**Improvements and Lessons Learned from Neoxa 2**

The development of **Neoxa 3** is based on the experience and insights gained from the previous version, **Neoxa 2**. While Neoxa 2 served as a valuable proof of concept, several limitations and technical challenges were identified during its development and testing phases. These findings have directly informed the upgrade roadmap for Neoxa 3.

### Identified Limitations in Neoxa 2:

* **Electrode Fit and Adaptability**: Difficulty adapting electrode contacts to different head shapes; the "one-size-fits-all" approach proved inadequate for diverse users.
* **Component Supply Challenges**: Use of electrodes from multiple suppliers due to inconsistent delivery times, impacting signal quality and device consistency.
* **PCB Size Constraints**: Unable to reduce the PCB footprint due to time limitations and reliance on OpenBCI modules, restricting miniaturization.
* **Non-Ergonomic Board Placement**: The main board was suspended via cable, leading to increased EEG signal noise and discomfort for the user, compromising overall ergonomics.
* **Connectivity and Firmware Instability**: Issues with Bluetooth connectivity, including dropped connections and firmware instability, significantly affected data acquisition—especially in the absence of embedded processing.
* **Low Durability of Components**: Several components and materials used in Neoxa 2 lacked sufficient resistance to mechanical wear and stress, resulting in frequent breakage and reduced overall device lifespan

### Targeted Improvements in Neoxa 3

#### 1. **Mechanical Design and Ergonomics**

* **Redesigned Form Factor**: A completely reengineered mechanical structure for improved **comfort**, **durability**, and **usability** during extended wear.
* **Electrode Optimization**: Removal of temporal electrodes and **relocation to the frontal region** to improve comfort and ergonomics.
* **Integrated PCB**: A **compact, embedded dual-sided PCB design**, with the battery and main board positioned on opposite sides to reduce volume and improve balance.
* **Exchangeable frontal EEG:** The **EEG frontal electrodes will be plugged to the back part will be directly mounted to the fixed electronic part** enabling a more stable fit across different head sizes.

#### 2. **Electronics and Sensor Architecture**

* **Optimized Sensor Layout**: Enhanced positioning and shielding of **EEG sensors**, with the introduction of **PPG (photoplethysmography)** and **bone conduction audio** modules for multimodal sensing.
* **Miniaturized PCB Design**: Custom PCB tailored to fit tight space constraints, moving away from modular platforms (e.g., OpenBCI).
* **Embedded Processing**: Onboard signal processing to reduce latency, increase reliability, and enable preliminary data analysis without requiring constant wireless transmission.
* **Reliable Connectivity**: Implementation of a **robust firmware stack** and improved **Bluetooth communication protocols** to eliminate connection drops and ensure continuous data streaming.

##### 2.1. **PCB and Hardware Specifications**

* **Form Factor**:
  + Maximum size: **5 mm (width) × 50 mm (length) × 25 mm (height)**.
* **Mechanical Layout**:
  + **Dual-sided configuration**, with PCB and battery on opposite faces to enhance compactness and heat dissipation.
* **Component Selection**:
  + Priority on **NXP components** to leverage ecosystem compatibility, robust development tools, and long-term support.

##### 2.2. **Signal Processing and Data Acquisition**

* **EEG Sampling Rate**:
  + **Target**: 500 Hz for high-resolution EEG signal acquisition.
  + **Fallback**: 256 Hz, in line with common wearable EEG standards.

##### 2.3. **Software and Platform Integration**

* **Mobile App Development**:
  + Implementation planned in **C++** for high performance and hardware-level control.
  + Evaluation of **existing SDKs or libraries** for seamless mobile communication.
  + Consideration of **cross-platform SDKs** to ensure compatibility with both **iOS** and **Android**.
* **Desktop Compatibility**:
  + The system must fully support development and data interaction on **Windows** and **MacOS** environments.