

Air Force Sustainment Center (AFSC)

416th SUPPLY CHAIN MANAGEMENT SQUADRON

AI for Air Force Supply Chain



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Global Logistics – Warfighter Focus



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AI for Air Force Supply Chain

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Bottom Line



416th Aircraft, Supply Chain Management Squadron

- **DoD (Air Force) is Big Business**
 - AF Supply Chain manages >100k item types valued >\$50B
- **AI for Air Force Supply Chain operation**
 - Explainable, automated, AI apps empower data analysts
- **Developed in 416 SCMS Data Analytics Project**
 - A series of contracts over last 7 years
- **In Operational use at 416 SCMS for last 3+ years**
 - Provides substantial benefits

Parts on the Shelf and Contracts in Place



AF is Big Business



416th Aircraft, Supply Chain Management Squadron

- **FY21 DoD Funds Appropriated by Congress \$715B**
 - **AF Budget FY21 \$207B (29% of DoD)**
 - **Research, Development, Test & Evaluation (RDT&E)**
 - \$47B (23%)
 - Development of a Capable Design
 - **Procurement**
 - \$50B (24%)
 - Production of Hardware/Software
 - **Operations & Maintenance (O&M)**
 - \$65B (31%)
 - Operations and Sustainment Through Life of System
 - **Other Funds**

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AF is Big Business



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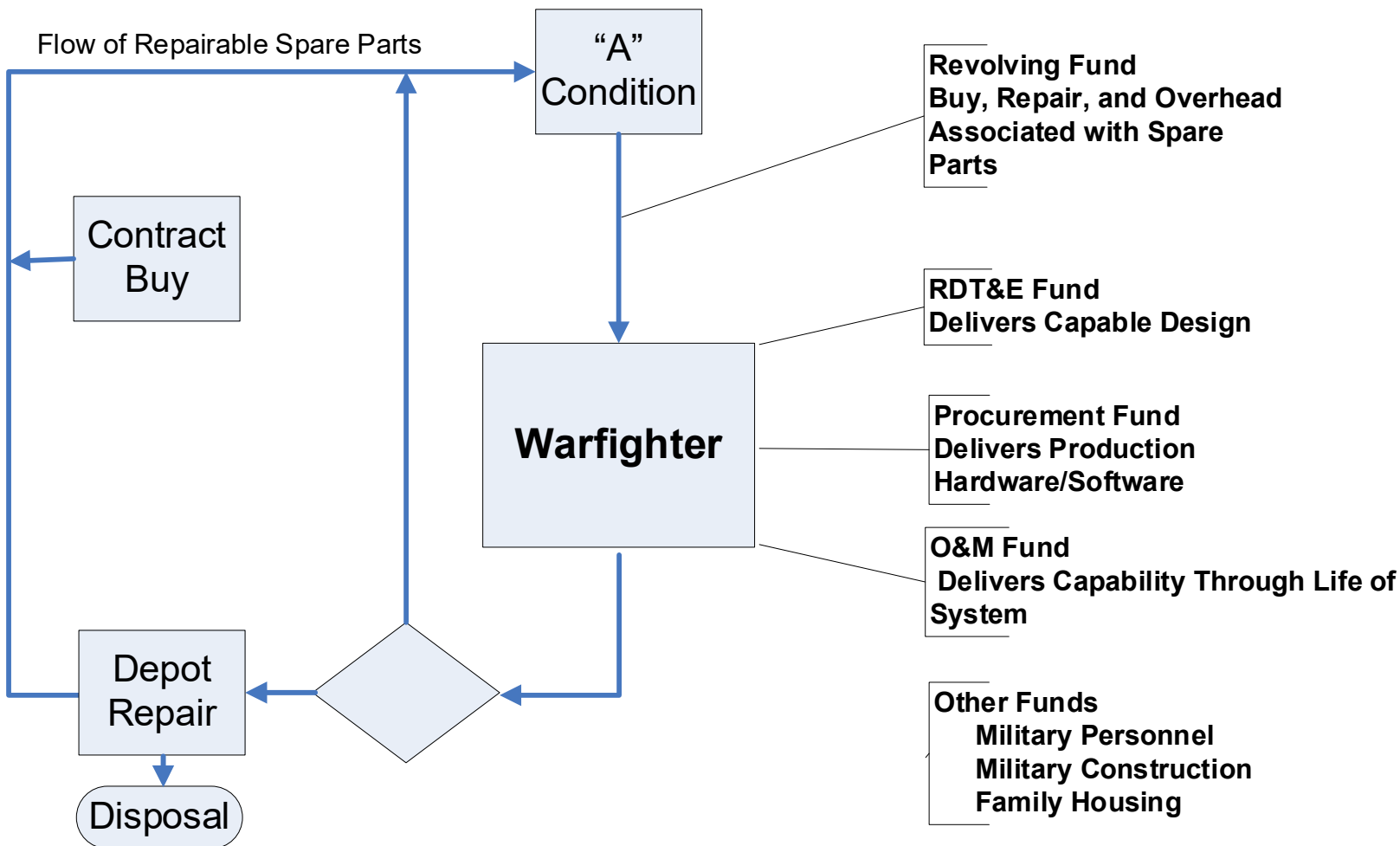
- **Revolving Fund**
 - **DoD Initiative to Operate Supply Chain Business**
 - **A non-appropriated account, ~\$8B, funded by sales of parts to O&M**
 - **Receives injection from appropriations based on projected parts requirements (\$96M in FY21)**
 - **416 SCMS ~\$670M**



Air Force is Big Business



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Air Force is Big Business



416th Aircraft, Supply Chain M

- 416 SCMS – Aircraft SCM
- Management of items to include:
 - Aircraft Structures, Avionics, and Electronics
 - A-10, F-16, T-38, T-7A
- Buy/Repair Execution Approx \$674M+
- NSNs Managed - ~7,500 Items/\$6.2B
 - Buy, Repair, Distribution, Disposal



Supplying Warfighter Dominance



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AI for Air Force Supply Chain Operation

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Analysis Need



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- **Need Supply Chain Performance Analysis**
 - Availability and Supply Chain Effectiveness Metrics
 - Limited Study, One Aircraft Type Showed \$270M Impact

- **In the Past Done by Analysts**
 - Labor intensive and not scalable when done by analysts
 - Supply chain data for item usage and failures has quality issues
 - Multiple failure maintenance records per part removal
 - Parts installed on two aircraft at the same time

Parts on the Shelf and Contracts in Place



Analysis Need



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- **Legacy Analysis/Metrics Lag Science and Opportunity**
 - Standard AF Reliability Metric is MTBF
 - Mean Time Between Failure
 - AF MTBF is (Fleet Usage)/Failures
 - Wrong Measure Applied/Calculated Incorrectly
 - Cumulative Event Analysis is Appropriate Reliability Analysis
 - Requires Item Lifecycle History (Reliability Digital Twin)
 - Data Set of Sequential Usage and Events (Failures)
 - Supply Chain Management Must Anticipate Part Demands
 - Demand 'Pulls' Logistics System, Reverse Logistics
 - Models Require Item Logistics History
 - Reverse Logistics Digital Twin

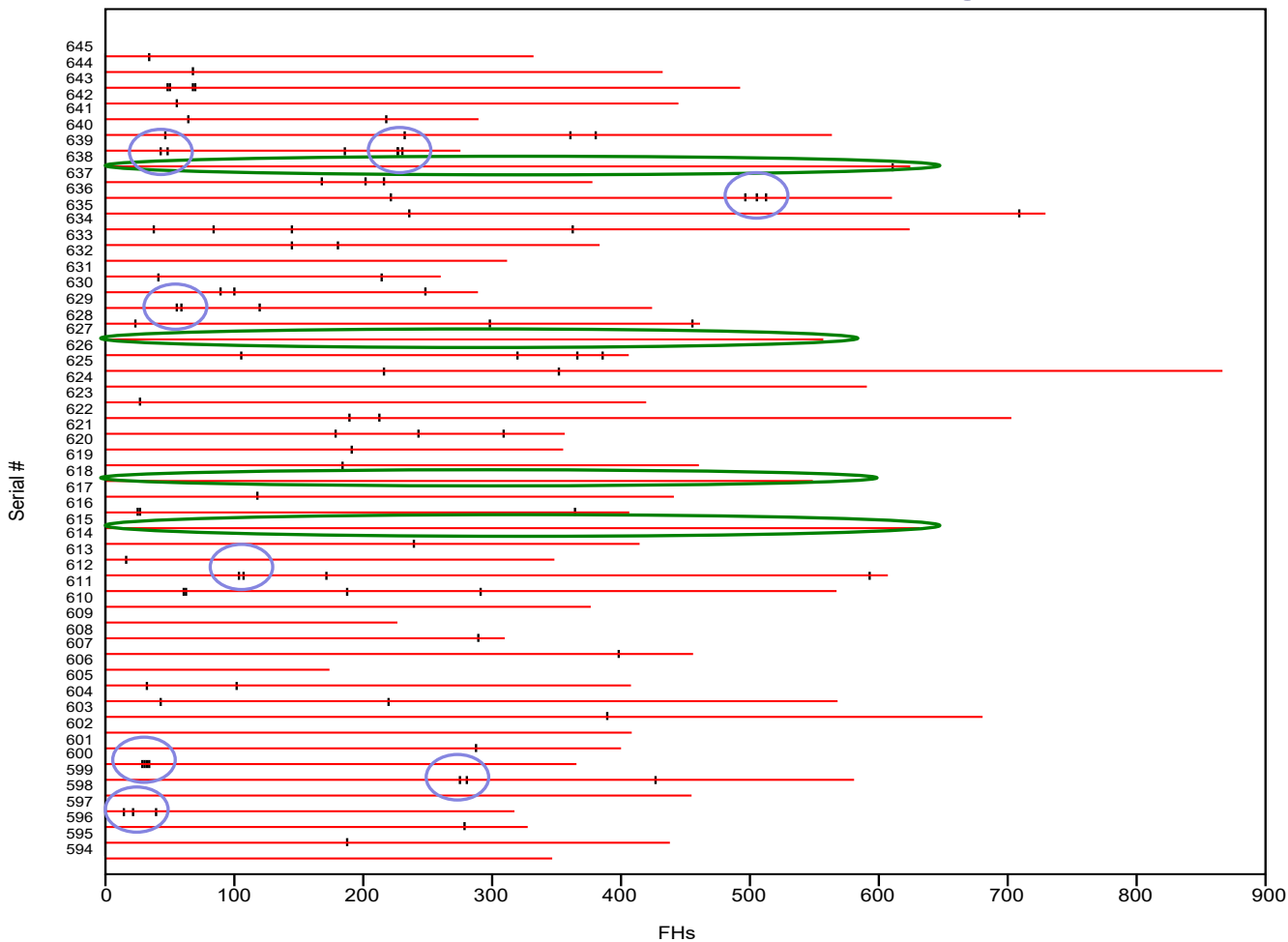


Item Lifecycle Event History



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Cumulative Event Analysis





AF AI Apps



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- **Centralized Development**
- **Apps Dev Typically Managed by R&D Organization**
 - Air Force Research Lab (AFRL), IT Program Offices, ...
 - Not Likely to have Specific Expertise in Application
 - Developed via Contract
 - Difficult to Directly Engage the User
 - Users are Likely to Resist Process Change from 'Above'
 - CBM+ is an Example



AF AI Apps



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- **Condition Based Maintenance Plus (CBM+)**
 - Participation Mandated
 - Drive Unscheduled MX to Scheduled, Predictive Maintenance
 - Predict Failures, Schedule Part Replacement Before Fail
 - Assumes Defined Reliability and Maintenance Analysis
 - Not a Generally Valid Assumption
 - Reliability Centered Maintenance (RCM)
 - Condition Based Maintenance (CBM)
 - RCM and CBM Analysis Selects CBM+ Candidates
 - CBM+ Tool Provided by Contractor
 - Not Explainable to End User
 - End User Participation is List of Parts to Contractor



AF AI Apps



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- **Decentralized Development**
- **End User Needs AI Capability**
 - Fully automated and scalable analysis
 - Existing best practices and new functions
- **AI App Development Managed by the User**
 - User Requirements and Continuous User Feedback
 - User Contracted Directly to Experts
 - Results Used Operationally Throughout Development



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Developed in 416 SCMS Data Analytics Project

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AI Apps Scope

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- **AI for RCM and Supply Chain Effectiveness**
 - Supports CBM+ requirements
 - Based on existing maintenance and logistics process data



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AI Apps Features



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- **Supply Chain Effectiveness**
 - Prediction of demand, and trends of repair performance
- **Logistics Performance Effectiveness**
 - Predictive trends of actual sparing vs computed
 - Changes required to address part unavailability
- **Subpopulation Analysis**
 - Special repairs effectiveness, modified parts
- **Maintenance Effectiveness**
 - Depot repairs: infant mortality and Bad Actors
 - Line maintenance: No Fault Found and effort per failure

Parts on the Shelf and Contracts in Place

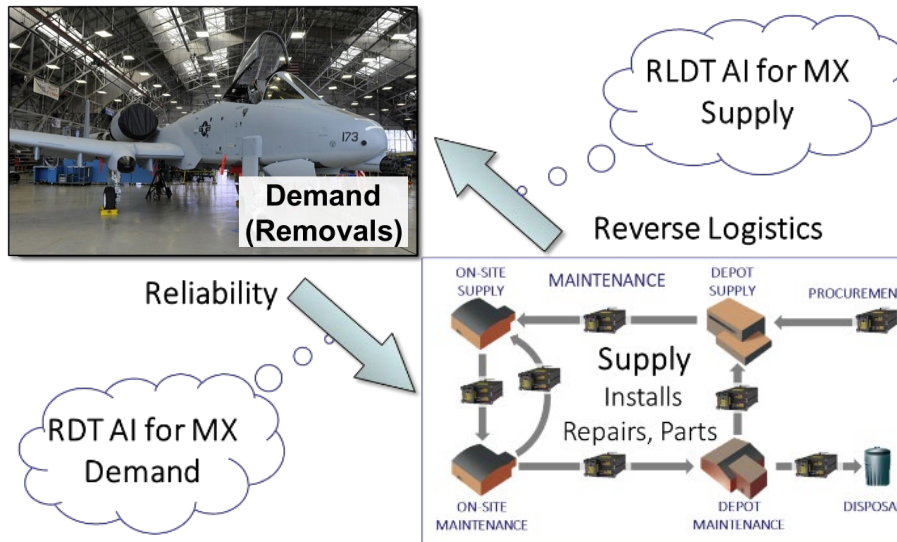


AI Apps



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- **RDT AI – Reliability Digital Twin**
 - Line maintenance, Reliability, RCM
- **RLDT AI – Reverse Logistics Digital Twin**
 - Logistics, Depot Repairs, CBM+



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AI Apps



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- **AI App Functions/Attributes (Applicable to all AI)**
 - Resolve Data Issues, Reconciliation and Cleansing
 - Explainable AI – Models Understood by Engineers
 - Machine Learning of Models
 - Verified on Simulated Data Sets
 - Validated Against Data from Other Systems
 - User Interface Tailorable to Roles
 - Engineer, MX Technician, Executive Summary
 - Models Extend to Performance Prediction
 - Usage Prediction from Model or AF Plan



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In Operational use at 416 SCMS for last 3+ years

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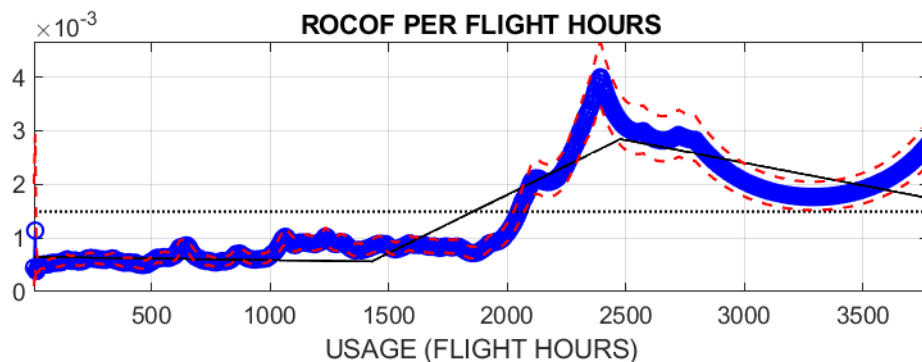


Reliability Model from AI



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- **From Reliability Digital Twin AI**
 - Automates Analysis
 - Not 'Standard' Reliability Functions
 - Rate of Occurrence of Failure (ROCOF)
 - Describes Reliability as Expected Failures per FH
 - Unexpectedly Shows High Failure Rate at 0 FH





Success Story: A-10 CICU



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- **A-10 CICU**
 - Central Interface Control Unit
 - Caused almost half of A-10 MICAPs
- **AI found high infant mortality**
 - Indicates defects in Depot repairs
- **The issue was traced to Depot repairs process**
 - Test software loaded in Depot runs Ok
 - Operational software fails to load at the Base
- **Successful process fix**
 - Load the operational software in Depot and retest there
 - Reduced wasteful shipping and supply chain delays





Reliability Model from AI



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- **Subpopulation Analysis**
 - Compare Subpopulation to General Population
 - Modified Parts
 - Exceptional Repair Processes



Reliability Model from AI



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- **Example Subpopulation Analysis**
- **Programmable Signal Processor (PSP)**
 - **Complex Avionics Computer**
 - >30 Circuit Card, >6k Internal Conductor Connections
 - **Suffered High Re-Test Okay Rate**
 - **Intermittent Fault Detection System Test Applied**
 - Tester Cost >\$6M, Test Added 3 Days to Repair
 - Tester Vendor Claimed >100% MTBF Increase
 - **RDT AI Subpopulation Analysis**
 - No Improvement In Tested Population
 - Stopped Testing
 - Don't Buy More Testers



AI Deployment

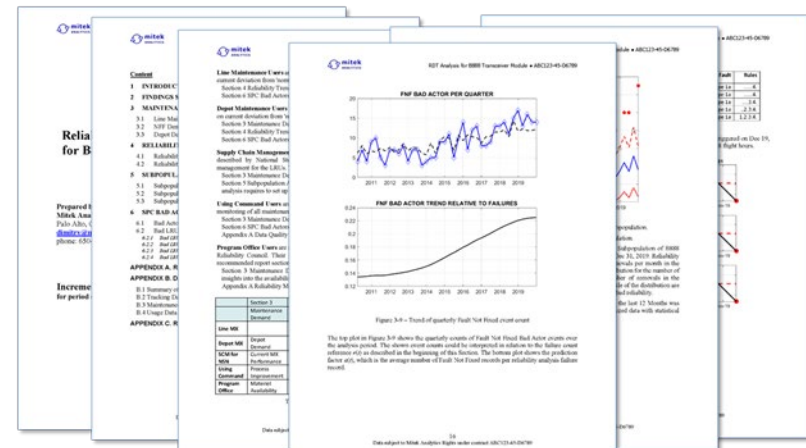
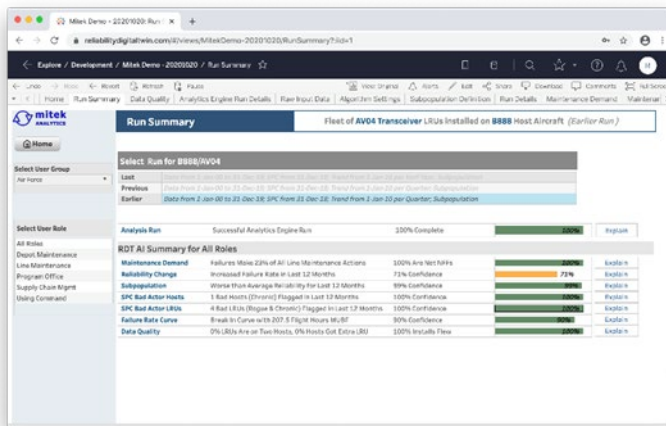
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Cloud Software Tool

- Cloud SaaS apps
 - Prototyped as demo
- Containerized services
- Working through AF IT

Report Generation

- Off-line processing of database query results
- Monthly reports
 - Automatically generated





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Parts on the Shelf and Contracts in Place