Aerocloud architecture

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1. INTRODUCTION

In today's world of worldwide air travel new tech has a big impact on making airports run and . As more people want quicker, safer, and more connected trips old-school setups can't keep up with the tricky parts of flying these days. Aero-Cloud steps in as a game-changer—it's a cloud system that works as the digital core of global travel. This setup brings together tech, up-to-the-minute info, and how things get done into one package. It backs smart, growing, and flexible airport systems.

At its heart, Aero-Cloud harnesses cloud computing, the Internet of Things (IoT), and Artificial Intelligence (AI) to improve decision-making and enable predictive automated responses to everyday airport issues. Aero-Cloud provides real-time, data-driven insights that boost productivity, from enhancing passenger flow and baggage handling to strengthening security protocols and flight coordination. AI integration allows for predictive maintenance and advanced analytics, while IoT devices ensure constant communication between systems creating a responsive and connected setting.

The shift to a digital cloud setup in airports does more than just cut costs and boost safety - it also makes the whole flying experience better for passengers. As people travel around the world, tools like Aero-Cloud play a key role in creating smart airports ready for the future. These airports aim to keep up with what both airport staff and travelers want and expect.

1.1 MISSION

At Aero Cloud, we have a straightforward goal: to improve air travel for everyone. We think airports should offer more than just a place to board planes—they should provide smart, smooth, and safe spaces where tech works behind the scenes to boost every step of your trip. By using cloud tech live data, and smart automation, we help airports run more . Our aim is to build a smarter system that helps travelers, airport teams, and operations alike, whether it's cutting down wait times upping safety, or making things easier for airport workers. We're not just upgrading infrastructure—we're changing how airports function and what they feel like. At Aero Cloud, we're turning regular travel into something a bit more special.

2. OBJECTIVE

3.

1. **Operational Efficiency:**

   AeroCloud wants to make airports run smoother. We're all about getting stuff done quicker, with more smarts, and without blowing the budget. By using awesome tech and making things automatic, we cut down on waiting times, stop wasting materials, and make sure tasks get done faster.

2. **Customer Experience & Satisfaction (CRM):**

   At AeroCloud, we're all about top-notch service. Our goal: to make travelers feel awesome with super smooth tailored experiences they can count on. Plus, we're into making friends for keeps with our passengers by talking to them just right.

3. **Revenue Growth:**

   We're on the lookout for cool new ways to make more cash and grow our presence in the market. AeroCloud is big on using numbers and smart operations to help airports keep making money and get bigger in a way that lasts.

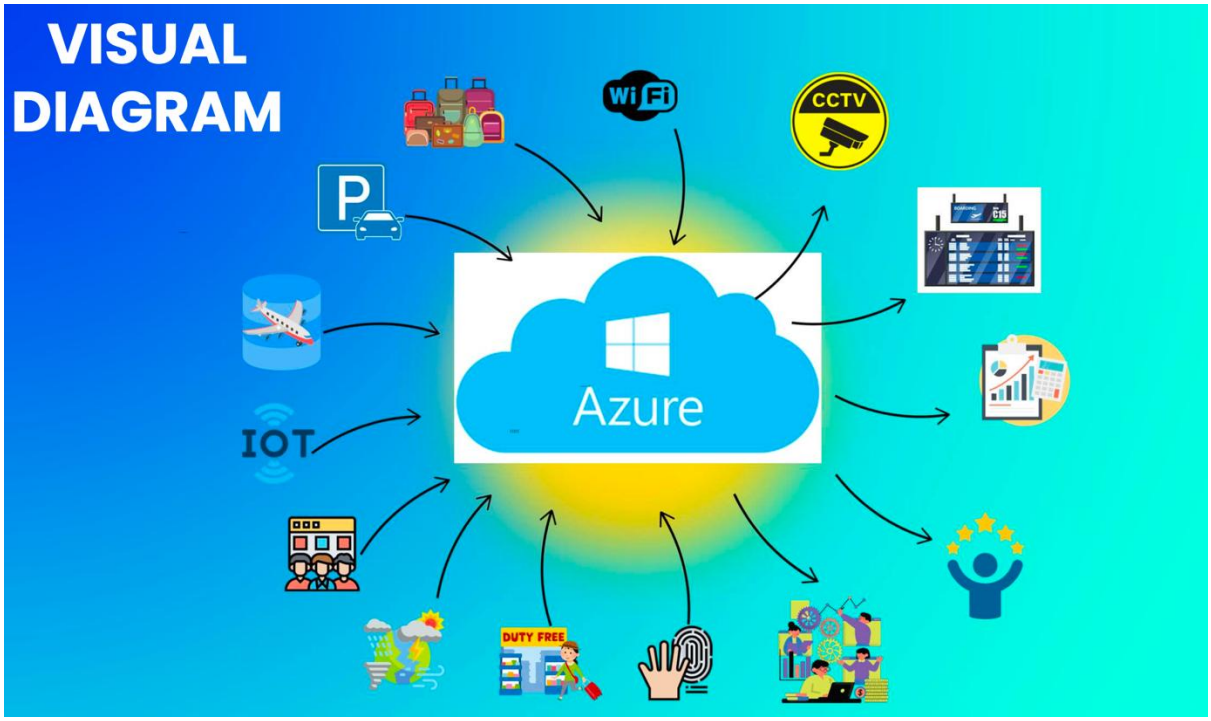
4. **Safety & Security:**

   Making sure that individuals, info, and setups are safe stands as a primary concern. AeroCloud brings in clever surveillance and takes action before threats arise shielding every aspect of airport functioning. This guarantees a protected space for everyone involved.

2.2 PURPOSE

- Make better decisions using real-time data.
- Improve operations like baggage handling, aircraft turnaround, and passenger movement.
- Keep data safe and ensure smooth data flow.
- Increase financial performance and support sustainable growth.
- Enhance security with automation and Artificial Intelligence.

4. VISUAL DAIGRAM

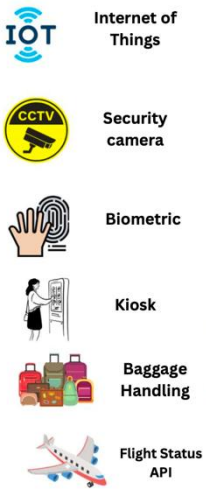


The diagram outlines AeroCloud's integrated architecture built on the Azure cloud platform. It shows how real-time data from IoT sensors is securely collected and processed using Azure services, enabling immediate analytics and decision-making. Key components like Azure Functions and data storage ensure efficient data flow and scalability, while built-in AI tools enhance operational efficiency and security. Azure's automation and monitoring capabilities continuously optimize performance across the system. Overall, the diagram captures a robust, cloud-powered ecosystem that revolutionizes airport operations into a smarter, more connected experience.

5. DATA SOURCE

The AeroCloud system collects crucial info from lots of different sources at the airport. Stuff like security cameras (CCTV), Internet of Things (IoT) gadgets, biometric scanners kiosks, and Wi-Fi logs are all involved. They make it sort of easy to keep an eye on folks and everything that's going on right on the spot. From baggage handling to parking systems, and even flight status APIs, every bit helps make the journey less bumpy and way more slick. Plus, the scoop coming from passenger and visitor data, along with retail stores, and inventory systems, helps a lot with serving the people and keeping the airport biz humming. All that info goes up to the cloud and comes back down as smart choices.

6. STREAMING SOURCES IN AEROCLOUD



- **IoT & Security Cameras:**

  IoT sensors and security cameras stream live surveillance footage and environmental data to the cloud. This allows airport staff to monitor activity in real time, improving safety and operational awareness.

- **Biometric Systems:**

  Biometric scanners capture and verify passenger identities instantly as they move through checkpoints. This ensures secure, fast, and contactless processing at gates, entrances, and boarding areas

- **Self-Service Kiosks:**

  These kiosks send real-time check-in and boarding data as passengers interact with them. They also help track luggage by updating the system with baggage status at each step of the process.

- **Flight Status API:**

  The flight status API provides continuous updates on flight schedules, delays, arrivals, and gate changes. This real-time information keeps both airport personnel and passengers accurately informed.

- **Baggage Handling System:**

  Baggage systems stream live data on the movement and location of passenger luggage. This enables precise tracking and helps prevent delays, loss, or misplacement of bags

7. BATCH SOURCE

- **Parking Data:**

  Parking systems log every entry and exit of vehicles across airport parking zones. This data is stored and later analyzed to understand vehicle flow and improve parking space utilization.

- **Wi-Fi Logs:**

  Wi-Fi connections track passenger movement throughout the terminal based on connected devices. These logs help analyze foot traffic patterns and support smarter facility management.

- **Passenger Data**:

  Information such as travel history, check-in details, and preferences are collected from passengers. This data is used to enhance services and personalize the travel experience.

- **Retail Stores:**

  Shopping behavior and purchase data from duty-free and retail shops are recorded. These insights help optimize product placement, sales strategies, and inventory control.

- **Visitor Data:**

  The system records details of non-travelers like guests, vendors, and service staff entering the airport. This data supports security checks and helps understand overall terminal occupancy.

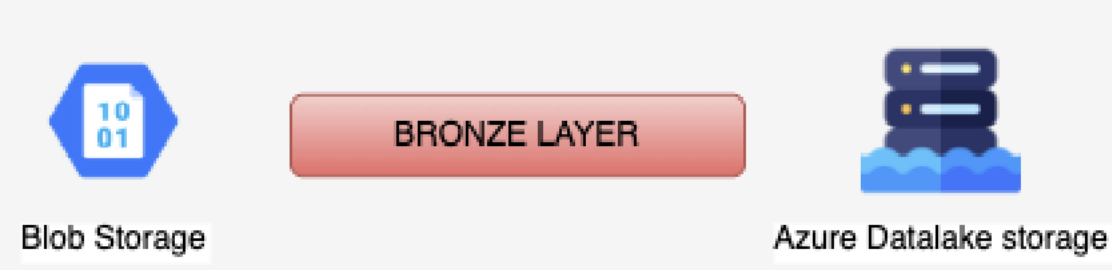
- **Inventory:**

  Inventory systems monitor stock levels for airport vendors in real time. This ensures timely restocking and smooth supply chain operations within airport stores.

7. AEROCLOUD DATA ARCHITECTURE LAYERS

7.1. **Bronze Layer – Raw Data Ingestion**

The Bronze Layer is the starting point where raw, unprocessed data is collected from multiple sources such as IoT devices, biometric systems, baggage handling systems, parking data, and Wi-Fi logs. This data is stored in its original format using Azure Blob Storage and Azure Data Lake, focusing solely on capturing the data without any transformation. Its main purpose is to preserve raw data for traceability and future processing.



7.2. Silver Layer – Data Curation

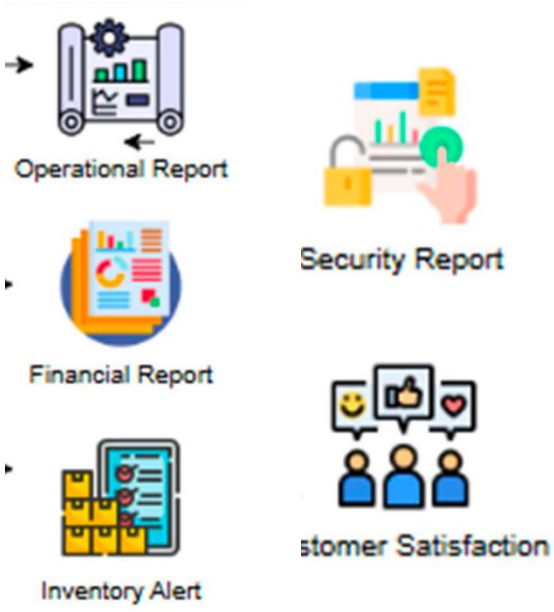
The Silver Layer processes and organizes the data collected in the Bronze Layer. It involves cleansing, filtering, and validating the data by removing duplicates, fixing errors, and eliminating irrelevant records. The curated data is stored in Delta Lake, which supports ACID transactions for reliability. This layer prepares clean and accurate datasets for further analysis and reporting.

7.3. Gold Layer – Data Aggregation

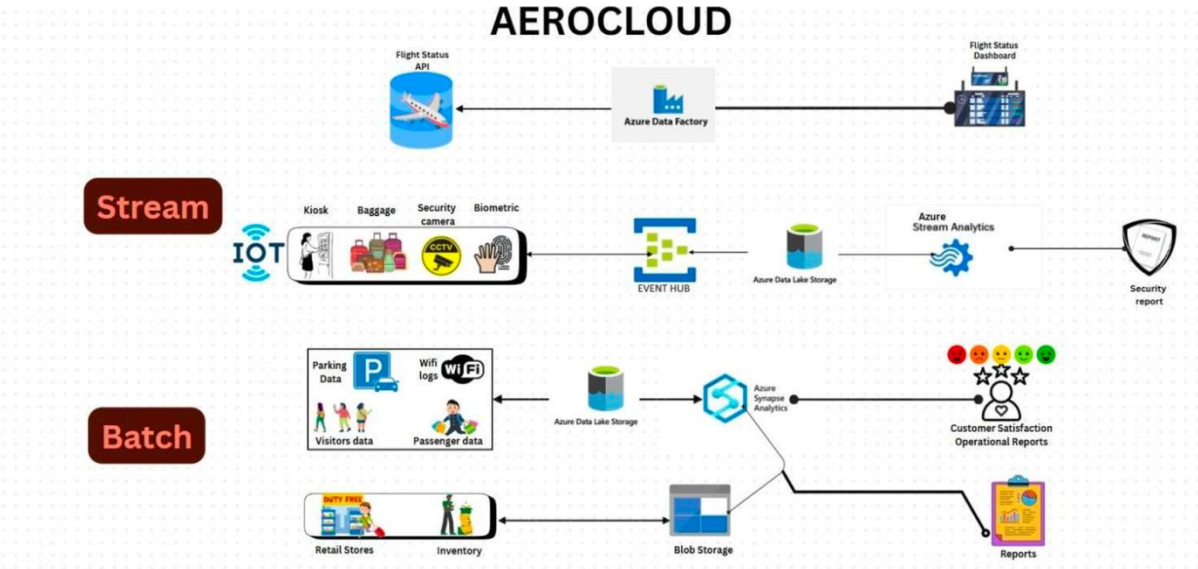
In the Gold Layer, the curated data is aggregated and summarized to create business-ready insights. It brings together data from different domains—such as security, passenger flow, and customer satisfaction—to support high-level reporting and decision-making. Stored in Azure Data Lake, this layer powers dashboards, KPIs, and business intelligence tools, enabling faster and more strategic actions.

7.4. Consumer Layer – Data Consumption

The Consumer Layer is where the final, processed data is delivered to users and applications. It provides outputs like security reports, operational and financial summaries, customer satisfaction analytics, and inventory alerts. Using Azure Synapse Analytics, this layer allows fast querying and access to insights that help drive key business outcomes and operational improvements.



8. INITIAL ARCHITECTURE – AEROCLOUD



The initial architecture of AeroCloud is designed to efficiently handle both streaming and batch data from various airport operations, using Microsoft Azure's cloud ecosystem.

1. Stream Data Flow

Real-time data sources such as Kiosks, Baggage Systems, Security Cameras (CCTV), and Biometric Devices generate continuous streams of data through IoT. These data streams are ingested into Azure Event Hub, which acts as a real-time data pipeline. From here, data is stored in Azure Data Lake Storage for further processing and archival. For immediate analysis, the data is processed through Azure Stream Analytics, enabling quick insights and alerts—such as real-time security updates or passenger movement patterns.

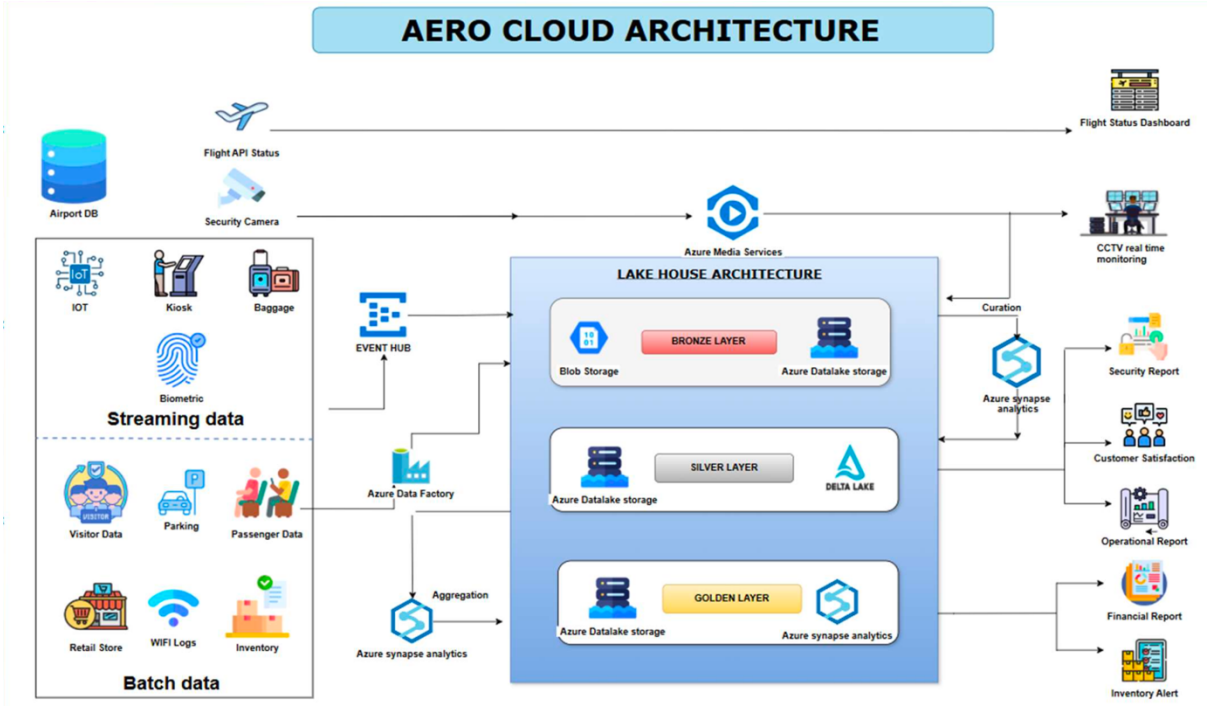
A separate Flight Status API integrates flight information like arrivals, delays, and gate changes. This data is funneled through Azure Data Factory and displayed on Flight Dashboards for staff and travelers, ensuring everyone is updated in real-time.

2. Batch Data Flow

Batch data sources include Parking Systems, Wi-Fi Logs, Passenger and Visitor Data, as well as Retail Store Sales and Inventory. These systems upload data at regular intervals into Azure Data Lake Storage and Azure Blob Storage. Azure Synapse Analytics is then used to run complex queries, analyze trends, and generate insights.

This curated and analyzed data powers the Customer Satisfaction and Operational Reports. These reports cover key areas like service quality, passenger behavior, stock management, and operational performance—helping airport teams make informed decisions.

9. FINAL ARCHITECTURE – AERO CLOUD



The final Aero Cloud Architecture adopts a robust **Lakehouse model** that unifies streaming and batch data processing using Azure services for enhanced real-time analytics and business insights.

1. Data Ingestion (Streaming & Batch)

- Streaming Data is captured in real-time from sources like IoT sensors, kiosks, baggage handling systems, biometric scans, and security cameras. These are funneled into Azure Event Hub, enabling live data transmission.
- Batch Data comes from periodic sources like visitor records, parking systems, passenger information, retail transactions, Wi-Fi logs, and inventory. This data is processed through Azure Data Factory for integration.

2. Lakehouse Architecture

The ingested data flows into a centralized **Lakehouse Architecture** composed of three structured layers:

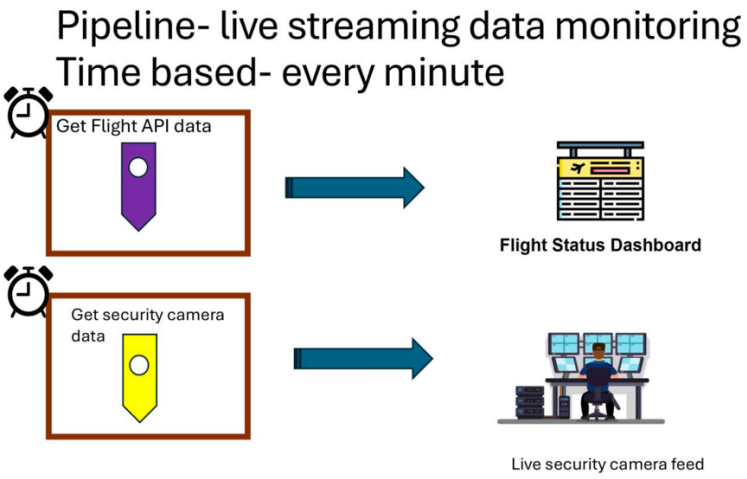
- **Bronze Layer:** Stores raw data as-is from all sources in Blob Storage and Azure Data Lake Storage, preserving original records for traceability.
- **Silver Layer**: Applies data cleaning, deduplication, and validation. The refined data is stored in Delta Lake, making it ready for analytics and reporting.
- **Gold Layer**: Aggregates and summarizes curated data across domains (e.g., security, passenger flow, finance). This layer is optimized for business use and powered by Azure Synapse Analytics.

3. Analytics & Insights

Using Azure Synapse Analytics, curated data from the Silver and Gold layers is used to generate powerful insights. These include:

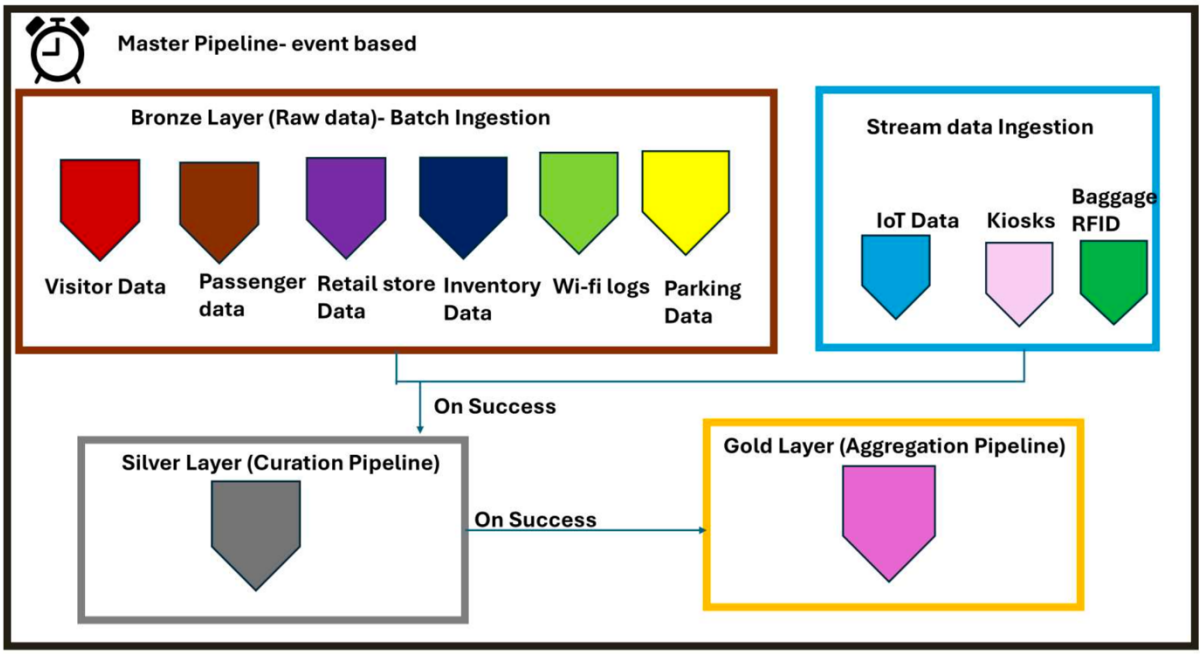
- Security Reports from CCTV and biometric data.
- Customer Satisfaction dashboards using behavioral data.
- Operational and Financial Reports for management and planning.
- Inventory Alerts to support vendor operations and stock control.
- Flight Status Dashboards are also updated in real-time from Flight APIs and Airport Databases.

10.PIPELINE – TIME BASED APPROACH



This approach uses a time-based data pipeline that runs every minute to monitor live data streams. It fetches real-time Flight API data and displays it on the Flight Status Dashboard, helping staff and passengers stay updated with flight schedules. At the same time, it continuously collects security camera footage, which is directed to the live surveillance monitoring system for security personnel. This ensures up-to-the-minute updates and live monitoring across critical airport operations.

11.PIPELINE – EVENT BASED APPROACH



This architecture uses an event-based pipeline that triggers data processing when specific activities occur. It begins with the Bronze Layer, where raw data like visitor, passenger, retail, inventory, Wi-Fi logs, and parking data are ingested in batches. Once the data is successfully loaded, the pipeline moves it to the Silver Layer for cleaning and curation. Simultaneously, stream data like IoT and kiosk inputs are processed in real time. Finally, curated data flows into the Gold Layer, where it is aggregated for business use such as reporting, analysis, and decision-making.

12.PIPELINE FAIL STRATEGY IN AZURE

- Pipelines may fail due to unforeseen circumstances (server unresponsive, network issues, API problems, IoT device malfunction)

- Implement retry mechanism with number of retries and delay between attempts
- Azure Data Factory uses 3 retries with 30-second delays by default for batch ingestion
- Change default retry value from 0 in Azure Synapse Analytics
- Monitor pipeline runs and trigger runs in Azure Synapse Analytics
- Use diagnostic settings in Azure Synapse Analytics to capture pipeline logs
- Send log files to Log Analytics, Event Hub, or Storage container
- Set up Azure Monitor alerts when pipelines fail
- Configure action groups for email and text message alerts
- Use Azure Logic Apps to automate recovery or restart pipeline runs.

13.CONLCUSION

Aero Cloud is a smart data platform that combines both real-time and batch data. It collects data from sources like flight APIs, CCTV, IoT devices, and retail systems. The data is organized using a Lakehouse model into raw, processed, and final stages. Time-based and event-based pipelines ensure timely updates and accurate insights. Overall, Aero Cloud improves airport operations, safety, and customer satisfaction**.**