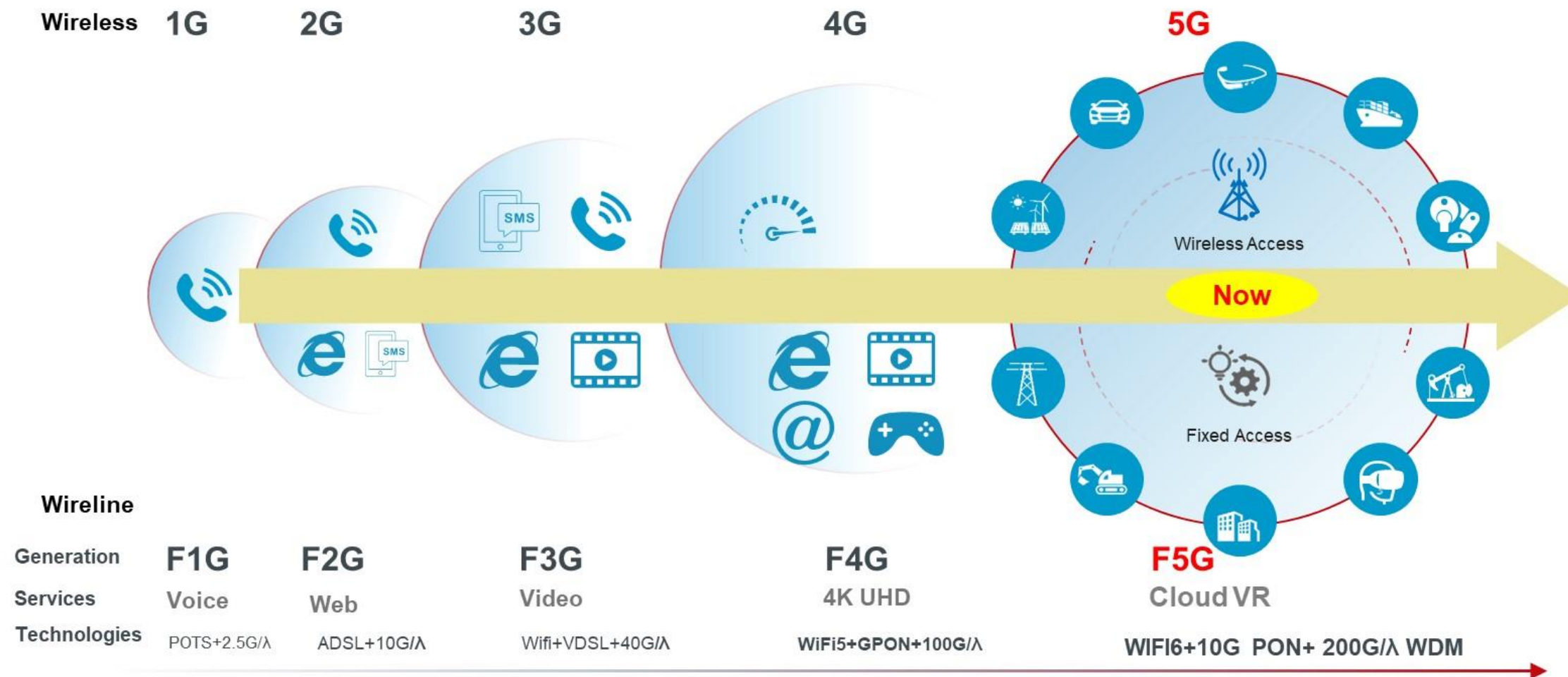# All-Optical Networks Enabled by ISG F5G

Presented by: Xiang Liu, Fellow of IEEE and OPTICA

NGON & DCI 2022, June 21, 2022, Barcelona, Spain

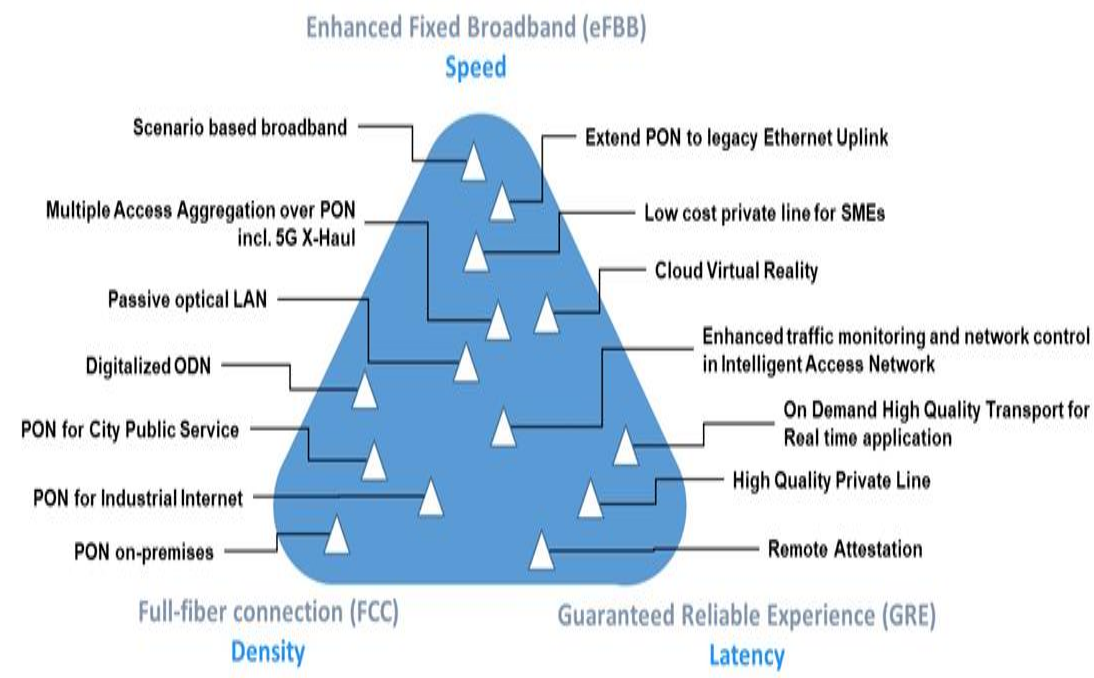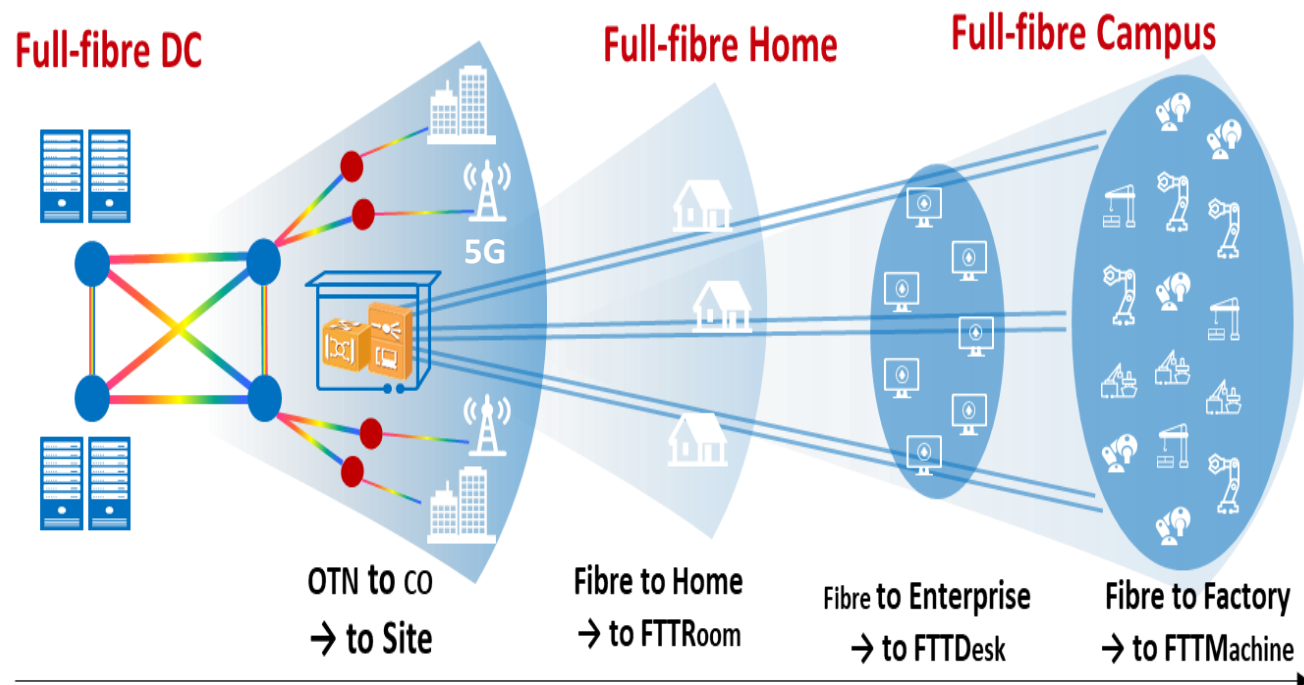# The 5th-Generation Fixed Network (F5G)

Generations definition: F5G together with 5G to build the new digital world

# The F5G Vision: Fiber to Everywhere & Everything

Fiber connectivity is becoming ubiquitous, extending from last "mile" to last "meter"

F5G enables many new use cases, expanding the application space of 5G

Full-fibre DC   **Full-fibre Home**   **Full-fibre Campus**

5G

OTN to CO
→ to Site

Fibre to Home
→ to FTTRoom

Fibre to Enterprise
→ to FTTDesk

Fibre to Factory
→ to FTTMachine

Enhanced Fixed Broadband (eFBB)
Speed

Scenario based broadband

Multiple Access Aggregation over PON incl. 5G X-Haul

Passive optical LAN

Digitalized ODN

PON for City Public Service

PON for Industrial Internet

PON on-premises

Extend PON to legacy Ethernet Uplink

Low cost private line for SMEs

Cloud Virtual Reality

Enhanced traffic monitoring and network control in Intelligent Access Network

On Demand High Quality Transport for Real time application

High Quality Private Line

Remote Attestation

Full-fiber connection (FCC)
Density

Guaranteed Reliable Experience (GRE)
Latency

References: https://www.etsi.org/committee/f5g; https://www.etsi.org/deliver/etsi_gr/F5G/001_099/002/01.01.01_60/gr_F5G002v010101p.pdf (Released in February 2021).

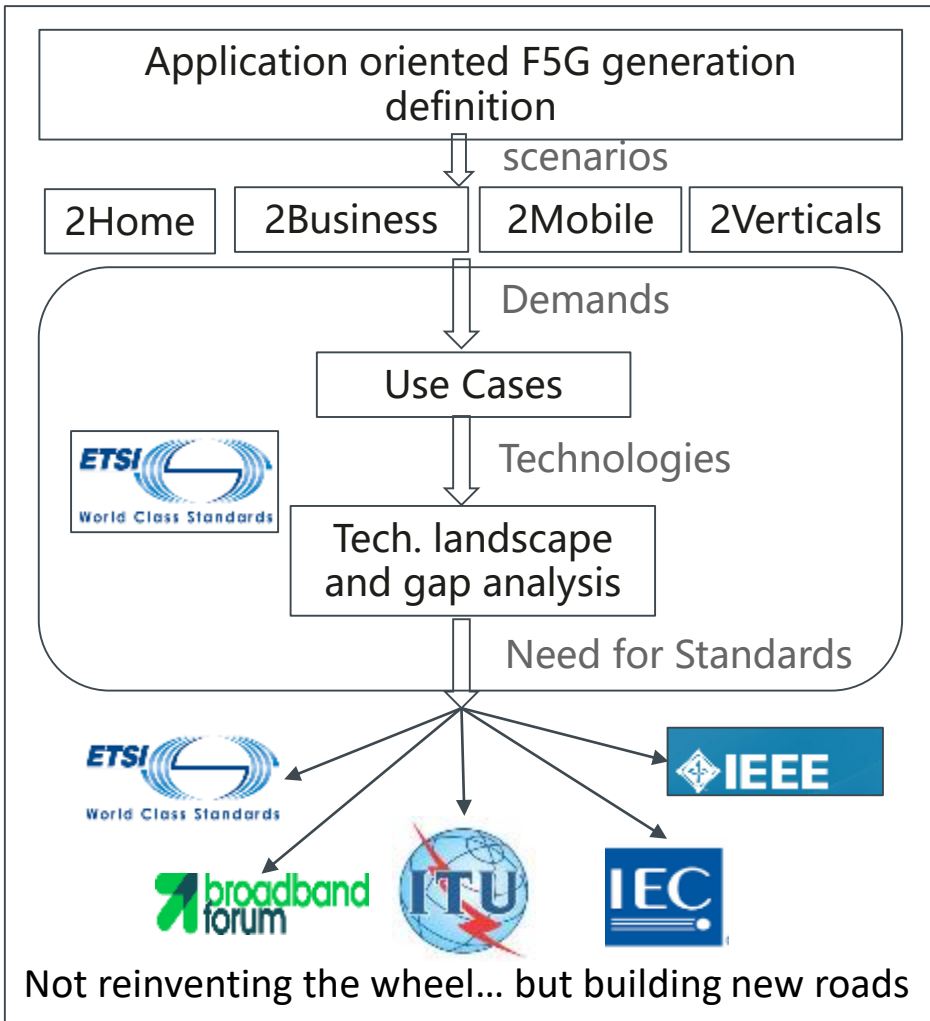# F5G's broad scope and cooperation with other SDOs
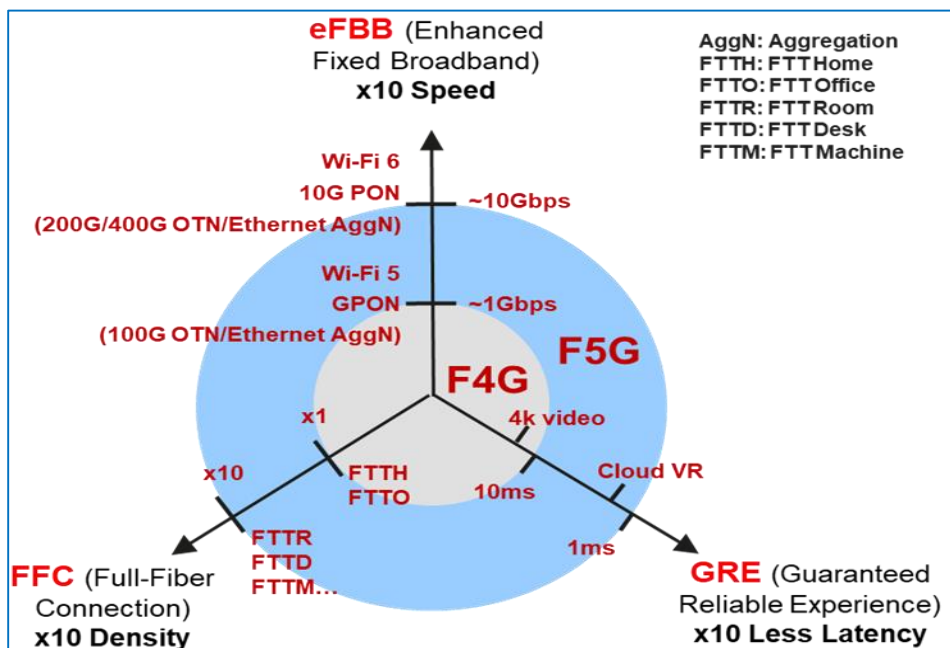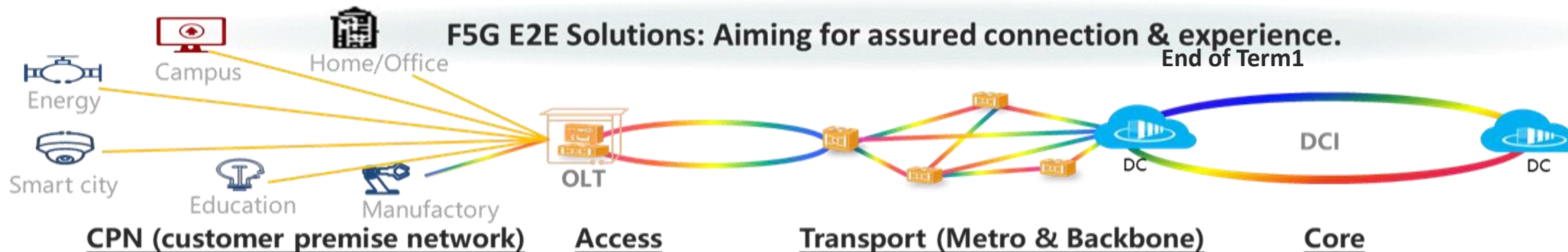
F5G focuses on end-to-end (E2E) network solutions for assured service connection & experience, and cooperates with other standards development organizations (SDOs) on topics such as

- FTTR/FTTH
- Optical access and aggregation
- Core network
- DCI network and optics
- Optical transport network
- Network control & management (C&M) ...

Value proposition of ISG F5G and synergy with other SDOs

ISG F5G as Hub

Application oriented F5G generation definition

scenarios

| 2Home | 2Business | 2Mobile | 2Verticals |

Demands

Use Cases

Technologies

Tech. landscape and gap analysis

Need for Standards

ETSI World Class Standards

IEEE

broadband forum

ITU

IEC

Not reinventing the wheel… but building new roads

ITU Webinars

Joint ITU-T SG15, ETSI ISG F5G, CCSA TC6 and BBF Workshop on:

Fibre-to-The-Room (FTTR)

14 June 2021
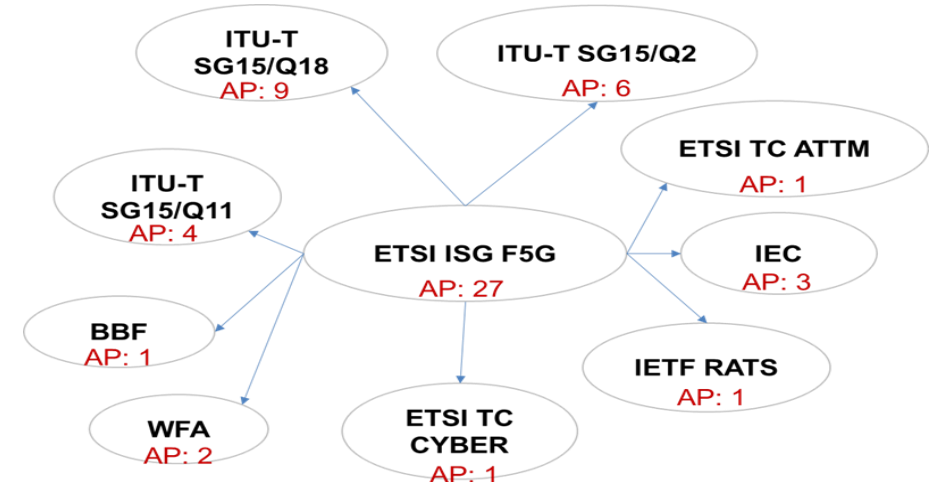14:00 – 18:00 CEST

https://itu.int/go/FTTR

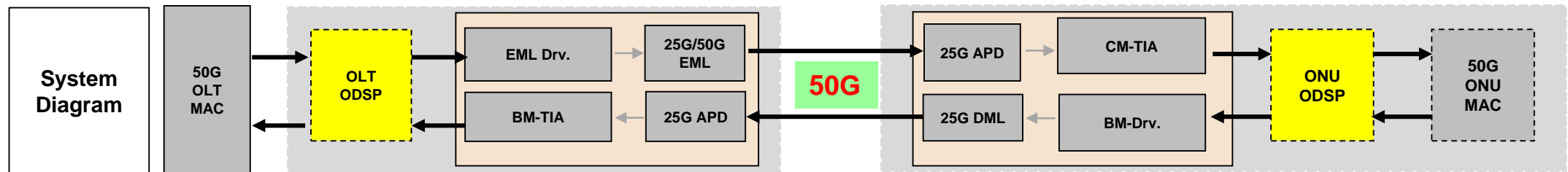Example 1: 4-party (ETSI, ITU, CCSA and BBF) joint workshop dedicated to FTTR (on June 14, 2021)

Example 2: 55 Liaison letters have been sent out from F5G to other SDOs for synergy

Co-organized by: broadband forum   CCSA   ETSI   ITU

ITU-T SG15/Q18
AP: 9

ITU-T SG15/Q2
AP: 6

ETSI TC ATTM
AP: 1

ITU-T SG15/Q11
AP: 4

ETSI ISG F5G
AP: 27

IEC
AP: 3

BBF
AP: 1

IETF RATS
AP: 1

WFA
AP: 2

ETSI TC CYBER
AP: 1

Optical Access: 50G PON standards progress

ETSI

Standard Progress

Research — 2016
Standard started — 2018.2
Requirement Standard released — 2019.7
technical standard consented — 2021.4
50G PON standard approved — **2021.9.6**
Amendment: 50G symmetric Low Latency

50G TDM-PON

Source： 50G PON Architecture based on ITU-T G.9804.1

50G PON OLT

50G Tx — 1340-1344

50G/25G/12.5G Triple rate Rx — 1290-1310

50Gb/s →

← 50G/25G/12.5Gb/s

(TDM)

50G/12.5G ONU

50G/25G ONU

50G/50G ONU

System Diagram

50G OLT MAC → OLT ODSP → EML Drv. → 25G/50G EML → **50G** → 25G APD → CM-TIA → ONU ODSP → 50G ONU MAC

BM-TIA ← 25G APD ← 25G DML ← BM-Drv.

System Architecture: first introduction of optical DSP for performance improvements

© ETSI

Beyond 400G standards progress
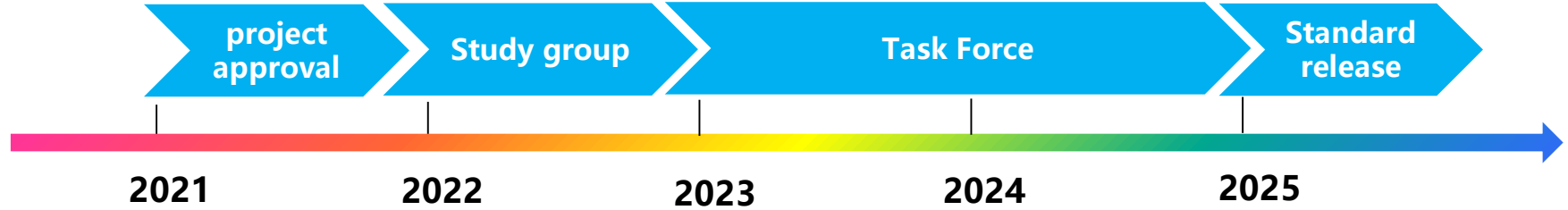
IEEE P802.3df working items

Ethernet Rate	Assumed Signaling Rate	AUI	BP	Cu Cable	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
200 Gb/s	200 Gb/s	Over 1 lane		Over 1 pair			Over 1 Pair	Over 1 Pair		
400 Gb/s	200 Gb/s	Over 2 lanes		Over 2 pairs			Over 2 Pair			
800 Gb/s	100 Gb/s	Over 8 lanes	Over 8 lanes	Over 8 pairs	Over 8 pairs	Over 8 pairs	Over 8 pairs	Over 8 pairs		
	200 Gb/s	Over 4 lanes		Over 4 pairs			Over 4 pairs	1) Over 4 pairs 2) Over 4 λ's		
	TBD								Over single SMF in each direction	Over single SMF in each direction
1.6 Tb/s	100 Gb/s	Over 16 lanes								
	200 Gb/s	Over 8 lanes		Over 8 pairs			Over 8 pairs	Over 8 pairs		

- Leverage existing or work-in-progress 100 Gb/s per lane (e.g. 3cu, 3ck, 3db) to higher lane counts
- Develop 200 Gb/s per lane electrical signaling for 1/2/4/8 lane variants of AUIs and electrical PMDs
- Develop 200 Gb/s per optical fiber for 1/2/4/8 fiber based optical PMDs and 4 lambda WDM optical PMD
- Potential for either direct detect and / or coherent signaling technology
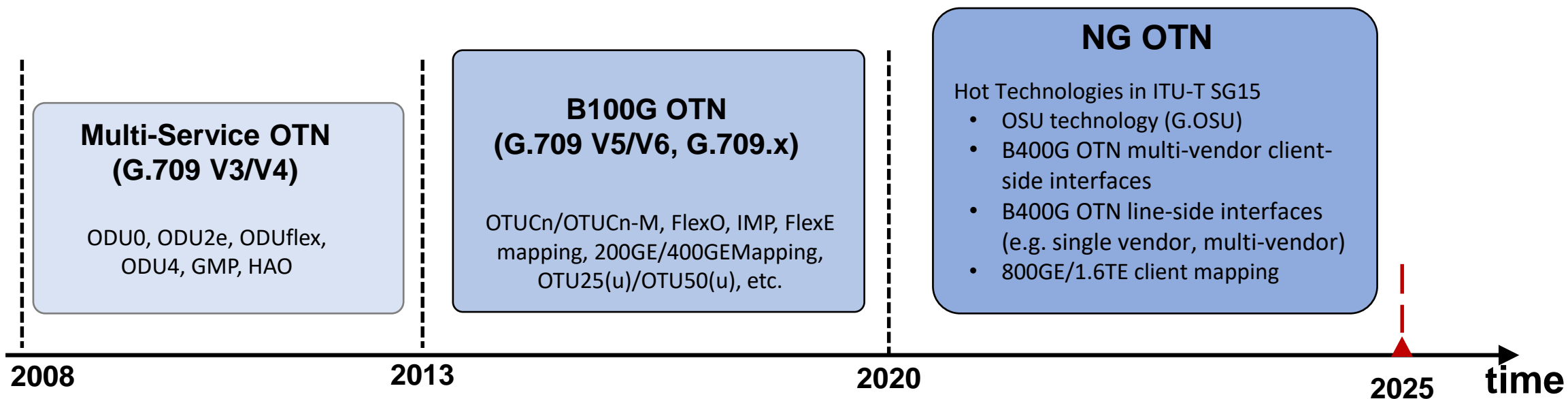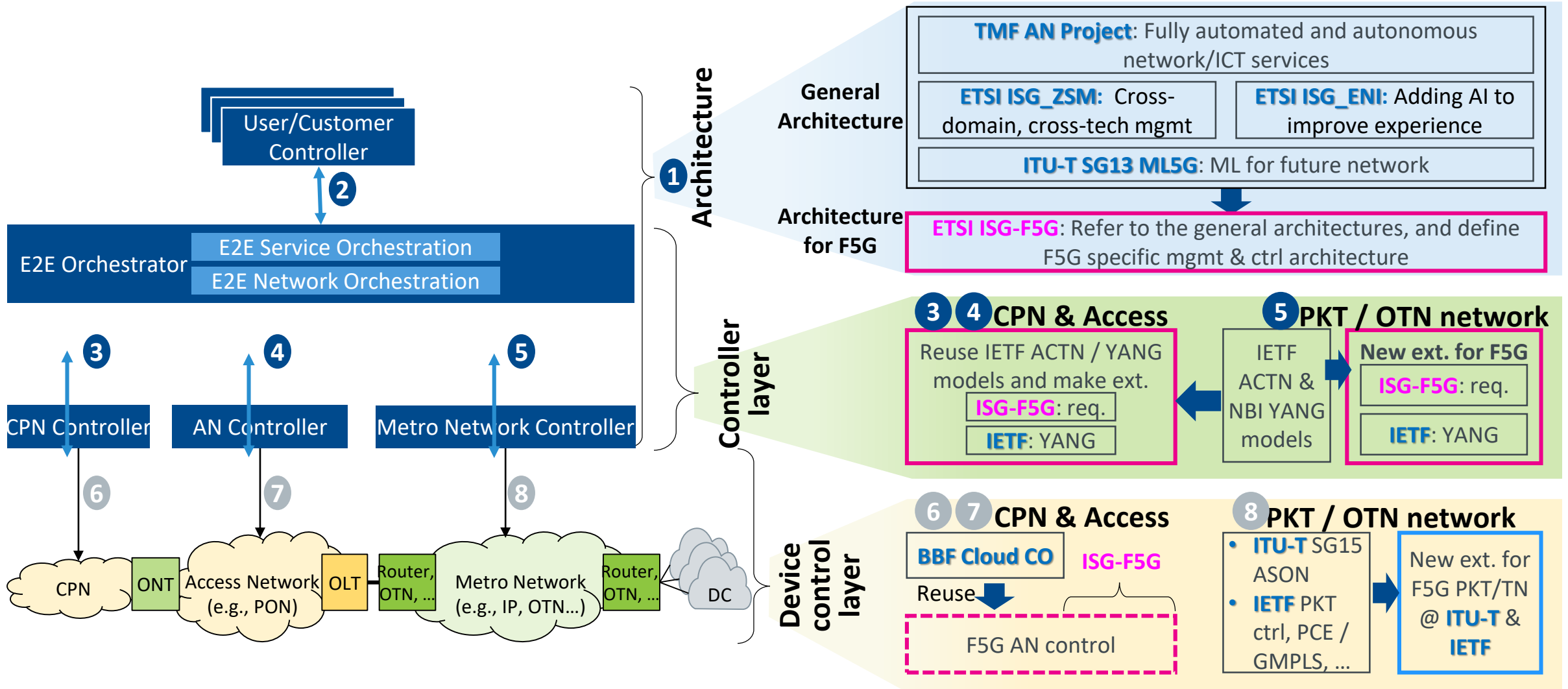
OTN standards progress

OTN Tech.

| MS OTN (100G OTU4,GMP) | B100G OTN (OTUCn, 100G/200G/400G FlexO) | G.OSU (developing) | Expecting release 2023.07 |
| | | B400G OTN (800G, 1.6T) | |

<2020   **2023**   **2026**

Multi-Service OTN (G.709 V3/V4)

ODU0, ODU2e, ODUflex, ODU4, GMP, HAO

B100G OTN (G.709 V5/V6, G.709.x)

OTUCn/OTUCn-M, FlexO, IMP, FlexE mapping, 200GE/400GEMapping, OTU25(u)/OTU50(u), etc.

NG OTN

Hot Technologies in ITU-T SG15
- OSU technology (G.OSU)
- B400G OTN multi-vendor client-side interfaces
- B400G OTN line-side interfaces (e.g. single vendor, multi-vendor)
- 800GE/1.6TE client mapping

2008   **2013**   **2020**   **2025**   **time**
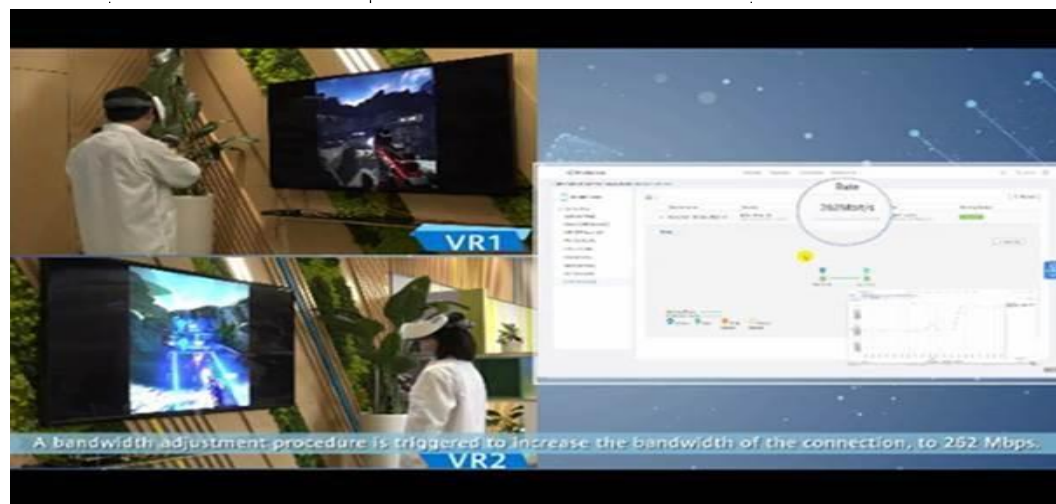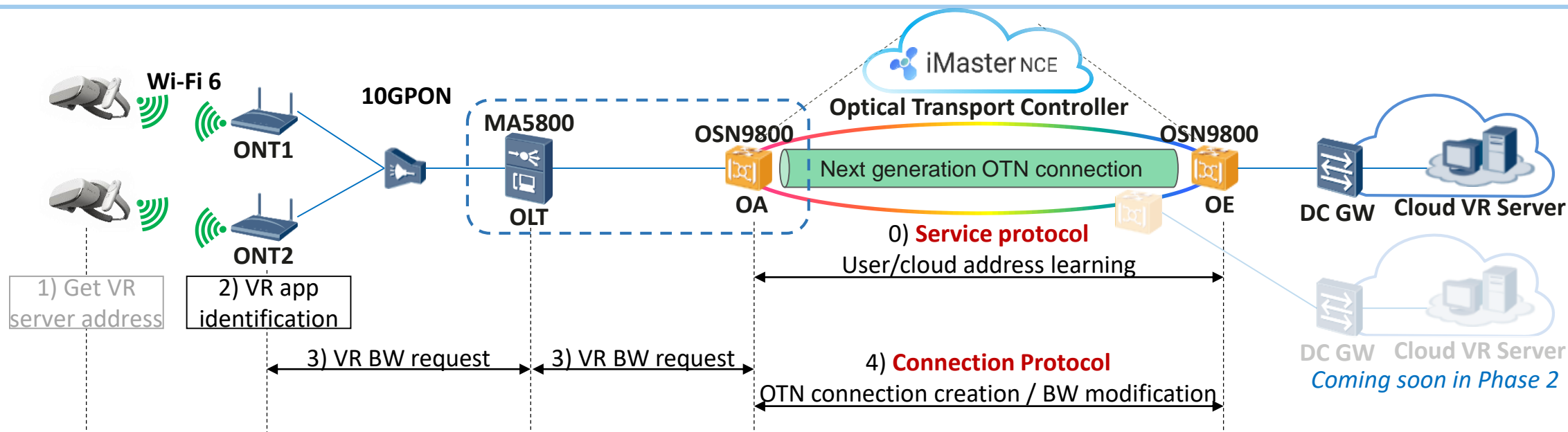
Standards coordination for autonomous networking (AN)

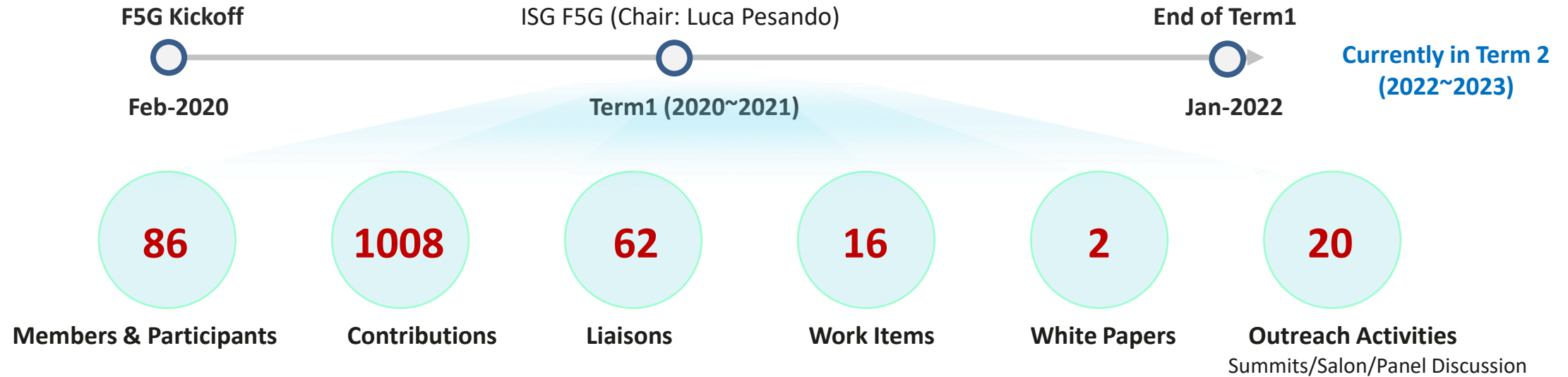# F5G proof-of-concept (PoC) demonstration on Cloud-VR

Recently, a PoC demonstration under the scope of the ETSI ISG-F5G has been conducted by Huawei, China Mobile and BUPT, showing real-time cloud-VR with agile (second-level) service creation/deletion and fine (~2 Mb/s) service bandwidth adjustment over an E2E F5G network consisting of CPN, AN, AggN and CN [1].

[1] Reported at the F5G Workshop at OFC 2022.
https://www.ofcconference.org/en-us/home/exhibition-and-show-floor-programs/industry-programs/f5g-update-emerging-use-cases-and-demonstrations/

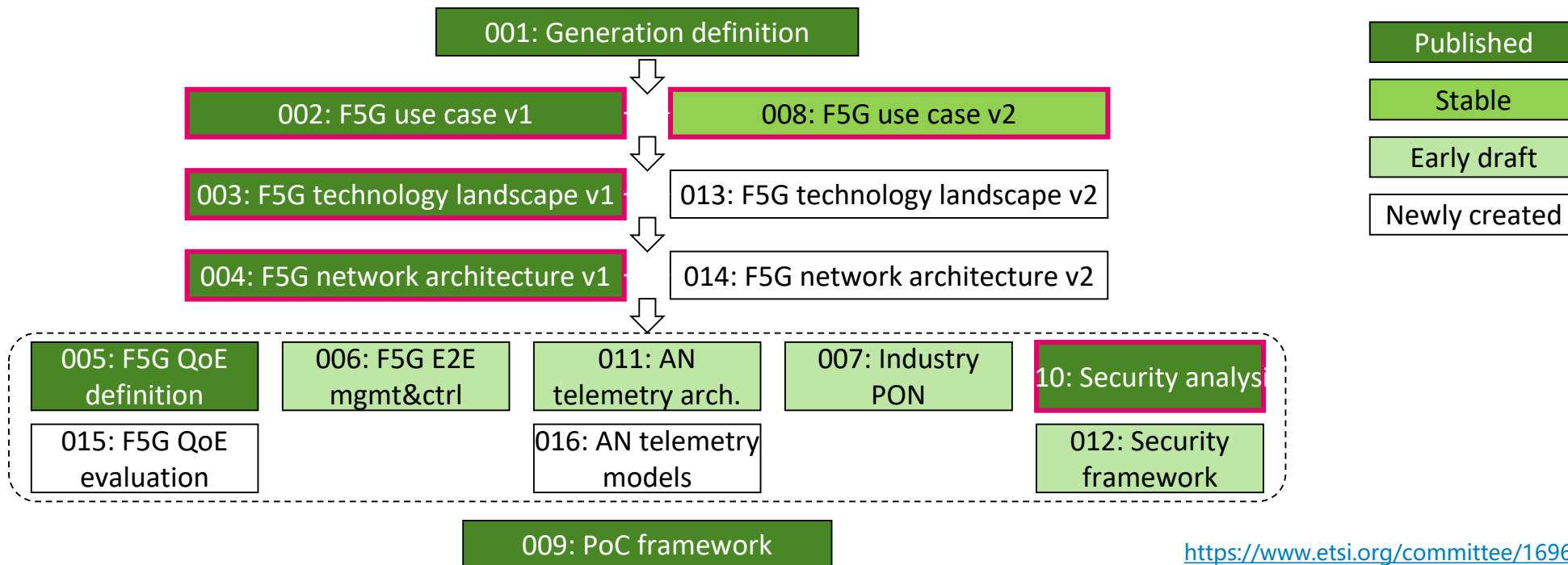# Achievements of ISG F5G of ETSI since its creation in 2020

F5G Kickoff

ISG F5G (Chair: Luca Pesando)

End of Term1

Currently in Term 2 (2022~2023)

Feb-2020

Term1 (2020~2021)

Jan-2022

86	1008	62	16	2	20
Members & Participants	**Contributions**	**Liaisons**	**Work Items**	**White Papers**	**Outreach Activities** Summits/Salon/Panel Discussion

ISG F5G becomes visible and recognizable

Coverage

- OFC
- ECOC
- ACP
- OECC
- OSA
- BBWF
- NGON &DCI
- ETSI Webinar
- …

Diversity

- Inside ISG F5G (Members, Participants), Outside ISG F5G (Verizon, DT; Univ. of Aveiro; Deakin Univ., OFS)
- Operators, vendors, Academia (including universities), Verticals and Consultancy…

Openness

- Joint Workshop with ITU, CCSA and BBF
- Set the F5G open area (https://docbox.etsi.org/ISG/F5G/Open/)

F5G standards work items and publications

F5G Work Items

- 001: Generation definition
- 002: F5G use case v1
- 008: F5G use case v2
- 003: F5G technology landscape v1
- 013: F5G technology landscape v2
- 004: F5G network architecture v1
- 014: F5G network architecture v2
- 005: F5G QoE definition
- 006: F5G E2E mgmt&ctrl
- 011: AN telemetry arch.
- 007: Industry PON
- 10: Security analysis
- 015: F5G QoE evaluation
- 016: AN telemetry models
- 012: Security framework
- 009: PoC framework

Legend:
- Published
- Stable
- Early draft
- Newly created

https://www.etsi.org/committee/1696-f5g

White Papers

- F5G: Bringing Fibre to Everywhere and Everything
- F5G Impact & Benefits: Fibre Development Index
- White Paper on F5G Advanced and Beyond

Plenary meeting	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Date	Feb 2020	May 2020	Aug 2020	Nov 2020	March 2021	June 2021	Sep 2021	Nov 2021	Feb 2022	May 2022
Work Items Creation	1~5	6	7	8~9	10	11~12		13	14~16	

Now it's time for F5G to evolve to the next level
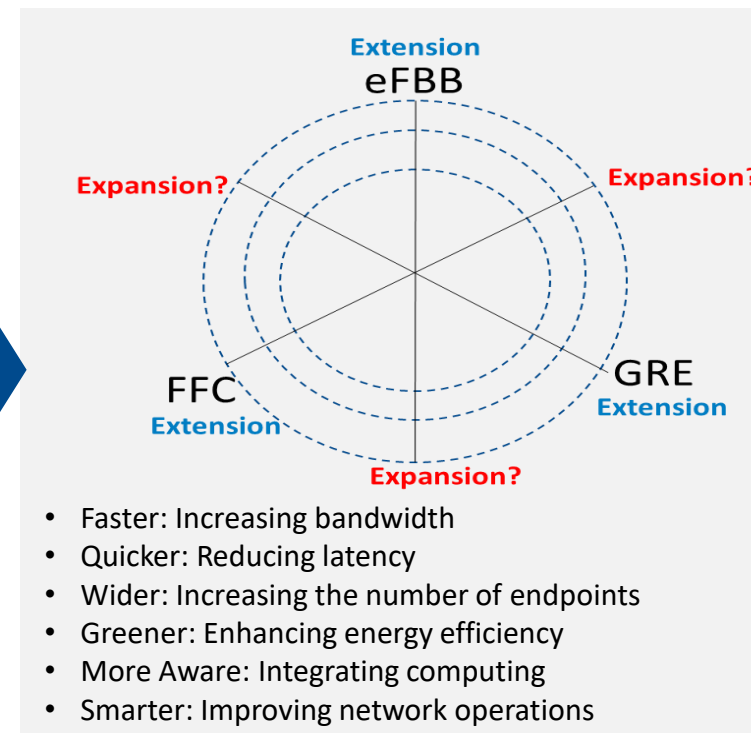
F5G: tri-angle features
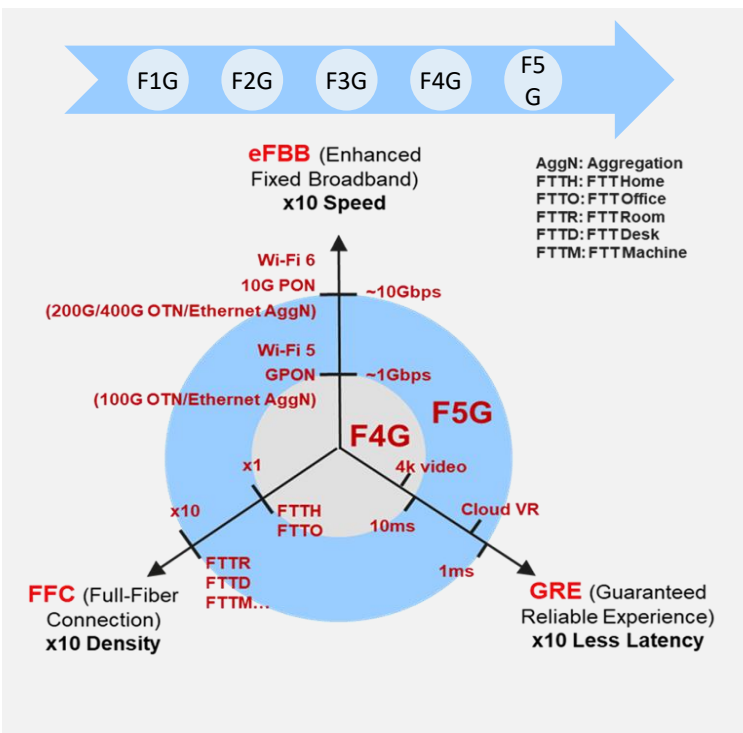
- The evolution of wireless has benefitted from having well-defined generations
- Fixed networks have lacked this structure and definition, and have had uneven deployment over time

New scenarios & services drive F5G development
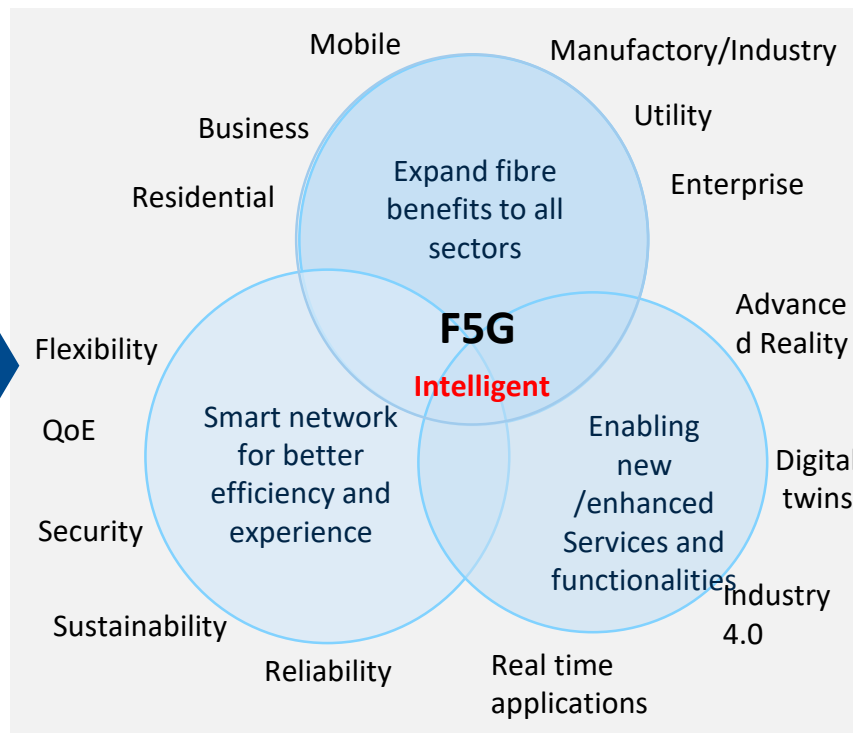
- Fiber to everything everywhere? Higher speed? Greener?
- Smarter to guarantee experience of both operator and end user(digital twins, ADN L4) Lower latency and zero jitter for machine?

What F5G would be in next phase?

- Faster: Increasing bandwidth
- Quicker: Reducing latency
- Wider: Increasing the number of endpoints
- Greener: Enhancing energy efficiency
- More Aware: Integrating computing
- Smarter: Improving network operations

The detailed directions and visions are under consideration and will be published as white paper on "**F5G Advanced and Beyond**".
https://www.etsi.org/technologies/fifth-generation-fixed-network-f5g

Upcoming workshop (28 June) and webinar (11 July)

Second Joint ETSI ISG F5G, BBF, CCSA TC6 and ITU-T SG15

Workshop on "Fibre to the room" (FTTR)

https://www.etsi.org/events/2084-2022-06-2nd-ws-fttr

ETSI Webinar: The new F5G fibre network
– A future proof architecture

https://www.etsi.org/events/2091-2022-07-webinar-the-new-f5g-fibre-network-a-future-proof-architecture
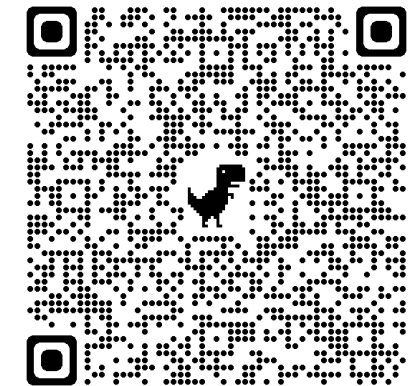

04:30 pm CEST (2:30 am UTC) to 05:30 pm CEST, 11 July, 2022
- on ETSI BRIGHTTALK CHANNEL

Welcome to F5G to envision and define the future together

Contributions to multiple domains
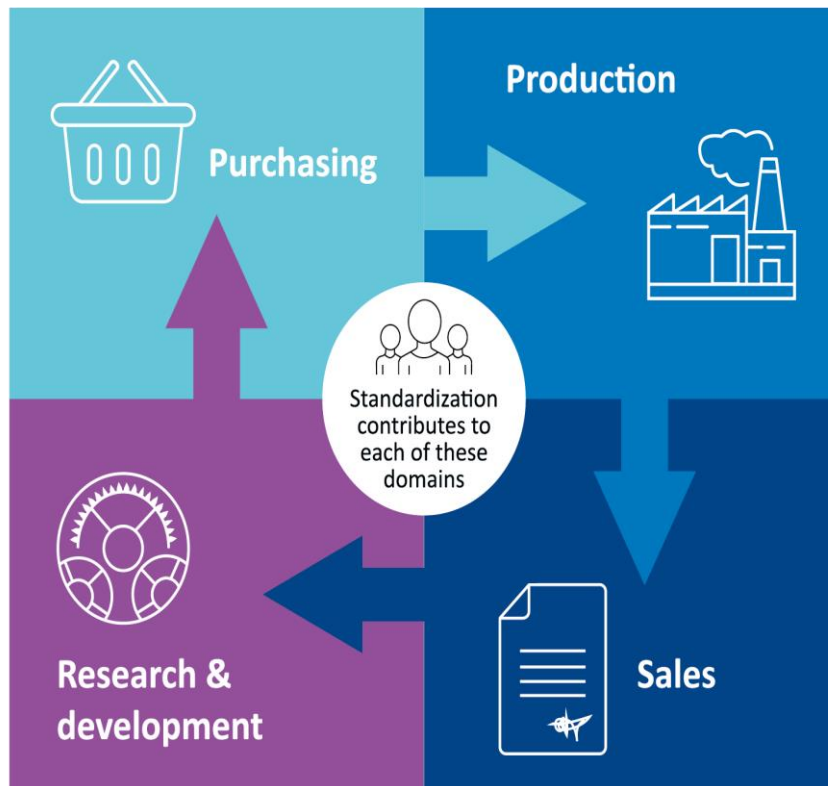
The benefits to ISG F5G members

- ✓ Scan the QR code to sign Participant Agreement online for ETSI non-members
- ✓ Open to all and free of charge.

Website: https://portal.etsi.org/tb.aspx?tbid=885&SubTB=885#/

Embracing the F5G era and Lighting up the Future.
Together, we make it Happen!