

5G experimentation facilities for the future of Transport and Logistics: the VITAL-5G approach

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Abstract – The Transport and Logistics industry has emerged as a prominent adopter of 5G technologies to tackle the changing societal demands for swift and dependable supply chain management and last-mile delivery. Optimizing this comprehensive approach can be made more feasible by showcasing 5G implementation through trials and pilots. The effectiveness of 5G implementation in any sector depends on the optimization of infrastructure and the performance of trial sites. The paper describes how the VITAL-5G project, through its three target use cases and the provision of resources to 3rd party experimenters, can lead innovation in the Transport and Logistics sector.

Keywords—Transport & Logistics; 5G; Industry 4.0; Experimentation; Innovation

I. INTRODUCTION

The supply chain industry has been revolutionized by the adoption of digital and automation technologies, transforming the way assets, materials, and workforce are managed [1]. To optimize logistics processes, integrating the Internet of Things (IoT), Big Data, Cloud Computing, and Artificial Intelligence (AI) requires advanced and stable communication systems. This fusion of digital technologies in logistics is referred to as "Smart Logistics" or "Logistics 4.0" [2].

Smart logistics heavily rely on the latest information and communication technologies (ICT), software systems, and the Internet of Things (IoT) to enable (i) superior control over logistics processes, (ii) the effective management of commodity flows, and (iii) the seamless flow of information. In this direction, the fifth-generation cellular networks (5G) are believed to offer the required connectivity, computing power, as well as the security and trustworthiness of information exchange among the various stakeholders in the supply chain.

While there are anticipated advancements in Transport & Logistics (T&L) due to the integration of 5G technology, there are only a few applications currently available. The integration of 5G with other technologies is still in its nascent stages of research, and there are other issues as well, including a shortage of funding for upgrading the existing 4G infrastructure [1].

In the above context, the scope of this paper is to highlight how the VITAL-5G project through its use cases and the provision of a platform offering 5G resources for Transport and Logistics applications can advance "Logistics 4.0".

II. 5G IN TRANSPORT & LOGISTICS (T&L)

A. Transition to Logistics 4.0 and 5G connectivity

Connectivity remains an underdeveloped domain in logistics operations despite the possibilities offered by recent advances in digital infrastructure. Considering that 5G

technology offers significantly faster speeds compared to 4G (up to 20 times faster), it is critical to explore its potential utilization in the enabling technologies of Logistics by implementing practical applications, such as in European projects.

To meet the required performance standards for reliability and speedy exchange of data, 5G networking is considered as a global unified multiple-device connectivity solution for T&L, offering crucial features to advance the sector, such as (i) data speed-up to 10 Gbps; (ii) ultra-responsive and ultra-reliable connections (1×10^{-5} probability of transmitting layer-2 PDU of 32 bytes in size within 1 ms); (iii) higher network availability (1×10^6 devices/Km²); (iv) lower power consumption (10 times lower consumption from previous technologies); (v) enhanced mobile broadband and; (vi) machine-type communication. Considering all these attributes, 5G has a unique value towards creating resilient and intelligent supply chain management by providing proper information flow between multiple stakeholders in logistics, enhanced visibility and process transparency, thus enabling better control of material flows.

B. What are possible obstacles in the vision?

5G technology facilitates reliable and real-time data exchange and coordination among logistics actors, enabling unparalleled visibility across the supply chain. However, governance, business aspects, and societal impacts pose significant hurdles to its widespread adoption. 5G is a relatively new concept in logistics, with limited literature and minor industrial applications [3]. Integrating 5G with legacy systems incurs additional costs for infrastructure and employee training. Privacy concerns and data security also threaten sensitive logistics data and AI. While 5G and Multi-access Edge Computing (MEC) provide increased compute capacity and low latency, data security can be compromised if the local breakout occurs outside the local premises. Due to the limitations of current wireless technologies, further development of 5G is necessary to support logistics applications and address critical factors hindering its adoption.

III. THE VITAL-5G PROJECT

The primary objective of the VITAL-5G consortium is to tackle the challenges faced in deploying 5G services for the Transport and Logistics (T&L) industry. The consortium's approach involves creating a user-friendly and fully functional platform for service orchestration and validation, complete with an open catalogue of network applications. This platform is intended to help overcome the current obstacles faced by industry verticals who want to design and implement virtualized T&L services on a 5G network.

With the VITAL-5G platform, users can easily create their own T&L-specific as well as vertical-agnostic Network Applications and deploy them in the platform, regardless of their technical expertise. This can be easily achieved through the user-friendly interface provided, which aims to simplify the application development process and provides access to a wide range of pre-built templates and building blocks that can be used to create complex services to meet the specific needs of different service providers and verticals.

The VITAL-5G platform is designed to provide powerful tools and features for experimenters in the T&L industry,

including software developers, network engineers, and researchers [4]. These users can leverage the platform to design, develop, and deploy custom network applications with a thorough validation process that ensures their reliability and performance. Once validated, these Network Applications can be added to the VITAL-5G catalogue, making them available to other 3rd-party service providers and verticals. Through the VITAL-5G Portal, experimenters can manage the creation, instantiation, life-cycle actions, and monitoring of T&L services and related 5G network slices, allowing them to experiment with different service and network configurations.

The VITAL-5G project has selected specific use cases that aim to meet the needs of the T&L industry while demonstrating the practical applications of 5G technology in three testbeds located in the Sea Port of Antwerp (BE), the River Port of Galati (RO), and a warehouse in Athens (GR). One of the use cases, called "Assisted vessel transport," is being trialed in the BE node and uses 5G technology to improve the efficiency and safety of vessel transport operations in the port by enabling real-time monitoring and control of vessel movements. Another use case, called "Automation and remote operation of freight logistics," is being trialed in the GR node and enables the remote control and monitoring of complex logistics operations with the use of AGVs, resulting in improved efficiency and reduced costs for logistics companies. Lastly, the "data-enabled assisted navigation using IoT sensing and video cameras" use case is being trialed in the RO node and enables safer port operations, even in severe weather and water conditions.

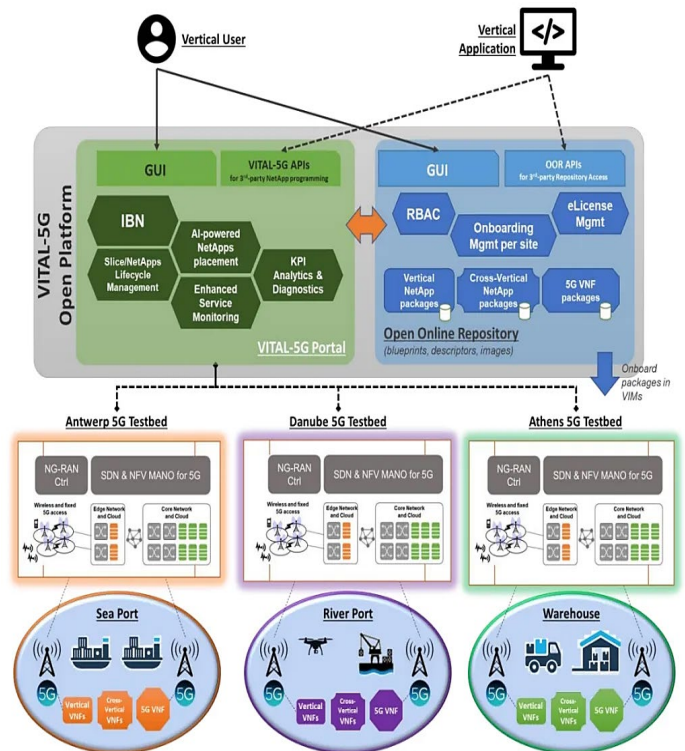


Figure 1: VITAL-5G architecture.

IV. CONCLUSIONS & NEXT STEPS

This paper provided the VITAL-5G project's contribution to the multi-perspective impact of 5G for optimizing end-to-end T&L processes. Particularly, the paper presented the perspective of covering different complementary domains of the complete value chain of the communications arena in the sector, such as business models, technical architectures, federation concepts, multimodality, flexibility, and sustainability.

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