

Architecture

Complete system overview showing FreeRTOS, sensor polling loop, protobuf encoding, UDP transmission, and memory layout. Includes initialization sequence and error handling strategy.

Main Loop Operation

```
while (1) {  
    // STEP 1: System Health Check  
    // - Check heap (critical: <8KB)  
    // - Toggle status LEDs  
    // - Send raw Ethernet beacon  
  
    // STEP 2: Initialize Diagnostics Message  
    SensorBoardDiagnostics diagnostics_msg;  
  
    // STEP 3: Poll All Sensors  
    // - pH Sensor  
    // - GPS Sensor  
    // - IMU Sensor  
    // - Load Cells (x2)  
    // - Pressure Sensors (x2)  
  
    // STEP 4: Encode & Transmit  
    // - Encode diagnostics to Protobuf  
    // - Send UDP broadcast (192.168.0.255:7)  
  
    // STEP 5: Wait  
    osDelay(5000); // 5 seconds  
}
```

Error Handling Strategy

Polling Error States

```
if (poll_result == RESULT_ERR_UNIMPLEMENTED) {
    sensor.state = SENSOR_IDLE;
    sensor.error_code = COMMUNICATION_FAILURE;

} else if (poll_result == RESULT_ERR_COMMS) {
    sensor.state = SENSOR_ERROR;
    sensor.error_code = COMMUNICATION_FAILURE;

} else if (poll_result == RESULT_OK) {
    if (validate_sensor_data(value) == RESULT_OK) {
        sensor.state = SENSOR_OPERATING;
        sensor.error_code = NO_ERROR;
    } else {
        sensor.state = SENSOR_ERROR;
        sensor.error_code = INVALID_DATA;
    }
}
```

Sensor Status Codes

Code	Meaning
SENSOR_IDLE	Not connected or not implemented
SENSOR_OPERATING	Normal operation, valid data
SENSOR_ERROR	Communication failure or invalid data

Initialization Sequence

Phase 1: Hardware Setup

1. MPU/Cache configuration
2. HAL initialization
3. System clock → 480 MHz
4. RTOS kernel init
5. GPIO initialization
6. Timer initialization (TIM1)

Phase 2: Communication Setup

1. UART initialization (115200 baud)
2. Logging system init
3. Ethernet PHY init (LAN8742)
4. MAC address filtering
5. ARP table setup

Phase 3: Application Setup

1. Packet dispatcher registration
2. Sensor initialization
3. UDP queue creation
4. UDP callback registration

Phase 4: Main Loop

1. LED initialization
2. Sensor polling starts
3. Continuous 5-second cycles

Revision #6

Created 2026-04-14 15:56:40 UTC by Shishir Nambiar

Updated 2026-04-23 12:17:48 UTC by Shishir Nambiar