**Fuel Calculator Module: Detailed Feature Summary**

This document outlines the complete feature set for the proposed Fuel Calculator module, designed to be a comprehensive race strategy tool. It is divided into two main components: a real-time system for in-car dash displays and a pre-race planning tool for the plugin's UI.

**1. Live Dash System (Real-Time)**

This component focuses on providing the driver with immediate, actionable data while on track.

* **Live Fuel Consumption Calculation:**
  + Continuously calculates an accurate Fuel per Lap average.
  + This average is based on a configurable number of the most recent, clean laps (e.g., ignores laps with pit stops, major incidents, or formation laps).
* **Race Completion & Leader Logic:**
  + Intelligently determines if a race is lap-limited or time-limited.
  + **For timed races:** It will dynamically calculate the true number of laps remaining by monitoring the race leader's pace and their position relative to the driver. This accurately accounts for the extra time and distance you must cover after the leader crosses the finish line and triggers the final lap. This leader logic will also be available for use in the Messaging System.
* **Pit Box Location Awareness:**
  + The system will know the location of your pit box relative to the start/finish line.
  + This ensures that fuel-to-end calculations are precise, correctly accounting for whether you need to complete almost a full lap or just a short distance after your final stop.
* **Key Dash Properties Exposed to SimHub:**
  + Laps of Fuel Remaining: A simple countdown of laps left in the tank.
  + Fuel Delta: The critical surplus or deficit of fuel required to finish the race without further stops, displayed in laps (e.g., +2.1 Laps or -0.8 Laps).
  + Target Fuel per Lap: If you are in a fuel deficit, this property will show the exact fuel consumption you need to average to make it to the end.
  + Pit Stops Required: A live countdown of mandatory stops remaining.
* **Pit Stop Intelligence:**
  + **Next Stop Info:** When a stop is required, it will calculate the minimum Fuel to Add and predict the stationary Refuel Time.
  + **Pre-Pit Prediction:** As you approach the pit entry, the system will show a *predictive* Fuel Delta for the rest of the race based on your planned fuel fill. This allows you to make last-second adjustments to the required fuel amount before you stop.

**2. Pre-Race Prediction UI**

This component is a powerful planning tool located in a new "Fuel" tab within the plugin's settings UI.

* **Dynamic UI Controls:**
  + **Car & Track Selection:** Dropdown menus to select any saved car profile and any track variation. This is the primary driver for loading all relevant data.
  + **Conditional Sliders:** The UI will dynamically show/hide controls. For example, selecting "Time-Limited" will show the "Race Minutes" slider and hide the "Race Laps" slider.
* **User Inputs for Strategy:**
  + Race Length (laps or minutes).
  + Your Estimated Lap Time.
  + Leader's Estimated Pace (for accurate timed-race predictions).
  + Estimated Fuel per Lap (can be manually entered or auto-filled).
  + Max Fuel Override (a slider to limit tank size for series with fuel restrictions).
  + Wet Race toggle, which reveals a "Wet Factor" slider to adjust fuel burn.
  + Contingency Type (Extra Laps or Extra Litres), which reveals the appropriate slider.
* **Calculated Strategy Outputs:**
  + **Total Fuel Needed:** The final calculated amount, including contingency.
  + **Required Pit Stops:** The number of stops needed for the race.
  + **Stint Breakdown:** A clear, lap-by-lap plan for each stint, showing laps, fuel to add, and starting fuel load.
* **Advanced Strategy Simulators:**
  + **"Fuel Save vs. Time Loss" Tool:** An interactive feature where you can input a "fuel save per lap" target. The tool will then calculate the estimated lap time loss required to hit that target and show you if it results in saving a pit stop and whether the total race time is faster or slower.
  + **Engine Mode Modeling:** The calculator will use per-car settings for different engine modes (e.g., Quali, Race, Lean) to predict their impact on the overall strategy.
* **Comprehensive Pit Stop Time Factoring:**
  + The calculator will account for the total time lost in a pit stop, including tire changes, penalties, and a per-track/per-class calculation for the time spent driving down the pit lane.
* **Endurance & Post-Race Features:**
  + **Lapped Car Prediction:** For long endurance races, the planner will estimate how many times you are likely to be lapped, which reduces the total number of laps you'll have to complete and thus the total fuel needed.
  + **Post-Race Analysis:** An optional mode to load data from your last session to compare the pre-race predictions against the actual results, helping you refine your fuel estimates for future events.

**3. Per-Car & Per-Track Settings**

The system will expand your existing per-car profile system.

* **Per-Car/Per-Profile Settings:**
  + Fuel Contingency (laps or litres).
  + Laps for Accuracy (for the live calculator).
  + Car Fuel Tank Size.
  + Car Refuel Rate.
  + WetFuelMultiplier.
  + Engine Mode Fuel Multipliers.
* **Per-Car, Per-Track Settings:**
  + **Historical Fuel per Lap**: Automatically saved and updated after each clean session to be used as the default in the planner.
  + **Pit Lane Time Loss**: Calculated (from Dahl file data) and stored for each track/class combination.

**WORK WE MANGED SO FAR but needs some fixing**

**Fuel Module: Complete Technical & Functional Breakdown**

This document provides a comprehensive description of the Fuel Calculator module designed for the LalaLaunch SimHub plugin. It details the architecture, the functionality of every UI control and parameter, the purpose of the underlying C# classes and methods, and the intention behind the design choices.

**1. Architectural Overview**

The Fuel Module was intentionally designed with a decoupled, two-part architecture to ensure maintainability and a clear separation of concerns.

* **FuelCalcs.cs (The "Engine" / ViewModel):** This class is the heart of the module. Its sole purpose is to contain all the properties, state, and complex calculation logic for both the pre-race planner and the live system.
  + **Intention:** By isolating all fuel-related logic here, the main plugin file (LalaLaunch.cs) remains clean and is only responsible for providing raw game data and saving/loading profiles. This makes debugging and future expansion of the fuel module significantly easier. It acts as the "brain" for the UI.
* **FuelCalculatorView.xaml (The UI / View):** This is the WPF User Control that defines the layout and all the interactive elements (sliders, text boxes, toggles) for the "Fuel" tab.
  + **Intention:** This file is purely for presentation. It contains no complex logic itself; it simply binds its controls to the properties within the FuelCalcs class. This is a standard MVVM (Model-View-ViewModel) design principle that makes the UI independent of the business logic.
* **LalaLaunch.cs (The Integrator / Model):** The main plugin class was modified to support the Fuel Module.
  + **Intention:** Its role is to:
    1. **Instantiate** the FuelCalcs engine when the plugin starts.
    2. **Provide** the FuelCalcs engine with access to saved car profiles and historical data.
    3. **Execute** the live fuel calculation logic on every DataUpdate tick.
    4. **Expose** the final calculated properties (e.g., LiveFuelPerLap, DeltaLaps) to SimHub for use in dashboards.

**2. Pre-Race Planner UI: Controls and Functionality**

This section details every control in the "Fuel" tab, its function, and its strategic purpose.

**Race and Car Parameters**

* **Car Profile & Track Selection (ComboBoxes):**
  + **Functionality:** Displays lists of all saved car profiles and tracks. The user's selection determines which historical data is loaded.
  + **Intention:** To provide the primary context for a strategy calculation. Selecting a known car/track combination allows the planner to auto-populate with accurate, previously recorded performance data, speeding up the planning process.
* **Race Type (Radio Buttons: Lap-Limited / Time-Limited):**
  + **Functionality:** Toggles the visibility of the "Race Laps" and "Race Minutes" sliders.
  + **Intention:** To allow the user to specify the fundamental format of the race, which is the first and most critical step in determining the total race distance.
* **Race Laps / Race Minutes (Sliders):**
  + **Functionality:** Sets the duration of the race. Only the relevant slider is visible based on the selected Race Type.
  + **Intention:** To provide the core input for calculating the total number of laps the race will consist of.
* **Your Est. Lap Time & Leader's Est. Pace (TextBoxes):**
  + **Functionality:** Accepts lap times in a m:ss.fff format. The input is validated to reject impossible values (e.g., more than 59 seconds). These are always visible.
  + **Intention:** These inputs serve two critical strategic purposes. First, for timed races, the **Leader's Pace** is used to calculate the total number of laps. Second, the **difference between your pace and the leader's** is used to predict how many times you will be lapped, which reduces the total number of laps *you* need to complete, leading to a more accurate fuel calculation for endurance races.
* **Fuel per Lap (TextBox) & Use historical average (Toggle):**
  + **Functionality:** The text box allows manual entry of fuel consumption (with two decimal places). The toggle controls its behavior.
  + **Intention:** To provide the core fuel burn rate. The **toggle's primary purpose is convenience and accuracy**. When checked, it locks the text box and fills it with the last known value for that car/track, providing a reliable starting point. When unchecked, it allows the user to manually input a value for a new car or to experiment with a different target.
* **Max Fuel Override (Slider):**
  + **Functionality:** Sets the maximum usable fuel tank capacity.
  + **Intention:** To account for series with BoP (Balance of Performance) rules that restrict a car's fuel tank to less than its actual maximum capacity. This ensures stint length calculations are correct.
* **Is this a wet race? (Toggle) & Wet Factor (%) (Slider):**
  + **Functionality:** The toggle reveals the slider. The slider applies a percentage multiplier to the fuel per lap value.
  + **Intention:** To provide a simple way to account for the increased fuel consumption typical of wet weather conditions without having to manually change the base Fuel per Lap value.

**Strategy Parameters**

* **Contingency Type (Radio Buttons: Extra Laps / Extra Litres):**
  + **Functionality:** Toggles the visibility of the two contingency sliders.
  + **Intention:** To give the user flexibility in how they define their safety margin. Some drivers prefer a buffer of a few laps, while others prefer a fixed amount of extra fuel.
* **Contingency Laps / Litres (Sliders):**
  + **Functionality:** Sets the amount of safety fuel to add to the final calculation.
  + **Intention:** To ensure the final calculated Total Fuel Needed includes a buffer for factors like extra formation laps, higher pace, or slight miscalculations, preventing the driver from running out of fuel.
* **Pit Lane Time Loss (TextBox) & Override default (Toggle):**
  + **Functionality:** The text box allows manual entry of the time lost driving through the pit lane. The toggle controls its behavior.
  + **Intention:** This value is critical for the "Fuel Save vs. Time Loss" simulator. The **toggle's purpose is accuracy**. When unchecked, it loads the known historical value for that track. When checked, it allows manual entry for a new track or to test different scenarios.
* **Tire Change Time (Slider):**
  + **Functionality:** Sets the expected stationary time in the pit box.
  + **Intention:** This value is added to the Pit Lane Time Loss to calculate the total time lost during a pit stop, which is essential for the fuel-saving simulation.

**3. Live Dash System: Properties and Intentions**

This system runs in the background, constantly updating a set of properties that can be used to build a smart, real-time fuel dash.

* **Core Logic - Rolling Average (LiveFuelPerLap):**
  + **Functionality:** The system monitors fuel level and lap distance. When a "clean" lap (not an in-lap or out-lap) is completed, it calculates the fuel used and adds it to a list containing the last 3 clean laps. The LiveFuelPerLap property is the average of the values in this list.
  + **Intention:** To provide a fuel consumption value that is far more accurate and responsive to current race conditions than a simple session-wide average. It automatically adapts to changes in pace or engine modes.
* **Confidence (LalaLaunch.Fuel.Confidence):**
  + **Functionality:** A 0-3 rating based on the number of clean laps in the rolling average list.
  + **Intention:** To give the driver a clear, at-a-glance indication of how much they should trust the live calculations. A low confidence means the data is still preliminary.
* **Primary On-Track Properties:**
  + **DeltaLaps**: The most important live property. It shows the fuel surplus/deficit in laps. **Intention:** To provide a single, simple number that tells the driver if they need to save fuel (-) or are safe (+).
  + **TargetFuelPerLap**: Shows the fuel burn needed to reach the end. **Intention:** To give the driver an actionable target when they are in a fuel deficit.
  + **LapsRemainingInTank**: Laps left in the current tank. **Intention:** To provide a clear warning for when a pit stop is imminent.
* **Predictive Pit Window Properties:**
  + **IsPitWindowOpen & PitWindowOpeningLap**: These are calculated based on whether the driver has enough fuel to complete one full stint *after* the current one.
  + **Intention:** To proactively inform the driver when their pit window is opening, allowing them to plan their stop around traffic rather than being forced in at the last possible moment.
* **Predictive Pit Stop Properties (LalaLaunch.Fuel.Pit.\*):**
  + **Functionality:** This suite of properties calculates everything the driver needs to know when preparing to pit: the minimum fuel they *must* add (NeedToAdd), how much space is available (TankSpaceAvailable), and, most importantly, what their fuel delta will be for the rest of the race based on the planned fuel fill (DeltaAfterStop).
  + **Intention:** To eliminate guesswork during pit stops. The DeltaAfterStop property allows the driver to adjust the fuel amount in their car's MFD on the pit entry lap to ensure they leave the pits with the perfect amount of fuel for the final stint.