TSG-RAN WG1 #113 R1-23xxxxx

Incheon, Korea, May 22 – 26, 2023

Source: Nokia

Title: Summary on the [113-R18-Others-02] Email discussion on MC-Enh draft CR for TS38.214

Agenda Item: 9.17

Document for: Discussion and Decision

# Introduction

This thread [113-R18-Others-02] is addressing the draft CR to 38.214 for NR\_MC\_enh-Core under agenda item #9.17 with the focus on the contentious issues of the RAN1#112bis that prevented RAN1 endorsement of the draft CR after 5 rounds of commenting and revising.

[113-R18-Others-02] Email discussion on MC-Enh draft CR for TS38.214 – Mihai (Nokia)

* To be used for coordinating discussions in the draft folder

The RAN1#112bis email discussion summary document can be found in [1], and the latest post-RAN1#112bis, unendorsed draft CR for introducing UL TX switching across up to 4 bands to TS38.214 in [2]

# References

1. [R1-2304205](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_112b-e/Docs/R1-2304205.zip) Summary of email discussion on the introduction of UL Tx switching across up to 4 bands in [112bis-e-R18-38.214-MC\_Enh] Moderator (Nokia)
2. [38214CRdraftv0](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_112b-e/Inbox/drafts/9.18%28Other%29/%5B112bis-e-R18-38.214-MC_Enh%5D/Draft%20CRs/R1-23XXXX%20draft%20CR%2038.214%20NR_MC_enh-Core_ULSwitching-v05.docx)5 Introduction of UL Tx switching across up to 4 bands, Nokia

# Discussion

## Issue #1: Simultaneous UL Tx when SUL is part of the configuration

The following alternatives can be identified when at least one cell with a SUL carrier is part of the UE’s configuration

**Alt 1**: Transmission may take place only on one uplink band at a time

**Alt 2**: One or more of the following simultaneous transmission cases is allowed

1. Transmission on two non-SUL UL bands may take place at the same time if UE reported ‘DualUL’ for that band pair
2. Transmission on one cell’s SUL carrier and another cell’s non-SUL band may take place at the same time if the UE reported ‘DualUL’ for that band pair
3. Transmission on one cell’s SUL carrier and another cell’s SUL carrier may take place at the same time if the UE reported ‘DualUL’ for that band pair

RAN had provided the following guidance on the UL Tx switching cases as below

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| **RAN provides following guidance to RAN1/2/4.*** If Rel-18 UL Tx switching is supported,
	+ RAN1/2/4 shall ~~work~~ focus on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands ~~at least for following scenarios during Rel-18 timeframe~~ in Q3 2022
		- Inter-band UL-CA Option 1 (i.e., switched UL) and Option 2 (i.e., dual UL) without SUL band
		- Inter-band UL CA Option 1 (i.e., switched UL) for {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s)
			* UL CA framework where UL CA is performed between NULs according to current RAN4 specifications should not be changed
			* Note: switching across any band in this scenario is not precluded
		- Intra-band two contiguous aggregated carriers within one non-SUL band out of 3 or 4 bands
	+ ~~Other~~Further check additional scenarios ~~as below can be discussed~~ in ~~RAN4#104e and~~ RAN#97e, e.g.,
		- {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}
		- Simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL)

Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching |

Please provide your comments on the issue to the table below

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| Company | Comments |
| Qualcomm | Following the RAN guidance, it’s clear that Alt. 1 is correct.The additional switching behaviors in Alt. 2 would require further discussion and agreement at least in RAN1. Unfortunately, this has not been discussed in Rel-18 or before due to limited TUs.We propose to clearly indicate Alt. 1 in Rel-18 specs to correctly reveal Rel-18 status. |
| Nokia, NSB | Our interpretation of the RAN guidance is the same as Qualcomm’s |
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## Issue #2: Applicability of the minimum time between two switches

Specifying the following RAN1#112 agreement was causing difficulty:

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| **Agreement**Confirm the working assumption with following updates(working assumption) If two uplink switching are triggered and UL transmissions involved in the two uplink switching are on more than 2 bands within any two consecutive reference slots, then the time duration between the start of all transmission(s) after the first uplink switching and the start of all transmission(s) after the second uplink switching within the two reference slots is expected to be not less than a minimum separation time * The minimum separation time is a maximum of X us and the switching gap required for the second uplink switching.
* X us is subject to UE capability with a value set of {0us, 500us}
 |

The argument made against the bracketed text was that the minimum separation time should not apply if the UE reported 0 us.

**Alt 1:** Keep the agreement as it was and remove the square brackets on the following

- Within any two consecutive reference slots corresponding to numerology *µUL*, when the UE first performs one uplink switch and later performs another uplink switch and at least three bands are involved in the transmissions before the first switch, between the first switch and the second switch, and after the second switch,

[- the separation time between the start of all transmission(s) after the first switch and the start of all transmission(s) after the second switch is not expected to be less than max {*X*, *Y*}, where

- *X* = 500 µs if the UE reported [*MinSwitchSeparation*] capability, otherwise *X* = 0 µs, and

- *Y* is the switching gap $N\_{Tx1-Tx2}$applied to the second switch.]

**Alt 2:** Clarify the RAN1#112 agreement by making the modification stating that minimum time between switches definition only applies when the UE reported a non-zero X, by adding the following bullet, and revising the CR text as

* If the UE does not report non-zero X, the minimum time duration definition does not apply

- If the UE reported [*MinSwitchSeparation*] capability, w~~W~~ithin any two consecutive reference slots corresponding to numerology *µUL*, when the UE first performs one uplink switch and later performs another uplink switch and at least three bands are involved in the transmissions before the first switch, between the first switch and the second switch, and after the second switch,

[- the separation time between the start of all transmission(s) after the first switch and the start of all transmission(s) after the second switch is not expected to be less than max {*X*, *Y*}, where

- *X* = 500 µs ~~if the UE reported [~~*~~MinSwitchSeparation~~*~~] capability, otherwise~~ *~~X~~* ~~= 0 µs~~, and

- *Y* is the switching gap $N\_{Tx1-Tx2}$applied to the second switch.]

Please provide your comments on the issue to the table below

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| Company | Comments |
| Apple | In our view, we can wait for the decision on UE features and following that capture the text accordingly. Also, for Alt 2, a clarification question – what does it imply that minimum time duration definition does not apply? Does it mean that there is no restriction on the in terms of gap between the two switching instances? |
| vivo | Same view as Apple. we can wait for the decision in UE feature. |
| Qualcomm | Same view as Apple and vivo. |
| Nokia, NSB | We would prefer taking a clean agreement on a proposal here, rather than kick the issue to UE features, when UE features session is not supposed to make RAN1 specification-impacting decisions, but implement the FGs around the agreed stage 2 functionality / stage 3 spec.On the topic, we are OK either way.@Apple, our understanding is that if the minimum time duration does not apply, the specification restriction is not binding and no restriction (as is the case in Rel-17) does not exist. |
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## Issue #3: Same SCS definition for contiguous intra-band CA?

RAN1#112bis draft CR had the following statement square-bracketed

[- If there are two contiguous intra-band carriers in one band, the UE may assume that the two carriers will be configured with the same subcarrier spacing.]

This was motivated by the following RAN1#112 conclusion:

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| **Conclusion [RAN1#112]**For Rel-17 UL Tx switching, if there are two carriers configured on the same band of the uplink transmission for a UE, the UE does not expect that the active UL BWPs of the two carriers on the band are of different numerologies. |

**Alt 1.** Do not capture anything on the same SCS assumption to the specs

**Alt 2.** Capture the suggested text to 38.214 subclause 6.1.6

**Alt 3.** Capture the suggested text as a generic specification statement that applies to intra-band UL CA regardless of UL Tx Switching

Please provide your comments on the issue to the table below

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| Company | Comments |
| Apple | We prefer to capture the conclusion and support Alt 2 |
| vivo | alt2 is ok |
| Qualcomm | We support Alt. 2 which is to capture this into the spec. |
| Nokia, NSB | We would actually prefer Alt.3 as it is a bit risky to make the limitation conditioned to UL Tx Switching configuration, as that would seem to imply that on regular intra-band UL CA different SCS can be supported. That said, we can accept alt2 as well. |
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## Issue #4: Conditions where one Tx switch switches two Tx chains and >2 bands are involved in the switch

In the following draft CR text, three sub-bullets were left in square brackets requiring further discussion.

- If more than two bands are involved in the determination of one uplink switching and if on any two of the bands the UE is configured with [*uplinkTxSwitchingOptionForBandPair*] set to 'dualUL',

- When the UE is to transmit a 2-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}.

- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port or 2-port transmission on a carrier on the 3rd band and the UE is under the operation state in which 2-port transmission can be supported on the 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band } and for the band pair {2nd band, 3rd band}.

[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers if UE doesn’t indicate [*AdvancedCapabilityDefinedbyRAN4*], where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}, otherwise the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band}, band pair {1st band, 3rd band}, band pair {2nd band, 3rd band}.]

[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.]

[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band,

- if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 2nd band and is configured with uplinkTxSwitching-DualUL-TxState set to 'oneT', and the band associated with the 1st band is configured as 2nd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers on the 1st band and the 3rd band, where *N*Tx1-Tx2 is the [uplinkTxSwitchingPeriod] that UE indicates for the band pair {1st band, 3rd band}.

- if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 3rd band and is configured with uplinkTxSwitching-DualUL-TxState set to 'oneT', and the band associated with the 1st band is configured as 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers on the 1st band and the 2nd band, where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band}.

- otherwise, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}.]

- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3rd band and/or the 4th band and the UE is under the operation state in which 1-port transmission can be supported in the 3rd and 4th band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band}, band pair {1st band, 4th band}, band pair {2nd band, 3rd band}and band pair {2nd band, 4th band}

Please provide your comments on the issue to the table below

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| Company | Comments |
| Apple | Between the first 2 bullets with square brackets, we prefer second one, i.e.:When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.On the text under the third square brackets, we support the text, but it seems one of the scenarios is missing. Basically, the possibility when the associated band for 1st band is configured as 4th band is not included. This will impact how the switching gap will be determined. Basically, the switching gap will be based on the maximum of the switching period that the UE indicates for the band pair {1st band, 2nd band}, band pair {1st band, 3rd band}, band pair {4th band, 2nd band}and band pair {4th band, 3rd band}. Therefore, the corresponding case should also be included. Based on this, we propose to add following bullet as well:***- if UE is configured with uplinkTxSwitching-DualUL-TxState set to 'oneT', and the band associated with the 1st band is configured as 4th band, then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers, where NTx1-Tx2 is the max of [uplinkTxSwitchingPeriod] that UE indicates for the band pair {1st band, 2nd band}, band pair {1st band, 3rd band}, band pair {4th band, 2nd band}and band pair {4th band, 3rd band}.*** |
| vivo | For the following two alternative bullets from ZTE and CTC: First, the granularity of the [*AdvancedCapabilityDefinedbyRAN4*] is ‘*Per band (only for the band(s) in the band combination but not included in the pair of bands before and after switching) for each pair of bands before and after switching in each band combination.*’ according to RAN4 LS R4-2303507, and should be reflected in the spec. Second, regarding *N*Tx1-Tx2, as the Tx on the 1st band remains unchanged during the switching of the other Tx, *N*Tx1-Tx2 should be the switching period that UE indicates for the band pair {2nd band, 3rd band}. Thus, we prefer CTC’s version with following changes.~~[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1~~~~st~~ ~~band and the 2~~~~nd~~ ~~band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1~~~~st~~ ~~band and/or the 3~~~~rd~~ ~~band, then the UE is not expected to transmit for the duration of~~ *~~N~~*~~Tx1-Tx2~~ ~~on any of the carriers if UE doesn’t indicate [~~*~~AdvancedCapabilityDefinedbyRAN4~~*~~], where~~ *~~N~~*~~Tx1-Tx2~~ ~~is the [~~*~~uplinkTxSwitchingPeriod~~*~~] that UE indicates for the band pair {2~~~~nd~~ ~~band, 3~~~~rd~~ ~~band}, otherwise the UE is not expected to transmit for the duration of~~ *~~N~~*~~Tx1-Tx2~~ ~~on any of the carriers on the 2~~~~nd~~ ~~band and the 3~~~~rd~~ ~~band, where~~ *~~N~~*~~Tx1-Tx2~~ ~~is the max of [~~*~~uplinkTxSwitchingPeriod~~*~~] that UE indicates for the band pair {1~~~~st~~ ~~band, 2~~~~nd~~ ~~band}, band pair {1~~~~st~~ ~~band, 3~~~~rd~~ ~~band}, band pair {2~~~~nd~~ ~~band, 3~~~~rd~~ ~~band}.]~~[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for band pair{the 2nd band, the 3rd band}, then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.]For the bullets from the last round inputs at the last meeting. Similar comments on the granularity of [*AdvancedCapabilityDefinedbyRAN4*]. The 1st sub-bullet is for 2nd+3rd->1st+2nd (associated band without scheduled ul transmission)The 2nd sub-bullet is for 2nd +3rd ->1st+3rd (associated band without scheduled ul transmission)It seems that the current ‘otherwise’ part refers to the cases where UE does not support [AdvancedCapabilityDefinedbyRAN4] and when the associated band is the 2nd band or the 3rd band. However, the cases when UE does not indicate [AdvancedCapabilityDefinedbyRAN4] and the associated band is 4th band cannot be covered in otherwise sub-bullet. This case cannot be covered by ‘When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3rd band and/or the 4th band….’in the last bullet either, because there is no UL transmission on the associated band. Thus, we suggest changes in green.[- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band,- if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 2nd band for band pair{the 1st band, the 3rd band}, and is configured with uplinkTxSwitching-DualUL-TxState set to 'oneT', and the band associated with the 1st band is configured as 2nd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers on the 1st band and the 3rd band, where *N*Tx1-Tx2 is the [uplinkTxSwitchingPeriod] that UE indicates for the band pair {1st band, 3rd band}.- if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 3rd band for band pair{the 1st band, the 2nd band}, and is configured with uplinkTxSwitching-DualUL-TxState set to 'oneT', and the band associated with the 1st band is configured as 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers on the 1st band and the 2nd band, where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band}.- otherwise, when the band associated with the 1st band is configured as 2nd band or 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}.] If the band associated with the 1st band is configured as 4th band, *N*Tx1-Tx2 is the max of *[uplinkTxSwitchingPeriod]* that UE indicates for the band pair {1st band, 3rd band}, band pair {1st band, 4th band}, band pair {2nd band, 3rd band}and band pair {2nd band, 4th band} |
| Qualcomm | According RAN4 LS below, the advanced UE capability defined by RAN4 is per band per band pair. We propose to clear reveal this in RAN1 spec. Example wording could be “”UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for the band pair {2nd band, 3rd band}…”

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| R4-2303507**Issue 3: Impact from switching of one Tx chain on the other Tx chain****Scenario of one band with the number of Tx chain unchanged due to switching**When one of the two Tx chains is triggered to switch from one band (named “band A”) to another band (name “band B”), the other Tx chain is maintained on a different band (named “band C” or “band D” in the case of 4-band) and the number of Tx chain on band C or band D is unchanged due to the switching, RAN4 agreed the granularity of the optional UE capability to allow UL transmission on the band with the number of Tx chain unchanged during UL switching as follows: * Per band (only for the band(s) in the band combination but not included in the pair of bands before and after switching) for each pair of bands before and after switching in each band combination.
 |

Between 1st and 2nd alternative wording in the square brackets, we slightly prefer the 2nd which tens to clearly indicate the “[*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for the band pair {2nd band, 3rd band}. The 1st alternative tries to preclude the cases needs considering two switching periods but it might miss some cases which also needs to be precluded and create ambiguity.The 3rd part in the bracket is generally ok except the above “per-band pair” issue. One minor cent, we think the first two sub paragraphs are redundant as UE is capable to transmit on 1st & 2nd band before switching. However, we could live with this if majority think it’s necessary to differentiate whether actual transmission is scheduled or not.  |
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## Issue #5: Any other critical issue?

Any other critical issues needing a resolution for RAN1 to be able to endorse the draft CR?

Please provide your comments on the issue to the table below

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| Company | Comments |
| Qualcomm | We think current switching period location part still miss some cases. Assume the band priority is band A>B>C>D, the below switching cases should be clearly covered in the spec:* The highest priority band transmits before and after switch. i.e. A+B->A+C
* The highest priority band is not involved into the switch (i.e. B->C)
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