**3GPP TSG-RAN2 Meeting #117 electronic** ***R2-220xxxx***

**Online, February 21 – March 03, 2022**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **38.306** | **CR** | **-** | **rev** | **-** | **Current version:** | **16.7.0** |  |
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| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:***  | Introduction of Rel-17 Tx switching enhancements |
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| ***Source to WG:*** | China Telecom, Huawei, HiSilicon, Apple, CATT |
| ***Source to TSG:*** | RAN2 |
|  |  |
| ***Work item code:*** | NR\_RF\_FR1\_enh |  | ***Date:*** | 2022-02-28 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Uplink Tx switching has been extended to the following scenarios in Rel-17 FR1 RF requirements enhancement WI, with the latest WID in RP-212527.* *2Tx-2Tx switching between two uplink carriers for SUL and UL CA*
* *1Tx-2Tx and 2Tx-2Tx switching between 1 carrier on band A and 2 contiguous aggregated carriers on band B for SUL and UL CA*

Based on the following RAN2 agreements made in RAN2 #115 meeting, the R16 UE capability reporting should be extended to cover R17 scenarios.* No need to introduce Rel-17 UE capability of DL interruption for 2Tx-2Tx switching. The Rel-16 UE capability of DL interruption for 1Tx-2Tx switching applies to 2Tx-2Tx switching as well.
* To introduce Rel-17 per-band pair UE capability to indicate a different switching time for 2Tx-2Tx switching for a given BC (Option 1).
* The Rel-16 filter *uplinkTxSwitchRequest-r16* can be reused to request Rel-17 UL Tx switching UE capability.
* For R17 1Tx-2Tx/2Tx-2Tx switching between 1 carrier on band A and 2 contiguous aggregated carriers on band B for SUL and UL CA, RAN2 takes the following way-forward as RAN2 understanding.

Way-forward: the UE should report corresponding CA bandwidth class and UL MIMO layers in the UL featureSetPerCCs for 2 continuous CCs on band B in the legacy way. No new UE capability is needed specific to the case with 2CCs on band B. * On band B, the fallback capability from 2 CCs to 1 CC can be supported in the legacy way.

In RAN2#116bis-e meeting, the following agreements were reached on UL MIMO coherence capability reporting for Rel-17 1Tx-2Tx switching and further clarifications are needed.* Taking the endorsed Rel-16 CRs R2-2110483 and R2-2110484 as baseline for the Rel-17 UL Tx switching coherence capability discussion. We can revisit it if further information is received from RAN1.
* The Rel-16 per-BC UL MIMO coherent capability introduced for 1Tx-2Tx switching between 2 uplinks applies to Rel-17 UL Tx switching between 2 bands with 3 uplinks.
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| ***Summary of change:*** | * Clarify *ULTxSwitchingBandPair* is used to report 2Tx-2Tx capability as well. And for 2Tx-2Tx switching UE shall indicate support of 2-layer UL MIMO for both bands.
* Add Rel-17 *ULTxSwitchingBandPair-v17xx* to report 2Tx-2Tx switching time in *uplinkTxSwitchingPeriod2T2T-r17*.
* Clarify *uplinkTxSwitching-PUSCH-TransCoherence-r16* (as per the endorsed CR R2-2110483) is used to report UL MIMO coherence capability for Rel-17 1Tx-2Tx switching as well.
* Add *UplinkTxSwitchingBandParameters-v17xx* to report the UL Tx switching specific band parameters for a given band combination. The capability signalling comprises of the following parameters: *bandIndex-r17* indicates a band on which UE supports dynamic UL Tx switching with another band in the band combination. *uplinkTxSwitching2T2T-PUSCH-TransCoherence-r17* is used to report UL MIMO coherence capability for Rel-17 2Tx-2Tx switching.

**Impact Analysis**Impacted 5G architecture options:NR CA, SULImpacted functionality:UL Tx switchingInter-operability: |
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| ***Consequences if not approved:*** | R17 Tx switching enhancement is not supported by the standard. |
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| ***Clauses affected:*** | 4.2.7.1 |
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|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.331 CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | R2-2203114 |

*START OF CHANGE*

4.2.7.1 *BandCombinationList* parameters

| **Definitions for parameters** | **Per** | **M** | **FDD-TDD****DIFF** | **FR1-FR2****DIFF** |
| --- | --- | --- | --- | --- |
| ***bandEUTRA***Defines supported EUTRA frequency band by NR frequency band number, as specified in TS 36.101 [14]. | Band | Yes | N/A | N/A |
| ***bandList***Each entry of the list should include at least one bandwidth class for UL or DL. | BC | Yes | N/A | N/A |
| ***bandNR***Defines supported NR frequency band by NR frequency band number, as specified in TS 38.101-1 [2] and TS 38.101-2 [3]. | Band | Yes | N/A | N/A |
| ***ca-BandwidthClassDL-EUTRA***Defines for DL, the class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by the UE, as specified in TS 36.101 [14]. When all FeatureSetEUTRA-DownlinkId:s in the corresponding FeatureSetsPerBand are zero, this field is absent. | Band | No | N/A | N/A |
| ***ca-BandwidthClassDL-NR***Defines for DL, the class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by the UE, as specified in TS 38.101-1 [2] and TS 38.101-2 [3]. When all FeatureSetDownlinkId:s in the corresponding FeatureSetsPerBand are zero, this field is absent. For FR1, the value 'F' shall not be used as it is invalidated in TS 38.101-1 [2]. | Band | No | N/A | N/A |
| ***ca-BandwidthClassUL-EUTRA***Defines for UL, the class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by the UE, as specified in TS 36.101 [14]. When all FeatureSetEUTRA-UplinkId:s in the corresponding FeatureSetsPerBand are zero, this field is absent. | Band | No | N/A | N/A |
| ***ca-BandwidthClassUL-NR***Defines for UL, the class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by the UE, as specified in TS 38.101-1 [2] and TS 38.101-2 [3]. When all FeatureSetUplinkId:s in the corresponding FeatureSetsPerBand are zero, this field is absent. For FR1, the value 'F' shall not be used as it is invalidated in TS 38.101-1 [2]. | Band | No | N/A | N/A |
| ***ca-ParametersEUTRA***Contains the EUTRA part of band combination parameters for a given (NG)EN-DC/NE-DC band combination. | BC | No | N/A | N/A |
| ***ca-ParametersNR***Contains the NR band combination parameters for a given (NG)EN-DC/NE-DC and/or NR CA band combination. | BC | No | N/A | N/A |
| ***ca-ParametersNRDC***Indicates whether the UE supports NR-DC for the band combination. It contains the NR band combination parameters applicable across MCG and SCG. A UE indicating support for NR-DC shall support synchronous NR-DC configuration where all serving cells of the MCG are in FR1 and all serving cells of the SCG are in FR2. | BC | No | N/A | N/A |
| ***featureSetCombination***Indicates the feature set that the UE supports on the NR and/or MR-DC band combination by FeatureSetCombinationId. | BC | N/A | N/A | N/A |
| ***featureSetCombinationDAPS-r16***Indicates the feature set that the UE supports for DAPS handover on the NR band combination by FeatureSetCombinationId. A UE shall include this field if intra-freq or inter-freq DAPS handover is supported for this band combination. If the number of CCs within a band combination is more than two, UE shall support DAPS handover between every CC pair. A feature set including *intraFreqDAPS-r16* can only be referred to by *featureSetCombinationDAPS-r16*, not by *featureSetCombination*. A feature set without *intraFreqDAPS-r16* is only applied to inter-freq DAPS handover if it is referred to by *featureSetCombinationDAPS*. Both feature sets with and without *intraFreqDAPS-r16* can be referred to by the same *featureSetCombinationDAPS-r16*. | BC | N/A | N/A | N/A |
| ***mrdc-Parameters***Contains the band combination parameters for a given (NG)EN-DC/NE-DC band combination. | BC | No | N/A | N/A |
| ***ne-DC-BC***Indicates whether the UE supports NE-DC for the band combination. | BC | No | N/A | N/A |
| ***powerClass, powerClass-v1610***Indicates power class the UE supports when operating according to this band combination. If the field is absent, the UE supports the default power class. If this power class is higher than the power class that the UE supports on the individual bands of this band combination (*ue-PowerClass* in *BandNR*), the latter determines maximum TX power available in each band. The UE sets the power class parameter only in band combinations that are applicable as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. This capability is not applicable to IAB-MT. | BC | No | N/A | FR1 only |
| ***powerClassNRPart-r16***Indicates NR part power class the UE supports when operating according to this band combination.This field only applies for MR-DC BCs containing only single CC or intra-band CA in NR side in this release. | BC | No | N/A | FR1 only |
| ***scalingFactorTxSidelink-r16, scalingFactorRxSidelink-r16***Indicates, for a particular Uu band combination, the scaling factor for the PC5 band combination(s) on which the UE supports simultaneous transmission/reception (as indicated by *supportedTxBandCombListPerBC-Sidelink-r16* / *supportedRxBandCombListPerBC-Sidelink-r16*). The leading / leftmost value corresponds to the first band combination included in *BandCombinationListSidelinkEUTRA-NR* which is indicated with value 1 by *supportedTxBandCombListPerBC-Sidelink-r16* / *supportedRxBandCombListPerBC-Sidelink-r16*, the next value corresponds to the second band combination included in *BandCombinationListSidelinkEUTRA-NR* which is indicated with value 1 by *supportedTxBandCombListPerBC-Sidelink-r16* / *supportedRxBandCombListPerBC-Sidelink-r16* and so on. For each value of *ScalingFactorSidelink-r16*, value f0p4 indicates the scaling factor 0.4, f0p75 indicates 0.75, and so on. | BC | No | N/A | N/A |
| ***SRS-SwitchingTimeNR***Indicates the interruption time on DL/UL reception within a NR band pair during the RF retuning for switching between a carrier on one band and another (PUSCH-less) carrier on the other band to transmit SRS. *switchingTimeDL/ switchingTimeUL*:n0us represents 0 us, n30us represents 30us, and so on. *switchingTimeDL/ switchingTimeUL* is mandatory present if switching between the NR band pair is supported, otherwise the field is absent. It is signalled per pair of bands per band combination. | FD | No | N/A | N/A |
| ***SRS-SwitchingTimeEUTRA***Indicates the interruption time on DL/UL reception within a EUTRA band pair during the RF retuning for switching between a carrier on one band and another (PUSCH-less) carrier on the other band to transmit SRS. *switchingTimeDL/ switchingTimeUL:* n0 represents 0 OFDM symbols, n0dot5 represents 0.5 OFDM symbols, n1 represents 1 OFDM symbol and so on. *switchingTimeDL/ switchingTimeUL* is mandatory present if switching between the EUTRA band pair is supported, otherwise the field is absent. It is signalled per pair of bands per band combination. | FD | No | N/A | N/A |
| ***srs-TxSwitch, srs-TxSwitch-v1610***Defines whether UE supports SRS for DL CSI acquisition as defined in clause 6.2.1.2 of TS 38.214 [12]. The capability signalling comprises of the following parameters:- *supportedSRS-TxPortSwitch* indicates SRS Tx port switching pattern supported by the UE, which is mandatory with capability signaling. The indicated UE antenna switching capability of ′xTyR′ corresponds to a UE, capable of SRS transmission on ′x′ antenna ports over total of ′y′ antennas, where ′y′ corresponds to all or subset of UE receive antennas, where 2T4R is two pairs of antennas. *supportedSRS-TxPortSwitch-v1610*, which is optional to report, indicates downgrading configuration of SRS Tx port switching pattern. If the UE indicates the support of downgrading configuration of SRS Tx port switching pattern using *supportedSRS-TxPortSwitch-v1610*, the UE shall report the values for this as below, based on what is reported in *supportedSRS-TxPortSwitch*.

|  |  |
| --- | --- |
| ***supportedSRS-TxPortSwitch*** | ***supportedSRS-TxPortSwitch-v1610*** |
| *t1r2* | *t1r1-t1r2* |
| *t1r4* | *t1r1-t1r2-t1r4* |
| *t2r4* | *t1r1-t1r2-t2r2-t2r4* |
| *t2r2* | *t1r1-t2r2* |
| *t4r4* | *t1r1-t2r2-t4r4* |
| *t1r4-t2r4* | *t1r1-t1r2-t2r2-t1r4-t2r4* |

- *txSwitchImpactToRx* indicates the entry number of the first-listed band with UL (see NOTE) in the band combination that affects this DL, which is mandatory with capability signaling;- *txSwitchWithAnotherBand* indicates the entry number of the first-listed band with UL (see NOTE) in the band combination that switches together with this UL, which is mandatory with capability signaling.For *txSwitchImpactToRx* and *txSwitchWithAnotherBand*, value 1 means first entry, value 2 means second entry and so on. All DL and UL that switch together indicate the same entry number.The entry number is the band entry number in a band combination. The UE is restricted not to include fallback band combinations for the purpose of indicating different SRS antenna switching capabilities.NOTE: The first-listed band with UL includes a band associated with *FeatureSetUplinkId* set to 0 corresponding to the support of SRS-SwitchingTimeNR. | BC | FD | N/A | N/A |
| ***supportedBandwidthCombinationSet***Defines the supported bandwidth combination set for a band combination as defined in TS 38.101-1 [2], TS 38.101-2 [3] and TS 38.101-3 [4]. For NR SA CA, NR-DC, inter-band (NG)EN-DC without intra-band (NG)EN-DC component, inter-band NE-DC without intra-band NE-DC component and intra-band (NG)EN-DC/NE-DC with additional inter-band NR CA component, the field defines the bandwidth combinations for the NR part of the band combination. For intra-band (NG)EN-DC/NE-DC without additional inter-band NR and LTE CA component, the field indicates the supported bandwidth combination set applicable to intra-band (NG)EN-DC/NE-DC band combination.Field encoded as a bit map, where bit N is set to "1" if UE supports Bandwidth Combination Set N for this band combination as defined in the TS 38.101-1 [2], TS 38.101-2 [3] and TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if- the band combination has more than one NR carrier (at least one SCell in an NR cell group);- or is an intra-band (NG)EN-DC/NE-DC combination without additional inter-band NR and LTE CA component;- or both. | BC | CY | N/A | N/A |
| ***supportedBandwidthCombinationSetIntraENDC***Defines the supported bandwidth combination set for a band combination that allows configuration of at least one EUTRA serving cell and at least one NR serving cell in the same band, as defined in the TS 38.101-3 [4], table 5.3B.1.2-1 and table 5.3B.1.3-1.- For intra-band (NG)EN-DC with additional inter-band CA component(s) of LTE and/or NR, the field defines the bandwidth combinations for the intra-band (NG)EN-DC component.- For intra-band NE-DC with additional inter-band CA component(s) of LTE and/or NR, the field defines the bandwidth combinations for the intra-band NE-DC component.Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on.- It is mandatory if the band combination is an intra-band (NG)EN-DC/NE-DC combination supporting both UL and DL intra-band (NG)EN-DC/NE-DC parts with additional inter-band NR/LTE CA component.- It is optional if the band combination is an intra-band (NG)EN-DC/NE-DC combination without supporting UL in both the bands of the intra-band (NG)EN-DC/NE-DC UL part. If not included, the network assumes the UE supports BCS0 as defined in TS 38.101-3 [4], table 5.3B.1.2-1 and table 5.3B.1.3-1 for the intra-band (NG)EN-DC/NE-DC. | BC | CY | N/A | N/A |
| ***supportedTxBandCombListPerBC-Sidelink-r16, supportedRxBandCombListPerBC-Sidelink-r16***Indicates, for a particular Uu band combination, the PC5 band combination(s) on which the UE supports simultaneous transmission/reception. The leading / leftmost bit (bit 0) corresponds to the first band combination included in *BandCombinationListSidelinkEUTRA-NR*, the next bit corresponds to the second band combination included in *BandCombinationListSidelinkEUTRA-NR* and so on. with value 1 indicating simultaneous transmission/reception is supported. | BC | No | N/A | N/A |
| ***ULTxSwitchingBandPair-r16, ULTxSwitchingBandPair-v17xx***Indicates UE supports dynamic UL 1Tx-2Tx switching in case of inter-band CA, SUL, and (NG)EN-DC, and UL 2Tx-2Tx switching in case of inter-band CA and SUL as defined in TS 38.214 [12], TS 38.101-1 [2] and TS 38.101-3 [4]. The capability signalling comprises of the following parameters:- *bandIndexUL1-r16* and *bandIndexUL2-r16* indicate the band pair on which UE supports dynamic UL Tx switching. *bandindexUL1*/*bandindexUL2* xx refers to the xxth band entry in the band combination. UE shall indicate support for 2-layer UL MIMO capabilities on one of the indicated two bands in each FeatureSet entry supporting UL 1Tx-2Tx switching and indicate support for 2-layer UL MIMO capabilities on both bands in each FeatureSet entry supporting UL 2T-2Tx switching, and only the band where UE supports 2-layer UL MIMO capability can work as carrier2 as defined in TS 38.101-1 [2] and TS 38.101-3 [4].- *uplinkTxSwitchingPeriod-r16* indicates the length of UL Tx switching period of 1Tx-2Tx switching per pair of UL bands per band combination when dynamic UL Tx switching is configured, as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. UE shall not report the value n210us for EN-DC band combinations. n35us represents 35 us, n140us represents 140us, and so on, as specified in TS 38.101-1 [2] and TS 38.101-3 [4].- *uplinkTxSwitchingPeriod2T2T-r17* indicates the length of UL Tx switching period of 2Tx-2Tx switching per pair of UL bands per band combination when dynamic UL Tx switching is configured, as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. n35us represents 35 us, n140us represents 140us, and so on, as specified in TS 38.101-1 [2] and TS 38.101-3 [4].- *uplinkTxSwitching-DL-Interruption-r16* indicates that DL interruption on the band will occur during UL Tx switching, as specified in TS 38.133 [5] and in TS 36.133 [27]. UE is not allowed to set this field for the band combination of SUL band+TDD band, for which no DL interruption is allowed.Field encoded as a bit map, where bit N is set to "1" if DL interruption on band N will occur during uplink Tx switching as specified in TS 38.133 [5] and in TS 36.133 [27]. The leading / leftmost bit (bit 0) corresponds to the first band of this band combination, the next bit corresponds to the second band of this band combination and so on. The capability is not applicable to the following band combinations, in which DL reception interruption is not allowed:- TDD+TDD CA with the same UL-DL pattern- TDD+TDD EN-DC with the same UL-DL pattern | BC | FD | N/A | FR1 only |
| ***uplinkTxSwitching-OptionSupport-r16***Indicates which option is supported for dynamic UL Tx switching for inter-band UL CA and (NG)EN-DC. *switchedUL* represents option 1 as specified in TS 38.214 [12], *dualUL* represents option 2 as specified in TS 38.214 [12], *both* represents both option 1 and option2 as specified in TS 38.214 [12]. UE shall not report the value *both* for (NG)EN-DC case. The field is mandatory for inter-band UL CA and (NG)EN-DC case where UE supports dynamic UL Tx switching. | BC | CY | N/A | FR1 only |
| ***uplinkTxSwitching-PowerBoosting-r16***Indicates the support of 3dB boosting on the maximum output power for UE transmission under the operation state in which 2-port transmission can be supported on carrier2 in case of inter-band UL CA case where UE supports dynamic UL Tx switching. A UE shall only indicate this capability in case the UE supports power class 3 for inter-band UL CA for the band combination as defined in TS 38.101-1 [2]. | BC | No | N/A | FR1 only |
| ***uplinkTxSwitching-PUSCH-TransCoherence-r16***Indicates support of the uplink codebook subset for the carrier(s) on the band capable of two antenna connectors for UL 1Tx-2Tx switching, when UE is configured with uplink Tx switching with parameter *uplinkTxSwitching-r16* and uplink Tx switching is triggered between last transmitted SRS and scheduled PUSCH transmission, as specified in TS 38.101-1 [2]. UE indicated support of full coherent codebook subset shall also support non-coherent codebook subset.If the field is absent, the UE capability reported in *pusch-TransCoherence* is applied when the uplink switching is triggered between last transmitted SRS and scheduled transmission. | BC | No | N/A | FR1 only |
| ***UplinkTxSwitchingBandParameters-v17xx***Contains the UL Tx switching specific band parameters for a given band combination.The capability signalling comprises of the following parameters:- *bandIndex-r17* indicates a band on which UE supports dynamic UL Tx switching with another band in the band combination. *bandIndex* xx refers to the xxth band entry in the band combination. - *uplinkTxSwitching2T2T-PUSCH-TransCoherence-r17* indicates support of the uplink codebook subset for the carrier(s) on a band capable of two antenna connectors on which UE supports dynamic UL 2Tx-2Tx switching with another band in the band combination. UE indicated support of full coherent codebook subset shall also support non-coherent codebook subset. If this field is absent, the per BC UE capability reported in *uplinkTxSwitching-PUSCH-TransCoherence-r16* is applied, and if this field and *uplinkTxSwitching-PUSCH-TransCoherence-r16* are both absent, the UE capability reported in *pusch-TransCoherence* is applied when UE is configured with uplink Tx switching with parameter *uplinkTxSwitching-r16* and uplink Tx switching is triggered between last transmitted SRS and scheduled PUSCH transmission, as specified in TS 38.101-1 [2]. | BC | No | N/A | FR1 only |

END OF CHANG