Exigence Page

RTL-SDR Signal Processing & Antenna Systems Project

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1. Background / Context

Recent advances in low-cost software-defined-radio (SDR) hardware have enabled broad access to radio-frequency (RF) signals across a wide frequency range. While many introductory projects focus on signal reception or software processing in isolation, practical RF systems require coordinated integration of antenna design, controlled interfaces, digital signal processing (DSP), and verification methodologies. Without this integration, system-level understanding remains incomplete.

2. Problem Statement

There is a lack of compact, end-to-end instructional systems that demonstrate how RF energy is captured, conditioned, digitized, processed, and validated using disciplined systems engineering practices. Many existing student-level implementations emphasize isolated components (software, hardware, or theory) while omitting interface definition, verification planning, and subsystem traceability.

3. Project Exigence

This project exists to design and implement a modular, end-to-end RF signal processing system based on an RTL-SDR platform, with explicit emphasis on subsystem decomposition, interface definition, incremental hardware maturation, and quantitative verification. The project is

intended to demonstrate how RF, digital, and analog domains interact within a coherent system architecture.

4. Scope & Intent

In Scope

- Design and construction of receive antennas for VHF/UHF signals
- RF signal acquisition using an RTL-SDR receiver
- Digital signal processing and visualization at baseband.
- Definition of systems architecture and subsystem interfaces
- Verification through measurable test points and documented assumptions

Out of Scope

- RF transmission or high-power systems
- Classified, proprietary, or military-specific waveforms
- Production-optimized or commercial-grade hardware
- Full-scale model-based Systems engineering (MBSE) implementation

5. Stakeholders & Value

Primary stakeholders include the system developer and technical reviewers evaluating systems level engineering capability. Secondary stakeholders include future project iterations or extensions that may reuse the architecture, documentation, or verification approach. The project provides value by demonstrating disciplined engineering practices applied to a realistic RF system.

6. High-Level Success Criteria

The project will be considered successful if it demonstrates:

- Reception of known RF signals using a purpose-built antenna
- A documented systems architecture linking physical & digital subsystems
- Quantitative verification artifacts (spectra, measurements, logs)
- Clear documentation of assumptions, limitations, and planned improvements

End of Exigence.