

Recommendation **ITU-T F.748.24 (04/2024)**

SERIES F: Non-telephone telecommunication services

Multimedia services

Trusted contribution evaluation framework on federated machine learning services

ITU-T F-SERIES RECOMMENDATIONS
Non-telephone telecommunication services

TELEGRAPH SERVICE	F.1-F.109
Operating methods for the international public telegram service	F.1-F.19
The gentex network	F.20-F.29
Message switching	F.30-F.39
The international telemesssage service	F.40-F.58
The international telex service	F.59-F.89
Statistics and publications on international telegraph services	F.90-F.99
Scheduled and leased communication services	F.100-F.104
Phototelegraph service	F.105-F.109
MOBILE SERVICE	F.110-F.159
Mobile services and multideestination satellite services	F.110-F.159
TELEMATIC SERVICES	F.160-F.399
Public facsimile service	F.160-F.199
Teletex service	F.200-F.299
Videotex service	F.300-F.349
General provisions for telematic services	F.350-F.399
MESSAGE HANDLING SERVICES	F.400-F.499
DIRECTORY SERVICES	F.500-F.549
DOCUMENT COMMUNICATION	F.550-F.599
Document communication	F.550-F.579
Programming communication interfaces	F.580-F.599
DATA TRANSMISSION SERVICES	F.600-F.699
MULTIMEDIA SERVICES	F.700-F.799
ISDN SERVICES	F.800-F.849
UNIVERSAL PERSONAL TELECOMMUNICATION	F.850-F.899
ACCESSIBILITY AND HUMAN FACTORS	F.900-F.999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T F.748.24

Trusted contribution evaluation framework on federated machine learning services

Summary

Federated machine learning (FML) is an emerging distributed framework that enables collaborative machine learning (ML) and model construction across distributed and decentralized datasets. FML service has distinctive features, such as location of data in the calculation, and data availability without visibility. It allows participants to jointly train ML models without sharing raw data, which can technically break data isolation and promote cooperation among data owners.

FML service involves multiple participants who usually perform different contributions to ML model training tasks due to their many impact factors. An effective and trusted contribution evaluation mechanism for FML service is essential to increase participation of the parties involved and can promote sustainable development of FML services.

Recommendation ITU-T F.748.24 introduces a trusted contribution evaluation service for FML service that combines and takes advantage of FML and distributed ledger technology functionalities, and provides relevant concepts, characteristics, requirements and use cases, and specifies a relevant reference framework and common capabilities.

History *

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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Table of Contents

		Page
1	Scope	1
2	References.....	1
3	Definitions	1
	3.1 Terms defined elsewhere	1
	3.2 Terms defined in this Recommendation.....	2
4	Abbreviations and acronyms	2
5	Conventions	2
6	Overview of a contribution evaluation service for federated machine learning services	2
7	Characteristics and requirements of a contribution evaluation service for FML services	4
	7.1 Characteristic of contribution evaluation service for FML services	4
	7.2 Common requirements of a contribution evaluation service for FML services	5
8	Reference framework of a contribution evaluation service for FML services	5
	8.1 FML service agent.....	6
	8.2 Data collection-functional component	6
	8.3 Contribution calculator-functional component.....	6
	8.4 ML model management-functional component	6
	8.5 DLT agent-functional component	7
	8.6 Task management-functional component.....	7
9	Common capabilities of a contribution evaluation service for FML services.....	7
	9.1 Data storage of FML services.....	7
	9.2 Identity registration of FML services	7
	9.3 FML model-training task registration of FML services	8
	9.4 FML model-training task execution (one-time computation)	10
	9.5 FML model-training task execution (multiple repetitive computation)	11
	9.6 Evaluation of FML model-training task contribution	13
10	General functional components of coordinators of and participants in FML training.....	14
	10.1 FML training coordinator	14
	10.2 FML training participant	16
11	Security consideration	17
	Appendix I – Use cases of a contribution evaluation service for FML services	18
	Bibliography.....	19

Recommendation ITU-T F.748.24

Trusted contribution evaluation framework on federated machine learning services

1 Scope

This Recommendation provides a trusted contribution evaluation service (CES) for federated machine learning (FML) services, and specifies relevant requirements, a reference framework and common capabilities.

This Recommendation includes:

- the concept, characteristics and requirements of a CES for FML services;
- a reference framework and common capabilities of a CES for FML services.

Use cases of trusted a CES for FML services.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 distributed ledger [b-ITU-T X.1400]: A type of ledger that is shared, replicated, and synchronized in a distributed and decentralized manner.

3.1.2 distributed ledger technology (DLT) [b-ITU-T X.1400]: Technology that enables the operation and use of distributed ledgers.

3.1.3 distributed ledger technology system (DLT system) [b-ITU-T X.1400]: A system that implements a distributed ledger.

3.1.4 federated machine learning (FML) [b-IEEE 3652.1]: Federated machine learning (FML) is a framework or system that enables multiple participants to collaboratively build and use machine learning models without disclosing the raw and private data owned by the participants while achieving good performance.

3.1.5 ledger [b-ITU-T X.1400]: Information store that keeps final and definitive (immutable) records of transactions.

3.1.6 service [b-ITU-T Y.2091]: A set of functions and facilities offered to a user by a provider.

3.1.7 trust [b-ITU-T Y.3052]: The measurable belief and/or confidence which represents accumulated value from history and the expecting value for the future.

NOTE – Trust is quantitatively and/or qualitatively calculated and measured. Trust is used to evaluate values of entities, value-chains among multiple stakeholders and human behaviours, including decision-making.

3.1.8 trusted system [b-ISO/TR 15801]: Information technology system with the capability of managing electronically stored information in a trustworthy manner.

3.1.9 trustworthy [b-ISO/TR 15801]: Ability to demonstrate authenticity, integrity and availability of electronically stored information over time.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CC	Contribution Calculator
CES	Contribution Evaluation Service
DC	Data Collection
DLT	Distributed Ledger Technology
FC	Functional Component
FML	Federated Machine Learning
ML	Machine Learning
MMM	ML Model Management
PII	Personally Identifiable Information
TM	Task Management

5 Conventions

This Recommendation uses the following conventions:

- The phrase "is required to" indicates a requirement that must be strictly followed and from which no deviation is permitted if conformance with this Recommendation is to be claimed.
- The phrase "is recommended" indicates a requirement that is recommended, but which is not absolutely required to claim conformance with this Recommendation.
- The phrase "can optionally" indicates an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Overview of a contribution evaluation service for federated machine learning services

FML is an emerging distributed framework that enables collaborative ML and model construction across distributed and decentralized datasets. FML service has distinctive features, such as location of data in the calculation, and data availability without visibility. It allows participants to jointly train ML models without sharing raw data directly, which can technically break data isolation and promote cooperation among data owners.

FML service involves multiple participants who usually perform different contributions to ML model-training tasks due to many impact factors of the participants, such as quantity, quality and

types of datasets, and capabilities of computing and communication. An effective and trusted contribution evaluation mechanism for FML service is essential to increase participation of the parties involved and can promote the sustainable development of FML services.

In the traditional coordination paradigm of FML services, depicted in Figure 6-1-a, FML training coordinators exchange information directly with each FML training participants for ML model training and utilization, in which the exchanged information usually includes modules, parameters and dataset indexes. FML training coordinators can store all exchanged information and final ML models, but FML training participants only can store part of the exchanged information generated by themselves individually. In this paradigm, for an ML model-training task, usually only FML training coordinators have full information to calculate the contribution degree of FML training participants.

Distributed ledger technologies (DLTs) have inherent advantages to leverage data management and sharing, such as peer to peer communication, decentralization, data immutability, openness, crowd consensus, and support and automation of smart contracts. DLT systems can be used as trustworthy shared storage for exchanging data for ML model-training tasks, and also for algorithms and modules to evaluate contributions. In this case, FML training coordinators and FML training participants can calculate contribution degrees for ML model-training tasks independently and consistently.

The trusted CES takes advantages of DLT and enhances contribution evaluation capability on FML services. Figure 6-1-b depicts the relevant enhanced coordination paradigm of FML services for contribution evaluation. In this paradigm, FML training coordinators and FML training participants exchange information for ML model training and utilization through CES and DLT systems. The CES manages ML model-training tasks, and acts as a bridge for FML training coordinators and FML training participants to exchange information for ML model training and utilization. The CES also stores relevant information in DLT systems. DLT systems guarantee the reliability, integrity, consistency, availability and non-tampering of relevant information. The CES, supported by DLT systems, provides a trusted evaluation service to evaluate contribution degree on FML services for each participant.

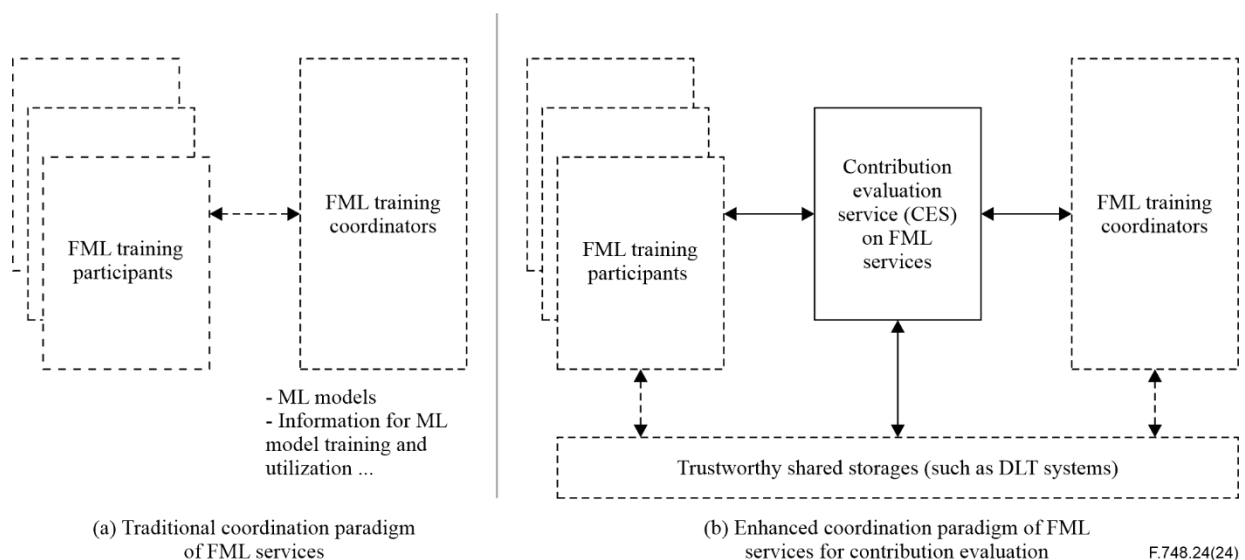


Figure 6-1 – Overview of a trusted contribution evaluation service for FML services

In addition, FML training coordinators can store modules for ML model training and modules for evaluating contributions in DLT systems. FML training participants can store indexes of datasets in DLT systems. Furthermore, FML training coordinators and FML training participants can initiate ML model-training tasks through CES and DLT systems.