**Source: Tencent**

**Title: [FS\_AI4Media] Federated Learning: control messages**

**Document for: Agreement**

**Agenda Item: 9.7**

# Introduction

This document proposed a set of control messages for communication between UE’s with AI/ML capability through a service for federated learning among them. In federated learning, each device uses its local data and possibly part of the server-provided data to improve its AI/ML model and then communicate its improvements to servers and consequently to the other devices. The control messages are used to manage the training process, synchronize the training rounds, define the selection criteria for participating devices, or to monitor the convergence of the training process. This contribution proposed to list the reduired control messages.

# Control messages

## Synchronization message

### Definition

Synchronization messages are used to ensure that all devices start the training process simultaneously and progress at the same pace. For example, the server may send a synchronization message to all UEs to start a new round of training.

### Behavior

From network server to device.

The server sends a synchronization message to all UEs to start a new round of training at the same time. The message contains the round number and may also contain a timestamp indicating when the training round should begin.

### Paramters

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1. The Round\_number indicates the training round in a model training.

2. The Start\_time indicates the start time of the training.

3. The Duration indicates the desirable duration of the training. This value just shows an indication of the desirable time for completing the training round.

## Device eligibility message

### Definition

Device eligibility messages are used to define the criteria for selecting the devices that will participate in the training process. For example, the server may send a device eligibility message to all devices that belong to the defined group by the application.

### Behavior

From network server to device.

The server sends a device eligibility message to select the devices that meet certain criteria defined by the application. Depending on the number of criteria met, the application assigns a group id to the device. For example, the criteria could contain information about the device's operating system, processor speed, available memory, available image library (number of images…), geographical location of the device, language setting, and other attributes.

### Parameters

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1. The Group\_id is used to assign a new id for the devices that meet the eligibility criteria of this message. If the device is eligible, it uses this value as one of its group ids and from now on, it reacts to messages with the same group id.

2. The Application\_group\_id, is assigned by the application on the device and if that value is equal to the value of this field, then the device is eligible.

3. The Hardware, Location, and Language parameters define the hardware, location, and language eligibility criteria respectively for the device.

4. The Data\_library\_id defines the data library an eligible device shall have.

Note that if more than one eligibility field exists, the device needs to meet all criteria to become eligible.

## Model evaluation message

### Definition

Model evaluation messages are used to evaluate the performance of the global model for each device and make decisions about the training process. After running the learning phase, a device sends a model evaluation message to the server that measures the accuracy of the model. The server can then decide whether to continue training for another round or stop.

Alternatively, this message can be used by the server to request the device to perform an evaluation of a newly downloaded global model.

### Behavior

For the server to the device

The message contains the metrics to be used for evaluation.

From device to server

The message could contain a metric such as accuracy or precision.

### Parameters

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1. The Round\_number shows the round after which the evaluation is performed.

2. The Metric\_number shows the number of metrics included in this message body.

3. The Metric is one or more of the Name-Value pairs showing the name of the metric and the corresponding value obtained in the evaluation.

## Model update message

### Definition

Model update messages are used to update the model parameters on the devices after each round of training. For example, the server may send a model update message to all devices to update the global model with the new model parameters.

Model update messages are also used to update the global model on the server with the new parameters updated by the local training on the device.

### Behavior

From server to device:

The server sends a model update message to all devices to update the AI/ML model with the new model parameters. The message contains the model id of the AI/ML model to be updated, the updated model parameters that the UE will use to train the model in the next round, and the new model id when the parameters are updated.

From device to server:

After running the training locally, each device may send a model update message to the server with the updated parameters. Together with the received model evaluation message, the server can decide if the global model needs to be updated or not. The model update message then only contains the model id of the AI/ML model used for local training and the updated parameters.

### Parameters

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1. The Parameters includes the new model vector of values.

2. The New\_model\_id is the id of the new model when the server sends the model to one or more devices.

## Failure reporting message

### Definition

Error messages are used to handle unexpected errors or exceptions that may occur during the training process. For example, the server may send an error message to all devices to handle a device failure or network disruption.

### Behavior

From server to device:

The server sends a request to all devices to report a device failure or network disruption. For example, if a device fails to send its model parameters back to the server, the device should notify the server so that the device has been removed from the training process.

From device to server:

The device sends a failure message to the server if a failure occurs.

### Parameters

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The Message describe the reason for the failure.

# Envelope for control messages

## General structure

In order to use multiple messages together, a general structure for the messages is shown as below.

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| **Type** | **Requirement** |
| Envelope | Mandatory |
| Messages\_number | Mandatory |
| Message\_body 1 | Mandatory |
| Message\_body 2 | Optional |
| … | … |
| Message\_body N | Optional |

In this case, a message consists of an envelope and one or more message bodies. The envelope provides the general information for this message. The Messages Number defines the number of the message bodies in this message. Each message body defines a specific message.

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# Proposal

Sections 2 and 3 defines a preliminary list of control messages and its packaging required to be supported in the federated learning and . We proposed to include these sections into the permanent document as the basis for further work.