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CO-LABEL

PROJECT IMPACT

2021007

InnoStar advances mmWave (>100 GHz) technology for 5G/6G and radar, enabling critical applications in communications and automotive safety through innovative system designs.

March 2026

Current mmWave technologies (>100 GHz) lack the design and testing capabilities required for future 5G/6G and radar applications. InnoStar addresses these gaps by developing new EDA and EM simulation technologies, advanced antennas, IC modules, and validation methodologies. These innovations enable reliable autonomous driving and efficient telecommunication systems, strengthening partners' industrial leadership and competitiveness.

Achievements and results of the project

InnoStar developed a comprehensive toolkit for next-generation wireless systems.

Key results include:

1. High-performance mmWave radar sensors for safer autonomous driving;
2. Energy-efficient 6G communication components;
3. Specialized software tools for designing complex high-frequency electronics;
4. Advanced Over-the-Air (OTA) testing methodologies for rapid manufacturing validation.

These achievements strengthen the European and Canadian technological autonomy and ecosystem, enabling reliable, high-speed connectivity infrastructure and advanced vehicle safety systems.

Background, objectives of the project and challenges

Our society is undergoing a rapid digital transformation driven by the critical need for instant connectivity and higher safety standards in mobility. Emerging applications like advanced driver assistance and autonomous driving and 6G communications require massive data transfer rates, ultra-low latency, and extreme reliability. This demand pushes the electronics industry to use higher-frequency bands, specifically "millimetre waves" (mmWave) above 100 GHz, where vast bandwidth is available.

However, operating at these frequencies presents significant hurdles that current technology cannot overcome. Standard semiconductor technologies struggle with energy efficiency and signal integrity at 100+ GHz. Furthermore, the European and Canadian ecosystems lack the necessary EDA tools and testing methodologies to reliably build and verify these complex systems. Existing manufacturing processes also suffer from low yields, making these advanced chips too expensive for mass market adoption. Without innovation, Europe and Canada risk depending entirely on foreign technology for this critical infrastructure.

Figure 1: PROJECT INNOSTAR Plenary Session. Consortium partners and external evaluators attending the Final Review Meeting at TU/e's "De Zwarte Doos" theatre, presenting finalized achievements and demonstrating overall project impact (source / copyright: PROJECT INNOSTAR Consortium).

Figure 2: PROJECT INNOSTAR Consortium Meeting at TU/e.

Project partners gathered at the Eindhoven University of Technology (TU/e) campus, highlighting the collaborative effort to strengthen the European and Canadian mmWave ecosystem (source / copyright: Eindhoven University of Technology (TU/e) / PROJECT INNOSTAR Consortium).

InnoStar addresses these challenges with the strategic goal of establishing a sovereign European and Canadian supply chain for mmWave technology.

The project aims to:

- Develop High-Performance Hardware: Create advanced/novel chips and antenna-in-package systems that operate efficiently at 100 GHz+ for both high-resolution automotive radar and high-speed telecommunications infrastructure.
- Close the Design Gap: Build specialized, physics-based simulation tools that enable engineers to accurately optimize complex high-frequency circuits, addressing current commercial limitations.
- Ensure Reliability: Implement advanced Over-the-Air (OTA) testing methodologies to rapidly identify performance issues and ensure chips meet the strict safety standards required for autonomous vehicles.
- Validate Technology: Prove these innovations work in real-world scenarios through advanced demonstrators for automotive radar and 6G telecom links.

Technological achievements

InnoStar strengthened a European and Canadian mmWave ecosystem above 100 GHz by enabling an end-to-end, physics-based “Design-to-Test” workflow from design to validation. Across the consortium, new EDA and EM simulation capabilities were integrated with advanced antennas, packaging, and measurement methods, improving how well simulations match measurements and increasing the likelihood that high-frequency chips work correctly the first time for 6G and automotive radar products. This lowers the barrier for companies to develop next generation 6G and automotive radar solutions.

Top 5 capabilities:

- Gap-filling EDA/EM: tools and flows that model layout-dependent effects and complex electromagnetic behaviour beyond 100 GHz.
- High-speed OTA validation: standardized over-the-air (OTA) methods and infrastructure for antenna systems above 100 GHz, designed to cut measurement time by >80% versus conventional element-by-element mechanical testing.
- Antenna-in-Package (AiP) integration: techniques to integrate antennas into the package, reducing interconnect losses and enabling compact modules.
- Low-loss interconnects: contactless transitions that reduce losses compared with traditional wire interconnects, supporting efficient mmWave links.
- AI/ML-assisted RF design: data-driven models to approximate RF behaviour and accelerate optimisation cycles.

These capabilities were validated through seven demonstrators:

- Integrated co-design & simulation tool flow used across hardware demos.
- OTA validation and measurement methods for >100 GHz antenna systems and arrays.
- 140–160 GHz automotive radar AiP (compact mmWave IC demonstrator).
- CMOS AFE silicon demo validating design flow and measurement correlation.
- 100 GHz telecom AiP with electronic beam-steering for 6G links.
- Active hybrid DRA antenna module around 28 GHz, validating active array performance.
- Large-scale array integration incl. contactless transitions and integrated beamforming.

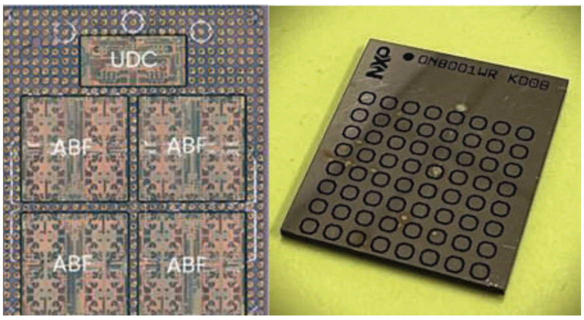

Figure 3: NXP Full Antenna-in-Package (AiP) Module.

Full AiP module featuring 1 UDC and 4 16-channel ABF ICs driving 8x8 TRX patch antennas. The left image displays the silicon side with 5 ICs, while the right displays the antenna side with the 8x8 patch antennas (source / copyright: NXP Semiconductors / PROJECT INNOSTAR Consortium).

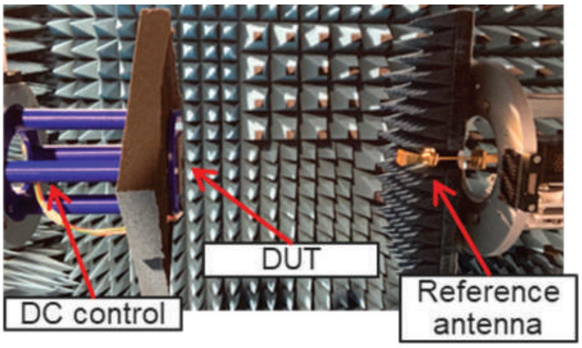

Figure 4: Chalmers Rapid Over-the-Air (OTA) Measurement Setup.

Successful demonstration of rapid Over-the-Air (OTA) measurement of Antenna-on-Chip impedance and gain at frequencies exceeding 100+ GHz, displaying the Device Under Test (DUT), DC control, and reference antenna (source / copyright: Chalmers University of Technology / PROJECT INNOSTAR Consortium).

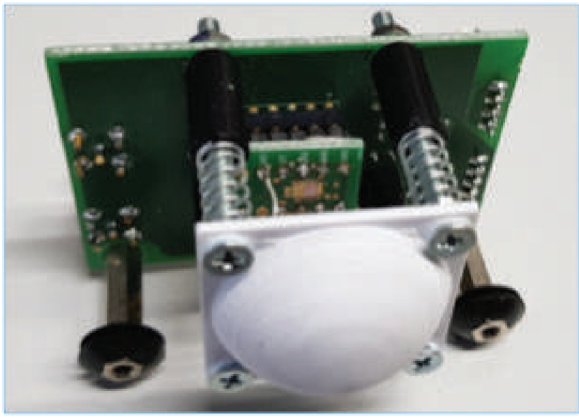

Figure 5: Radar MMIC with 3D Printed Dielectric Lens.

Radar Monolithic Microwave Integrated Circuit (MMIC) integrated with a 3D-printed dielectric lens, designed for high-resolution automotive radar applications (source / copyright: Infineon Technologies AG & Fraunhofer IIS/EAS / PROJECT INNOSTAR Consortium).

Market Potential

InnoStar targets the strategic 5G/6G infrastructure market, projected to reach USD 50 billion by 2027, with a 10-20% CAGR. The mmWave technology market is also expanding rapidly (CAGR: 26%). In particular, the global automotive radar market has been estimated at 6-8 billion USD, with an expected CAGR of up to 30%. The consortium is positioned to capture this value by strengthening a European and Canadian ecosystem that increases supply chain independence for frequencies above 100 GHz.

A dual exploitation strategy to pursue market leadership:

- Large semiconductor partners are integrating the “Design-to-Test” workflow into industrial design and validation flows. This accelerates time-to-market for 6G and automotive radar products, targeting a 40-50% share of the emerging high-frequency component market.
- SMEs are monetizing results through services, such as licensing specialized EDA tools and offering specialized testing. This supports revenue growth and expansion into international markets (e.g., Asia and the US).

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KEY APPLICATION AREAS

- Digital society
- Mobility

ESSENTIAL CAPABILITIES

- Connectivity
- Architecture and Design: Methods and Tools
- Process Technologies, Equipment,Materials and Manufacturing
- Components, Modules and Systems Integration
- Digital society
- Mobility

PARTNERS

Bluetest AB (Bluetest)
CEMWorks Inc. (CEMWorks)
Chalmers University of Technology (Chalmers)
Eindhoven University of Technology (TU/e)
Ericsson AB (Ericsson)
Fraunhofer ENAS
Fraunhofer IIS/EAS
Gotmic AB (Gotmic)
IMST GmbH (IMST)
Infineon Technologies AG (Infineon)
MunEDA/Cadence Design Systems GmbH
NXP Semiconductors Netherlands BV (NXP-NL)
NXP Sweden (NXP-SE)
Stichting Chip Integration Technology Center (CITC)
The Antenna Company Nederland BV (TAC)

COUNTRIES INVOLVED

Canada, Netherlands, Germany, Sweden

PROJECT LEADER

Name : Dr Jonatan Aronsson
Company: CEMWorks Inc.

KEY PROJECT DATES

Start: 01 January 2022
End: 31 December 2025

Societal & Economic Impact

InnoStar strengthens European and Canadian technological sovereignty by reinforcing a 100+ GHz electronics supply chain and ecosystem, reducing dependence on foreign technology, sustaining high-tech jobs, improving competitiveness, and supporting faster time-to-market. Societally, it enables high-resolution 140-160 GHz radar for safer mobility and advanced driver assistance and supports 6G connectivity. Environmentally, high-efficiency power amplifiers and “First-Time-Right” validation can reduce redesign iterations, energy use, and electronic waste in chip development and manufacturing.

Patents, Standardisation, Publications

InnoStar delivered 42+ technical outputs and took part in 25+ major events (EuCAP, IMS, EMC Europe, ICEAA/IEEE APWC), covering publications, conference papers, posters and presentations. Publications in IEEE journals and conferences supported standardization in the 3GPP framework and helped align OTA test methods with industry standards (e.g., CTIA/IEC). The consortium filed 1 foundational patent application and delivered reusable software tooling and methods. This balanced IP approach protects the “Design-to-Test” workflow while enabling commercialization by industrial and SME partners.

Future Developments

Partners are now focused on closing the industrialization gap. Post-project, industrial partners are progressing prototypes toward pre-series readiness for automotive radar modules, while SMEs are commercializing high-efficiency PA components and specialized testing and design services. In parallel, InnoStar methods are being integrated into commercial EDA tools, and follow-up initiatives are advancing standardization activities (e.g., in the 3GPP framework) to support long-term adoption of InnoStar’s ecosystem.

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