5Growth

5G-enabled Growth in Vertical Industries

08 October 2019

5GPPP TB meeting, Malaga

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Outline

- Project Overview
- Pilot Use Cases and Requirements
- Pilot Deployment Scenarios
- Roles of 5Growth and ICT-17
- Initial Interaction with ICT-17 Platforms
- Next Steps

5Growth

- ***Objectives***
  - The main objective is the **technical and business validation of 5G technologies from the verticals' points of view, by performing field-trials on 4 vertical sites**
  - Leverage on the results of 5G-PPP Phase II project: **5G-TRANSFORMER**
  - Apply and enhance two ICT-17 5G End-to-End platforms: **5G EVE** and **5G-VINNI**

- ***Pilots and field trials***
  - **4 pilots across 4 vertical industries**
  - 9 use cases will be field-trialed on 4 vertical-owned sites (in Spain, Italy, Portugal) in close collaboration with the vendors (Ericsson, Interdigital, NEC, Nokia) and the operators (Telefonica, Telecom Italia and Altice Labs/PT)

- ***Consortium (21 partners)***
  - Verticals: Innovalia, EFACEC Engineering/Systems, Comau
  - Operators: Telecom Italia, Telefonica, Altice Labs
  - Vendors: NEC, ERICSSON Spain/Italy, NOKIA Bell Labs, IDCC
  - SMEs: Nextworks, Mirantis, Telcaria
  - Research Centers: CTTC
  - Universities: POLITO, SSSA, UC3M, NKUA, ITAv

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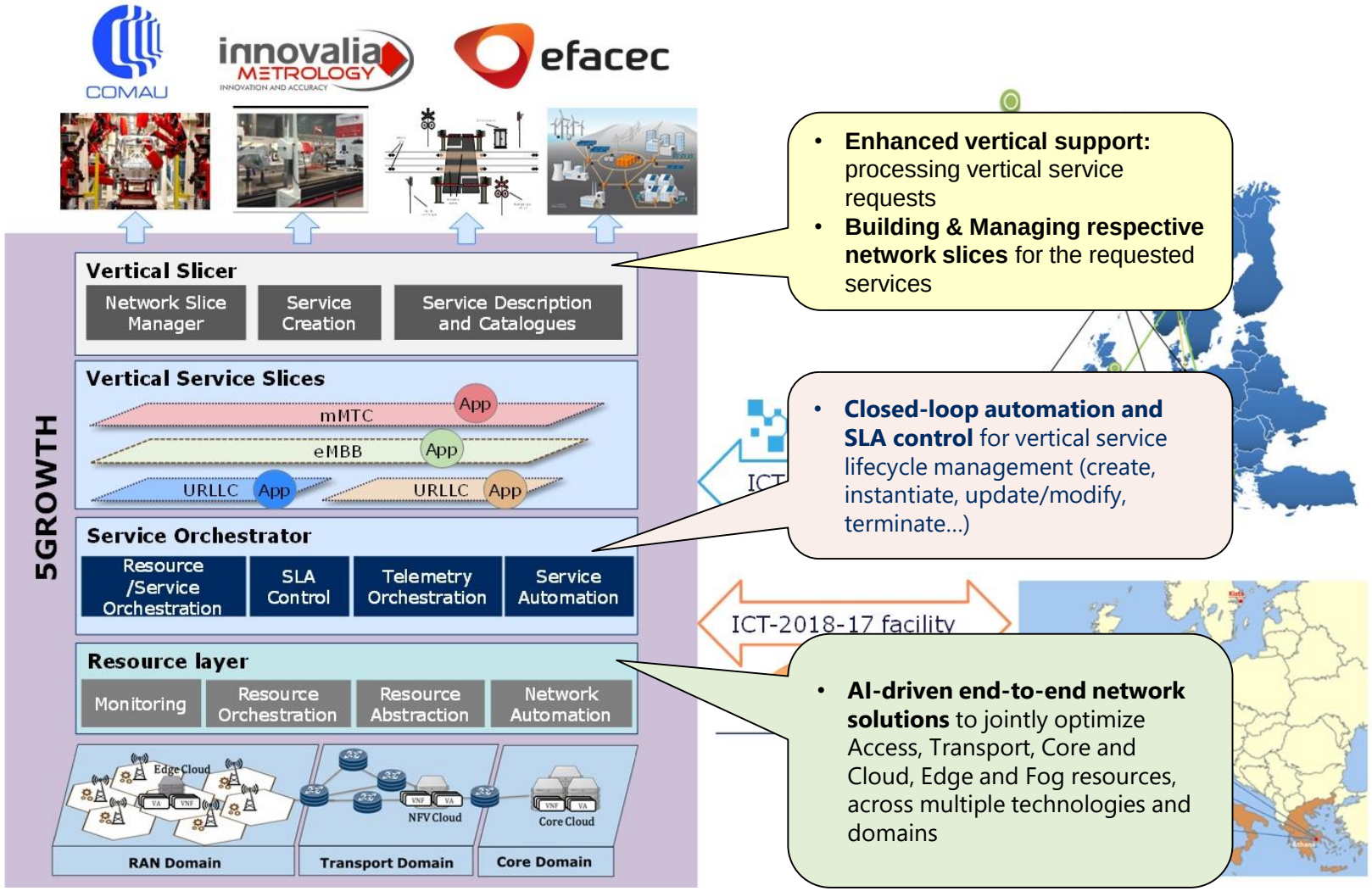
5Growth Vision

To empower vertical industries, such as **Industry 4.0, Transportation, and Energy** with an **AI-driven Automated and Shareable 5G End-to-End Solution**



- **Enhanced vertical support:** processing vertical service requests
- **Building & Managing respective network slices** for the requested services

- **Closed-loop automation and SLA control** for vertical service lifecycle management (create, instantiate, update/modify, terminate…)

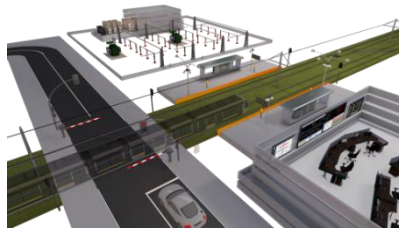
- **AI-driven end-to-end network solutions** to jointly optimize Access, Transport, Core and Cloud, Edge and Fog resources, across multiple technologies and domains

- **Develop the 5Growth platform** to create, provision and manage the vertical services with AI-driven innovations
  - Leverage on the 5GPPP Phase 2 project 5G-TRANSFORMER platform
- **Interaction with ICT-17 Platforms** to provide E2E Solution
  - Via standard Interfaces
  - Develop adaptations to each platform

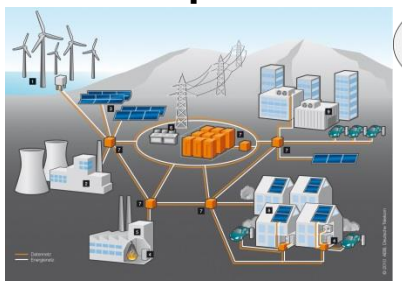
Vertical Pilots

- 5Growth aims to perform real field trials involving customer sites of four vertical locations in Portugal, Spain & Italy
- This requires the development, installation, validation and testing of pre-commercial 5G radio, transport and core technology in vertical sites, connected via the ICT-17 platforms

- Pilots
  - **Industry 4.0:**
    - INNOVALIA
    - COMAU
  - **Energy:**
    - EFACEC_E
  - **Transportation:**
    - EFACEC_S

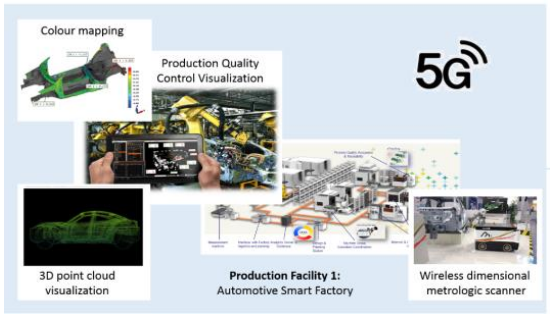


Transportation

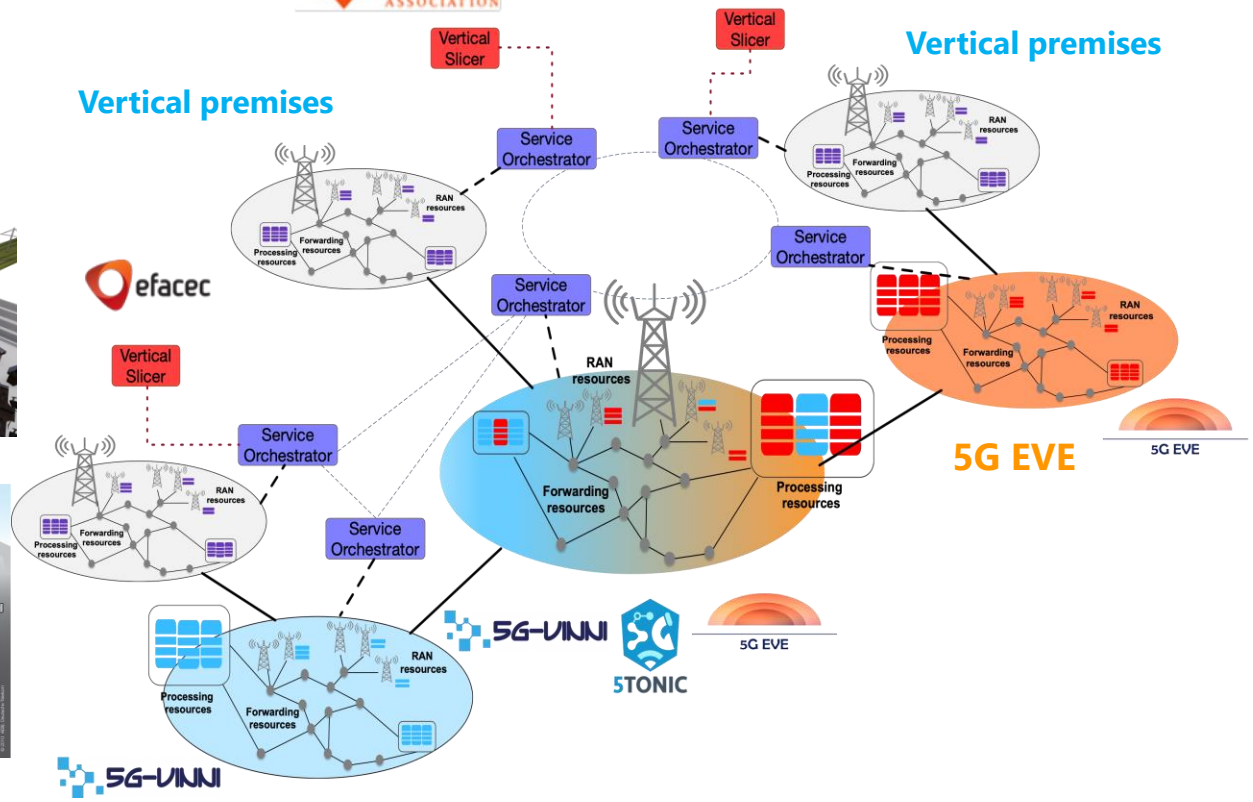


Energy

Industry 4.0



Industry 4.0



Project Status and Ongoing Work

- **In 5Growth**
  - Provided detailed UC descriptions, and defined the business, functional and technical requirements of all pilot use cases in the project (done, reported in D1.1, already delivered at the end of Sep.)
  - Design new innovations of the 5Growth system (ongoing in WP2, to be reported in D2.1, due to the end of Nov. 2019)
  - Analyze and identify the gaps (such as capabilities/features, software/tools, hardware, resources, target KPIs, etc.) in ICT-17 platforms to support all use case requirements (ongoing work in WP3, to be reported in D3.1, due to the end of Oct. 2019)

    -> to align with the Capabilities / Features Cartography Table and KPIs Cartography Table
  - Specification of service KPIs and their mapping to core 5G KPIs (5GPPP network performance related KPIs per vertical pilot (ongoing in WP4, to be reported in D4.1, due to May 2020)

Project Status and Ongoing Work

- **Ongoing discussions with ICT-17 projects**
  - Attended the 5GPP-TB ICT17 and ICT19 Synchronization meeting on 02. Sep.
  - Attended the meeting with 5G-EVE on 03. Sep. providing 5Grwoth view.
  - Provided the technical and KPI requirements of all vertical pilot UCs to 5G-EVE for the ICT-19/22 projects collaboration ->May provide additional input for the KPIs Cartography Table
  - **Proposals and discussions on the potential interaction with ICT-17 platforms (to be presented in Session 4)**
    - 5Growth project has proposed different options for the integration of 5Grwoth system with the ICT-17 platforms to both 5G-EVE and 5G-VINNNI projects.
    - The internal evaluation of the proposed solutions are carried on in both projects, some initial feedback have been provided but the discussion is still ongoing.

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Vertical use cases

Field-trial-based approach on vertical sites (TRL 6-7). In total, 4 pilots and 9 use cases (described in D1.1):

Industry 4.0 (INNOVALIA1): Connected Worker Remote Operation of Quality Equipment

Industry 4.0 (INNOVALIA2): Connected Worker Augmented Zero Defect Manufacturing (ZDM) Decision Support System (DSS)

Industry 4.0 (COMAU1): Digital Twin Apps

Industry 4.0 (COMAU2): Telemetry/Monitoring Apps

Industry 4.0 (COMAU3): Digital tutorials and remote support

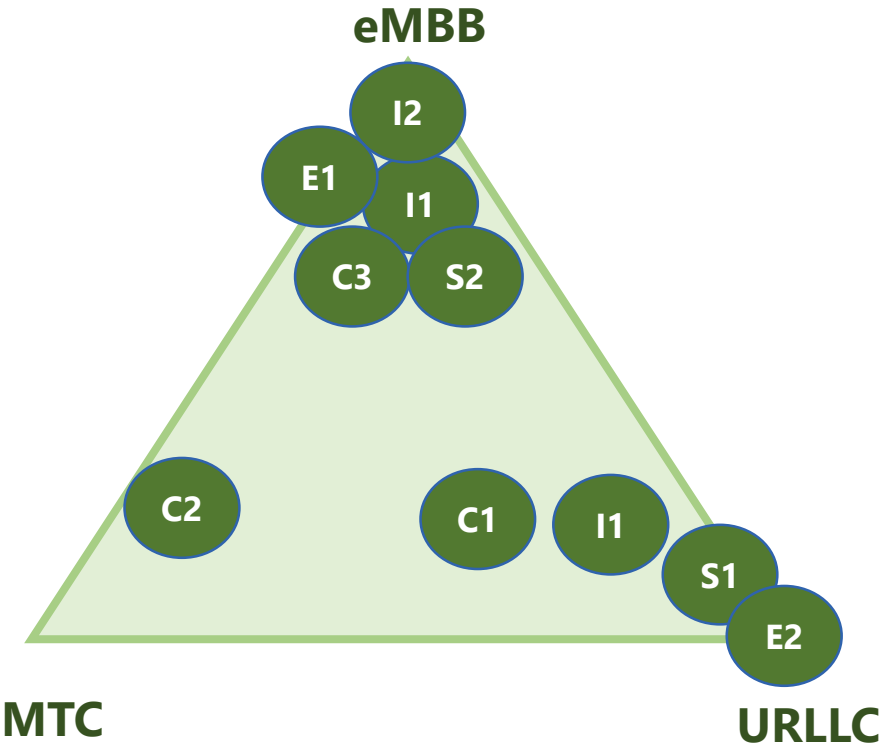
Transportation (EFACEC_S1): Safety Critical Communications

Transportation (EFACEC_S2): Non-safety Critical Communications

Energy (EFACEC_E1): Advanced monitoring and maintenance support of secondary substation - Medium Voltage/Low Voltage (MV/LV) distribution substation

Energy (EFACEC_E2): Advanced critical signal and data exchange across wide smart metering and measurement infrastructures

UC Requirements



Technical KPIs

	INNOVALIA1 (I1)	INNOVALIA2 (I2)	COMAU1 (C1)	COMAU2 (C2)	COMAU3 (C3)
Availability / Reliability (A/R)	99,9999%	99,9999%	99,9999% /80%	99,9999% /80%	99,9999% /80%
Latency (LAT)	<5ms	<5ms	<15ms	<30ms	<50ms
Bandwidth (BW)	1 Gbps	10-20 Gbps	200 Mbps (total)	500 Mbps (total)	500 Mbps (total)
Connection Density (DEN)	< 1000 devices per km^2	< 1000 devices per km^2	< 1000 devices per km^2	< 1000 devices per km^2	< 1000 devices per km^2
Mobility (MOB)	3 km/h	3-50 km/h	3-50 km/h	3-50 km/h	3 km/h
Wide-Area Coverage (COV)	5-8 km²	5 km²	5 km²	5 km²	5 km²

	EFACEC_S1 (S1)	EFACEC_S2 (S2)	EFACEC_E1 (E1)	EFACEC_E2 (E2)
Availability / Reliability (A/R)	99,99%	99,99%	99,99%	99,99%
Latency (LAT)	<10ms	<100ms	–	< 7ms for AR < 5ms for last-gasp < 1ms for synchronization Control plane latency: < 20ms
Bandwidth (BW)	>1200 bit/s	Downlink user experience data rate: > 100 Mbps	Downlink user experience data rate: > 100 Mbps	–
Mobility (MOB)	-	Speed < 160 km/h (expected to have 80 km/h in pilot scenario)	Speed < 120 km/	–
Wide-Area Coverage (COV)	2-30 km²	2-30 km²	10 km²	10 km²

UC Requirements

We provided the following requirements per pilot UC (described in D1.1, already public available)

- Business Requirements: describe high-level requirements from the business point of view, expected from the UCs (also relate to the defined business KPIs)
  - E.g., to deploy a system to remotely configure the machines, to reduce the travel of CMM's experts, etc.

- Functional Requirements: relate to the process and the functionality and features required by the UCs
  - E.g. the industrial environment must be equipped with 5G-enabled devices, enable 5G connectivity to the M3Box edge device, provide security of the data interchange (encryption), etc.

- Technical Requirements: relate to the technologies applied, including Technical KPIs required by the UCs
  - E.g. 5G network must allow 5G slicing for eMBB and URLLC, usage of RTSP for the video streaming (TCP and UDP), usage of TCP protocol for the control. (Joystick to M3Box), Video streaming of 4K HD definition (100Mbps BW), Max. Speed 3km/h (operator walking), availability 99,9999%, etc.

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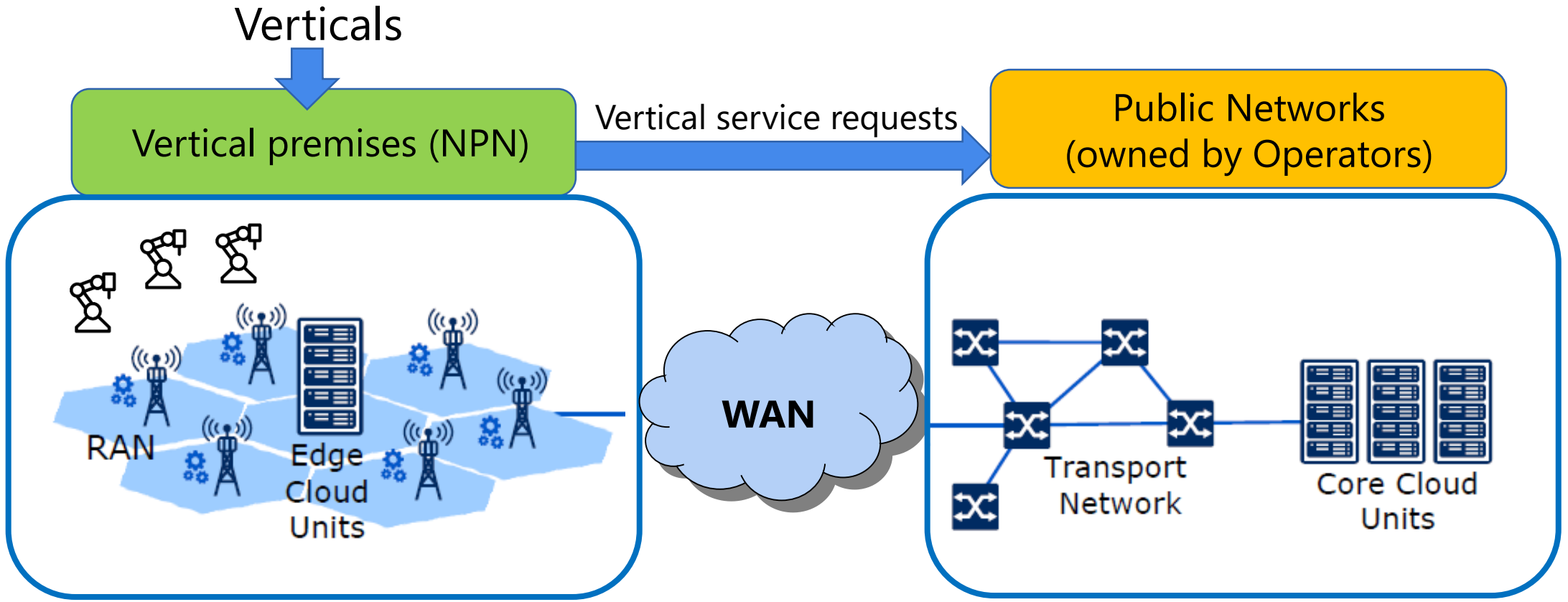
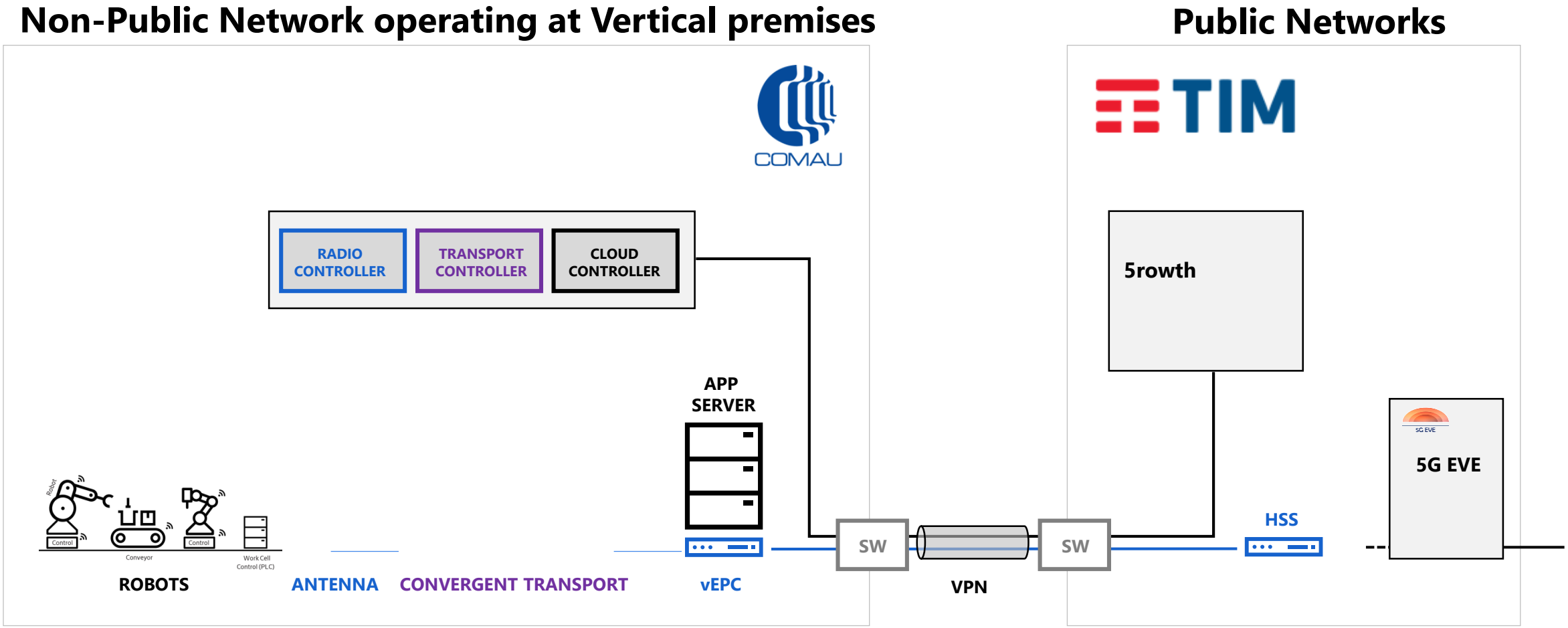
Pilot Deployment Scenarios

The pilot scenarios consist of a Non-Public Network (NPN) at vertical premises and public networks owned by operators providing E2E service and infrastructure that may partly or entirely use the ICT-17 platforms.



Example: COMAU Pilot UC



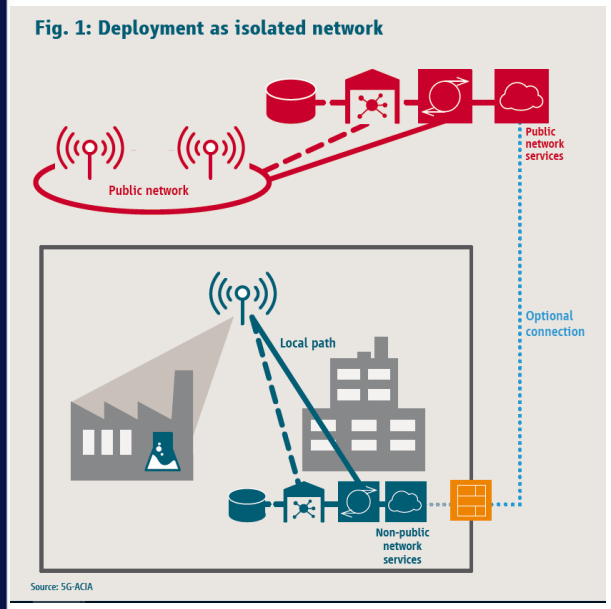
Responsibility of Operators in 5Growth

- The verticals may request the public network operators:
  - to partly or entirely operate their NPN at their premises
  - to deploy the vertical service deployment and management E2E by building a customized network slices tailored for the vertical service requirements.

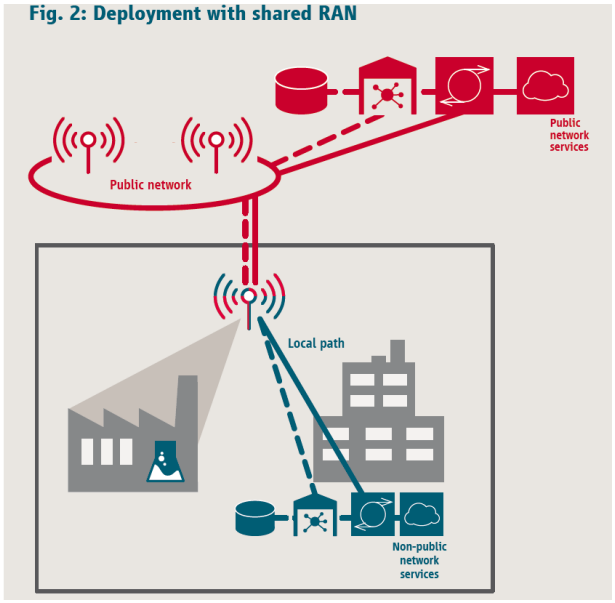
- The public network operators should provide the E2E infrastructure that may partly or entirely uses the ICT-17 infrastructures, as well as the connections to the vertical sites.
  - Responsible for vertical sites as well as the connection to the ICT-17 platforms

5G Non-Public Networks (NPN, or private networks) for Industrial Scenarios (Source: 5GACIA)

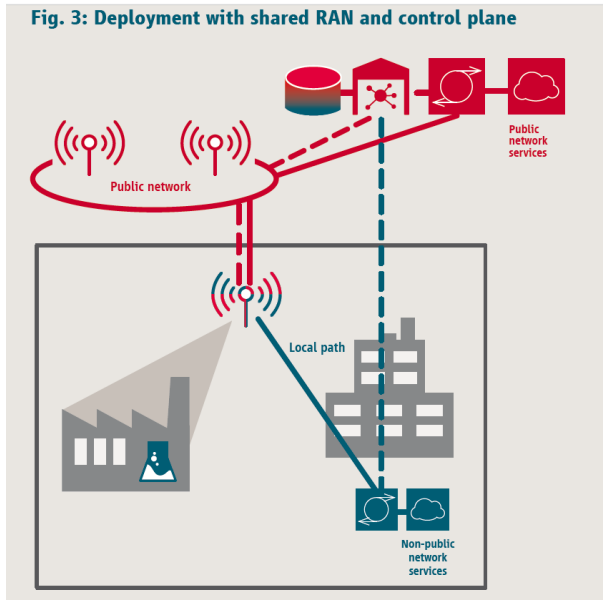
To be explored in 5Growth, depending on pilot UCs



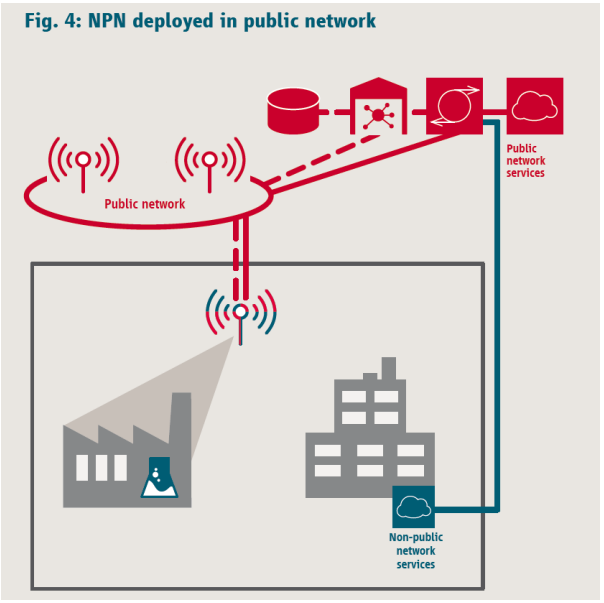
1) Standalone NPN (Isolated Deployment)



2) Shared RAN



3) Shared RAN and Control Plane



4) NPN hosted by public network

https://www.5g-acia.org/publications/5g-non-public-networks-for-industrial-scenarios-white-paper/

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The Roles of 5Growth and ICT-17

- **5Growth system is the entry point for the industrial verticals to request the deployment of their services**

- Everything (e.g. infrastructure of RAN, or edge resources) that will be deployed at the **vertical premises, as well as the WAN connections to the ICT-17, will be managed by 5Growth system**, whereas rest networks will be managed by ICT-17.

- **5Growth system is also responsible for specifying the external interfaces to interact with other domains/platforms** (e.g. ICT-17 platform), which can be tailored to the portal/APIs exposed by other domains or platforms.

The Roles of 5Growth and ICT-17 (cont')

- **5Growth system requests to the ICT-17 platforms "a network slice"**
  - **Scenario 1:** 5Growth system requests to the ICT-17 platform **a network slice covering all network domains (E2E slice) including RAN+TN+CN**.
    - 5Growth is responsible for attaching vApps to the provided E2E slice by making use of the defined SAPs, and provide the MEC or edge computing system in case some of vApps need to be deployed at the edge at the vertical sites.
  - **Scenario 2:** 5Growth system requests to the ICT-17 platform **a network slice covering only a subset of network domains**
    - 5Growth is responsible for implementing the network segments that are out of the ICT-17 network slice and as well the network connections to the ICT-17 platform.
    - For example, if 5Growth system requests the ICT-17 to facility a slice consisting of TN (backhaul) + CN, then 5Growth shall bring, install and maintain all the RAN part (including any front-/mid-haul links that could exist in case functional split in the radio protocol stack is applied).

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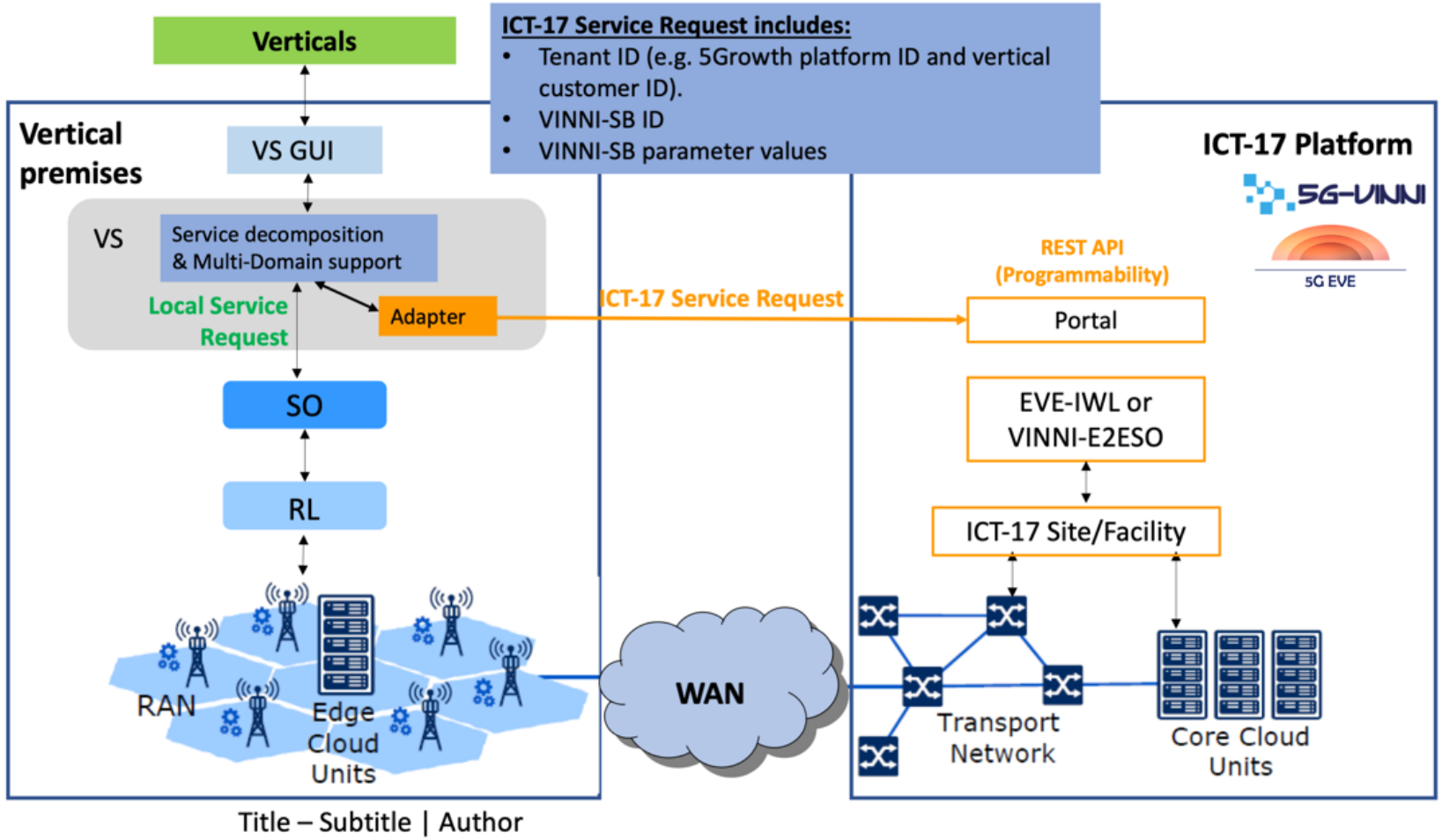
Open questions (under discussion)

1. What can be really offered by the ICT-17 platforms?
2. What are really needed from ICT-17 platforms per use case?
3. Who owns and operates each network, and what level of trust between verticals and operators?
4. What exposure levels are required by the UCs?
5. How to integrate the 5Growth platform with the ICT-17 platforms? E.g. at which layer, how are the interfaces to the ICT-17?
6. How to interconnect the vertical premises to the ICT-17 sites, especially if the vertical premises are far away from the main ICT-17 sites?
7. Where the 5Growth platform will be hosted physically, i.e. at the vertical premises or at the provider or operator premises?

Initial feedback from ICT-17 Projects

- Based on initial discussion and analysis, **both 5G-VINNI and 5G-EVE platforms prefer the interaction at the Vertical Slicer level** to request vertical service instantiation/deployment.

Common:
Both 5G-EVE and 5G-VINNI expose their portal that provide the service model based on vertical service blueprint, describing service offerings to allow verticals to request their services.



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Next Steps

- Propose high level architecture design of 5Growth, focusing on the interaction with ICT17 platforms (*Note that we are open to have different integration models for 5G-VINNI and 5G-EVE*):
  - To understand the deployment of all pilot use cases, so as to clearly identify the needs of ICT-17 platforms to support these use cases (to be reported in D3.1, due to Oct. 2019).
  - To understand the capabilities of both ICT-17 platforms and to identify the gaps (such as features, software, tools, hardware, resources, etc.) in ICT-17 platforms to support all use case requirements (to be reported in D3.1, due to Oct. 2019).
  - Try available experiment facilities from 5G-EVE and 5G-VINNI with real use cases.
  - Propose solutions to interconnect the vertical premises to the ICT-17 sites at the data plane/infrastructure level.
  - The above analyses will help us to decide the proper integration with the ICT-17 platforms. **This task will be in close collaboration with both 5G-EVE and 5G-VINNI projects to evaluate the proposed solutions**.
- It is essential to also align with other ICT-19 projects on their interactions with the ICT-platforms, to be coordinated by 5GPPP.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 856709.

5Growth

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  - SMEs: Nextworks, Mirantis, Telcaria
  - Research Centers: CTTC
  - Universities: POLITO, SSSA, UC3M, NKUA, ITAv

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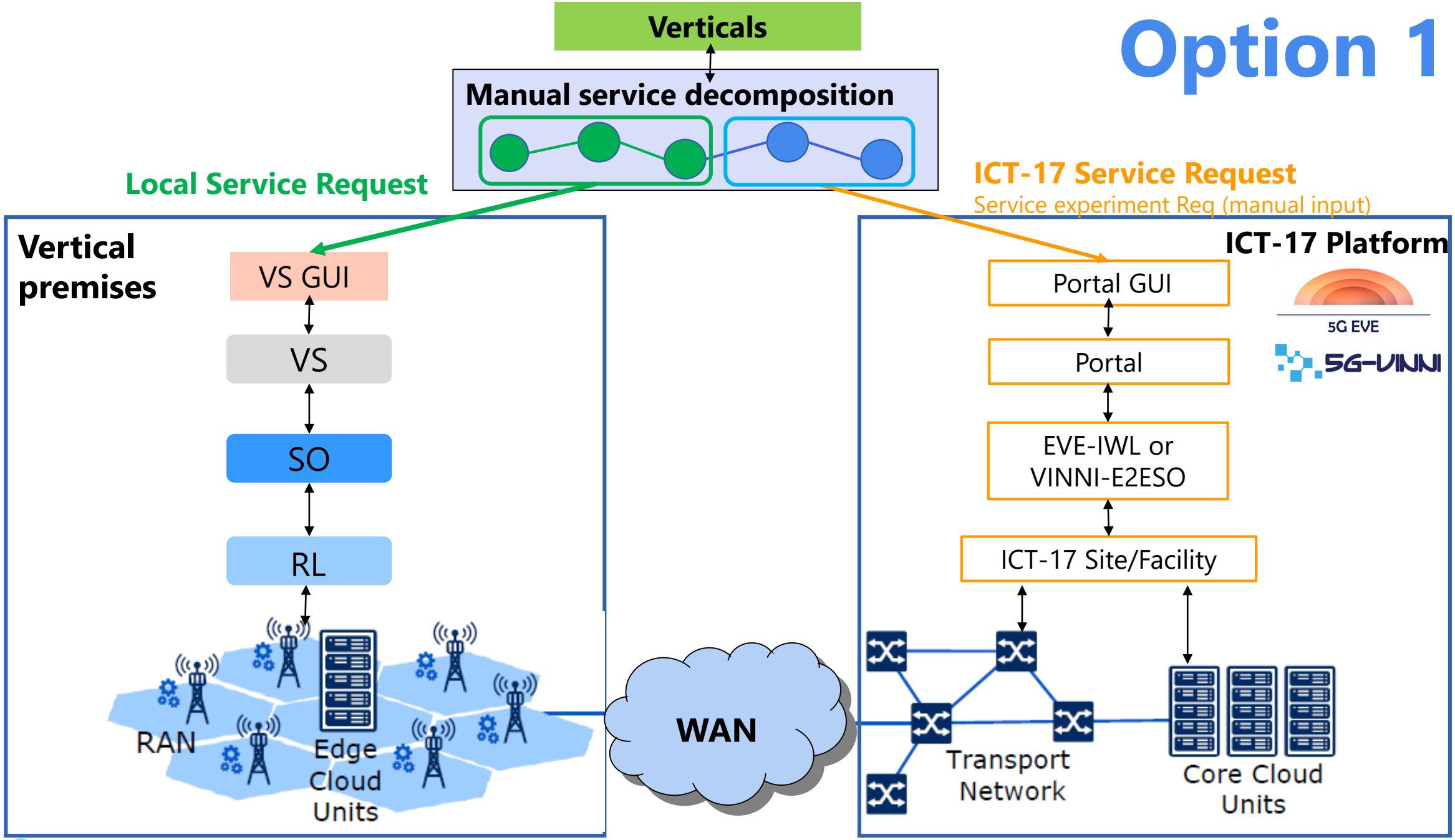
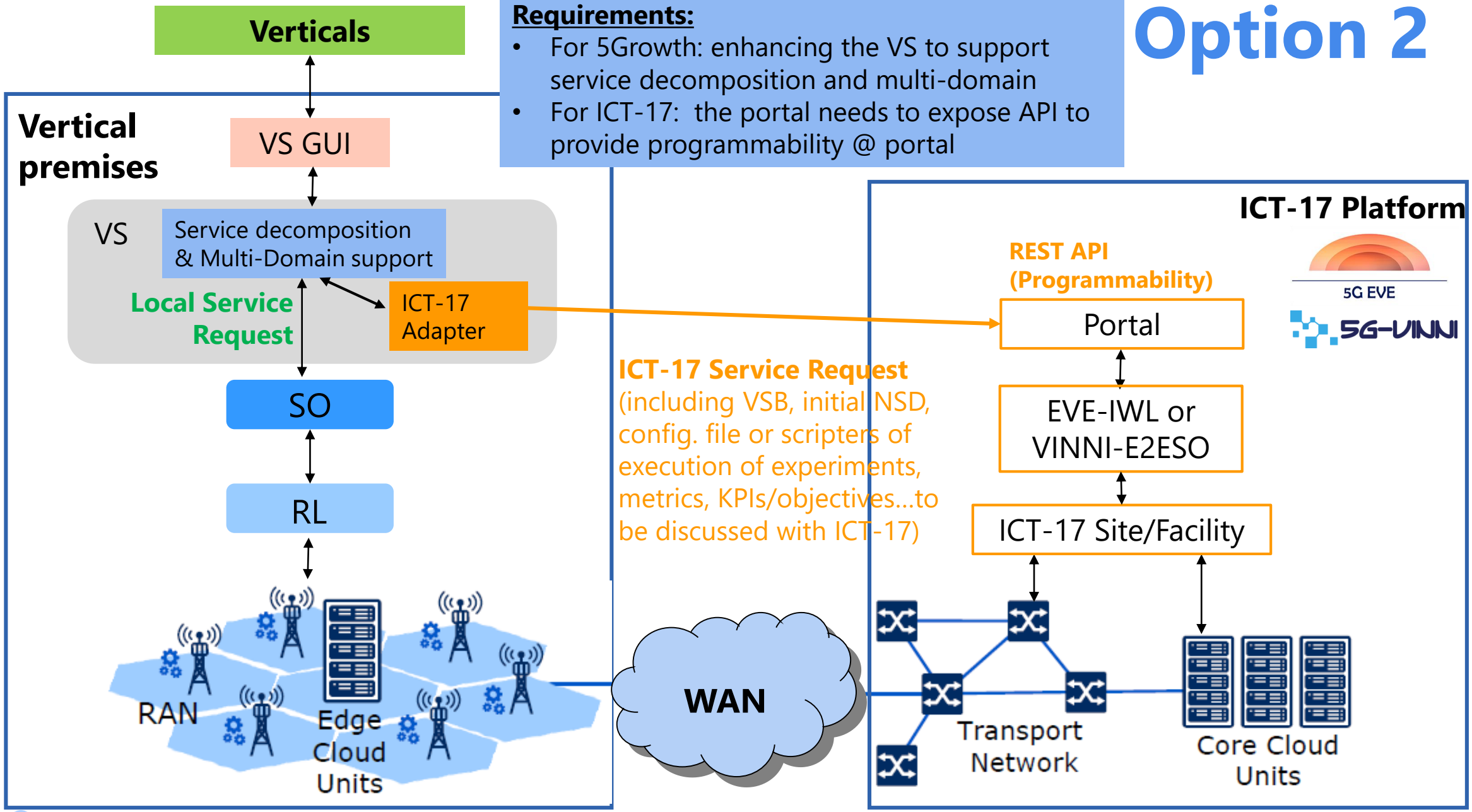
Option 1


Verticals
Manual service decomposition
Local Service Request
ICT-17 Service Request
Service experiment Req (manual input)
Vertical premises
VS GUI
VS
SO
RL
RAN
Edge Cloud Units
WAN
ICT-17 Platform
Portal GUI
Portal
EVE-IWL or VINNI-E2ESO
ICT-17 Site/Facility
Transport Network
Core Cloud Units
5G EVE
5G-VINNI

Option 2

Requirements:

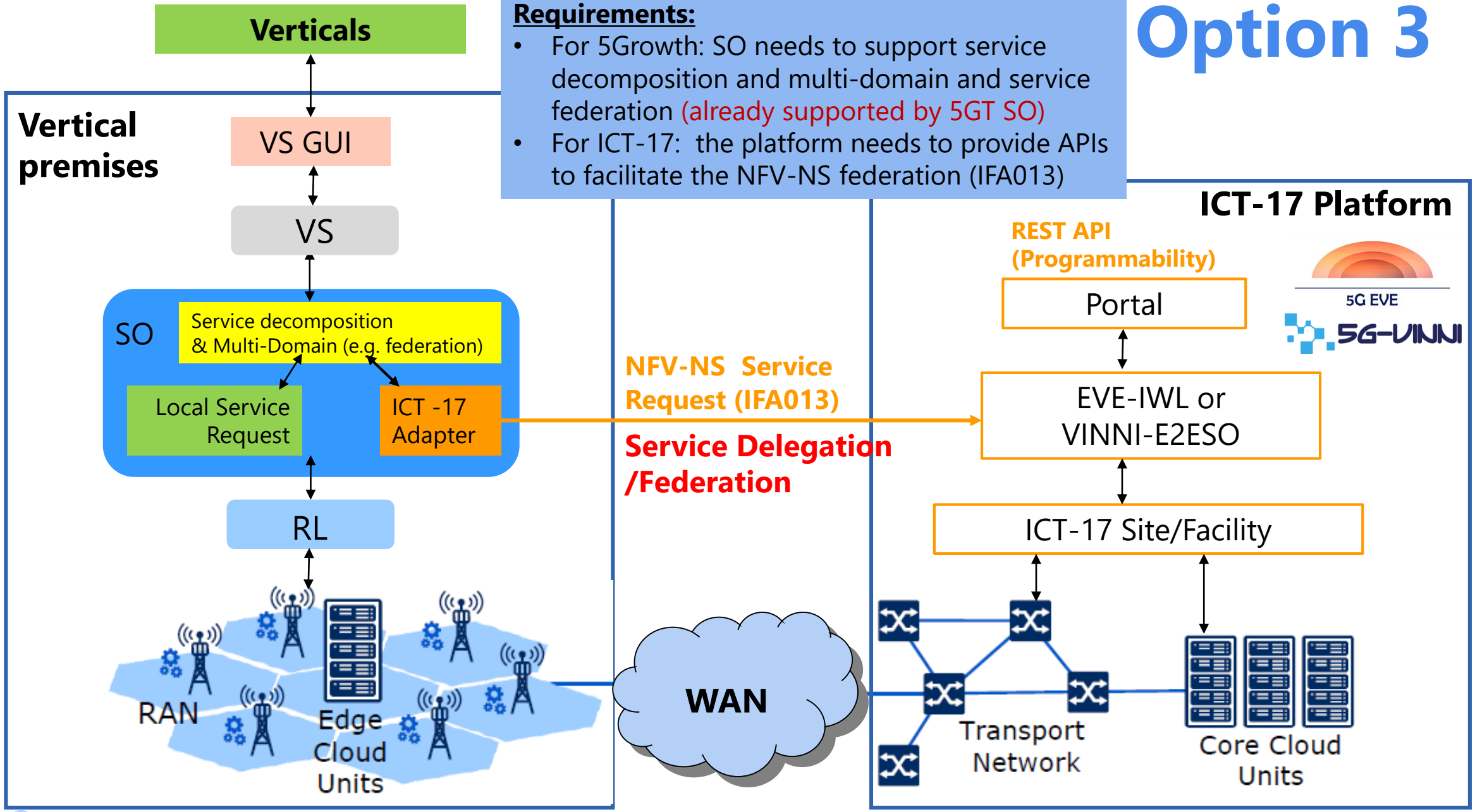
- For 5Growth: enhancing the VS to support service decomposition and multi-domain
- For ICT-17: the portal needs to expose API to provide programmability @ portal



Option 3

Requirements:

- For 5Growth: SO needs to support service decomposition and multi-domain and service federation (already supported by 5GT SO)
- For ICT-17: the platform needs to provide APIs to facilitate the NFV-NS federation (IFA013)



Summary

- **Options 1 and 2** are similar, assuming integration with 5Growth platform **at the "vertical service/network slice" level.**
  - Both options provide to the ICT-17 platform **a vertical service request** (similar to GSAM's GST, 5GT-Vertical Service Blueprint, VINNI-Service Blueprint), that **provides a customer-facing service specification**.
    - Vertical service request includes service related parameters: service type, service graph/topology, service requirements (service SLA, QoS/QoE, location or latency constraints, etc.), service exposure and monitoring metrics, ...
  - The difference of option 1 and 2 is on the service order process: either specify manually (op 1) via a portal GUI or via programming through the APIs (op 2)

- **Option 3** assumes integration with 5Growth platform **at the "NFV Network Service" level**.
  - It provide to the ICT-17 platform **a resource-facing service specification, directly to the ICT-17 service orchestrators.**
  - The 5Growth interacting with the ICT-17 platform via either service delegation or service federation, assuming service decomposition at the SO level.
  - To enable Option 3, ICT-17 Service Orchestrator needs to provide APIs able to process requests from 5Growth-Service Orchestrator, e.g. IFA013 compliant APIs.

The Roles of 5Growth and ICT-17

Example of EFACEC Trasnport and Energy Pilot scenarios: **Scenario 1**: 5Growth requests to ICT-17 to provide an E2E slice inclu. RAN+TN+CN

EFACEC

(to be further discussed)

Just provide vertical NBI and the portal to order service to VINNI

5Growth Stack (VS)

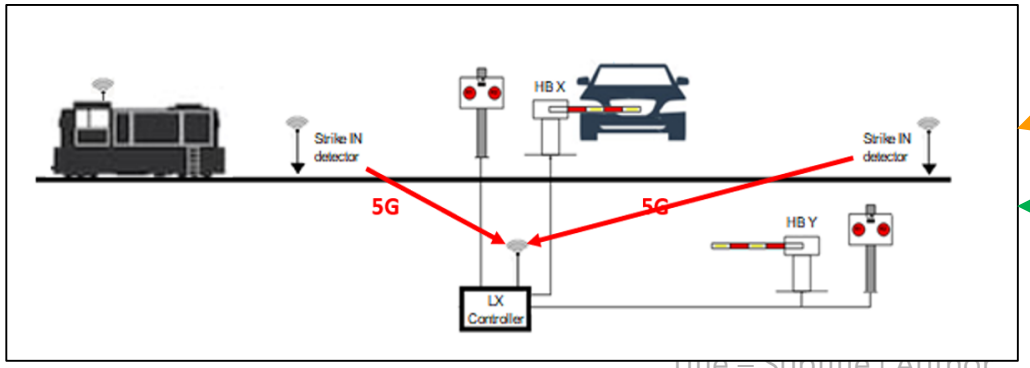
Managed by ALTICE LABS

Control plane

ICT-17 Platform

5G-VINNI Platform

Vertical Premises

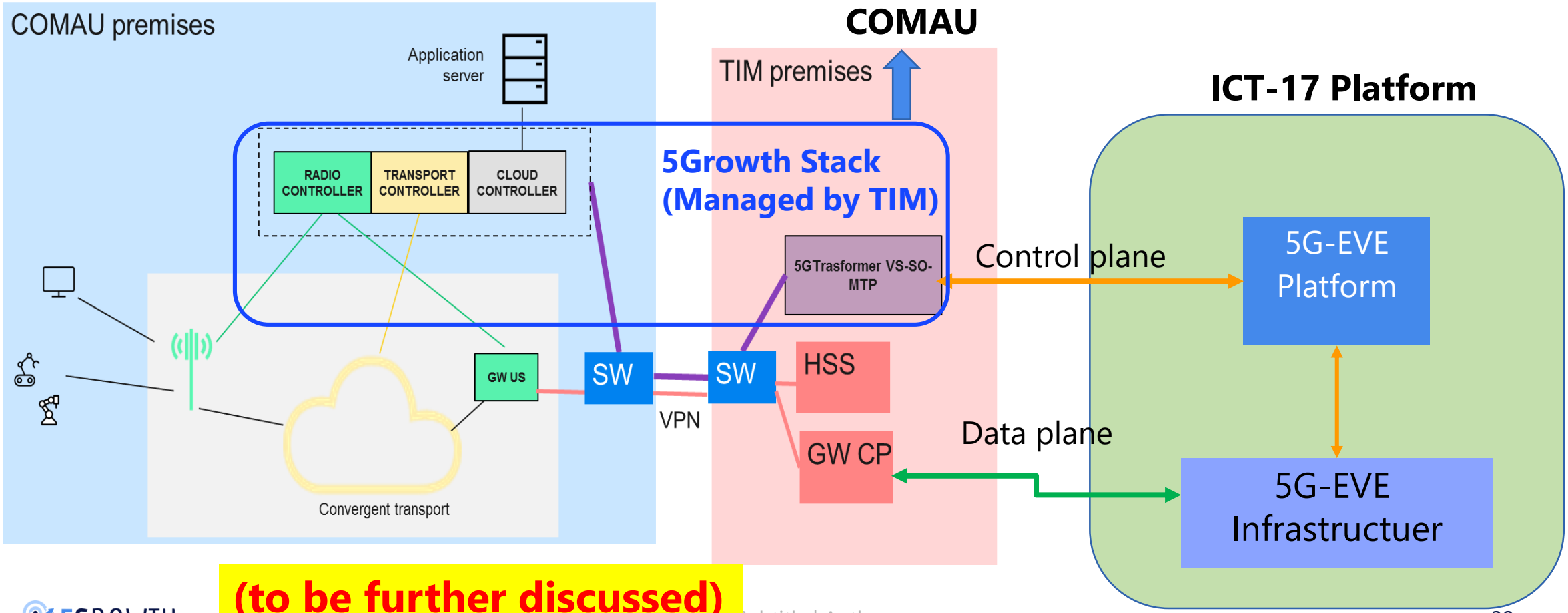


Data plane

5G-VINNI E2E Infrastructuer

The Roles of 5Growth and ICT-17

Example of COMAU Pilot scenarios: **Scenario 2** - 5Growth system requests to ICT-17 to facility a slice consisting of TN (backhaul) + CN



(to be further discussed)