5G TERRA

5G infrastrucTure and sERvices foR public interest and sociAl inclusion

D2.2 E2E Architecture and Technology Specifications

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Executive Summary

The document contains a description in terms of infrastructure and network design architecture of OTE 5G network in an all-encompassing view including Access/Radio, Transport, IP (Aggregation/Core), Mobile Packet Core Network. The key aspects of Radio Access Design and Planning are analyzed in terms of identifying the need for a new 5G base station in an area/community, suitable site selection/location by performing field surveys and geospatial tool analysis, designing the new 5G base station, licensing & acquisition activities, procurement, implementation and optimization. Furthermore, base stations, radio technical specifications are presented, such as Frequency Bands & Spectrum utilization, Dynamic Spectrum Sharing (DSS), Carrier Aggregation (CA), Reference Signal Received Power (RSRP), Quadrature Amplitude Modulation (QAM) and Massive (MIMO) Multiple Input Multiple Output.

The Transport Network (consisting of Layer 2.5 (MPLS-TP) and Layer 3 (IP/MPLS) devices) is responsible for delivering the traffic of each RAN base station to the Edge IP network while the IP Aggregation sites have two redundant routers, and they are protected by uplinks to two independent Core sites via independent paths. Furthermore, the Mobile Core Network is defined as the central component of a mobile communication system responsible for providing services and data processing dedicated to handle a range of essential functions such as Connectivity and Mobility management, Authentication and Authorization, Subscriber Data Management and Policy Management. Finally, the crucial technical specifications of NMS (a suite of Network Management applications supporting the operation and maintenance workload of Radio, Transport and Core networks) are presented.

OTE is taking the next step in wireless communications, as it is in the phase of upgrading its 5th generation mobile network infrastructure from 5G (Non-Standalone) to 5G SA (Standalone), which will “unlock” even higher download and upload speeds, zero latency, improved indoor coverage and even greater reliability of communications.

5G SA will offer even more possibilities, such as the ability to “slice” 5G network infrastructure resources (dynamic network slicing). More specifically, network slices are virtual networks that provide specialized features (bandwidth, response, etc.). Each network slice is perfectly adapted to the needs and requirements of the various applications users use at different times. This is very important for vertical markets, as it allows for the creation of multiple, configured and independent networks, which are located on common infrastructure.

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List of Acronyms and Abbreviations

TERM	DESCRIPTION
4G	Fourth Generation
5G	Fifth Generation
5G NSA	Fifth Generation Non-Standalone
5G SA	Fifth Generation Standalone
5G-PPP	5G Infrastructure Public Private Partnership
5GC	5G Core
6G	Sixth Generation
AI	Artificial Intelligence
AMF	Access and Mobility Management Function
API	Application Programming Interface
AR/VR	Augmented Reality/Virtual Reality
AUSF	Authentication Server Function
BITS	Basic International Telecommunications Services
BNG	Broadband Network Gateway
BS	Base Stations
BSC	Base Station Controller
CA	Carrier Aggregation
CEF	Connecting Europe Facility
DSS	Dynamic Spectrum Sharing
DL	Downlink
DT	Deutsche Telekom
DWDM	Dense Wavelength-Division Multiplexing
EC	European Commission
ECG	Electrocardiogram
EMBB	Enhanced Mobile Broadband (eMBB)
ENM	Ericsson Network Manager
ENODEB	Evolved Node Base Station
EPC	Evolved Packet Core
EU	European Union
FCAPS	Fault Configuration Accounting Performance Security
GNB	Next Generation Node B (gNB)
GPS	Global Positioning System
HADEA	European Health and Digital Executive Agency
HSS	Home Subscriber Server
HQOS	Hierarchical Quality of Service
IEEE	Institute of Electrical and Electronics Engineers
IOT	Internet of Things (IoT)
IP	Internet Protocol
IPOE	Internet Protocol over Ethernet
IPSEC	Internet Protocol Security
IPSECGW	IP Security Gateway
KPI	Key Performance Indicator
L2TPV2	Layer 2 Tunneling Protocol version 2
L2VPN	Layer 2 Virtual Private Network
L3VPN	Layer 3 Virtual Private Network
LSR	Label Switching Router

LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
MME	Mobility Management Entity
MMIMO	Massive MIMO
MMTC	Massive Machine-Type Communications (mMTC)
MPLS	Multiprotocol Label Switching
MPLS-TP	Multiprotocol Label Switching – Transport Profile
MW	Microwave
OM	Operations Maintenance
NATCOS	National Companies
NEF	Network Exposure Function
NMS	Network Monitoring System
NR	New Radio
NSA	Non-Standalone
PCC	Policy and Charging Control
PCF	Policy Control Function
PCG	Packet Core Gateway
PCRF	Policy and Charging Rules Function
PCW	Packet Data Network Gateway
PKI	Public Key Infrastructure
PO	Purchase Order
PPP	Point-to-Point Protocol
RNC	Radio Network Controller
QAM	Quadrature Amplitude Modulation
RAN	Radio Access Network
RES	Renewable Energy Sources
RSPR	Reference Signal Received Power
SA	Standalone
SBA	Service Based Architecture
SGI	Services of General Interest
SGW	Serving Gateway
SIM	Subscriber Identity Module
SMF	Session Management Function
SYNCE	Synchronous Ethernet (SyncE)
TETRA	TErrestrial Trunked RAdio
TMV WG	Test Measurement and Validation Working Group
UE	User Equipment
UC	Use Case
UDM	Unified Data Management
UL	Uplink
UPF	User Plane Function
URLLC	Ultra-Reliable Low Latency Communications
UTRAN	UMTS Terrestrial Radio Access Network
WO	Work Order
WP	Work Package

1 Introduction

The strategic objective of 5G-TERRA is to **provide high-quality 5G connectivity to the end customers of remote and sparsely populated areas** in Greece, for personal, business, and governmental growth, **to enable efficient, state-of-the-art Healthcare, Education and Civil Protection SGIs** [1], [2], and to support the deployment of 5G infrastructure as part of the European Gigabit Society EU strategy. Towards this, 5G-TERRA will extend OTE 5G network (in terms of construction, configuration, and connection with the rest of the network) with almost 50 new 5G base stations, towards high capacity, reduced latency, and high reliability mobile services for up to now de-prioritized, rural, and sparsely populated areas in Greece as shown in the map that follows (Figure 1).

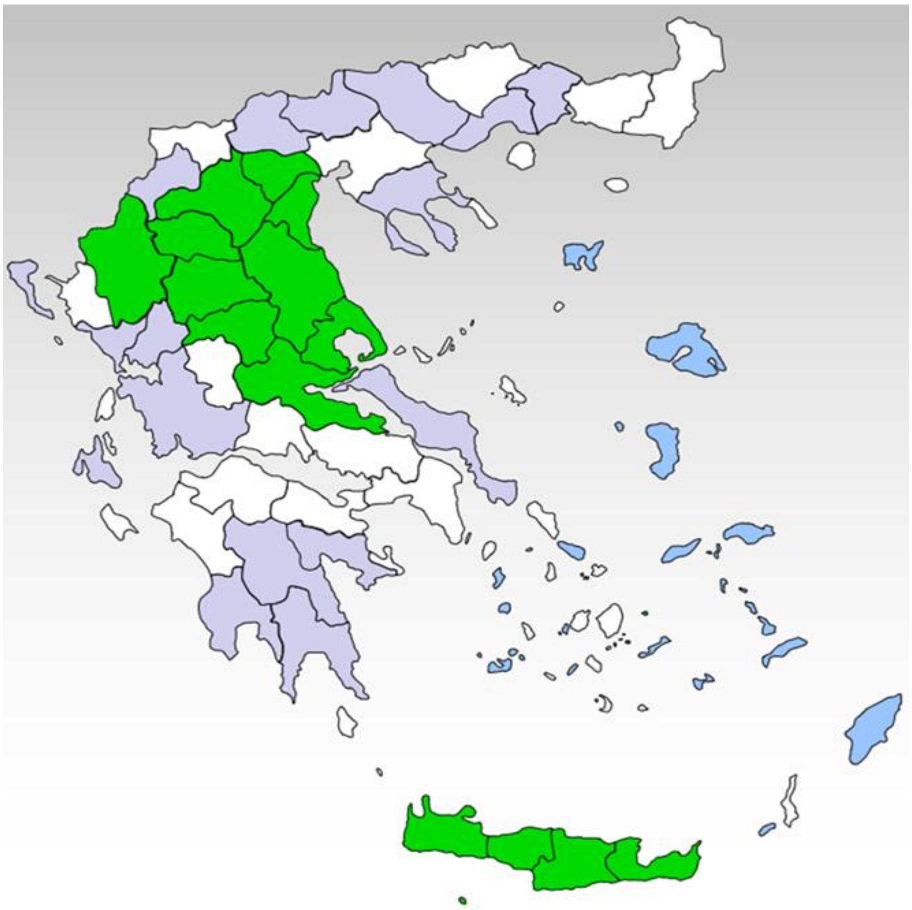

Figure 1: 5G-TERRA target regions

Deliverable 2.2 “E2E Architecture and Technology Specifications” addresses the above 5G-TERRA objective and aims specifically to:

- Design effective and efficient 5G network, providing the necessary coverage and performance
- Deliver an E2E network design including the network interconnection and relevant technology specifications.

This deliverable D2.2 is the second technical deliverable published by the 5G-TERRA consortium and presents the “E2E Architecture and Technology Specifications” as defined during the first 10 months of the project. The deliverable is produced as part of the Work Package 2 (WP2) “Requirements, Architecture & Scope of work” and Task 2.2 “5G End-2-End Architecture and Specifications” and marks the completion of the project’s milestone MS3 “E2E architecture and technology specifications”. In deliverable D2.1 “Requirements Analysis & Use Case definition” [3], the 5G-TERRA Use Cases were described through the detailed requirements analysis as well as the expected 5G network performance for supporting the selected UCs. Task 2.2 receives as input the UC requirements and targeted KPIs from T2.1 (D2.1) and uses them to design the 5G-TERRA network with the necessary specifications.

The document is public and is addressed to a wide audience and specifically to the:

- Project consortium itself, as a documented blueprint of the agreed technical scope and development plans of the 5G-TERRA network and its capabilities towards validating the identified requirements and ensure that the next actions can be concretely derived
- Research community, other 5G projects and funding organizations, to describe the 5G-TERRA network in accordance with the scope, objectives and intended project applications, and to open the floor for fruitful exchange of opinions and collaboration
- public, to obtain a better understanding of the framework and scope of the 5G-TERRA project.

1.1 Structure of the document

The main topics addressed in this deliverable are presented through the following structure:

- Section 2 presents an overview of the network and core technical developments
- Section 3 presents the detailed Radio and Access, Transport, IP(Aggregation/Core), Mobile Packet Core network architectures and technology specifications (including NMS), as well as the monitoring and operational tools for network management
- Section 4 provides concluding remarks and next steps for facilitating the delivery of fully operational and validated 5G-TERRA network by the end of 2026.

1.2 Relation to other 5G-TERRA deliverables

Deliverable D2.2 denotes the successful completion of WP2 and MS3 E2E architecture and technology specifications, as it is published in M10 (end of WP2). It is related to D2.1 Requirements analysis & Use Case definition, which was published in M6, in the sense that the network design reported here satisfies the requirements identified therein.

The outputs of this deliverable D2.2 (together with D2.1) will be used to create the detailed Network Design & Planning activities of WP3, which will be reported in deliverables D3.1 Initial Network Planning (M13), D3.2 Final Network Planning (M23) and D3.3 Procurement, Licensing and Acquisition (M24). Please note that all WP3 deliverables are denoted SEN, since they contain sensitive information, not possible to be shared publicly. (Table 1).

Deliverable	Description	Lead Beneficiary	Date
D2.1 Requirements analysis & Use Case definition	The document contains the approval of the detailed description of the UC scenarios, primarily driven by the Healthcare domain, as well as Education and/or Civil Protection, which are considered of high added value SGIs by the consortium members.	WINGS	M6

Deliverable	Description	Lead Beneficiary	Date
D3.1 Initial Network Planning	The document includes the approval of the radio network planning activities, and the results of the 5G Coverage simulation plan detailing per site the parameter values such as Antenna Direction, antenna Mechanical and Electrical tilt, and Physical Cell IDs. It contains sensitive information, not possible to be shared publicly.	OTE	M13
D3.2 Final Network Planning	The document includes the approved radio network planning activities, and the results of the 5G Coverage simulation plan detailing per site the parameter values such as Antenna Direction, antenna Mechanical and Electrical tilt, and Physical Cell IDs. It contains sensitive information, not possible to be shared publicly.	OTE	M23
D3.3 Procurement, Licensing and Acquisition	The document includes the approved information on the licensing, permits acquisition and procurement activities. It contains sensitive information, not possible to be shared publicly.	OTE	M24

Table 1: Related 5G-TERRA deliverables

2 5G-TERRA Network Overview

Mobile networks facilitate internet communication and data connectivity by using a combination of **base stations, frequency bands** (the available spectrum) and several advanced **technologies**.

The mobile base station is responsible for communicating with mobile equipment in its coverage area by transmitting and receiving radio signals using the allocated frequency bands. It processes voice and data traffic, managing the data flow between mobile equipment and the Core network.

Modern 4G & 5G technologies allow the mobile network to provide enhanced coverage, capacity & reliability, and to optimize its performance for various applications providing higher data rates and lower latency.

By designing a 5G mobile network we focus on offering communication with the:

- Highest possible speed
- Lowest possible latency and
- Support massive number of connected equipment and devices.

An end-to-end description of its architecture and a short overview of its **6 key elements** [4], [5], [6], is the following:

1. **User Equipment (UE)**
    - Devices such as smartphones, tablets, IoT devices, and laptops that connect to the 5G network
2. **Radio Access Network (RAN)**
    - **gNB (Next Generation Node B)**: The base station in 5G, responsible for wireless communication with the UE
    - **NR (New Radio)**: The new radio interface for 5G, capable of using frequencies from sub-1 GHz to millimeter waves (30-300 GHz)
3. **Backhaul Network**
    - Connects the RAN to the Core Network.
    - Typically uses high-speed fiber optics, microwave links, or other high-capacity transmission methods.
4. **Core Network**
    - The backbone of the 5G network, handling all the control and user data traffic
    - Composed of:
        - **AMF (Access and Mobility Management Function)**: Manages registration, connection, and mobility
        - **SMF (Session Management Function)**: Manages session establishment, modification, and release
        - **UPF (User Plane Function)**: Routes user data traffic
        - **PCF (Policy Control Function)**: Manages policy rules
        - **UDM (Unified Data Management)**: Handles user data storage and access
        - **AUSF (Authentication Server Function)**: Manages user authentication
5. **Transport Network**
    - Provides connectivity between the Core network and external networks (e.g., the internet, private networks).
6. **External Networks**
    - The internet, cloud services, enterprise networks, etc., that the 5G network provides access to.

2.1 5G Network Architecture: Non-Standalone & Standalone configurations

The 5G Network architecture can be deployed in two main configurations:

- Non-Standalone (NSA), which leverages existing 4G infrastructure for certain functions and
- Standalone (SA), which operates independently with its own Core network.

Architectural Aspects	Non-Standalone (NSA)	Standalone (SA)
Core Network	Uses existing 4G LTE Evolved Packet Core (EPC)	Uses a new 5G Core Network (5GC)
RAN	5G NR [en-gNB] is deployed alongside LTE eNB, which provides anchor	Solely uses 5G NR [gNB]
Control Plane	Handled by 4G LTE, with 5G NR providing additional data capacity	Fully handled by 5G NR
User Plane	Data can be carried by both LTE and 5G NR	Data exclusively carried by 5G NR
Deployment	Easier and quicker, leveraging existing 4G infrastructure	More complex and costly, requiring new infrastructure
Latency and Efficiency	Higher latency and lower efficiency compared to SA due to reliance on 4G EPC	Lower latency and higher efficiency, with advanced features like network slicing and improved mobility management
Interface	S1-MME, S1-U, X2: between eNB and en-gNB ensuring interworking between 4G and 5G	Service-Based Architecture (SBA)-network functions interact through services & NG interface: N1 (UE-AMF), N2 (gNB-AMF), N3 (gNB-UPF)

Table 2: Architectural aspects NSA & SA

The key differences between NSA and SA architectures lie in the use of the Core network and the degree of dependence on 4G infrastructure, with SA offering more advanced features and better performance but requiring a more extensive deployment effort.

In **5G-TERRA project** the novel RAN base stations will be connected to OTE transport and Core Network, the existing NSA (Non-Stand Alone) 3GPP Rel. 16 network at first, and then migrated to forthcoming SA (Stand Alone) to be deployed till the end of the project.

Cloud and edge computing resources will be provided by WINGS to support the envisaged services.

The network management framework of OTE will provide performance monitoring, proactive/reactive fault management and anomaly detection functionalities. The 5G-TERRA network will be validated through extended amount of measurement data (both on physical/lower layer as well as service-level) to provide statistical confidence and heterogeneity. Furthermore, a detailed analysis of the performance of the 5G deployed infrastructure under various configurations, for various realistic network load conditions and use cases will be performed.

3 5G-TERRA Network Architecture

3.1 Radio Access Network

The majority of the new 5G base stations of the project will be originated from a list of **122** planned new base stations eligible for funding (all candidate sites are in the target regions). Their deployment will expand the 5G network directly and bridge the connectivity gap for the relevant communities significantly.

3.1.1 Aspects of Radio Access Design & Planning

The key aspects of the planning procedure and the formation of the list were:

1. **Identifying the need for a new 5G base station in an area/community**. The process typically begins with the identification of areas where either subscribers have reported poor network coverage or areas have arisen from our simulation tools. Nonetheless, customer complaints of poor network coverage, along with the demands of local authorities or public organizations for high network performance, drive the need for continuous improvement in mobile network infrastructure. In response to this feedback and to address the challenge, the telecommunications companies usually employ an initial planning process involving drive/car measurements/field tests and coverage/capacity simulation analysis to measure and prioritize the problem. In addition to our standard network performance data analysis and reporting, customer feedback is always very essential in pointing the trouble spots.
2. **Suitable site selection/location by performing field surveys and geospatial tool analysis**. Selecting the right location for the new base station is crucial. Factors like proximity to existing infrastructure (access by road and ease of connection to the public electricity supply network are of great importance), terrain, and zoning regulations need to be carefully considered. Field surveys and geospatial analysis tools are used to identify suitable sites.
3. **Designing the new 5G base station**. By carrying out the relevant coverage & interference analysis – capacity planning/radio architecture and antenna & equipment selection, we have finally all the data available to be sure that the new 5G base station can meet the demands of the target area. Notably, low band frequencies are used for rural & urban coverage and mid and high bands for urban areas and hotspots. Bearing in mind interference issues, we use a diverse set of frequency bands so the network can achieve a balance between coverage, capacity, and latency, catering to a wide range of Use Cases from enhanced mobile broadband (eMBB) to ultra-reliable low latency communications (URLLC) and massive machine-type communications (mMTC).
4. **Site acquisition & licensing**. The responsible department starts the preliminary communication with the owners of the land for the agreement of the lease of the necessary space and respectively the processing for the submission of the necessary studies & documents for regulatory approvals is made.
5. **Seeking the regulatory approvals.** All permits and regulatory approvals from local authorities and government agencies are fully obtained before proceeding with the construction of the base station. The licensing related activities may run for several months, and imply the involvement of the responsible Public Services/Authorities (e.g., Local municipalities, Regional Agricultural Land Department, National Center of Public Health Protection and Regional Health Inspectorate, Regional inspection of environment and water, Fire safety and protection of the population Department, Electricity Distribution Company, Directorate of National Construction Supervision, Road Infrastructure Agency, Regulatory Authority, Urban Planning Office, Forestry, Architectural Council, Ministry of Rural Development and Food) depending on the site.

The next steps in the process for deployment of a new 5G base station include:

6. **Issuance of Work Orders (WOs)** for construction (installation materials and works).

7. **Issuance of Purchase Orders (POs)** for all needed hardware, software, and services.
8. **Procurement activities** related to the radio and the transmission software/hardware components required.
9. **Issuance of WOs** for implementation of the radio hardware-radio access network and the transmission parameters.
10. **Optimization activities**, including remote electrical tilt actions, measurements, and site visits.

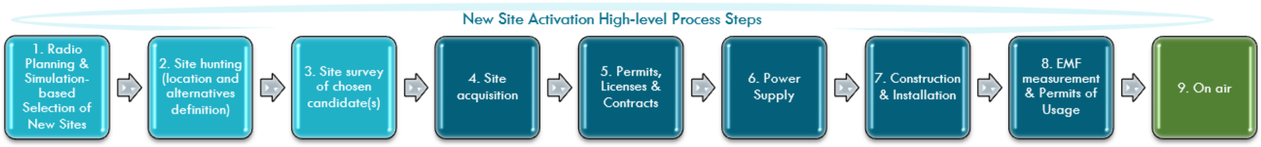

Figure 2: New site activation high-level process steps

Lastly, but of great importance, comes a course of actions standardly taken by OTE such as:

11. **Strengthening the community engagement** by developing plans for involving local communities in the process of developing the mobile network, address concerns, provide opportunities for feedback, and generally ensuring community buy-in.
12. **Illustrate how the deployment of a new base station aligns with community goals and aspirations** by outlining the environmental impact assessments and taking mitigation measures if necessary and emphasizing sustainable and eco-friendly practices.

3.1.2 Radio Network Technical Specifications

In the following table the most important technical specifications of the new 5G-TERRA project base stations are presented:

Radio Specifications	Description
Frequency Bands & Spectrum utilization	The 5G-TERRA network will be deployed on: **700MHz** [5G FDD layer - 1 carrier (BW: 10MHz) and/or **2100 MHz** [4G&5G FDD layer – 1 carrier (BW: 20MHz) - Utilized by both 4G & 5G Users (Dynamic Spectrum Sharing- **DSS**). Carrier aggregation (**CA**) and inter-frequency load balancing will be also supported for all 4G & 5G carrier combinations resulting to higher capacity & throughput. The available spectrum will also include: 800 MHz 4G FDD layer – 1 carrier (BW: 10MHz) & 1800 MHz 4G FDD layer – 2 carriers [BW: 20+10MHz].
Dynamic Spectrum Sharing (**DSS**)	**DSS** is the method that allows 4G and 5G to share the same frequency bands dynamically. **DSS** enables a smoother transition from 4G to 5G and optimizes the use of spectrum resources maximizing coverage & capacity. In the 5G-TERRA network **DSS** will be deployed in the **2100 MHz** band**.**
Carrier Aggregation (**CA**)	**CA** is the combination of multiple frequency bands to increase the overall bandwidth available for data transmission. This results in higher data rates and better utilization of the available spectrum. In the 5G-TERRA areas we aggregate 10+20MHz of 5G [700 & 2100 bands] with 10 MHz [800 band] and 30 MHz [1800 band] dependent on the deployment.
Reference Signal Received Power **(RSRP)**	**RSRP** is the critical metric used in 5G mobile networks to measure the power level of a received reference signal. This measurement determines the quality of the radio link between the user's device and the cell and is essential for various network functions, including cell selection, handover decisions, and signal quality assessment. **RSRP** is specifically the average power received from a single reference signal resource element and is measured in **dBm** (decibel-milliwatts). In the 5G-TERRA areas we aim to achieve **5G RSRP > -95 dBm.**
Quadrature Amplitude Modulation (**QAM**)	**QAM** is a modulation scheme that combines amplitude modulation and phase modulation. 5G uses different orders of QAM, such as 64-QAM, 256-QAM, and 1024-QAM, to achieve higher data rates by encoding more bits per symbol.
Massive (**MIMO)** Multiple Input Multiple Output	**MIMO** employs several antennas to simultaneously serve multiple users, improving capacity and throughput. In 5G-TERRA network with **MIMO 4x4** for HB layers & **256 QAM modulation,** we expect a maximum throughput in good radio conditions of around **1 Gbps in DL and 100 Mbps in UL**.

Table 3: Technical specifications of 5G-TERRA base stations

3.2 Transport Network

The development of the OTE 5G network that the 5G-TERRA project requires affects the transport network that must be modernized to enable the successful delivery of the targeted Use Cases. The transport network is responsible for delivering the traffic of each RAN base station to the Edge IP network. OTE transport network consists of three (3) layers (as depicted in the following figure):

- Last-mile connectivity (also known as backhaul)
- Aggregation transport network
- Core transport network.

Within the scope of the 5G-TERRA Project, the required modernization activities refer to last-mile connectivity (backhaul) and aggregation transport network, which are depicted in the following figure:

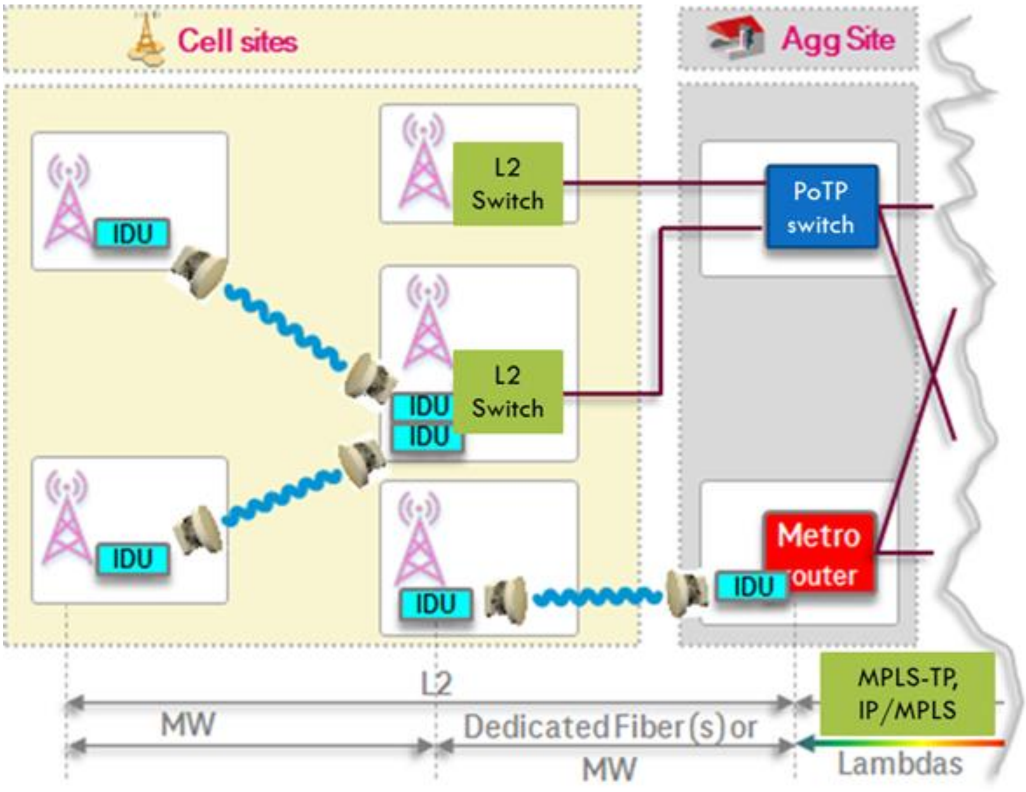

Figure 3: OTE Transport network

The backhaul (last-mile) connectivity consists either of fiber or “fiber speed”-like wireless backhaul technologies. The aggregation transport network consists of Layer 2.5 (MPLS-TP) and Layer 3 (IP/MPLS) devices. Due to RAN requirements, the phase/time synchronization is carried over the transport network with respect to the ITU G.8275.1 full on-path timing support along with SyncE to ensure extended holdover. In specific cases, GPS directly connected to the RAN BS can be also provided [7], [8], [9].

3.2.1 IP Aggregation Network

The IP Aggregation network is deployed with Cisco 9k and Nokia routers– Nokia 7750 SR7 [10]. All the IP Aggregation sites have two redundant routers, and they are protected by uplinks to two independent Core sites via independent paths. The function of this layer is:

- Mobile Network Services:
  - Aggregate Base Station Traffic
  - Offer RNC / BSC connectivity
- Fixed Network Services
  - Broadband Access (PPP based) for residential subscribers
    - Dual Stack offered to all subscribers
    - Offering of IPv6 only access Lw4o6 Access
  - Broadband IPTv (IPoE based) for residential subscribers
  - Broadband Access for Enterprise Customers
    - PPP based (BNG offering LAC functionality) Access
    - Metro Ethernet Access (HQoS mechanisms implemented)
    - L3VPN, L2VPN & Internet Access services
  - Wholesales Services (regulatory obligation)
    - L3 based Services (based on L2TPv2)
    - L2 based Services (BNG implementing L2 switching for subscriber traffic).

IPSecGW, or IP Security Gateway, is a crucial component in mobile networks for ensuring secure communication between mobile devices and the Core network. It acts as a gateway that establishes secure IP tunnels, using the IPSec protocol, between the mobile devices and the network. IPSecGW authenticates and encrypts the data traffic, protecting it from unauthorized access and eavesdropping. It also provides integrity checking to detect any tampering with the data during transit. IPSecGW enables secure remote access to enterprise networks, secure voice and video calls, and secure transmission of sensitive data, ensuring the privacy and integrity of mobile network communications.

OTE employs IPSec as the security protocol for handling user traffic of the eNodeB and gNBs (4G/5G) across multiple clusters for redundancy and load balancing. The logical topology used for this purpose is as follows:

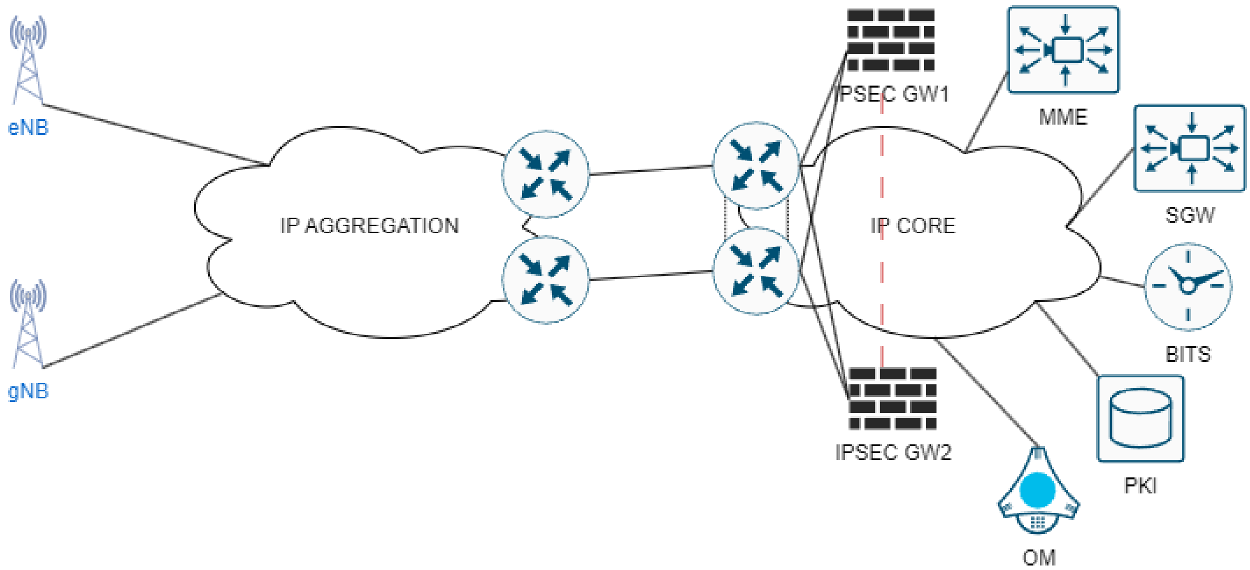

Figure 4: OTE IPsec network design

3.2.2 IP Core Network

Core network basically consists of two types of nodes:

- The "secondary nodes", which are purely LSR devices, and their role is to perform intermediate traffic aggregation between the edge layer and the "primary" nodes. Six Cisco ASR9900 chassis are distributed in pairs in 6 locations, all over country (Larisa, Patra, Crete). Each router of such pair is placed in different geographical area, in terms of geo-redundancy.
- The "primary nodes", responsible to aggregate traffic from both the edge and "secondary" nodes. In addition, these devices provide Internet peering connectivity with OTE upstream Internet provider. With redundancy and capacity as the main drivers, a total of 6 x ASR9900 chassis are evenly distributed in 4 sites. These devices have connectivity to OTE upstream Internet Provider, MPLS edge devices and the secondary nodes.

Each edge node is dual homed towards the Core network, with n x 100GE connections. The Core network is partially meshed with the primary nodes being the center of our topology. The internal/backbone connections' capacity are n x 100GE or 400G connections. In addition, Internet peering connections utilize multiple 100GE or 400G links, in terms of capacity and redundancy. The transmission infrastructure (presented in the following figure) is Hundred Gigabit Ethernet, Dark Fiber or DWDM based.

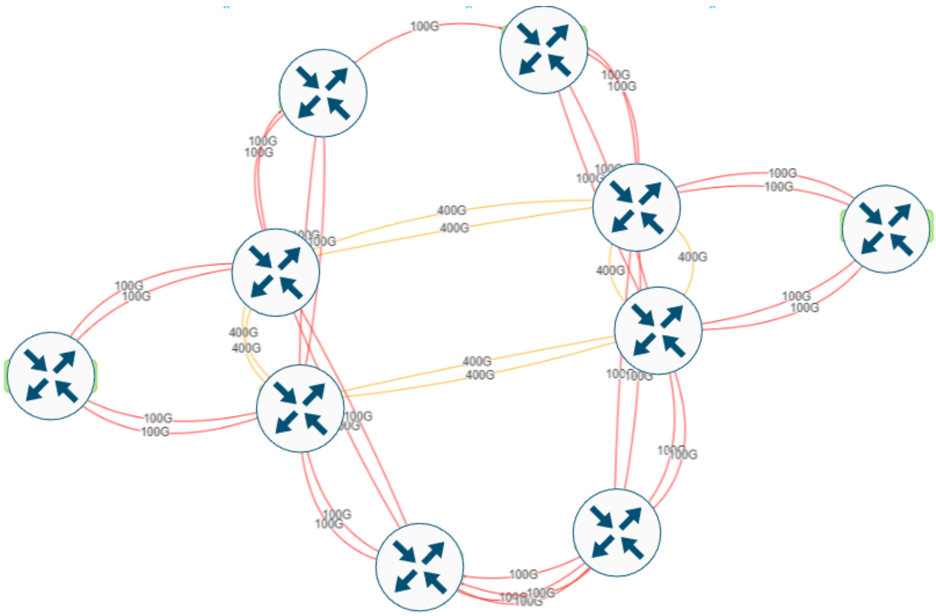

Figure 5: OTE IP Core network

3.3 Mobile Packet Core Network

OTE current Core network (4G/5G NSA) is a native solution consisting of MME, S-GW, P-GW, PCRF, HSS connected to LTE radio network [12], [13].

Current topology for 4G/5G NSA Core network [11], [16] is presented below:

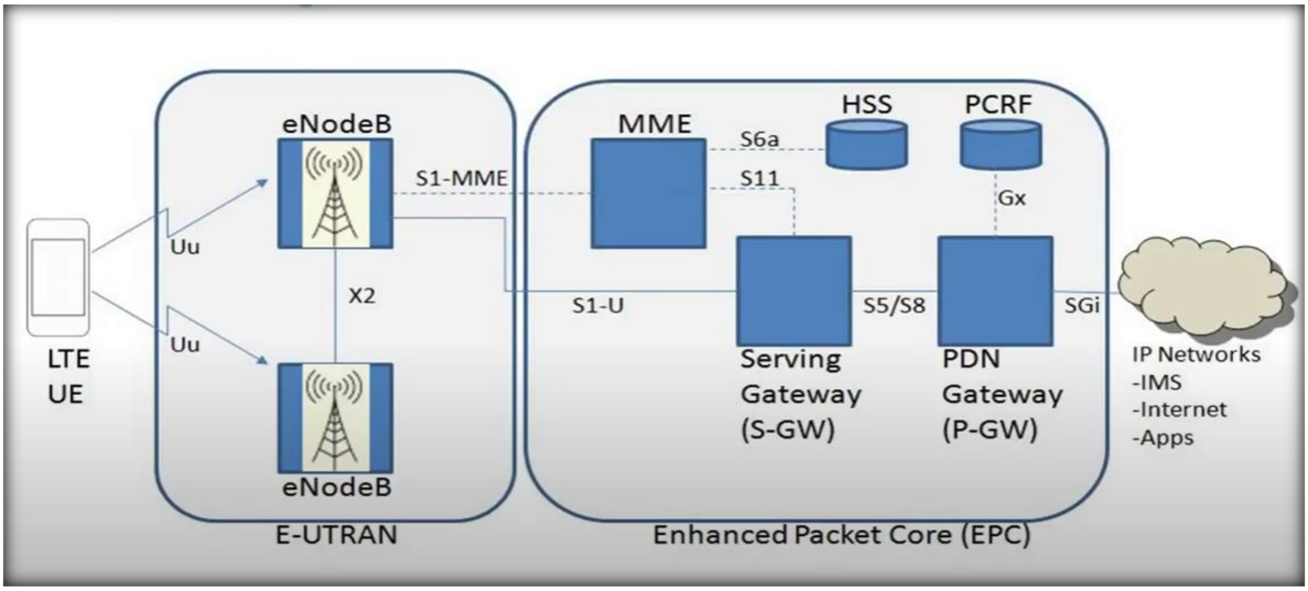

Figure 6: OTE 4G/5G NSA Core network architecture

After the 5GC (5G SA) deployment in the network, the high-level network topology will be changed as below [17]:

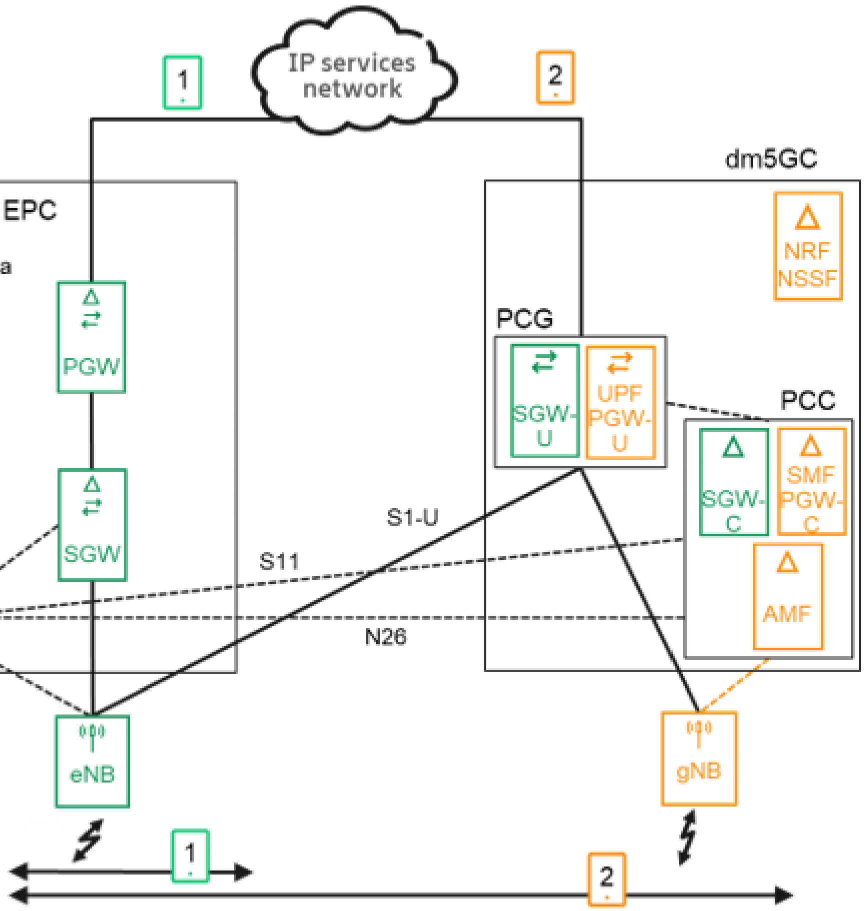

Figure 7: OTE high level network topology

Below is the diagram of 5GC (5GSA) Core network architecture [15].

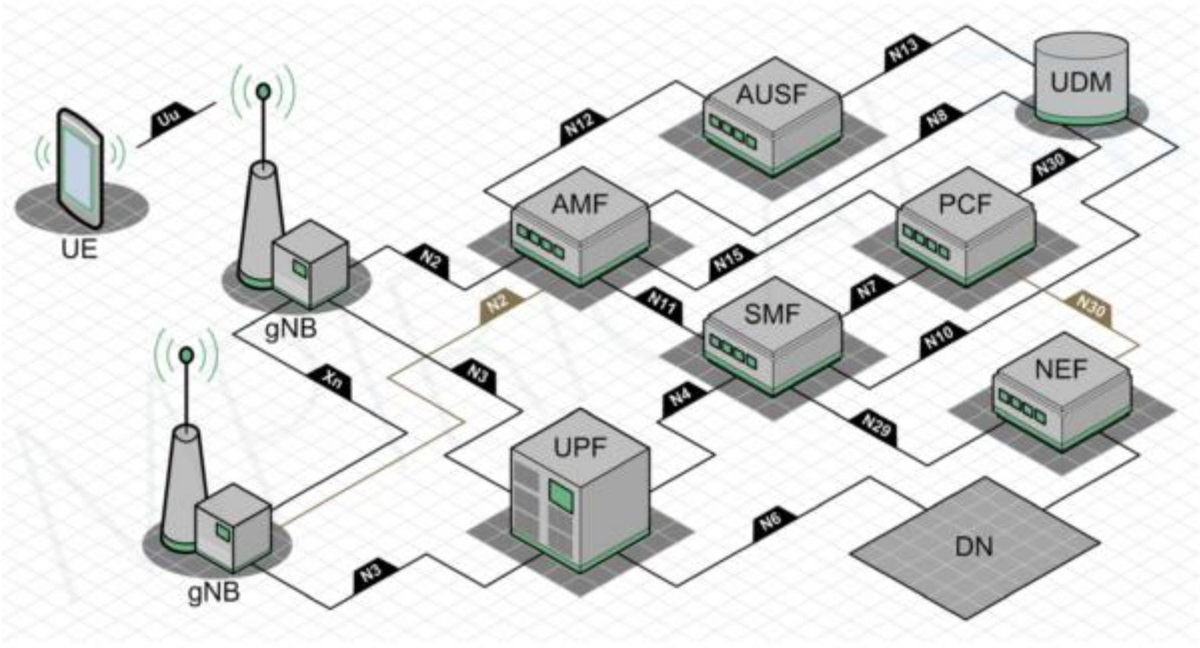

Figure 8: 5GC (5G SA) Core network architecture

3.4 NMS

The Network Management System (NMS) should consist of a suite of Network Management applications, supporting the operation and maintenance workload of Radio, Transport, and Core networks.

High Availability and Fault Tolerance should be the system's Core business characteristics. This ensures that failures in software processes, whether controlled or not, are contained and not of consequence to operations.

The suite of different management applications should be able to support all various network elements associated with the FCAPS management, including advanced management applications, focusing on automation and AI.

All applications should support integrated online help, with overviews, tutorials and videos to help explain common network operations.

Such a system is the **Ericsson Network Manager** or simply **ENM** [14], which is widely used within DT NatCos to handle all sorts of Core, Radio, and Transport elements.

4 Conclusions

5G-TERRA will extend OTE 5G network (in terms of construction, configuration, and connection with the rest of the network) with almost 50 new 5G base stations, towards high capacity, reduced latency, and high reliability mobile services for up to now de-prioritized, rural, and sparsely populated areas in Greece.

OTE scope of the project is the deployment 5G New Radio equipment, along with upgrades in the wireless Backhaul equipment, antennas and links to support the newly deployed or upgraded RAN, towards delivering leading-edge connectivity. Besides the aforementioned works, key activities of the project comprise the specification and execution of Use Cases' scenarios for testing and validating 5G infrastructure.

Next steps regarding activities for Radio Network Planning and the results of the 5G Coverage simulation plan detailing per site as well as parameter values (such as Antenna Direction, Antenna Mechanical and Electrical tilt and Physical cell IDs) will be presented/analyzed in the Deliverable 3.1 (WP3).

5 References

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