VR Driving Simulator — System Model

Input & Hardware Modules

Control Rig (Custom Hardware)

Steering (encoder/pot)
Pedals (throttle, brake[load cell], clutch)
Gear shifter / Buttons
E-stop (hardware)

MCU / Bridge

ESP32 / STM32
Sensor ADC & Filtering
BLE GATT Server / HID
Haptic Driver Interface
Timestamp + Seq#

Aux Sensors (optional)

IMU (6-DOF)
Load-cell amplifier (HX711)
Temperature / Battery

Processing & Control

Host Input Adapter

BLE Client / USB HID
Packet Parsing & Validation
Latency Estimator
Input Queue to Unity

BLE notify: 200 Hz (target) | Latency: ≤ 50 ms | Log: 100 Hz

Calibration & Mapping Service

Auto-calibration routine
Deadzone & Nonlinearity correction
Per-rig & Per-vehicle profiles

stores profiles

Vehicle Dynamics Engine

Torque curve, steering ratio
Suspension, slip & tire model
Collision & Damage model

Simulation Orchestration

Scenario manager (traffic, weather)
AI agent controller (NPCs)
Event injection (hazards)

Output, Analytics & Interfaces

Rendering & XR Layer

OpenXR / Quest runtime
Render pipeline (URP)
Latency-aware pose update

Haptics & Force Feedback

Force commands -> MCU
Torque / Resistance profiles
Safety limits

Logging & Analytics

High-freq input log (CSV/protobuf)
Session metrics (scores)
Real-time telemetry stream (ws)

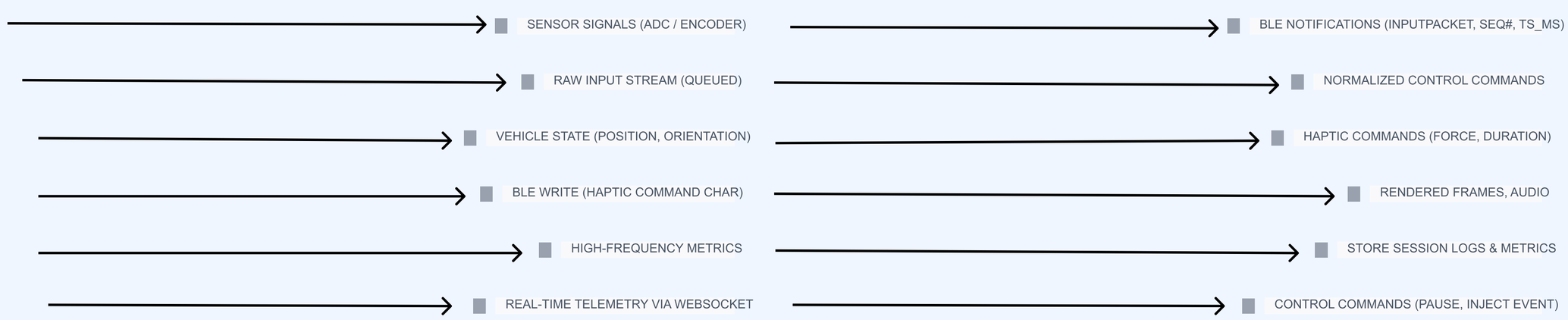
User Profiles & Storage

Local DB / SQLite
Cloud sync (optional)
Profile: calibration + progress

Packet Format:

```
InputPacket {
  uint16 seq;
  uint32 ts_ms;
  int16 steering; // -32768..32767
  uint16 throttle; // 0..65535
  uint16 brake;
  uint8 gear;
  uint8 status; // e.g., E-STOP flag
}
```

Data Flow:



External / Integration

Instructor Dashboard (Web/PC)

Live metrics, replay, session control

Mumbai RTO / Authority Export

Signed training reports (PDF), CSV export for compliance

Cloud Services

Profile sync, analytics, backup