**3GPP TSG-SA5 Meeting #154S5-241492**

**Changsha, China, 15 - 19 April 2024**

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| *CR-Form-v12.0* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **28.908** | **CR** | **0001** | **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 | **X** | Core Network | **X** |

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| ***Title:*** | Add use case for management of Federated Learning | | | | | | | | | |
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| ***Source to WG:*** | Intel | | | | | | | | | |
| ***Source to TSG:*** | S5 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_AIML\_MGT\_Ph2 | | | | |  | ***Date:*** | | | 2024-04-05 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-19 |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)*  *Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | When FL is used in 5GS, such as by NWDAFs, an ML model is collaboratively trained by a group of ML training functions including one acting as FL server and the others acting as FL clients.  The ML training functions involved in FL need to be managed considering their roles. | | | | | | | | |
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| ***Summary of change:*** | | Add use case and potential requirements for management of Federated Learning. | | | | | | | | |
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| ***Consequences if not approved:*** | | The FL cannot be managed. | | | | | | | | |
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| ***Clauses affected:*** | | 5a.1 (new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... 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:*** | |  | | | | | | | | |

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| **1st modified section** |

# 5a Use cases, potential requirements and possible solutions (phase 2)

## 5a.1 Management Capabilities for ML training

### 5a.1.1 Management of Federated Learning

#### 5a.1.1.1 Description

Typical ML entity training methods aggregate data from distributed multi-vendor functions into a single central function. Federated Learning, however, enhances privacy of distributed multi-vendor functions (also referred to as FL clients), where instead of training a single ML entity at a central function (also referred to as FL server), multiple ML entities are trained in parallel at the FL clients, utilizing the available local training data.



Figure 5a.1.1.1-1: Federated Learning

The FL Server plays a pivotal role in orchestrating the federated learning process. The main functionality for FL Server includes:

* Client Discovery and Selection: The Server discovers and selects FL Client in an FL procedure
* FL Initialization: The server initiates the federated learning process and distributing an initial global model to the clients for local training.
* Model Aggregation and Distribution: After receiving intermediate results (e.g., gradients, loss) from the clients, the server aggregates these results to update the global model and then distributes the updated global model back to the clients for further training in subsequent rounds.
* Coordination: The server coordinates the training process, deciding when to start or end the learning process.

The FL Clients, are the entities that hold the local data on which the local model is trained. The main functionality for FL Clients includes:

* Local Training: Each client trains the global model locally on its own data.
* Model Update: Clients receive the feedback from the server and use it for further local training. After training the model locally, the client sends the intermediate results to the server. The actual data remains on the client.

In 3GPP, there may be several deployment options for FL, as shown in Table X.

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|  | FL server | FL client(s) |
| Case 1 | Central NWDAF | Distributed NWDAF(s) |
| Case 2 | Application Function | UE(s) |
| Case 3 | gNodeB | UE(s) |

Table X: Federated Learning deployment options in mobile networks

Note: A prior agreement needs to exist between the FL server and the FL clients to exchange ML entities. Alternatively, exchanging of ML entities between the FL server and the FL clients may happen only via secure encryption techniques enabling both the parties not to disclose any details (e.g., model parameters) about the ML entities itself.

#### 5a.1.1.2 Use cases

##### 5a.1.1.2.1 Management of different roles in Federated Learning

In case 1, where NWDAFs takes the role of both FL server and FL clients, an ML model is collaboratively trained by a group of ML training functions including one acting as FL server and the others acting as FL clients. In case 2 and case 3, an ML model is collaboratively trained by an ML training function acting as FL server and UE(s) acting as FL clients.

As depicted in figure 5a.1.1.1-1, each ML training function or each UE acting as FL client trains the ML model locally using the local data set and reports the trained local ML model to the ML training function acting as FL server. The FL server generates the global ML model by aggregating the received local ML models and shares the global ML model with all FL clients.

For managing the FL, the ML training MnS consumer needs to know the ML training functions involved in the FL, and the role (FL server, FL client) of each ML training function, so that the consumer understands the impact of ML training function and can manage it correspondingly.

When receiving an ML Training request, the ML Training MnS Producer should evaluate whether FL procedure needs to be triggered according to the FL training requirements provided by the ML training consumer in the ML Training request. Then, based on the requirements provided by the ML training consumer to select FL clients, the ML Training MnS Producer may select appropriate FL Clients based on their supported capability.

To evaluate the performance of local ML models and global ML model, the consumer needs to know the relation between the global ML model and the local ML models, and their training performance along with the statistical information on the overall participant FL clients. For instance, if an FL server cannot generate a global ML model with better performance, the consumer may take some actions to optimize the FL.

5.1.x.2.1 FL Server Determination and FL Client Selection

#### 5a.1.1.3 Potential requirements

**REQ-FL\_MGMT-1** The ML training MnS producer should have a capability allowing an authorized consumer to get the FL capability type (FL server or FL client) of an ML Training Function in Federated Learning.

**REQ-FL\_MGMT-2** The ML training MnS producer should have a capability allowing an authorized consumer to provide FL training requirements to the ML Training Function acting as FL server.

**REQ-FL\_MGMT-3** The ML training MnS producer should have a capability allowing an authorized consumer to provide requirements for selecting FL clients in Federated Learning to the ML Training Function acting as FL server.

**REQ-FL\_MGMT-4** The ML training MnS producer should have a capability allowing an authorized consumer to get the information about the local ML models trained by FL clients and the global ML model generated by an FL server from an ML Training Function acting as FL server.

**REQ-FL\_MGMT-5** The ML training MnS producer should have a capability allowing an authorized consumer to get the statistical information about the participation of FL clients in Federated Learning from an ML Training Function acting as FL server.

**REQ-FL\_MGMT-6** The ML training MnS producer should have a capability allowing an authorized consumer to get the relation between the ML training functions in Federated Learning.

**REQ-FL\_MGMT-7** The ML training MnS producer should have a capability allowing the authorized consumer to get the information relation between the global ML model and the local ML models.

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| **End of modified sections** |