SUCCESS-6G: EXTEND – DEVISE - VERIFY

WP1 Deliverable E3

Interim Activity Report II

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Executive Summary

This document provides a comprehensive summary of the progress of tasks and activities in the coordinated SUCCESS-6G project (subprojects: EXTEND, DEVISE, VERIFY) from October 2023 until May 2024. For each subproject, summary reports are organized per work package (WP) and associated consortium member. Besides reporting on the technical work, the Deliverable summarizes management-related aspects.

Table of Contents

List of Figures

List of Tables

1 Progress on technical work and achievements

This section provides a summary of the technical work performed by each partner in the corresponding Work Packages (WPs) of each subproject.

1.1 SUCCESS-6G-EXTEND: Summary and progress towards project objectives

1.1.1 WP2: Use cases, Requirements and Key Performance Indicators

	Partner	Progress
WP2: SUCCESS-6G-EXTEND	CTTC	CTTC has actively contributed to the identification and definition of the key performance indicators of the two user stories. Some of these indicators will be considered for the performance assessment conducted in WP4 and WP5. The aforementioned information has been reported in the updated version of Deliverable E5. CTTC has also contributed to the definition of the generic SUCCESS-6G-EXTEND system architecture and the involved modular components for vehicular condition monitoring and over-the-air software updates. In Deliverable E6, CTTC has also defined the condition monitoring service and contributed to the data analytics layer.
	CELLNEX	CELLNEX has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. CELLNEX has identified innovations related to the network, as well as relevant network KPIs for the use cases. In Deliverable E6, CELLNEX has contributed to defining the system architecture for both use cases. Besides, CELLNEX has defined the local cloud architecture, the network layer, and their requirements.
	IDNEO Technologies	Idneo has contributed to Deliverables E5 and E6 in the definition of the generic SUCCESS-6G-EXTEND system architecture for vehicular condition monitoring and FOTA software updates. On one hand, defining the CV2X communications and how the vehicle data was going to be extracted from the CAN bus, and in use case 2, in the definition of the FOTA system, both in the infrastructure part and the OBU part. Regarding Deliverable E6, participating in the definition of the system and subsystems architecture in both use cases, as well as in the cybersecurity methods. In Deliverable E5, Idneo has also defined part of the KPIs.
	Optare Solutions	Optare Solutions has actively contributed to the identification, description, and definition of the use cases and involved use stories that conform to the backbone of the project in the deliverable E6. For the E6 deliverable, Optare Solutions has led the delivery of the system architecture definition document. Also, we have contributed to the definition of the Architecture describing the suggested MLOPS environment and the expected AI models that will be tested on the different scenarios.
	Nearby Computing	Nearby Computing has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. Nearby Computing has also contributed to the definition of the generic SUCCESS-6G-EXTEND system

		architecture and the involved modular components for vehicular condition monitoring and over-the-air software updates. In Deliverable E6, Nearby Computing has also defined the orchestration layer and its requirements.

Table 1: WP2: SUCCESS-6G-EXTEND progress summary per partner.

1.1.2 WP3: Data-empowered Solutions for Robust V2X Connectivity

	Partner	Progress
WP3: SUCCESS-6G-EXTEND	CTTC	Theoretical study of the imputation problem as a dynamic Bayesian network. Introduction of a method to recover/reconstruct missing information based on expectation-maximization. Performance assessment of the proposed method has been conducted on the VeReMi dataset, where we have considered the log file for a single vehicle (keeping only the genuine information). Synthetic dropouts are used to generate missing data by uniformly selecting space-time points for occlusion. All aforementioned progress has been reported in Deliverable E7 where CTTC has been the lead editor and contributor.
	Nearby Computing	Nearby Computing has designed and implemented the observability stack, based on open-source components like Prometheus and Thanos that can be leveraged to aggregate telemetry data and logs from edge-to-cloud Infrastructure, services, and application workloads. The observability stack is designed to be orchestrated, and integrated as a background service that can also be used to influence policies and configurations and enable the automation control loops. This work will be reported in the Deliverable E8.

Table 2: WP3: SUCCESS-6G-EXTEND progress summary per partner.

1.1.3 WP4: Real-time Supervision and Health Prediction for Vehicles

	Partner	Progress
WP4: SUCCESS-6G-EXTEND	CTTC	The CTTC monitoring software solution for automatic condition monitoring in on-board vehicular equipment is currently under development. An initial open-source version has been generated at https://github.com/5uperpalo/success6g-edge and it is available as Deliverable (software) E9. As the integration plan with the rest of the partners is carried out, re-configuration of the existing modular components is expected.
	CELLNEX	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the “local cloud” in the experimental facilities. Besides, CELLNEX has collected the computational requirements requested by the applications, to provide virtual resources for the critical ones.
	IDNEO Technologies	Idneo has contributed to Deliverable E9 in the design and initial implementation of the security mechanisms for in-vehicle data communications part. Especially in the vehicle domain (CAN bus architecture security) and the public network domain to secure the V2X data. Idneo provided a tool to inject real vehicle data directly into the database using commercial diagnostics tools.

	Optare Solutions	Optare Solution is currently developing the required models to infer the information of the vehicle in this scenario. Some AI models have been already tested and delivered. Also, we have been involved in the development of the testing facilities that will be used in the next phases of the project. The work is in progress as the integration with the rest of the components is still taking place.
	Nearby Computing	Nearby computing is working on the edge services orchestration design for the CTTC monitoring software solution for automatic condition monitoring in onboard vehicular equipment. Nearby blocks have to be implemented for services' deployment in the orchestrated CELLNEX infrastructure. Integration efforts are a work in progress.

Table 3: WP4: SUCCESS-6G-EXTEND progress summary per partner.

1.1.4 WP5: Seamless Connectivity for Vehicular Software Updates

	Partner	Progress
WP5: SUCCESS-6G-EXTEND	CTTC	CTTC has defined the architectural framework adopted in SUCCESS-6G-EXTEND for the seamless updates of vehicular software in an over-the-air manner. Besides detailing the innovations applicable to the second use case, CTTC has developed a novel location-aware network management and service provisioning technology. In addition, the workflow defining the sequence of commands that facilitate the seamless operation of software updates has been explained. All this information has been documented in Deliverable E12, where CTTC has been the lead editor and contributor.
	CELLNEX	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the "local cloud" in the experimental facilities. Besides, CELLNEX has collected the computational requirements requested by the applications, to provide virtual resources for the critical ones.
	IDNEO Technologies	Idneo has contributed to Deliverable E12 in the design and initial implementation of the FOTA system. On one hand with the initial implementation of the FOTA system that applies to the OBU, power modes, dual bank, and fallback flash. On the other hand, in the initial implementation of the server part, where FOTA will be implemented using a protocol called LWM2M.
	Nearby Computing	Nearby Computing has provided an orchestration mechanism to automate the software updates of the orchestrated services, implementing dynamic upgrades with rollout and rollback strategies. This feature defines how to upgrade different versions of applications, minimizing the downtime and disruption of the service, while ensuring a smooth deployment process. All this information has been documented in Deliverable E12.

Table 4: WP5: SUCCESS-6G-EXTEND progress summary per partner.

1.1.5 Deviations

Certain deliverables have been submitted with a delay with respect to the original timeline. Table 13 summarizes the due date for each deliverable and the actual submission date/status. It is noted that deliverables E10 and E13, related to the implementation phase of the use cases, are currently at a preliminary stage. The same holds for milestones H7 and H8 (as indicated in Table 14). The project could benefit from an extension to ensure all objectives' fulfillment.

1.2 SUCCESS-6G-DEVISE: Summary and progress towards project objectives

1.2.1 WP2: Use cases, Requirements and Key Performance Indicators

	Partner	Progress
WP2: SUCCESS-6G-DEVISE	CTTC	CTTC has actively contributed to the identification and definition of the key performance indicators of the two user stories. Some of these indicators will be considered for the performance assessment conducted in WP4 and WP5. The aforementioned information has been reported in the updated version of Deliverable E5. CTTC has also contributed to the definition of the generic SUCCESS-6G-DEVISE system architecture and the involved modular components for vehicular condition monitoring and over-the-air software updates. In Deliverable E6, CTTC has also defined the condition monitoring service and contributed to the data analytics layer.
	CELLNEX	CELLNEX has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. CELLNEX has identified innovations related to the Network, as well as relevant Network KPIs for the Use Cases. In Deliverable E6, CELLNEX has contributed to define the System Architecture for both Use Cases. Besides, CELLNEX has defined the Local Cloud Architecture, the Network Layer, and their requirements.
	IDNEO Technologies	Idneo has contributed to Deliverables E5 and E6 in the definition of the generic SUCCESS-6G-EXTEND system architecture for vehicular condition monitoring and FOTA software updates. On one hand, defining the CV2X communications and how the vehicle data was going to be extracted from the CAN bus, and in use case 2, in the definition of the FOTA system, both in the infrastructure part and the OBU part. Regarding Deliverable E6, participating in the definition of the system and subsystems architecture in both use cases, as well as in the cybersecurity methods. In deliverable E5, Idneo has also defined part of the KPIs.
	Optare Solutions	Optare Solutions has actively contributed to the identification, description, and definition of the use cases and involved use stories that conform to the backbone of the project in the deliverable E6. For the E6 deliverable, Optare Solutions has led the delivery of the System Architecture definition document. Also, we have contributed to the definition of the Architecture describing the suggested MLOPS environment and the expected AI models that will be tested on the different scenarios.
	Nearby Computing	Nearby Computing has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. Nearby Computing has also contributed to the definition of the generic SUCCESS-6G-DEVISE system architecture and the involved modular components for

		vehicular condition monitoring and over-the-air software updates. In Deliverable E6, Nearby Computing has also defined the orchestration layer and its requirements.

Table 5: WP2: SUCCESS-6G-DEVISE progress summary per partner.

1.2.2 WP3: Detection, Identification and Mitigation of Malicious V2X Attacks

	Partner	Progress
WP3: SUCCESS-6G-DEVISE	CTTC	The detailed assessment of the security landscape in V2X systems has been reported in Deliverable E7 where CTTC was the lead editor and contributor. On top of this, the following two publications have been produced: • R. Asensio-Garriga, P. Alemany, A. Molina Zarca, R. Sedar, C. Kalalas, J. Ortiz, R. Vilalta, R. Munoz, and A. Skarmeta, “ZSM-based E2E Security Slice Management for DDoS Attack Protection in MEC-enabled V2X Environments”, in IEEE Open Journal of Vehicular Technology, to appear, March 2024. • R. Sedar, C. Kalalas, F. Vazquez-Gallego, J. Alonso-Zarate, “Deep Reinforcement Learning-Based Adversarial Defense in Vehicular Communication Systems”, IEEE International Conference on Communications (ICC) 2024, Denver, CO, USA, 9-13 June 2024. In the first paper, we employ the zero-touch network and service management (ZSM) standard, integrating autonomous security into end-to-end (E2E) slicing management. We consider an entire 5G network, including vehicular user equipment, radio access networks, MEC, and core components, in the presence of DDoS attacks targeting V2X services. Our framework complies with security service-level agreements and policies, autonomously deploying and interconnecting security sub-slices across domains. Security requirements are continuously monitored, and, upon DDoS detection, our framework reacts with a coordinated E2E strategy. The strategy mitigates DDoS at the MEC and deploys countermeasures in neighboring domains. Performance assessment reveals effective DDoS detection and mitigation with low latency, aligned with the mission-critical nature of certain V2X services. In the second paper, we propose a deep reinforcement learning (DRL)-based approach to defend against two data poisoning attacks, namely label-flipping and policy induction. Extensive evaluation with the aid of an open-source dataset demonstrates that our scheme outperforms benchmark classifiers, achieving significantly superior detection performance in the presence of label-flipping attacks. The effectiveness of our DRL-based approach is also showcased under different adversarial strategies in the policy induction attack.
	Nearby Computing	Definition of the components and interfaces to enable zero-touch closed-loop orchestration. This framework enables communication between data analytics and orchestration layers to guarantee service provisioning. This work will be reported in the Deliverable E8.

Table 6: WP3: SUCCESS-6G-DEVISE progress summary per partner.

1.2.3 WP4: Secure Message Exchange for Condition Monitoring of Vehicles

	Partner	Progress
WP4: SUCCESS-6G-DEVISE	CTTC	As lead editor and contributor in Deliverable E9, CTTC has developed an edge-based security framework for secure and trustworthy vehicular data monitoring based on ensemble learning. The solution jointly combines i) an unsupervised learning layer for discovering hidden patterns from unlabeled vehicular traffic traces, and ii) a reinforcement learning (RL) layer for consistently improving malicious data detection over unknown V2X environments without relying on security thresholds. Performance assessment has been conducted on the VeReMi dataset and compared to benchmark classifiers, our approach exhibits superior or equivalent detection performance in the presence of potentially inaccurate or mislabeled training data. Detection latencies are shown to comply with edge-related requirements.
	CELLNEX	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the "local cloud" in the experimental facilities. Besides, CELLNEX has collected from Nearby Computing the computational requirements requested by its Nearby One orchestrator, to enable the associated virtual resources. Besides, CELLNEX has facilitated the edge infrastructure needed to deploy the MEC architecture and support distributed UPFs.
	IDNEO Technologies	Idneo has contributed to Deliverable E9 in the design and initial implementation of the security mechanisms for in-vehicle data communications part. Especially in the vehicle domain (CAN bus architecture security) and the public network domain to secure the V2X data.
	Optare Solutions	Optare Solution is currently developing the required models to infer the information of the vehicle in this scenario. Some AI models have been already tested and delivered. Also, we have been involved in the development of the testing facilities that will be used in the next phases of the project. The work is in progress as the integration with the rest of the components is still taking place.
	Nearby Computing	Nearby Computing is working on the design and future implementation of the CELLNEX edge nodes provisioning with Kubernetes clusters and onboarding into the orchestration layer.

Table 7: WP4: SUCCESS-6G-DEVISE progress summary per partner.

1.2.4 WP5: Secure Service Development and Provisioning

	Partner	Progress
WP5: SUCCESS-6G-DEVISE	CTTC	CTTC has defined the architectural framework adopted in SUCCESS-6G-DEVISE for vehicular software updates with security guarantees in an over-the-air manner. Besides detailing the innovations applicable to the second use case, CTTC advocates the novel security as a service paradigm developed in the project which represents a key component of the overall network architecture. In addition, the workflow defining

		the sequence of commands that facilitate security as a service deployment and the threat detection and mitigation has been explained. All this information has been documented in Deliverable E12, where CTTC has been the lead editor and contributor.
	CELLNEX	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the "local cloud" in the experimental facilities. Besides, CELLNEX has collected from Nearby Computing the computational requirements requested by its Nearby One orchestrator, to enable the associated virtual resources. Besides, CELLNEX has facilitated the edge infrastructure needed to deploy the MEC architecture and support distributed UPFs.
	IDNEO Technologies	Idneo has contributed to Deliverable E12 in the design and initial implementation of the FOTA system. On one hand with the initial implementation of the FOTA system that applies to the OBU, power modes, dual bank, and fallback flash. On the other hand, in the initial implementation of the server part, where FOTA will be implemented using a protocol called LWM2M.
	Nearby Computing	Nearby Computing has provided an orchestration mechanism to automate the software updates of the orchestrated services, implementing dynamic upgrades with rollout and rollback strategies. This feature defines how to upgrade different versions of applications, minimizing the downtime and disruption of the service, while ensuring a smooth deployment process. All this information has been documented in Deliverable E12. Moreover, the following publication has been produced: • Ojaghi, B., Dehshibi, M.M. & Antonopoulos, A., „A supervised active learning method for identifying critical nodes in IoT networks", the Journal of Supercomputing (2024).

Table 8: WP5: SUCCESS-6G-DEVISE progress summary per partner.

1.2.5 Deviations

Certain deliverables have been submitted with a delay with respect to the original timeline. Table 13 summarizes the due date for each deliverable and the actual submission date/status. It is noted that deliverables E10 and E13, related to the implementation phase of the use cases, are currently at a preliminary stage. The same holds for milestones H7 and H8 (as indicated in Table 14). The project could benefit from an extension to ensure all objectives' fulfillment.

1.3 SUCCESS-6G-VERIFY: Summary and progress towards project objectives

1.3.1 WP2: Use cases, Requirements and Key Performance Indicators

WP2: SUCCESS-6G-VERIFY	Partner	Progress
	CTTC	CTTC has actively contributed to the identification and definition of the key performance indicators of the two user stories. Some of these indicators will be considered for the performance assessment

		conducted in WP4 and WP5. The aforementioned information has been reported in the updated version of Deliverable E5. CTTC has also contributed to the definition of the generic SUCCESS-6G-VERIFY system architecture and the involved modular components for vehicular condition monitoring and over-the-air software updates. In Deliverable E6, CTTC has also defined the condition monitoring service and contributed to the data analytics layer.
	CELLNEX	CELLNEX has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. CELLNEX has identified innovations related to the Network, as well as relevant Network KPIs for the Use Cases. In Deliverable E6, CELLNEX has contributed to defining the System Architecture for both Use Cases. Besides, CELLNEX has defined the Local Cloud Architecture, the Network Layer, and their requirements.
	IDNEO Technologies	Idneo has contributed to Deliverables E5 and E6 in the definition of the generic SUCCESS-6G-EXTEND system architecture for vehicular condition monitoring and FOTA software updates. On one hand, defining the CV2X communications and how the vehicle data was going to be extracted from the CAN bus, and in use case 2, in the definition of the FOTA system, both in the infrastructure part and the OBU part. Regarding Deliverable E6, participating in the definition of the system and subsystems architecture in both use cases, as well as in the cybersecurity methods. In Deliverable E5, Idneo has also defined part of the KPIs.
	Optare Solutions	Optare Solutions has actively contributed to the identification, description, and definition of the use cases and involved use stories that conform to the backbone of the project in Deliverable E6. For the E6 deliverable, Optare Solutions has led the delivery of the System Architecture definition document. Also, we have contributed to the definition of the Architecture describing the suggested MLOPS environment and the expected AI models that will be tested on the different scenarios.
	Nearby Computing	Nearby Computing has actively contributed to the identification and definition of the innovations and key performance indicators of the two user stories. The aforementioned information has been reported in the updated version of Deliverable E5. Nearby Computing has also contributed to the definition of the generic SUCCESS-6G-VERIFY system architecture and the involved modular components for vehicular condition monitoring and over-the-air software updates. In Deliverable E6, Nearby Computing has also defined the orchestration layer and its requirements.

Table 9: WP2: SUCCESS-6G-VERIFY progress summary per partner.

1.3.2 WP3: Addressing V2X Channel Impairments with Over-the-air Computing

	Partner	Progress
WP3: SUCCESS-6G-	CTTC	We have considered the problem of distributed lossy computation (DLC) where the goal is to recover one or more linear combinations of the

		sources at the decoder, subject to distortion constraints. For certain configurations, it is known that codes with algebraic structure can outperform i.i.d. codebooks. Our work takes a discretization approach to extend this rate region to include both integer- and real-valued sources. As a case study, the rate region is evaluated for the Gaussian case. The resulting joint-typicality-based rate region recovers and generalizes the best-known rate region for this scenario, based on lattice encoding and sequential decoding. This work has resulted in the following publication: • A. Pastore, S.H. Lim, C. Feng, B. Nazer, M. Gastpar, "Distributed Lossy Computation with Structured Codes: From Discrete to Continuous Sources", 2023 IEEE International Symposium on Information Theory (ISIT), Taipei, Taiwan, June 25-30, 2023, pp. 1681-1686. Future work will concentrate on leveraging this theoretical framework to elucidate tradeoffs between analog and digital channel resource allocation in the context of vehicular communication, as well as the development of practical coding schemes. More details can be found in Deliverable E7 where CTTC was the lead editor and contributor.
	Nearby Computing	Nearby computing is working on the orchestration algorithms to automate the lifecycle management of services based on the communication channel.

Table 10: WP3: SUCCESS-6G-VERIFY progress summary per partner.

1.3.3 WP4: Predictive Vehicle Diagnostics with Distributed Learning

	Partner	Progress
WP4: SUCCESS-6G- VERIFY	CTTC	The focus has been on collaborative transfer learning solutions where distributed computation can be efficiently performed by leveraging semantic relatedness metrics. In particular, we have introduced a trust-based similarity metric to quantify the trust level of each source edge node for collaborative V2X hazard detection. Trust-based similarity captures the intrinsic correlation between the hazard detection tasks performed at each source edge node and the target edge node. We have also devised a selective knowledge transfer scheme, called experience selection, to select source samples with high trustworthiness. Specifically, experience selection filters out semantically important samples for the hazard detection task at the target edge node. Ongoing work has been submitted as a journal article (minor revision).
	CELLNEX	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the "local cloud" in the experimental facilities. Besides, CELLNEX has collected the computational requirements requested by the applications, to provide virtual resources for the critical ones.
	IDNEO Technologies	Idneo has contributed to Deliverable E9 in the design and initial implementation of the security mechanisms for in-vehicle data communications part. Especially in the vehicle domain (CAN bus architecture security) and the public network domain to secure the V2X data.

	Optare Solutions	Optare Solutions has helped design the test environment with an MLOPS approach to achieve the goals expected that will be included in the deliverables E9 and E10. The laboratory environment is already set, and the development of the algorithms that will be modeled for the scenario is in progress.
	Nearby Computing	Nearby Computing has designed the distributed computing platform, based on Kubernetes edge nodes, that also includes the deployment of cloud-native 5G connectivity to guarantee V2X connectivity. This ongoing work is intended to be reported in E9.

Table 11: WP4: SUCCESS-6G-VERIFY progress summary per partner.

1.3.4 WP5: Automated Software Updates for Vehicles

	Partner	Progress
WP5: SUCCESS-6G- VERIFY	CTTC	CTTC has defined the architectural framework adopted in SUCCESS-6G-VERIFY for the computationally efficient process of vehicular software updates in an over-the-air manner. Besides detailing the innovations applicable to the second use case, CTTC has explored the synergistic relationship between the bandwidth management service and the overall network architecture in optimizing resource allocation for over-the-air software updates. In addition, the workflow defining the sequence of commands that facilitate bandwidth management and integration with the software-defined network controller has been explained. All this information has been documented in Deliverable E12, where CTTC has been the lead editor and contributor.
	Cellnex	On the one hand, CELLNEX has provided 5G connectivity services, to test and grant interoperability between vehicles and the 5G-RAN. On the other hand, CELLNEX has provided the computing infrastructure to deploy the “local cloud” in the experimental facilities. Besides, CELLNEX has collected the computational requirements requested by the applications, to provide virtual resources for the critical ones.
	IDNEO Technologies	Idneo has contributed to Deliverable E12 in the design and initial implementation of the FOTA system. On one hand with the initial implementation of the FOTA system that applies to the OBU, power modes, dual bank, and fallback flash. On the other hand, in the initial implementation of the server part, where FOTA will be implemented using a protocol called LWM2M.
	Nearby Computing	Nearby Computing has provided an orchestration mechanism to automate the software updates of the orchestrated services, implementing dynamic upgrades with rollout and rollback strategies. This feature defines how to upgrade different versions of applications, minimizing the downtime and disruption of the service, while ensuring a smooth deployment process. All this information has been documented in Deliverable E12. Moreover, Nearby Computing is working towards the design of AI/ML algorithms for zero-touch orchestration for efficient use of computational resources.

Table 12: WP5: SUCCESS-6G-VERIFY progress summary per partner.

1.3.5 Deviations

Certain deliverables have been submitted with a delay with respect to the original timeline. Table 13 summarizes the due date for each deliverable and the actual submission date/status. It is noted that deliverables E9, E10, and E13, related to the implementation phase of the use cases, are currently at a preliminary stage. The same holds for milestones H7 and H8 (as indicated in Table 14). The project could benefit from an extension to ensure all objectives' fulfillment.

2 Progress on Dissemination, Standardization and Exploitation

2.1 Summary

During the reporting period, the following SUCCESS-6G-related papers have been accepted:

- A. Abishek, R.Vilalta, Ll. Gifre, P.Alemany, C. Manso, R. Casellas, R.Martínez, R.Muñoz, “Network Extensions to Support Robust Secured and Efficient Connectivity Services for V2X Scenario”, IEEE International Conference on Transparent Optical Communications (ICTON), Bari, Italy, July 2024.
- L. Liatsas, G. Kibalya, A. Antonopoulos, "XAI-driven Model Design for Resource Utilization Forecasting in Cloud-native 6G Networks", IEEE MeditCom, Madrid, Spain, 8-11 July 2024.
- R. Sedar, C. Kalalas, F. Vazquez-Gallego, J. Alonso-Zarate, “Deep Reinforcement Learning-Based Adversarial Defense in Vehicular Communication Systems”, IEEE International Conference on Communications (ICC) 2024, Denver, CO, USA, 9-13 June 2024.
- B. Ojaghi, M.M. Dehshibi, and A. Antonopoulos, "A supervised active learning method for identifying critical nodes in IoT networks“, the Journal of Supercomputing, Springer, April 2024.
- R. Asensio-Garriga, P. Alemany, A. Molina Zarca, R. Sedar, C. Kalalas, J. Ortiz, R. Vilalta, R. Munoz, and A. Skarmeta, “ZSM-based E2E Security Slice Management for DDoS Attack Protection in MEC-enabled V2X Environments”, in IEEE Open Journal of Vehicular Technology, to appear, March 2024.
- Carlos Manso, Ricard Vilalta, Lluis Gifre, Ramon Casellas, Ricardo Martínez, Raul Muñoz, “Introducing End-to-End Location Awareness in Packet-Optical Networks”, IEEE/Optica European Conference on Optical Communications, Glasgow, Scotland, October 2023.

The following papers (not reported in Deliverable E2) were also accepted:

- A. Pastore, S.H. Lim, C. Feng, B. Nazer, M. Gastpar, “Distributed Lossy Computation with Structured Codes: From Discrete to Continuous Sources”, 2023 IEEE International Symposium on Information Theory (ISIT), Taipei, Taiwan, June 25-30, 2023, pp. 1681-1686.
- Anton Aguilar-Rivera, Ricard Vilalta, Raúl Parada, Fermín Mira Perez, Francisco Vázquez-Gallego, “Evaluation of AI-based Smart-Sensor Deployment at the Extreme Edge of a Software-Defined Network”, 2022 IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN), Chandler, AZ, USA, November 2022.

Besides the accepted journal and conference papers, several outreach activities have been performed by SUCCESS-6G partners. We provide the details in the following.

2.1.1 Mobile World Congress

A series of SUCCESS-6G project presentations took place during the Mobile World Congress on 26-29 February 2024 in Barcelona, Spain. In particular, SUCCESS-6G researchers from CTTC, Cellnex, and Nearby Computing presented an overview of the key achievements in the project so far.

Figure 1: SUCCESS-6G at the CTTC booth at Mobile World Congress 2024

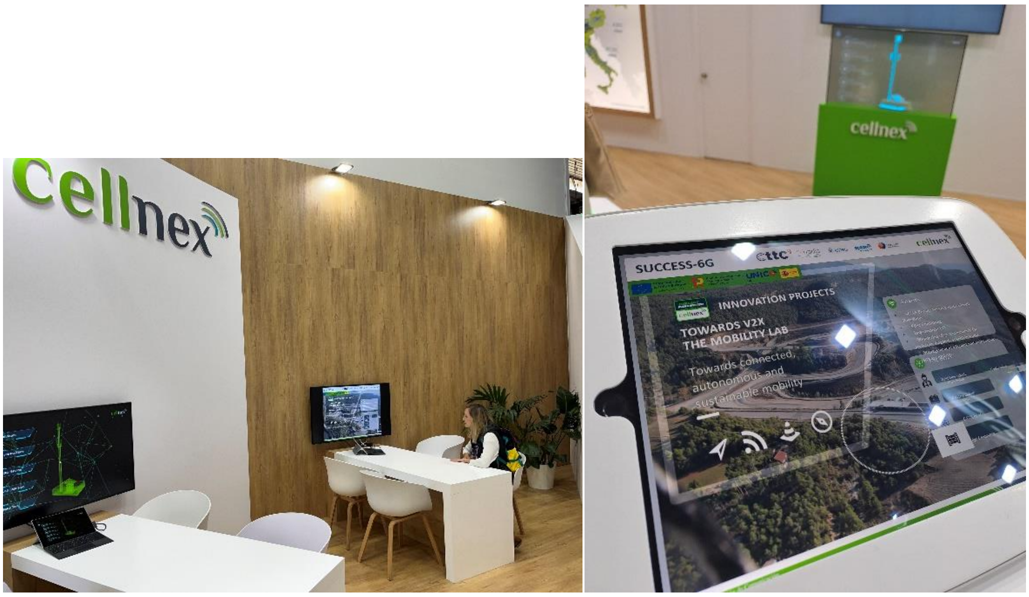

Figure 2: SUCCESS-6G at the Cellnex booth at Mobile World Congress 2024

Figure 3: SUCCESS-6G at the Nearby Computing booth at Mobile World Congress 2024

SUCCESS-6G was also presented at the 4YFN Barcelona startup event in the Teleco Renta booth.

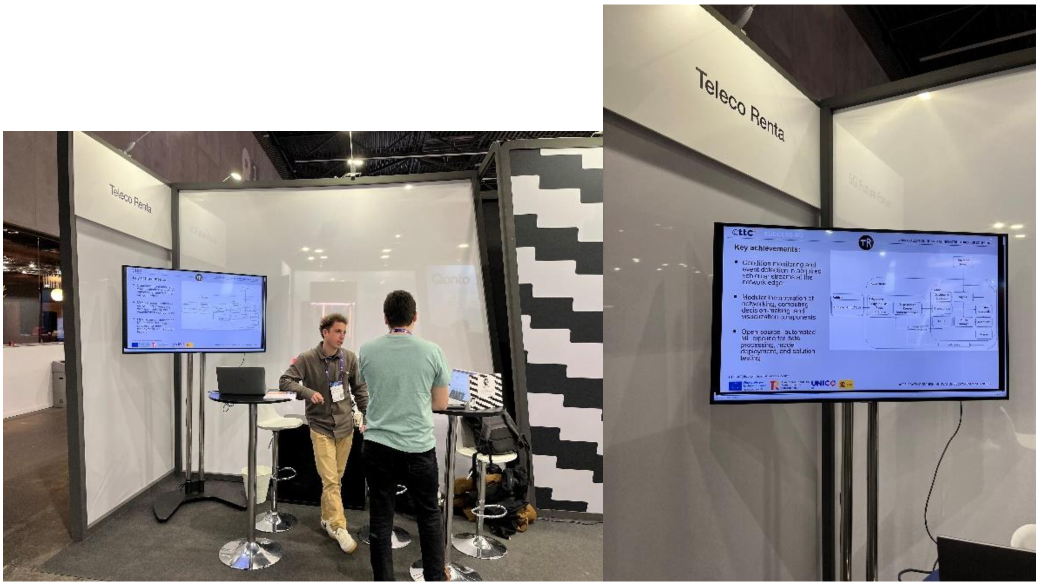

Figure 4: SUCCESS-6G at the Teleco Renta booth in the 4YFN event

2.1.2 International Student Workshop

A five-day workshop for early-stage researchers including PhD students and postdocs was organized by CTTC on May 13th – 17th, 2024. The workshop covered the latest advances in artificial intelligence and machine learning and their interplay with telecommunication systems.

Figure 5: International student workshop organized at CTTC

The workshop combined lectures by renowned invited speakers, demos, and practical hands-on with the experimental facilities at CTTC as well as visits to local industrial partners and key players. Moreover, the attendees had the possibility to present their work, interacting among themselves and with the senior researchers attending the event.

More information can be found here: https://telecorenta-workshops.cttc.es/

2.2 Deviations

No deviations from the original workplan have been identified.

3 Project management and administrative issues

3.1 Summary

In all three subprojects, Project Management (WP1) has taken care of the administrative tasks, quality assurance, management of risks, technical management of each subproject, and organization of technical activities. The smooth advancement of project activities and their overall coordination, ensuring participation from all project partners, contractual matters, and the provision of collaborative tools are examples of that.

Figure 6: SUCCESS-6G team members during a F2F meeting at CTTC premises

Regular plenary conference calls have been performed to exchange technical status updates and administrative news, facilitate coordination on deliverable contributions, discuss the technical activities but also to identify any potential issue or risk materializing early. Ad-hoc meetings have been also scheduled by particular SUCCESS-6G teams to advance on enablers' integration tasks and solve technical issues and doubts.

3.2 Deviations

Until the end of this reporting period, the project has achieved the successful delivery of the majority of deliverables and milestones, although with some delays with respect to the original planning. Detailed information is provided in Section 4.

4 Status of deliverables and milestones

4.1 Deliverables

The preparation of deliverables has been monitored and quality checks have been performed. Details on their status are given in the table below.

Subproject	Deliverable No.	Deliverable Title	Lead Beneficiary	Planned due date	Submitted
EXTEND/DEVISE /VERIFY	E3	Interim activity report II	CTTC	31/05/2024	14/06/2024
EXTEND	E5 (updated version)	Use case description, service requirements, and key performance indicators	CELLNEX	31/08/2023	31/10/2023
	E6	System architecture design	OPTARE	30/11/2023	12/01/2024
	E7	Data-driven schemes for imperfect V2X communication	CTTC	31/12/2023	14/02/2024
	E9	Monitoring framework for fault identification and predictive diagnostics	CTTC	31/01/2024	06/02/2024
	E10	Initial testing and preliminary validation of service KPIs	IDNEO	31/05/2024	Not yet submitted
	E12	Architectural framework for seamless updates of vehicular software	CTTC	31/01/2024	31/01/2024
	E13	Initial testing and preliminary validation of service KPIs	CTTC	31/05/2024	Not yet submitted
	E15	Interim report on dissemination, standardization, and exploitation activities	Nearby Computing	31/12/2023	31/12/2023
DEVISE	E5 (updated version)	Use case description, service requirements, and	CELLNEX	31/08/2023	31/10/2023

		key performance indicators			
	E6	System architecture design	OPTARE	30/11/2023	12/01/2024
	E7	Assessment of security landscape in V2X systems	CTTC	31/12/2023	12/01/2024
	E9	Secure and trustworthy condition monitoring of vehicles health	CTTC	31/01/2024	12/02/2024
	E10	Initial testing and preliminary validation of service KPIs	IDNEO	31/05/2024	Not yet submitted
	E12	Secure lifecycle service management for vehicular software updates	CTTC	31/01/2024	31/01/2024
	E13	Initial testing and preliminary validation of service KPIs	CELLNEX	31/05/2024	Not yet submitted
	E15	Interim report on dissemination, standardization, and exploitation activities	Nearby Computing	31/12/2023	31/12/2023
VERIFY	E5 (updated version)	Use case description, service requirements, and key performance indicators	CELLNEX	31/08/2023	31/10/2023
	E6	System architecture design	OPTARE	30/11/2023	12/01/2024
	E7	Distributed/collaborative coding mechanisms to minimize V2X signal distortion	CTTC	31/12/2023	14/02/2024
	E9	Decentralized methods for predictive diagnosis of vehicles condition	Nearby Computing	31/01/2024	Not yet submitted

	E10	Initial testing and preliminary validation of service KPIs	IDNEO	31/05/2024	Not yet submitted
	E12	Over-the-air software updates for seamless operation of vehicles	CTTC	31/01/2024	31/01/2024
	E13	Initial testing and preliminary validation of service KPIs	IDNEO	31/05/2024	Not yet submitted
	E15	Interim report on dissemination, standardization, and exploitation activities	Nearby Computing	31/12/2023	31/12/2023

Table 13: Deliverable status - due in the reporting period

4.2 Milestones

The table below provides an overview of the status of milestones during the reporting period.

Subproject	Milestone No.	Milestone Title	Lead Beneficiary	Planned due date	Achieved
EXTEND	H3	System architecture, relevant variables, processes, and inter-dependencies	OPTARE	30/11/2023	12/01/2024
	H4	Mechanisms to address V2X communication impairments	CTTC	31/12/2023	14/02/2024
	H6	Proof-of-concept description for real-time supervision of vehicles condition	All partners	01/01/2024	31/05/2024
	H7	Proof-of-concept description for seamless updates of vehicular software	CTTC	01/01/2024	Not yet achieved
	H8	Preliminary validation of KPIs	IDNEO	31/05/2024	Not yet achieved
	H10	Strategy for	Nearby	31/12/2023	31/12/2023

		dissemination, standardization, and exploitation	Computing		
DEVISE	H3	System architecture, relevant variables, processes and inter-dependencies	OPTARE	30/11/2023	12/01/2024
	H4	Mechanisms to detect, identify and contain/mitigate malicious V2X attacks	CTTC	31/12/2023	12/02/2024
	H6	Proof-of-concept description for real-time supervision of vehicles condition with security enforcement and control	All partners	01/01/2024	31/05/2024
	H7	Proof-of-concept description for secure updates of vehicular software with enhanced protection against malicious content	CTTC	01/01/2024	Not yet achieved
	H8	Preliminary validation of KPIs	IDNEO	31/05/2024	Not yet achieved
	H10	Strategy for dissemination, standardization, and exploitation	Nearby Computing	31/12/2023	31/12/2023
VERIFY	H3	System architecture, relevant variables, processes and inter-dependencies	OPTARE	30/11/2023	12/01/2024
	H4	Identification of communication-computation tradeoffs in V2X	CTTC	31/12/2023	14/02/2024
	H6	Proof-of-concept description for real-time supervision of vehicles condition with efficient	All partners	01/01/2024	31/05/2024

		computational methods			
	H7	Proof-of-concept description for computationally efficient updates of vehicular software	CTTC	01/01/2024	Not yet achieved
	H8	Preliminary validation of KPIs	IDNEO	31/05/2024	Not yet achieved
	H10	Strategy for dissemination, standardization, and exploitation	Nearby Computing	31/12/2023	31/12/2023

Table 14: Milestone achievement - due in the reporting period

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