging Physical Resource Block (PRB) specific paging configuration configured per

paging PRB;

Bandwidth Part (BWP) specific paging configuration configured per paging BWP; or
control-resource set (CORESET) specific paging configuration configured per paging CORESET.

5. The method of claim 1, wherein the first message is triggered to be sent to the first network element by a UE specific S1AP or NGAP connection establishing procedure in the second network element.

6. The method of claim 1, when the UE specific paging resource configuration comprises a paging eDRX information and does not comprise a Paging Time Window (PTW), the method further comprising causing the UE to:

obtain a paging eDRX cycle according to the paging eDRX information; and

determine a DRX Cycle(T) associated with the UE to be the shortest of the paging eDRX cycle and a RAN paging cycle, wherein the RAN paging cycle is pre-defined in the network.

7. The method of claim 1, wherein the paging message comprises at least one of:

an S1AP paging message;

an NGAP paging message;

a XnAP paging message;

an F1AP paging message; or

a RAN base paging message.

8. The method of claim 7, when the UE is in a RRC idle state, and when the paging message comprises a paging eDRX cycle information element (IE) and does not comprise a Paging Time Window (PTW), the method further comprising causing the UE to:

obtain a paging eDRX cycle according to the paging eDRX cycle IE; and

determine a DRX Cycle (T) associated with the UE to be the paging eDRX cycle.

9. The method of claim 1, wherein before sending the paging message over the paging radio resource to the UE, the method further comprises sending a second message comprising the UE specific paging resource configuration to the UE.

10. The method of claim 9, wherein the second message comprises an RRC connection release message and the second message triggers the UE to enter the RRC inactive state.

11. The method of claim 1, wherein the first message comprises the UE specific paging resource configuration associated with the UE.

12. The method of claim 11, wherein the second network element comprises a core network node in the network, the core network node comprises at least one of a Mobility Management Entity (MME) or an Access and Mobility Management Function (AMF), and the second network element sends the first message to the first network element in response to establishing an S1AP or NGAP connection for the UE.

13. The method of claim 12, wherein the first message comprises at least one of the following messages:

INITIAL CONTEXT SETUP REQUEST;

UE CONTEXT MODIFICATION REQUEST;

HANDOVER REQUEST; or

PATH SWITCH REQUEST ACKNOWLEDGE.

14. The method of claim 11, wherein the first message comprises a paging message.

15. The method of claim 14, wherein the first message is sent to the first network element by the second network element in response to a core network node in the network sending the UE specific paging resource configuration to the second network element.

16. The method of claim 15, wherein the first network element comprises a first base station, the second network element comprises a second base station, wherein the UE is served by the first network element.

17. The method of claim 16, wherein the second network element comprises at least one of:

a 5G NR gNB;

a 4G LTE eNB; or

an enhanced Machine Type Communication (eMTC) NodeB.

18. The method of claim 14, wherein the first network element comprises a distribution unit of a base station in the network, and the second network element comprises a central unit of the base station.

19. The method of claim 18, wherein the first network element comprises a gNB-DU, and the second network element comprises a gNB-CU.

20. The method of claim 14, wherein the first network element comprises a base station, and the second network element comprises at least one of an MME, or an AMF.

21. The method of claim 1, wherein:

the second network element comprises the UE;

the first message comprises UE parameters including at least one of:

CEL preferred;

CEL based paging resource selection capability;

Rmax-paging preferred; or

Rmax-paging based paging resource selection capability.

22. The method of claim 21, wherein the first message comprises a paging information

request including at least one of:

UL MAC CE;

RRCConnectionReconfigurationComplete;

RRCConnectionReestablishmentComplete;

RRCConnectionResumeComplete;

RRCConnectionSetupComplete;

RRCEarlyDataRequest;

UEAssistanceInformation;

UECapabilityInformation; or

UEPagingInformationRequest.

23. The method of claim 21, wherein after deriving the UE specific paging resource configuration, the method further comprises:

sending a paging information update request to a third network element in the network to trigger the third network element to update its UE specific paging configuration, the paging information update request comprising at least one of UE parameters including:

CEL;

Rmax-paging;

CEL based paging deactivating indication; or

Rmax-paging based paging deactivating indication.

24. The method of claim 23, wherein when the paging information update request does not contain the CEL parameter, the paging information update request is indicative of an instruction to deactivate CEL based paging.

25. The method of claim 23, wherein when the paging information update request does not contain the Rmax-paging parameter, the paging information update request is indicative of an instruction to deactivate Rmax-paging based paging.

26. The method of claim 23, wherein the paging information update request comprises at least one of:

RRC INACTIVE TRANSITION REPORT; or

paging information configuration update message.

27. The method of claim 23, wherein the first network element comprises a base station, and the third network element comprises at least one of an MME, or an AMF.

28. The method of claim 1, wherein the network comprises at least one of a 5G communication network, a 4G communication work, or a 3G communication network.

29. A method for transmitting system information, performed by a first network element in a network, the method comprising:

sending a first message to a UE in the network during a first pre-determined System Information (SI) acquisition period, the first message comprising an SI update indicator

instructing the UE to acquire an SI update from the beginning of a second pre-determined SI acquisition period following the first pre-determined SI acquisition period; and

sending the updated SI to the UE in the second pre-determined SI acquisition period.

30. The method of claim 29, wherein a duration of the first or second pre-determined SI acquisition period is longer than a BCCH modification period, is shorter than an eDRX acquisition period, and equals to the maximum value in a RAN paging cycle value range or the maximum value in a DRX Cycle(T) value range of the UE when the UE is in RRC inactive state.

31. The method of claim 30, wherein the BCCH modification period, the eDRX acquisition period, the RAN paging cycle value range, and the DRX Cycle(T) value range are pre-defined in the network.

32. The method of claim 29, wherein the first message further comprises at least one of a BCCH SI modification indicator, or an eDRX SI modification indicator, the BCCH SI modification indicator being used to instruct the UE to acquire an SI update from the beginning of an following BCCH modification period, and the eDRX SI modification indicator being used to instruct the UE to acquire an SI update from the beginning of an following eDRX acquisition period.

33. The method of claim 29, wherein the first message comprises at least one of a paging message or a Downlink Control Information (DCI).

34. The method of claim 29, wherein before sending the first message to the UE, the method further comprising:

negotiating eDRX parameters with the UE and with a second network element through a NAS message; and

sending a second message comprising RAN paging DRX parameters to the UE, to configure the RAN paging DRX parameters on the UE and trigger the UE to monitor the first message for detecting the SI update indicator carried in the first message in at least one of the following cases:

RAN paging cycle (ran-pagingCycle) is longer than a BCCH modification period;

idle mode paging eDRX Cycle is longer than the BCCH modification period; or

the UE is configured with idle mode paging eDRX information and RAN paging cycle is longer than the BCCH modification period;

wherein the eDRX parameters comprise the idle mode paging eDRX cycle, the RAN paging DRX parameters comprise RAN paging cycle, and the BCCH modification period is pre-defined in the network.

35. The method of claim 34, wherein the second message comprises an RRC connection release message and sending the second message to the UE triggers the UE entering RRC inactive state.

36. The method of claim 34, wherein the second network element comprises a core network node in the network, the core network node comprises at least one of an MME or an AMF.

37. The method of claim 29, wherein the first network element comprises at least one of:
- an eNB;
 - a gNB; or
 - an eMTC NodeB.
38. The method of claim 29, wherein the network comprises at least one of a 5G communication network, a 4G communication work, or a 3G communication network.
39. A method for acquiring system information, performed by a UE in a network, the method comprising:
- receiving a first message sent from a first network element in the network during a first pre-determined System Information (SI) acquisition period, the first message comprising an SI update indicator instructing the UE to acquire an SI update from the beginning of a second pre-determined SI acquisition period following the first pre-determined SI acquisition period; and
 - receiving the updated SI sent from the first network element in the second pre-determined SI acquisition period.
40. The method of claim 39, wherein a duration of the first or second pre-determined SI acquisition period is longer than a BCCH modification period, is shorter than an eDRX acquisition period, and equals to the maximum value in a RAN paging cycle value range or the maximum value in a DRX Cycle(T) value range of the UE when the UE is in RRC inactive state.

41. The method of claim 40, wherein the BCCH modification period, the eDRX acquisition period, the RAN paging cycle value range, and the DRX Cycle(T) value range are pre-defined in the network.

42. The method of claim 39, wherein the first message further comprises at least one of a BCCH SI modification indicator, or an eDRX SI modification indicator, the BCCH SI modification indicator being used to instruct the UE to acquire an SI update from the beginning of an following BCCH modification period, and the eDRX SI modification indicator being used to instruct the UE to acquire an SI update from the beginning of an following eDRX acquisition period.

43. The method of claim 39, wherein the first message comprises at least one of a paging message or a Downlink Control Information (DCI).

44. The method of claim 39, wherein before receiving the first message sent from the first network element, the method further comprising:

negotiating eDRX parameters with a second network element through a NAS message;

receiving a second message comprising RAN paging DRX parameters sent from the first network element;

configuring the RAN paging DRX parameters on the UE; and

monitoring the first message for detecting the SI update indicator carried in the first message in at least one of the following cases:

RAN paging cycle (ran-pagingCycle) is longer than a BCCH modification period;

idle mode paging eDRX Cycle is longer than the BCCH modification period;
or

the UE is configured with idle mode paging eDRX information and RAN paging cycle is longer than the BCCH modification period;

wherein the eDRX parameters comprise the idle mode paging eDRX cycle, the RAN paging DRX parameters comprise RAN paging cycle, and the BCCH modification period is pre-defined in the network.

45. The method of claim 44, wherein the second message comprises an RRC connection release message and receiving the second message triggers the UE entering RRC inactive state.

46. The method of claim 44, wherein the second network element comprises a core network node in the network, the core network node comprises at least one of an MME or an AMF.

47. The method of claim 39, wherein the first network element comprises at least one of:

an eNB;

a gNB; or

an eMTC NodeB.

48. The method of claim 39, wherein the network comprises at least one of a 5G communication network, a 4G communication work, or a 3G communication network.

49. The first network element of any one of claims 1-28, comprising a processor configured to implement a method in any one of claims 1-28.

50. The first network element of any one of claims 29-38, comprising a processor configured to implement a method in any one of claims 29-38.

51. The UE of any one of claims 39-48, comprising a processor configured to implement a method in any one of claims 39-48.

52. A computer program product comprising a non-transitory computer-readable program medium with computer code stored thereupon, the computer code, when executed by a processor, causing the processor to implement a method of any one of claims 1-48.