# **[102-e-NR- 5G\_V2X\_NRSL-PHYprocedure-01] Email discussion/approval regarding the following aspects for HARQ operation**

[102-e-NR- 5G\_V2X\_NRSL-PHYprocedure-01] Email discussion/approval regarding the following aspects for HARQ operation

* Issue 3-1: Details of indicating groupcast HARQ feedback option
* Issue 3-2: Capturing PSFCH reception behavior in the specifications
* Issue 3-3: Exact location of PSFCH slots in the time domain

By 8/21, followed by potential TPs by 8/26 – Hanbyul (LGE)

**1. Details of indicating groupcast HARQ feedback option**

Q1: Do you support physical layer signaling to indicate groupcast with HARQ feedback Option 1 (i.e., NACK only) without distance-based feedback?

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| Company | Answer | Comment |
| NTT DOCOMO | Yes | RAN1 concluded in the last meeting that the operation is feasible from L1 signaling perspective.  RAN2 agreed that the operation is supported.  Based on the above two, RAN1 should support it. |
| Sharp | Yes | Same reason as NTT DOCOMO. |
| Ericsson | Yes | Due to RAN2 agreement. |
| ZTE, Sanechips | yes | This is aligned to RAN2 agreements and RAN1 conclusion. |
| Intel | Yes | RAN1 should follow RAN2 agreement if there is no big issue (we assume no) |
| Futurewei | No | While we understand RAN2 made a decision, we think that without distance-based feedback, option 1 can create issues: it essentially implies that we support transmission with implicit ACK. Because of half duplex issues, a UE might miss a transmission, and not even be aware of it. This is always a risk with option 1, but at least the distance threshold can somehow contain it. Before having signaling for opt 1 without distance RAN1 should first discuss the cases for which opt 1 without distance should be enabled (e.g., only low priority services) |
| OPPO | Yes | Similar view as NTT DOCOMO. |
| QC | Yes | RAN2 has reached an agreement, and RAN1 has concluded that this is feasible to support from signaling point of view. |
| CATT | Yes | RAN2 has agreed to support this operation, RAN1 should support it. |
| NEC | Yes | Same view as NTT DoCoMo |
| Apple | Yes | To support RAN2 agreement. |
| Vivo | Yes | Align with RAN2 decision |
| Panasonic | Yes | RAN2 supports Groupcast option 1 (i.e., NACK only feedback) when Zone ID or Communication range requirement is not provided. In addition, the case of group size is greater than the number of candidate PSFCH resource is also HARQ option 1. Both should be supported in physical layer signaling. |
| Samsung | Yes | We still have concern on the performance of Option 1 without distance-based feedback. However, if RAN2 want this feature and RAN1 majority consider it as feasible, we can compromise and live with it. |
| Spreadtrum | Yes | By referring to RAN2 agreement. |
| Huawei,  HiSilicon | No | RAN2, rushing at the end of the May meeting, appear to have looked at a direction that would not be good for the physical layer, if changes to PHY are made. We explained before that this what is essentially sidelink broadcast with HARQ is a new feature which has been trying to add during maintenance, and it would degrade the stability and performance of group communication in general. The remote UE may keep replying NACK due to Tx UE limited coverage, and the Tx UE may decrease the MCS and even ramp up the Tx power for better coverage. Therefore, without the reasonable distance control, GC HARQ feedback option 1 cannot work properly, it is not only related to signaling feasibility but the function of the whole feedback mechanism.  On the other hand, the RAN2 agreement itself does not request any PHY change, and no LS has been received in RAN1 to activate the conditions in the RAN1 conclusion. The RAN2 agreement also does not state that groupcast option 1 must be used in the given case – only that HARQ feedback without distance-based operation is used. Therefore, we interpret that RAN2 have concluded the issue in the MAC layer, and (as per normal operation) if higher layers want a kind of non-distance based groupcast, they will give the appropriate instruction to PHY by requesting groupcast option 2 feedback. |
| LG Electroincs | Yes | According to RAN2 agreements, groupcast with HARQ feedback Option 1 (i.e., NACK only) without distance-based feedback is supported.  **RAN2#110-e**   * + The following additional condition is needed for HARQ option1:     - The group size is greater than the number of candidate PSFCH resources associated with the selected PSSCH resource.   + For sidelink groupcast option1, TX UE can enables HARQ feedback without the distance-based operation when range configuration for sidelink logical channel or zone\_id is not (pre-)configured.   In the perspective of physical layer signalling, it is feasible to support this feature. |
| Interdigital | Yes | Per RAN2 agreement |

Q2: If the answer to Q1 is yes, which option is used to indicate groupcast with HARQ feedback Option 1 (i.e., NACK only) without distance-based feedback?

* + Option 1: SCI format 2-A is used
    - Option 1-1: A value of Cast type indicator in SCI format 2-A is used to indicate groupcast HARQ feedback option 1 without distance-based feedback
    - Option 1-2: Additional 1-bit indicator in SCI format 2-A is introduced to indicate whether the distance-based feedback is applied or not.
  + Option 2: SCI format 2-B is used
    - Option 2-1: Communication range requirement field in SCI format 2-B is used to indicate distance-based HARQ-ACK feedback is disabled
  + Option 3: Others (please specify)

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| Company | Preferred option | Comment |
| NTT DOCOMO | Option 1-1 | 2-A is better since if 2-B is used, the unused overhead is not so small.  Cast type indicator has a reserved state. The state can be used. Meanwhile, additional bit degrades performance. |
| Sharp | Option 2-1 | It would be better to have the “Groupcast Option 1” support in one place. |
| Ericsson | Option 1-1 | We think, it is a straightforward approach to use cast type indicator in SCI format 2-A for this purpose which avoid extra overhead which is unnecessary. |
| ZTE, Sanechips | Option 1-1 | This option is the simplest one. SCI format 2-A already contains a code-point to potentially support this. |
| Intel | Option 2-1 or  Option 1-3 (see details) | Our first preference is to keep SCI format 2-B for NACK-only operation and use a codepoint of comm range to indicate ‘no range information’  The second preference is Option 1-3: to use cast type set to ‘broadcast’ AND enable feedback request. |
| OPPO | Option 1-1 | The reserved codepoint can be used to indicate the HARQ feedback option, no necessary to introduce additional field. |
| QC | Option 2-1 | The simplest change is to keep SCI format 2-B for NACK-only operation and use a codepoint of comm range to indicate ‘no range information’.  This is also a preferred option from extensibility point of view, there is currently 9 spared values for communication range in format 2-B. Option 1-1 means there is no other spared value for format 2-A, so no extension beyond R16 is possible. |
| CATT | Option 1-1 | From the overhead aspects, option 1-1 is preferred. |
| NEC | Option 1-1 | No additional field will introduced |
| Apple | Option 2-1 | Associating “Groupcast HARQ feedback Option 1” with SCI format 2-B (distance-based or non-distance-based) makes the category clear.  Also, the usage of the only reserved codepoint of “cast type indicator” in SCI format 2-A may prevent any further extension in a future release. |
| vivo | Option 1-1 | Format 2-B has larger overhead, which is designed for distance based feedback. When there is no distance based operation, format 2-A is straightforward way. |
| Panasonic | Option 1-1 | We think application layer connection-less group or application layer managed group can be distinguished by destination ID. To use SCI format 2-A as much as possible can minimize the signalling overhead. Therefore, we propose to take option 1-1. As the realization, reserved case in cast type indicator is used for NACK only indication would be straight forward. |
| Samsung | Option 1-1 | Using format 2-A can minimize the overhead. |
| Spreadtrum | Option 2-1 | Same reason as QC. |
| Huawei,  HiSilicon | Not supported. |  |
| LG Electronics | Option 1-1 | First of all, Option 1-1 does not increase SCI overhead, and does not restrict scheduling flexibility.  Next, in our understanding, according to RAN2 spec, the same setting of Zone ID and communication range requirement is used across (re)transmissions for a TB. In other words, once SCI format 2-B is used to schedule groupcast option 1 with distance-based feedback, retransmissions for the same TB can be scheduled by SCI format 2-B even though the TX UE lost its own location. In this case, Zone ID and communication range requirement used in initial transmission are also used for retransmissions. |
| Interdigital | Option 1-1 | The bit field and code points are already available in 2-A and using 2-A can reduce SCI-2 overhead |

**2. Capturing PSFCH reception behavior in the specifications**

Q3: Do you agree to capture UE behavior that physical layer reports HARQ-ACK information of the received PSFCH to higher layer?

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| Company | Answer | Comment |
| NTT DOCOMO | Yes | In LTE, UE receives HARQ-ACK on PHICH and it is reported to higher layer, which is captured in spec (36.213 – section 8.3).  We can follow the direction; i.e. capture UE behavior of HARQ-ACK report from PHY to higher layer.  In addition to Q4/Q5, report for PSFCH RX drop might be described as 16.5? |
| Sharp | Yes | In fact, we think this should be done along with restructuring the “PSFCH reception” as already captured for mode 1 in section 16.5 of 213.  There are three levels of UE behaviors pertaining to PSFCH reception: (1). Determine one value for each PSFCH time/frequency/code resource; (2). Perform (1) for all PSFCH resources associated with one PSSCH transmission. (3). For mode 1 only, depending on type of HARQ-ACK codebook, for one or more of the PSSCH transmissions granted by a DCI format, perform (2) to determine one or more values to report in UL.  In our view (1) and (2) are common to mode 1 and 2, and should be captured in one place (in section 16.3.1) so that a HARQ-ACK value can be determined for a PSSCH transmission, and reported to higher layers. (3) should be separately captured (i.e. in section 16.5) for mode 1).  (In comparison, in the current specs, (1),(2) and (3) are messed up and are captured for mode 1 only, in section 16.5 of TS 38.213.) |
| Ericsson | Yes | We are fine with capturing it. |
| ZTE, Sanechips | ok | We can be fine if most companies want this, although we think it is not necessary to specify this intra-UE behavior. |
| Intel | Ok |  |
| Futurewei | Yes |  |
| OPPO | Yes |  |
| QC | Yes |  |
| CATT | Yes |  |
| NEC | Yes |  |
| Apple | Yes |  |
| vivo | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |
| Huawei,  HiSilicon | Yes | It should be sufficient to have a brief, formal, sub-section in 38.213 which can refer to 16.5 without much need to duplicate the specification of what is provided to higher layers. |
| LG Electronics | Yes | According to RAN2 spec, the higher layer expects that physical layer reports SL HARQ-ACK information. |
| Interdigital | Yes | It can be captured in the section 16.3 UE procedure for reporting HARQ-ACK on sidelink of TS 38.213. The SL behavior specified should be consistent with what is specified in section 16.5 Mode 1 UE procedure for reporting HARQ-ACK on uplink |
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Q4: If the answer to Q3 yes, what is the UE behavior when SL HARQ-ACK information includes NACK-only (i.e., groupcast option 1)?

* + Option 1: UE reports NACK if the UE determines NACK from the received PSFCH. It reports ACK, otherwise.
  + Option 2: Others (please specify)

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| Company | Preferred option | Comment |
| NTT DOCOMO | Option 2 | Reuse description of 16.5 with some update; i.e.  “if the UE receives a PSFCH associated with a SCI format 2-B  - report ACK when the UE determines absence of PSFCH reception for each PSFCH reception occasion from the number of PSFCH reception occasions; otherwise, report NACK” |
| Sharp | Option 1 | Wording can be resolved at TP phase. |
| Ericsson | Option 1 |  |
| ZTE, Sanechips | Option 1 | The wording can have two alternatives:   * Alt-1: to put NACK determination in “if” case and ACK determination in “otherwise” case. (Option 1 as above) * Alt-2: to put ACK determination in “if” case and NACK determination in “otherwise” case. (Option 2 from DoCoMo)   GC option-1 has signal reception for NACK only, i.e., UE should interpret an ACK reception if either it does not receive anything or something that it cannot interpret as NACK. To choose Option 1 as from FL proposal seems a better choice. |
| Intel | Option 1 |  |
| Futurewei | Option 2 | The UE should report NACK if it receives NACK on PSFCH. If it receives nothing, it should report that “no NACK” has been received, since not receiving NACK either means implicit ACK or that the packet has not been received at all |
| OPPO | Option 1 |  |
| CATT | Option 1 |  |
| NEC | Option 1 |  |
| Apple | Option 1 |  |
| vivo | Option 1 |  |
| Samsung | Option 1 |  |
| Spreadtrum | Option 1 |  |
| Huawei,  HiSilicon | Option 2 | The agreements which led to section 16.5 for reports on PUCCH/PUSCH already apply here. There is no need for new agreements. |
| LG Electronics | Option 1 | According the TS38.321, PSFCH reception behavior is not differentiated based on groupcast option as follows: 5.22.1.3.2 PSFCH reception The MAC entity shall for each PSSCH transmission:  1> if an acknowledgement corresponding to the PSSCH transmission in clause 5.22.1.3.1a is obtained from the physical layer:  2> deliver the acknowledgement to the corresponding Sidelink HARQ entity for the Sidelink process;  1> else:  2> deliver a negative acknowledgement to the corresponding Sidelink HARQ entity for the Sidelink process; |

Q5: If the answer to Q3 yes, what is the UE behavior when SL HARQ-ACK information includes ACK or NACK (unicast and groupcast option 2)?

* + Option 1: UE reports NACK if the UE determines NACK from the at least one received PSFCH. It reports ACK if the UE determines ACK from all the received PSFCH(s).
  + Option 2: UE report NACK if the UE determines NACK from the at least one received PSFCH. It reports ACK if the UE determines ACK from all the received PSFCH(s). DTX is reported otherwise.
  + Option 3: Others (please specify)

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| Company | Preferred option | Comment |
| NTT DOCOMO | Option 3 | Reuse description of 16.5 with some update; |
| Sharp | Option 1 | Wording can be resolved at TP phase. |
| Ericsson | Option 1 | We believe that we don’t have to capture DTX signaling. |
| ZTE, Sanechips | Option 1 | DTX reporting is not necessary according to 38.321 (copied below). It is strange to report DTX for a groupcast option 2 process.  ------------------------------the following is only for unicast-----------  1> if PSFCH reception is absent on the PSFCH reception occasion:  2> increment *numConsecutiveDTX*;  --------------------------------------------------------------------------------------- |
| Intel | Option 1 |  |
| Futurewei | Option 1 |  |
| OPPO | Option 3 | We have discussed how to report HARQ-ACK on uplink in 16.5. We can reuse them with necessary update.  At least, the option 1 and option 2 are not correct in my view. In both options, the following modification is necessary:  “ It reports ACK if the UE determines ACK from all the ~~received~~ expected PSFCH(s)” |
| QC | Option 3 | UE reports ACK if both of the 2 following conditions are met “the UE determines ACK from all the received PSFCH(s) *and UE determines no NACK from all the received PSFCH”.* UE reports NACK otherwise. |
| CATT | Option 3 | From our understanding, the behavior of unicast could be different from that of groupcast option 2.  For example, in Groupcast option 2, the DTX is similar as that of NACK, no need to introduce DTX in groupcast.  However, in unicast, the DTX is used for RLF management in RAN2. |
| NEC | Option 1 |  |
| Apple | Option 1 | We do not need a separate DTX reporting. |
| vivo | Option 1 | Do not need to report DTX as explained by ZTE. |
| Samsung | Option 3 | Similar view as OPPO. We can reuse the description in 16.5. Current option 1/2 are not accurate. |
| Spreadtrum | Option 1 | DTX could be indirectly indicated by not reporting ACK or NACK. |
| Huawei,  HiSilicon | Option 3 | The agreements which led to section 16.5 for reports on PUCCH/PUSCH apply here. There is no need for new agreements. |
| LG | Option 1 | According to RAN2 spec [5.22.1.3.3, TS38.321], the higher layer also considers the absence of PSFCH reception as follows:  The Sidelink HARQ Entity shall for each PSFCH reception occasion associated to the PSSCH transmission:  1> if PSFCH reception is absent on the PSFCH reception occasion:  2> increment *numConsecutiveDTX*;  Considering that physical layer always reports HARQ-ACK information when the UE determines ACK or NACK, DTX reporting is not necessary. |
| Interdigital | Option 2 | There are cases that a UE may not attempt to decode PSFCH due to intra-UE prioritization and the MAC doesn’t know whether PSFCH is missing or the PHY didn’t attempt to decode it. Therefore, it would be better PHY indicate DTX to upper layer only when the UE decode the PSFCH but no PSFCH is detected |
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**3. Exact location of PSFCH slots in the time domain**

Q6: Which options is used to define PSFCH slot location in a resource pool when PSFCH resource period is N,

* + Option 1: Logical slot index #0, #N, #2N, …. within 10240 ms period
  + Option 2: Logical slot index #N-1, #2N-1, #3N-1, … within 10240 ms period
  + Option 3: Logical slot index …, #M-2N, #M-N, #M within 10240 ms period, where logical slot #M is the last slot of a resource pool
  + Option 4: Others (please specify)

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| Company | Preferred option | Comment |
| NTT DOCOMO | Option 1, or  Option 2 |  |
| Sharp | Option 4 | No strong opinion on Option 1/2/3, but we think *MinTimeGapPSFCH* should also be taken into account. |
| Ericsson | Option 3 | In our view, option 1 and option 3 are similar in the sense that either the first slot (Option 1) or the last slot (Option 3) is always a PSFCH slot. However, Option 3 provides the following additional benefits compared to Option 1:   * Less wasteful of resources, because the PSFCH resources in first slot is useless since it cannot be used (due to *MinTimeGapPSFCH*.) * Option 3 always results in the least number of dangling/orphan slots at the end of the resource period/pool which cannot be used for HARQ feedback based transmissions. This is also an advantage compared to Option 2. * Option 3 does not require truncating the resource pool period to be a multiple of N.   The MinTimGapPSFCH can be further taken into account in Option 3 by skipping the PSFCH slot that has index smaller than MinTimeGap PSFCH. |
| ZTE, Sanechips | Option 1 | Option 1 can avoid so-called ‘orphan’ PSSCH slots. Option 3 is technically the same as option 1, but option 1 is simpler. |
| Intel | Option 3 | On the resource pool border there will be no issue of mapping of more than N PSSCH slots to one PSFCH occasion |
| Futurewei | Option 1 | We can also accept option 2 as second preference |
| OPPO | Option 1 or Option 2 |  |
| QC | Option 2 | This is the simplest solution. There is also no issue of mapping more than N PSSCH slots to one PSFCH occasion, given this is a rare occasion. |
| CATT | Option 1 | Option 1 is more simple to avoid “orphan” PSSCH slots. |
| NEC | Option 2 | MinTimGapPSFCH may always cause 'orphan' PSSCH/PSCCH slots in one resource pool period. Coordination with next resource pool should be discussed. |
| Apple | Option 2 or Option 3 | Option 1 seems to always have waste on the first PSFCH slot. |
| vivo | Option 1 | Option 1 and option 3 are similar, both can avoid to map more than N PSSCH slots to one PSFCH occasion. Since we do not see technical benefit one over the other, we would like pick a simple way. |
| Panasonic | Option 2 |  |
| Samsung | Option 1 | We can also accept Option 2. |
| Spreadtrum | Option 2 or option 3 | As PSFCH resource on logical slot index #0 in option 1 will not be used. |
| Huawei, HiSilicon | Option 2 | Because the PSFCH configuration may be different for the two adjacent resource pools, supporting inter-period HARQ feedback will introduce PSFCH collision. Thus in order to maximize utilization of the first PSFCH slot, option 2 is the best choice. |
| LG Electronics | Option 1 | Option 1 has the benefit of ensuring that the number of PSSCH slots associated with the same PSFCH occasion is not be greater than the PSFCH resource period if RAN1 allows a case where the number of logical slots in a resource pool is NOT a multiple of PSFCH resource period. On the other hand, Option 2 may be problematic since the number of PSSCH slots associated with the same PSFCH occasion can be greater than the PSFCH resource period and the specification does not specify PSSCH-to-PSFCH associated for this case.  If RAN1 agrees to have a restriction that the number of logical slots in a resource pool is a multiple of PSFCH resource period, Option 2 and 3 do not give technical difference.  Depending on the packet arrival time or first PSCCH/PSSCH transmission time, we cannot say that which option is better in terms of PSFCH resource utilization or latency. Moreover, considering that the PSFCH slot patterns will be repeated across 10240 ms periods, these options do not give technical or benefit difference.  Note that according to agreement and the latest version of TS38.213, PSSCH-to-PSFCH association could be across different SFN/DFN periods as shown in following figure (10 logical slots in a resource pool within 10240ms period, 4 slots of PSFCH resource period, K=3).    At that time, Option 3 could be seen as shifted version of Option 1 as follows:    Meanwhile, in the perspective spec writing, Option 1 is very simple since it does not needs to consider how many slots belong to a resource pool, or what is PSFCH resource period. |
| Interdigital | Option 3 | Option 3 can avoid both “orphan” slot and doesn’t put constraint on the number of logical slots being a multiple of N. |
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Q7: Do you think the number of logical slots of a resource pool is always a multiple of N, the PSFCH resource period?

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| Company | Answer | Comment |
| NTT DOCOMO | Yes | Otherwise, some PSSCH resources would not be associated with PSFCH resources, according to Q6 and the current specification. To solve this issue, further discussion would be necessary, which is not good way in maintenance phase. |
| Sharp | Yes | If this is not the case, for a given resource pool, some of the PSSCH transmissions have associated PSFCH resources while others don’t have. Exceptions have to be identified and fixed one by one in the specs (including in RAN2 specs) e.g. for the cases where a selected/granted resource may not have associated PSFCH resource etc. |
| Ericsson | No | We don’t think that such restriction on the configuration is necessary. See also our response to Q6. |
| ZTE, Sanechips | Depending on conclusion from Q6. | If option 1 or option 3 in Q6 is agreed, it is not necessary to have this restriction. If option 2 was agreed in Q6, we prefer to have this restriction to avoid ‘orphan’ slots. Q6/Q7 could be merged into one discussion. |
| Intel | No | Given the answer to Q6, it is an unnecessary restriction |
| Futurewei | Yes | We agree that it does not strictly have to be the case. For example, on some slots, there could only be transmissions with no associated PSFCH. However, having the number of logical slots as a multiple of N is not a strong restriction and can simplify the system |
| OPPO | No | Firstly, we need to clarify “the number of logical slots of a resource pool”. How to define the number of the logical slots of a RP? The slots of a RP is repeated in the time domain. Once it is configured, the logical slots of the RP will repeat in time domain until it is re-configured. There is no obvious stating time and ending time of the RP. |
| QC | Yes | This will simplify the procedure a lot. |
| CATT | Yes | It could simplify the system |
| NEC | Depending on Q6 |  |
| Apple | Yes | This simplifies the design. |
| Vivo | No | Firstly, we do not see a problem when a resource pool is notmultiple of N, each PSSCH slots will correspond to a PSFCH occasion if option 1/3 in Q6 is adopted.  Secondly, such restriction may sacrifice the pool configuration flexibility. |
| Panasonic | No | SL enabling slots should be usable. If some slot should not be (pre-)configured in the resource pool, it wastes SL slots in every resource pool period. The last X slots where X is"(the number of SL slots in a resource pool) mod (the period of PSFCH resource)", could be orphan slots. Rx UE doesn’t transmit PSFCH corresponding to PSSCH on orphan slots. |
| Samsung | No | It depends on the conclusion of Q6. If the orphan PSFCH slot issue can be solved, it’s unnecessary to introduce such a restriction. |
| Spreadtrum | No | It depends on Q6. |
| Huawei,  HiSilicon | No | The orphan slots in the last of resource pool always exist, no matter it isa multiple of N or not. Since the minimum time GAP =2 or 3 |
| LG Electronics | Yes | It will make any potential issue due to the imbalance of PSSCH-to-PSFCH mapping simple. |
| Interdigital | No | The constraint is not necessary if option 1 or option 3 in Q6 is selected. |
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