**3GPP TSG-CT WG3 Meeting #128 *C3-232164r1***

**Bratislava, Slovakia, 22nd May – 26th May 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **29.552** | **CR** | **0062** | **rev** | **-** | **Current version:** | **18.0.0** |  |
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| *For* [***HE******LP***](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 |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | Preparation and Maintenance Procedures for Federated Learning in 5GC | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** | CT3 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | eNA\_Ph3 | | | | |  | ***Date:*** | | | 2023-05-09 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *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 can be 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)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | In TS 23.288 clauses 6.2C.2.1 and 6.2C.2.3, the following two additional procedures beside the general procedure are added for Federated Learning, i.e.   * Registration and Discovery Procedure for Federated Learning * Procedure for Maintenance of Federated Learning Process   In the approved stage2 CRs #0755 (S2-2306097) and #0732 (S2-2306096) in SA2#156e, the two procedures are updated by adding Nnwdaf\_MLModelTraining and Nnwdaf\_MLModelTrainingInfo services for preparation information exchange and for update/terminate Federated Learning process. The Nnwdaf\_MLModelTrainingInfo service is introduced in detail in stage2 CR #0808 (S2-2306101).  This CR introduces the above two procedures for Federated Learning to stage 3 specification. | | | | | | | | |
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| ***Summary of change:*** | | The following changes are made:   * Added Preparation Procedure for Federated Learning to clause 5.10.2.2. * Added Procedure for Maintenance of Federated Learning Process to clause 5.10.2.3. | | | | | | | | |
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| ***Consequences if not approved:*** | | Misalignment with stage 2. Incomplete procedures for Federated Learning among multiple NWDAFs in 5GC. | | | | | | | | |
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| ***Clauses affected:*** | | 5.10.2.2 (new), 5.10.2.3 (new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 23.288 CR 0755  TS 23.288 CR 0732  TS 23.288 CR 0808 | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

**Additional discussion(if needed):**

**Proposed changes:**

\*\*\* 1st Change \*\*\*

#### 5.10.2.2 Preparation Procedure for Federated Learning

This procedure is used by the NWDAF containing MTLF (as FL Server NWDAF or FL Client NWDAF(s)) to register into NRF, discover the FL Server NWDAF and select FL Client NWDAF(s) for Federated Learning (FL).



Figure 5.10.2.2-1: Preparation procedure for Federated Learning

The NWDAF containing MTLF as FL Server NWDAF or FL Client NWDAF(s) registered to NRF its NF profiles. Details are described in clause 5.2.2.2 of 3GPP TS 29.510 [26].

1. The FL Server NWDAF and FL Client NWDAF(s) are discovered via NRF. Details are described in clause 5.3.2.2 of 3GPP TS 29.510 [26].

2. The Nnwdaf\_MLModelTraining service is used for the preparation information exchange between the FL Server NWDAF and the FL Client NWDAF(s).

2a. The FL Server NWDAF invokes Nnwdaf\_MLModelTraining\_Subscribe service operation by sending an HTTP POST request targeting the resource "NWDAF ML Model Training Subscriptions", The request shall include the "mLPreFlag" attribute and set to "true". Details are described in clause 4.6.2.2 of 3GPP TS 29.520 [5].

2b. The FL Client NWDAF(s) decides whether to join the FL process based on implementation.

2c. The FL Client NWDAF responses to the Nnwdaf\_MLModelTraining\_Subscribe request to indicate its decision. Upon receipt of the HTTP POST request, if the preparation request is accepted, the FL Client NWDAF responds to the FL Server NWDAF with "201 Created".

3. The Nnwdaf\_MLModelTrainingInfo service is used for the preparation information exchange between the FL Server NWDAF and the FL Client NWDAF(s).

3a. The FL Server NWDAF invokes Nnwdaf\_MLModelTrainingInfo\_Request service operation.

3b. The FL Client NWDAF(s) decides whether to join the FL process based on implementation.

3c. The FL Client NWDAF sends Nnwdaf\_MLModelTrainingInfo\_Request response to the FL Server NWDAF to indicate if it will join the FL procedure or not.

Editor’s Note: How the Nnwdaf\_MLModelTrainingInfo service be used in step 3 is FFS.

4. The FL Server NWDAF conducts selection of the FL Client NWDAF(s).

\*\*\* 2nd Change \*\*\*

#### 5.10.2.3 Procedure for Maintenance of Federated Learning Process

This procedure is used by the NWDAF containing MTLF (the FL Server NWDAF) to maintain a FL process in FL execution phase, including: the FL Server NWDAF triggers reselection, addition, or removal of FL Client NWDAF(s), discovery of new FL Client NWDAF(s) via NRF, and FL Client NWDAF(s) joins or leaves FL process dynamically.

In FL execution phase, the FL Server NWDAF monitors the status changes of FL Client NWDAF(s), and may reselect the FL Client NWDAF(s) based on the received information of status changes.

NOTE: The FL Server NWDAF checks if there is a need to carry on the FL execution phase and then reselects FL members for the next iteration if needed.



**Figure 5.10.2.3-1: Procedure for Maintenance of Federated Learning Process in FL Execution Phase**

The FL Server NWDAF registered to NRF by invoking the Nnrf\_NFManagement\_NFRegister\_request service operation about the FL process, which includes Analytics ID.

1. The FL Server NWDAF may get the updated status of the current FL Client NWDAF(s) via NRF by using the Nnrf\_NFManagement service in the FL execution phase. Details are described in clauses 5.2.2.5 and 5.2.2.6 of 3GPP TS 29.510 [26].

2. The current FL Client NWDAF(s) may inform the FL Server NWDAF to leave the FL process. The FL Client NWDAF(s) invokes Nnwdaf\_MLModelTraining\_Notify service operation by sending an HTTP POST request to the FL Server NWDAF identified by the notification URI received during the creation/modification of the subscriptions. The request shall include "termTrainReq" attribute and with the "termTrainCause" attribute in data type "TermMLModelTrainInfo" being provided. Details are described in clause 4.6.2.4 of 3GPP TS 29.520 [5]. The FL Server NWDAF responds to the Nnwdaf\_MLModelTraining\_Notify service operation with an HTTP "204 No Content" status code to the FL Client NWDAF(s).

3. The FL Server NWDAF may get the information of the new FL Client NWDAF(s) dynamically via NRF. Details are described in clauses 5.2.2.5 and 5.2.2.6 of 3GPP TS 29.510 [26].

4. The FL Server NWDAF may subscribe to other NWDAF (Assist NWDAF) or the FL Client NWDAF(s) for analytics of the FL Client NWDAF(s), as defined in clauses 4.2.2.2 and 4.2.2.4 of 3GPP TS 29.520 [5].

5. The FL Client NWDAF(s) may report status of FL training including accuracy of local model and Training Input Data Information. The FL Client NWDAF(s) invokes Nnwdaf\_MLModelTraining\_Notify service operation to the FL Server NWDAF. The FL Server NWDAF stores the notification and responds to the Nnwdaf\_MLModelTraining\_Notify service operation with an HTTP "204 No Content" status code to the FL Client NWDAF(s). Details are described in clause 4.6.2.4 of 3GPP TS 29.520 [5].

6. The FL Server NWDAF checks the FL Client NWDAF(s) status based on the received information, determines whether reselection of the FL Client NWDAF(s) for the next round(s) of FL is needed. The checking and determination are made according to the updated status of the FL Client NWDAF(s) received in steps 1-5.

7. If re-selection is needed as determined in step 6 and if step 3 is not performed, the FL Server NWDAF may discover new candidate FL Client NWDAF(s) via NRF by using the Nnrf\_NFDiscovery services as described in clause 5.3.2.2 of 3GPP TS 29.510 [26]. The FL Server NWDAF reselects the FL Client NWDAF(s) from the current FL Client NWDAF(s) and the new candidate FL Client NWDAF(s).

8. The FL Server NWDAF sends termination request to the FL Client NWDAF(s) which will be removed from the FL process, and optionally indicating the reason. The FL Client NWDAF(s) terminates FL operations when receives a termination request from the FL Server NWDAF and may perform further action to be qualified in participation of FL training in the next cycles.

8a-8b. To send the termination request, the FL Server NWDAF may invoke the Nnwdaf\_MLModelTraining\_Unsubscribe service operation by sending an HTTP DELETE request, which targets the resource "Individual NWDAF ML Model Training Subscription", to the FL Client NWDAF(s). If the request is accepted, the FL Client NWDAF deletes the subscription and responds to the FL Server NWDAF service consumer with an HTTP "204 No Content" message. Details are described in clause 4.6.2.3 of 3GPP TS 29.520 [5].

8c-8d. The FL Server NWDAF may send the termination request by invoking the Nnwdaf\_MLModelTrainingInfo\_Request service operation.

Editor’s Note: How the Nnwdaf\_MLModelTrainingInfo service be used in steps 8c-8d is FFS.

\*\*\* End of Changes \*\*\*