

# Supply Chain AI for Resilient Civil Aviation

Supply Chain AI supports Civil Aviation recovery through Digital Transformation. The AI is used by the Air Force, where estimated benefits are in the hundreds of millions of dollars.

## Supply Chain Transformation

Mitek's Supply Chain AI applications help create Digital Transformation opportunities out of crisis recovery. The AI uses existing data in an integrated way to deliver dynamic prediction of supply chain effectiveness through explainable engineering models of reliability and logistics. The analytics allows addressing rapid changes in load, aircraft fleet composition, and supply chain, including MROs. Using the AI for Digital Transformation allows the creation of a resilient, less complex, supply chain.

Traditionally, Civil Aviation operators would effectively maintain 99.6% Dispatch Availability. This was achieved through allocation of spare parts that often remained static for years. The approach mostly worked, even though excess spares were sometimes used to cover lingering problems of fractioned supply chains with multiple MROs and inefficient lateral supply of the parts. Aircraft on the Ground (AOG) events were mostly addressed by maintaining multiple replacement aircraft on stand-by.

With the crisis, Civil Aviation is living through big up and down swings in loads, changing aircraft type mixture (including many airframe retirements), and replacing the usual supply chain by cannibalizing parts. The dynamics differ between airlines, who experienced a sharp drop in operational load, and cargo or special operators, who experienced load increase.

## AI for Reliability and Supply Chain Effectiveness

Mitek's Supply Chain AI applications were originally developed for and have been operationally proven in US Air Force projects. Large dynamics changes in demand are inherent for military aviation and addressed by the AI. This makes the predictive and prescriptive AI analytics for Supply Chain effectiveness developed for the USAF ideally suited to address crisis recovery in Civil Aviation. Developed for a fully integrated military supply chain, the AI can accommodate multiple sources of existing data. It can be scaled up without a need to hire extra analysts.

## Data Required

The AI uses existing maintenance, usage, and logistics data that are already collected by aircraft operators and MROs as well as in military aviation. Real data often have errors and inconsistencies. The AI apps include proven data cleansing and reconciliation logic; the apps monitor and report data quality.

The Supply Chain maintenance and logistics processes data used are collected after an aircraft operation problem is indicated by a pilot, fault code, and maintenance initiated. Mitek's Supply Chain AI does not require changing existing processes. Yet, if required, it could be used in conjunction with condition-based maintenance (CBM) algorithms driving part removals.

## Supply-Demand Balance

The Reverse Logistics Digital Twin (RLDT) AI app predicts and optimizes Supply-Demand Balance in supply chain processes.

RLDT is centered around an Explainable AI model for predicting supply chain process performance. RLDT AI functions include:

- Repair demand prediction based on fleet usage that also accounts for seasonality
- Process performance predictions including logistics delays, repairs time in Maintenance Repairs & Overhaul (MRO) operations, part stocks, and part flows driven by the demand
- Prediction for part availability risk using analysis approaches from finance industry
- Quantifying alternatives for reducing cost while controlling risk: reliability vs logistics delay vs MRO performance vs spare parts

## Reliability and Maintenance Demand

Reliability Digital Twin (RDT) AI provides and optimizes Reliability Centered Maintenance demand for an asset or a repairable part. RDT uses Explainable AI model for reliability as a foundation for Reliability-Centered Maintenance (RCM) analysis. RDT AI functions include:

- Failure Mode Analysis including analysis of troubleshooting performance and maintenance trends
- Statistical Process Control for Bad Actor parts and aircraft
- Subpopulation analysis detecting reliability change for selected group of parts
- Early detection of recent change in fleet reliability
- Reliability centered prediction of various demand components related to line maintenance, MRO, No Fault Found, and bad actors

### AI for Maintenance Demand and Logistics Supply Processes in Supply Chain

## Use Cases

The RDT and RLDT AI apps have been developed over the last 7 years for the USAF supply chain. They have been operationally used by the 416th Supply Chain Management Squadron (SCMS) at Hill AFB over the last two years for monitoring, prediction, and optimization of military aviation sustainment processes.

RDT and RLDT AI functions are applied to sustainment of NWC missile fleets in an on-going USAF project managed from Edwards AFB.

A use case for the AI in the DoD new weapons acquisition process, to predict the performance of future supply chains, is currently being studied. In that case, the data comes from supply chain simulations based on tentatively allocated reliability and supply chain requirements.

## A-10 CICU Success Story

As one example, RDT led to availability improvement for the A-10 Central Interface Control Unit (CICU), the part that was causing almost half of aircraft unavailable events. RDT AI reported high infant mortality, which indicates defects in Depot repairs. The issue was traced to CICUs performing Ok with test software loaded in Depot and failing after operational software was loaded at the Base. This caused a lot of wasteful shipping and supply chain delays. A successful process fix was to load the operational software in Depot and retest there.

## AI Software

At the heart of each AI app is an Analytics Engine (AE) that is powered by proprietary custom-developed convex optimization algorithms for Machine Learning. Each AE is thoroughly verified using simulated data and validated over years of customer deployment.

The AI is available as a cloud-based service that receives customer database query results for a particular asset via REST interface. The analysis results are accessible through dashboards with drill-down capability. The results can be also downloaded as a formatted PDF report where each Section narrates results for one dashboard (one AI function).

Virtual Machines with AI apps could be deployed as on-premise microservices, if necessary.

For pilot projects, and where AI software integration is restricted by IT issues, the RDT and RLDT AI reports can be provided as a service. In that case, a customer provides CSV files with data query results and receives the reports as the deliverable.

The AI Analytics Engines are used as desktop tools for custom analytical studies, data set troubleshooting, and customer support.