

Offline Clinic Workflow + DICOM Imaging & Reporting System

1. Introduction

This document outlines the high-level functional and technical overview of the Offline Clinic Workflow and DICOM Imaging & Reporting System.

The system is designed to streamline clinical operations—patient registration, scheduling, imaging workflows, diagnostic reporting, and document management—while operating entirely on a local network (LAN) with optional cloud synchronization.

The solution supports seamless DICOM integration from imaging modalities like ultrasound, X-ray, CT, and MRI, enabling clinicians to view images, annotate, and generate standardized medical reports.

2. Product Vision

To provide clinics with a **fast, reliable, fully offline-capable medical imaging and reporting system** that improves patient flow, enhances diagnostic accuracy, and eliminates dependency on internet connectivity. The system ensures controlled data storage, interoperability with medical imaging devices, and secure access to patient information.

3. Core Objectives

- Ensure smooth clinical workflow from patient check-in to report delivery.
 - Enable **DICOM ingestion** directly from imaging machines using secure local protocols.
 - Provide fast and intuitive tools for **image viewing, selection, and comparison**.
 - Support **structured and template-based diagnostic reports** with embedded thumbnails.
 - Maintain system operability even without internet connectivity.
 - Provide secure, compliant data handling with role-based access.
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4. Key User Roles

The system supports multiple user types, each with distinct permissions:

- **Receptionist** – Patient registration, demographics management, scheduling.
 - **Technician** – Worklist review, imaging session management, DICOM verification.
 - **Radiologist / Doctor** – Study review, diagnosis, structured reporting, report approval.
 - **Administrator** – User management, audits, settings, data control.
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5. Functional Scope

5.1 Patient Management

- New patient registration with validation (name, DOB, contact number).
 - Automatic duplicate detection using fuzzy matching logic.
 - Edit/update demographics with audit control.
 - Patient timeline showing previous visits, studies, and reports.
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5.2 Appointment & Workflow Management

- Create and manage appointments for imaging or consultation.
 - Update patient status: *Waiting* → *In-Room* → *In-Scan* → *Review* → *Completed*.
 - Live updates via WebSocket for all workstations.
 - Color-coded UI indicators for workload visibility.
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5.3 DICOM Integration

The system acts as a **DICOM C-STORE SCP**, enabling modalities to push studies directly.

Capabilities include:

- Accept DICOM studies/images from modalities over LAN.
- Parse metadata: Study Instance UID, Patient ID, Modality, Series, SOP UID.
- Organize stored data by patient, study, and series.
- Auto-trigger background tasks for:
 - Thumbnail generation
 - Metadata extraction
 - Study linking to existing patient
 - Study progress/status updates

The system supports common ultrasound, X-ray, and CT transfer syntaxes.

5.4 Image Viewer

A fast, browser-based viewer offering:

- Thumbnail grid for quick navigation
 - Full-size diagnostic image display
 - Window/level presets (if applicable)
 - Zoom, pan, flip, rotate
 - Multi-frame cine playback for ultrasound
 - Series comparison (side-by-side)
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5.5 Reporting Module

Doctors can create structured diagnostic reports using:

- Predefined templates (e.g., ultrasound abdomen, pelvis, obstetrics)

- Rich-text editor with adjustable sections
- Auto-insertion of images/thumbnails
- Custom findings, impressions, measurements
- Draft → Final report workflow
- Automatic PDF generation on final approval

Reports are stored permanently and can be shared or printed.

5.6 System Administration

Admins can:

- Manage user accounts and roles
 - Configure modality AE Titles & connection settings
 - View audit logs (who changed what and when)
 - Manage backup & retention settings
 - Adjust report templates
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5.7 Offline-First Architecture

- Entire system runs on LAN without internet dependency
 - Interfaces remain usable during network interruptions
 - Local caching for patient data on workstations
 - Pending actions automatically sync when connection restores
 - Optional cloud sync module (future-ready)
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6. High-Level System Architecture

6.1 Components

- **Frontend:** React + TypeScript SPA
- **Backend:** FastAPI (Python)
- **DICOM Listener:** Pynetdicom SCP
- **Database:** PostgreSQL
- **Message Broker:** Redis for background jobs
- **Worker:** Celery worker(s) for heavy tasks
- **File Storage:** Local disk for DICOM + generated PDFs

6.2 Data Flow — Overview

1. Patient created in reception UI
 2. Modality pushes DICOM → SCP receives → Stores to disk
 3. Worker processes DICOM → Extracts metadata → Generates thumbnails
 4. Study becomes visible to technicians/doctors in UI
 5. Doctor reviews → Creates report → Finalizes
 6. PDF generated → Linked to patient and study
 7. Audit log created for each action
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7. Security & Compliance Overview

- Role-based access control
- Encrypted passwords using bcrypt
- Local database encryption supported
- Secure DICOM storage with controlled folder permissions

- Audit logs for all CRUD operations
 - Automatic session timeout and login throttling
 - Backup encryption supported
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8. High-Level Data Structure (Summary)

Patients

- Name, DOB, gender, phone, clinic ID, demographics
- Linked studies and reports

Studies

- Study UID
- Modality (US/XR/CT)
- Study date
- Linked patient
- Associated series and images

Images

- SOP Instance UID
- Disk file path
- Thumbnail path
- Key DICOM tags

Reports

- Report text (HTML)

- PDF file path
 - Author, status (draft/final)
 - Finalization timestamp
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9. High-Level Use Cases

Use Case 1 — Patient Check-In

Actor: Receptionist

Goal: Register patient and prepare for imaging

Flow:

1. Receptionist enters patient details
 2. System checks duplicates
 3. New patient record created
 4. Patient appears in waiting list
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Use Case 2 — Imaging Workflow

Actor: Technician

Goal: Receive images pushed from modality

Flow:

1. Technician selects patient/study
 2. Modality sends DICOM files
 3. SCP receives & stores files
 4. Worker processes metadata & thumbnails
 5. Images appear on technician's panel
 6. Study marked "Ready for Review"
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Use Case 3 — Doctor Reviewing & Reporting

Actor: Radiologist/Doctor

Goal: Create a diagnostic report

Flow:

1. Doctor selects study
 2. Views images in full-screen viewer
 3. Opens reporting template
 4. Enters findings & impression
 5. Saves draft
 6. Finalizes report
 7. System generates PDF and archives it
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Use Case 4 — Offline Operation

Actor: Any user

Goal: Continue workflow without internet

Flow:

1. LAN stays operational
 2. Workstations cache data locally
 3. New registrations stored offline
 4. Once connected, sync occurs automatically
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Use Case 5 — Searching Historical Studies

Actor: Doctor/Admin

Goal: Retrieve past imaging data

Flow:

1. User enters patient name or study ID

2. Database returns full patient history
 3. All past reports and images available for review
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10. Benefits

- **Fast imaging workflow:** Immediate study availability
 - **Accuracy:** Structured reporting improves quality & consistency
 - **Reliability:** Offline-first system ensures uninterrupted clinic operation
 - **Security:** Full control over patient data within the clinic
 - **Scalability:** Ready for multi-modality and multi-branch setups
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11. Future-Ready Extensions (Optional)

(Not part of current scope but can be included later)

- Cloud synchronization for remote access
 - AI-assisted measurement & anomaly detection
 - SMS/WhatsApp report delivery
 - PACS integration
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