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Discrepancy between RAN1 and RAN4 power control decisions

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Background

- RAN1 has considered two UE types
  - UE capable of dynamic power sharing, a.k.a. Type 1
  - UE not capable of dynamic power sharing, a.k.a. Type 2

- In the EN-DC power control procedure, RAN1 has considered that ‘NR’ in the Type 1 UE modem knows about ‘LTE’ but not the other way around
  - This is because the different time-lines of LTE and NR
    - This resulted in the decision of not changing LTE power by RAN1 power control definition for Type 1 UEs
    - This resulted in the decision of not supporting sTTI in EN-DC

Background

- 4ms timeline has always been assumed for LTE
  - E.g. no look-ahead in LTE CA or LTE DC

  - **R1-143517,** WF on “look-ahead” aspect in asynchronous dual connectivity, Ericsson, NTT DoCoMo, Softbank, Nokia Networks, Nokia Corporation, Alcatel-Lucent Shanghai Bell, Alcatel-Lucent
  - Agreements:
    - At least for PUCCH and PUSCH, for asynchronous dual-connectivity,
      - All remaining power is first made available to CG associate with earlier transmission
        - No-Look-ahead (for the case that transmission timing difference is larger than around 33 micro sec) is specified as the UE behavior
    - Definition of synchronous and asynchronous dual-connectivity is according to RAN4
      - Timing relationship in any TA groups should be clarified in RAN4
    - FFS: For asynchronous dual connectivity with the case that transmission timing difference is very small (e.g., around 33 micro sec)

Background

- The same assumption (no LTE look-ahead) has been made for EN-DC

- **R1-1715185,** Way forward on power sharing for LTE-NR NSA operation, Ericsson, CATT, Samsung, Mediatek, Nokia, NSB
  - Agreements:
  - At least for LTE-NR NSA operation
    - Maximum allowed power values for LTE (P_LTE) and NR (P_NR) are set separately
      - i.e., when UE is configured for NR, P_LTE can be configured up to P_cmax and P_NR can be configured up to P_cmax.
      - e.g. P_LTE + P_NR > P_cmax or P_LTE + P_NR = P_cmax
    - Signaling details for P_LTE, P_NR are left to RAN2, RAN4.
    - Note: 'P_cmax' is a limit that is similar to 'The configured maximum UE output power' that was specified for LTE.
    - Note: The network will still have flexibility to prioritize or reserve certain NR transmission power depending on network implementation
    - All UEs are mandated to handle P_LTE + P_NR = P_cmax while handling of P_LTE + P_NR > P_cmax depends on UE capability
    - At least, when DL/UL LTE sTTI/reduced UE processing time based operation is not configured for the UE, if total transmit power exceeds P_cmax when there is simultaneous NR and LTE UL tx,
      - For NR, UE scales down/drops NR transmission and NR power scaling details are left to UE implementation (note: it is not intended to have RAN4 test from RAN1 perspective)
        - If there are two or more UL carriers, the power scaling or tx dropping can be performed for each of the UL carriers separately or jointly up to UE implementation
      - For LTE, no change in power control procedure
    - FFS the case when DL/UL LTE sTTI/reduced UE processing time based operation is configured for the UE
    - The following is FFS
      - The case when P_NR is configured such that P_NR < P_cmax, and UE can use power up to P_cmax in NR when it knows that there will be no UL transmission in LTE by semi-static configuration (e.g., measurement gap, DL/UL configuration)

Background

- RAN4 has defined MPR/A-MPR definitions [R1-1807805, “LS on RAN4 agreement on intraband EN-DC A-MPR”], which made different set of assumptions
  - ‘LTE side knows about NR side’, even if NR UL grant arrives much later than LTE grant (i.e. much later than 4ms before the LTE transmission)
  - LTE PHR has a dependency on NR grant, even if NR UL grant arrives much later than LTE grant

- The RAN4 decisions require substantial changes in the LTE processing time requirements, even though the NR Work Item was aimed to minimize impact resulting from NSA to LTE physical layer

Background

- Consider that LTE and NR use different slot formats, numerologies, the situations depicted below will occur for Type 1 UEs

- The RAN4 decision results in LTE power changes within the LTE subframe, which is not supported in the LTE air-interface

Background, Examples

- FDD Example

- TDD Example

Background, Examples

- Example

Background (Phase continuity)

- There is a phase continuity problem in the cases of intra-band EN-DC with common PA, even when there is no MPR/A-MPR issue

Proposal 1 (MPR/A-MPR)

- Agree that the specification with the current definitions is not feasible to implement

- Decide whether the RAN4 definition should be changed or the RAN1 definition should be changed
  - If RAN4 definitions are to be changed, no RAN4 modification is necessary for Type 2 UEs
  - If RAN1 definitions are to be changed, decision should be based on the proposals in the remaining slides

Proposal 2 (MPR/A-MPR)

- If RAN1 specification is to be changed
  - Agree that modifications in the RAN1 procedure are needed to avoid significant changes to LTE timeline requirement for Type 1 UEs
  - Agree that modifications in the RAN1 procedure are needed to solve problems with signal phase continuity

Proposal 2, RAN1 specification changes

- Change in the LTE PHR requirement
  - The UE is not expected to update LTE PHR report if the LTE reporting timeline is not met
    - i.e. UE does not need to include in the PHR determination any information received later than 4ms prior to the PHR reference UL subframe

- Change in power dropping rule
  - (1) the UE calculates LTE power (P_LTE_only) considering no NR Tx
  - (2) the UE calculates NR power (P_NR_only) considering no LTE Tx
  - (3) the UE calculates the LTE power (P_L) and NR power (P_N) according to the dynamic power sharing rule and RAN4 MPR/A-MPR definition
  - (4) the UE performs the following
    - If both P_LTE_only == P_L && P_NR_only == P_N
      - UE transmits LTE and NR at powers P_L and P_N, respectively
    - Else
      - UE chooses a new P_N' power within the bounds 0 <= P_N' < P_N
      - UE determines LTE power P_L' based on P_N'
        - If P_N' == 0, P_L' = P_LTE_only
        - If P_N' == P_N, P_L' = P_L
        - Else P_L < P_L' < P_LTE_only
      - UE transmits LTE and NR at powers P_L' and P_N', respectively

Proposal 2, RAN1 specification changes

- Possible text proposal to implement the proposal in previous slide

  - If the UE indicates a capability for dynamic power sharing between EUTRA and NR and
    - if the UE is not configured for operation with shortened TTI and processing time on the MCG [13, TS 36.213], and
    - if the UE transmission(s) in subframe i_1 of the MCG overlap in time with UE transmission(s) in slot i_2 of the SCG, and if any of the following conditions is satisfied
      - The presence of transmission(s) in a portion of slot i_2 of the SCG would change the allowed power reduction [ref X, TS 36.101, 38.101] and transmission power in any portion of subframe i_1 of the MCG, or
      - The presence of transmission(s) in a portion of slot i_1 of the MCG would change the allowed power reduction [ref X, TS 38.101] and transmission power in any portion of subframe i_2 of the SCG, or

  the UE may reduce transmission power or drop transmission of the SCG within slot i_2.

Proposal 3 (Phase continuity)

- In order to solve the phase continuity issue, adopt the following for both Type 1 and Type 2 UEs
  - When the LTE and NR Tx overlaps
    - The transmission boundaries are aligned
      - Same start and end times
    - Frequency hop boundaries are aligned
      - Either both NR and LTE doesn't hop or both NR and LTE hops at the same boundary
- Possible text proposal to implement the above

  - MCG and SCG transmissions occur in bands with at least partially overlapped frequency ranges and the SCG transmission(s) subcarrier spacing is 15 kHz, and the following condition is not satisfied
    - Any contiguous transmission of a channel in MCG that at least partially overlaps with a contiguous transmission of a channel in SCG, occurring within subframe i_1 and i_2, respectively, have their transmission start and end times aligned, and have their frequency hop boundaries, if any, occur simultaneously and time aligned.

  the UE may reduce transmission power or drop transmission of the SCG within slot i_2.

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