Month 1: Deploy and Analyze the ISAC Scenario on OAI-gNB using Flexric.

Goal: Establish a transparent data pipe from the PHY layer to the Near-RT RIC.

Key Tasks:

- Extend llc_sm/ie/ structures to include SRS raw IQ metadata.
- Hook the OAI gNB process to map iq_srs_estimated pointers to the LLC Agent.
- Verify the E2 Indication message flow using USRP.

Deliverable: Successful export of SRS channel estimates in .txt format for offline validation.

Month 2: Visualization & Initial Detection (SRS-based)

- Goal: Achieve the visualization of sensing data.

- Key Tasks:
  - Develop xApp logic to decode raw_iq buffers received via E2.
  - Implement Range FFT (IFFT) to generate the Power Delay Profile (PDP).
  - Create a real-time Range-Doppler Heatmap in the xApp dashboard.

- Deliverable: A functional demo showing distance detection of a moving target.

Month 3: Spatial Positioning & AoA Implementation

- Goal: Transition from 1D Range detection to 2D/3D Positioning.

- Key Tasks:
  - Extract Phase Information from multi-antenna arrays at the E2 Node.
  - Implement the AoA (Angle of Arrival) algorithm within the xApp.
  - Fuse Range and Angle data to calculate absolute (X, Y) coordinates.

- Deliverable: A high-precision radar UI displaying the real-time spatial coordinates of the target.

Month 4: Multi-RS Expansion & DMRS Integration

- Goal: Incorporate DMRS to enable "Communication-assisted Sensing."

- Key Tasks:
  - Update llc_sm_agent.c to support multi-type RS labeling (SRS vs. DMRS).
  - Hook into the OAI nr_pusch_decoding chain to extract DMRS Channel Estimations.
  - Analyze DMRS signatures for Micro-Doppler extraction (e.g., identifying target types).

- Deliverable: A unified sensing framework capable of switching between periodic SRS and traffic-associated DMRS.

Month 5 ：Spatial Positioning & RAN Optimization

Goal: Transition from "Passive Sensing" to "Active Network Intelligence."

Key Tasks:

- Extract phase information from multiple antenna units provided by the LLC Indication.
- Dynamic Resource Allocation: Develop control logic to automatically increase SRS reporting frequency when a moving object is detected in a critical zone.
- Network Tuning: Implement RIC Control messages to optimize beamforming directions toward the sensed target for improved signal-to-interference-plus-noise ratio (SINR).

Deliverable:

- A closed-loop demo showing the xApp responding to environmental changes by reconfiguring RAN parameters.

Month 6: System Integration & ISAC Demo

Goal: Full-scale verification on commercial-grade hardware.

Key Tasks:
Migrate the LLC SM and xApp to the Lite-On RU (Split 7.2) environment.
Deploy Closed-loop Control: xApp triggers an E2 Control message to adjust reporting periodicity upon intrusion.

Deliverable: Final Demo and comprehensive technical report for the thesis.

Implementation Strategy: Defining the RAN Function

1. LLC Service Model Expansion (Base for Detection)
   - Definition: Modify e2sm_llc to include containers for SRS/DMRS Raw IQ Data and Noise Floor.

2. xApp Algorithm Development (Base for Positioning)
   - Signal Processing: Implement IFFT for Range Estimation (PDP) and AoA for Spatial Localization within the xApp callback logic.
   - Feature Extraction: Process current outputs (iq_srs_estimated.txt) to differentiate moving targets from static background clutter.

3. Closed-Loop Control Logic (Base for RAN Optimization)
   - Control Interface: Utilize the on_control_llc_sm_ag interface in the Agent to receive incoming RIC Control messages.
   - Dynamic Tuning: Program the xApp to trigger automated RAN parameter adjustments (e.g., SRS periodicity) based on real-time sensing results.