EN-DC Overview

E-UTRA New Radio – Dual Connectivity (EN-DC) is a 3GPP release 15 feature introduced to support New Radio 5G data with existing LTE core and radio networks and without introducing 5G core network. EN-DC can be a useful feature for Heterogeneous networks (HetNets) where LTE provides reliable coverage and NR can be used for improving data rates. EN-DC ensures better system reliability by reducing service interruptions due to higher propagation loss in mmwave or non-line of sight situations in Massive MIMO (beam sweeping)*
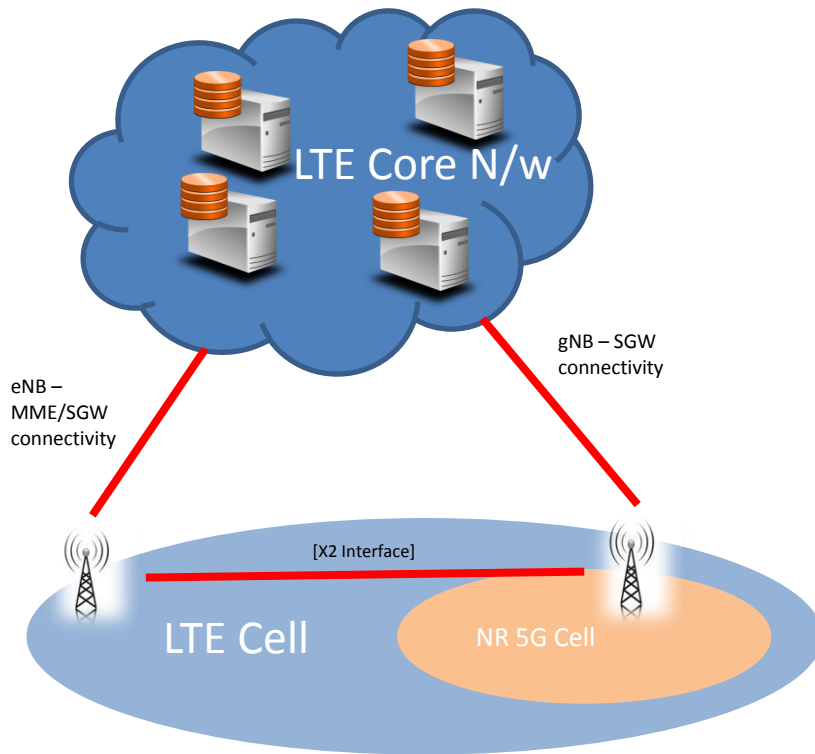

Figure: [1]

EN-DC Elements

Master Node (LTE):

Master Node or eNB(LTE) in EN-DC is used to access EPC on control plane and user plane by the user equipment(UE). It is used for:

- ➢ Maintaining connection state transitions
- ➢ Handling connection setup/ release
- ➢ Initiating first time secondary node addition (EN-DC setup)
- ➢ User data over LTE RAN

Secondary Node (NR):

Secondary Node or gNB(NR) in EN-DC is used for user Data only. It is connected to LTE EPC only on user plane

UE Device:

A UE device supporting EN-DC should be at least 3GPP release 15 compliant. The UE will have 2 RRC termination points (LTE and NR). Having 2 RRC termination points enable secondary node to trigger intra-NR mobility i.e. change/release/modification of secondary Node.

*Massive MIMO(beam sweeping) is not explained in this document

Signalling Radio Bearers(SRB)

Master Cell Group (LTE):

Cell(s) part of LTE network will be part of Master cell group (MCG). SRB1 and SRB2 will be used for reconfiguration including Secondary cell group (SCG) addition.

Split Signalling Radio Bearers (LTE+NR):

EN-DC gives an option to use split bearers. The concept of split bearers enables operators to transmit SRBs via LTE radio network and/or NR 5G radio network. See Figure[2].
Below are the routes a signalling message can take in split bearer configuration:
  ➢ Master Node RRC messages via RLC, MAC and PHY of either the master node or secondary node.
  ➢ Master Node RRC messages via RLC, MAC and PHY of both the master node and secondary node.
  ➢ Master Node RRC message can also embed Secondary Node RRC message.
Split SRB to improve mobility robustness especially for NR high frequency bands.
RRC message can be exchanged via both LTE and NR lower layers for
  ➢ Duplicating the message on both paths
  ➢ Selecting the best radio path

Secondary Cell Group (NR):

Signalling message can be transmitted to UE devices using SRB3 via NR5G radio network. It can be used for SCG reconfiguration in DL and measurement reporting in UL by the UE
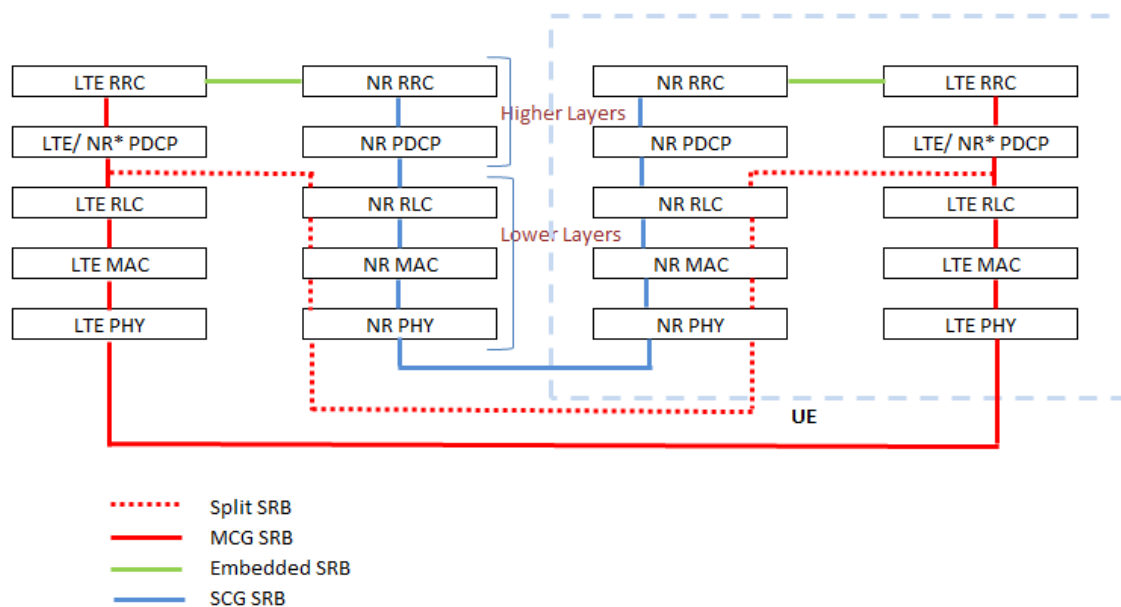

Figure: [2]

Data Radio Bearers(DRB)

Master Cell Group DRBs use only master node lower layers
In **Master Cell Group Split DRBs,** bearers terminate at master node. The data path can use wither LTE and/or NR lower layers.
Secondary Cell Group DRBs, will use only secondary node lower layers
In **Secondary Cell Group Split DRBs,** bearers will terminate at NR node and can use lower layers of both LTE and/or NR
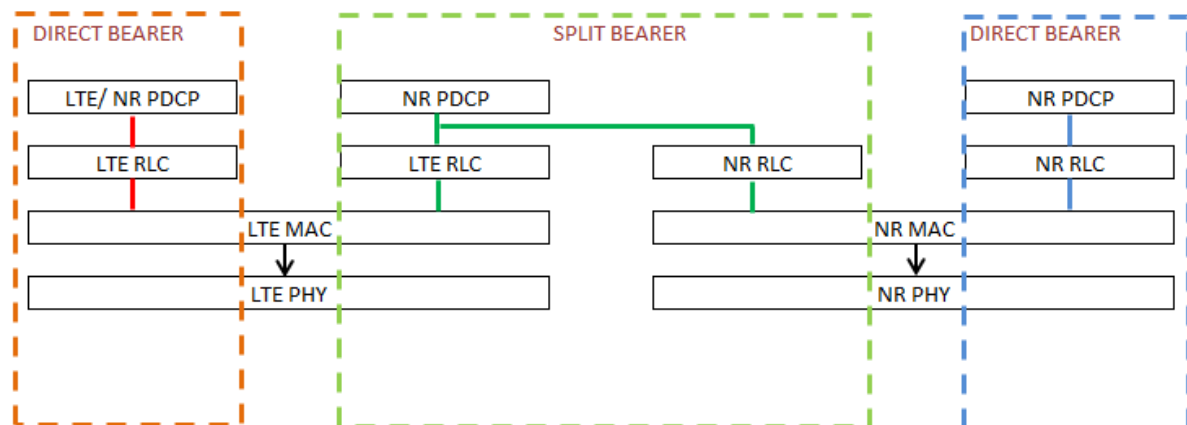

Figure: [3]

Below are some basic differences between LTE DC and EN-DC

Features	LTE DualConnectivity	EN-Dual Connectivity
RRC Termination	Only at master node	Both at master node and secondary node
Control plane termination at core network	Only at master node	Only at master node
Supported DRBs	MCG, MCG Split, SCG	Direct, Split
Supported SRBs	MCG SRB	MCG SRB (Optionally including NR RRC) split SRB (Optionally including NR RRC) SCG SRB (Including only NR RRC)
Path Duplication/ Path switching for Split DRBs/ SRBs	Only path switching for MCG split DRBs	Patch switching and duplication for split DRB/ SRB
Mobility	Master node controls mobility	Master node controls LTE mobility Master/ Secondary node controls NR mobility

ASN Configuration

As mentioned previously, SRB1 on LTE network will be used to add NR SCG for EN-DC. The RrcReconfiguration message will include IEs for NR setup. The RRCReconfiguration message is 36.331 compliant. NR specific configuration is sent in HEX string.

 For e.g.

```
nr-Config-r15 setup : {
        endc-ReleaseAndAdd-r15 FALSE
    },
    nr-RadioBearerConfig2-r15 '1409289F86048AE9B060 'H
    }
nr-Config-r15 setup : {
        endc-ReleaseAndAdd-r15 FALSE,
     nr-SecondaryCellGroupConfig-r15 '0880FD5C40B0440......4080E00'H
    },
    sk-Counter-r15 0
```

3GPP 38.313 is required to decode **nr-RadioBearerConfig2-r15** and **nr-SecondaryCellGroupConfig-r15**
Configuration related to DRB parameters is included in **nr-RadioBearerConfig2-r15**
For e.g.

```
drb-ToAddModList {
  {
   cnAssociation eps-BearerIdentity : 5,
   drb-Identity 3,
   pdcp-Config {
    drb {
      discardTimer ms10,
      pdcp-SN-SizeUL len12bits,
      pdcp-SN-SizeDL len12bits,
      headerCompression notUsed : NULL,
      outOfOrderDelivery FALSE
    }
   }
  }
}
```

Below are the Need codes and conditions in NR

Abbreviation	Meaning
CondC conditionTag	Configuration condition Presence of the field is conditional to other configuration settings.
CondM conditionTag	Message condition Presence of the field is conditional to other fields included in the message.
Need S	*Specified* Used for (configuration) fields, whose field description or procedure **specifies** the UE behavior performed upon receiving a message with the field absent (and not if field description or procedure specifies the UE behavior when field is not configured).
Need M	*Maintain* Used for (configuration) fields that are stored by the UE i.e. not one-shot. Upon receiving a message with the field absent, the UE maintains the current value.
Need N	*No action* (one-shot configuration that is not maintained) Used for (configuration) fields that are not stored and whose presence causes a one-time action by the UE. Upon receiving message with the field absent, the UE takes no action.
Need R	*Release* Used for (configuration) fields that are stored by the UE i.e. not one-shot. Upon receiving a message with the field absent, the UE releases the current value.

nr-SecondaryCellGroupConfig-r15 IE will include all common and dedicated parameters for the NR leg of EN-DC. A representative example is shown below :

```
rrc-TransactionIdentifier 0,
criticalExtensions rrcReconfiguration : {
 secondaryCellGroup CONTAINING {
  cellGroupId 1,
  rlc-BearerToAddModList {
  },
  mac-CellGroupConfig {
  },
  physicalCellGroupConfig {
  },
  spCellConfig {
   servCellIndex 1,
   reconfigurationWithSync {
   },
   rlf-TimersAndConstants release : NULL,
   spCellConfigDedicated {
    initialDownlinkBWP {
     pdcch-Config setup : {
     },
     pdsch-Config setup : {
     }
    },
    uplinkConfig {
     initialUplinkBWP {
    },
    pdsch-ServingCellConfig setup : {
    },
    csi-MeasConfig setup : {
    tag-Id 0
   }
```

For detailed NR IEs, refer to 3GPP 38.331.