

5G SEAGUL

5G Seamless Roaming for the Greece-Bulgaria Cross-Border



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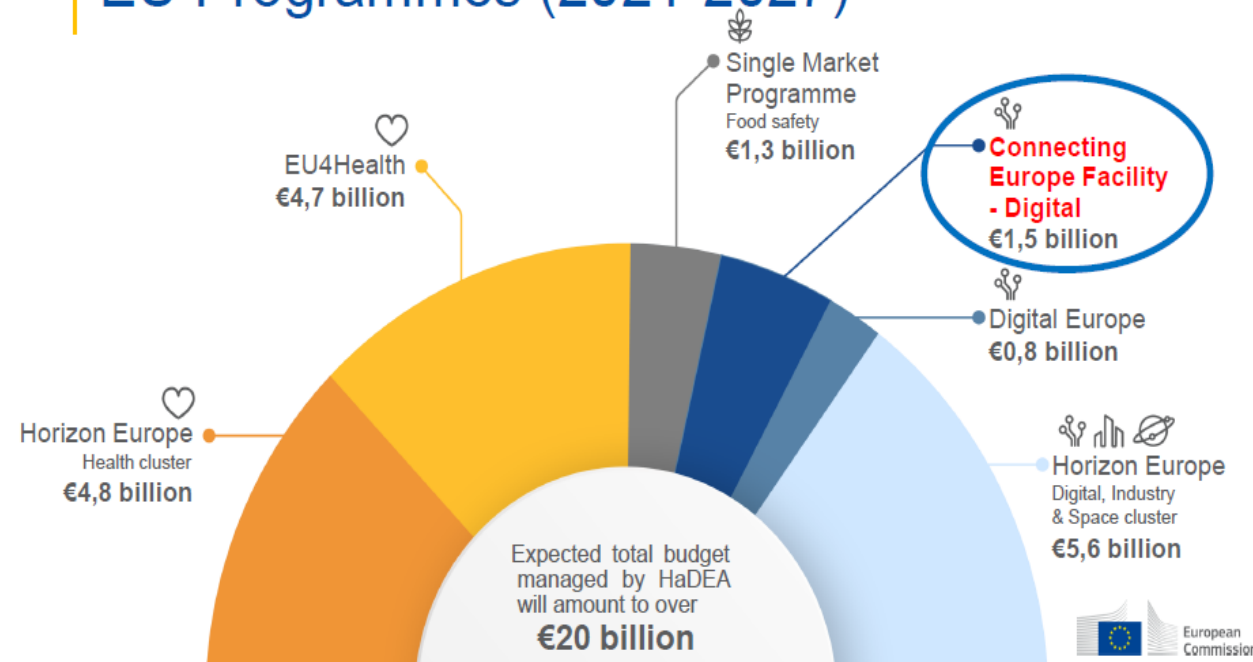
Use Cases

CEF-Digital Programme Scope

The programme implemented by the European Health and Digital Executive Agency (HaDEA) plans **to support and stimulate the digital infrastructure investments in Member States** by providing co-funding/investment opportunities targeting four (4) key areas, namely:

- **Cross-border 5G corridors along major European transport routes.**
- Connectivity for 5G smart communities in Europe.
- Backbone networks of strategic importance, such as for High Performance Computing (HPC), EU cloud infrastructures and submarine cables.
- Synergy projects between digital, transport and energy infrastructures.

HaDEA implements EU Programmes (2021-2027)



5G Seamless Roaming for the Greece-Bulgaria CBC^(*)

CEF-DIG-2021-5GCORRIDORS- WORKS

Main Goal

To deploy SoTA 5G network infrastructure (access, transport, core, edge) to provide seamless, uninterrupted connectivity along 473Km of the Orient/East-Med TEN-T^(**) corridor Sofia-Thessaloniki-Athens, incl. the GR-BG border-crossing of Promahonas/Kulata

Consortium

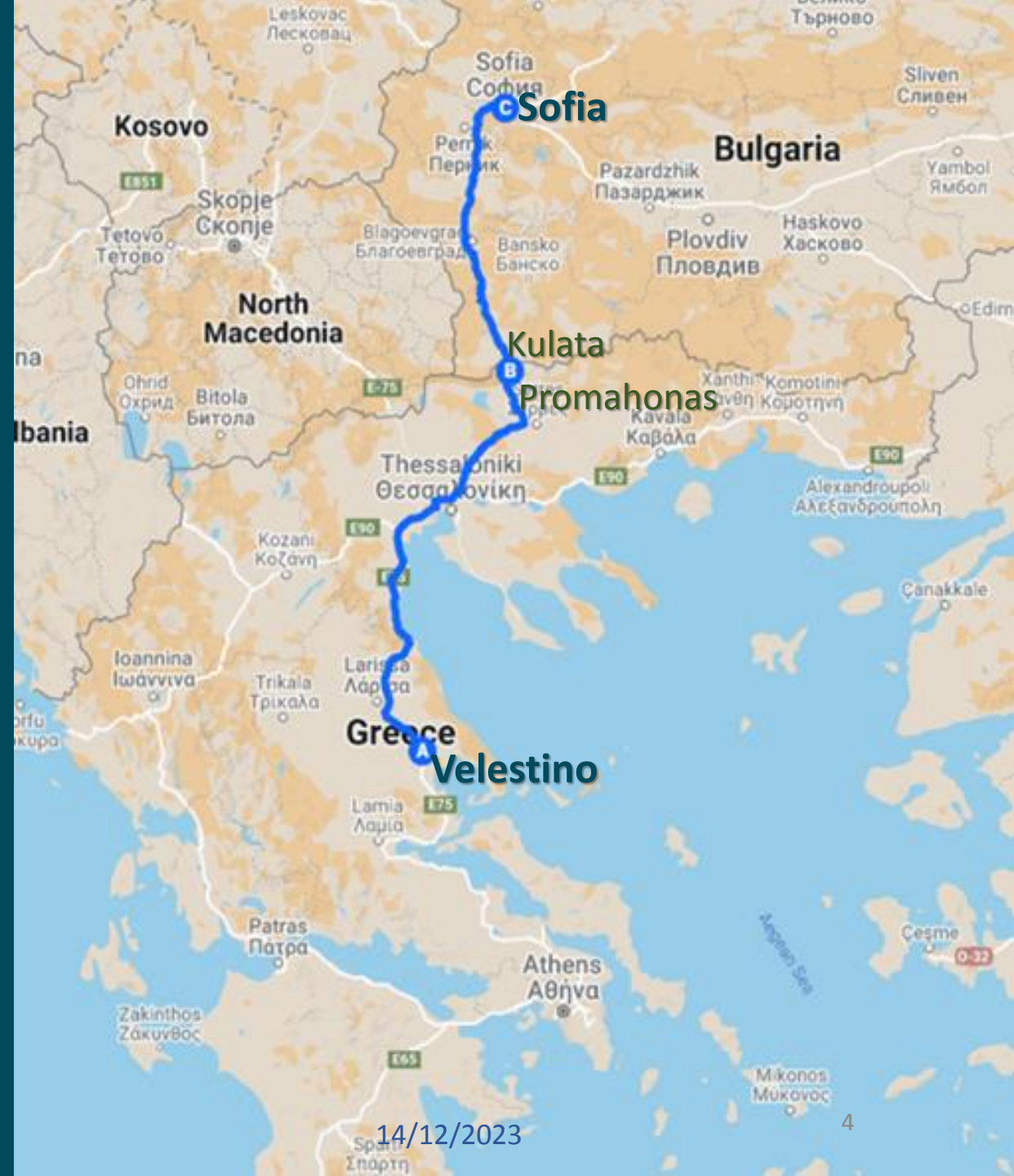
WINGS (GR), COSMOTE (GR), A1 (BG)

Duration

3 years (1/1/2023 – 31/12/2025)

Total Budget

11, 5 m€ (50% Funding)



^(*) Cross Border Corridor, ^(**) Trans-European Transport Network

Key Project Objectives



Obj.1: Provide uninterrupted 5G connectivity, based on 3GPP Rel.16 SA, capable of supporting selected advanced CAM UCs, focusing on the Orient/East-Med corridor traversing the GR-BG borders, including the border-crossing of Promahonas/Kulata.

Obj.2: Support the effective interconnection of COSMOTE and A1BG PLMNs and investigate the **optimal roaming configurations to support CAM traffic**.

Obj. 3: Validate the network (and applications) performance and the usefulness of 5G connectivity for automotive traffic via **field trials targeting 5GAA CAM use cases**.

Obj. 4: Deliver a thorough **Business and Techno-economic analysis** regarding cross border and national highway corridor 5G deployments.

Obj.1: Uninterrupted 5G Connectivity



Obj.1: Provide **uninterrupted 5G connectivity**, based on 3GPP Rel.16 SA, capable of supporting select advanced CAM UCs, focusing on the Orient/East-Med corridor traversing the GR-BG borders, including the border-crossing of Promahonas/Kulata

- Deployment of 3GPP Rel.16 SA 5G network (Core, gNBs) and upgrade of existing NSA 5G (eNBs, backhaul):
 - **Phase 1:** Based on NSA architecture (over the existing commercial EPC)
 - **Phase 2:** Based on SA architecture | Deployment of 5G SA core network
- Uninterrupted 5G coverage @700 MHz for the 473 km GR-BG corridor length
 - 300 Km (GR) (Velesino – Promahonas)
 - 173 Km (BG) (Kulata – Sofia)
- Supplementary coverage @**3.5 GHz for 11 km** around Promahonas/Kulata CBC
 - 4 Km (GR)
 - 7 Km (BG)
- CAM services support (at least 20 Mbps throughput, 20 ms e2e latency and 99% reliability, in line with the requirements of the 5GAA CAM UCs) | URRLC Use Cases, CAM Slice, BG for low latency

Implementation Approach

Year 1 - 2023

Year 2 - 2024

Year 3 - 2025

Phase 1: NSA Implementation

Phase 2: SA Implementation

- ❑ New BG (Border Gateway) in Thessaloniki
- ❑ S1 Handover (EPLMN)
- ❑ inter-MME S10
- ❑ Direct Interconnection Thessaloniki-Sofia

- ❑ SEPP (Security Edge Protection Proxy), NSSF (Network Slice Selection Function)
- ❑ Deployment of a new 5GC UPF in Thessaloniki
- ❑ NEF (Network Exposure Function)

Uninterrupted 5G coverage @700 MHz for the 473 km GR-BG corridor length
Seamless Roaming (no dropped calls)

CAM services support **20 Mbps throughput, 20 ms e2e latency and 99% reliability**, for 5GAA CAM UCs

- ❑ 300 Km (GR) (Velestino – Promahonas) | Upgrade of 66 BS and 11 New Sites (COSMOTE)
- ❑ 173 Km (BG) (Kulata – Sofia) | Upgrade of 29 BS, 11-15 New Sites (A1BG)

3.5 GHz for 11 km at the border crossing area (Promahonas/Kulata)

- ❑ 4 Km (GR) | 1 gNB
- ❑ 7 Km (BG) | 2 gNBs



COSMOTE:
28 upgrades
1 new gNB

A1BG:
29 upgrades

COSMOTE:
29 upgrades

A1BG:
1-3 new gNBs

COSMOTE:
9 upgrades
10 new gNBs

A1BG:
10-12 new gNBs

Obj.2: Optimal 5G Roaming Blueprint



Obj.2: Support the effective interconnection of the COSMOTE and A1BG PLMNs and investigate the **optimal roaming configurations** to support CAM traffic.

- Deliver 5G roaming blueprint (documentation) in synergy with peer projects (e.g. DELUX), focusing on challenges, recommendations, etc., to serve as a handbook for other MNOs to implement
 - Impact on existing Billing, Accounting and NRTRDE (Near Real-Time Roaming) and Roaming Data Exchange processes
- Analysis of the CAM UC performance under different roaming configurations and respective proposals for further enhancements of the roaming procedure:
 - **Phase 1:** S10 interface (inter-MME HO), equivalent PLMNs, S1 Handover, Release with Redirect, etc.
 - **Phase 2:** N14 interface (inter AMF HO), SSC mode 3, Home Routed Roaming Model
- Evaluation of the direct interconnection between COS-A1BG 5G core networks to guarantee performance
 - Direct interconnection to be used for the user-plane traffic, with guaranteed performance
 - Control plane for NSA deployments shall still be in GRX, as the CAM service can't be distinguished
 - Control Plane for SA will be implemented through direct interconnection

Obj.3: Field Trials



Obj. 3: Validate the network (and applications) performance and the usefulness of 5G connectivity for automotive traffic via field trials targeting 5GAA CAM use cases.

- Analysis of key network, service and security level requirements of selected UCs and the respective targeted KPIs for each UC
 - Uninterrupted (Packet-Switched) Voice call
 - Video call: Few seconds freezing during network reselection
 - Selected 5GAA Use Cases
- Trial methodology and measurements' framework targeting the extensive validation of the selected UCs via field trials
 - Target various roaming configurations and performance optimizations
 - COSMOTE app, WINGS OBUs + commercial CAVs
 - Extensive field measurement campaign with multiple test cycles to provide statistical confidence

5GAA eV2X UCs	5GAA UC	Max e2e latency (ms)	Reliability (%)	Data Rate	N28 (5G 700)	N78 (5G 3.5)	3GPP UC group
Safety	Cooperative Traffic Gap	50	99.9	2 Mbps	YES	YES	
Safety	Interactive VRU crossing	100	99.9	64 kbps	YES	YES	
Convenience	In-Vehicle entertainment	20	99	Up to 250 Mbps ^[1]	YES	YES	
Convenience	Obstructed view assist	50	99	5 Mbps	YES	YES	Extended sensors
Autonomous Driving	Cooperative lane merge	20	99.9	12 kbps	YES	YES	
Autonomous Driving	Vehicle platooning in steady state	50	99	48 kbps	YES	YES	Vehicles platooning
Autonomous Driving	Infrastructure assisted environment perception	100	99.9	4-80 Mbps	YES	YES	Extended sensors

• Demos of advanced CAM UCs
 [1] This is actually the max resolution for extremely high-quality video resolution which nonetheless is not the average type of video to be supported in the near future. The 3GPP TS 22.186 version 16.2.0 Release 16 sets the upload limits for video sharing between a UE supporting V2X application and a V2X application server to 14Mbps which can be considered as a min requirement

Obj.4: Business & Techno-economic Analysis

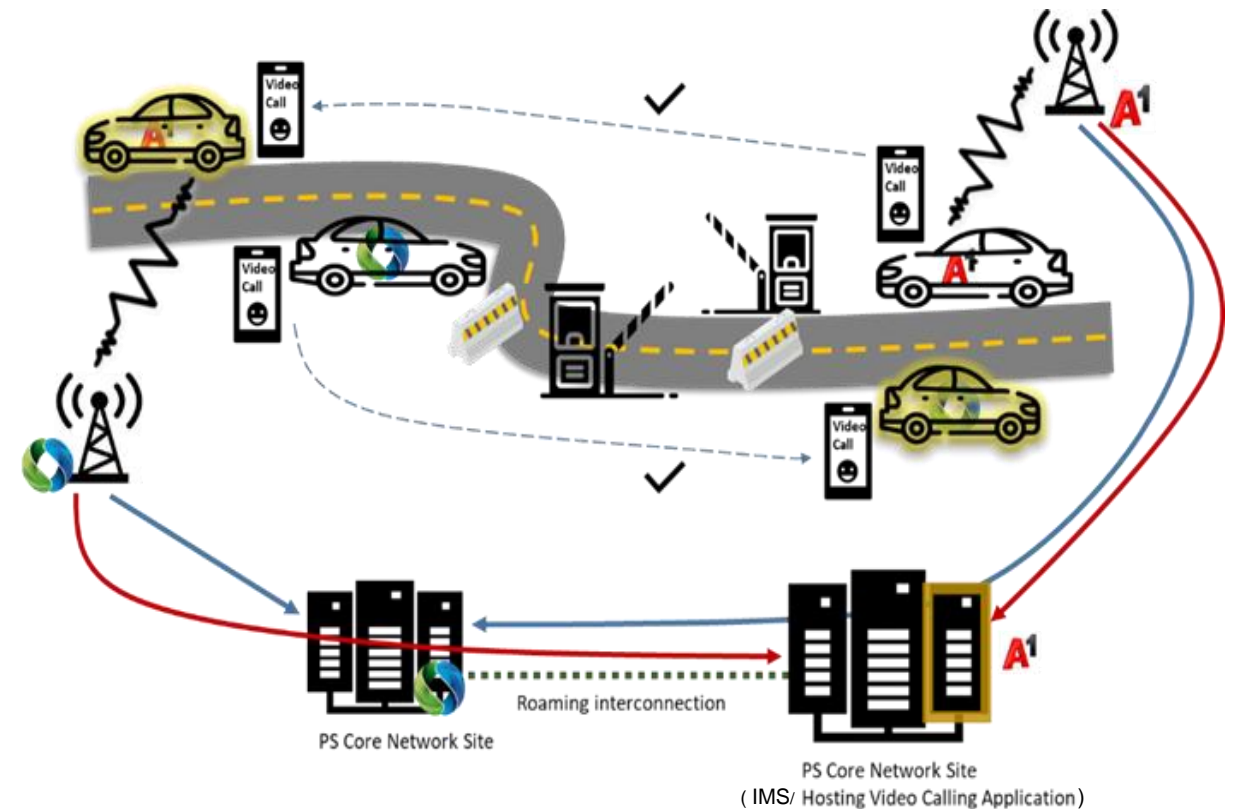


Obj. 4: Deliver a thorough **Business and Techno-economic analysis** regarding cross border and national highway corridor 5G deployments

- Analysis of the processes/procedures (procurement, regulatory permissions, licensing, etc.) and prerequisites to set-up, configure and operate 5G networks across EU corridors
- 5G SEAGUL business models, stakeholders & roles
- Techno-economic (cost per equipment category, CAPEX/OPEX, etc.) analysis of the deployment, operation and maintenance of the 5G networks, and ROI analysis based on the CAM UCs
 - [5G-MOBIX Deployment Study](#)
- Analysis of the necessary security requirements and guarantees needed to support the 5G network deployment and operation, including the relevant audit results

Basic voice and video call services:

- **Voice call:** Ability to maintain a voice call during network reselection without the call being dropped, with focus solely on packet-switched voice (i.e., VoLTE, VoNR).
- **Video call:** Ability to maintain a video call during network reselection without the call being dropped or freezing for more than a few seconds.



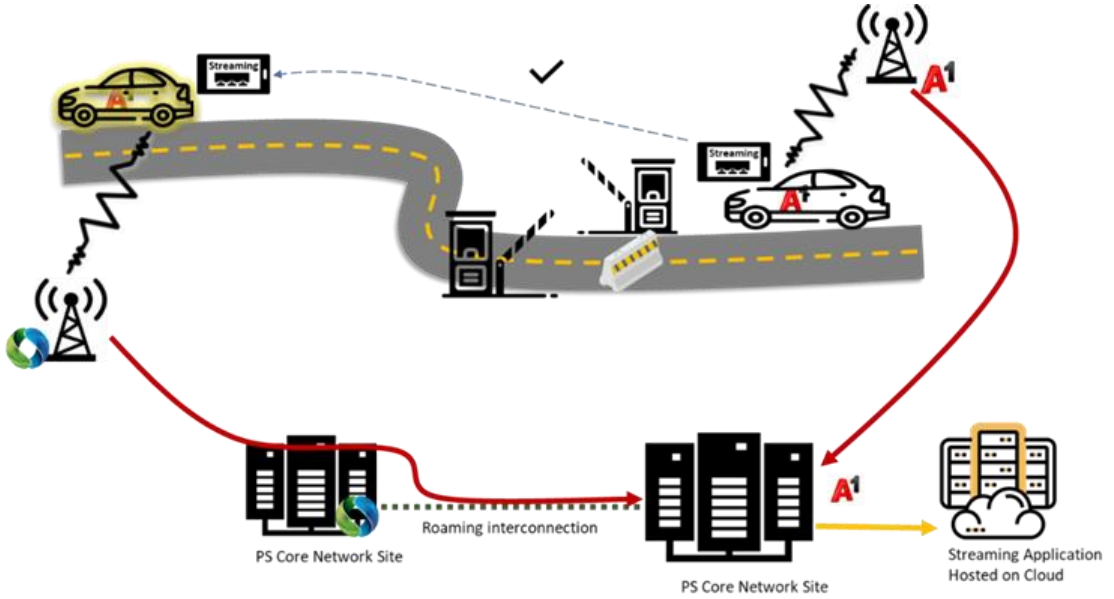
5G SEAGUL Use Cases

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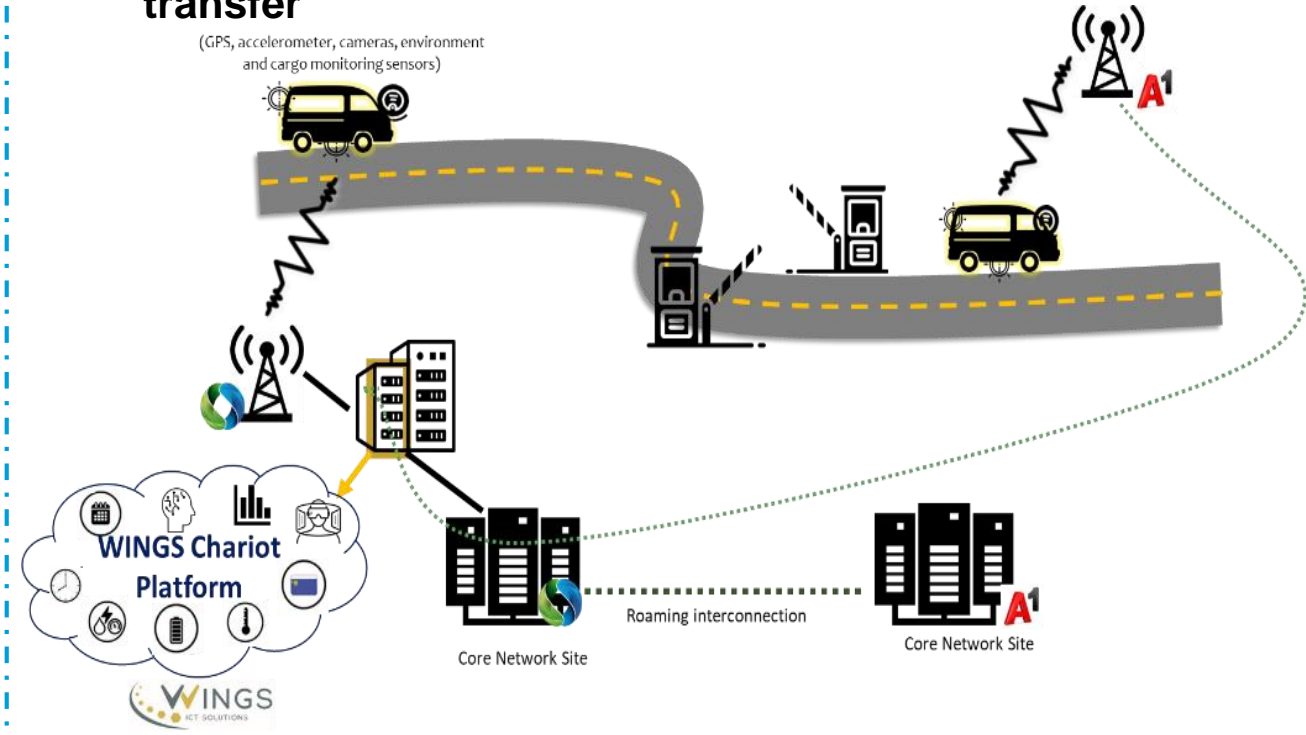
CAM-related use cases for:

- **Convenience:** Infotainment, by demonstrating video streaming applications (e.g., YouTube)



- **Transport safety, convenience and sustainable goods transfer**

(GPS, accelerometer, cameras, environment and cargo monitoring sensors)



5G SEAGUL Use Cases

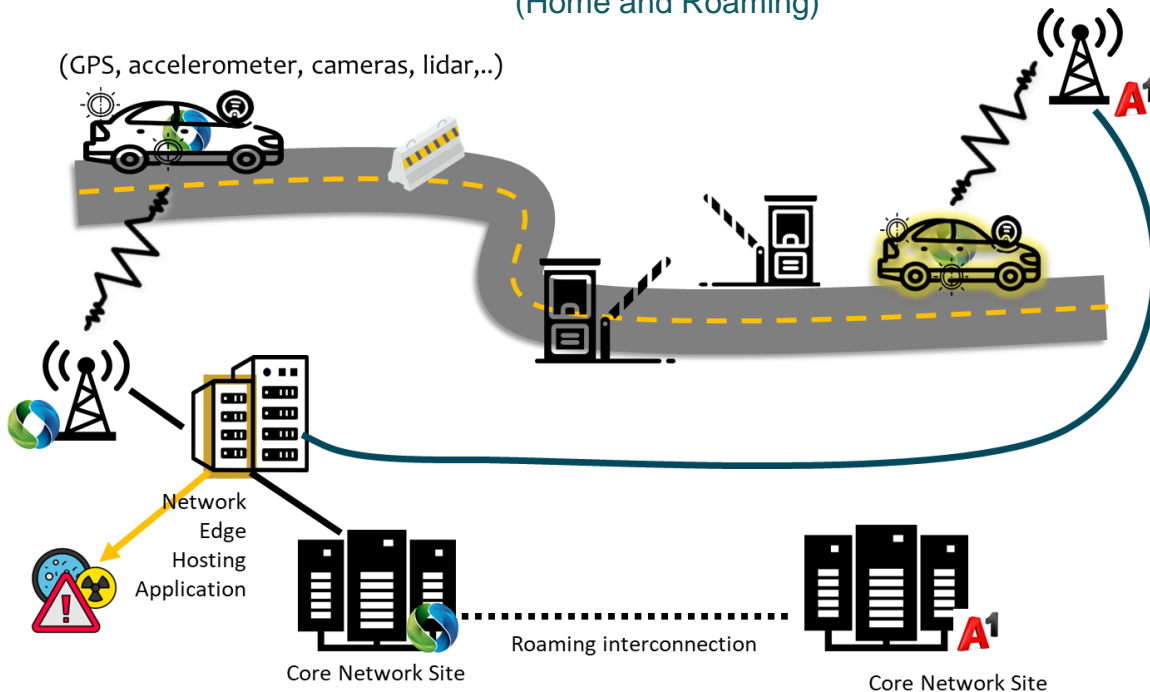
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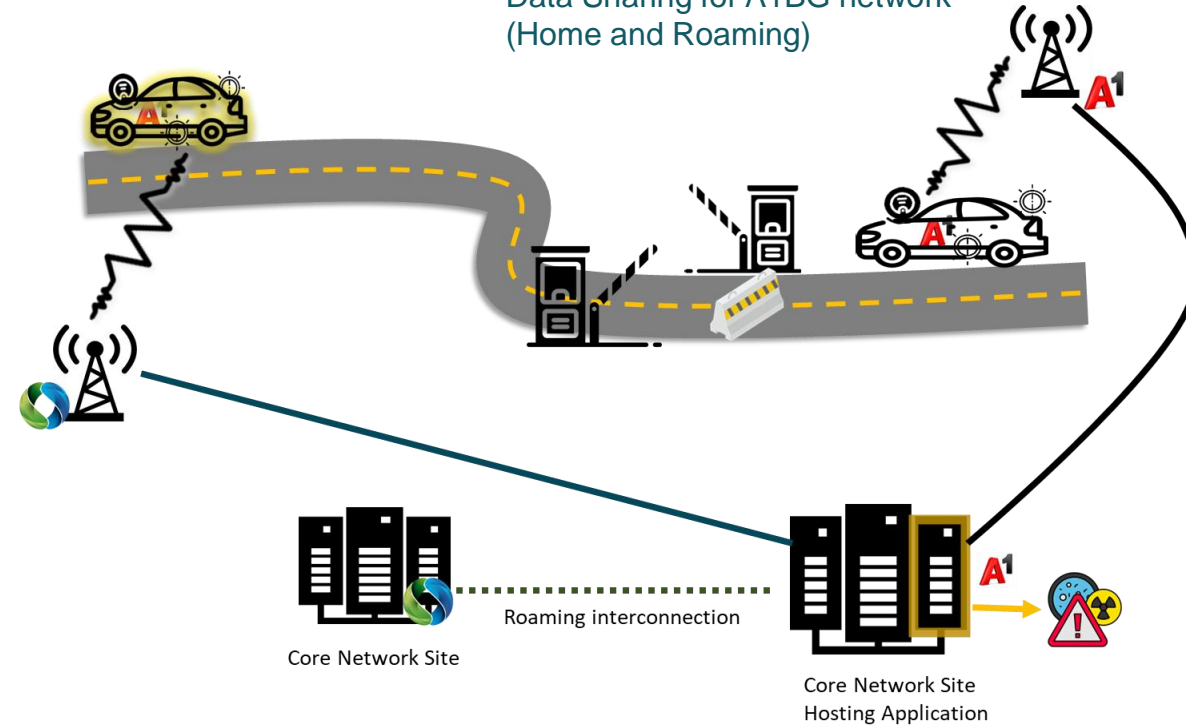
CAM-related use cases for:

- **Safety:** Data Sharing for real-time situation awareness and traffic information

Data Sharing for COSMOTE network
(Home and Roaming)



Data Sharing for A1BG network
(Home and Roaming)



Thank you.