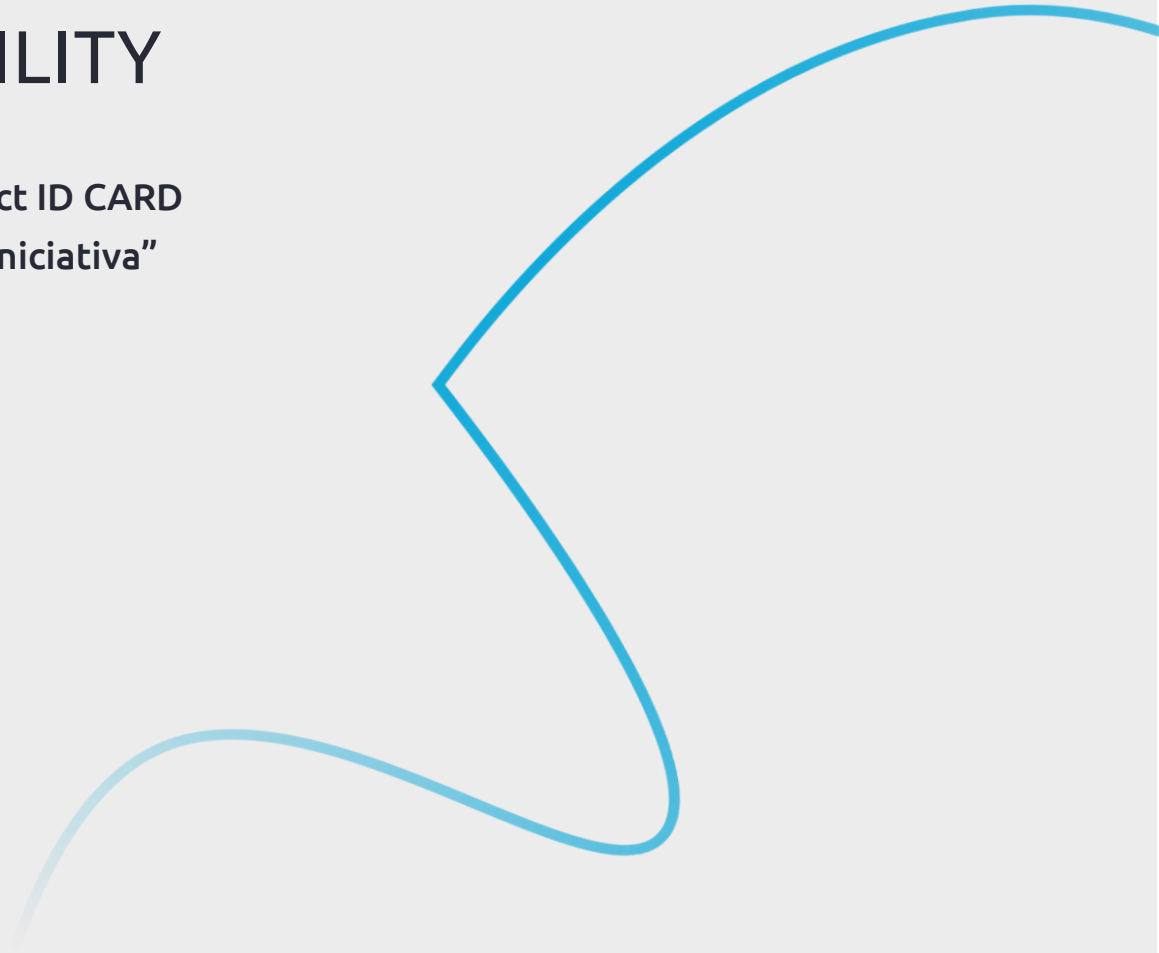


ROUTE 25 – AGENDA FOR AUTONOMOUS, INTELLIGENT, INTEROPERABLE AND INCLUSIVE MOBILITY

R&D Project ID CARD
“Ficha de Iniciativa”





General Information

Template Information

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General

Project ID		Project Sponsor	João Neves
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Name	Function	Organization

Table 1: Distribution list

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Table 2: Change History



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1 Project description

Project "Route 25" is positioned at the forefront of the evolving mobility market, aimed at leveraging the social, technological, and economic shifts in how people and goods move. It focuses on enabling the Portuguese industry to capitalize on emerging global opportunities in urban, suburban, and rural mobility. Central to this transformation is the integration of electrified vehicles, Cooperative, Connected, and Automated Mobility (CCAM), and Mobility as a Service (MaaS) models. These elements are seen as individually disruptive but collectively transformative, promising significant environmental and economic benefits. Route 25 aims to harness these advancements, fostering growth and innovation within the Portuguese ecosystem by supporting the development of technology, digital, and physical infrastructures essential for this shift.

WP2 of the project is dedicated to advancing data networking solutions to ensure resilient connectivity in urban and larger mobility contexts, enhancing the digital experience for autonomous vehicle drivers. Through Tasks 2.1 (T2.1) and 2.2 (T2.2), WP2 focuses on creating secure multi-network communications and networking AI tailored for the Future Mobility ecosystem. This initiative aims to improve data exchange between connected vehicles and the cloud, supporting a range of vehicle applications and telematics services by optimizing wireless network use. Furthermore, WP2 explores distributed edge computing to provide essential network connectivity to IoT devices and connected vehicles, facilitating decentralized networking and reducing latency for critical services. Importantly, WP2 also integrates a hybrid algorithm for positioning that leverages both GNSS and 5G signals, enhancing the accuracy and reliability of vehicle positioning systems. This comprehensive approach, combining advanced networking, edge computing, and hybrid positioning, aligns with Route25's mission to deliver a seamless and inclusive digital experience for vehicle users, promoting V2X communication and leveraging AI for network : it's optimization. The synergy of these efforts is set to drive the evolution of future mobility services and spawn new market opportunities in the ecosystem.



2 Motivation

The Route 25 agenda, aims to shape the future of mobility in Portugal by positioning the country at the forefront of intelligent and inclusive transportation technologies. The evolution of the automotive industry is moving at a breakneck pace, and the winners are most likely to be those companies and organisations that make better and faster decisions. Route 25 is ready to break the mould and deliver global impact, directly contributing to placing Europe in a technological highpoint.

In the near future, different forms of mobility (more convenient, safer, with less impact on health and environment) will be essential to support the population and economic activity. This transformation will fully rely on the electrification of vehicles, Cooperative, Connected and Automated Mobility (CCAM) features and Mobility as a Service (MaaS) business models. Individually, these features would be capable of disrupting the current status quo; together, however, they have the capacity to drive unprecedented changes, environmental breakthroughs, and economic opportunity: it is here that the target outcomes of Route 25 play a vital role. By embracing cutting-edge technologies and fostering innovation, this initiative aims to address critical challenges while reaping substantial gains for the nation and its citizens.

These are the key areas this agenda aims to tackle:

- **Autonomous and Intelligent Mobility:** Route-25 focuses on developing disruptive technological solutions for assisted and autonomous driving, ensuring safe and efficient mobility. By advancing research and development in this area, it aims to create a new value chain within Portugal.
- **Interoperability and Inclusivity:** The project aims to foster interoperable and inclusive mobility solutions. This involves creating a seamless experience for users across different modes of transportation, including connected vehicles, public transport, and smart infrastructure.
- **Digital Experience for Cooperative Mobility:** Route-25 seeks to enhance the digital experience for cooperative mobility. By leveraging technology, it aims to improve communication and coordination between various mobility services, leading to more efficient and user-friendly transportation systems.
- **Resilient and Inclusive Cities:** Connected infrastructures play a crucial role in building resilient and inclusive cities. Route-25 aims to develop smart infrastructure solutions that enhance urban mobility while considering environmental sustainability and social equity.
- **Low-Carbon Intercity Mobility:** The project also focuses on smart infrastructures for low-carbon intercity mobility. By promoting energy-efficient transportation systems, it contributes to a more sustainable planet.

Nevertheless, the agenda faces significant challenges while simultaneously assessing substantial benefits.

Main challenges:

1. **Complex Technological Challenges:** Developing disruptive solutions for autonomous, intelligent, interoperable, and inclusive mobility involves overcoming intricate technological hurdles. These challenges include ensuring safety-critical software development and validation for automotive applications.



2. **Market Adaptation:** As the mobility industry evolves rapidly, Portugal must adapt to stay relevant. The transition to new technologies and paradigms can be challenging, requiring adjustments across various sectors and stakeholders.
3. **Complex Ecosystem Coordination:** Coordinating efforts across different stakeholders—such as public transport providers, private vehicle manufacturers, and technology companies—can be intricate. Ensuring seamless cooperation between these entities is essential for Route 25's success.

Main Gains:

1. **Technological Advancements:** Route 25 builds upon mature and well-tested technologies with high Technology Readiness Levels (TRLs). By doing so, it addresses market needs related to connected cars, buses, trucks, autonomous vehicles, telematics units, drones, and more. The resulting products and services enable efficient data transfer to/from the cloud, fostering innovation and better AI algorithms.
2. **Network Efficiency:** Network operators benefit from Route 25 by offering communication services tailored to IoT players. Efficient load balancing across networks ensures a superior connected experience for both people and devices.
3. **Ecosystem Growth:** The agenda creates an ecosystem with network effects, promoting sustainable and equitable intelligent networking. Mobility service providers, industries, and ultimately, the planet, reap the rewards of energy-efficient systems and improved quality of life.
4. **Measurable outputs:** The project is expected to generate EUR 80 million in sales and create over 1000 jobs. Route 25 efforts will result 47 innovative and disruptive products and services will enhance mobility

In conclusion, the Route 25 agenda represents Portugal's bold step toward a future of intelligent and inclusive mobility. By embracing cutting-edge technologies, addressing challenges, and fostering innovation, this agenda aims to create a sustainable ecosystem that benefits both its citizens and the planet. As Route 25 accelerates, Portugal positions itself as a trailblazer in the world of transportation, ready to navigate the road ahead with resilience and vision.



3 Scope and Objectives

The underlying strategy of Route 25 is designed to enable the Portuguese industry to seize the global opportunities created by the dramatic shift that the mobility market is currently facing: a social, technological, and economic change, essentially altering the way people and products move in urban, suburban and even rural environments. In the near future, different forms of mobility (more convenient, safer, with less impact on health and environment) will be essential to support the population and economic activity. This transformation will fully rely on the electrification of vehicles, Cooperative, Connected and Automated Mobility (CCAM) features and Mobility as a Service (MaaS) business models. Individually, these features would be capable of disrupting the current status quo; together, however, they have the capacity to drive unprecedented changes, environmental breakthroughs, and economic opportunity: it is here that the target outcomes of Route 25 play a vital role.

The advent of these combined features and product platforms, heavily supported on technology and digital and physical infrastructure creates a myriad of growth opportunities for Portuguese companies and innovation ecosystem, which has long been investing in research and development of specific aspects of these key areas.

[WP2] is focused on the digital enhancement and adaptive connectivity essential for cooperative mobility. It is designed to cater to the evolving needs of urban and large-mobility scenarios, providing an enriched digital experience for drivers and users of autonomous vehicles.

Scope and Objectives of T2.1:

T2.1 is aimed at developing multi-network and secure communication software, paired with networking AI. The objectives are:

- To facilitate robust data exchanges between connected vehicles and cloud services, ensuring seamless V2X communication.
- To enable a broad range of connected vehicle applications and telematics services through the effective use of wireless networks and interfaces.
- To harness AI in networking to optimize connectivity and to enhance the resilience and security of the communication platforms.

Scope and Objectives of T2.2:

T2.2 is directed toward leveraging distributed edge computing in the context of vehicular networking with the goals of:

- Reducing end-to-end latency for connected services like tele-operation and complex vehicle maneuvers.
- Maximizing and monetizing computation and data storage resources across connected devices, treating them as digital real estate.
- Processing large volumes of data from various sources including communication messages, sensors, and vehicles to support rapid autonomous driving services.
- Develop and document GNSS positioning capabilities for accuracy and reliability in vehicular navigation (M2.2.3.1).
- Test and refine 5G positioning technologies to harness the high-speed and low-latency benefits of 5G networks (M2.2.3.2).



- Create a hybrid positioning system that combines GNSS and 5G signals, aiming to deliver superior positioning performance (M2.2.3.3).
- Develop 5G network-based positioning services (PPS 2) that could offer new solutions for real-time, safety-critical applications in the automotive sector.



4 Expected benefits

Route 25 is heavily focused on the deployment of digital components, tools, services, infrastructure for emerging mobility systems, thus responding to the challenge of digital transformation and supporting the reinforcement of the industry and the scientific and technologic system. The Project will directly contribute to the growth of the Portuguese Economy via high-growth tech companies, driving for technology-intensive activities, promoting the development of innovative and exportable goods and services and by creating a number of qualified jobs and attracting new talent in a sector lacking experts. Route 25 will also promote the consolidation and the emergence of new and innovative products, processes and services of technologic complexity, reducing the dependence from international markets, thus increasing Portugal's autonomy, and increasing the potential of the productive role of the country, directly contributing to making Europe a leader in the sector.

As such, Route 25 will seek to answer some important questions: How can Portugal adapt to stay relevant in the mobility industry? What is Portugal's role in the European and global mobility? Where do we place Portugal's mobility in the near future? Will Portugal's industry be disrupted, or will it be part of the revolution?

[WP2]

PPS for T2.1: Advanced networking software and AI-driven tools for secure, resilient V2X communications. Including new methodologies for data handling and network optimization that leverage AI for improved connectivity across various vehicular applications. Enhanced telematics and cloud services for connected vehicles, providing a seamless digital experience for users.

PPS for T2.2: Edge computing hardware and distributed network infrastructure that facilitate low-latency, high-reliability communication. Including, Decentralized data processing techniques that utilize edge computing for faster service delivery and response times in vehicular networks. Real-time data processing and storage solutions for IoT and connected vehicles, maximizing the digital real estate's value.

Additionally, T2.2.3 into the PPS framework: Hybrid positioning systems that integrate GNSS and 5G technologies for superior accuracy and dependability. This includes protocols and documented tests for GNSS and 5G positioning, as well as the methodologies for combining these into a cohesive hybrid system. 5G network-based positioning services support a host of new mobility applications, from navigation to safety-critical operations.



5 State of the Art

Indeed, by 2030, it is expected that the autonomous car market in Europe can amount to over EUR190 billion¹, driven by the global sales of electric vehicles, which expanded by 56% from 2016 to 2017 – promoted by policy and regulatory changes, and public interest in reducing emissions. Also, the Advanced Driver Assistance Systems (ADAS) global market is expected to grow from USD 27.0 billion in 2020 to USD 83.0 billion by 2030, at a CAGR of 11.9%². Data from 2018 showed that over 90% of new vehicle models in the USA had at least one ADAS feature with Adaptive Cruise Control, Blind Spot Warning, and Automatic Emergency Braking being the most common³. Additionally, the World Health Organization estimates that there are 1.35 million road deaths and 50 million injuries annually. With human being the cause in roughly 95% of the cases, assisted and autonomous vehicles have the potential to reduce these casualties dramatically⁴. For public authorities, one of the great opportunities of connected vehicles is the optimisation of road capacity. As autonomous cars optimise costs, they make services for remote communities more affordable, guaranteeing a territorial cohesion, as well as allowing better public transport in crowded cities. The introduction of these technologies is seen as a way of transforming commuting and providing a better user-centred experience.

Cars will become “data hubs on wheels” as they will generate more data than ever before, which will directly benefit the end-user, via a better mobility experience, sustained on safe, convenient and better performance principles; and it will also enable authorities to better monitor road capacity and conditions, to keep traffic flowing in an effective and safe way, by relying on the vehicle's connectivity and cooperation capabilities. The future of mobility means our day-to-day journeys will become cleaner, safer, cheaper and more productive.

There is no doubt that digital road infrastructure will significantly gain importance, playing a key role in the ability of connected and automated vehicles as well as other road users to interpret their surroundings. Hence, to enable efficient data exchange between vehicles and fully exploit the support from digital road infrastructure, automated vehicles must also be cooperative and connected. These elements will allow vehicles to receive, in real-time, key attributes of roads relevant for automated driving, with the aim of adding predictability on what to expect on the road ahead and enlarging the decision base for using automatic mode. It is also worth noting that the wireless Internet as it exists today was not designed for billions of human users and tens of billions of moving things. The bottom line is that current network economics and the lack of network intelligence and automation are hindering growth. Perennial questions such as how to connect, where to connect and what data to send are therefore more relevant than ever.

The WP2 of the Route25 project reflects the cutting-edge convergence of networking technologies and edge computing within the framework of cooperative mobility. For Task 2.1 (T2.1), the current technological forefront is defined by sophisticated multi-network communication software and networking AI, both of which are integral for seamless vehicle-to-everything (V2X) interactions and extensive cloud-based data exchanges. These developments represent the pinnacle of secure, adaptive connectivity and testify to the substantial progress in vehicular networking AI. Task 2.2 (T2.2) further elevates the project's innovative stature by integrating distributed edge computing, which significantly minimises latency for vehicular services and optimises the computational potential of mobile IoT devices. The advent of Task 2.2.3 (T2.2.3) accentuates this progress with network-based positioning, utilizing both GNSS and 5G signals to forge a hybrid system that sets a new benchmark for precision



and reliability in vehicular positioning. This trinity of tasks within WP2 collectively embodies the avant-garde of autonomous vehicle support systems, setting the stage for a revolution in digital mobility and connectivity services.



6 Scientific & Technical Risks

1. Technological Limitations:

T2.1, the complexity of integrating multi-network communication software and AI that must work seamlessly across a plethora of vehicle platforms, each with its own proprietary systems and limitations, could be a significant hurdle. Ensuring the vehicle provides all required functionalities for V2X communication could also be a significant hurdle.

T2.2, deploying edge computing infrastructure presents the challenge of technological deployment and achieving synchronization with existing network infrastructures. The real-time processing requirements and the storage of vast data sets at the edge push current technological capacities to their limits.

T2.2.3, integrating GNSS and 5G for hybrid positioning demands high precision and the mitigation of signal interference, which is technically challenging given the variability of signal strength and integrity in different environments.

2. Site Access for Demonstrations:

Live demonstrations are crucial for testing and validating the technologies developed in WP2. Securing access to sites that can accommodate the comprehensive trials, especially in urban environments or areas with the necessary infrastructure for 5G and GNSS, can be complex due to regulatory, logistical, and safety considerations.

3. Partnership and Collaboration Challenges:

The success of WP relies heavily on collaboration between various partners who may have differing priorities, capabilities, and timelines. Ensuring all partners provide the necessary inputs, from data to hardware, within the required time frames can be a significant logistical and managerial challenge.



7 Technological / Scientific Uncertainties

Route 25 builds and expands on very mature and well tested technologies with high TRL to address the aforementioned market needs. The total addressable market is composed by all companies that build their businesses on assisted/autonomous and connected cars, buses, trucks, drones, robots, industrial machines, and other moving things. The products and services accelerated by Route 25 enable these prospective customers and their end customers to shift from the current paradigm of user-operated vehicles to self-driven vehicles and, ultimately, to AI-driven on-demand mobility.

This paradigm shift will be supported by the development of higher vehicle autonomy that will empower the vehicle to make more decisions, reducing the number accidents on the roads in 30%; by the extension of advanced connectivity that will enable the transfer of 10x more and better-quality data to and from the cloud; and by rationally deploying the supporting urban, suburban and rural infrastructure that will ensure continuity and 99,9% reliability of the data streams necessary for urban-to-urban mobility scenarios. Knowing that all necessary building blocks are in place, those companies can focus on what they do best: run their operations, and invent new products, services and businesses that delight their customers. In short, the digitisation strategy within Route 25 will offer car manufacturers the opportunity to build direct customer relationships that are deep, long-lasting, and mutually beneficial.

Route 25 further leads to an overall ecosystem growth with cascading effects powered by intelligent networking in a much more sustainable and equitable way, also acting inclusively for people located in different geographies. End customers thrive, from mobility service providers to industries of all kinds. And ultimately, the planet is more sustainable due to much more energy efficient mobility systems and infrastructures, and millions of people can lead happier, more inclusive, and healthier lives.

For T2.1, developing multi-network communication software and networking AI presents complexities in integrating disparate wireless technologies while ensuring robust, secure connectivity for V2X communications. The unpredictability of AI performance and its adaptability to real-world vehicular scenarios also pose significant challenges. T2.2's commitment to distributed edge computing introduces the uncertainty of deploying infrastructure that must operate seamlessly across diverse geographic and technological landscapes, raising concerns about the consistency and reliability of edge computing resources. The ambitious T2.2.3, focusing on hybrid positioning, must grapple with the synchronisation of GNSS and 5G signals, where the variability in signal strength, environmental interference, and the nascent state of 5G infrastructure could hinder system accuracy and reliability. Collectively, these uncertainties highlight the need for innovative solutions, rigorous testing, and adaptable frameworks to advance the state of the art in cooperative mobility and connectivity.



8 Activities Description (Project Backlog)

Information: In order to achieve these impacts, Route 25 brings together 28 partners, leveraging a common investment in five focus areas, to promote the Go To Market strategy of each partner's Products, Processes and Services (PPS) in the CCAM domain. By promoting a single project with 47 PPS, the consortium believes that it is increasing the value for money, avoiding the repetition of the common ground in individual projects, while accelerating their development and industrialisation, and ensuring their market acceptance through relevant operational demonstrations.

8.1 January 2025

- Support for multiple GNSS constellations (GPS, GLONASS, Galileo, BeiDou).
- Disaggregate Edgellery (MEP) on a EdgeNode and add Edge Node.
- Evaluation of srsRAN and OAI-RAN software tools for developing radio access network (RAN).
- The current implementation of position algorithms can become unreliable in different cases, so an improved ITS with high-precision

8.2 February 2025

- Survey the state-of-the-art and technical documentation of the Standardization Body (3GPP and ETSI)
- Ability to process signals in real-time.
- Compatibility with different SDR hardware.
- ITS with improved Location information.
- Deployment band 46 and 47.
- V2X Network Slice Testing with dynamic allocation of RAN resources based on V2X traffic demand.
- Continuous evaluation of metrics and performance of GPS/Galileo satellite systems.

8.3 March 2025

- Survey the state – of – the – art and technical documentation of the Standardization Body
- Ability to process Signals in real-time.
- Compatibility with differente SDR hardware.
- Evaluate Compatibility with Differente SDR Hardware Platforms.
- ITS with improved location information
- V2X Network Slice Testing with dynamic allocation of RAN resources based on V2X traffic demand.
- Compatibility with different SDR hardware.
- Deployment band 46 and 47.
- Summarize WBS 1 in one document
- Implementation of GNSS-SDR Monitor Platform:
- Development of the Visualization and Storage Layer:
- Creation of the graphical interface using frameworks like Qt or web frameworks such as React.
- Consolidation of WBS1.
- Integration with map APIs (Google Maps, OpenStreetMap).
- Database configuration and optimization (SQL, NoSQL).
- Implementation of APIs for data access.
- WBS 1 unification.



8.4 April 2025

- Send WBS 1 to validation.
- Using the Unlicensed spectrum for ITS is a challenge since there are interferences and strong algorithms of spectrum management.
- Ability to process signals in real-time.
- Graphical interface for data visualization.
- Security and integrity of processed data.
- Evaluate Compatibility with Different SDR Hardware Platforms.
- Create Technical Documentation Describing System Architecture and Components.
- Develop User Documentation Including Guides and FAQs for Platform Usage.
- Adaptation of the architecture to meet quality of service requirements.
- ITS with improved Location information
- V2X Network Slice Testing with dynamic allocation of RAN resources based on V2X traffic demand.

8.5 May 2025

- Develop and Test xAPPs Prototypes
 - Continue the development of xAPPs for ITS message optimization.
 - Begin testing prototypes of xAPPs with existing network setups.
- Consolidate Research on RAN Development Tools
 - Finalize initial research on srsRAN and OAI-RAN, documenting key findings and gaps for future development.
 - The current implementation of position algorithms can become unreliable in different cases, so an improved ITS with high-precision localization can enable complex maneuvers and lane changes for autonomous vehicles.
- Security and integrity of processed data.
- Support for multiple GNSS constellations (GPS, GLONASS, Galileo, BeiDou).
- Study of the open-source code of the OAI MAC layer and identification of relevant functions for the implementation of LBT.
 - WBS 3 - Project Support Document

8.6 June 2025

- Refine Functional and Technical Requirements
 - Continue research on signal processing in real-time.
 - Assess current positioning algorithms and design improvements.
 - Update the research documents for signal processing and ITS algorithms.
 - Ability to process signals in real-time.
- Develop Initial Concepts for xAPPs
 - Work towards more detailed conceptualization of xAPPs for ITS message optimization.
 - Prepare early-stage designs for integration into the system.
 - Opportunities to use radio bands in the NR-U spectrum for critical and non-critical automotive ITS systems and offer an alternative to Public Operators to provide these services away from their precious spectrum.
 - The current implementation of position algorithms can become unreliable in different cases, so an improved ITS with high-precision localization can enable complex maneuvers and lane changes for autonomous vehicles.
 - WBS 2 - Project Support Document.
 - WBS 3 - Project Support Document.



8.7 July 2025

- Onboard New Developers and Review Documentation
 - Focus on onboarding new team members (new developers who joined in January).
 - Continue reviewing and finalizing the documentation for easier integration.
- Maintain IMAGINE Collaboration
 - Continue collaboration to bridge gaps in development expertise
- Refine Functional and Technical Requirements
 - Continue research on signal processing in real-time.
 - Assess current positioning algorithms and design improvements.
 - Update the research documents for signal processing and ITS algorithms.
 - Ability to process signals in real-time.
 - WBS 2 - Project Support Document.
 - WBS 3 - Project Support Document.

8.8 August 2025

- Documentation Finalization
 - Ensure all documents and processes are well-documented and accessible for team members and stakeholders.
 - Create a consolidated knowledge base for the project.
- Refine Functional and Technical Requirements
 - Continue research on signal processing in real-time.
 - Assess current positioning algorithms and design improvements.
 - Update the research documents for signal processing and ITS algorithms.
 - Ability to process signals in real-time.
 - WBS 2 - Project Support Document.
 - WBS 3 - Project Support Document.
- Onboard New Developers and Review Documentation
 - Focus on onboarding new team members (new developers who joined in this month).
 - Continue reviewing and finalizing the documentation for easier integration.



Activity Description	Type	Expected Output	Detailed Task Description
Check SDR Compatibility	Technical	Compatibility Report	Validate compatibility of current SDR platforms with project specifications and test suites.
Create Project Knowledge Base	Non-Technical	Knowledge Base	Organize and structure a centralized knowledge base with architecture, scripts, and guides.
Final Documentation	Non-Technical	Report	Review, consolidate, and finalize all documentation related to WBS2 and WBS3 for current sprint.
Onboard New Developers	Technical	Internal Training	Introduce new developers to the tools, architecture, documentation, and setup procedures.
Research on Real-Time Signal Processing	Technical	Technical Report	Continue research on real-time signal processing methods relevant to ITS and GNSS.
Review and Update Technical Requirements	Technical	Specification Document	Update technical and functional requirements based on latest research and integration feedback.
Security Checklist for Dev Environment	Non-Technical	Security Checklist	Perform cybersecurity audit of dev environment, including network access and storage policies.
System Architecture Documentation	Technical	Architecture Document	Document the system architecture, interfaces, and communication flows for technical reference.
Update Tool Inventory	Non-Technical	Inventory Document	Review internal repositories, update list of tools in use, and publish inventory on shared drive.

8.9 September 2025

8.9.1 Technical Activity 1 – Yolo Dataset Research

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: WBS3 – Conceptualization of the Solution and Architecture Definition] [TeamAllocation correspondence: Work Break Down Structure]	WBS3 – Conceptualization of the Solution and Architecture Definition
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Dataset Research and Preparation for Vehicle & License Plate Detection
Activity Type	Code Documentation Testing Research Configuration	Research / Documentation



	[ex.: Code]	
Expected Deliverable [Definition of Done]	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Organized dataset in YOLOv5 format (images/train, images/val, labels/train, labels/val) + dataset YAML file. At least one dataset identified, structured correctly for YOLOv5, and ready for training.
Activity Summary Description	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Research and preparation of open datasets (Kaggle, GitHub, etc.) containing vehicles and license plates. Organize them into YOLOv5 format and prepare a dataset configuration YAML.
Skills	Skills description [ex.: React, JavaScript, CSS, API integration]	Dataset handling, Python basics
Detailed Requirements [if applied]	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Convert dataset to YOLOv5 structure; include metadata (classes, number of samples).
Main User Stories	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	- As an engineer, I need a dataset ready for YOLOv5 training. - As a researcher, I want documented dataset sources for reproducibility.
Step by Step Instructions	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	1. Search for public datasets.2. Organize into YOLO format.3. Create YAML config file.4. Document dataset origin and license.
Background Information / Links	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	R&D Support Document (RD_Activity_YOLO 2): RD_Activity_YOLO 2.docx

8.9.2 Technical Activity 2 – Yolo Model Training

Item	Purpose	Description
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WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	04 – Development and Solution Integration
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Training YOLOv5 Model for License Plate Detection
Activity Type	Code Documentation Testing [ex.: Code]	Model Training
Expected Deliverable [Definition of Done]	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Trained YOLOv5 model file (best.pt) with documented performance metrics. Model trained successfully with validation precision \geq X% and results saved.
Activity Summary Description	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Train a YOLOv5 model for license plate detection using the prepared dataset. Document parameters, training process, and validation metrics (precision, recall, mAP).
Skills	Skills description [ex.: React, JavaScript, CSS, API integration]	Python, PyTorch, YOLOv5
Detailed Requirements [if applied]	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	GPU environment (if possible), dataset prepared in Activity 1, training logs stored.
Main User Stories	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	- As an engineer, I want to train a custom model for plates.- As a researcher, I want to evaluate the performance of YOLOv5 on this dataset.



Step by Step Instructions	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	1. Clone YOLOv5 repo.2. Install dependencies.3. Run training with dataset YAML.4. Monitor metrics.5. Save and document results.
Background Information / Links	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	R&D Support Document (RD_Activity_YOLO 2): RD_Activity_YOLO 2.docx

8.9.3 Technical Activity 3 – Inference & Workflow Integration

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	05 – Testing and Validation
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Inference and Combined Detection Workflow
Activity Type	Code Documentation Testing [ex.: Code]	Testing / Integration
Expected Deliverable [Definition of Done]	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Annotated images/videos with bounding boxes + CSV file linking detected vehicles and plates. Correct inference results generated for both vehicles and plates, with CSV output linking them.
Activity Summary Description	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Test YOLOv5 pretrained COCO model for vehicles and custom-trained model for license plates. Develop a small script linking detected plates to cars and export results in CSV format.



Skills	Skills description [ex.: React, JavaScript, CSS, API integration]	Python, Data Processing, YOLOv5
Detailed Requirements [if applied]	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Both vehicle and plate models available; script developed for linking results.
Main User Stories	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	- As an engineer, I want to test inference to validate the detection workflow. - As a stakeholder, I want annotated outputs that demonstrate detection performance.
Step by Step Instructions	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	1. Run inference with vehicle model.2. Run inference with plate model.3. Link detections via script.4. Export CSV with frame, car_bbox, plate_bbox, confidence.5. Save annotated images/videos.
Background Information / Links	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	R&D Support Document (RD_Activity_YOLO 2): RD_Activity_YOLO 2.docx

8.9.4 Non-Technical Activity – AI Research for AI for Smart Traffic Lights

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	01 – Preliminary Studies and State of the Art Review
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Literature & Dataset Survey – AI for Smart Traffic Lights
Activity Type	Code Documentation Testing [ex.: Code]	Documentation / Research
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting	Report including at least 5 datasets and 5 research papers on AI-based adaptive traffic light control.



[Definition of Done]	play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Comparative table with datasets and methods, written summary in simple English.
Activity Summary Description	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Research and summarize available datasets and recent academic solutions (2020–2025) applying AI to adaptive traffic light systems, bus prioritization, and urban mobility optimization.
Skills	Skills description [ex.: React, JavaScript, CSS, API integration]	Research, Documentation, Comparative Analysis
Detailed Requirements [if applied]	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Collect datasets (e.g., SUMO, METR-LA, CitySim); analyze reinforcement learning, deep learning, and heuristic approaches; document findings.
Main User Stories	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	- As a team member, I want a clear summary of existing AI solutions for traffic prioritization. - As a manager, I want to identify datasets that can be used to accelerate development.
Step by Step Instructions	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	1. Collect public datasets.2. Review 5+ research papers.3. Create comparison table.4. Write summary in simple English.5. Share documents internally.
Background Information / Links	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	State-of-the-art articles (2020–2025); Open traffic simulation datasets (SUMO, METR-LA, CitySim).

8.10 October 2025

8.10.1 Technical Activity – AI Research for AI for Smart Traffic Lights

Item	Purpose	Description
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WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	01 – Preliminary Studies and State of the Art Review
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Literature & Dataset Survey – AI for Smart Traffic Lights
Activity Type	Code Documentation Testing [ex.: Code]	Documentation / Research
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Report including at least 5 datasets and 5 research papers on AI-based adaptive traffic light control.
[Definition of Done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Comparative table with datasets and methods, written summary in simple English.
Activity Summary Description	Skills description [ex.: React, JavaScript, CSS, API integration]	Research and summarize available datasets and recent academic solutions (2020–2025) applying AI to adaptive traffic light systems, bus prioritization, and urban mobility optimization.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Research, Documentation, Comparative Analysis
Detailed Requirements	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Collect datasets (e.g., SUMO, METR-LA, CitySim); analyze reinforcement learning, deep learning, and heuristic approaches; document findings.
Main User Stories	For quick onboarding	- As a team member, I want a clear summary of existing AI solutions for traffic prioritization.- As a manager, I want to



	[ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	identify datasets that can be used to accelerate development.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Collect public datasets.2. Review 5+ research papers.3. Create comparison table.4. Write summary in simple English.5. Share document internally.
Background Information / Links		State-of-the-art articles (2020–2025); Open traffic simulation datasets (SUMO, METR-LA, CitySim).

8.10.2 Technical Activity – Data Analysis & Feature Engineering

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	03 – Conceptualisation of the Solution and Architecture Definition
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Data Analysis and Feature Engineering for Adaptive Traffic Lights
Activity Type	Code Documentation Testing [ex.: Code]	Data Analysis / Pre-processing
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Cleaned dataset with descriptive statistics, visualizations, and engineered features ready for model input.
[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Missing values handled, features normalized or scaled, engineered features documented, exploratory report produced.
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Perform exploratory data analysis on mobility/traffic datasets. Clean the data, identify correlations, and design features (e.g.,



		vehicle flow, congestion levels, signal timings) that will feed the AI models.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Python (pandas, matplotlib, seaborn), statistics, feature engineering
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Ensure reproducible notebooks/scripts; generate a concise report with plots; define input–output structure for the model.
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As a data scientist, I want to understand the dataset and extract meaningful features. • As a team member, I want clear visualizations to better interpret the traffic patterns.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Load and clean datasets. 2. Perform exploratory analysis and visualizations. 3. Engineer candidate features. 4. Save processed dataset. 5. Document findings.
Background Information / links		State-of-the-art survey (previous activity); datasets identified (e.g., SUMO, METR-LA, CitySim).

8.10.3 Technical Activity 2 – Model Design & Implementation

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	04 – Development and Solution Integration
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Model Design and Implementation for Traffic Light Prioritization
Activity Type	Code Documentation Testing [ex.: Code]	AI Model Development
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video	Implemented baseline AI model (e.g., Reinforcement Learning or Deep Learning) with reproducible training pipeline.



	without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	
[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Model code implemented, runs without errors, produces initial training logs, and is version-controlled.
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Select and implement a baseline AI model for adaptive traffic light control, building on the features extracted in the previous step. Define architecture (e.g., RL agent, neural network, heuristic baseline) and set up the training pipeline.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Python (PyTorch/TensorFlow), Reinforcement Learning, ML pipeline design
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Modular code structure; configuration files for reproducibility; baseline comparison (e.g., fixed-timing).
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As an engineer, I want to implement a baseline AI model. • As a manager, I want to see a working prototype that can evolve over time.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Define model architecture. 2. Implement model in code. 3. Set up training pipeline. 4. Run first experiments. 5. Document initial results.
Background Information / links		Previous dataset analysis; open-source RL/traffic control frameworks (e.g., SUMO-RL, CityFlow).

8.10.4 Technical Activity 3 – Model Training & Testing

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8).	05 – Testing and Validation



	[ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Training and Testing of AI Model for Traffic Lights
Activity Type	Code Documentation Testing [ex.: Code]	Model Training & Evaluation
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Trained model with performance metrics (delay reduction, throughput, travel time improvement).
[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Training completed, metrics reported, comparison baseline vs. AI documented.
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Train the implemented AI model on the prepared dataset or simulation environment. Evaluate performance against baselines and record metrics for improvement.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	ML model training, metrics evaluation, experiment tracking
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Use experiment tracking (e.g., MLflow); compute relevant KPIs (avg. waiting time, bus prioritization success).
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As a researcher, I want to measure the performance of the AI solution. • As a stakeholder, I want to know if the AI reduces bus delays and improves flow.



Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Train model on datasets/simulation.2. Log metrics.3. Evaluate vs. baseline.4. Produce performance report.5. Share results.
Background Information / links		Traffic simulation environments (SUMO, CityFlow); prior AI research papers.

8.10.5 Technical Activity 4 – Validation & Documentation

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	06 – Dissemination Activities and Demonstration
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Validation and Documentation of AI Model for Adaptive Traffic Lights
Activity Type	Code Documentation Testing [ex.: Code]	Validation / Reporting
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Validation report including methodology, results, visualizations, and conclusions.
[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Written report completed (3–5 pages) + visual demo (plots or video of simulation).
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Validate the AI model in different scenarios, document results in a concise report, and prepare visual outputs for dissemination (charts, demo video).
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile;	Technical writing, visualization, communication



	integrate with backend API for video metadata]	
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Clear documentation of metrics, limitations, and possible improvements; accessible visuals for non-technical readers.
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As a project manager, I want a clear validation report to share with stakeholders. • As a team member, I want visual outputs to understand system behavior.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Validate model in multiple scenarios. 2. Collect results and visuals. 3. Write validation report. 4. Prepare demo visuals. 5. Share internally.
Background Information / links		State-of-the-art survey; dataset analysis; training results.

8.10.6 Technical Activity 8 – Coordination and Project Management

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	08 - Coordination and Project Management
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Coordination and Project Management
Activity Type	Code Documentation Testing [ex.: Code]	Management / Reporting
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Planned tasks are properly managed (i.e., tasks are executed and tracked monthly; execution rate is recorded; delayed tasks are postponed to the next month), team is engaged and committed (full attendance), and all artifacts are duly filled in.



[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Logbook, team allocation, weekly report, detailed report and id card (next month) are filled as per frequency defined in Refer to RnD Activities Manager - Responsibilities.docx .
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Ensures weekly team allocation, task execution tracking, and completion of administrative forms.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Technical writing, visualization, communication, Scrum, PMP, excel, jira, confluence
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	N/A
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	Refer to RnD Activities Manager - Responsibilities.docx
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	Refer to RnD Activities Manager - Responsibilities.docx
Background Information / links		N/A

8.11 November 2025

8.11.1 Technical Activity – QoS Prediction Model Development

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	04 – Development and Solution Integration
Activity Name	Short, action-oriented name.	QoS Prediction Model (Regression and/or Classification)



	<p>[ex.: Implement Video Player Widget]</p> <p>[TeamAllocation correspondence: Macro Activity]</p>	
Activity Type	<p>Code Documentation Testing</p> <p>[ex.: Code]</p>	Model Development / ML Engineering
Expected Deliverable	<p>Clear description + success conditions</p> <p>[ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout]</p> <p>Explicit pass/fail conditions</p> <p>[ex.: Plays video without buffering, responsive layout]</p>	A reproducible ML pipeline that predicts web-service QoS (e.g., Response Time/Latency/Availability) or classifies Service Classification (1–4), with saved model, code, configs, and a short model card.
[definition of done]	<p>Context and purpose of the activity</p> <p>[ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs]</p> <p>[TeamAllocation correspondence: Activities]</p>	1) Clean training/validation/test splits; 2) Pipeline script/notebook runs end-to-end; 3) Metrics reported (regression: RMSE/MAE/R ² ; classification: Accuracy/F1/Confusion Matrix); 4) Trained model artifact saved; 5) Model card completed.
Activity summary description	<p>Skills description</p> <p>[ex.: React, JavaScript, CSS, API integration]</p>	Build a first working ML model to predict QoS. Two target options: (A) regression for a numeric metric (e.g., Response Time/Latency), (B) multi-class classification for Service Classification (1–4) using the other metrics as features. Provide a clean pipeline that the team can rerun and extend.
Skills	<p>Specs, standards, constraints</p> <p>[ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]</p>	Python, pandas, scikit-learn, basic stats/ML, experiment tracking, version control
Detailed Requirements [if applied]	<p>Granular, 1–2 weeks max</p> <p>[ex.: As a user, I can play/pause video in dashboard]</p>	<ul style="list-style-type: none">• Deterministic random seed;• Clear feature list and target definition;• Handle missing/outliers;• Scaling/encoding where needed;



		<ul style="list-style-type: none"> • Baselines (e.g., mean regressor or majority class) + at least 2 ML models (e.g., RandomForest, XGBoost, Logistic/Linear); • Hyperparameter search (RandomizedSearchCV); • Save model
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	<ul style="list-style-type: none"> • As a data scientist, I need a robust baseline model to quantify predictability of QoS. • As a PM, I want an objective comparison (baseline vs ML) to justify next steps.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1. Define the task: choose target (numeric QoS or Service Classification 1–4). 2. Load & inspect data: check shapes, nulls, distributions; fix types. 3. Split data: stratified split for classification; temporal split if timestamps exist. 4. Preprocess: impute, scale numeric features; encode categoricals; remove/leakage features. 5. Baseline: compute simple baseline (mean regressor / majority class). 6. Train models: start with 2–3 algorithms (e.g., Linear/Logistic, RandomForest, XGBoost). 7. Tune: RandomizedSearchCV with cross-validation; keep best params. 8. Evaluate: regression → RMSE/MAE/R ² ; classification → Accuracy/F1/ROC-AUC (+ confusion matrix). 9. Interpret: feature importance/SHAP (if feasible). 10. Package: save preprocessor + model, export metrics as JSON/CSV, write a model card (data, features, metrics, limitations).
Background Information / links		Team-provided QWS v1.0 dataset (QoS metrics table); internal repo for code; scikit-learn docs. https://qwsdata.github.io/

8.11.2 Technical Activity – Evaluation & Monitoring Framework (Depends of Technical Activity 1)

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	05 – Testing and Validation
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Model Evaluation, Back-testing and Drift Monitoring Setup
Activity Type	Code Documentation Testing	Testing / MLOps



	[ex.: Code]	
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Evaluation suite (scripts/notebooks) that: (i) runs cross-validation/back-tests, (ii) produces standardized reports/plots, (iii) computes drift checks on inputs/targets, and (iv) flags performance regressions.
[definition of done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	Automated evaluation produces: confusion matrix or error distribution plots, metric tables per split, and a drift summary (e.g., PSI/KS or population stats deltas). Readme explains how to run it.
Activity summary description	Skills description [ex.: React, JavaScript, CSS, API integration]	Build a lightweight but reliable evaluation & monitoring layer around the prediction model: consistent metrics, plots, and simple drift checks so the team can track stability across versions/datasets.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Python, pandas, scikit-learn, matplotlib, basic statistics, software packaging
Detailed Requirements [if applied]	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	• Fixed evaluation seeds; • Save reports to reports/ (HTML/PNG/CSV); • Track experiments (CSV/MLflow); • Provide alert thresholds (e.g., $\pm 10\%$ metric drop).
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As an engineer, I want a one-command evaluation to compare model versions. • As a stakeholder, I want clear visuals to understand gains/risks.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1) Define the official metric set (RMSE/MAE/R ² or Accuracy/F1/AUC). 2) Implement k-fold or time-based back-tests. 3) Generate standard plots (residuals/ROC/PR, confusion matrix). 4) Add drift checks (feature distributions vs reference; PSI/KS). 5) Save artifacts + summary report; document run steps.



Background Information / links		Same dataset and model from Technical Activity 1; internal evaluation templates. https://qwsdata.github.io/
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8.11.3 Technical Activity – AI Research for AI for Smart Traffic Lights

Item	Purpose	Description
WBS	Work Breakdown Structure reference (1–8). [ex.: 3] [TeamAllocation correspondence: Work Break Down Structure]	01 – Preliminary Studies and State of the Art Review
Activity Name	Short, action-oriented name. [ex.: Implement Video Player Widget] [TeamAllocation correspondence: Macro Activity]	Landscape of Web-Service QoS Datasets + Documentation & Charts
Activity Type	Code Documentation Testing [ex.: Code]	Research / Documentation
Expected Deliverable	Clear description + success conditions [ex.: A functional video player component integrated into the dashboard, supporting play/pause and responsive layout. Plays video without buffering, responsive layout] Explicit pass/fail conditions [ex.: Plays video without buffering, responsive layout]	Short report (3–5 pages or slide deck) with: (i) list of public QoS datasets, (ii) pros/cons & licenses, (iii) summary charts (distributions, correlations) for the most promising dataset(s).
[Definition of Done]	Context and purpose of the activity [ex.: Develop the core video player feature for the streaming dashboard, ensuring compatibility with existing UI and backend APIs] [TeamAllocation correspondence: Activities]	At least 5 datasets identified; a comparison table (size, features, license, update cadence); simple visuals (histograms/boxplots/correlation heatmap) for top candidate(s); a recommendation (“use / do not use”) with rationale.



Activity Summary Description	Skills description [ex.: React, JavaScript, CSS, API integration]	Broaden the dataset options for QoS modelling. Survey public web-service QoS datasets (e.g., academic collections like QWS v1.0), capture key characteristics and create easy-to-read charts so non-technical colleagues can judge relevance quickly.
Skills	Specs, standards, constraints [ex.: Must support MP4 and HLS formats; responsive design for desktop and mobile; integrate with backend API for video metadata]	Desk research, clear writing, basic data visualization (Excel/Power BI/matplotlib)
Detailed Requirements	Granular, 1–2 weeks max [ex.: As a user, I can play/pause video in dashboard]	Use plain English; include a one-paragraph description per dataset; note any privacy or license restrictions; keep visuals simple and labeled.
Main User Stories	For quick onboarding [ex.: 1. Clone repo 2. Install dependencies 3. Implement component 4. Test locally]	• As a non-technical stakeholder, I want to understand what datasets exist and why they matter. • As a data scientist, I want a quick way to pick the best dataset for modelling.
Step by Step Instructions	Docs, repos, previous outputs [ex.: [Repo Link], [Design Spec]]	1) List candidate datasets; collect metadata. 2) Build a comparison table (features, rows, license, access). 3) Load top 1–2 datasets; produce simple charts. 4) Write a brief narrative with recommendations. 5) Share internally and collect feedback.
Background Information / Links		Team-provided link to QWS v1.0 ; other academic repositories (to be listed in the report).

8.12 December 2025

- Review Documentation
 - Conduct a review of technical documentation and ensure that all processes are streamlined.
 - Continue consolidating and updating knowledge resources.



9 Project Timeplan

WBS #	WBS Description	Month Start	Month End
01	Preliminary Studies and State of the Art Review	01/2023	05/2025
02	Technical Specifications and Use Case Definitions	02/2023	07/2025
03	Conceptualisation of the Solution and Architecture Definition	03/2023	08/2025
04	Development and Solution Integration	06/2023	09/2025
05	Testing and Validation of Solutions	09/2023	09/2025
06	Dissemination Activities and Demonstration	01/2023	09/2025
08	Coordination and Project Management	01/2023	09/2025



10 Project Team and effort estimation

WBS #	WBS Description	Profile Needed (please detail technologies, LOB, seniority)	Estimated person days Estimated w/ risk)	Estimated person days (relative %)
01	Preliminary Studies and State of the Art Review	Computer or Telecommunications Engineer (Linux, Machine Learning, 5G, Computer network, 3GPP, OAI, O-RAN, NTN, API's definition, SDR concepts) – Consultor Computer or Telecommunications Engineer – Consultant <ul style="list-style-type: none">Linux Basics: Mandatory	36 47	22%
02	Technical Specifications and Use Case Definitions	Computer or Telecommunications Engineer (Linux, Machine Learning, 5G, Computer network, 3GPP, OAI, O-RAN, NTN, API's definition, SDR concepts) – Consultor Computer or Telecommunications Engineer – Consultant / Advanced Consultant <ul style="list-style-type: none">Linux Basics: MandatoryUML Basics: Mandatory	36 47	22%
03	Conceptualisation of the Solution and Architecture Definition	Master's Computer or Telecommunications Engineer (Linux, C, C++, Matlab, Machine Learning, Python, 5G, Computer network, 3GPP, OAI, O-RAN, NTN, API's definition, SDR concepts) – Senior Master's Computer or Telecommunications Engineer – Advanced Consultant / Senior Consultant <ul style="list-style-type: none">Linux Basics: MandatoryUML Advanced: MandatorySysML Basics: Nice to have	18 24	11%
04	Development and Solution Integration	Computer or Telecommunications Engineer (Linux, C, C++, Matlab, Bash script, Backend, Frontend, Machine Learning, Python, 5G, Computer network, 3GPP, OAI, O-RAN, NTN, API's definition, SDR concepts) – Senior/Consultor	36 47	22%



WBS #	WBS Description	Profile Needed (please detail technologies, LOB, seniority)	Estimated person days Estimated w/ risk)	Estimated person days (relative %)
		Master's Computer or Telecommunications Engineer – Advanced Consultant / Senior Consultant Configuration Role <ul style="list-style-type: none"> Linux Advanced: Mandatory Docker Basics: Mandatory Ansible Basics: Nice to have Development Role <ul style="list-style-type: none"> Linux Basics: Mandatory C/C++ Basics: Mandatory Simulink Basics: Mandatory ROS 2 Basics: Nice to have Testing Role <ul style="list-style-type: none"> Linux Basics: Mandatory C/C++ Basics: Mandatory GTest/GMock Basics: Mandatory 		
05	Testing and Validation of Solutions	Computer or Telecommunications Engineer (Linux, Tester, pipeline design, Documentation skill) – Consultor/Junior Computer or Telecommunications Engineer – Consultant / Advanced Consultant <ul style="list-style-type: none"> Linux Basics: Mandatory Python Basics: Mandatory Test Pipeline: Nice to have CARLA Simulator: Nice to have 	-	-
06	Dissemination Activities and Demonstration	Computer or Telecommunications Engineer (5G, Computer network, 3GPP, OAI, O-RAN, NTN, API's definition, SDR concepts, Documentation skill) – Senior/Consultor/Junior Computer or Telecommunications Engineer – Consultant / Advanced Consultant <ul style="list-style-type: none"> Linux Basics: Mandatory 	-	-
07	Training		-	-
08	Coordination and Project Management	Project Management (Agile, Kanban, Scrum, Documentation skill) – Consultor	38 47	22%

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About Capgemini

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of 270,000 team members in nearly 50 countries. With its strong 50 year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2020 global revenues of €16 billion.

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