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re:MARS
JUNE 21 – 24, 2022 | LAS VEGAS, NV

ROB313

Autonomous racing at 200 miles per hour

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DARPA challenge begat Indy Autonomous Challenge (IAC)

- IAC university teams worldwide compete in challenges to advance technology, speeding the acceptance and commercialization of autonomous vehicles and advanced driver-assistance systems (ADAS) for safety and performance
- Why IAC, after 15 years from the DARPA challenge
  - DARPA led to low-speed autonomy; IAC is high speed
- What needs to be solved
  - Accelerate autonomous technology development
  - Develop a global talent pipeline
  - Win hearts and minds





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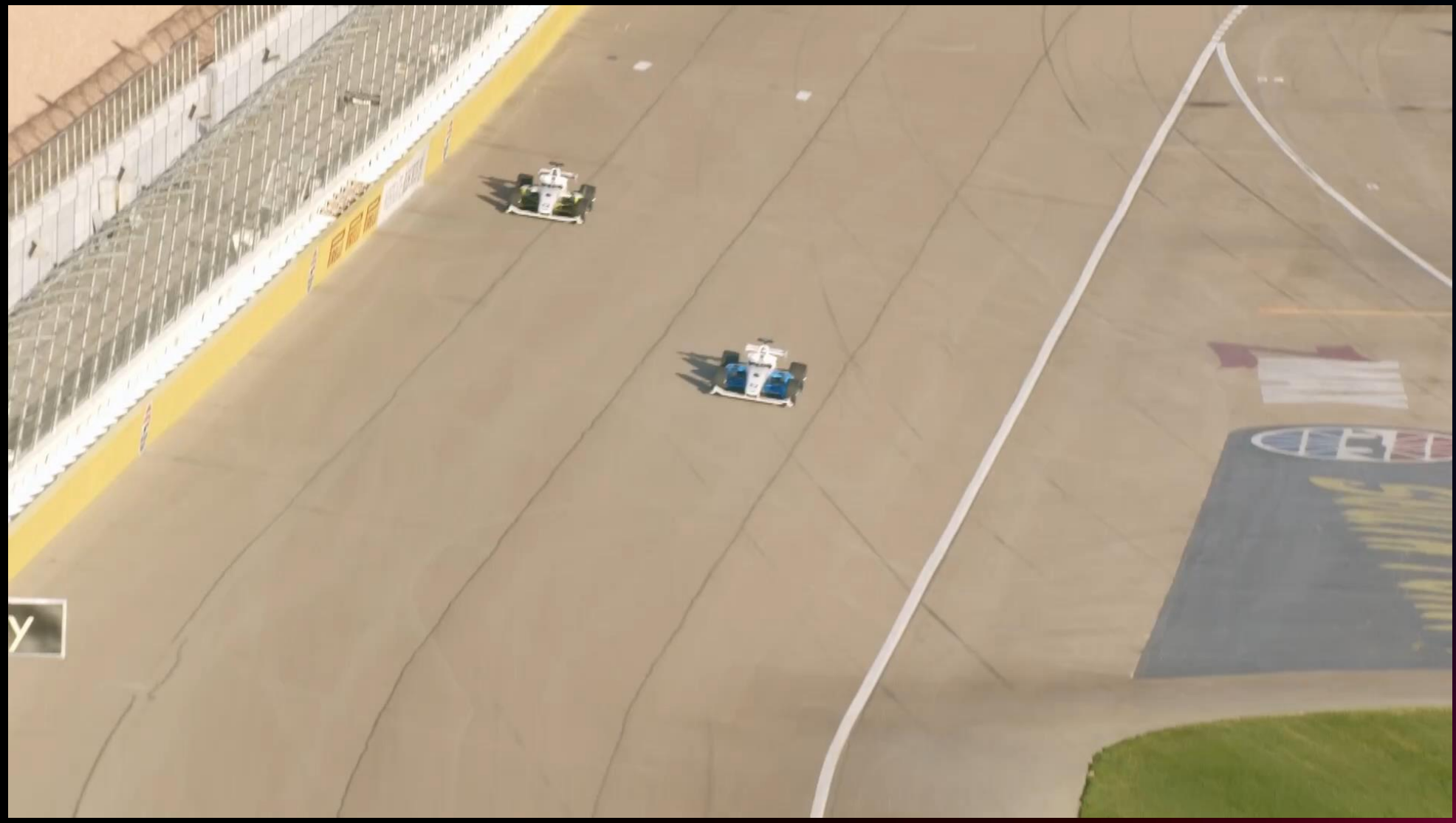
IAC @ CES 2022: 170-mph pass to win



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IAC: PoliMOVE speed world record

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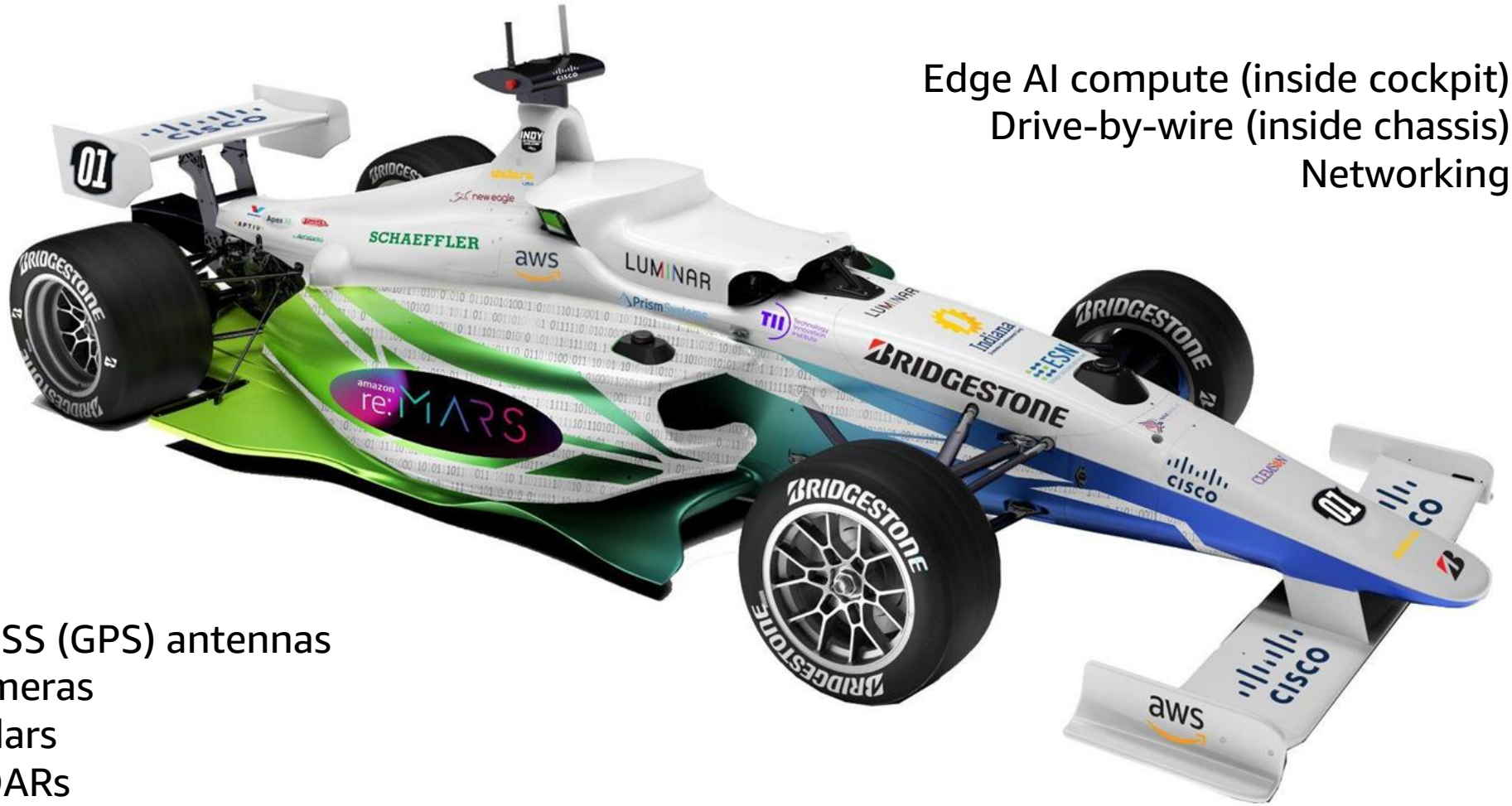
Okay, we started...

The car: Dallara AV-21 with autonomous gear



Edge AI compute (inside cockpit)
Drive-by-wire (inside chassis)
Networking

4 GNSS (GPS) antennas
6 cameras
3 radars
3 LiDARs
Networking

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Open-source stack in the IAC race cars

- Open Robotics ROS 2 – all started with Foxy; the winners use **Galactic**
- ROS middleware – all teams use **Eclipse Cyclone DDS**; **Galactic** has **iceoryx** shared memory zero-copy built in
- **Autoware** vehicle interface for drive-by-wire
- **Ubuntu** 18.04 Linux



ROS 2 iceoryx Cyclone DDS

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IAC base vehicle software and tools























Autonomous driving functions

ROS 2 tools | bag | rviz2 | tf2 | rqt

ROS middleware and client libraries (rclcpp and rclpy)

Eclipse Cyclone DDS | iceoryx zero-copy

Container orchestration

Operating system

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IAC speeds open source

Apex.AI

- Many improvements were made to open source for IAC by Apex.AI and friends
- Open Robotics ROS 2
  - ROS 2 bag data recording refactored to be 6x faster for IAC's sensor suite – 3x LiDAR, 6x camera, 2x GNSS, drive-by-wire
- Eclipse ROS middleware
  - Eclipse Cyclone DDS made the default
  - Eclipse iceoryx zero-copy built in – reduces camera image latency from milliseconds to microseconds, very low CPU cost, very low jitter



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The central compute unit



- ADLINK AVA-3501 Autonomous Driving Platform, an AWS Partner device (https://bit.ly/3anBQxq)
- NVIDIA RTX 8000 GPU for AI acceleration
- Intel Xeon processor with dual-slot full-length
- The AVA-3501 is qualified to support the **Apache MXNet** and **Amazon SageMaker Neo DLR** frameworks to perform ML inference at the edge with **AWS IoT Greengrass** on locally generated data using cloud-trained models, as well as for use with **AWS RoboMaker**

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The winning team: Software setup and workflows

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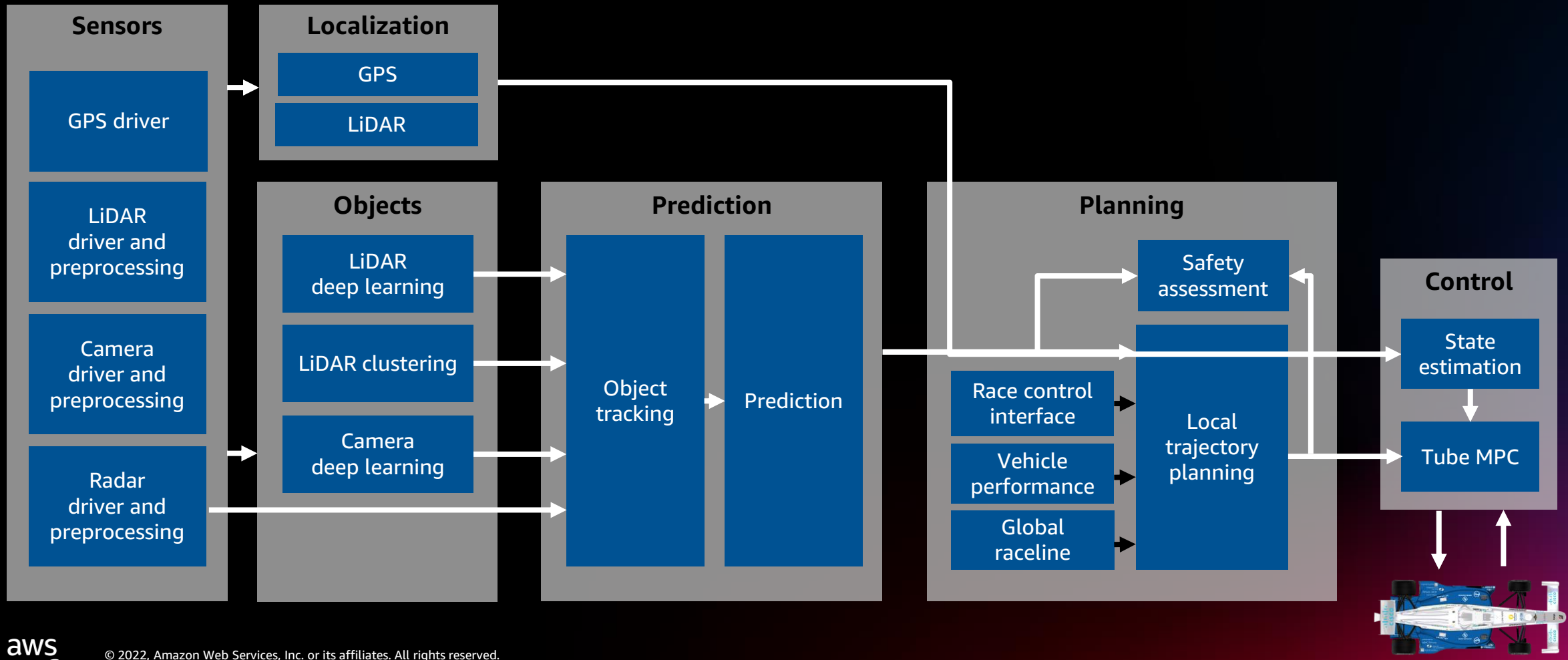
Race-winning ROS 2 software

TUM'S APPROACH FOR MULTI-VEHICLE COMPETITIONS



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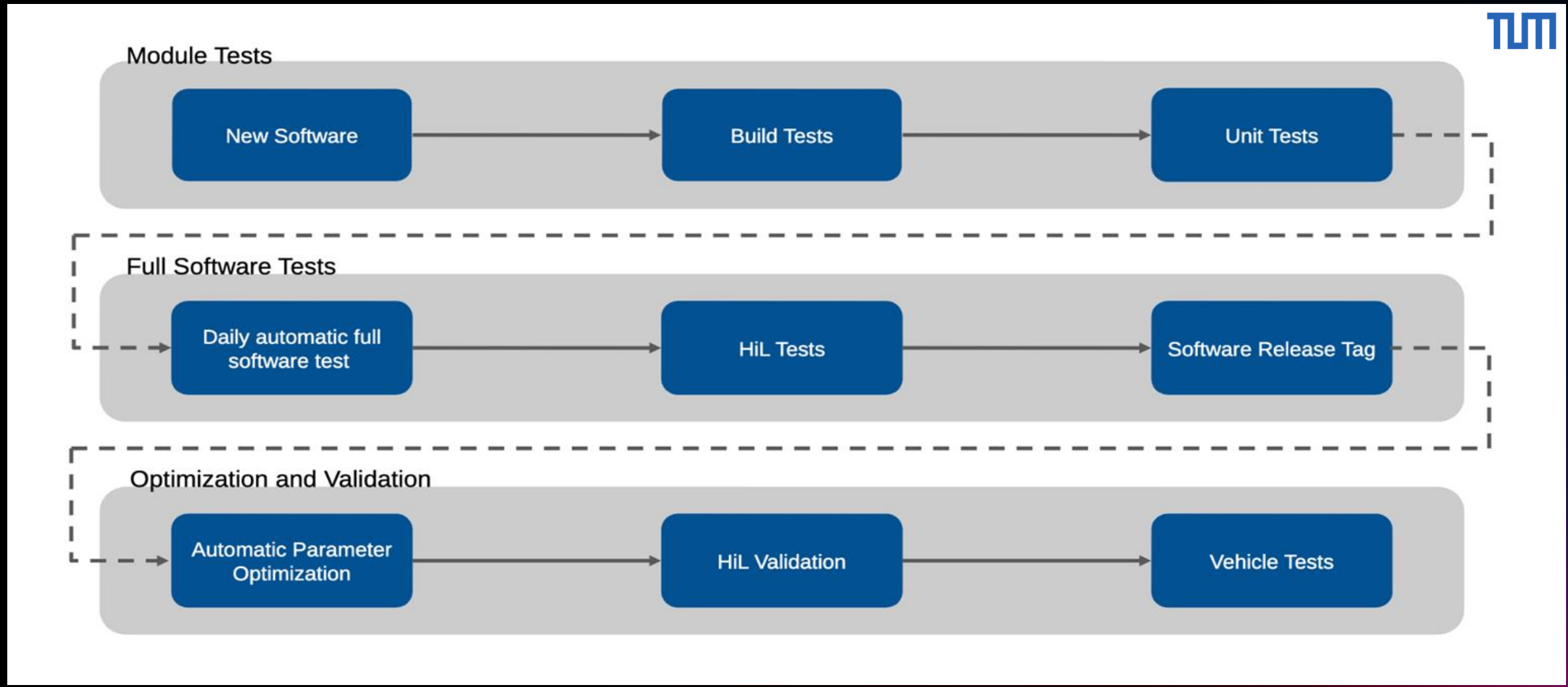
Development process



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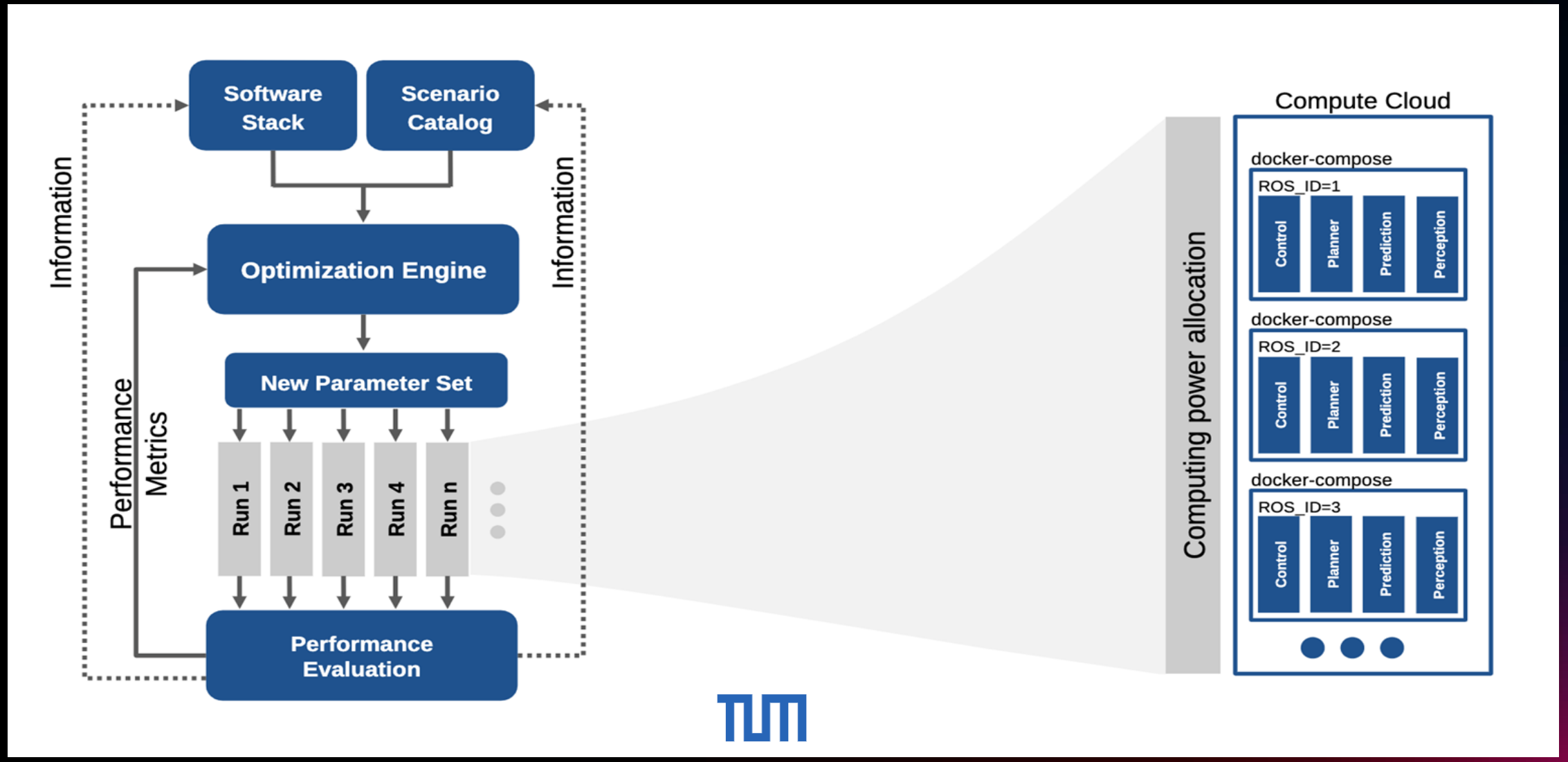
Parameter optimization



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Let’s get hands-on!

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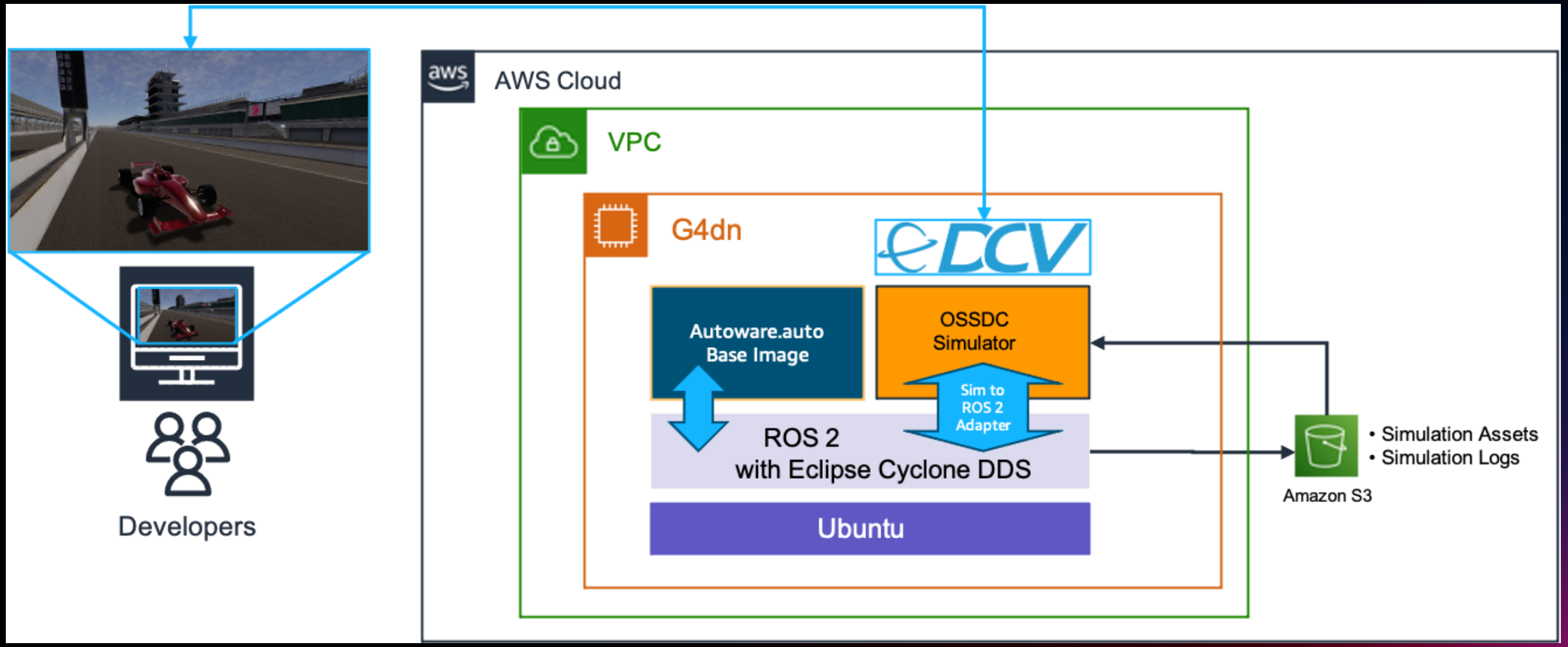
The simulation architecture



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Workshop structure

- Link to workshop – http://bit.ly/remars-racing
- **Ready, set, go!** 🏁

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It’s a wrap-up!

- IAC – Indy Autonomous Challenge
- Autonomous racing is important to address some unsolved issues in autonomy, such as autonomous driving at very high speed, avoiding obstacles at high speed, GPS/tracking under high speed as well as under bad weather conditions, and live streaming of media and data from racing vehicle
- In the workshop, we demonstrated how to develop an end-to-end autonomous vehicle platform on AWS
- What’s next for IAC – beyond improving safety and environmental quality, the IAC seeks to help overcome three prominent barriers to automated vehicle (AV) commercialization
    1. Solving “edge case” scenarios
    2. Catalyzing new AV technologies and innovators
    3. Engaging the public to help ensure acceptance and use of AV technologies

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Credits

This workshop is the result of the work from many specialists

- Stefano Marzani
- Michael Nguyen
- Matt Pollock
- Matt Williams
- Joe Speed
- Marius Slavescu
- Andre Slavescu
- Mahendra Bairagi
- . . . and Gina O’Connell and Andrew Keats for their logistic support

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What’s next

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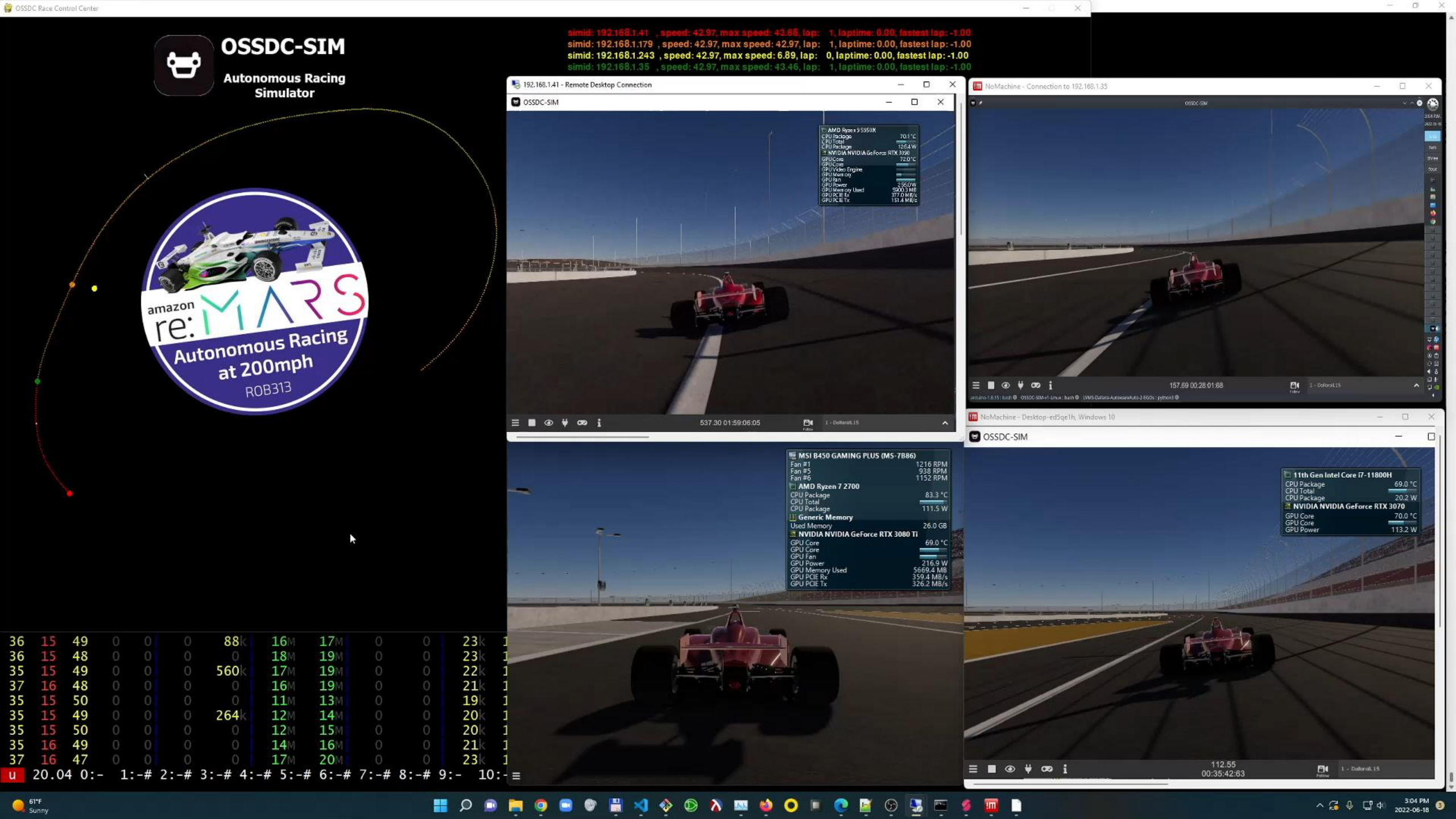
OSSDC Race Control Center
OSSDC-SIM
Autonomous Racing Simulator
simid: 192.168.1.41 , speed: 42.97, max speed: 43.68, lap: 1, laptime: 0.00, fastest lap: -1.00
simid: 192.168.1.179 , speed: 42.97, max speed: 42.97, lap: 1, laptime: 0.00, fastest lap: -1.00
simid: 192.168.1.243 , speed: 42.97, max speed: 6.89, lap: 0, laptime: 0.00, fastest lap: -1.00
simid: 192.168.1.35 , speed: 42.97, max speed: 43.46, lap: 1, laptime: 0.00, fastest lap: -1.00
amazon re:MARS
Autonomous Racing at 200mph
ROB313
192.168.1.41 - Remote Desktop Connection
OSSDC-SIM
NoMachine - Connection to 192.168.1.35
NoMachine - Desktop-ed5qe1h, Windows 10
MSI B450 GAMING PLUS (MS-7B86)
AMD Ryzen 7 2700
NVIDIA NVIDIA GeForce RTX 3080 Ti
11th Gen Intel Core i7-11800H
NVIDIA NVIDIA GeForce RTX 3070
61°F
Sunny
3:04 PM
2022-06-18

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Thank you!

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