3GPP RAN WG4 Meeting #110bis R4-2406587

Changsha, China, April 15th – 19th, 2024

Title: WF on power class fallback issues

Agenda item: 11.2

WI/SI: TEI18

Release: Rel-18

Source: Apple

Document for: Approval

# 1 Background

* The term of “power class fallback”, though has not been formerly defined in 3GPP specifications, was often quoted during RAN4 high-power UE (HPUE) related discussions.
* In 3GPP, UE power class has been defined as the UE transmitter maximum output power capability in RAN4 specifications. It is also an indirect indication of how high the UE power amplifier output power can be driven while meeting certain emission requirements.

* For frequency range 1 (FR1), UE power class 3 (PC3) with nominal output power at 23 dBm has been defined as the default power class. For other UE power classes supporting higher maximum output power than default power class are all considered as High-Power UE (HPUE).
* Ever since HPUE was introduced, RAN4 also incorporated the conditions where HPUE shall apply all requirements for the default power class, including UL duty cycle exceeding certain % number or when P-Max is 23 dBm or lower which are specified under the sub-clauses of UE maximum output power (power class) for all UE features.
* The behavior when an HPUE applies all requirements for the default power class or next power class with lower maximum output power was often unofficially regarded as “power class fallback”.
* The concern of the power class fallback concept in current RAN4 specifications has been brought up in last RAN4 meeting [1] which could potentially cause misunderstanding on how the UE configured maximum output power can be applied, and that may result in double-counting the PCMAX power reduction and excessive allowance of MPR/A-MPR for HPUE.
* While the power class fallback issues were generally acknowledged by most RAN4 companies during the discussions in last RAN4 meeting, there was no concrete way forward on how to mitigate this issue in current RAN4 specifications.
* In this meeting, there are two proposals on how to make RAN4 specifications revisions to mitigate the power class fallback issues:
  + **R4-2404660 (Vivo)**: Keep the texts for power class fallback behavior in MOP sections and change “apply all requirements for” a certain power class to a more restricted “apply maximum output power of” this power class [2 – 4].
  + **R4-2404186 (Apple)**: Move the text descriptions on UL duty cycle and P-max conditions below the power class tables in “UE maximum output power” sub-clauses to ΔPPowerClass definitions in “Configured output power” sub-clauses [5 – 8].
* During offline discussions, three more issues related to power class fallback were also brought up:
  + P-Max should not be included in the conditions for defining ΔPPowerClass as ΔPPowerClass should only be related to UL duty cycle conditions.
  + ΔPPowerClass in PCMAX\_L formula has been incorrectly placed as it is a power reduction from PPowerClass which should not be additive to other power reduction terms, such as MPR. The alternative PCMAX\_L formula may be written as below (for single carrier):

PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass + ΔPPowerBoost) – MAX(MAX(MPRc+∆MPRc, A-MPRc) + ΔTIB,c + ∆TC,c + ∆TRxSRS, P-MPRc, ΔPPowerClass)}

* + Power class fallback does occur during SRS transmission occasions with usage in SRS-ResourceSet set as ‘antennaSwitching’ with configured SRS resources in each SRS resource set(s) consisting of one SRS port when PC2 capable UE with txDiversity-r16 capability or PC1.5 capable UE. ΔPPowerClass = 3dB in the current specifications may not fully represent the UE behavior as MPR/A-MPR should be based on the fallback power class instead of the reported power class.
* This way forward intends to provide guidelines on how RAN4 specifications may be revised to mitigate the power class fallback issues.

# Way forward

## 2.1 Way forward on RAN4 specifications revisions to mitigate power class fallback issues

***Proposal:*** *Companies are encouraged to consider the following options for RAN4 specifications revisions to mitigate power class fallback issues*

***Option 1:*** *Keep the texts for power class fallback behavior in MOP sections and change “apply all requirements for” a certain power class to a more restricted “apply maximum output power of” this power class (R4-2404660)*

***Option 2****: Move the text descriptions on UL duty cycle and P-max conditions below the power class tables in “UE maximum output power” sub-clauses to ΔPPowerClass definitions in “Configured output power” sub-clauses (R4-2404186).*

***Option 3****: Other options are not precluded.*

## 2.2 Way forward for other power class fallback related issues

***Proposal:*** *Companies are encouraged to consider the following options for the corresponding issues:*

***Issue 2.2-1****: Should P-Max be included in the ΔPPowerClass definition?*

***Option 1:*** *Yes*

***Option 2****: No*

***Issue 2.2-2****: Is it agreeable to revise the PCMAX\_L formula as below for single carrier and apply the similar change to other UL features?*

PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass + ΔPPowerBoost) – MAX(MAX(MPRc+∆MPRc, A-MPRc) + ΔTIB,c + ∆TC,c + ∆TRxSRS, P-MPRc, ΔPPowerClass)}

***Option 1:*** *Yes*

***Option 2****: No*

***Issue 2.2-3****: How to describe power class fallback UE behavior during SRS transmission occasions for PC2 capable UE with txDiversity-r16 capability or PC1.5 capable UE?*

***Option 1:*** *No change in current specifications, meaning that ΔPPowerClass = 3dB is sufficient.*

***Option 2****: Change ΔPPowerClass = 3dB with the wordings that “for PC2 UE with txDiversity-r16 capability, all requirements for the default power class apply, and for PC1.5 UE, all requirements for PC2 apply.*

***Option 3:*** *Other options are not precluded.*

***Issue 2.2-4****: If RAN4 agrees to make specifications revisions to mitigate the power class fallback issues, which release should be the starting release for the changes?*

***Option 1:*** *Rel-17*

***Option 2****: Rel-18*

## 2.3 Company comments

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| **Company** | **Comments** |
| CMCC | Thanks for organizing the discussion.  First of all, we do not think there is “power class fallback” issue in the current spec. Then the equation change is not necessary, especially we already have it for several releases. Unless critical issues are identified for the commercial UEs, otherwise we prefer to not make such a big change to existing spec, especially for previous releases. |
| CHTTL | We share similar view as CMCC. In our understanding there might be some dependency between the text below the MOP table and the HPUE supported configurations in the table, so we are not fine to move the whole text at this stage, maybe some clarifications can be considered if proponent think they are needed. |
| China Unicom | Thanks for the draft WF.  We share similar view with CMCC and CHTTL. We prefer not to move all the text descriptions of power class fallback to another location of the specification. However, some clarifications may be made if they are found necessary. |
| Samsung | 2.1, Option 2  2.2-1/2, Intuitively seems option 2 is reasonable, need more time checking  2.2-3, Does Option 2 exclude PC2 PA+PC3 PA with PC2 in total while transmitting SRS with PC2 PA?  2.2.4, Rel-18 |
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# References

1. R4-2400180 “On misconception of power class fallback”, Apple, 3GPP TSG RAN WG4 Meeting #110, Athens, Greece, February 26th – March 1st, 2024
2. R4-2404660 “Cleanup of Delta\_powerclass and MOP requirements for HPUE”, Vivo, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
3. R4-2404661 “Draft CR on 38.101-1 for cleanup of Delta\_powerclass and MOP requirements for HPUE”, Vivo, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
4. R4-2404663 “Draft CR on 38.101-3 for cleanup of Delta\_powerclass and MOP requirements for HPUE”, Vivo, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
5. R4-2404186 “WF on mitigating power class fallback misconception in technical specifications”, Apple, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
6. R4-2404187 “Draft CR to 38.101-1 on mitigating the potential misconception of power class fallback”, Apple, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
7. R4-2404188 “Draft CR to 38.101-3 on mitigating the potential misconception of power class fallback”, Apple, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024
8. R4-2404189 “Draft CR to 36.101 on mitigating the potential misconception of power class fallback”, Apple, 3GPP TSG RAN WG4 Meeting #110bis, Changsha, China, April 15th – April 19th, 2024