R-CAS®

Racing Collision Avoidance System

Patented in Monaco

"The next standard in racing safety."

FIA - Early Stage Project Presentation

English version

(Confidential - Discussion document - Non-binding)

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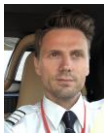
RACING COLLISION AVOIDANCE SYSTEM

RCAS EXECUTIVE & TECHNICAL BOARD



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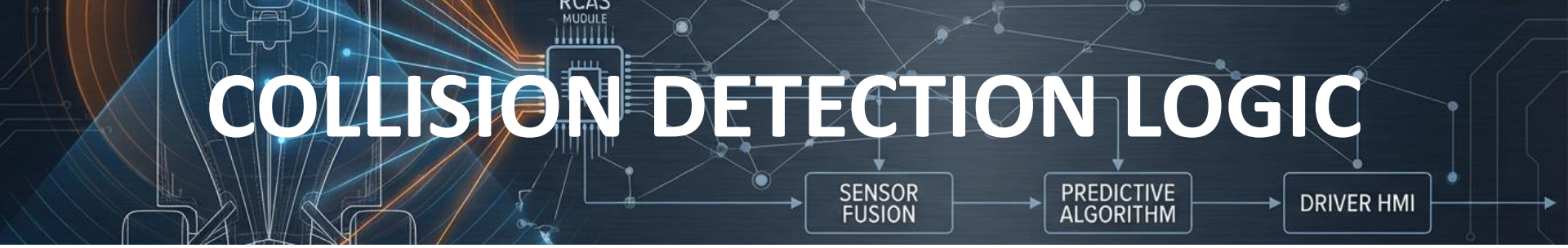
- 5 engineering agencies and space service centers
- Managed major programs with 5,000 consultants total

+ Engineering Team Automotive & Embedded Software

- Renault-Nissan-Mitsubishi Alliance automotive specialists
- Safety-critical software & Body Control Module architecture experts
- ISO26262 functional safety & AUTOSAR compliance

Video link:
https://www.youtube.com/watch?v=gYF0YituzWc



COLLISION DETECTION LOGIC

How we detect collision risks, and control false positives ?

We rely on **3 redundant ingredients:**

- **On board state**, GNSS RTK and IMU, accelerometers and CAN speed so each car knows its own position, speed and G loads independently
- **V2V safety link**, low latency communication directly between cars and via trackside relay antennas, so R CAS can still operate car to car even if FIA telemetry is degraded
- **FIA timing and telemetry**, transponder based position, race status and G channels, used as an additional path for validation, logging and Race Control oversight

RCAS Computation

From **GNSS, CAN BUS** and **transponder** data, the system knows, in real time, where each car is on the track, its speed and heading, It projects the fast car a few seconds ahead and checks:

- **Is there an “obstacle” on that path?**
- **Is the speed difference large enough?**
- **And has this situation lasted long enough to be abnormal for that segment?**

Only when distance, speed delta and persistence cross those limits, do we issue a caution or warning.

CRASHES, G SPIKE LOGIC

(We use G sensors to detect real impacts)

- **Primary trigger : strong impact path**, around 10 G Sustained over 150ms, is enough to trigger on its own (filters out transient spikes from kerbs, gear shifts)

- **Secondary validation path :** impact path around 8 G, needs at least two of these:
  - Large speed drop or speed delta above a threshold
  - Trajectory still on, or very close to the track, transponder ON
  - Abnormal attitude (rollover, inverted car, extreme roll or pitch)

If either the strong impact is seen, or the moderate impact plus the extra criteria, the incident is validated and broadcast as a hazard via V2V and telemetry to cars behind.

FALSE POSITIVE FILTERING

1. Temporal and Segment Filters

- Car must stay abnormally slow for several seconds
- Thresholds tuned per segment type (high-speed straights vs slow)

2. Race Phase and Geography

- Specific logic for green flag, VSC, Safety Car and restarts
- No alerts in pit lane & other predefined areas

3. Data Quality and Redundancy

- Alerts only when GNSS, IMU, V2V and FIA telemetry are consistent
- High combined confidence required (typically >80%)

4. Stable Behaviour and FIA Control

- Internal states prevent alert flickering (sustained evidence required)
- Drivers can trigger manual warnings
- Race Control can arm or silence zones and trigger manual warnings

Target: <2% false positives while keeping ≥99% detection of genuine hazards

TRACK SAFETY EXTENSIONS

- R-CAS is not limited to car to car alerts, it also protects track safety assets

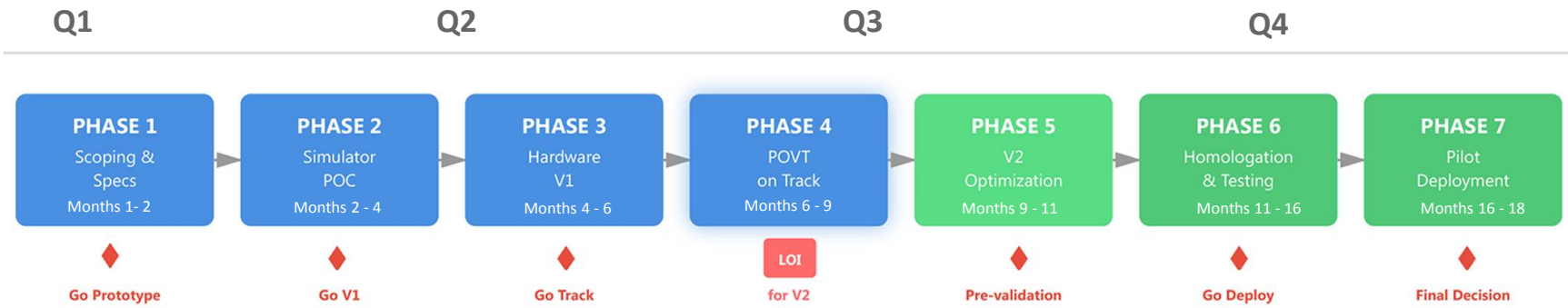
- Safety Car, Medical Car and recovery vehicles can be equipped with R-CAS modules transmitting via V2V and telemetry

- Track marshals can carry portable R-CAS beacons, if a race car approaches too quickly the beacon vibrates and warns the marshal and the car driver

- Circuit specific safe and danger zones can be defined in the digital track model, adapting the system to each venue’s characteristics

R-CAS 18-Month Program

Phases and Decision Gates



Objectives: Requirements, ICD, safety and cyber plan, pilot circuits
Deliverables: Specifications, ICD, POVQ plan
Decision: Go prototype

Objectives: Monaco and Azerbaijan scenarios, measure alert relevance
Deliverables: POC video and report
Decision: Go V1

Objectives: Sensor kit, compute unit, wheel HMI, bench tests
Deliverables: V1 prototype validated on bench
Decision: Go track

Objectives: Private track tests, value and quality metrics, synchronized logs and video
Deliverables: POVQ report, key metrics
Decision: LOI for V2

Objectives: Protocol alignment with FIA, miniaturization, latency and robustness optimization
Deliverables: V2 ready for homologation
Decision: Pre validation

Objectives: Conformity, safety documentation, official tests
Deliverables: Certificate, final report
Decision: Go deployment

Objectives: Limited installation, training, on track support, lessons learned
Deliverables: Industrialization plan
Decision: Final decision

Key Deliverables

- Phase 1-4: Specs → POC Report → V1 Prototype → POVT Report
- Phase 5-7: V2 System → Homologation Certificate → Industrialization Plan

⚡ Critical Path

Each decision gate must be validated before proceeding to next phase

Option A (Lean POVT): Phases 1-4

Option B (Full Program): Phases 1-7

POVT Phase (Phases 1-4) Post-POVT Phase (Phases 5-7) Decision Gate LOI Milestone

RACING COLLISION AVOIDANCE SYSTEM

EARLY PROJECT COST BREAKDOWN

Item	Scope	Low (k€)	High (k€)
Phase 1: Scoping & Specs	Requirements, ICD, safety plan	35	50
Phase 2: Simulator POC	Monaco and Baku scenarios, report	25	40
Phase 3: Hardware V1	Sensor kit, compute unit, wheel HMI, bench	90	140
Phase 4: POVT on Track	Private track tests, logs, synchronized video	90	130
SUBTOTAL Option A - Lean POVT, Phases 1-4		240	360
Phase 5: V2 Optimization	Latency and robustness improvements	60	90
Phase 6: Homologation & Certification	ISO 26262 ASIL B/C certification, FIA compliance	150	250
Phase 7: Pilot Deployment	Training, on-track support	30	45
CapEx: Relay Antennas	Four nodes, installed	8	12
CapEx: Marshal Beacons	Twenty units, rechargeable	3	5
CapEx: Track Vehicles	Two modules (Safety & recovery)	6	10
TOTAL Option B + 20% contingency		**597**	**927**

IMPLEMENTATION OPTIONS

- **Co-development :** shared funding for V2 & homologation, royalties per discipline
- **Annual License**: per championship/season, includes maintenance. Predictable OPEX and budget control
- **Outright IP Acquisition:** one-time fee, milestone bonus on adoption, FIA internalizes future updates

RACING COLLISION AVOIDANCE SYSTEM

RCAS - FIA MEETING SUMMARY

- **Safety challenge**

  High-speed racing in blind zones, crests, tunnels and degraded visibility, with large speed differentials and limited reaction time

- **R-CAS concept**

  On-board, TCAS-inspired alert-only system using GNSS, IMU, V2V and FIA telemetry to warn drivers of slow, stopped or crashed vehicles on their probable path

- **Robust detection and filtering**

  Kinematic and G-spike crash logic, segment-specific thresholds, and FIA-grade false positive mitigation targeting <2% false alerts while keeping ≥99% detection of genuine hazards

- **Track safety extensions**

  Integration with Safety Car, Medical Car, recovery vehicles and marshal beacons, plus circuit-specific safe and danger zones in the digital track model

- **18-month program and POVT**

  Phases 1-4: Proof of Value on Track with real cars, synchronized telemetry and video. Phases 5-7: optimized V2 system, homologation preparation and pilot deployment

- **Proposed next step with FIA**

  Sign MOU: 18-month program including POVT and ISO 26262 certification. Target metrics: <100ms latency, <2% false positives, ≥99% detection