AUTOMETA Newsletter

Connected AUTOnomous Driving and Perception using Reconfigurable Intelligent METAsurfaces

Issue 2 - Final Results

22 Jan 2025 - 21 Nov 2025

The final project phase focused on validating RIS-assisted cooperative driving and collective perception through end-to-end simulation, analytical timeliness metrics (Age of Information), and adaptive control designs. A three-month extension was requested and approved to accommodate the intensive Horizon Europe proposal preparation in 2024. AUTOMETA concluded on 21 November 2025 with a stakeholder workshop at Frederick University.

Project at a glance

Project	AUTOMETA (BRIDGE2HORIZON/0823A/0004)
Period covered	22 Jan 2025 - 21 Nov 2025
Key exploitable result	CoopeRIS/COOPERIS: publicly available RIS-enabled cooperative driving simulation capability (PLEXE ecosystem)
Project website	https://autometa.frederick.ac.cy/
Funding	Cyprus Research and Innovation Foundation (RIF); implemented under THALIA 2021-2027 with co-funding by the EU

Final phase highlights

- Validated Age of Information (AoI/PAoI) analysis for RIS-assisted vehicular networks and assessed impact on cooperative maneuvers.
- Developed a DNN-based AoI predictor to enable proactive delay-aware behavior.
- Designed adaptive longitudinal controllers robust to delay and sensing uncertainty while enforcing passenger comfort (jerk regulation).
- Built a coupled simulation framework (CoopeRIS + CARLA + SUMO) to evaluate collective perception message (CPM) exchange over RIS-assisted links.
- Demonstrated substantial CPM reliability gains with RIS (packet loss reductions up to ~68%) and improved information freshness (AoI kept below a 2 s safety threshold in evaluated scenarios).
- Strong outreach: keynote talk (June 2025), participation in European Researchers' Night 2025 (September 2025), and the final dissemination workshop (21 Nov 2025).

Technical results by theme

RIS-enabled simulation tools (WP4)

- Extended RIS simulation to support realistic beam steering, multi-user operation, and controller-network driven reconfiguration.
- Characterized reconfiguration workload, delay, and power consumption to link electromagnetic functionality with hardware-aware control overheads.
- Supported urban intersection scenarios to study RIS feasibility under severe blockage (single- and multi-reflection setups).

Communication timeliness and cooperative control (WP5)

- Developed analytical and simulation-based delay characterization using AoI/PAoI.
- Demonstrated the impact of RIS-derived delays on an intersection merging maneuver and motivated delay-adaptive control.
- Implemented proactive AoI prediction via a multilayer perceptron regressor (DNN) to anticipate timeliness degradation.
- Validated an adaptive platoon controller under large delays (250 ms) and sensing noise with smooth, comfort-aware actuation.

Collective perception over RIS-assisted links (WP6)

- Integrated video-based cooperative perception by generating CPMs that include compressed camera frames and detected-object metadata.
- Adopted YOLOv7 object detection variants and evaluated accuracy vs inference-time trade-offs for real-time deployment.
- Quantified trade-offs between CPM freshness, frame compression, and detection precision; identified 50% JPEG compression as an effective balance in tested scenarios.
- Produced design guidelines linking communication reliability, information freshness, and perception uncertainty to cooperative control needs.

Key quantitative takeaways (CPM exchange)

RIS-assisted communication improved CPM reliability across multiple transmission speeds (up to ~68% packet loss reduction in obstructed scenarios).

AoI analysis showed RIS can keep cooperative perception updates within safety-relevant freshness bounds (e.g., below 2 s in evaluated scenarios).

Dissemination and outreach (2025)

Selected activities from the final project phase:

- IEEE VTC2025-Spring (Oslo, Norway, 17-20 Jun 2025) - paper presentation on AoI analysis and cooperative maneuvers.
- IEEE ITS Society Workshop 'Emerging Mobility Systems for Smart Cities' (Cyprus, 30 Jun 2025) - keynote: 'Metasurface Assisted Collective Perception and Control for Autonomous Driving'.
- Conference on Advancements in Sustainable Engineering 2025 (Limassol, Cyprus, 11-12 Sep 2025) - paper on adaptive controllers for CCAM under RIS-assisted collective perception.
- European Researchers' Night 2025 (26 Sep 2025) - AUTOMETA showcased to the public and research community.
- IEEE VTC2025-Fall (Chengdu, China, 19-22 Oct 2025) - paper on a simulation framework for RIS-assisted CPM exchange.
- Final stakeholder workshop (Frederick University, 21 Nov 2025) with participation from key Cyprus stakeholders.

Selected publications (Feb 2025 - Nov 2025)

- S. Han et al., "Empowering Vehicle Connectivity - The SOTA and Future Prospects of Reconfigurable Intelligent Surfaces in Mobile Communications: A Review", IEEE Sensors Journal, 01 Sep 2025. doi: 10.1109/JSEN.2025.3586678.
- S. Munawar et al., "AoI Analysis of RIS-Assisted Vehicular Networks and the Impact on Cooperative Maneuvers", IEEE VTC2025-Spring, Jun 2025. doi: 10.1109/VTC2025-Spring65109.2025.11174711.
- E. Emoyon-Iredia et al., "Adaptive Controllers for CCAM Applications in the presence of RIS assisted Collective Perception", IOP Conference Series: Earth and Environmental Science, 2025. doi: 10.1088/1755-1315/1558/1/012029.
- R. Saeed and M. Lestas and M. Segata, "Towards a Simulation Framework for Performance Evaluation of RIS-Assisted Collective Perception Message Exchange", IEEE VTC2025-Fall, Oct 2025.

Project evolution and sustainability

- Project coordination transition completed smoothly in August 2025, with Dr. Chrysostomos Chrysostomou assuming the role of Principal Coordinator (PC).
- AUTOMETA results and know-how were leveraged to prepare and resubmit follow-on research proposals (including SAFEMETA resubmission in November 2025).
- Long-term sustainability is supported through continued research activities and PhD-level capacity building on RIS-assisted autonomous driving topics.