

Background

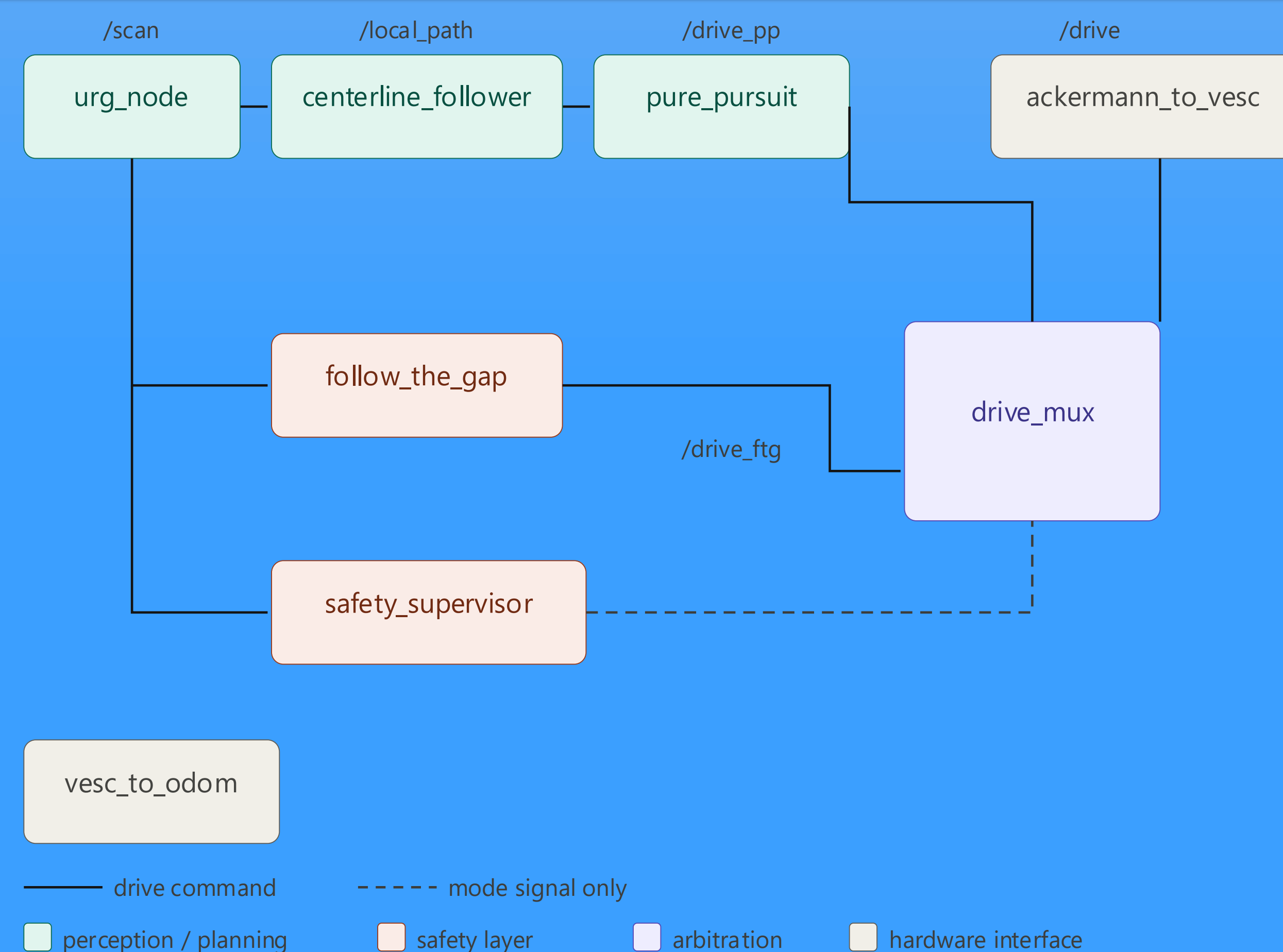
Autonomous racing pushes the limits of real-time perception, planning, and control. The F1Tenth competition challenges teams to build a 1/10th-scale autonomous vehicle capable of racing safely at high speed on a track. Our motivation was to develop a full autonomy stack to compete in a racing format under real-world constraints like sensor noise, latency, and limited compute.

Overview / Design Specs

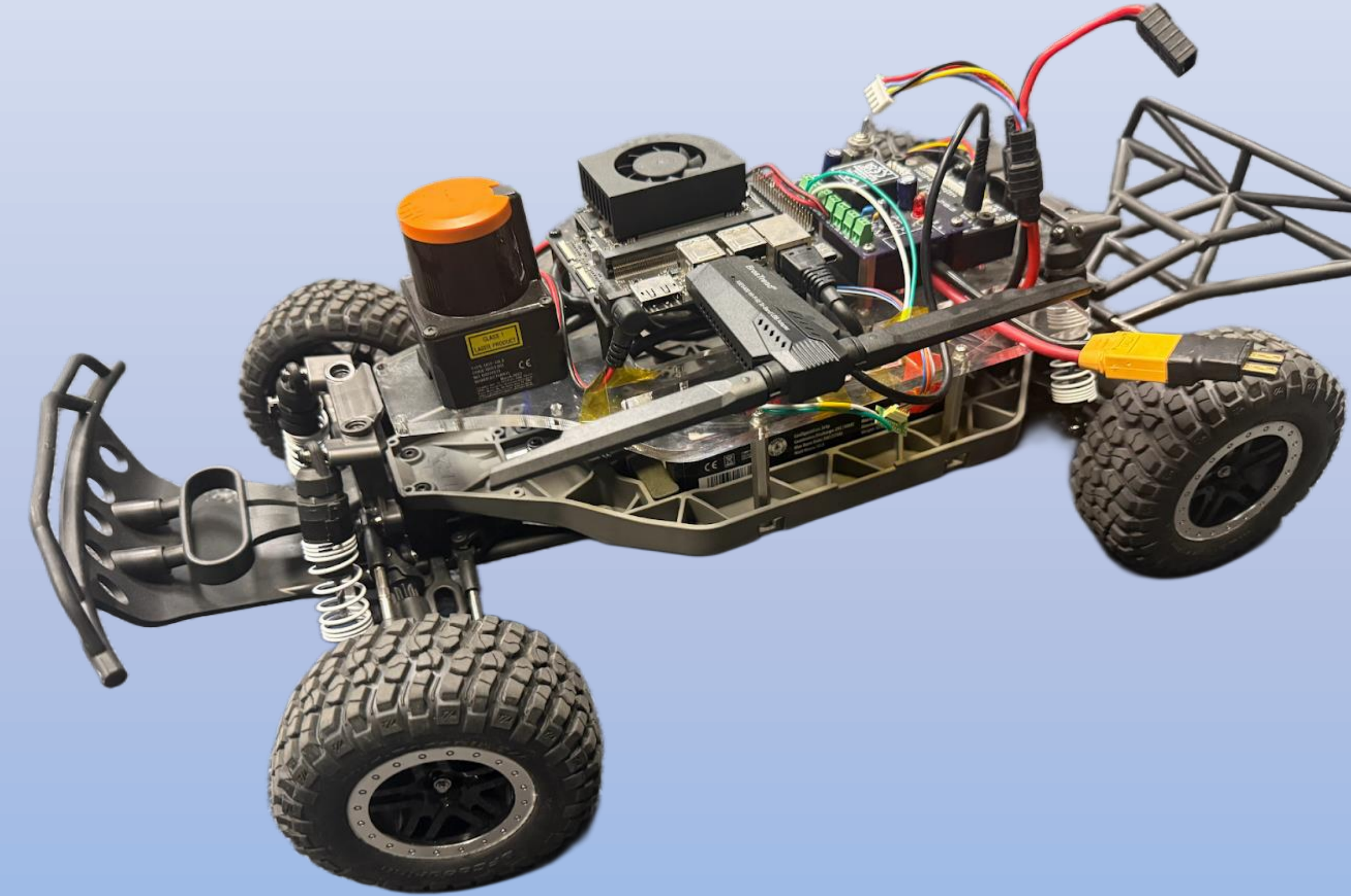
TenthGear is a ROS2-based autonomy stack for a Traxxas Slash 4X4 VXL HD chassis. It solves the challenge of reliable high-speed autonomous navigation using a layered pipeline of path following and reactive safety algorithms.

- Centerline follower for track-aligned baseline navigation.
- Pure Pursuit path tracking with curvature-adaptive speed.
- Follow-the-Gap reactive obstacle avoidance with front danger zone detection.

ROS2 Node Diagram

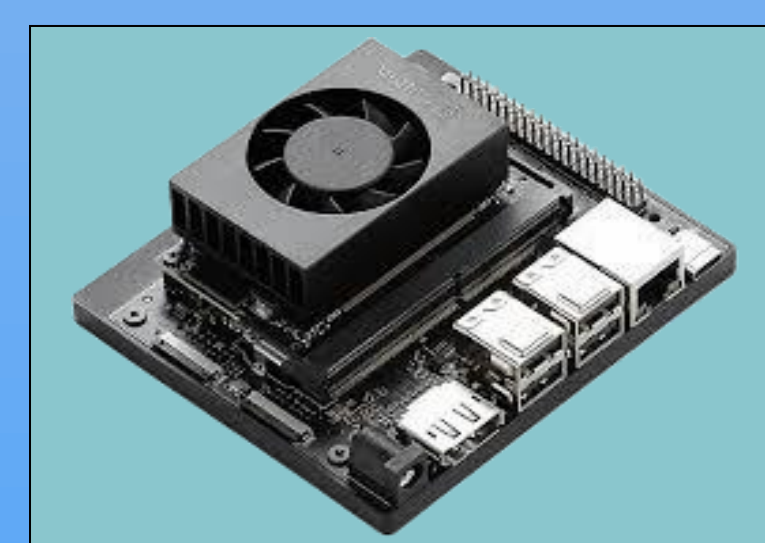


Final Design



F1Tenth platform with Hokuyo LiDAR mounted on top, Jetson Orin Nano compute module, VESC 6 motor controller, and servo. All components are mounted on a custom laser-cut deck and integrated onto the Traxxas Slash 4X4 VXL HD chassis.

Hardware / Key Components



NVIDIA Jetson Orin Nano

Main compute unit running Ubuntu 22.04 + ROS2 Humble. Handles all perception, planning, and control in real time.



Hokuyo 2D LiDAR

Laser scanner providing a 270° scan coverage 40 Hz per scan. Primary sensor for obstacle detection.



VESC 6 and Servo

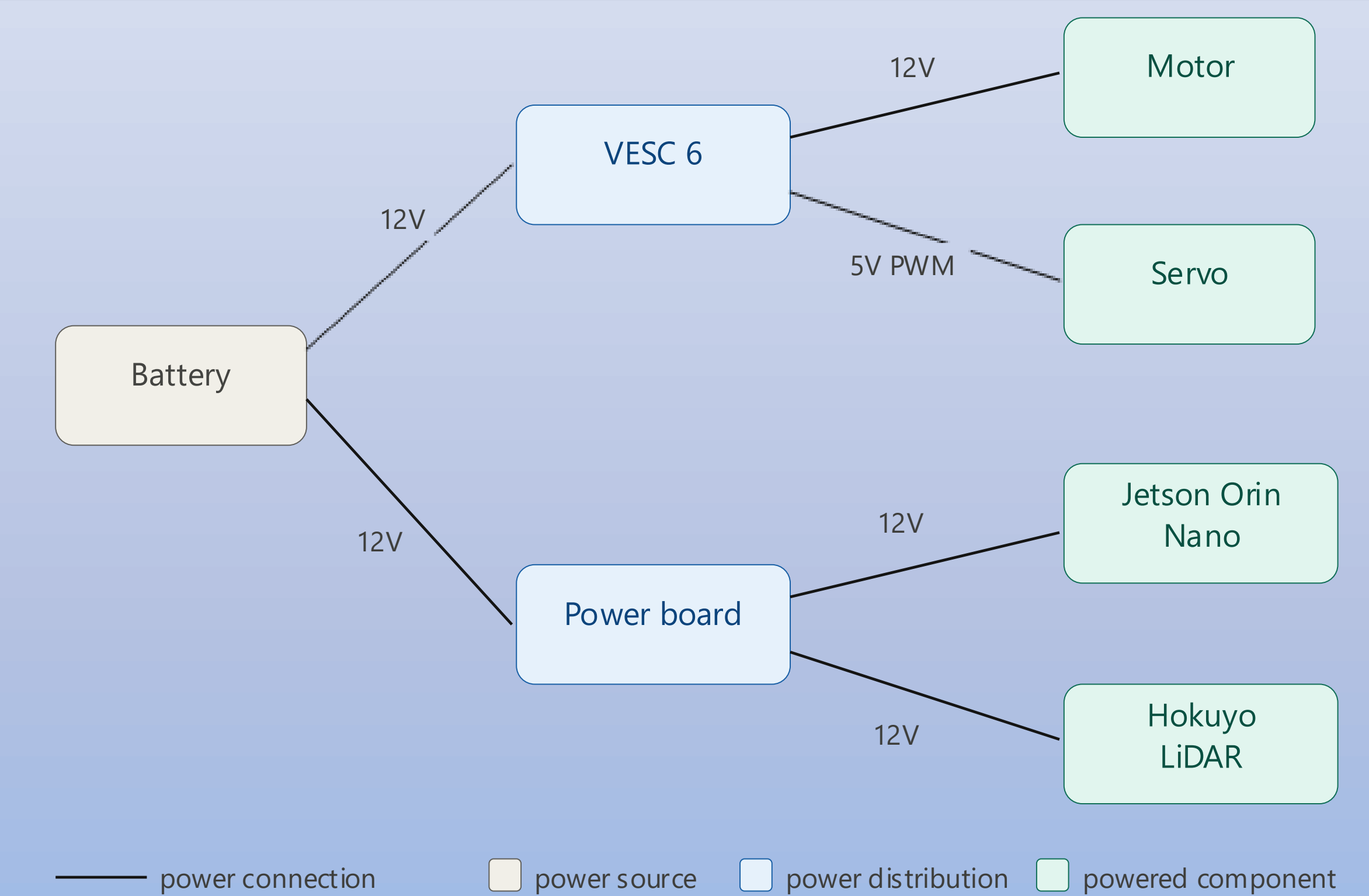
Motor controller for throttle and steering servo. Tuned for competitive speed while maintaining safety margins.



Power Board

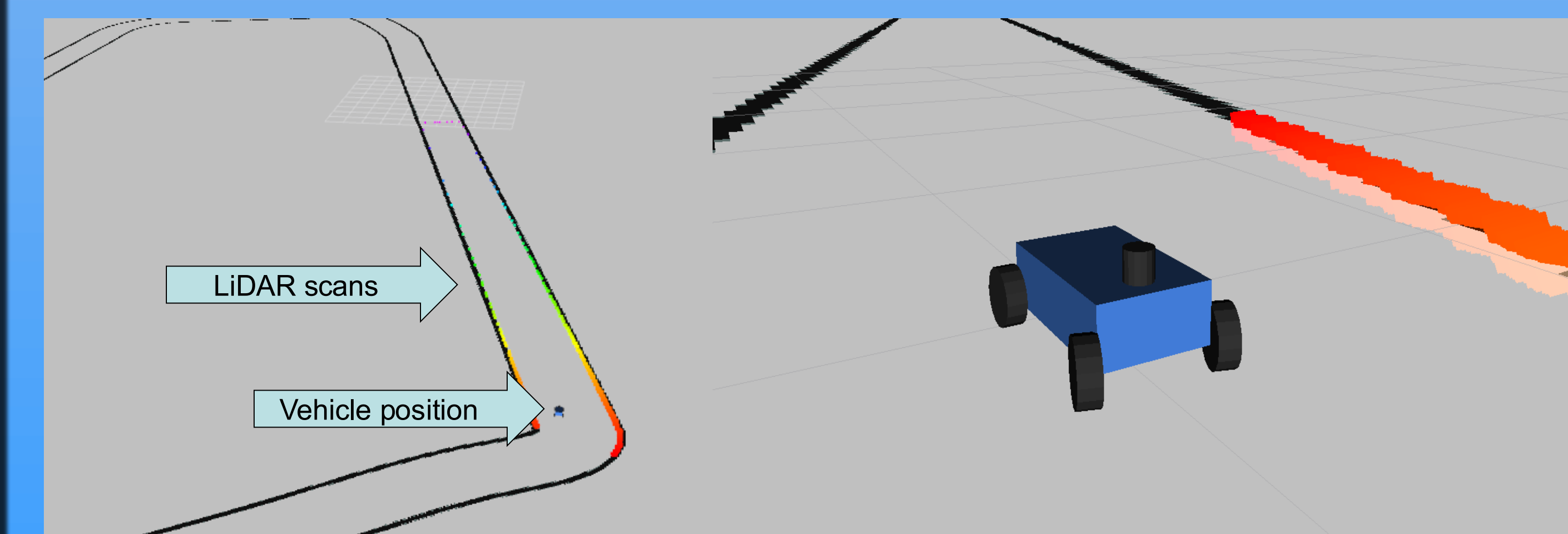
Distributes power from LiPo battery to Jetson and LiDAR at a constant 12V.

Power Distribution



- LiPo battery supplies 12V to both VESC6 and Power Board
- VESC6 drives the motor at 12V and servo at 5V PWM
- Power Board distributes constant 12V to Jetson Orin Nano and Hokuyo LiDAR

Simulation → Real World Testing



- Pure Pursuit and Follow-the-Gap algorithms validated in RViz simulation before hardware deployment
- Curvature-adaptive speed scaling and safety supervisor thresholds tuned during real world testing
- Conclusion: A modular layered stack enables reliable autonomous racing on constrained embedded hardware. Future work includes further speed tuning and improved gap selection.

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