

System Architecture & Logic Triggers

Project: FarmSense Hydrological OS (hOS)

Core Engine: The "Basin Oracle" Synthesis Layer

1. The Hierarchy of Truth (Conflict Resolution)

To maintain **Hydrological Autonomy**, the system resolves sensor conflicts using physics-based weighting:

1. **Level 1: Physical Truth (Primary):** Radar (Sentinel-1), Thermal (ECOSTRESS), and Gravity (GRACE).
2. **Level 2: Operational Truth (Secondary):** JDLink CAN-bus (actual fuel/pump load), CDSS Wells.
3. **Level 3: Probabilistic Truth (Tertiary):** Weather models (Tomorrow.io), NDVI/Optical imagery.

Logic: If a soil probe shows "Wet" but ECOSTRESS shows "Thermal Fever" ($\$LST > 305K\$$), the system trusts the Thermal signal—assuming the probe is bypassed or malfunctioning.

2. Core Operational Triggers

Trigger A: The "Ghost Water" Alarm (PPA 2)

- **Inputs:** LWE_trend < -5% + subsidence_rate > 2mm/mo + static_well = Stable.
- **Condition:** The container is shrinking, keeping the water level artificially high while mass disappears.
- **Action:** Generate "Aquifer Integrity Report" and downgrade the Hydrological FICO score by 50 points.

Trigger B: The "Flash-Drought" Reset (PPA 24)

- **Inputs:** VPD > 2.2 kPa + ESI < 0.4 + Time = 22:00–04:00.
- **Action:** Trigger API Callback to JDLink/Pivot Controller: "Execute 0.25-inch Cooling Pulse."
- **Safety:** Requires "Commander Approval" via push notification unless "Full Autonomy" is toggled ON.

Trigger C: The "Nitrate Lockdown" (PPA 3)

- **Inputs:** Precip_Forecast > 0.75" + Soil_Ksat = High + App_Rate > 0.
- **Action:** Disable fertigation pump via hardware interlock to prevent deep percolation of chemicals into the unconfined aquifer.

3. System Architecture Layers

- **L1: Ingestion Engine:** Standardizes 18+ APIs into a synchronous **JSON-LD** stream.

- **L2: Spatio-Temporal Mesh:** A 4D-grid (Lat, Lon, Depth, Time) at 30m resolution.
- **L3: The Neural Kalman:** Predicts the state of low-frequency variables (Gravity) using high-frequency drivers (Weather).
- **L4: The Sovereign API:** The outbound gateway for alerts, FICO scores, and machine commands.

4. Hardware Interoperability

- **Primary Bridge:** John Deere Operations Center (API).
- **Protocol:** ISO 11783 (ISOBUS) compatibility for variable-rate prescriptions.
- **Latency Target:** < 300ms from Trigger Logic to "Command Sent" status.