**Research Document**

**Data Received by the beacon and integrating it with our application**  
  
Once the **Qorvo DWM3001CDK UWB beacon** is flashed with the appropriate firmware and successfully connected to the iOS device via **Apple's Nearby Interaction (NI) framework**, the following data can be retrieved:

**Data Retrieved from the UWB Beacon:**

1. **Distance (Range)**
   * The straight-line distance between the iPhone and the beacon, measured in meters.
   * This is derived from **Time of Flight (ToF)** calculations.
2. **Angle of Arrival (AoA) or Angle of Elevation**
   * Provides the **vertical tilt angle** (θ) between the iPhone and the beacon.
   * Useful for **multi-floor environments** where elevation changes matter.
3. **Azimuthal Angle (Φ) - Horizontal Direction**
   * Defines the **relative horizontal angle** between the beacon and the user.
   * Helps in determining which direction the user is facing relative to the beacon.
4. **Session Validity & Confidence Level**
   * Indicates the **accuracy of measurements**, ensuring reliable tracking.
   * The iPhone’s UWB chip continuously refines data based on signal quality.
5. **Beacon Identification & Metadata**
   * Unique identifier (UID) of the beacon for distinguishing multiple sensors.
   * Device capabilities, status, and other manufacturer-defined metadata.
6. **Signal Strength & Quality (RSSI, SNR, etc.)**
   * Provides information about signal reliability, which can help refine location accuracy.

**How the Data is Retrieved:**

* **Apple’s Nearby Interaction (NI) Framework**
  + Uses NISession to start tracking the beacon.
  + Retrieves real-time updates via session(\_:didUpdate nearbyObjects:).
  + Processes ranging data to continuously determine location.
* **Qorvo's UWB Firmware & APIs**
  + Qorvo provides a **C-based API** for fetching raw UWB data.
  + Data is processed and formatted according to Apple’s NI framework for use in iOS applications.

**How This Data is Used for User Location:**

1. **Triangulation & Positioning:**
   * Multiple beacons can be used to **triangulate** a user's precise position in a space.
   * The **distance and angles (AoA, azimuth)** are combined to determine **x, y, z coordinates**.
2. **Real-Time User Tracking:**
   * Continuous updates from the beacon allow dynamic tracking of user movement.
3. **Sensor Interaction & UI Updates:**
   * The app displays a **real-time list of nearby sensors** based on distance and location changes.
   * The user’s position relative to sensors is visualized on an **interactive map/UI**.

**Required Frameworks & Libraries:**

* **Apple Nearby Interaction (NI) Framework** (for UWB communication).
* **CoreBluetooth Framework** (if beacon discovery uses Bluetooth pairing).
* **Flutter Plugin (Custom or flutter\_uwb)** for integrating native iOS code with Flutter.
* **Geolocator (optional)** to combine GPS data for hybrid positioning.

This setup ensures that the **UWB-based tracking system provides accurate, real-time location awareness** while integrating seamlessly with your Flutter-based iOS application.