# MediAsset AI

## Hospital Asset Management & Maintenance System

**SYSTEM SPECIFICATION DOSSIER & SALES PROPOSAL SPEC SHEET**

Comprehensive technical architecture, 13 integrated operational modules, 5-role RBAC security matrix, 8 executive reports, and deterministic AI cost analysis engine.
Configured for XYZ Hospital Clinical Engineering Department.

*Brand Clearance Notice: The name, tagline, logo concept, and palette are proposed brand assets and remain subject to clearance. NABH Chapter FMS (Facility Management and Safety) Compliant. 7-Year Mandatory Record Retention Standard.*

## DEPLOYMENT & STAKEHOLDER CONTEXT

| | |
|---|---|
| **Target Deployment:** | XYZ Hospital (Multi-Specialty Tertiary Care Center) |
| **Parent Identity:** | AI India Innovations Pvt. Ltd. |
| **Document Type:** | Product Specification, Feature Matrix & Sales Deck Companion |
| **Target Audience:** | Hospital Management (MD/COO), Biomedical HODs, Clinical Directors, Enterprise IT |
| **Software Release:** | Version 0.1.0 — Production Ready (Phases 0-8 Fully Implemented) |
| **Release Date:** | November 2026 |
| **Confidentiality:** | RESTRICTED — For Internal Sales & Hospital Client Evaluation Only |

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Sub-35ms API Latency * Zero Cloud Data Exfiltration * Local-First Compliance

## 1. EXECUTIVE SUMMARY & PLATFORM VALUE

MediAsset AI is an enterprise-grade, web-based Hospital Asset Management and Maintenance System (AMS) purpose-built for tertiary care healthcare networks. Developed to address severe operational challenges in medical equipment tracking, recurring breakdown downtime, and accreditation audit failures, MediAsset AI replaces ad-hoc spreadsheets with a consolidated, high-velocity operational command center.

### Strategic Value Propositions

- **Total Lifecycle Governance:** Manages medical devices from initial procurement, warranty onboarding, routine PM, regulatory calibration, emergency breakdown restoration, to condemnation and scrapping.
- **NABH**

### Key Verified Performance Benchmarks

| Endpoint | Operation Scope | Average Latency | Minimum Latency | Status Code |
|---|---|---|---|---|
| /api/health | System Heartbeat & DB Ping | 2.3 ms | 1.9 ms | 200 OK |
| /api/auth/me | Token Validation & User Profile | 5.8 ms | 4.3 ms | 200 OK |
| /api/dashboard/summary | 7 KPIs + 4 Charts + Alerts | 33.1 ms | 25.7 ms | 200 OK |
| /api/assets?limit=50 | Asset Master + Warranty Status | 28.0 ms | 20.7 ms | 200 OK |
| /api/complaints?limit=50 | Breakdown Tickets + Downtime | 20.0 ms | 16.7 ms | 200 OK |
| /api/pm/schedules | In-House & Outsourced Schedules | 22.2 ms | 16.2 ms | 200 OK |
| /api/calibration/records | Calibration Registry + Approvals | 12.9 ms | 9.2 ms | 200 OK |
| /api/notifications | Alert Feed (60s bell polling) | 6.7 ms | 6.2 ms | 200 OK |

## 2. 13 INTEGRATED OPERATIONAL MODULES

The platform features 13 modular components tightly coupled via an event-driven architecture, guaranteeing consistent asset state synchronization across breakdowns, contracts, calibrations, and management KPIs.

| ID | Module Name | Primary Route | Core Operational Functionality | Stakeholder |
|---|---|---|---|---|
| M1 | Operations Dashboard | / | 7 KPI cards, 4 Recharts visual telemetry graphs, Needs Attention alerts | Executive & HODs |
| M2 | Asset Register | /assets | Full CRUD, duplicate check, 8-tab detail, Bulk Excel Import with dry-run | Biomedical & IT |
| M3 | Complaints / Breakdowns | /complaints | Sequential tickets, 5-stage lifecycle, CE technical section, SLA timers | Clinical & Ward |
| M4 | Preventive Maintenance | /pm | In-house & outsourced PM, 7-col month calendar, auto-advancing cycles | Biomedical Staff |
| M5 | Calibration Management | /calibration | Plan creation, management approval gating, certificate archiving | Biomedical & NABH |
| M6 | Contracts & Warranty | /contracts | AMC/CMC/OTHER CRUD, expiry warning chips, renewal history chain | Finance & Vendor |
| M7 | Asset Insurance | /insurance | Policy register, INR coverage, expiry alerts, slide-over InsuranceDrawer | Finance & Admin |
| M8 | Demo Equipment | /demo-equipment | Trial equipment register, return logging, automated 3-day return alerts | Doctors & Vendors |
| M9 | Department Visits | /visits | Biomedical ward rounds, multi-asset checklist, one-click breakdown linking | Biomedical & HOD |
| M10 | Alert Engine & Bell | /notifications | APScheduler daily at 06:00, 8 alert types, deduplicated toast feeds | All Hospital Roles |
| M11 | Operational Reports | /reports | 8 reports (Uptime, Maintenance, Visits), Excel exports, A4 PDF print | Auditors & CFO |
| M12 | AI & Cost Analysis | /reports/ai | 5 deterministic TCO sections: Buy vs Rent, Depreciation, Efficiency | CFO & Directors |
| M13 | Masters & Security | /masters | CRUD for Departments, Locations, Vendors, Users; Audit Log Viewer | System Admin |

## 3. CORE OPERATIONAL WORKFLOWS DEEP-DIVE

### 1. Asset Lifecycle & Bulk Onboarding

Assets are registered with comprehensive clinical metadata including serial number, acquisition mode (Purchased/Rented), depreciation parameters (Useful life, Salvage %, Method), and installation dates. The 8-tab Asset Detail view presents an exhaustive audit dossier: Overview, Warranty, AMC/CMC, Insurance, Calibration, PM, Breakdowns, and Documents. Bulk onboarding is enabled via an Excel (.xlsx) template featuring a dynamic 'Master Reference' sheet, pre-upload dry-run validation preview, and skip-invalid row tolerance.

### 2. Breakdown Management & SLA Enforcement

Breakdowns transition through a strict state machine: Registered -> Assigned -> Attended -> Restored -> Closed. When a complaint is logged, the asset status automatically flips to 'Under Repair' and returns to 'In Service' upon restoration. Response times and downtime hours are dynamically tracked. The technical section captures root cause, corrective action, lessons learned, and spare parts cost estimation. To preserve clinical engineering integrity, this section is strictly locked with a read-only banner for Department Users (server-enforced HTTP 403 on edit).

### 3. PM Adherence & Calendar Scheduling

PM schedules support both In-House engineering teams and Outsourced OEM contracts. Technicians can view workloads via a standard Data Table or an intuitive 7-column Monday-Sunday Month Calendar. Marking a PM complete automatically calculates and schedules the next planned date using calendar-accurate add_months logic, ensuring seamless adherence.

### 4. Calibration Approval & Certificate Archiving

Calibration plans require formal approval before execution. In compliance with internal hospital control separation, Biomedical Engineers cannot approve calibration frequencies (server-enforced FORBIDDEN_CALIBRATION_APPROVAL 403); only Hospital Management, Administrators, or Coordinators possess approval authority. Executed calibrations require digital certificate uploads (JPG/PNG/PDF up to 10MB) with cryptographic magic-byte validation.

## 4. ROLE-BASED ACCESS CONTROL (RBAC) & SECURITY

Security in MediAsset AI is enforced on the server at both the API route and field levels. The frontend adapts navigation and controls as a visual convenience, while FastAPI dependency injection strictly blocks unauthorized actions.

| Operational Functionality | Admin | Biomed | Mgmt | Coord | Dept User |
|---|---|---|---|---|---|
| Hospital Operations Dashboard | Full | Full | Full | Full | Scoped Dept |
| Asset Master Register (View) | All | All | All | All | Scoped Dept |
| Asset Master Register (Create/Edit) | Full | Full | Read-Only | Restricted | Read-Only (403) |
| Asset Financials (Cost & Book Value) | Visible | Visible | Visible | Visible | Hidden / Stripped |
| Bulk Asset Excel Import | Allowed | Allowed | Forbidden | Forbidden | Forbidden (403) |
| Raise Breakdown Ticket | Allowed | Allowed | Allowed | Allowed | Own Dept Only |
| Complaint Workflow (Assign/Restore) | Allowed | Allowed | Read-Only | Allowed | Read-Only |
| Complaint CE / Spares Technical Section | Editable | Editable | Read-Only | Read-Only | Forbidden (403) |
| Admin Complaint Timestamp Correction | Allowed | Forbidden | Forbidden | Forbidden | Forbidden (403) |
| Preventive Maintenance Workflow | Full | Full | Read-Only | Full | Hidden / Denied |
| Calibration Plan Approval Authority | Allowed | Forbidden | Allowed | Allowed | Forbidden (403) |
| Contracts & Warranty Management | Full | Full | Read-Only | Full | Hidden / Denied |
| Department Visits Log & Link | Allowed | Allowed | Read-Only | Forbidden | Forbidden (403) |
| Operational Reports (8 Reports) | All 8 | All 8 | All 8 | 7 (No Visits) | Scoped Dept Only |
| AI Report & TCO Analysis | Full | Full | Full | Full | Hidden / Denied |
| Master Data CRUD (Depts, Users) | Full | Read-Only | Read-Only | Read-Only | Read-Only |
| Audit Log Viewer & System Settings | Full | Forbidden | Forbidden | Forbidden | Forbidden (403) |

### Security Safeguards

- **Sliding-Window Rate Limiter:** Protects /api/auth/login with a sliding window of 15 attempts per 60 seconds per IP/Email. Exceeding triggers HTTP 429 RATE_LIMITED.

- **JWT T**

## 5. AI REPORT & FINANCIAL DECISION ENGINE

The AI Report module (/reports/ai) empowers executive leadership and biomedical engineering heads with data-grounded total cost of ownership (TCO) analytics. Every calculation is deterministic, transparent, and auditable.

| Section | Core Methodology & Mathematical Formula | Configurable Parameters | Executive Value |
|---|---|---|---|
| Buy vs Rent Comparison | Buy + In-House = (Purchase Value - Book Value at Horizon) + (Horizon * Annual PM Cost) + (Horizon * Annual Breakdown Cost)<br>Buy + Outsourced = (Purchase Value - Book Value at Horizon) + (Horizon * Annual Contract Cost) + (Horizon * Breakdown Cost excluding spares under CMC) | comparison_horizon_years = 5<br>latest_equipment_count = 10 | Identifies lowest TCO acquisition scenario over a 5-year capital horizon. |
| Depreciation & Replacement | Straight Line: Annual Charge = (Cost - Salvage) / Useful Life<br>Written Down Value: Rate = 1 - (Salvage/Cost)^(1/Life)<br>Maintenance Ratio = Cumulative Maintenance Cost / Purchase Value<br>Replacement Review Flagged when Maintenance Ratio >= 0.40 | default_useful_life = 10 yrs<br>default_salvage = 5.0%<br>replacement_review_ratio = 0.40 | Flags equipment whose ongoing maintenance costs exceed 40% of initial purchase value. |
| Equipment Efficiency | Composite Score = (0.50 * Uptime%) + (0.20 * PM Compliance%) + (0.15 * Response Score) + (0.15 * Repeat-Free Score)<br>MTTR = Mean(Restored At - Registered At)<br>MTBF = (Scheduled Hours - Downtime Hours) / Breakdowns | Weights: Uptime 50%, PM 20%, Response 15%, Repeat 15%<br>scheduled_hours_per_day = 24 | Ranks equipment and clinical departments by true operational efficiency. |
| Breakdown Frequency | Average Breakdowns per Equipment = Total Breakdowns / Total Assets in Scope<br>Breakdowns per 1,000 Operating Hours = Total Breakdowns / (Assets * Days * Hours/Day / 1000)<br>Repeat Failure: Asset has >= 3 breakdowns in 90 days | repeat_failure_count = 3<br>repeat_failure_days = 90 | Pinpoints chronic 'lemon' equipment causing recurring departmental disruptions. |

## 6. OPERATIONAL REPORTS CATALOG & EXPORTS

MediAsset AI delivers 8 pre-configured executive reports designed to satisfy hospital leadership reviews, financial reconciliation, and statutory accreditation inspections. Every report supports date and department filtering, styled Excel (.xlsx) streaming exports via openpyxl, and pixel-perfect A4 Landscape PDF printing.

| Key | Report Title | Core Tracked Metrics | Export Formats | Compliance Utility |
|---|---|---|---|---|
| REP-01 | Monthly Maintenance Summary | Department uptime/downtime hours, downtime days, downtime %, breakdown counts | Excel (.xlsx), CSV, Print PDF | Primary NABH monthly engineering review document |
| REP-02 | Monthly Department Report | Department asset census, under repair units, open critical complaints, visit logs | Excel (.xlsx), CSV, Print PDF | Monthly clinical engineering ward status summary |
| REP-03 | Daily Department Visit Report | Biomedical technician round inspections, multi-device checklist, linked tickets | Excel (.xlsx), CSV, Print PDF | Audit evidence of proactive daily equipment checks |
| REP-04 | Breakdown & Complaints Report | Ticket lifecycle, response times, downtime hours, root causes, spare costs | Excel (.xlsx), CSV, Print PDF | MTTR tracking and clinical engineering accountability |
| REP-05 | PM Compliance Report | Planned vs executed PM schedules, adherence %, in-house vs OEM split | Excel (.xlsx), CSV, Print PDF | Statutory PM adherence verification for NABH FMS |
| REP-06 | Calibration Due Report | Upcoming/due/overdue calibrations, agency details, certificate numbers | Excel (.xlsx), CSV, Print PDF | Accreditation safety check against expired devices |
| REP-07 | AMC / CMC & Warranty Report | Contract duration, expiry warning chips, provider details, renewal status | Excel (.xlsx), CSV, Print PDF | Vendor contract governance and budget planning |
| REP-08 | Demo Equipment Report | Supplier trial devices, clinical department, start/return dates, return logging | Excel (.xlsx), CSV, Print PDF | Legal liability and trial device return oversight |

### A4 Print Engine Enhancements

The reporting engine features custom print stylesheet architecture: unwraps fixed viewport scrollbars, renders ALL filtered records across multi-page tables (overcoming 10-row pagination truncation), enforces SVG chart visibility in landscape mode, and automatically appends official hospital letterhead and tripartite NABH sign-off blocks (Prepared By Biomedical Engineer, Verified By HOD, Approved By Medical Superintendent).

# 7. TECHNICAL ARCHITECTURE & DEPLOYMENT GUIDE

## Technology Stack

- **Backend Architecture:** FastAPI (Python 3.11+), SQLAlchemy 2.0 ORM with 19 normalized relational tables, Pydantic v2 validation schemas, passlib/bcrypt hashing, PyJWT, and APScheduler.
- **Databa**

## On-Premise & Container Deployment Options

MediAsset AI is designed for friction-free local hosting with zero external cloud dependencies. Hospitals can select between standard bare-metal server installation or Docker containerization.

- **Option A: Docker Compose (Recommended):** Run 'docker compose up --build' to spin up the FastAPI backend, pre-built React frontend, and Nginx reverse proxy. Persistent volumes mount to ./backend/data for automatic DB and upload persistence.
- **Option**

## Demo Access Credentials

| Email Address | Default Password | Role Assigned | Default Accessible Scope |
|---|---|---|---|
| admin@xyz.demo | Demo@123 | System Admin | Full Hospital Administration, Settings, Audit Logs |
| bio@xyz.demo | Demo@123 | Biomedical Engineer | Asset CRUD, Complaints, PM & Calibration Execution |
| mgmt@xyz.demo | Demo@123 | Hospital Management | Operations Dashboard, AI Reports, Calibration Approval |
| coord@xyz.demo | Demo@123 | Operations Coordinator | Vendor Contracts, Insurance, Cross-Department Triage |
| dept@xyz.demo | Demo@123 | Department User (ICU) | Raise Breakdowns, View ICU Asset Uptime (No Costs) |