**Domain Architecture: Cannabis Module**

The Cannabis Module is a dedicated subsystem within the larger traceability platform, built to ensure full lifecycle visibility, regulatory compliance, and data immutability across all cannabis-related operations-from cultivation to regulatory submission. It is designed for government-grade environments, optimized for field use in low-connectivity areas, and built on a modern, modular technology stack.

**Overview**

The Cannabis Module is functionally and architecturally independent, yet fully integrated with the platform's shared services (e.g., logging, analytics, blockchain, identity management). It includes dedicated services for each domain-relevant process, an underlying cannabis-specific database, and an immutable blockchain ledger for regulatory-grade audit trails.

The architecture supports role-based user interactions (Regulator, Operator, Auditor), offers both web and offline-capable mobile interfaces, and is designed for interoperability with external systems such as POS, LIMS, and IoT devices.

**Key Components and Functional Services**

**1. Cultivation Service**

Tracks the setup and management of cultivation facilities, including plot setup, license validation, and strain registration. Integrates with IoT sensors (optional) for automated environment monitoring (humidity, light, temperature).

**2. Planting & Harvesting**

Allows operators to log plantings, growth stages, harvests, and drying batches. Data can be captured on mobile devices offline and later synced securely. All plant lifecycle events are recorded with timestamps and linked IDs.

**3. Growth Monitoring**

Includes periodic check-ins and health tracking. Supports photo attachments, QR scans, and optional sensor integration. Data is used to trigger alerts for irregular growth patterns or unauthorized activity.

**4. Packaging & Labeling**

Enables operators to create packages, generate labels with unique identifiers, and link them to source batches. Barcodes or RFID tags are supported via mobile scanning.

**5. Inventory Management**

Tracks package quantities, warehouse storage, transfer activities, and returns. Each item is linked to its origin (plant or package), ensuring traceability and preventing diversion.

**6. Waste Tracking**

Supports compliant destruction workflows, including waste categorization, logging, validation by a second party, and chain-of-custody tracking. Waste events are logged and hashed for immutability.

**7. POS Sync**

Integrates with external point-of-sale (POS) systems to log real-time sales data, inventory deductions, and customer receipt records. Supports scheduled and event-based syncing via secure APIs.

**8. Regulatory Submission**

Automates reporting to regulators. Batches reports, flags anomalies, and validates entries before submission. Submissions are logged, hashed, and stored in both the cannabis database and the blockchain ledger.

**User Roles & Interactions**

* **Operator** (e.g. farmer or license holder):  
  Interacts via mobile or web interface to perform operational tasks like planting, inventory updates, or packaging. Offline support ensures uninterrupted logging in remote areas. Sync engine queues actions for secure submission once online.
* **Regulator**:  
  Uses the web interface to monitor compliance, receive flagged reports, audit trails, and blockchain logs. Can issue warnings, request documentation, or perform remote inspections.
* **Auditor**:  
  Has read-only access to logs, events, and the blockchain ledger. Can trace activities back to their source with timestamped hashes and full data lineage.

**Workflow Example: End-to-End Traceability**

*An operator uses the mobile app to register a new plant batch in an offline greenhouse. The entry is queued locally using secure storage (SQLite). Once internet connectivity is restored, the sync engine pushes the data to the API Gateway, which routes it to the Cannabis Service. The entry is validated, stored in the Cannabis Database, logged via the ELK stack, and committed as a hash to the blockchain ledger. Inventory is automatically updated, and a submission is prepared for regulatory review. The regulator receives a dashboard alert and can inspect the audit trail or generate a compliance report via the analytics engine.*

**Integration with External Systems**

* **Point-of-Sale (POS)**: Sales data is automatically imported to reconcile inventory in real time. This ensures closed-loop lifecycle management and prevents untracked movement.
* **Laboratory Information Management Systems (LIMS)**: Lab test results (e.g., THC/CBD content) are automatically synced to match batch IDs.
* **IoT Sensors**: Optional integration for temperature, soil, or humidity sensors to provide growth monitoring and compliance analytics.
* **Customs or Government Data Services**: Submission of high-level statistics, licensing statuses, and compliance logs.

**Security & Compliance**

* **Identity and Access Management**: Role-based access is handled via Keycloak, with OAuth2 and MFA.
* **Blockchain Commitments**: All critical lifecycle events are hashed using SHA-256 and recorded in Amazon QLDB for tamper-proof immutability.
* **Audit Logging**: Every user action is captured and searchable via ELK Stack, with optional integration to Prometheus for performance metrics.

**Conclusion**

The Cannabis Module is engineered for accountability, transparency, and future-proof regulatory compliance. By combining offline-first design, modular microservices, and secure government-grade infrastructure, it ensures Saint Lucia has a sustainable, sovereign system for traceability and control-beginning with cannabis and built to scale.