



# 6G-INTEGRATION-01-E15: Activities plan for the first year



## 6G-INTEGRATION

Full Title: Construction of an ecosystem for research and development in non-terrestrial networks (satellite and HAPS) and B5G (3GPP rel. 17 and beyond): NTN networks for LEO satellites and for HAPS platforms.

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## Executive Summary

This document contains the Ericsson's work plan within the subproject 6G-INTEGRATION-01 devoted to developing a portable gNB using a Non-Terrestrial Network (NTN) as backhaul or as radio multi-access point, building a Public Network Integrated Non-Public Network (PNI-NPN). Initially, a requirement analysis will be performed to define the gap in terms of infrastructure, network architecture and features needed to develop the laboratory environment. Once this is defined, two tasks will run in parallel. The first one is focused on acquiring and installing the infrastructure as well as starting the configuration of the network required. The second one aims to dive into the following lines of investigation for the NTN development: (i) backhauling with constant delay to minimize the impact on the 3GPP network architecture and (ii) 5G direct access with transparent satellite.

*Este documento contiene el plan de actividades de trabajo de Ericsson dentro del subproyecto 6G-INTEGRATION-01 dedicado al desarrollo de un gNB portable usando una red no terrestre (NTN) como backhaul o como punto de multi-acceso radio, construyendo una red no pública integrada en la red pública (PNI-NPN). Inicialmente, se hará un análisis de requisitos para definir las carencias en infraestructura, la arquitectura de red y las funcionalidades necesarias para desarrollar en el entorno de laboratorio. Una vez definido, dos tareas avanzarán en paralelo. La primera se centra en adquirir e instalar la infraestructura, así como comenzar la configuración de la red requerida. La segunda tiene como objetivo profundizar en las siguientes líneas de investigación para el desarrollo de la NTN: (i) backhaul con delay constante para minimizar el impacto en la arquitectura de red 3GPP y (ii) el acceso directo 5G vía satélite transparente.*



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## Glossary

3GPP	3 <sup>rd</sup> Generation Partnership Project
5G	5 <sup>th</sup> Generation technology standard for cellular networks
5GS	5G System
5GC	5G Core
ATSSS	Access Traffic Steering, Switching and Splitting
B5G	Beyond 5G
CP	Control Plane
CUPS	Control and User Plane Separation
GEO	Geosynchronous equatorial orbit
HAPS	High Altitude Platform Station
gNB	gNodeB – RAN node in a 5G network
KPI	Key Performance Indicator
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
NPN	Non-Public Network
NR	New Radio
NTN	Non-Terrestrial Network
PNI-NPN	Public network integrated - Non-Public Network
RAN	Radio Access Network
SLA	Service Level Agreement
UP	User Plane
UPF	User Plane Function

## 1 Introduction

The main objective of the 6G-INTEGRATION project is to develop the knowledge and technology to lead the integration of B5G and NTN. It is divided into 4 subprojects, each of them focused on specific but related aspects:

- **6G-INTEGRATION-01: Integration of non-terrestrial networks in mobile devices and backhaul for B5G networks.**
- 6G-INTEGRATION-02 – Extension of network operators through non-networks terrestrial.
- 6G-INTEGRATION-03 - The hyper-distributed edge and its orchestration in non-networks terrestrial (including HAPS)
- 6G-INTEGRATION-04 - Onboard B5G systems in non-terrestrial networks included HAPS.

This document is called deliverable 6G-INTEGRATION-01-E15, “Activities plan for the first year”. It contains the activities plan within the scope of the work under subproject 6G-INTEGRATION-01 awarded to *Ericsson España S.A.U.*

In the technical specifications sheet of the public bidding, it is described that this subproject is focused on the integration of non-terrestrial networks i) as backhaul and ii) in mobile devices for B5G networks (focusing on 3GPP release 17 and beyond).

Ericsson’s contribution in this subproject aims the development of two uses case, a portable gNB using a non-terrestrial backhaul network and the Multiaccess with non-terrestrial networks, the evolution of the laboratory environment to provide connectivity to the use cases through a state-of-the-art 5G mobile network, as well as support to integration and showcasing of the use cases.

More information about 6G-INTEGRATION project can be found at the website [\(6G-INTEGRATION - UNICA 6G, 2024\)](#)

## 2 Activities plan

The goal of the work will be to be able to contribute to the development of an integrated architecture for NTN and B5G networks, focusing on understanding how to integrate the NTN segment (satellite and HAPs) into a 3GPP R17 network, including all the different possible interactions with the system and developing a reference architecture. For this matter, two use cases are proposed:

### - NTN as backhaul

The objective is the satellite integration in the 5G system as backhaul between the core and terrestrial access network, providing backhaul connectivity to the portable gNB. This integration will connect a 5G non-public network (NPN) segment with a 5G public network providing coverage in areas where it cannot be assumed that there are fixed network deployments (e.g., fiber optics) and therefore alternatives are needed to connect the non-public segment to the network.

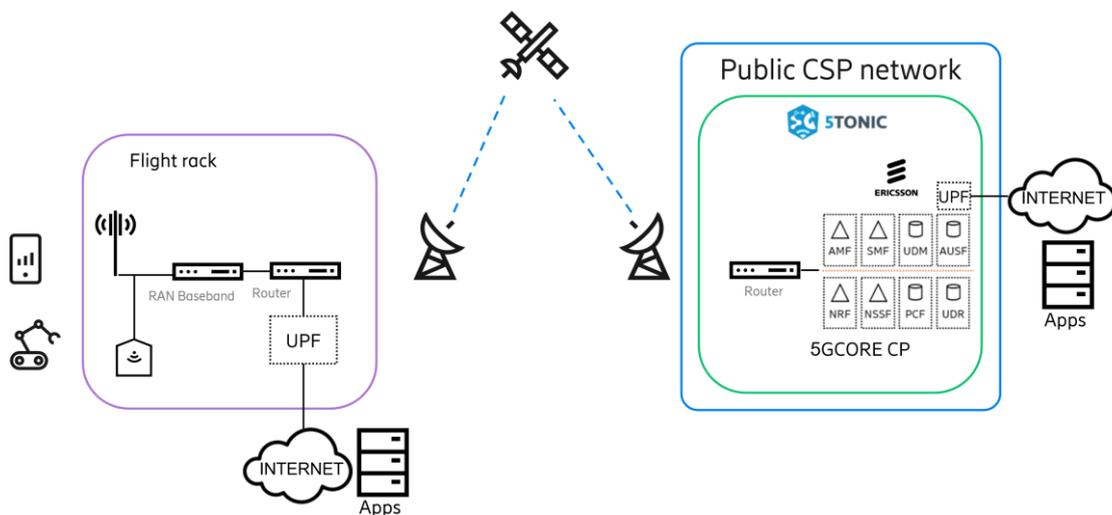


Figure 1. NTN backhaul

The figure above describes a possible non-public network deployment, where an industrial use case is served through the local deployment of the radio access network (RAN) and the user plane function (UPF), while the public network provides the service for the rest of the 5G core.

### - ATSSS - Multiaccess with NTN

Another application of NTN networks is to provide access redundancy for mission-critical services. This use case investigates the use of NTN networks in a 3GPP multi-access environment (ATSSS), where the NTN network supports a B5G network to increase the reliability of the solution.

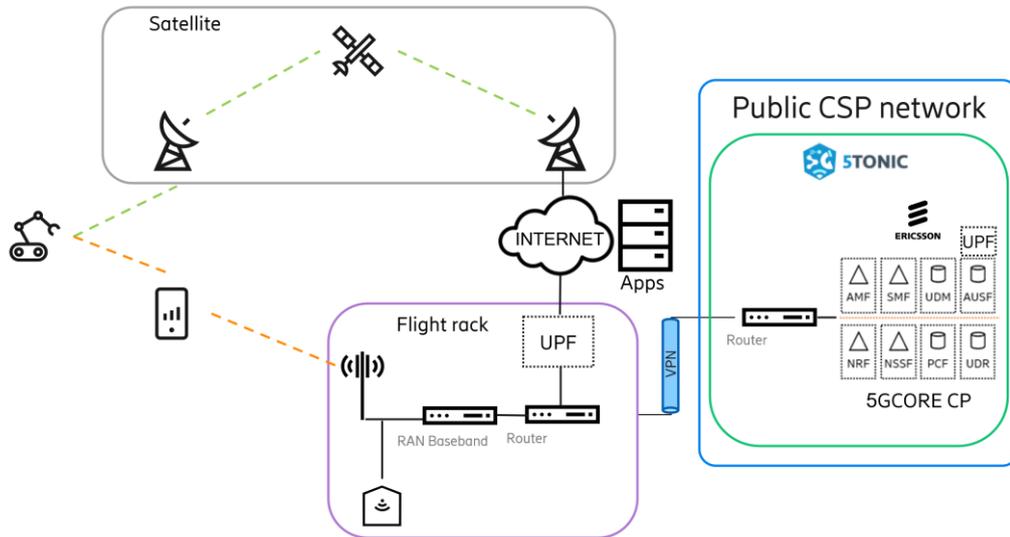
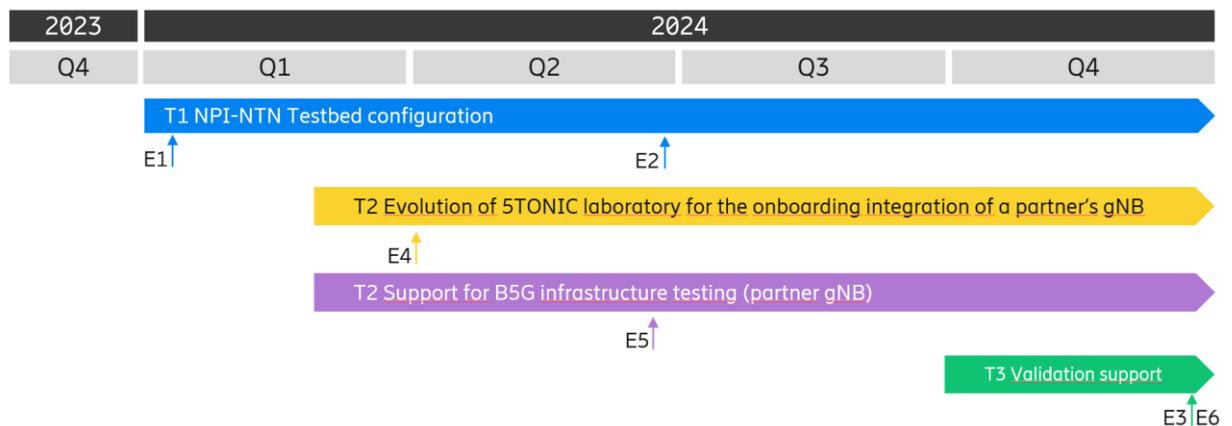


Figure 2. ATSSS - Multiaccess with NTN

The plan will be focused on adapting the laboratory environment and the integration of the use cases and the demos execution.

The original project plan was included in the proposal delivered by Ericsson during the public bidding process. However, as the project starting date has been finally established in January 2024, the following figure reflects the plan adapted to such modification:



**Deliverables:**

- E1 (6G-INTEGRATION-01-E15), Jan/24. Activities plan for the first year
- E2 (6G-INTEGRATION-01-E16), Jun/24. Analysis report regarding needs and requirements for implementing the NPI-NTN gNB
- E3 (6G-INTEGRATION-01-E17), Dic/24. Integration testing report
- E4 (6G-INTEGRATION-04-E23), April/24. Activities plan for the first year
- E5 (6G-INTEGRATION-04-E24), Jun/24. Analysis report regarding needs and requirements for implementing the NPI-NTN gNB.
- E6 (6G-INTEGRATION-04-E25), Dic/24. Integration testing report

Figure 3: Project plan

Based on this project plan, the following subsections detail the activities that will be performed during the first year within the tasks that have planned effort in that period, which are: Task 1 (T1), Task 2 (T2) and Task 3 (T3).

## 2.1 Task 1: Configuration of a test laboratory in version Rel. 17

(January 2024 – December 2024)

This activity includes the analysis, evolution and integration of functionalities defined in Release 17 in the 5Tonic laboratory to support the integration of non-terrestrial networks. The focus for the selection of functionalities will be the use cases described in the technical proposal: NTN as backhaul and Multiaccess with NTN.

For the integration tests of the NTN network as backhaul, Ericsson will provide 5Tonic with a real non-public network environment, consisting of a portable system that includes the 5G radio access network (antenna and gNB) as well as the user plane (UPF). In the case of multi-access, Ericsson proposes the use of the ATSSS (Access Traffic Steering, Switching and Splitting) architecture for the integration and demonstration of a multi-access solution using 5G New Radio (NR) and NTN, in order to provide a system with high reliability.

During the year, the work for this task will be focused first on the acquisition of the equipment. Then, such equipment will be installed, configured and integrated in the laboratory environment.

Additionally, the 5G RAN and Core software will be regularly upgraded with the new official software released by Ericsson. Along with the new software releases comes the possibility to activate certain new features. Before activating new features, a feasibility analysis must be done to make sure it is feasible technically (it is aligned with the laboratory environment conditions and with the goals of the project) and timewise (it can be done within the lifetime of the project).

This task has the following deliverables:

- 6G-INTEGRATION-01-E15 Activity plan for the first year (January 2024)
- 6G-INTEGRATION-01-E16 Testbed Gap Analysis Report of integration tests. Will include a roadmap for the implementation of the gap in 5Tonic (June 2024)

## 2.2 Task 2: Support for experimentation in a B5G network

(March 2024 – December 2024)

Based on the configuration defined in Task 1, Ericsson will provide support for integration testing providing the 5TONIC 5G CORE, in order to prepare for the experimental phase defined in the next task. This task belongs to the 6G-INTEGRATION-04 subproject.

The support for the onboarding of the 5G network in NTN is mentioned among the verification tasks. This task is not included in the scope of this Ericsson proposal, as providing the necessary equipment is beyond the scope of Ericsson Spain and, given the nature of the project, Ericsson cannot commit to supporting the integration of a non-Ericsson gNB.

This task has not deliverables in the 6G-INTEGRATION-01 subproject, they belong to 6G-INTEGRATION-04 subproject

## 2.3 Task 3: Support for experimentation and validation

(October 2024 – December 2024)

During this phase, Ericsson will provide support for the experimentation and validation of the two use cases:

1. NTN as backhaul
2. Multiaccess with NTN networks (ATSSS)

This task has the following deliverables for each subproject:

- 6G-INTEGRATION-01-E17 Integration testing report. (December 2024)
- 6G-INTEGRATION-04-E25 Integration testing report. (December 2024)

## 2.4 Research Areas

High-level analysis of Ericsson's research areas are detailed below

### 2.4.1 Non-Public Network.

5G & B5G networks support non-public networks (NPNs) which are designed to serve specific industrial or enterprise needs. NPNs provide dedicated and private networks that are not accessible to the public.

NPNs allow businesses to customize and tailor their networks to meet specific needs, such as ultra-low latency, high reliability, or high bandwidth requirements. This can enable a wide range of applications, including automation, industrial IoT, smart factories, and autonomous vehicles.

NPNs can be deployed in two ways: as a standalone network or as a slice within a public network as described. In either case, the network is designed to be isolated from the public internet, providing an extra layer of security.

One of the benefits of NPNs is that they can be quickly deployed and customized to meet the needs of specific industries, providing a level of flexibility that is not possible with public

networks. This can be especially valuable for industries such as manufacturing or healthcare, where connectivity is critical, and downtime can be costly.

Overall, NPNs are an important feature of 5G & B5G networks, enabling a new generation of customized and dedicated networks to support the needs of specific industries and enterprises.

5G & B5G non-public network (NPN), also called as private network, provides 5G & B5G network services to a clearly defined user organization or group of organizations. The 5G & B5G non-public network is deployed on the organization's defined premises, such as a campus or a factory. Non-public networks can be desirable for several reasons:

- High quality-of-service requirements
- High-security requirements, met by dedicated security credentials
- Isolation from other networks, as a form of protection against malfunctions in the public mobile network. Also, isolation may be desirable for reasons of performance, security, privacy, and safety.
- Accountability. A non-public network makes it easier to identify responsibility for availability, maintenance, and operation.

Ericsson developed at 5Tonic a portable system, inspired in the concept of Non-Public Network, which is able to provide 5G NR coverage to sites outside 5Tonic premises but using the 5G Core and the experimental infrastructure of 5Tonic. The design takes the advantage of the new capabilities provided by 5G, such as CUPS and User Plane flexibility, to deploy at vertical premises only the equipment required for providing the access network (gNB) and the local break-out of the user plane (UPF, transmission routers).

The on-premises equipment uses a secure connection towards 5Tonic facilities in order to get access to the control plane part of the 5G Core. With this, we can extend the 5Tonic 5G coverage to external premises and we are able to provide the same capabilities that 5Tonic has, including all the experimentation infrastructure.

Detailed definitions of 5tonic lab infrastructure and roadmap can be found in the Ericsson's document report (Molla, 2023).

## 2.4.2 Non-Terrestrial Network.

Non-terrestrial networks became part of the 3rd Generation Partnership Project standard in Release 17, establishing a strong foundation for direct communication between satellites, smartphones and other types of mass-market user equipment. (Ericsson, 2023)

Integration with satellite networking technologies that can provide coverage in areas that TNs cannot reach would help to deliver resilient services to people and businesses currently unserved in both developed and undeveloped parts of the world, bringing significant social and economic benefits.

Beyond the benefits NTN will deliver to smartphones, they will also have the capability to support both industrial and governmental IoT devices for verticals such as automotive, health

care, agriculture/forestry, utilities, maritime transport, railways, aeronautic/drone sector, national security and public safety.

Modern satellites typically divide their service areas into several hundred sub-areas, which they serve with individual beams (“spot beams”). In general, each of these areas corresponds to one cell, and can have a diameter of tens or even hundreds of kilometers.

While GEO satellites are (almost) stationary with respect to a point on the Earth’s surface, LEO satellites move at approximately 8km/s (~30,000km/h) in their orbits. If the beams are fixed with respect to the satellite, the beams will sweep the surface of the Earth, leading to frequent mobility events, such as handover between cells, even for stationary UEs (typically every few seconds).

Alternatively, a beam steering mechanism can be implemented on the satellite to steer the beams toward a fixed area on the Earth for as long as possible. This concept, known as “Earth-fixed beams,” allows a device to remain in the same beam and cell for several minutes. While both alternatives are supported in Rel-17, a particular benefit of the Earth-fixed beam concept is that it avoids frequent handover between cells. (Ericsson, 2023)

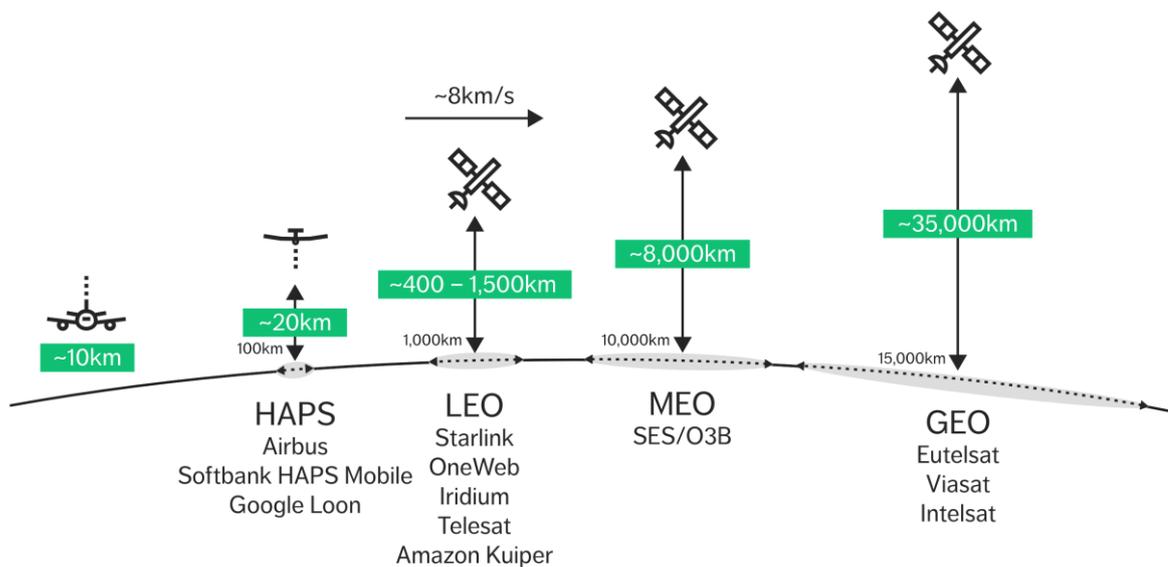


Figure 4. Overview of existing satellite systems

Some of the lines of investigation in this 6G-INTEGRATION project for the NTN development will be the backhauling with constant delay to minimize the impact on the 3GPP network architecture and the 5G direct access with transparent satellite for LEO satellites

### Impacts on 5GC of Satellite NG-RAN used as backhaul

Rel-17 only considers backhauling with constant delay. Here, the satellite operator is able to mask any delay changes in service/feeder links by exploiting the knowledge of the satellite position to calculate how much variable delay should be added to keep the overall delay constant. Connecting gNBs to 5GC via, e.g., a single GEO satellite or a single NGSO satellite without inter-satellite links are examples of such backhauling. (3GPP, Summary of Rel-17 Work Items - TR 21.917, 2023)

### Impacts on 5GC of Satellite NG-RAN used as new RAN 3GPP access

In Rel-17, only direct access with transparent satellite is considered (3GPP, Summary of Rel-17 Work Items - TR 21.917, 2023)

In this solution, the satellite repeats the NR-Uu radio interface from the feeder link (between the NTN gateway and the satellite) to the service link (between the satellite and the UE) and vice versa. (3GPP, Solutions for NR to support NTN - TR 38.281, 2023)

## 2.5 Risk analysis

Below, the detected risks are detailed and possible mitigation actions are described.

### 2.5.1 R01: Hardware supply chain

Currently, hardware equipment is having delayed delivery times, typically between 6 and 18 months, impacting specially networking equipment. Ericsson takes this situation into account when planning installations at 5Tonic. To mitigate this issue, Ericsson has a certain stock of equipment that can be used temporarily while the final ordered products arrive.

### 2.5.2 R02: Integration of other subprojects

As the requirements from other 6G-INTEGRATION subprojects are not known in advance, it could happen that some requirements are out of scope for this project. Ericsson will share the foreseen evolution of their network equipment and which functionalities can be expected from them.

6G-INTEGRATION-04 subproject requires a UC3M partner for the gNB onboarding in satellite/HAPs. Ericsson may only provide support for the integration with the 5G CORE CP deployed at 5TONIC data center so it will be needed to clarify its scope.

### 2.5.3 R03: NTN technology

For the use cases' experimentation defined in this proposal, Ericsson assumes that an expert NTN contractor will provide UC3M with both the NTN devices necessary for communication and the network itself, whether real or through emulation/simulation.

The study of different satellite communication aspects (doppler shift, beam management, mobility management...) will be managed by the NTN contractor.

## 3 Expected results and exploitation plan

For the 6G-INTEGRATION, Ericsson foresees the next results.

### 3.1 Demonstration results

The Proof of Concepts and demonstrations performed at 5Toonic laboratory will provide valuable results, as they will allow to obtain information about the performance of the project in a real mobile network. With the obtained data, Ericsson plans to do several technical publications in collaboration with the rest of participants in the demonstration, if all the participants agree with that the scientific quality is enough for the publications.

Also, these results will allow to Ericsson to analyze and demonstrate how a NTN can be integrated in a 5G mobile network, bringing support of new use and business cases. Ericsson España will use these results to provide internal feedback to Ericsson product development groups and will be in charge of disseminating the results and the research internally in the different units of Ericsson that might be interested in this project.

### 3.2 Integration results

The integration of the satellite communications into the 5G networks is a valuable source of results that are useful for analyzing. Ericsson will focus in two areas of interest:

- (i) How non-terrestrial network can be integrated as part of the 5G system
- (ii) How NTN enhances PNI-NPN for verticals to use 5G mobile communications in uncovered or under-covered areas

As result of this activities, Ericsson could publish *White Papers* with the topic of the integration of satellite in the mobile networks.

### 3.3 Standards and IPR

Ericsson plans to bring the innovations of this project to standardization groups such as 3GPP or IETF, if they have enough entity to be standardized. Ericsson will use its presence in those organization to support the standardization efforts of this project.

In the same way, Ericsson will determine the possibility of protecting its innovations with the use of IPRs. This process is out of scope of this project, and it will be handled internally in Ericsson.

## 4 Quality plan

Ericsson has a quality plan named *Ericsson Operational Quality Manual* (Ericsson, 2024), which includes all Ericsson operations, where it is defined how the company handles its business by following the well-defined core values.

Our *Ericsson Group Management System* is globally certified in ISO 9001, ISO 14001, ISO 45001 and ISO 27001.

For more information, please refer the main website of the quality plan (Ericsson, 2024)

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