UDC 656

I.A. Steniakin, D.O. Shevchuk
(National Aviation University, Ukraine)

Data Flow Control and Predictive Maintenance in Aviation Enterprise

This research explores the use of Salesforce Data Cloud as a strategic tool to manage data flow and provide predictive services in the aviation industry. By integrating custom machine learning models with Data Cloud BYOM (Bring Your Own Model) capabilities, the research aims to address critical issues in aviation data management.

In the highly complex and data-rich aviation environment, managing the flow of information is critical to operational efficiency, security and compliance. As the aviation industry continues to generate massive amounts of real-time data from a variety of sources—aircraft sensors, flight logs, maintenance records, and customer interactions—effectively managing this flow of data has become a challenge and an opportunity for innovation. One area where this data can be used is predictive maintenance, which allows airlines to predict equipment failures before they occur, thus minimizing downtime and optimizing maintenance schedules.

Salesforce Data Cloud, with its advanced data management capabilities and Bring Your Own Model (BYOM) functionality, offers a unique solution to this problem. It allows companies to integrate custom machine learning models to process and analyse data streams in real-time, providing actionable insights. By enabling predictive maintenance through data analytics, Salesforce Data Cloud can help airlines reduce unscheduled maintenance, improve safety protocols and optimize overall operations.

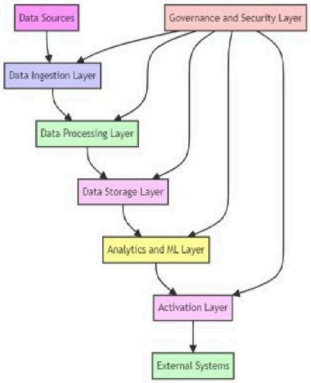

Fig. 1. Salesforce data cloud architecture [1]

This study focuses on exploring the role of Salesforce Data Cloud in controlling the flow of aviation data and implementing predictive maintenance strategies. The study explores how integrating custom ML models into the data cloud can offer an advantage in early detection of potential equipment failures, ensuring

uptime and optimizing resource allocation. As a result, airlines can turn data into a strategic asset that enables better decision-making and operational stability.

Although Data Cloud has its own LLMs (Large Language Models) with Salesforce support, it also allows you to integrate your own models from various sources. These are Amazon SageMaker, Google Cloud Vertex AI, or Databricks models.

This flexibility allows airlines to use specialized models developed or hosted on these platforms while leveraging the robust data infrastructure of Salesforce Data Cloud for seamless data flow and analysis.

As shown in Figure 2, the integration process includes structured inputs such as aircraft sensor data, maintenance logs, and operational statistics that are sent to a remote service for processing. These external platforms, such as SageMaker or Vertex AI, use this data to train machine learning models.

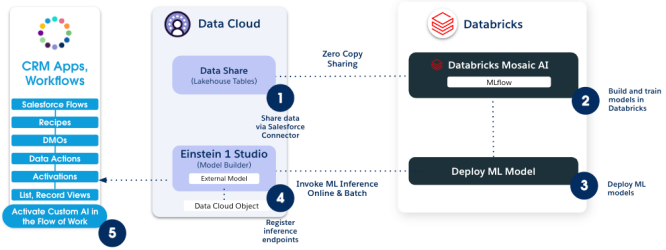

Fig. 2. Typical scheme of embedding custom ML model into Data Cloud flow

Once trained, models can be deployed and activated for real-time use in the Salesforce Data Cloud. The results generated by the model—whether predictive maintenance insights or operational forecasts—are then sent back to Salesforce, where they can be used to make decisions, report, or trigger automated workflows.

This architecture allows Salesforce Data Cloud to act as a central hub for data processing and analysis [2], while leveraging the power and expertise of external machine learning platforms. By integrating BYOM capabilities, airlines can use advanced predictive maintenance algorithms or adapt models specific to their operating environment, providing a high level of customization and optimization. This flexibility is especially important in the aviation industry, where real-time data analysis is critical to improving efficiency, reducing operational risk and preventing costly failures.

The process of integrating Salesforce Data Cloud with dedicated machine learning models into airline operations involves several key steps to ensure seamless integration of data flow management and predictive maintenance into the enterprise ecosystem. This integration provides a powerful framework for optimizing decision-making, streamlining processes and reducing maintenance costs while improving safety and operational efficiency [3].

The first step in the integration process is to identify and map the various data sources within the airline. These sources include aircraft sensors, engine performance data, historical maintenance records, flight logs, weather information,

and even external inputs such as air traffic control updates. Structured data coming from these sources must be organized and prepared for use in the Salesforce Data Cloud. An airline should evaluate its data needs with a focus on predictive maintenance goals, such as identifying components prone to failure, optimizing maintenance schedules, and reducing unplanned downtime.

Next, the airline must set up Salesforce Data Cloud to handle large volumes of data coming from various sources (Fig. 3). This involves creating data flows and pipelines that can process data in real-time, providing efficient inflow and structured storage. Salesforce's native capabilities provide advanced data visualization and harmonization, allowing data from disparate sources to be combined and used in a consistent manner.

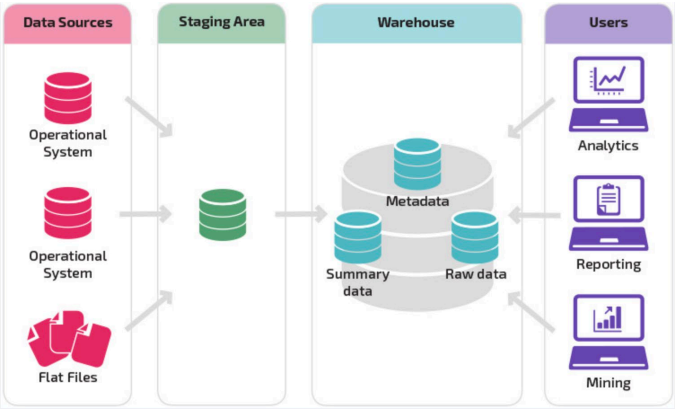

Fig. 3. Airline's data warehouse flow

In this step, the airline will configure data models and define workflows that meet predictive maintenance goals, such as triggering alerts when sensor data indicates a potential problem or scheduling maintenance based on the expected life of components.

With data flowing seamlessly into the Salesforce data cloud, the airline can continue to integrate its own machine learning models from platforms such as Amazon SageMaker, Google Cloud Vertex AI or Databricks. This is facilitated by Data Cloud BYOM capabilities.

For predictive maintenance, special models trained on specific data or aircraft components are integrated. These models use historical data to predict future failures based on patterns found in past maintenance records, sensor data, and operating conditions. Integration involves:

- Send structured input data (such as engine temperature fluctuations or vibration levels) from Salesforce Data Cloud to an external platform of your choice.
- Running data through a custom model to extract information, such as determining when a component is likely to fail.

• Bringing these forecasts back to the Salesforce data cloud, where they can trigger alerts or actions, such as automated work orders for maintenance crews.

Machine learning models require continuous training to improve accuracy and reliability. Real-time operational data, such as new sensor readings and maintenance results, are continuously fed into the system. As the airline collects more data, the models become better at predicting maintenance needs, thus improving operational efficiency.

Training can be done on external platforms such as SageMaker or Vertex AI, and any improvements or updates to the models are fully integrated back into the Salesforce data cloud. This continuous feedback loop ensures that the airline's predictive maintenance strategies remain current and relevant.

After the machine learning models are integrated, they are deployed in all divisions of the airline. Salesforce Data Cloud ensures that model-generated predictions and recommendations are available in real-time to all relevant groups, such as maintenance crews, operations managers, and security professionals.

The system can be monitored using Salesforce dashboards and reporting tools, where key performance indicators (KPIs) such as component failure rates, maintenance efficiency and aircraft downtime can be monitored. Alerts and notifications can be triggered automatically when a potential problem is detected, allowing for preventative maintenance and reducing the risk of costly unscheduled repairs.

Once a predictive maintenance system is in place, the airline can continuously evaluate its performance. Metrics such as forecast accuracy, reduced downtime, cost savings through proactive maintenance and improved aircraft availability can be measured and analyzed. Based on these assessments, the system can be adjusted and extended to other areas of the airline's operations, such as optimizing fuel efficiency, route planning and improving the customer experience.

Integrating Salesforce Data Cloud with dedicated machine learning models provides a robust framework for improving data flow control and implementing predictive maintenance in the aviation industry. This process allows aviation businesses to harness the power of data analytics, resulting in increased operational efficiency, lower costs and improved aircraft reliability. By leveraging the flexibility of Salesforce Data Cloud's BYOM capabilities, airlines can tailor solutions to their specific needs, providing a forward-looking approach to maintenance and operational excellence.

References

1. Guduru, Venkat Sumanth. (2023). Enhancing Customer Experience with Personalized Data Strategies in Salesforce Data Cloud. Journal of Mathematical & Computer Applications. 1-5. 10.47363/JMCA/2023(2)E112.

2. What Is Data Cloud?, April 2024 https://www.salesforce. com/blog/what - is - data - cloud/

3. Learn How Data Cloud Works, 2023 https: //trailhead.salesforce. com/content/learn/modules/data - cloud -powered - experiences/learn - how - data - cloud - works