

ICTビジネス戦略セミナー

「デジュール及びフォーラムの最新標準化動向と今後の取組」

# 情報通信NWサービスへのAI/ML, MEC利 活用に関する標準化動向

(ITU-T FG-ML5G, ETSI ISG-MEC)

*2020/1/29*

*Hidenori Inouchi*

*The University of Tokyo*

# Agenda

- ITU FG-ML5G
- ITU Workshop on Machine Learning for 5G and beyond
- ETSI ISG MEC
- まとめ

***ITU FG-ML5G***

***(Focus Group on ML for Future NWs including 5G)***

# ITU Focus Group on ML for Future NWs including 5G

- 2017年11月ITU-T SG13会合にて設立
- 2019/6/18-20第6回会合, 11/6-8の第7回会合に出席
- 2020/3/19-20第8回会合, 2020年7月で終了(予定)

The screenshot shows a web browser window displaying the ITU website. The page title is "Focus Group on Machine Learning for Future Networks including 5G". The breadcrumb navigation is "YOU ARE HERE HOME > ITU-T > FOCUS GROUPS > ML5G". There are social media share buttons for Facebook, Twitter, LinkedIn, and Email. A language selection menu shows "Automatic Translation: English, عربي, 中文, Español, Français, Русский". On the left, there is a sidebar with links to other focus groups: "Focus Group on AI for autonomous and assisted driving", "Focus Group on Quantum Information Technology for Networks", "Focus Group on Environmental Efficiency for Artificial Intelligence and other Emerging Technologies", "Focus Group on Artificial Intelligence for Health", "Focus Group on Vehicular Multimedia", "Focus Group on Technologies for Network 2030", "Focus Group on Machine Learning for Future Networks including 5G", and "Concluded Focus Groups". The main content area features the heading "FG-ML5G" and a paragraph: "The ITU-T Focus Group on Machine Learning for Future Networks including 5G was established by ITU-T Study Group 13 at its meeting in Geneva, 6-17 November 2017. The Focus Group will draft technical reports and specifications for machine learning (ML) for future networks, including interfaces, network architectures, protocols, algorithms and data formats." Below this is a "Terms of Reference:" section with two bullet points: "ToR of FG ML5G" and "Work plan of 2<sup>nd</sup> phase of FG ML5G (March 2019 – July 2020)". An "Output" section follows with two bullet points: "Unified architecture for machine learning in 5G and future networks processed and approved by SG13 on 1 of July 'Architectural framework for machine learning in future networks including IMT-2020'" and "ITU's ML-Aware Network Architecture: Bringing Intelligence to Verticals March 2019". At the bottom, it states: "Participation in FG-ML5G is free of charge and open to all. To receive updates and announcements related to this group, please subscribe to the FG-ML5G mailing list (see the 'FG-ML5G Mailing lists' tab on the right of this page)." On the right side, there are three tabs: "Meetings and Related Event", "Focus Group News", and "Focus Group Videos". Under "Meetings and Related Event", there are three items: "Workshop on 'Machine Learning in communication networks', 18 March 2020", "8<sup>th</sup> meeting of FG ML5G Beijing, China, 19-20 March 2020", and "Hosted by China Mobile Research Institute Address: 32 Xuanwumen West Street, Xicheng District, Beijing, China". Under "Focus Group News", there are five items: "Circular (20 December 2019)", "Registration (20 December 2019)", "Practical Information (20 December 2019)", "Visa information (20 December 2019)", and "Workshop on Machine Learning in communication networks, 18 March 2020". Under "Focus Group Videos", there are two items: "Highlights from #Berlin5GWeek [ 5G & Beyond Day - 5 November ]" and "[ ML5G Workshop - 6 November ]".

# ITU FG-ML5Gの現況

• Slawomir STANCZAK (Fraunhofer HHI) 議長

将来ネットワークにおけるML適用の「ユースケース」、「データ管理」、「アーキテクチャ」の標準化に関する報告書の作成、及びITU-T勧告文書の作成

	WG1 Deployment and application scenarios	WG2 Data management for ML	WG3 ML-aware network architecture
チエア	Seongbok BAIK (KT韓国) Mostafa ESSA (Vodafoneエジプト)	Qi SUN (China Mobile中国)	Wei MENG (ZTE Corp中国)
検討内容	<ul style="list-style-type: none"><li>機械学習を用いたユースケース (C-V2X、スマート工場等) や導入シナリオに対する現状とのギャップ分析</li><li>機械学習を用いたネットワークキリング機能とは何か？</li><li>上記の機能を実現するための実体は何か？ (WG2連携)</li><li>機械学習を用いたサービスやアプリケーションが将来ネットワークに与える影響は？</li></ul>	<ul style="list-style-type: none"><li>機械学習に必要なデータを、ネットワークからどのように収集・精査・処理を行うか？</li><li>機械学習アルゴリズムのリファレンス実装 (WG3連携)</li><li>オペレータが保有するデータを第三者に提供する際のデータ共有のためのフレームワークとプライバシー要求条件</li></ul>	<ul style="list-style-type: none"><li>ネットワークオーケストレータとMLFO間のインターフェース、MLインテント、ML活用ネットワークアーキテクチャ</li><li>インテリジェンスレベル規定</li><li>導入シナリオ、OSS互換性</li><li>MLモデル取引市場</li><li>サンドボックスフレームワーク</li></ul>
主成果 ITU-T 勧告文書	<ul style="list-style-type: none"><li>Supplement 55 to Y.3170-series: Y.ML-IMT2020-Use-Cases “Machine learning in future networks including IMT-2020</li></ul>	<ul style="list-style-type: none"><li>Framework for data handling to enable machine learning in future networks including IMT-2020 (Y.3174)</li></ul>	<ul style="list-style-type: none"><li>Architecture framework for integration of ML in future networks including 5G (Y.3172)</li><li>Framework for evaluating intelligence level of future networks including IMT-2020 (Y.3173)</li></ul>

# *ITU WS on Machine Learning for 5G & beyond*

# ITU Workshop Programme on "Machine Learning for 5G and Beyond" Geneva, Switzerland, 17 June 2019

<b>Session 1:</b> Tutorial on work of ITU's FG ML5G	<i>From use cases to implementation-Machine Learning for Future Networks including 5G</i>
<b>Session2:</b> Machine learning in the open source community and SDO	<i>How to make AI accessible with an Open Marketplace</i>
	<i>Machine Learning and Artificial Intelligence in Future Wireless Networks: A WWRF Perspective</i>
	<i>Communications for Artificial Intelligence *強化学習 for V2X*</i>
<b>Session3</b>	<i>Predicting the Black Swan-Ludic Fallacy and Self-Healing in Future Cellular Networks</i>
	<i>Case Implementation for Intelligent Edge System-Stream Data Analysis based on LF EdgeX Platform</i>
	<i>End-to-End Network Operation Automation in IMT-2020 and Beyond Systems</i>
<b>Session4</b>	<i>The Race to Neural Class Networks</i>
	<i>ETSI's Industry Specification Group on Experiential Networked Intelligence (ETSI ISG ENI)</i>
	<i><u>Acumos</u>'s Open Source Framework for Artificial Intelligence</i>

# ITU Workshop Programme on Machine Learning for 5G Berlin, Germany, 5 November, 2019

<b>Session 0: ITU's work on Machine Learning for 5G</b>	<i>Overview of ITU's work on Machine Learning for 5G and beyond [0]</i>
<b>Session 1: Research</b>	<i>Tactile Internet with <u>Human-In-The-Loop</u> * Democratization*</i>
	<i><u>Federated Learning</u> and its Applications in Communications [2]</i>
	<i>Deep Learning meets Modeling: Taking the Best out of Both Worlds</i>
	<i>Machine Learning for RAN - Salvation or Delusion?</i>
<b>Session 2: Telcos</b>	<i>AI for (B)5G Network Automation</i>
	<i>Current Explorations into Machine "Education" for Networking</i>
	<i>AI and ML toward the future * AI&amp;ML Introduction * [1]</i>
<b>Session 3: Verticals, SMEs &amp; Startups</b>	<i>Machine Learning on the Edge for 5G</i>
	<i>Creating a data lake with <u>ONAP</u></i>
	<i>Machine Learning for Resource Management in Access Networks</i>
	<i><u>AI for Industrial 5G</u> – Challenges and Opportunities *KICK* [3]</i>
	<i>ML-Based QoE Testing in Mobile Networks</i>



# ITU-T FG-ML5G Workshop 公開プレゼン資料のダウンロードURL

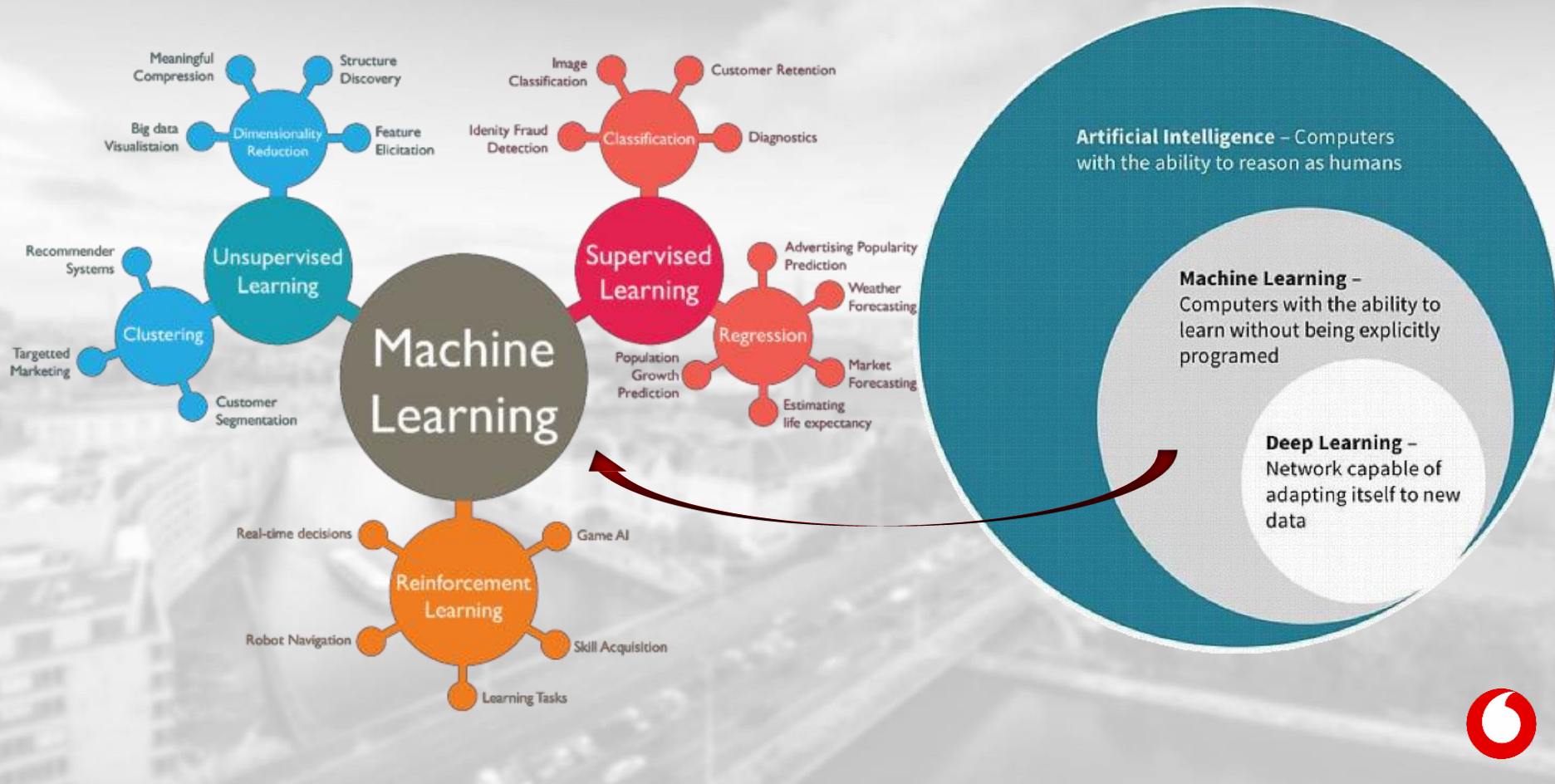
**【ITU Workshop on "Machine Learning for 5G and Beyond" Geneva, Switzerland, 17 June 2019】**

<https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20190617/Pages/programme.aspx>

**【ITU Workshop on Machine Learning for 5G Berlin, Germany, 5 November, 2019】**

<https://www.itu.int/en/ITU-T/Workshops-and-Seminars/201911/Pages/programme.asp>

# AI とMLの関係模式図



**ML (教師あり/教師なし/強化等)**

**AI ⊃ ML ⊃ DL**

SOURCE: [1] AI and ML toward the future <sup>10</sup>

# ML (機械学習) 学習方式の大分類

• 教師あり学習

• 分類

• 回帰

• 教師なし学習

• 次元削減

• クラスタリング

• 強化学習

従来型ML

• 転移学習 (Transfer Learning)

• 統合学習 (Federated Learning)

# Federated Learning (統合学習)

On-device deep learning



Privacy-preserving

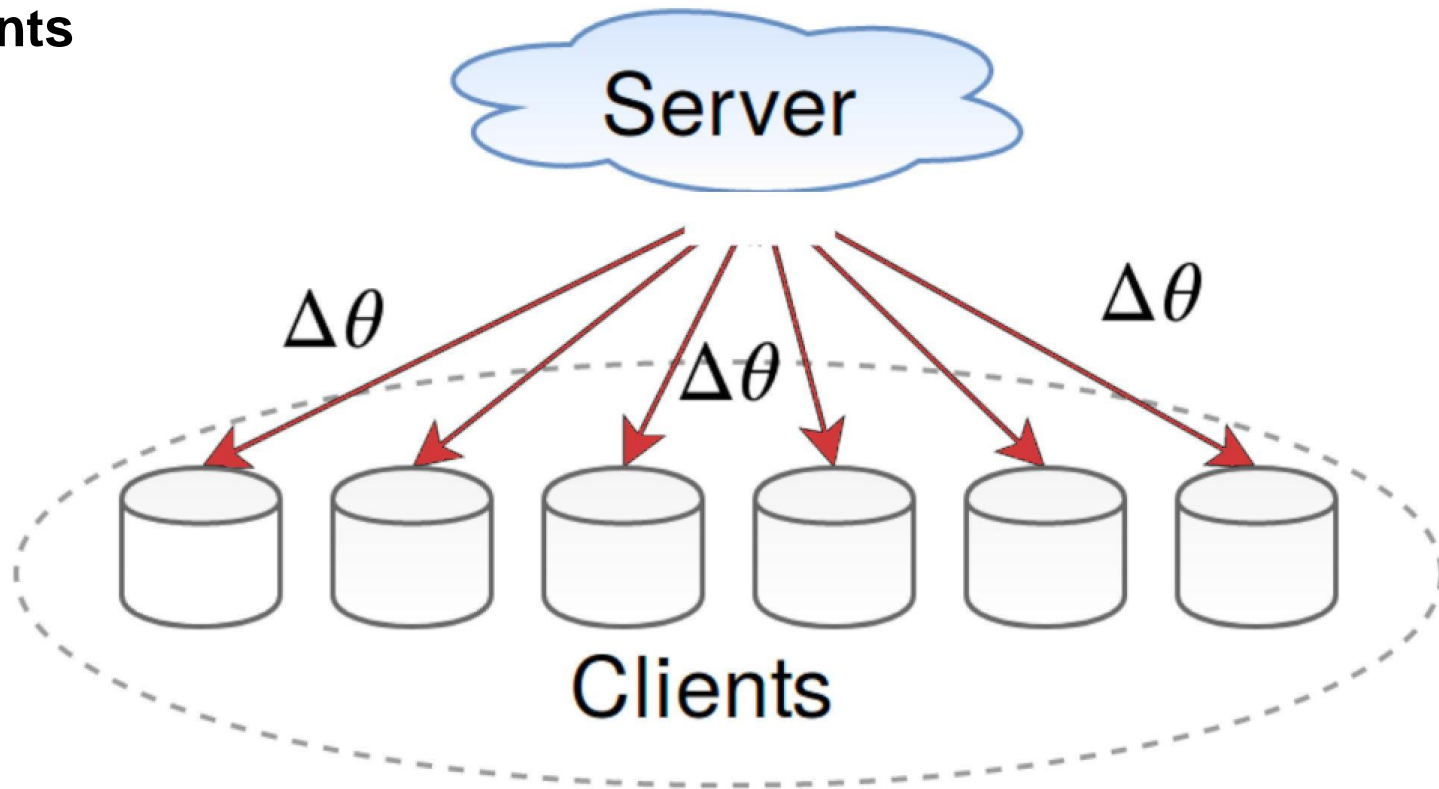


Latency constraints



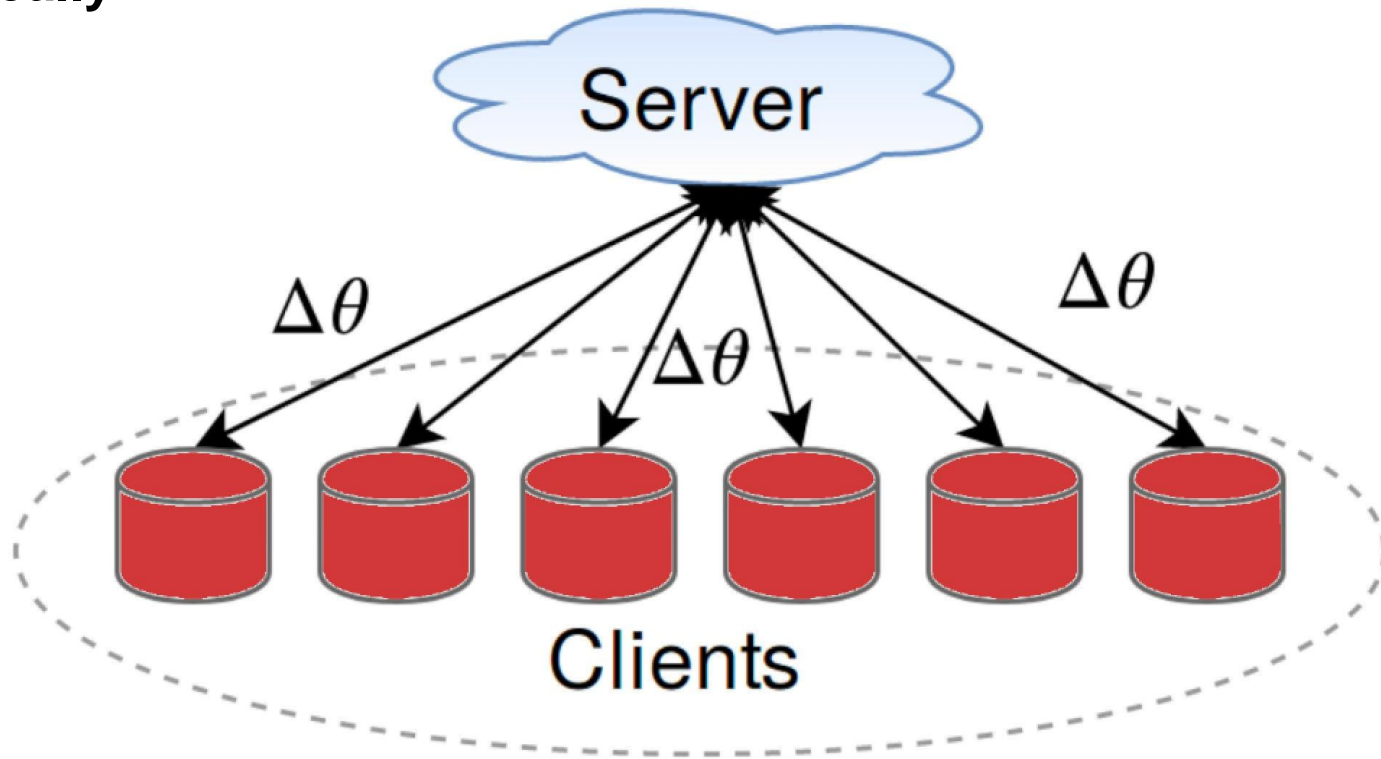
# Federated Learning (統合学習)

Send model  
to clients



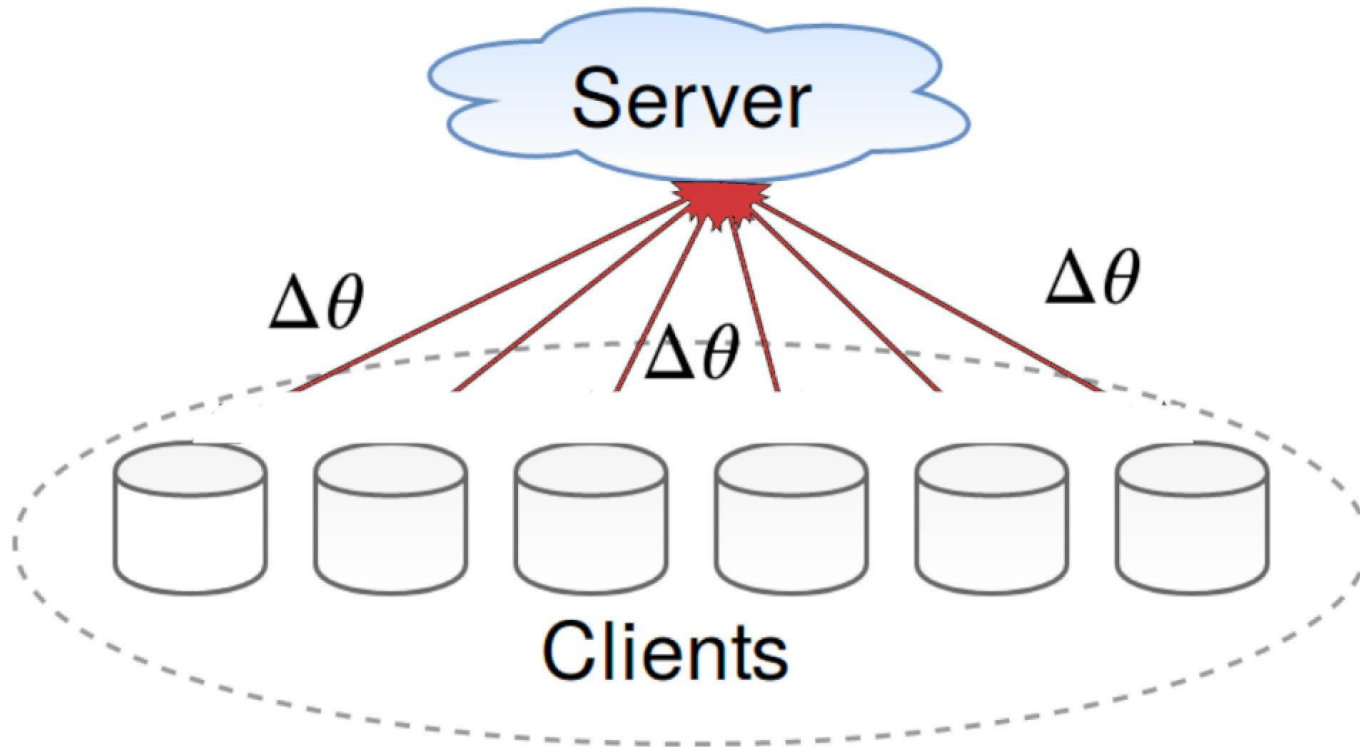
# Federated Learning (統合学習)

Train locally



# Federated Learning (統合学習)

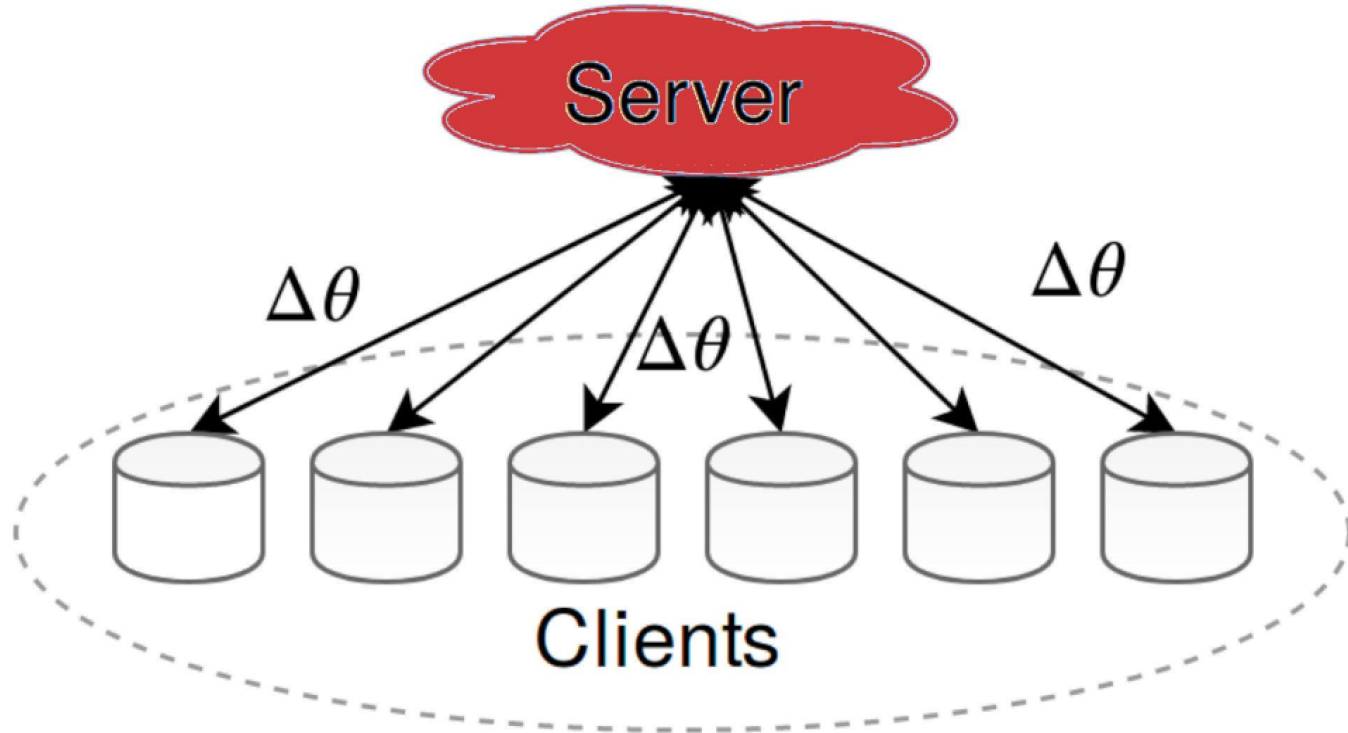
Send updates to  
server





# Federated Learning (統合学習)

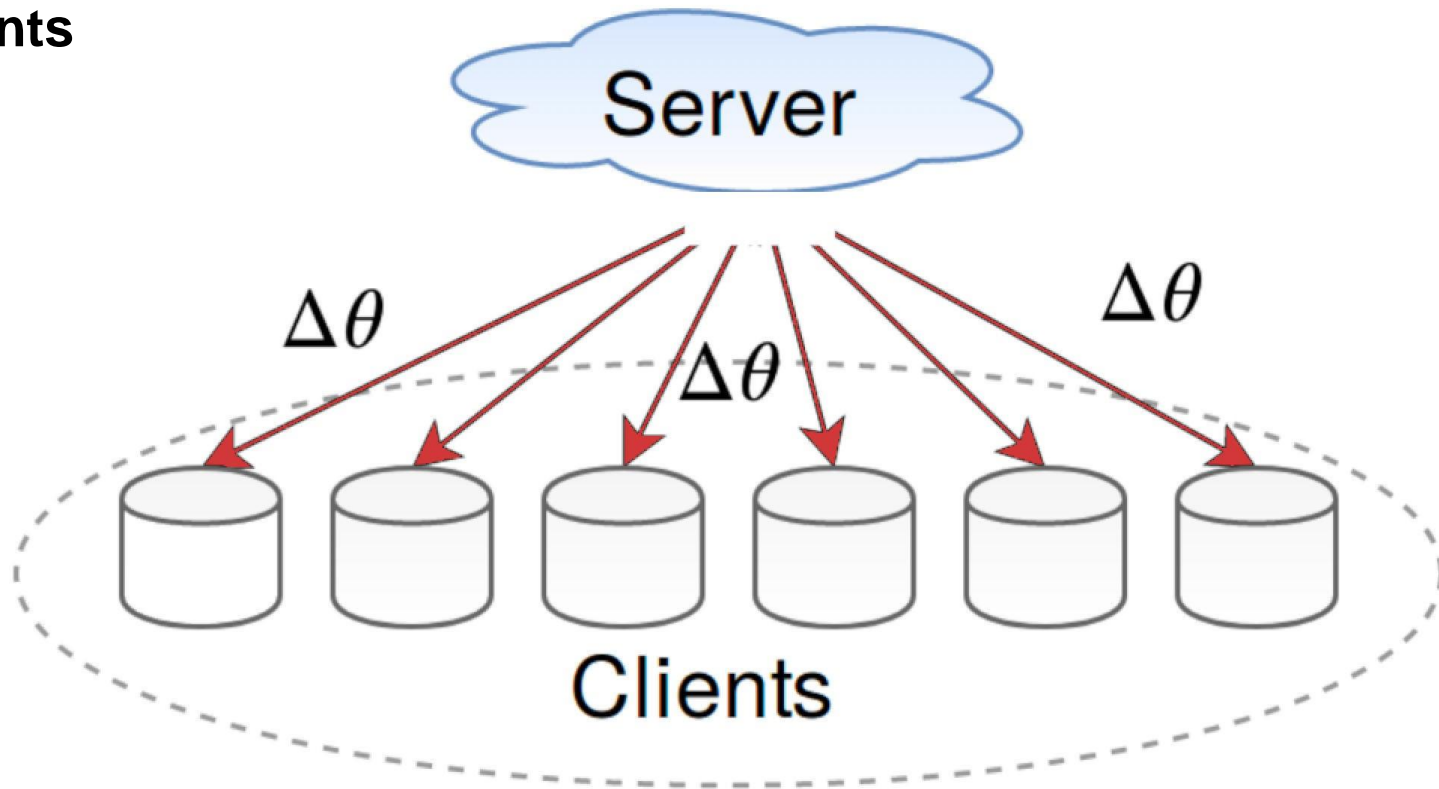
Update model





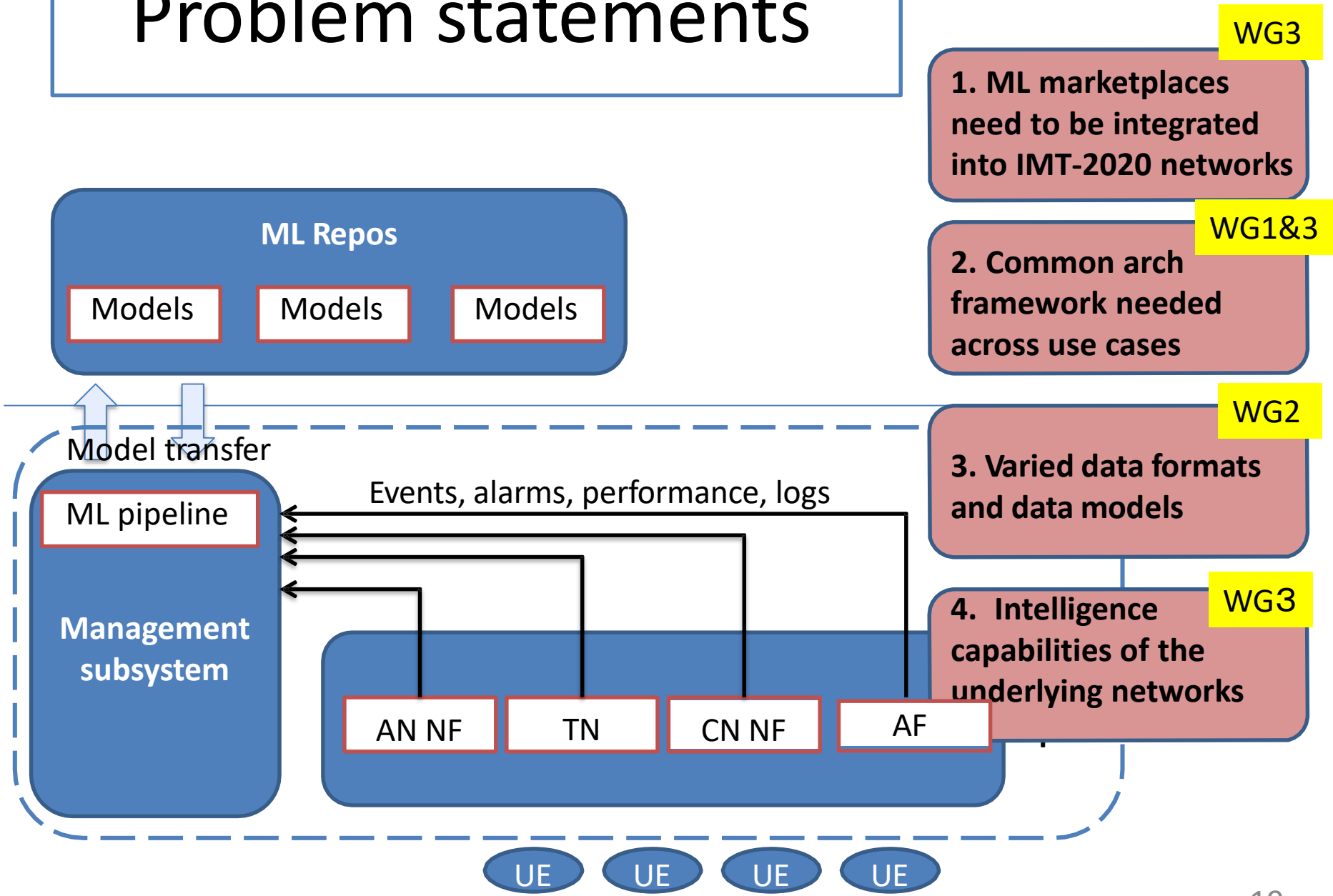
# Federated Learning (統合学習)

Send model  
to clients



# *ITU FG-ML5G WG Discussion*

# Problem statements



# WG1ユースケース議論から見えてきたポイント

- ・ 日本寄書をきっかけに、AIのユースケースの中で、ルールベースで且つ人間が介在する知識ベースの(エキスパート)システムと、大量のデータを必要とするMLシステムが混在した統合AIシステムについて、その重要性が認識された。

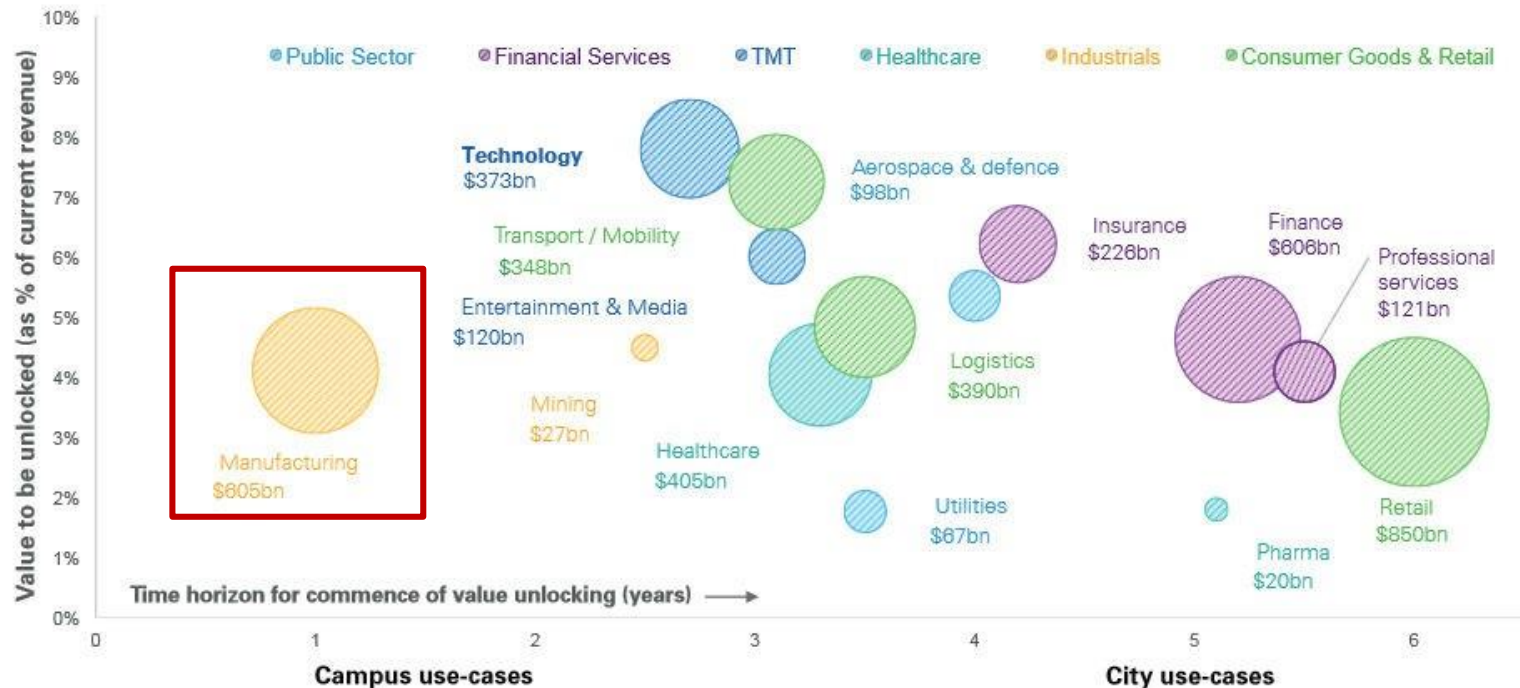
昨今のエキスパートシステムは、大量のデータを必要とするML(強いAI)より適している場合もあり、議長からは、I4.0(RAMI Model)へのAI適用可能性についても紹介された。

- ・ 目的が明確な場合、あるべき出力値から最適入力を決定するユースケース(予測の逆問題)は、特に創薬、生産効率化等でのML商用例の重要課題であるが、NW業界での共通認識は総じて高くない。

- ・ 次回会合以降のユースケースとして、議長からPrivate5GへのPoC参加提案があり、FGとしての対応を今後議論する。

# AI for Industrial 5G | Challenges and Opportunities

## Value to be Unlocked by 5G in Different Vertical Domains



Source: KPMG, "Unlocking the benefits of 5G for enterprise customers", 2019

CR/AEX1 - Andreas Mueller | 05 November 2019

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# AI for Industrial 5G | Challenges and Opportunities **Planned German National Research Project KICK**



## **KICK = Artificial Intelligence for Campus Communication**

### Major Objectives

- (1) AI-supported network management incl. suitable interfaces between production system and network management system
- (2) Consideration of short and medium time scales + transfer learning
- (3) Development & evaluation of hybrid approaches
- (4) Validation and experimental evaluation in real-world factory environment
- (5) Identification of standardization gaps

### Key Facts

- Jan 2020 – Dec 2022 (expected)
- Funding body: **BMBF**
- Total volume: ~9.5 Mio. € (costs)



**BOSCH**

**NOKIA**

atesio



**SIEMENS**

**TRUMPF**



**GHMT**

## WG2データ管理議論から見えてきたポイント

- ・ オペレータが保有するデータを第三者に提供する際のデータ共有のためのフレームワークとプライバシー要求条件についての寄書 (Y.3174)については、コメント対応後発行予定。
- ・ プライバシー問題の解として、市場では、Apple社は On-Device データ学習、Google社の Edgeとクラウドの組み合わせによる匿名化 Federation学習などのソリューションが出てきており GAP分析が必要。

## WG3アーキテクチャ議論から見えてきたポイント

- ・ MLパイプライン処理、MLFOという名のオーケストレータ、SandBox、OSS展開など、多岐にわたる活動が行われている。特定ベンダの標準化活動という観点に偏りすぎていないか要注視。

# ***ETSI ISG MEC*** ***(Multi-access Edge Computing)***

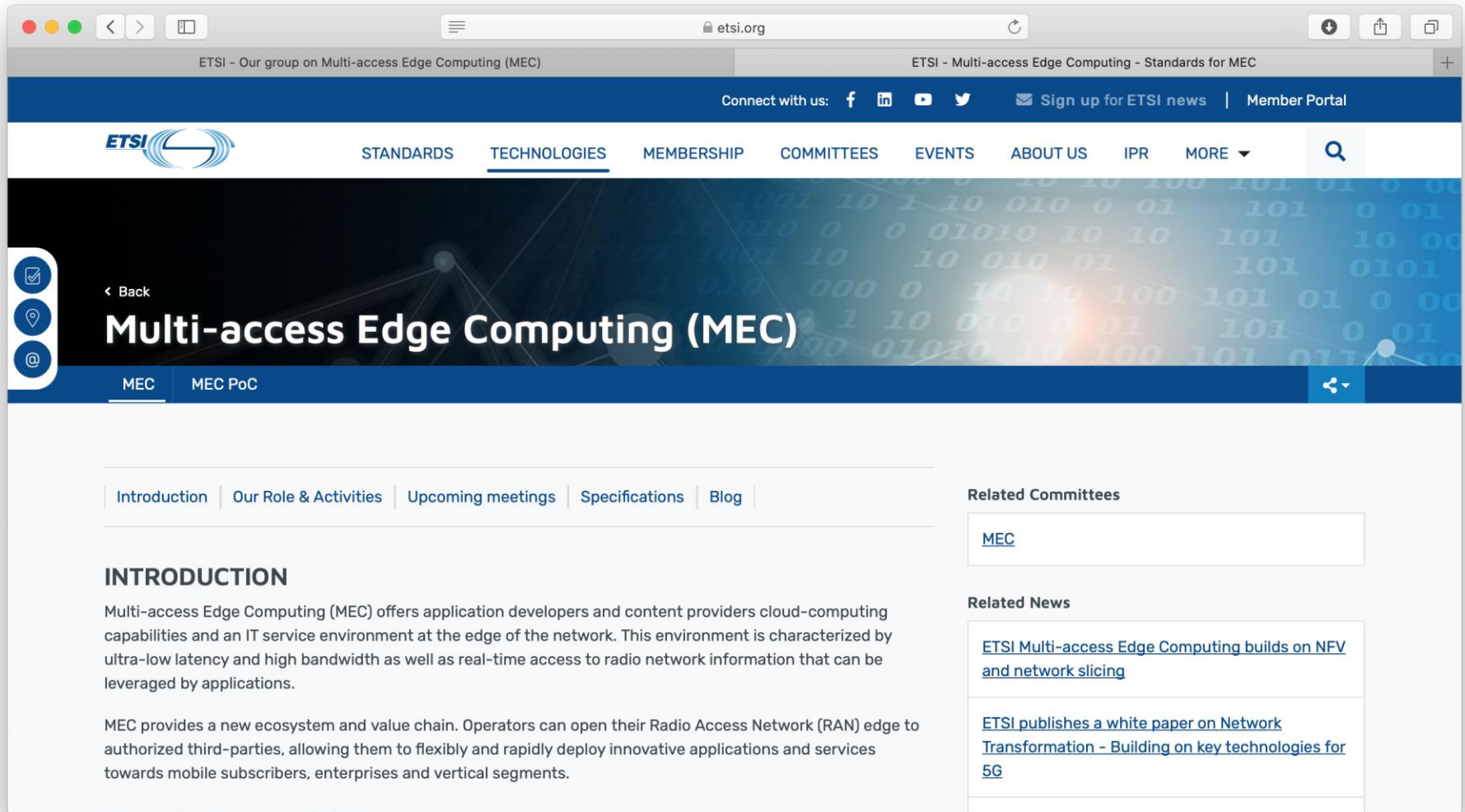
**MEC: Multi-access Edge Computing**

**MEC Decode: MEC Deployment and Ecosystem Development**



# ETSI ISG MEC

- 2014年10月SDN & OpenFlow World Congress (Dusseldorf) にて設立
- 2019/9/10-13の第19回会合, 11/12-15の第20回会合に出席
- 2020/12/8-11の第24回会合は東京で開催決定



The screenshot shows the ETSI website for Multi-access Edge Computing (MEC). The browser address bar displays [etsi.org](https://www.etsi.org). The page title is "ETSI - Multi-access Edge Computing - Standards for MEC". The navigation menu includes: STANDARDS, TECHNOLOGIES (selected), MEMBERSHIP, COMMITTEES, EVENTS, ABOUT US, IPR, and MORE. The main content area features a large header with the text "Multi-access Edge Computing (MEC)" and a sub-header "MEC". Below the header, there is a navigation bar with "MEC" and "MEC PoC". The main content area has a navigation menu with "Introduction", "Our Role & Activities", "Upcoming meetings", "Specifications", and "Blog". The "Introduction" section is expanded, showing the following text:

**INTRODUCTION**

Multi-access Edge Computing (MEC) offers application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network. This environment is characterized by ultra-low latency and high bandwidth as well as real-time access to radio network information that can be leveraged by applications.

MEC provides a new ecosystem and value chain. Operators can open their Radio Access Network (RAN) edge to authorized third-parties, allowing them to flexibly and rapidly deploy innovative applications and services towards mobile subscribers, enterprises and vertical segments.

Related Committees

- [MEC](#)

Related News

- [ETSI Multi-access Edge Computing builds on NFV and network slicing](#)
- [ETSI publishes a white paper on Network Transformation - Building on key technologies for 5G](#)

<https://www.etsi.org/technologies/multi-access-edge-computing>

# 先進MNO向けのETSIプロジェクト

- NFV (Network Functions Virtualization)
- MEC (Multi-access Edge Computing)

## 現研究チームでのMEC標準化のフォーカス:

- MEC-in-NFV reference architecture

## MEC標準化ターゲットの変化:

- セルラーからエッジクラウドへ

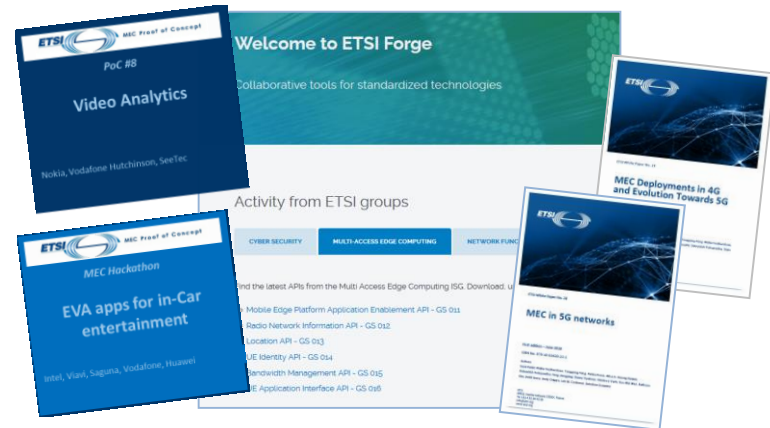
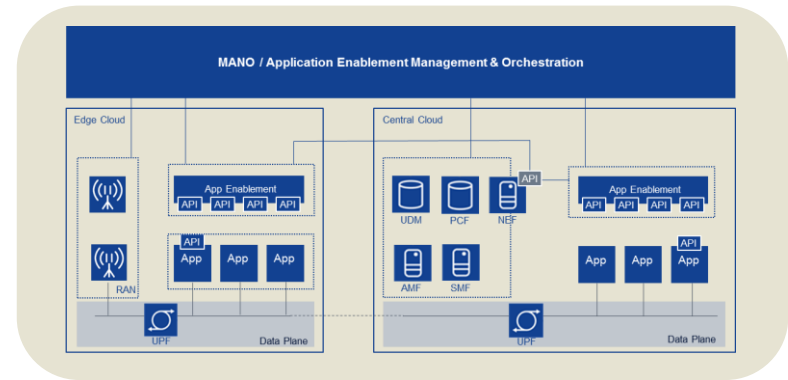
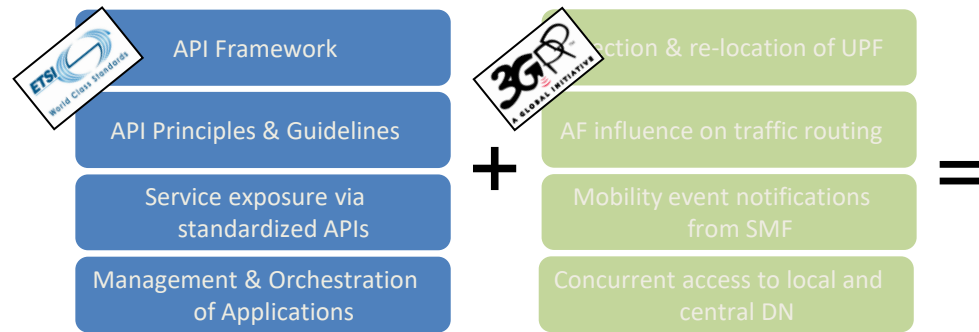
Computing and Connectivity for a given location.

- APIを提供するためにMECアーキテクチャ再構築  
APIを優先開発して産業界への早期導入を促進

# ETSI MECの概要

Foundation for Edge Computing created

– Fully standardized solution to enable applications in distributed cloud created by ETSI MEC + 3GPP

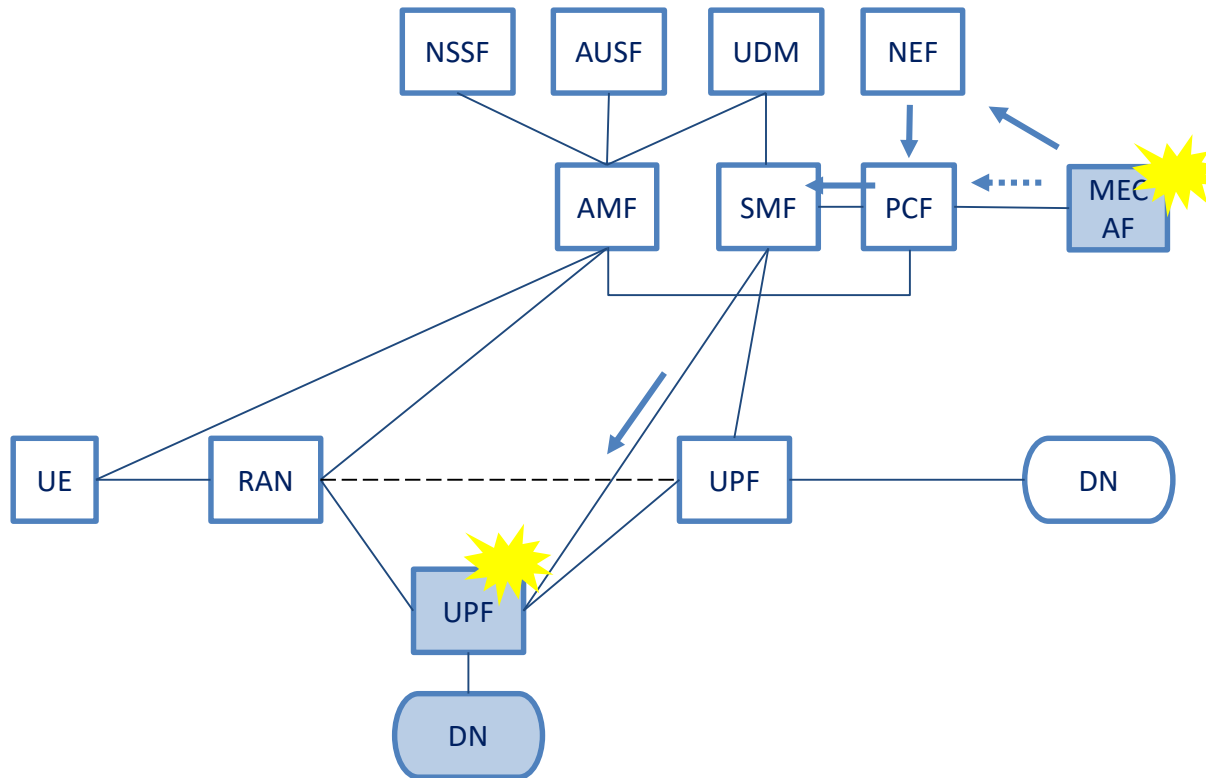


82 members - Operators – Technology Vendors – IT players – Application developers



# 3GPP enablers for MEC

## – Selection & re-location of UPF

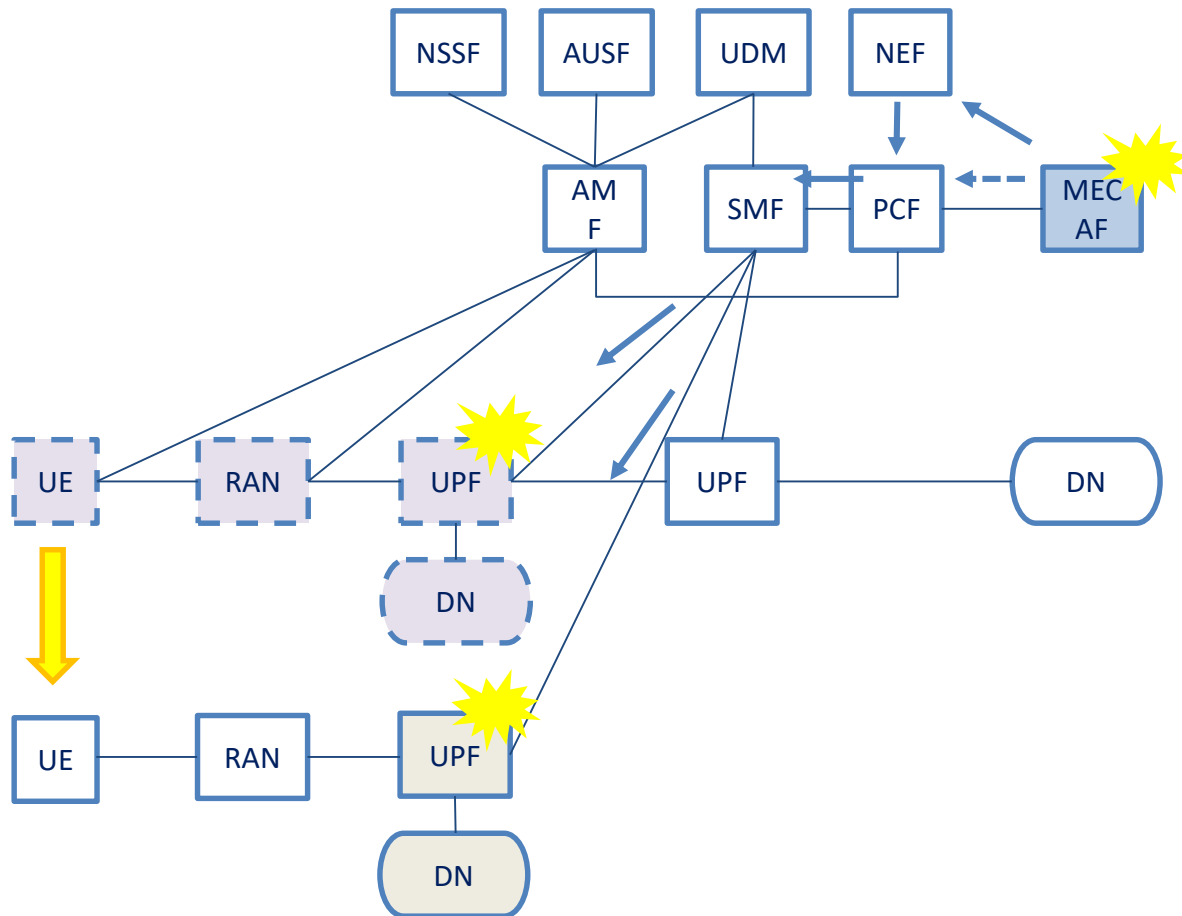


MEC as an AF (Application Function) can request the 5GC to

- Select a local UPF near the target (R)AN node
- use the local UPF for PDU sessions of the target UE(s)
- control the traffic forwarding from the local UPF so that the UL traffic matching with the traffic filters received from MEC (AF) is diverted towards MEC hosts while other traffic is sent to the Central Cloud

# 3GPP enablers for MEC

## – Selection & re-location of UPF

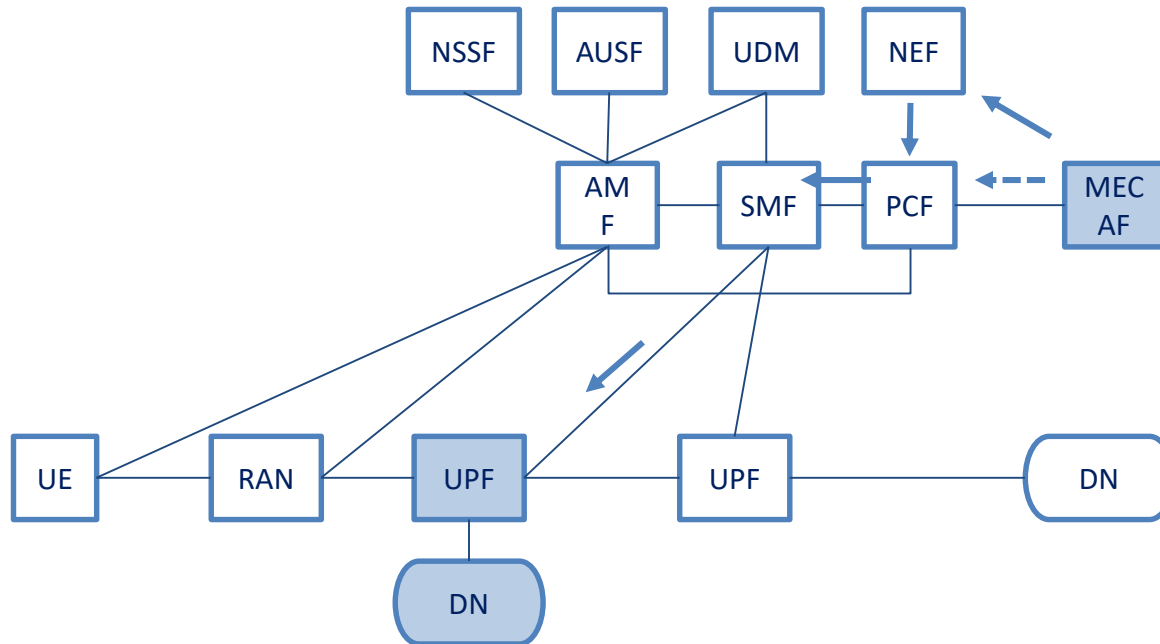


In case of UE mobility, the 5GC can

- re-select a new local UPF more suitable to handle application traffic identified by MEC (AF)
- notify the AF about the new serving UPF

# 3GPP enablers for MEC

## – AF influence on traffic routing

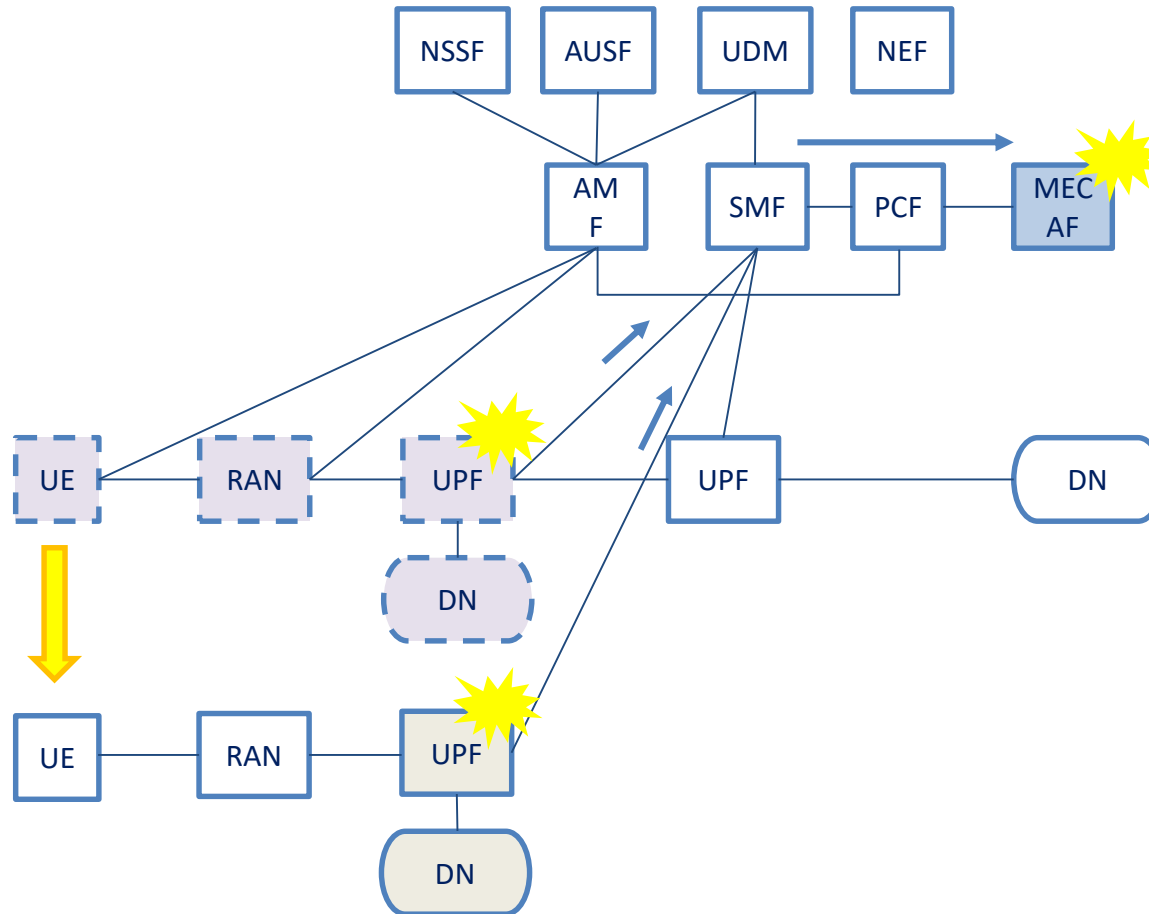


MEC as an AF can provide the following to 5GC

- traffic filters identifying MEC applications deployed locally on MEC hosts in Edge Cloud
- the target UEs (one UE identified by its IP/MAC address, a group of UE, any UE)
- information about forwarding the identified traffic further e.g. references to tunnels towards MEC hosts

# 3GPP enablers for MEC

## – Mobility event notifications



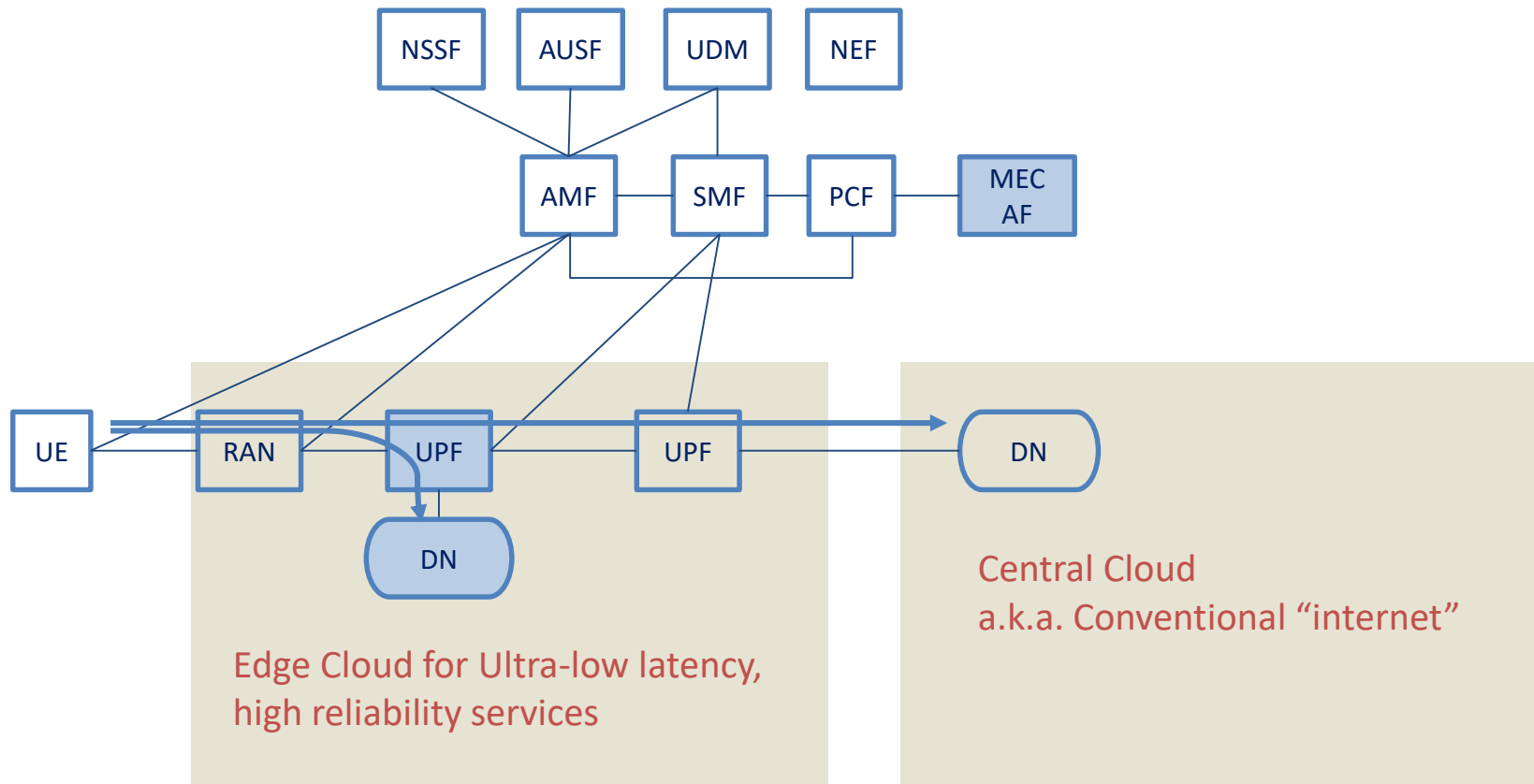
5GC allows MEC as an AF

- subscribe to UE mobility events that may affect traffic forwarding to MEC applications

- Receive notifications of UE mobility events affecting MEC application instances<sup>31</sup>

# 3GPP enablers for MEC

## – Concurrent access to local and central DN



MEC as an UPF can provide the following to UE

- Same UP session allows the UE to obtain content both from local server and central server
- Service continuity enabled by IP address anchoring at the centralized UPF.
- No impact on UE in case of Uplink Classifier (ULCL) option is used.



# MEC White Papers



## Standards are necessarily tools, not solutions

- Enable interoperability
- Support a broad range of use cases and system architecture
- Address only a specific part of the whole picture

- Network Transformation;(Orchestration, Network and Service Management Framework) (October 2019)  
[https://www.etsi.org/images/files/ETSIWhitePapers/ETSI\\_White\\_Paper\\_Network\\_Transformation\\_2019\\_N32.pdf](https://www.etsi.org/images/files/ETSIWhitePapers/ETSI_White_Paper_Network_Transformation_2019_N32.pdf)

- Developing Software for Multi-Access Edge Computing (2<sup>nd</sup> edition - February 2019)  
[http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp20ed2\\_MEC\\_SoftwareDevelopment.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp20ed2_MEC_SoftwareDevelopment.pdf)

- MEC in an Enterprise Setting (September 2018)  
[https://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp30\\_MEC\\_Enterprise\\_FINAL.pdf](https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp30_MEC_Enterprise_FINAL.pdf)

- MEC in 5G Networks (June 2018)  
[http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp28\\_mec\\_in\\_5G\\_FINAL.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp28_mec_in_5G_FINAL.pdf)

- MEC deployment in 4G and towards 5G (February 2018)  
[http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp24\\_MEC\\_deployment\\_in\\_4G\\_5G\\_FINAL.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp24_MEC_deployment_in_4G_5G_FINAL.pdf)

- CRAN and MEC: A Perfect Pairing (February 2018)  
[http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp23\\_MEC\\_and\\_CRAN\\_ed1\\_FINAL.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp23_MEC_and_CRAN_ed1_FINAL.pdf)

- Mobile Edge Computing: A key technology towards 5G (First Edition - September 2015)  
[http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp20\\_MEC\\_SoftwareDevelopment\\_FINAL.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp20_MEC_SoftwareDevelopment_FINAL.pdf)

# MEC WGの主要ワークアイテム (2020.1)

Work Item	Title ( Multi-access Edge Computing (MEC) は省略)
GS MEC 001	Terminology
GS MEC 002	Phase 2: Use Cases and Requirements
GS MEC 003	Framework and Reference Architecture
GS MEC 005	Proof of Concept Framework
GS MEC 009	General principles for Mobile Edge Service APIs
GS MEC 010	Mobile Edge Management; Part 1: System, host and platform management
GS MEC 011	Mobile Edge Platform Application Enablement
GS MEC 012	Radio Network Information API
GS MEC 013	Location API *** Civic location or Geographical location ***
GS MEC 014	UE Identity API
GS MEC 015	Bandwidth Management API
GS MEC 016	UE application interface
GS MEC 021	Application Mobility Service API
GS MEC 028	WLAN Information API
GS MEC 030	V2X Information Service API
GR MEC 031	MEC 5G Integration ***NSA is not in the scope of MEC 031***
GS MEC 033	IoT API

# まとめ

# まとめ

ITU-Tの会員資格がなくても、FGへの参加は可能。  
Workshopでの多種多様な専門家による、最新のML技術の社会実装、最新のAI関連のOSS動向や学生によるPoC等の、オープンイノベーション活動を知る良い機会として活用させて頂いた。

## ⌘ 機械学習(ML/AI)のネットワーク領域(5G and beyond)適用の動向

WG1: AI for NW からNW by AIへのパラダイムシフトの兆候

- ✓ ユースケースについてはほぼ収束
- ✓ Private5GユースケースへのAI適用PoCが次の議題に

WG2: ビッグデータの第三者活用スキーム

- ✓ データ共有方法に関してはFederated Learningなどの匿名化が鍵

WG3: MLモデル取引市場

- ✓ ML/AI実装におけるNWアーキテクチャ変革とビジネス展開の同期が鍵

## ⌘ FG-ML5Gへの日本対応

✓ E2Eネットワーク管理の運用・管理や、エッジAIを対象する

ユースケースに関する日本（事業者・ベンダ）からの寄書の継続提案

✓ ML/AI導入の基盤技術としてネットワークソフトウェア化の継続提案 36