SIKORSKY'S HEALTH MANAGEMENT JOURNEY: PAST, PRESENT AND FUTURE

James P. Cycon

Manager, Health Management Systems
Sikorsky Aircraft Corporation

SAC HEALTH MANAGEMENT EVOLUTION

S-6™

S-76C++™

S-92A®

CH-148

S-76D™

CH-53E

UH-60A,L,M

SAFETY

MAINTENANCE & TROUBLE SHOOTING

MH-60S/R

CONDITION BASED MAINTENANCE

SAC HEALTH MANAGEMENT VISION

Eliminate Unscheduled Maintenance

Optimize Scheduled Maintenance

Focus Troubleshooting & Reduce False Removals

Maximize Detection Time Before Failure

Enhance Safety

S-92® HEALTH MANAGEMENT SYSTEM

Customer

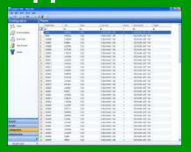
Sikorsky

S-92® Operators

HUMS Collected Data

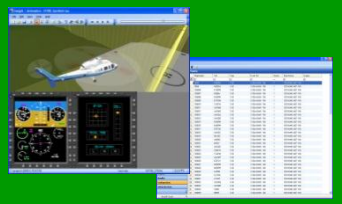
MFD

Ground Based Application



"Check HUMS"

Helicopter Flight Data Mgt.



HUMS/Maintenance Data & Field Events

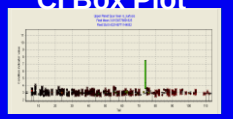
Data Transfer Multiple time a day

Proactive Support

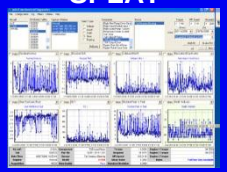
Web Portal

KDT

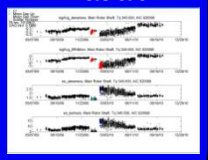
CI Box Plot



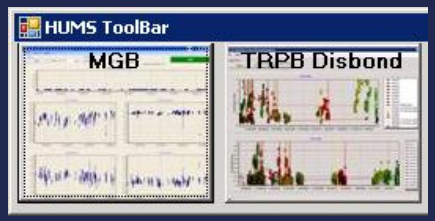
SPLAT



Matlab



New HUMS Tools



Retirement Time Adjustment

S-92® Hub

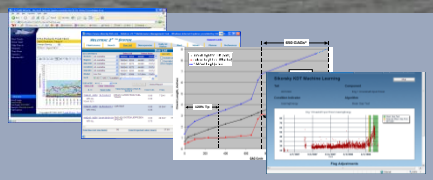
VALUE TO THE OPERATOR

New HUMS tools, maintenance credits, etc.

S-92® TEN YEARS OF MATURATION

S-92® FMOC

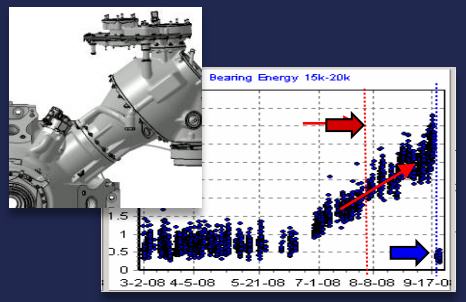
Now 250+ aircraft



10GB+ data daily

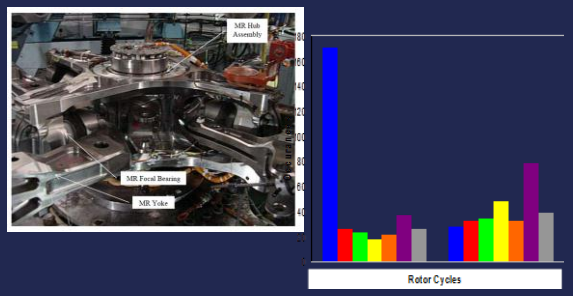
Downtime Avoidance

High-sensitivity vibe analysis enabled early detection of degrading health and proactive response.



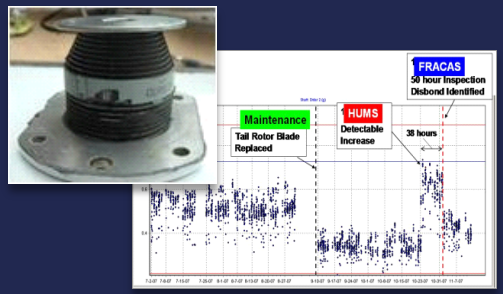
Extended Time-on-Wing

Leveraged S-92® Main Rotor Hub life adjustment to gain additional retirement time adjustment credits from the FAA



New Detection Capability

Research isolated vibe-signature of previously undetectable Pivot Bearing issue and enabled software enhancement



Level-of-Repair Optimization

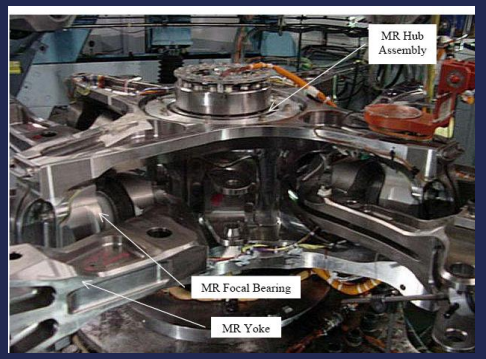
Identified opportunity to significantly reduce removals of APU Generator - a top AOG driver

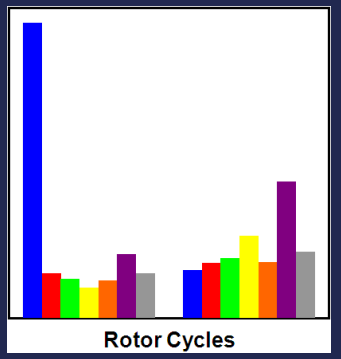
EXTENDING TIME-ON-WING

LLP Retirement Extension (Serial #)

FAA approved S-92® main rotor (MR) hub life

Average benefit of 50% one-time CRT extension

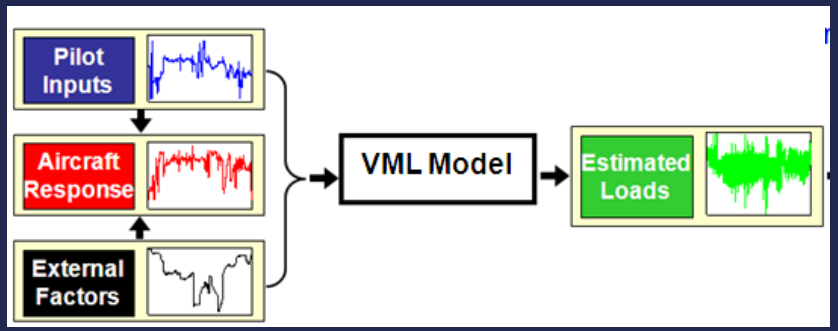


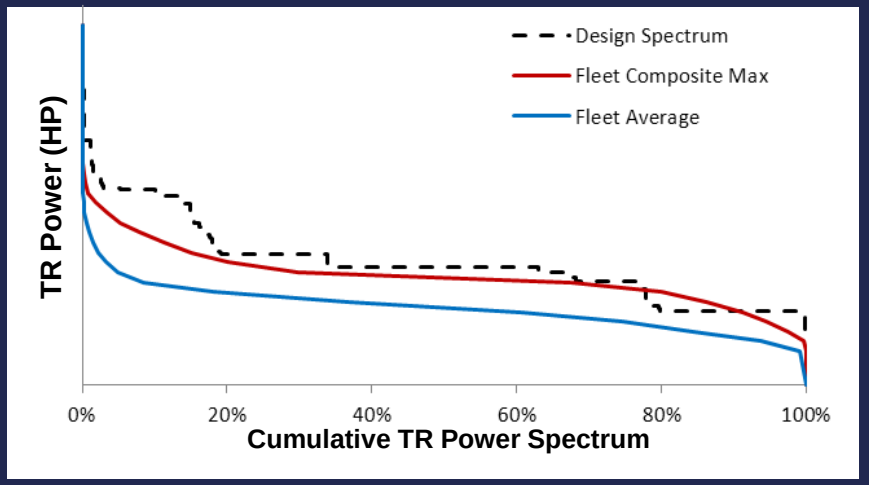


Fleet Spectrum Update (Part #)

Virtual Monitoring of Loads (VML) used to calculate TR torque from 500kFH

Load statistics used to revise usage spectrum ➔ 3.25X retirement time

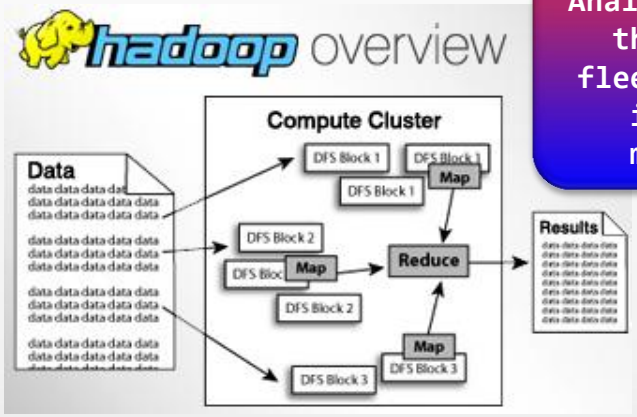




“BIG DATA” ANALYTICS APPLICATIONS

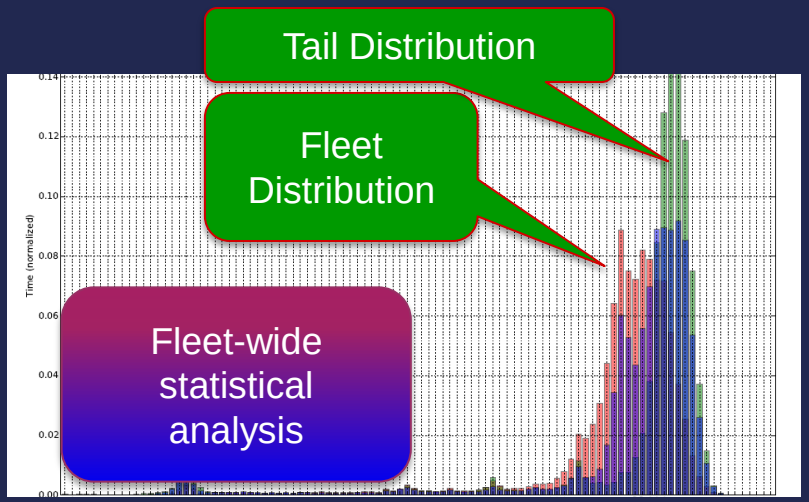
Hadoop® Cluster

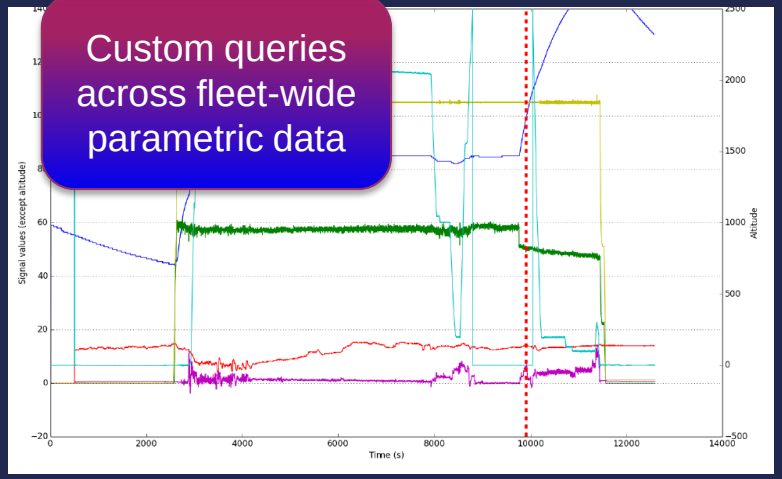
- The new paradigm – cloud computing
- HADOOP by Cloudera



Analysis across the entire fleet (16+ Tb) in a few minutes.

- HADOOP = An open source implementation of MapReduce, a powerful for deep analysis of very large data sets.

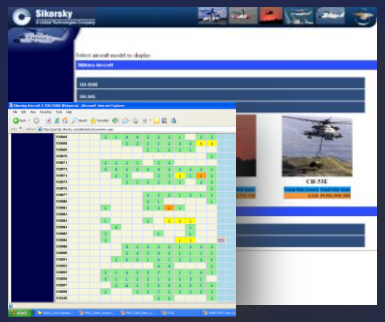




EXPANDING ANALYTICS

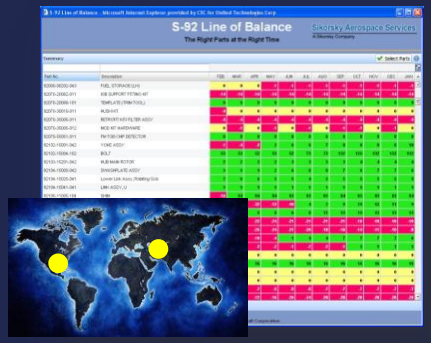
Optimizing support through awareness and insight

Fleet Demographics

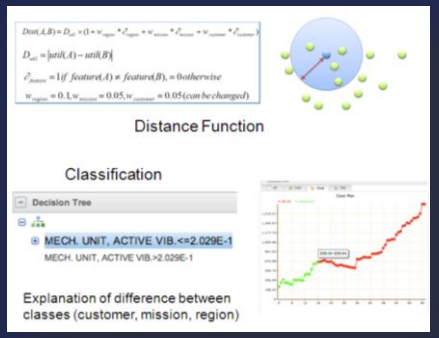


Health Monitoring and Drill-Down

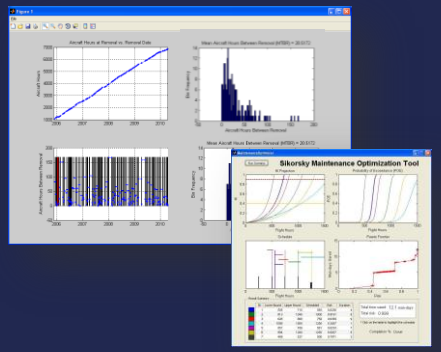
Cost/Maintenance Trending and Investigation



Supply Chain Optimization



Text mining and Statistical Analysis



Maintenance Optimization

PHM SYSTEM INTEGRATION LAB (SIL)

Architectural Elements Developed in Parallel to Subsystem Technology Maturation

Integrated Vehicle Health Management Unit (IVHMU)

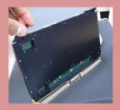
On-Board Processing and Storage of Aircraft State Parameters

Traditional HUMS Functionality

Prognostic and Health Management Unit (PHMU) Card

Integrated Diagnostic and Reasoning Algorithms

Embedded Application Software



Aircraft Notebook

At-aircraft download, health displays, and troubleshooting

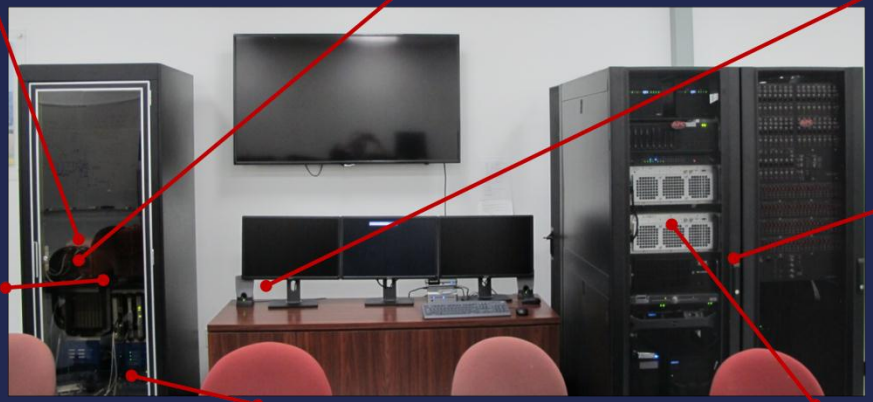
Data transfer between Operators Server & Aircraft

Network Acquisition and Interface Unit (NAIU)

I/O handling for PHM Network

Data Management for Real-Time SW

Data Storage and Download to GBS



FMOC Server

Fleet-based diagnostic & prognostic algorithms

Knowledge Discovery Toolkit (KDT)

Optimized maintenance planning

PHM SIL Hydraulics

Integrated VMS hardware and sensors for technology V&V

PHM Network

Various sources of input data for on-board processing

PHM SIL Playback

Purpose

Playback Previously-Recorded Data and Simulate Flight for V&V of New Diagnostic and Prognostic Technologies

PHM SIL Static Room

Purpose

Integrate Structural and Electrical HW and sensors for technology V&V

SIL PLAYBACK SYSTEM

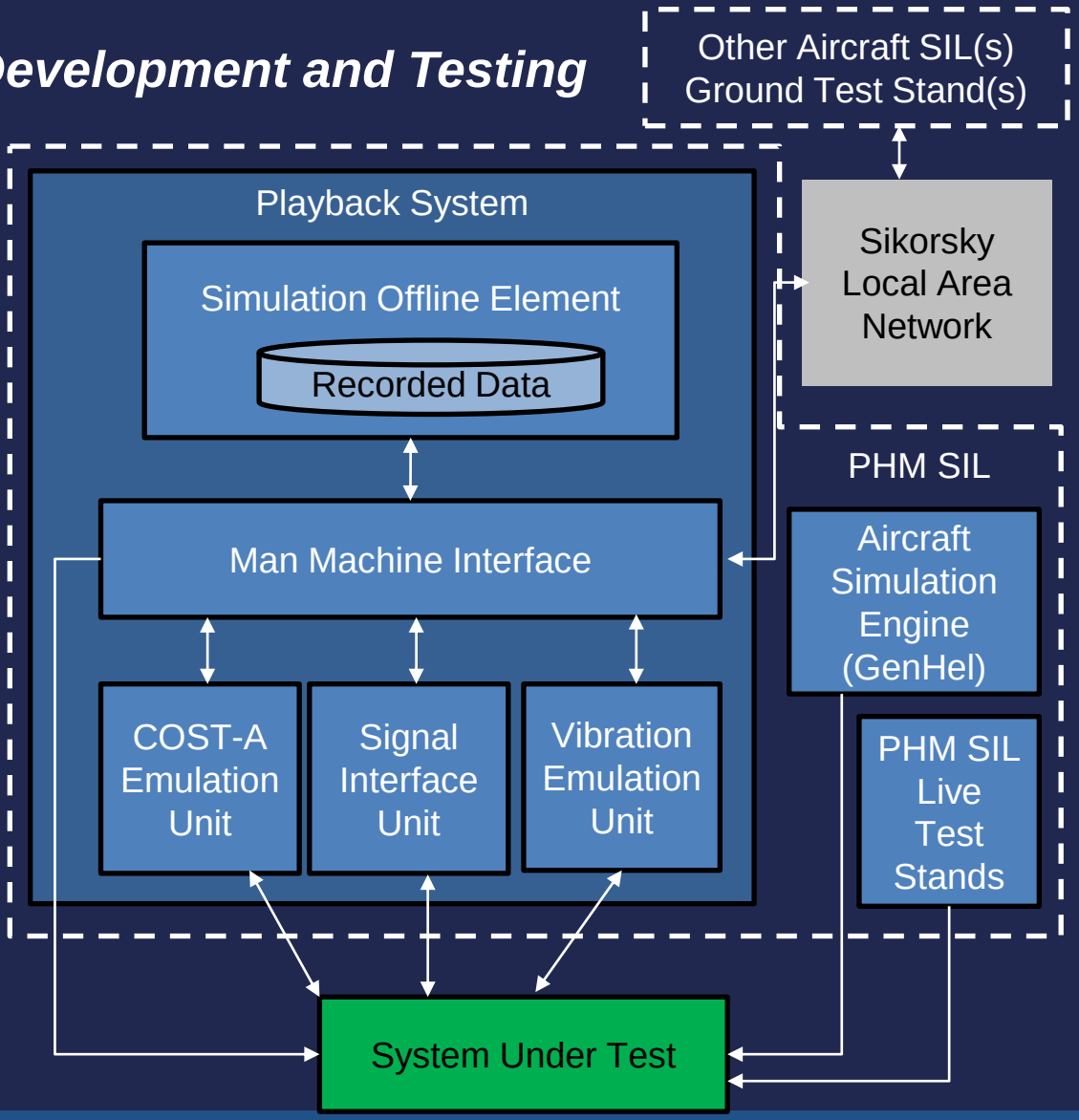
Enabling capability for PHM Development and Testing

Primary Functionality

- Seamlessly merge integrated flight data, seeded fault data, simulated data
- Playback data to fully simulate avionics system

Challenges

- Specifying and developing intuitive user interface
- Converting often massive, heterogeneous data files to common format
- Defining and implementing playback interfaces



REAL-TIME DATA DOWNLOAD

Satellite Message
- Small Offload (~10Kbytes)
- Push Only
- 2.4Kbits/s

Internet

Cellular Message
- Partial On-Demand Offload (~1MByte)
- Push/Pull
- Ground can request additional data
- 300KBits/s (3G)

Flight Operations Center

Tablet

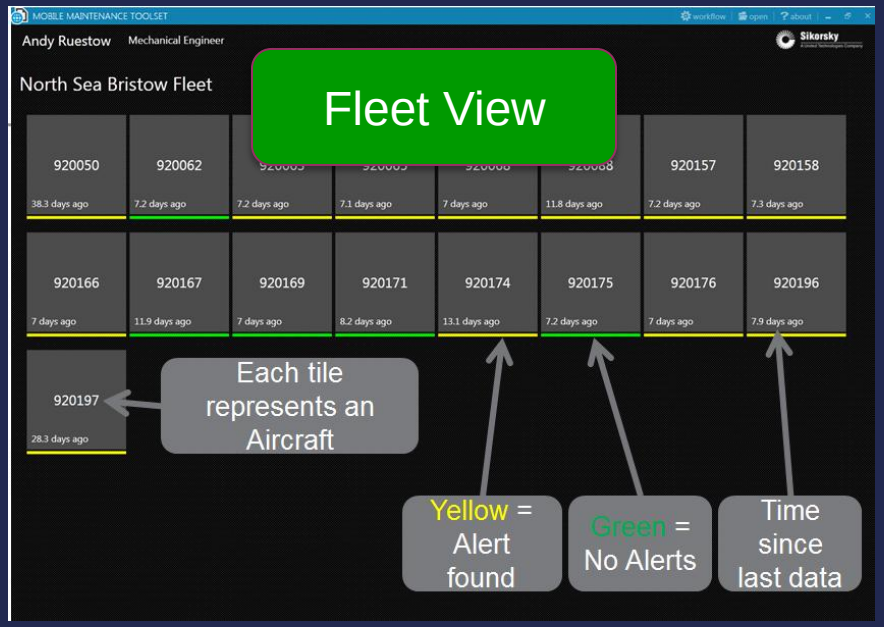
At Wing

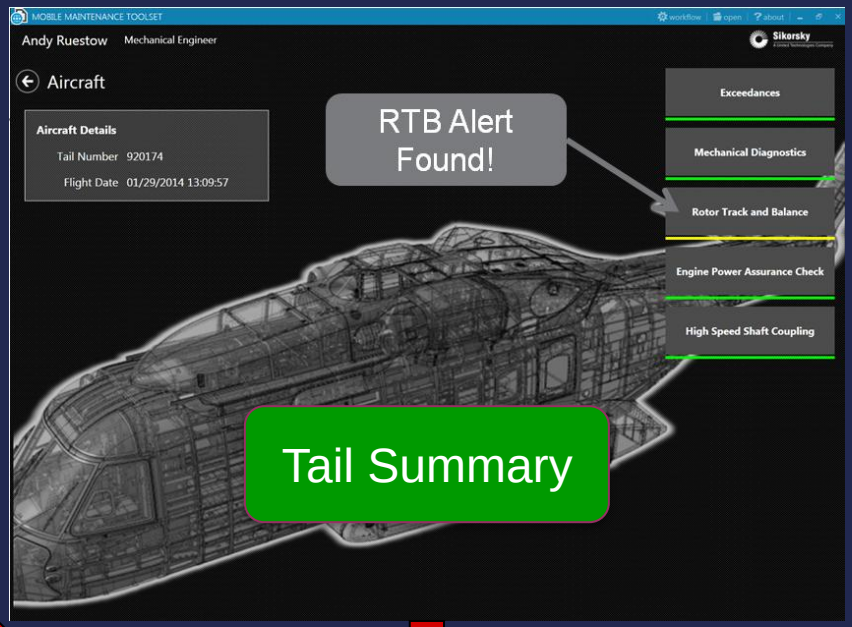
Wi-Fi Message
- Full Offload of MUD File
- Up to 256MBytes
- 54MBits/s

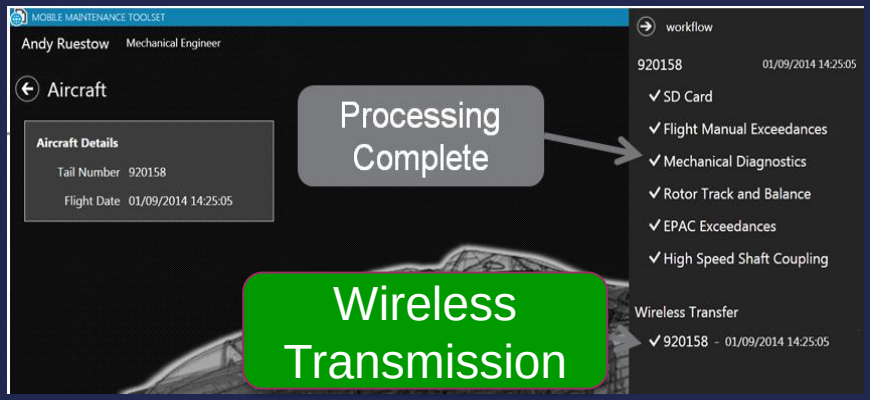
- Immediate access to data
- Shortened post flight process
- Automated post flight process
- Standard communication protocols

- timely access to information

MOBILE MX TOOLKIT WORKFLOW



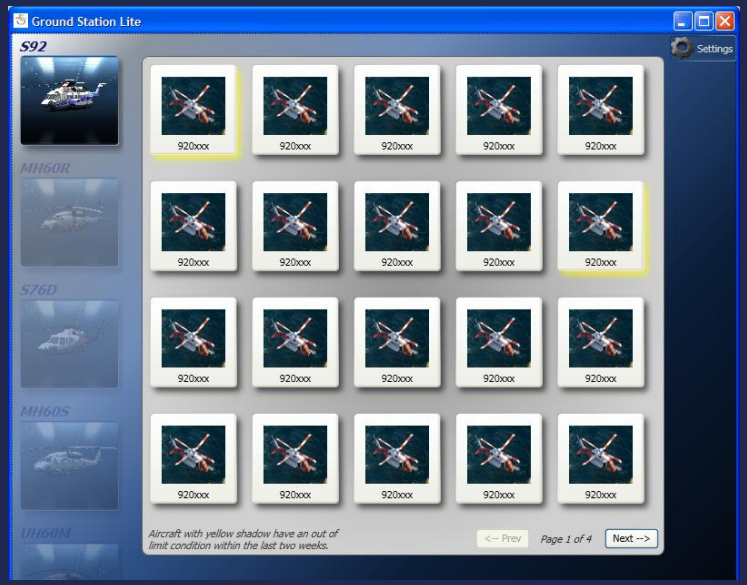


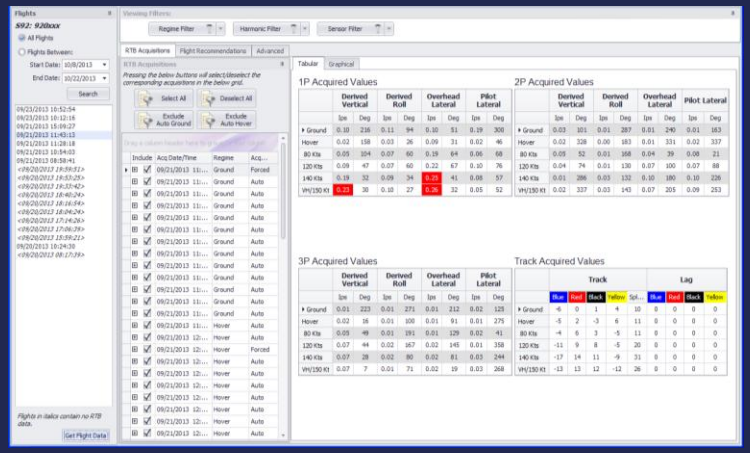


SAC GROUND BASED APPLICATION

Sikorsky SGBA Key Functions

- *Operation Usage*
- *Mechanical Diagnostics*
- *RTB*
- *Flight Manual Exceedances*
- *Alert Trending*
- *Parametric*
- *HUMS Toolbar*

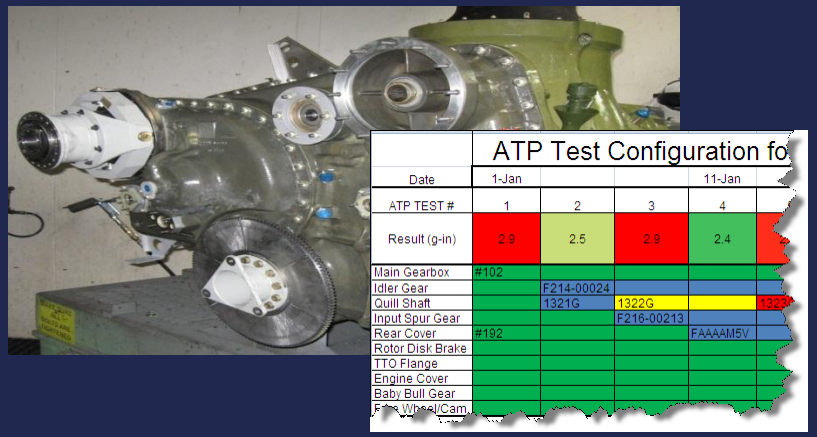




INCREASING THE VALUE OF HUMS

Transition to CBM+

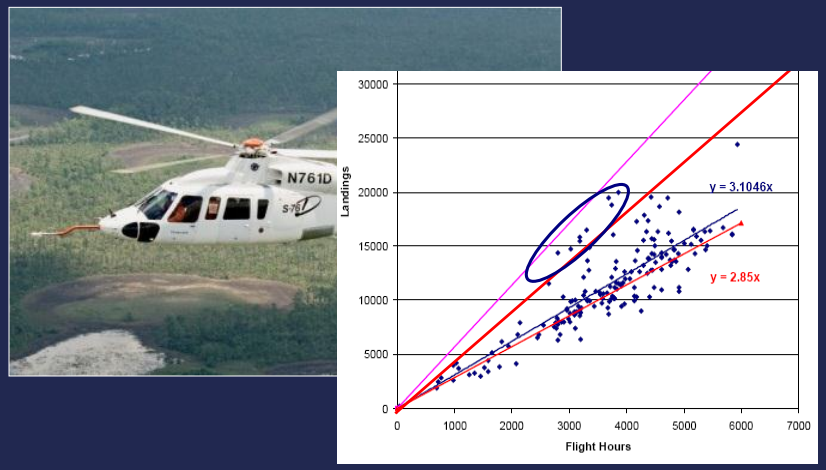
Incorporate into Aircraft Delivery



	ATP Test Configuration fo				
Date	1-Jan			11-Jan	
ATP TEST #	1	2	3	4	
Result (g-in)	2.9	2.5	2.9	2.4	
Main Gearbox	#102				
Idler Gear		F214-00024			
Quill Shaft		1321G	1322G		1323
Input Spur Gear			F216-00213		
Rear Cover	#192			FAAAAM5V	
Rotor Disk Brake					
TTO Flange					
Engine Cover					
Baby Bull Gear					
[illegible] Wheel/Cam					

Expand Safety Attributes

Change the Design Paradigm



Questions?