

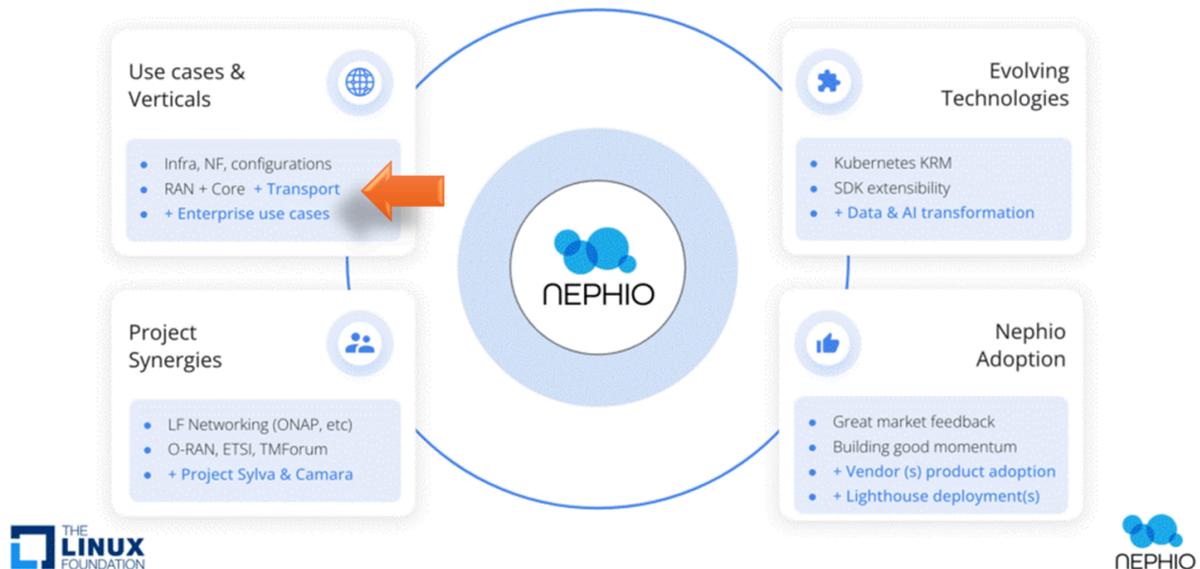
## Feature Overview

### Problem Statement:

Currently, the Nephio project has implemented solutions for the 5G Core Network and Radio Access Network (RAN) using open-source projects such as “Free5GC” and “OpenAirInterface”. However, the implementation of the Transport Network, which connects the 5G Core Network and RAN, is still on the Nephio roadmap:

## A year+ with Nephio, market **feedback** and next steps

Continue to develop additional features



### Rationale:

For large-scale 5G network deployments and Private 5G solutions with over a hundred gNodeBs, a Transport Network is necessary for traffic aggregation and long-distance communication.

To ensure high availability of the connection between the Core and RAN, many routers forming complex topologies such as Chain, Spur, Ring, and Mesh may be used.

A Transport Manager/Controller/Orchestrator is needed for the automatic configuration of these routers, considering the traffic priorities of the RAN network, such as 5QI, DNN, and Slicing.

Open-source project “Kubenet” is proposed to manage Nephio Transport Network in this User Story.

## Details of the Feature:

Nephio Transport Network Management should cover following features (based on Kubenet features):

- Intent-based description of the Transport Network state.
- Source of truth (Generic):
  - Node, Link, IP, VLAN, AS, other
- Source of truth (Telco specific):
  - 5QI
  - DNN
  - Slicing
  - N1, N2, N3, N4 termination points.
  - other
- Network Design templates:
  - Addressing (IPv4, IPv6)
  - Protocols (ISIS, EVPN)
  - Encapsulation (Segment Routing)
- Business Logic to convert Abstract Device Configuration to the Vendor Specific Device Configuration.
- GitOps principles to apply Vendor Specific Device Configuration files on the Transport Network elements.

## How this Feature will Address the Problem Domain:

- 1) Traffic in the Transport Network will be routed with the same priority as dictated by RAN.
- 2) Automatically update Transport Network for each new gNodeB.

## Stakeholders

- Mobile Operators
- Private 5G Operators
- NF Vendors
- CaaS Providers
- Developers

## Personas:

- Network Designer
- Network Operator
- Infra Provider

## Design and Architectural Considerations

- **Integrations:** REST API between Nephio and KubeNet API Servers.
- **Interplay with Other OSS Projects:** "KubeNet" and "RS-Linux" Open-Source Projects.
- **Deployment:** Support deployment in cloud and isolated environments on GitOps principles. Bare Metal Deployment.

## Prerequisites

- Core and RAN Networks are in place, and all main parameters are available for Transport Network connectivity over the Nephio REST API (Source of thrust):
  - 5QI, DNN, Slicing - for traffic prioritization in the Transport Network.
  - N1, N2, N3, N4 connection points - for creation of new MPLS-SR Tunnels in the Transport Network.

## Requirements

### Core Functional Requirements:

- **Must Have:**
  - Declarative description of the desired Transport Network state.
  - Provide connectivity for N1, N2, N3, and N4 interfaces.
  - Auto discovery function to detect new network elements in the Transport Network.
  - Automation of connection provisioning for new gNodeB.
  - Abstract Device configuration files with RAN traffic priorities.
  - Bare Metal and/or K8s Cluster environment for SR Linux deployment.
  - Apply Vendor-specific configuration files using GitOps principles.
- **Nice to Have:**
  - Segment Routing as a preferable encapsulation protocol.

### Non-Functional Requirements:

- **Scalability:** In this User Story proposed just 4 Routers, but to demonstrate High Availability features will be needed up to 10 Routers (Bare Metal).
- **Security:** Secure communication between Nephio and KubeNet API Servers.

## Acceptance Criteria (Definition of Done)

- Secure communication between Nephio and KubeNet API Servers.
- Nephio provide the "Connectivity" and "Source of thrust" API:
  - Connectivity: N1, N2, N3, N4 connection points.
  - Source of thrust: 5QI, DNN, Slicing.
- Successful end-to-end tests.
- Documentation

## Priority

- High (1)

## What's not in Scope

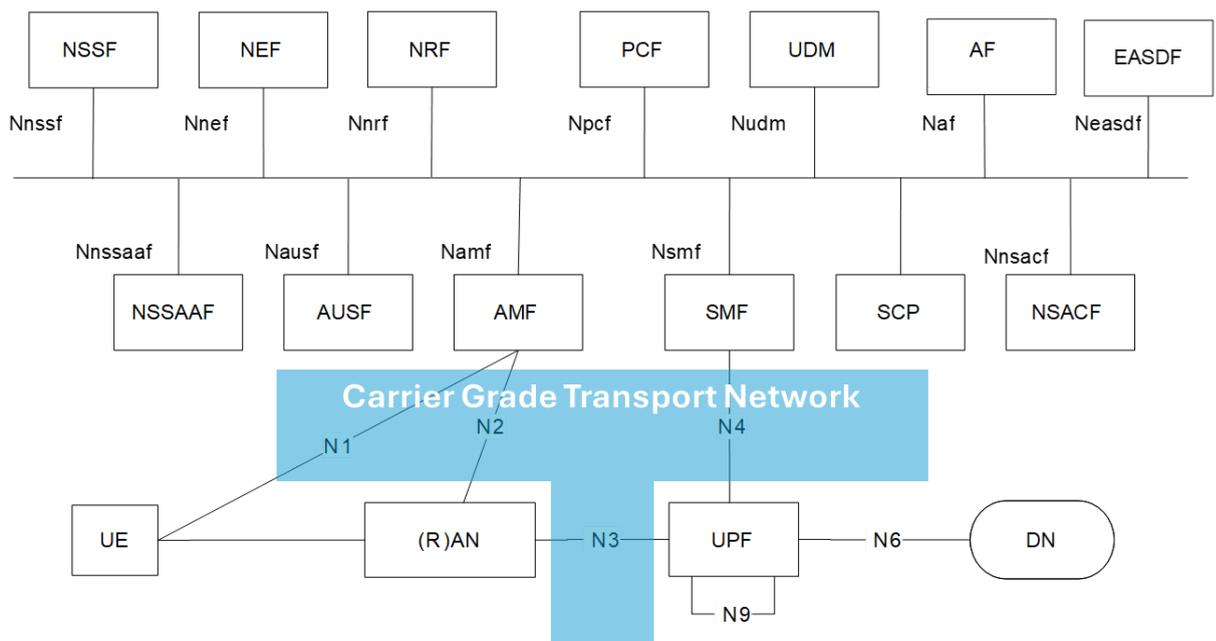
- Transport Redundancy not in Scope: Ring Topology and Redundancy mechanisms usually in place in any carrier grade Network, but this User Story focused on basic connectivity. Transport Redundancy might be considered in some future User Story.
- DC-SDN not in Scope: Data Center Network (Leaf and Spine) usually in place to manage all interconnections within 5GC, including interconnection with Transport Network. Well known Open-Source DC-SDN Controllers like "Open Daylight" or "SONiC" but might be considered in some future User Story.
- Legacy HW Routers which are not supported by Kubenet.
- CWDM/DWDM Transport are not in Scope.
- FrontHaul/MidHaul Networks are not in Scope.
- Transport SDN Controller not in Scope: User Intent implementation will be enough for this User Story.

## References

- <https://learn.kubenet.dev/>

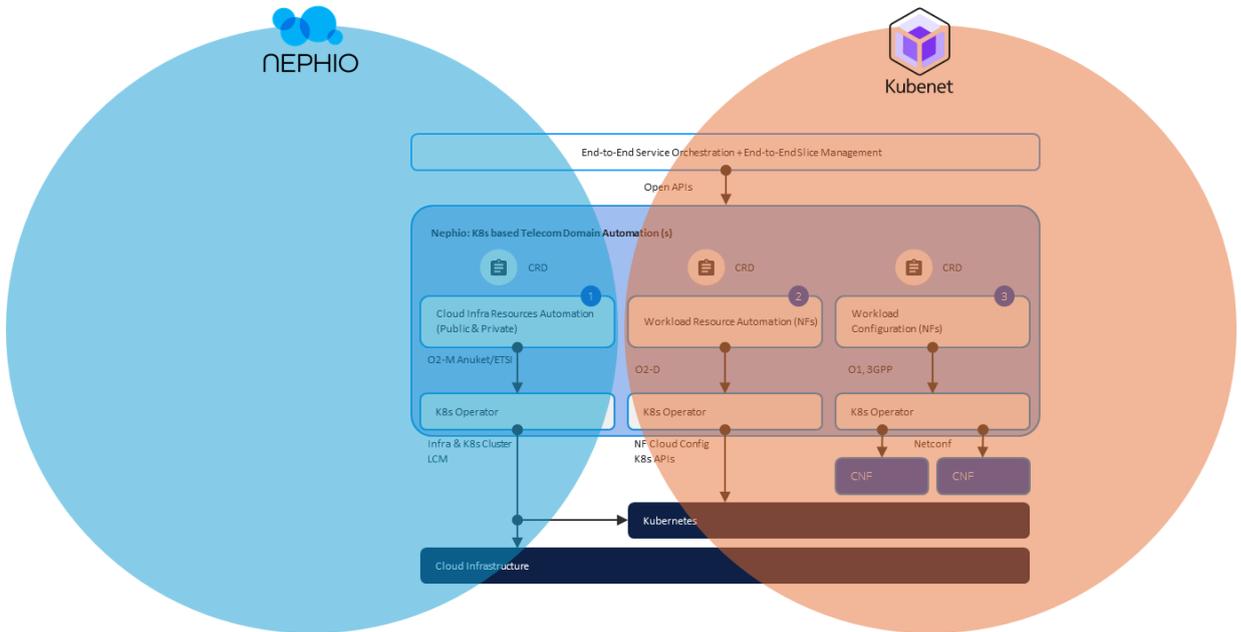
## Component Architecture

- Scope of 5G Transport Network. N1, N2, N3, N4 interfaces:



- Configuration Layers:

### Configuration Layers:

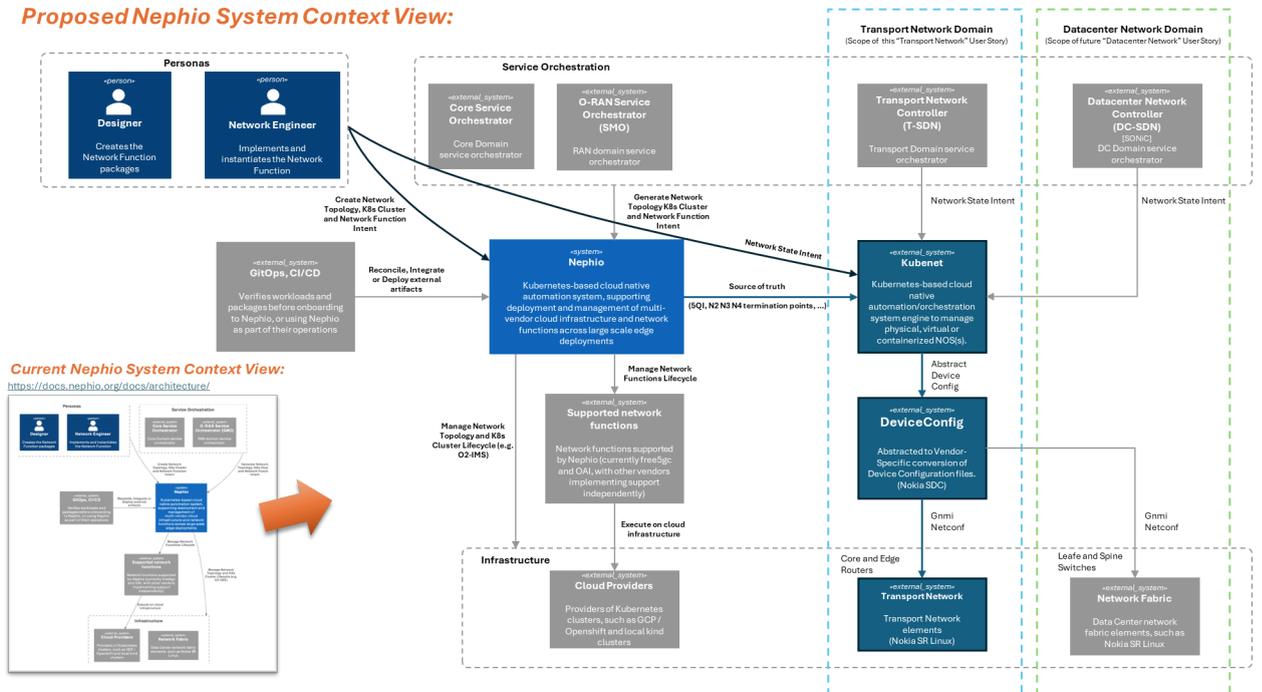


Swim line 1 functionality performed by **Nephio** for Transport Network Elements

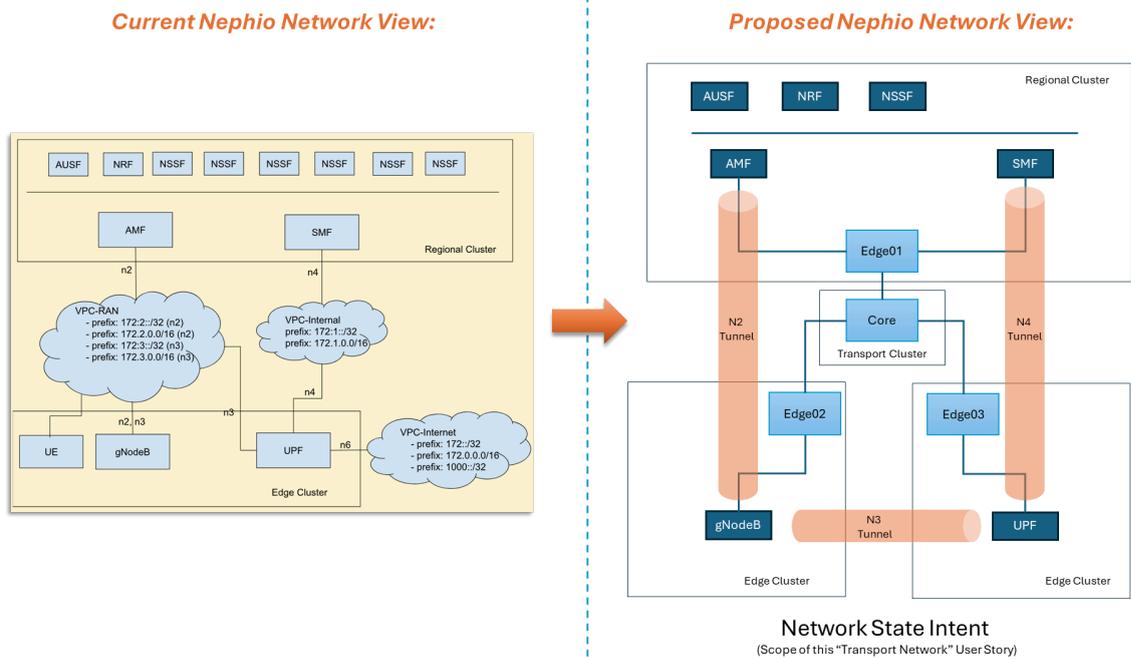
Swim line 2 and 3 functionality performed by **Kubenet** for Transport Network Elements

- Nephio System Context View:

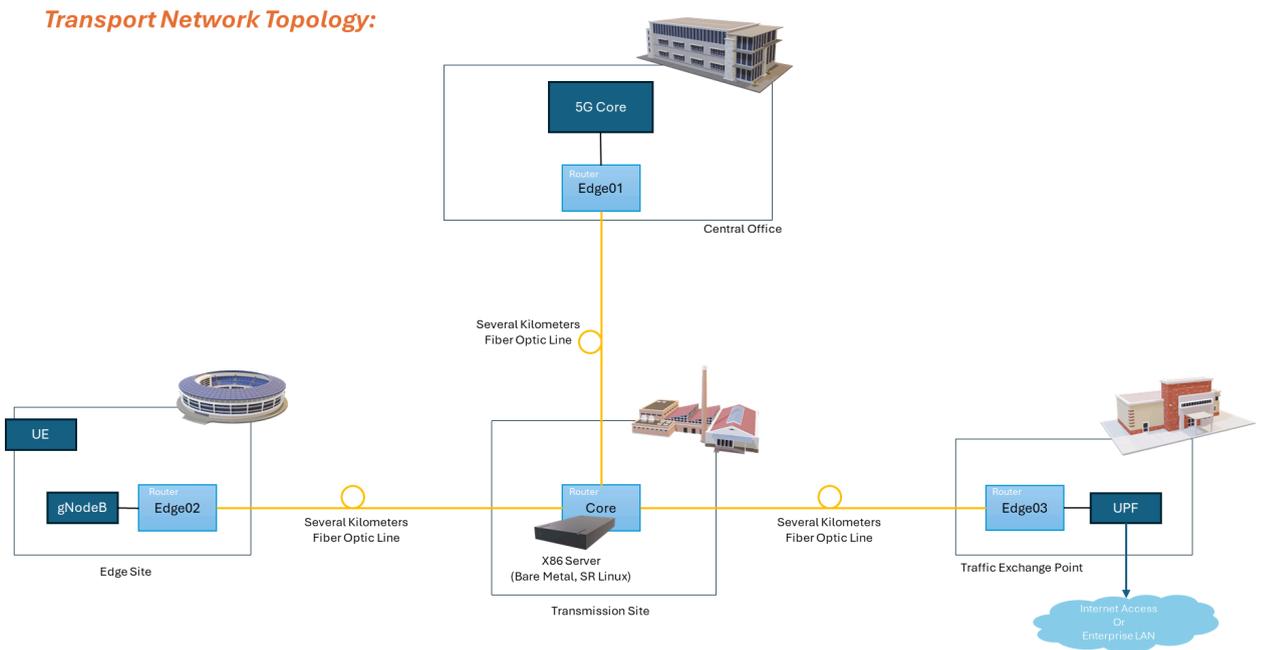
### Proposed Nephio System Context View:



- Nephio Transport Network for implementation:

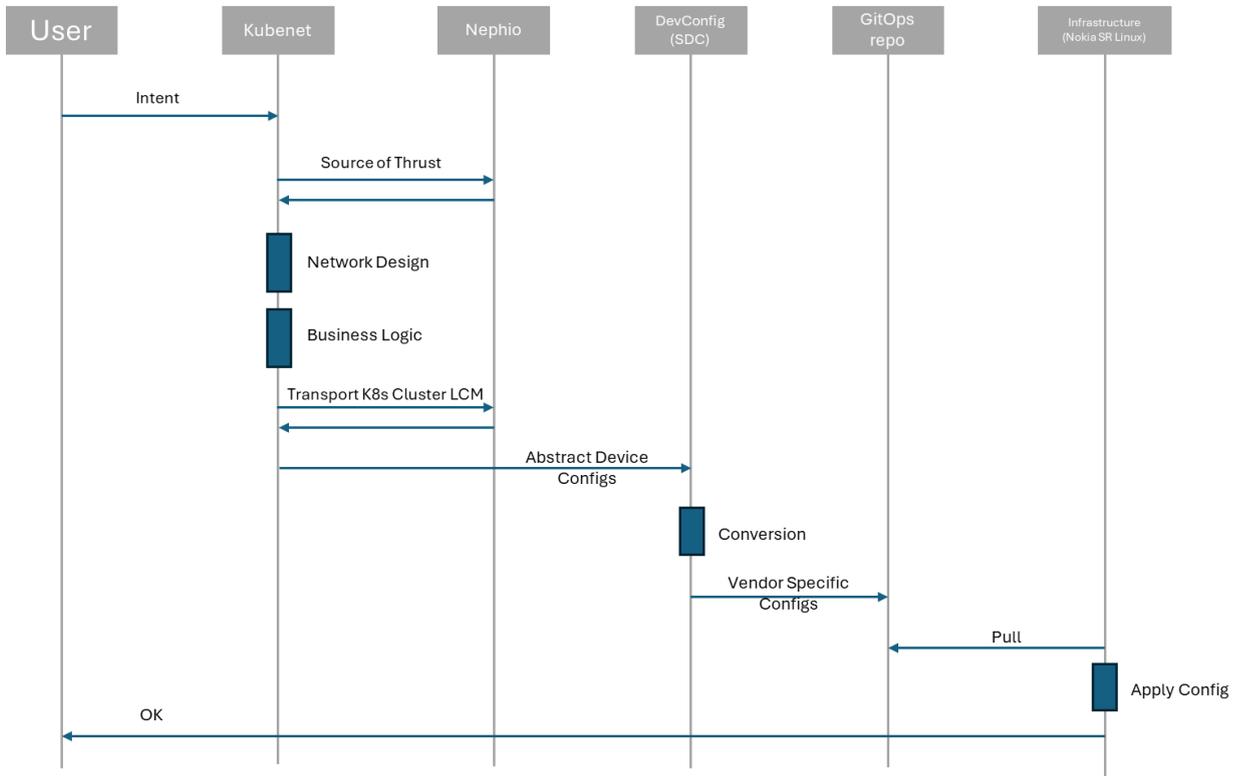


- Example of Transport Network Topology. Long-distance communication:



- Sequence Diagram:

### Transport Network Configuration flow



### Needed Software Development

- Needed Software Development effort to be discussed with Nephio Team.

### API Design

Nephio API to be extended for GET operations:

- RAN Priorities (5QI, DNN, Slicing) to be applied for traffic prioritization in the Transport Network Domain.
- N1, N2, N3, N4 connection points for Tunnel termination endpoints in Transport Network Domain.
- Bare Metal and K8s Cluster LCM for Transport Network elements.

### E2E Test Environment

- E2E Test Environment to be discussed with Nephio Team.