

# Farm Controller Layer (Local / Federated)

See overview: [System Architecture Overview](#)

The **Farm Controller Layer** is the on-site AOFS controller that provides **local supervision, configuration, and federation**. It sits between the Field Controller (authoritative safety layer) and HQ / Federated Controllers.

This layer is **offline-first, federation-capable**, and **authoritative for non-critical decisions**.

## 1. Responsibilities

The Farm Controller Layer **must**:

- Aggregate telemetry from Field Controllers:
  1. Soil moisture sensors
  2. Tank levels
  3. Flow meters
  4. Power usage
  5. Optical monitoring data
- Provide a **local operator interface** for monitoring and configuration.
- Validate all operator requests against Field Controller safety rules.
- Manage irrigation schedules and configuration updates locally.
- Enable **push/pull federation** with other Farm Controllers or HQ Controllers.
- Log all local actions, operator inputs, and synchronization events for auditability.

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## 2. Offline Operation

### 1. Full local autonomy:

- Must operate independently of network connectivity.
- Irrigation schedules, sensor monitoring, and fail-safe enforcement continue uninterrupted.

### 2. Local operator interface:

- Operators can view data and update configurations.
- Only non-critical adjustments are applied locally; safety-critical overrides are blocked by Field Controller logic.

### 3. Local data storage:

- Telemetry and logs are persisted locally.
- Data is queued for synchronization when connectivity is restored.

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## 3. Federation Model

Farm Controllers support a **Git-like push/pull model**:

- **Pull:**
  1. Farm Controller can pull configuration, software, or firmware updates from HQ or peer controllers.
  2. Pulled changes are validated against local rules and logged.
- **Push:**
  1. Farm Controller can push logs, irrigation events, and audit data to HQ or peer controllers.
  2. Push is queued if connectivity is unavailable.
- **Peer-to-peer:**
  1. Farm Controllers can synchronize directly with other farms for configuration and data exchange.
  2. Conflicts are resolved using deterministic rules (see section 4).

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## 4. Conflict Resolution

When multiple controllers modify configurations or schedules:

1. **Timestamp precedence:**
  - \* The most recent authorized change takes effect.
2. **Operator approval:**
  - \* In case of conflicting schedule changes, local farm operators must approve before applying.
3. **Field Controller enforcement:**
  - \* Field Controller always vetoes any configuration that violates **safety constraints**.
4. **Logging:**
  - \* All conflict events must be logged with timestamps, operator ID, and resolution outcome.

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## 5. Authority Rules

### 1. Safety authority:

- Field Controller is authoritative for safety-critical decisions.
- Farm Controller cannot override irrigation cut-offs, pump safety, or flood prevention rules.

## 2. Configuration authority:

- Farm Controller is authoritative for **non-critical configurations** and local schedules.
- HQ or peer controllers may propose updates, but local rules take precedence.

## 3. Audit and compliance:

- All configuration changes, operator interactions, and sync operations must be logged.
- Logs must be retained locally and transmitted to upstream controllers when possible.

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# 6. Human Interface

\* The Farm Controller **must provide a full local UI**:

1. Monitoring dashboards for all irrigation zones
2. Configuration of schedules and thresholds
3. Alerts and notifications for operators

\* Operator actions are validated against Field Controller safety rules. \* The interface supports **manual requests**, but these cannot bypass critical safety decisions.

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# 7. Implementation Notes

\* Hardware: Industrial-grade single-board computers (e.g., NanoPi, Raspberry Pi). \* Communication protocols: LAN, WiFi, or cellular for synchronization. \* Data format: Structured, versioned, and compatible with HQ controller ingestion. \* Security: All communications must be encrypted; operator authentication is required. \* Scalability: Supports multiple Field Controllers per farm; multiple zones; multi-farm federation.

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# 8. Compliance Notes

\* Any AOFS-compliant Farm Controller **must implement offline operation, federation, logging, and safety validation**. \* Failure to preserve Field Controller authority or provide audit logs **invalidates compliance**. \* Synchronization conflicts must follow the deterministic resolution rules defined above.

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