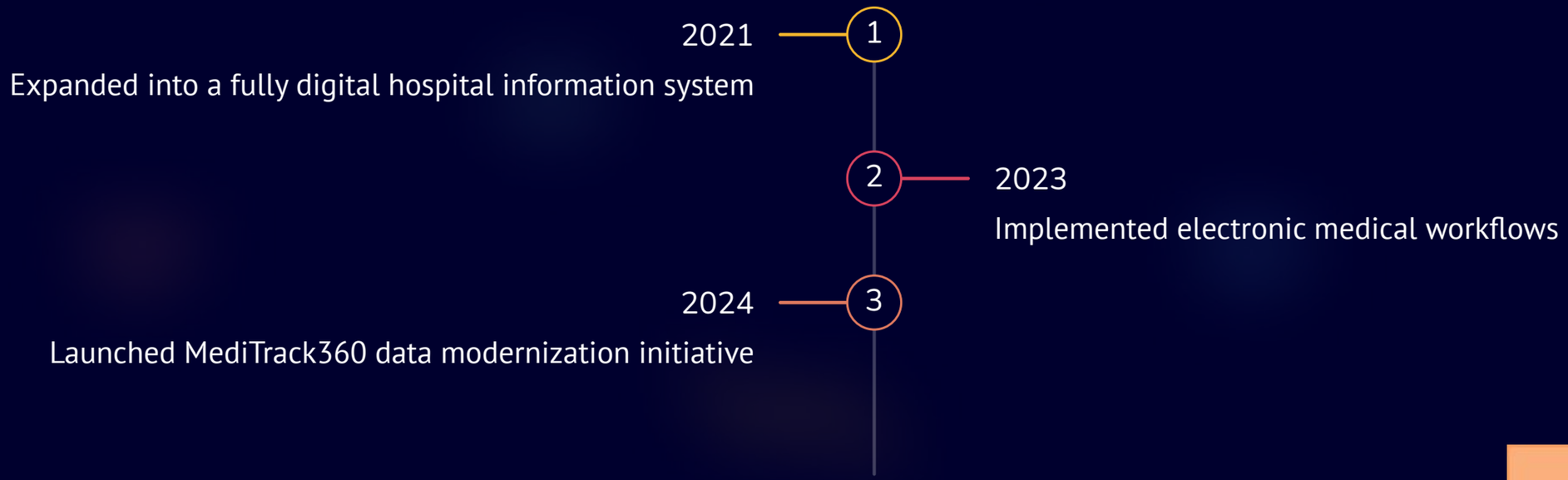
MediTrack360 – Healthcare Operations Data Platform

Company Overview

MediTrack360 Hospital is a leading healthcare provider focusing on efficient patient care, emergency response, and seamless hospital operations. The hospital handles thousands of daily records across admissions, pharmacy inventory, laboratory tests, ICU monitoring, and administrative workflows. To maintain excellent service delivery, MediTrack360 depends heavily on reliable data, real-time insights, and smooth coordination across all units including:

- Admissions & Discharge
  - Pharmacy
  - Laboratory
  - ICU Monitoring
  - Wards & Bed Management

Key Milestones:



Project Overview

Today's hospitals generate massive amounts of data from disparate systems—Electronic Medical Records (EMR), on-premise databases, event streams (vitals), pharmacy management solutions, laboratory instruments, and cloud services. These datasets are scattered, unstructured, and often exist in silos that are difficult to integrate. As the healthcare industry moves toward digital transformation, hospitals now require real-time insight into operations to reduce delays, prevent resource shortages, and make informed decisions.

MediTrack360 is a collaborative, production-grade data platform project simulating hospital operations. It integrates Data Engineering and Data Analytics roles in a realistic healthcare workflow. The objective is to build a full end-to-end data platform powering operational dashboards for a 300-bed hospital.

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Current Business Challenge

Hospitals operate in high-pressure environments where timely decisions can directly impact patient outcomes. However, most hospitals—especially in emerging markets—struggle with fragmented data systems, manual reporting, and limited operational visibility. This leads to challenges such as:

Inefficient Patient Flow

Admissions, discharges, and bed assignments are documented in multiple systems that don't communicate with each other. This creates:

- long waiting times
- misplaced records
- bed allocation issues
- poor forecasting of daily demand

Limited Visibility Into Resource Usage

Wards, ICUs, pharmacies, and labs often maintain separate logs or spreadsheets. As a result:

- bed occupancy cannot be tracked in real time
- drugs run out unexpectedly
- equipment shortages go unnoticed
- management cannot anticipate peak periods

Inconsistent and Unreliable Data

Operational data is collected manually or exported from different systems with inconsistent:

- schemas
- timestamp formats
- identifiers
- naming conventions

This inconsistency becomes a major blocker for analytics and decision-making.

Delayed Insights

Without a central data platform:

- Hospital executives rely on outdated reports
- Pharmacy stockout risks are identified too late
- Lab turnaround delays are noticed only after complaints
- Clinical teams cannot monitor trends in vital signs or patient deterioration

Delayed insights = delayed interventions.

Lack of Automation and Real-Time Alerts

Hospitals need:

- real-time vitals monitoring
- early warning indicators for critical patients
- automated alerts for stockouts or laboratory backlogs
- predictive insights for admissions and bed occupancy

But fragmented systems make automation almost impossible.

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Rationale for the Project

Implementing a robust data platform for MediTrack360 is essential to improve hospital efficiency, reduce operational risks, and support clinical decision-making. The project provides several strategic benefits:

Enhanced Operational Efficiency

Automating data ingestion from Postgres, APIs, CSVs, and Kafka reduces manual work and ensures faster availability of patient and operational data.

Improved Data Quality & Consistency

Using a Medallion architecture (Bronze → Silver → Gold) ensures standardized, cleaned, and validated data across all hospital units.

Real-Time Access to Critical Information

With Kafka streaming vitals and automated pipelines, the hospital gains near real-time visibility into patient status, lab delays, and pharmacy stock levels.

Cost Reduction

Eliminating manual reconciliation and reducing errors lowers operational costs, enabling resources to be redirected towards patient care.

Better Decision-Making

High-quality Gold tables in Redshift give management fast, reliable insights into daily operations such as bed occupancy, stock risks, and patient movement.

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Project Objectives

Our project outlines four core objectives crucial for transforming MediTrack360's data infrastructure and capabilities.

01

Automation

Build automated data pipelines orchestrated through Airflow for consistent ingestion and transformation.

02

Data Cleaning & Transformation

Use Spark to clean, standardize, and prepare data across labs, admissions, pharmacy, and vitals.

03

Data Extraction

Pull data from multiple sources:

- Postgres (Admissions & Wards)
- CSV (Labs)
- API (Pharmacy)
- Kafka (Vitals Stream)

04

Warehouse Loading

Load Gold-standard analytical tables into Redshift for reporting, dashboards, and hospital analytics.

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Team Roles & Responsibilities

Data Engineer (DE)

- Build entire data pipeline: Postgres, Kafka, API ingestion, Airflow orchestration, AWS(S3, Redshift, IAM roles), Docker
- S3 Medallion architecture (Bronze/Silver/Gold)
- PySpark transformations
- Data quality with Great Expectations
- CI/CD setup

Data Analyst (DA)

- Define KPIs with PM
- Create SQL models on Silver/Gold
- Build Power BI dashboards
- Provide insights and final analytics report

Data Sources

Patient Admissions (Postgres DB)

patients, admissions, discharges, wards, bed_assignments, triage_levels

Pharmacy API

drug_name, stock_on_hand, reorder_level, expiry_date, supplier_price

Lab Results (CSV drop to S3)

test_name, patient_id, result, sample_time, completed_time

ICU Vital Signs Stream (Kafka)

heart_rate, oxygen_level, BP, timestamp, patient_id

Medallion Architecture

Bronze Layer

Raw Postgres extracts, raw pharmacy API JSON, raw lab CSVs, raw Kafka event microbatches

Silver Layer

Cleaned, standardized Parquet data. Normalized timestamps, joined patient/ward mappings, validated fields

Gold Layer

Fact tables: fact_admissions, fact_lab_turnaround, fact_pharmacy_stock, fact_icu_alerts. **Dimension tables:** dim_patient, dim_ward, dim_date, dim_drug

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Tech Stack

Terraform

Infrastructure-as-code for S3, IAM, Redshift.

Airflow (Docker)

Orchestrates ingestion, validation, and transformations.

Kafka

Streams real-time ICU vitals.

Spark

Performs Silver & Gold transformations at scale.

AWS S3

Data lake for Bronze/Silver/Gold.

AWS Redshift

Analytical warehouse for dashboards & insights.

GitHub

Version control & collaboration.

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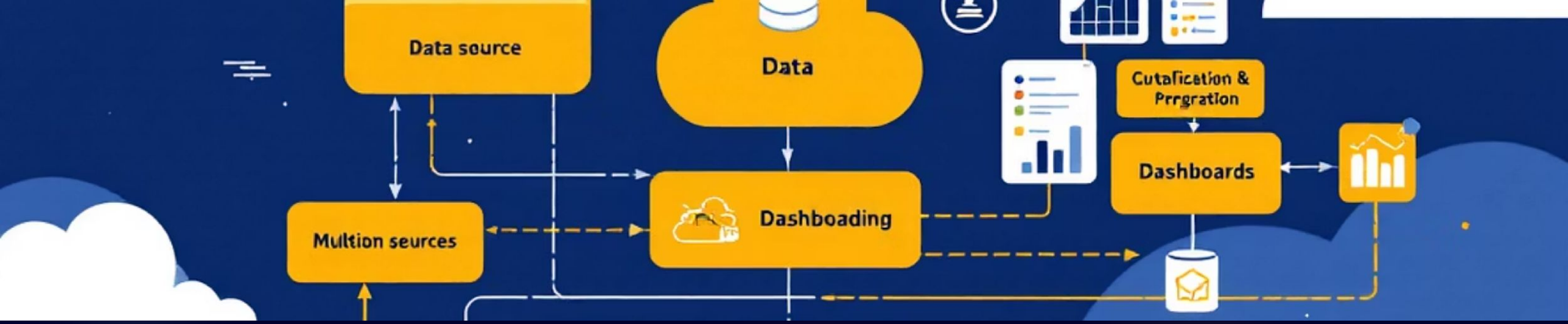

Architecture Overview

Technologies: Terraform, Docker, Postgres, Kafka, Airflow, S3 (Bronze/Silver/Gold), Redshift, Great Expectations, Power BI, GitHub Actions.

Pipeline Flow: Sources → Airflow → S3 Bronze → Spark → S3 Silver → Data Quality → S3 Gold → Redshift → Power BI.

KPIs for Analysts

Bed Occupancy Rate

Average Length of Stay

ICU Early Warning Score

Admission-to-Treatment Time

Lab Test Turnaround Time

Pharmacy Stockout Risk

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Healthcare Redefined.

The MediTrack360 platform fundamentally transforms hospital operations, moving from fragmented systems to a unified, data-driven ecosystem. This project underscores the power of data engineering in delivering actionable intelligence where it matters most.

We've enabled real-time visibility, driving unprecedented operational efficiency and ultimately, superior patient outcomes. This is not just technology; it's a commitment to a healthier future.

Join us in building the future of healthcare data, one insight at a time.