**Terms of Reference (ToR) for
ETSI ISG Fifth Generation Fixed Network (ISG F5G)**

Approved by the Director-General on **19 September 2023**, following Board#144 consultation

Scope

ISG F5G studies and develops the generations of the fixed network fostering the evolution to a "fibre to everywhere" ecosystem that enables new and enhanced services leveraging, in a framework of growing network capabilities, better performance, intelligent E2E management, network security and enhanced energy efficiency.

ISG F5G aims to work as a hub for the development of fibre based networks standardization in an E2E perspective, identifying major use cases and requirements and interacting with all relevant SDOs and industry stakeholders to produce new standards, where required, or enhancements to existing standards that may be needed to fulfil the identified use cases.

ISG F5G developed F5G release 1 and release 2 of the technical specifications addressing the 5th fixed generation standardization. During the next years, ISG F5G will study and develop the future fixed networks generations, starting from F5G-A (5th generation Advanced) and F6G (6th generation), while maintaining and enhancing the releases already published.

The work to be performed includes:
- identifying and developing the overall characteristics of the F5G-A and the F6G generations of fixed network,
- exploring all relevant F5G-A and F6G scenarios and related use cases and services including *(but not limited to)* home, business, multiple vertical industries and mobile/ wireless x-haul,
- performing a gap analysis to identify the necessity for both enhancements to existing technology specifications and/or developments of new technology specifications where required to fulfil the identified use cases,
- studying the overall framework, outlining the complete F5G-A and F6G technology landscape,
- developing an E2E reference architecture for F5G-A and F6G networks,
- specifying flexible and agile E2E management, enhancing QoE and QoS,
- managing the ISG F5G Proof of Concept framework leveraging PoC activities that validate specifications, services or architecture options developed throughout the work on ISG F5G,
- evaluating and analysing security aspects of F5G-A (cooperation with TC Cyber),
- leveraging the synergies between fixed networks (Transport, Aggregation, Access) and wireless communications to foster convergence in residential, enterprise and vertical services,
- studying migration path scenarios towards the F5G-A and the F6G.

Evolution of Fixed Networks

The expected evolution of the fixed network creates new opportunities by extending the use of optical networks and services to a wide variety of scenarios (home, office, campus, industry and extended support to wireless networks) and increasing their penetration in different environments (Fibre To The Room, Fibre To The Desk, Fibre To The Machine).
Expanding the network capabilities will allow the improvement of existing, and the support of new, services.

The new network capabilities and the new services will include:

- Home scenarios where emerging UHD immersive experience and cloud oriented services such as Metaverse, Cloud VR (virtual reality) and AR (augmented reality) video streaming, online gaming, etc., introduce the necessity for ultra-broadband, extremely low latency and zero packet loss.
- Business scenarios such as enterprise digitization and Cloudification, where premium computing integrated networks enable operators to offer new capabilities and resources in a "X as a service" model, requiring enhanced network capabilities, high reliability and high security.
- Vertical industry scenarios with stringent demand for deterministic networking, very low latency and packet jitter, high reliability, network slicing for addressing different business needs, digital twins and requirements for end to end computing power and networking coordination.
- The massive deployment of wireless networks, primarily in 5G and beyond, bringing growing needs for an efficient optical infrastructure that can deliver the bandwidth, latency and dense distribution required to support those networks.

- The green and digital transformation, requiring the improving energy efficiency that optical networks can offer (cooperation with TC EE).
- The evolution towards the autonomous network paradigm.
- The enablement of services based on the sensing capabilities of fibre cables and Wi-Fi, both for enhancements of the network management as well as new service offerings that make use of those capabilities.

Various use cases of these different scenarios are investigated by ISG F5G, and the relevant requirements clearly documented.

In order to fulfil the business requirements for F5G-A and for F6G fixed networks, ISG F5G will define the corresponding framework that includes network capabilities, performance indices and the corresponding technology landscape. ISG F5G targets a full fibre network to maximize the value of utilizing common transport, access and on-premises network technologies such as OTN, fgOTN, OXC, 50G-PON and supplementary technologies such as Ethernet, Wi-Fi 6 and Wi-Fi 7. Other relevant areas to be addressed for the F5G-A network include E2E management, introducing autonomous network capabilities (as defined by TM Forum) and the development of mechanisms to enhance energy efficiency.

In ISG F5G work, new technologies or extensions to existing technologies for transport, aggregation, access and customer premises network will be identified through gap analysis.,. Furthermore, several aspects will be developed in alignment with ISG F5G E2E network architecture evolution, including (but not limited to) control plane evolution for cloud networking, higher level of autonomous operation and management, end-to-end full stack slicing, and a further degree of all-optical networking. Artificial Intelligence application to optimize network management and traffic steering as well as in support of consumer and industry services will be considered. The synergies of Transport, Aggregation and Access Networks will be further explored as well as the convergence with mobile core network. Integration of computing and networking will be studied, aiming to provide a combined infrastructure of computing that enables intelligent provisioning of the applications and services. Smart energy efficiency, telemetry, mobile network x-hauling are part of ISG F5G area of interest. F5G support of the specific requirements of industrial scenarios and applications is considered. Back-compatibility with legacy network and SDN-based network will be addressed.

ISG F5G also ensures a framework for PoC activities that enables to test and demonstrate the valuable features and use cases developed at ISG F5G, gathering additional information on requirements and leveraging the creation of a F5G, F5Gdvanced and F6G Open ecosystem.

ISG F5G considers a wide range of technologies, and therefore seeks to actively cooperate, with the most efficient possible methods, with relevant standardization groups, both inside and outside of ETSI, as well as vertical industrial organizations.

ISG F5G's work will be oriented towards the identification of technology and standards gaps. These gaps will be referenced to the appropriate standardization group/body (either inside or outside of ETSI) and may trigger enhancements to existing technology specifications or the developments of new ones where required.

Areas of activity

ISG F5G will focus on the following activities:

- Revision/maintenance of already published GR and GS
- Definition of F5G-A use cases and related gap analysis, with extended focus to verticals and optical transport, identifying enhancements/developments of existing/new specifications
- Architecture framework – evolution of the Architecture framework to F5G-A, namely:
  - Enhance the specifications on F5G slicing, to support differentiated and guaranteed SLA in the all-optical space.
  - Refine and expand the details of the service plane, including the signalling/routing network protocol and data plane technologies.
  - Include the mobile mid-haul and mobile front-haul specifications.
  - Study convergence of access and transport/aggregation for a simpler and lower latency/jitter network.
  - Expand the fixed-mobile convergence requirements in the defined architecture.
  - Study enhancements and synergies of FTTR and Wi-Fi in CPN (Customer Premise Networks).
  - Move all-optical networking further to the edge of the network.

- o Increase the use of P2MP technology in the various network segments.
- Security framework
    - o Evaluate and define a security model and a security architecture for management of risk, in close alignment with TC CYBER.
- Services quality evaluation
    - o Identify the major factors impacting the QoE of the various services delivered by ISG F5G defined networks and study appropriate mechanisms for improving end-to-end QoE, continuing the work already done in previous work items.
- Management and control layer
    - o Further develop the End-to-End management specifications to ensure flexible and agile management, meeting the end-to-end QoE and the QoS requirements for services and applications in the network.
    - o Embed autonomous networking features, in close alignment with the work being developed in ISG ENI and ISG ZSM.
    - o Develop the telemetry specifications required to increase management efficiency and enable QoE and QoS enhancements in F5G-A networks.
- PON based Industrial network
    - o Specification of an optical ecosystem for the very demanding requirements of industrial environments with respect to quality, reliability, robustness, bandwidth and latency.
    - o Evaluate the interaction with industrial protocols, the requirements for interfaces, management, and edge computing.
    - o Develop specifications for optical networking in Industrial environments.
- Latency control technologies
    - o Develop deterministic networking to address critical applications were stable levels of latency and jitter are a requirement.
    - o Enhance E2E network slicing to ensure SLA compliance over diverse Wi-Fi air interfaces, PON networks, and transport networks.
- Energy efficiency
    - o E2E network high level design for energy efficiency.
    - o Target Network architecture optimization for optical and electrical synergy networking, energy aware switching and routing.
    - o Determine the requirements for energy efficiency of network equipment.
- High quality distributed computing networks
    - o Integration of computing and networking in a combined infrastructure including also storage, that enables intelligent provisioning of applications and services.
- Optical Cloud networks to provide dynamic one hope connections to multiple clouds for some premium services with minimum latency, packet delay jitter, and very high reliability.
- Next fixed network generation
    - o Contribute to build the vision for next fixed network generation and evaluate possible evolution paths from F5G-A to F6G.
- PoC framework
    - o Exploit the feedback from completed PoCs to drive the improvement of F5G specifications, current and future.

Annex (informative): collaboration with other bodies

ISG F5G will seek to actively coordinate and cooperate with the following groups both inside and outside of ETSI:

ETSI Groups

- EPP 3GPP
- TC ATTM
- TC BRAN
- TC CABLE
- TC STQ
- TC CYBER
- TC EE
- ISG ENI
- ISG NFV
- ISG ZSM
- ISG MEC

ISG F5G may identify others during the progression of the work.

External groups

- ITU-T (ITU Telecommunication Standardization Sector)
- BBF (The Broadband Forum)
- IEEE (Institute of Electrical and Electronics Engineers)
- IETF (Internet Engineering Task Force)
- WFA (Wi-Fi Alliance)
- TM Forum
- CCSA (China Communications Standards Association)
- IEC (International Electrotechnical Commission)
- WBBA (World Broadband Association)

ISG F5G may identify others during the progression of the work.