F-35

Program Overview

13 February 2008

Major General Charles R. Davis, USAF

Program Executive Officer, F-35 Lightning II Program

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

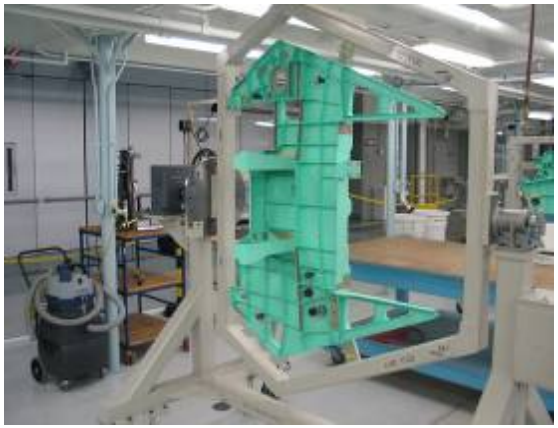
CV Variant

Critical Design Review
June 18, 2007

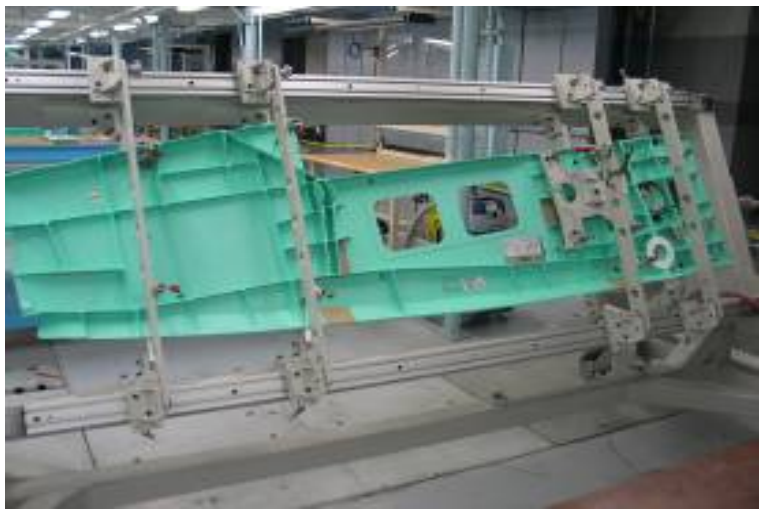
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

CF-1 Progressing

Forward Fuselage



Wing



Center Fuselage

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Master Schedule

FY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

Major Program Events

Critical Design Reviews
- USAF / USMC
- USN CDR

First Flights
- USAF
- USMC
- USN

Initial Operational Capability
- USMC
- USAF
- USN

Test Completions
- Developmental
- Operational

AA-1 (15 Dec)

CATB (23 Jan)

Low-Rate Initial Production (LRIP)

Production and Sustainment
- LRIP 1 (2)
- LRIP 2 (12)
- LRIP 3 (19)
- LRIP 4 (32)
- LRIP 5 (47)
- LRIP 6 (118)
- LRIP 7 (132)
- Multi-Year 1: EOQ, MYP →

Planned U.S. Production and Sustainment
- Air Force 1,763 A/C
- Dept of Navy 680 A/C

Planned International Production > 500

EOQ = Economic Order Quantity MYP = Multi-Year Procurement

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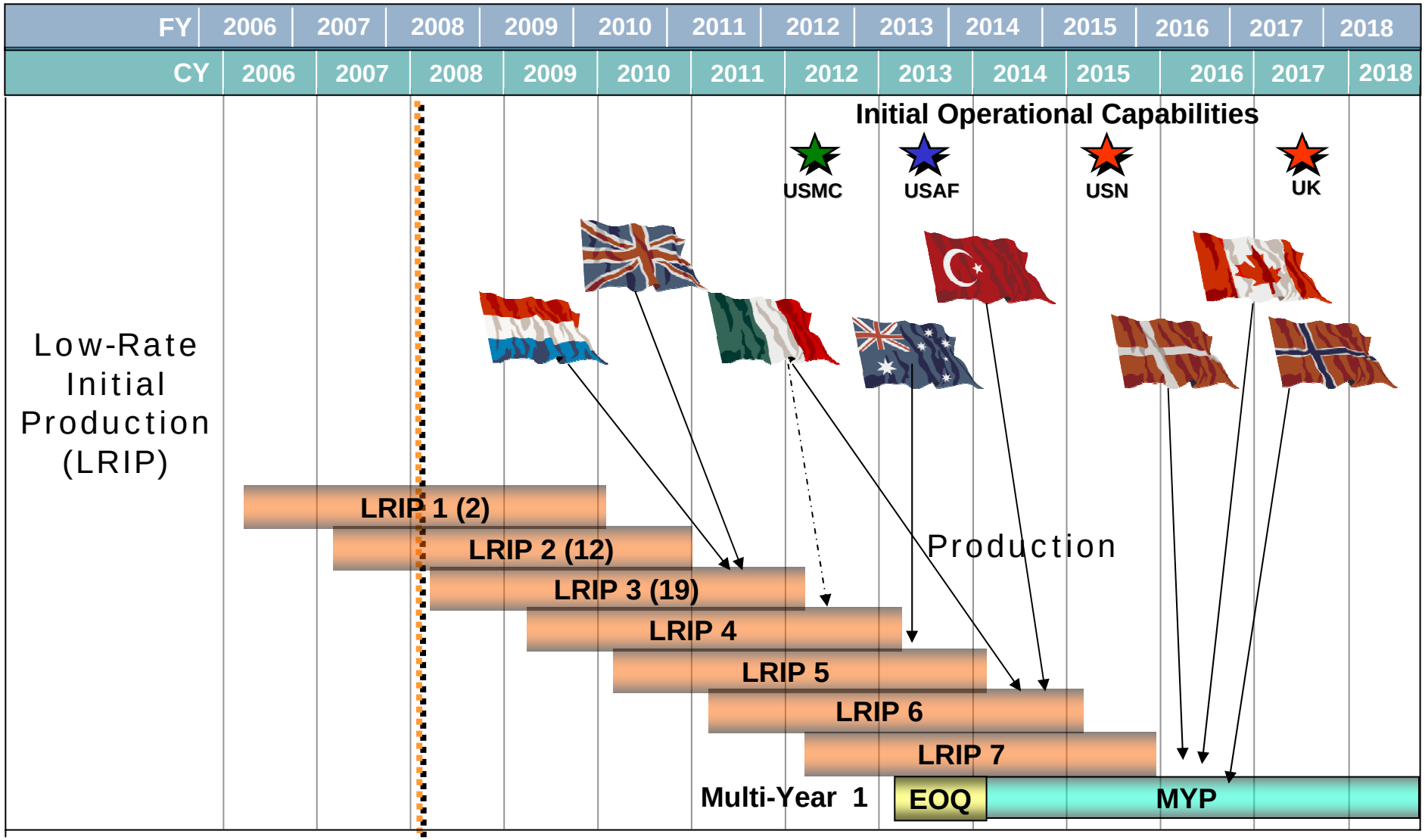
Program Schedule



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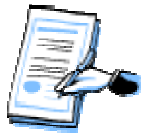
2007 Milestones

Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec

- LRIP #2 LL Proposal Submittal

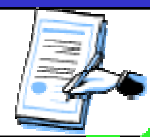


- ALIS Ft Worth

- CV CDR

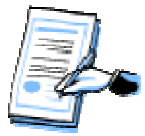
- 1st STOVL Engine and Lift Delivery

- LRIP #2 FF Proposal Submittal



- CATB 1st Flight

- LRIP #1 Award



- Pilot Training CDR

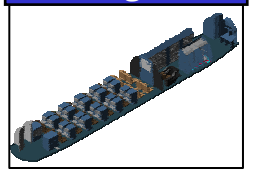
- STOVL Power On

- STOVL Engine and Lift Fan Installation

- Partner MoU Signatures Complete

- BF1 Wing Completion

- CATB 1st Mission Systems Flight



- BF-1 Rollout

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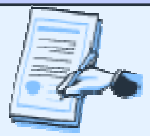
2008 Milestones

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

LRIP #2 CTOL FF Approved



BF-1 FRR

BF-1 Structural Coupling Tests Start

BF-1: Hover Pit Testing

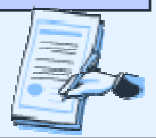
BF-1 1st Flight

AA-1 Launch to EAFB

BG-1 transfer to Test Lab

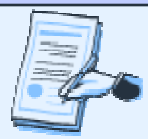
Sustainment Readiness Review-EAFB

LRIP #3 LL Approved

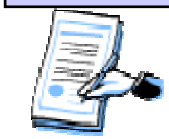


BF-2 Rollout

LRIP #2 STOVL FF Approved



LRIP #3 FF Proposal Submitted



Sustainment Readiness Review-PAX

BF-1 Deploy to PAX River

AF-1 Power On

AF-1 Rollout

Maintenance Training CDR

BF-3 Rollout

BF-4 Rollout

ALIS 1.0.2 Delivery

CF-1 Start Major Mate

CATB 1st Federated Flt

AG-1 Static Test Start

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Flight Test Underway

Objectives

- Mission Systems Risk Reduction/Confirmation
- Missions Systems Integration

Status

- 29 Flights To Date; 85.5 Flt Hrs
- Basic Airworthiness Proven
- Initial Mission Systems Installed
- First Mission Systems Flight on Dec 7, 2007

Objectives

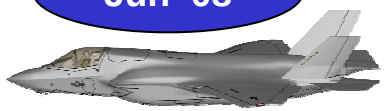
- Risk Reduction/Confirmation
- Basic Envelope Expansion
- Systems Integration

Status

- 25 Flights To Date; 28 Flt Hrs
- 38,000 Feet, 0.8 Mach, 20 Degrees AoA
- Vehicle Systems Being Validated
- Reliability/Maintainability Evaluation

CATB — 23 Jan '07

STOVL — Jun '08



CTOL — 2009

CV — 2009

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First Flights Status

STOVL (BF-1)

Jun '08

CTOL (AF-1)

2009

CV (CF-1)

2009

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What We Have Learned From AA-1 That Reduces Program Risk

Handling Qualities Development
- Excellent Handling qualities verify design goals.
- Initial Autopilot testing
- Mode – Speed Brake/ Air Refuel/ APC

F-135 Engine
- Engine Transients to AB
- Engine Response
- 'Control to Thrust Concept'

IPP
- Cross wind Start
- IPP screen
- ECS Temperature
- ECS Deicing
- EPU operation
- Temperature Control
- Defog pattern
- IPP operation

Electrical System
- ICC Operation
- Emergency Fill in
- 270 V Power to Flight controls

EHA
- Integration with electrical system – produced gear box changes / REGEN resistor .
- Hydraulic Reservoir Temperatures
- High altitude Electronics Unit Changes to improve component design.
- IBIT Mechanization

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F135 Turbine Blade Failure Summary

Failure Summary – October 2007

- Engine #FX634 surge / failure in STOVL mode at MIL power
- Root Cause: High cycle fatigue failure of a 3rd Stage LPT blade
- Testing curtailed while corrective actions and path ahead approved

Return to Test Strategy – December 2007

- Finished NDI of all turbine blades – No issues
- Finished "Proof test" of test cell engine to confirm LPT durability – No issues found
- All test assets will be proof tested with periodic Eddy Current Inspection—CTOL flying and STOVL engines returned to test
- Potential design changes identified; verification test plan built

Failure Summary – February 2008

- Failure almost identical to FX634 in August
- Root Cause: High cycle fatigue failure of a 3rd Stage LPT blade
- Confirmed to be STOVL powered lift issue

Way Forward

- Fly STOVL about 30 days late on a CTOL clearance
- Validate stresses and confirm root cause fix—May-Jun
- Re-clear BF-1 for STOVL ops Dec-Jan

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Validating Mission Systems in Flight

QF-4

EO DAS

Sabreliner

EOTS

BAC-111

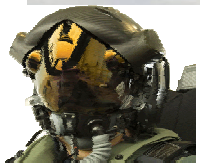
Radar, EO DAS, INS, GPS

Systems in Test	Flight Hrs	Lab Hrs
HMD	15 Hrs (AA-1)	950
Radar	125 Hrs (BAC- 111)	6500
EO DAS	83 Hrs (F-16, BAC-111, QF-4)	4700
EOTS	10 Hrs (Sabreliner) (CATB – Fall '08)	3650
Integrated CNI	20+ Hrs INS: AA-1 10 Hrs INS/GPS: BAC-111 35 Hrs RALT (CATB Fall 07)	4400
EW/CM	70+ Hrs	11,255

F-16

DAS, EW CM

F-35 AA-1



HMD **MFD**

CATB

Fully Integrated MS

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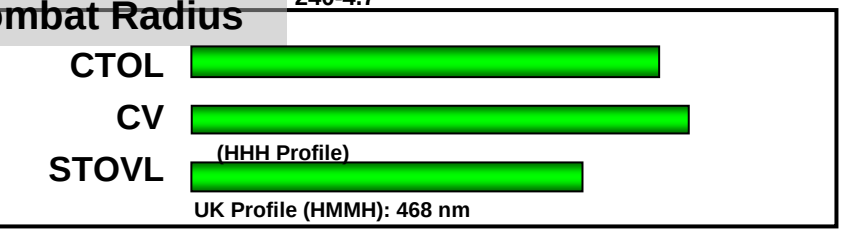
Key Performance Parameter Status

3 Jan 08

Combat Radius

240-4.7

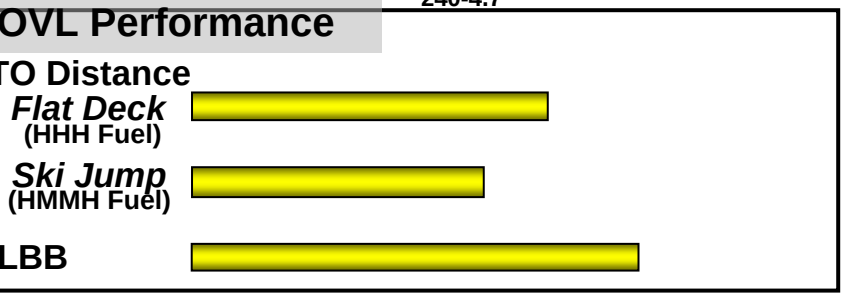


CV Recovery

240-4.7

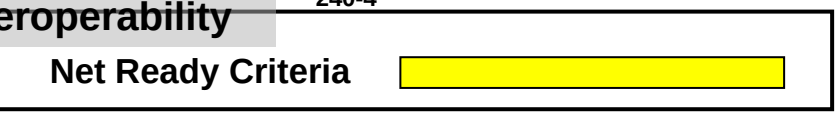
STOVL Performance

240-4.7



Interoperability

240-4



RF Signature

240-4.7

- CTOL 240-4.4; STOVL 240-4.3; CV 240-4.5 unless noted
- Contract Engine Deck
- Projected IOC Weight Empty based on WSR 209 CE
- Data as of 1-3-08

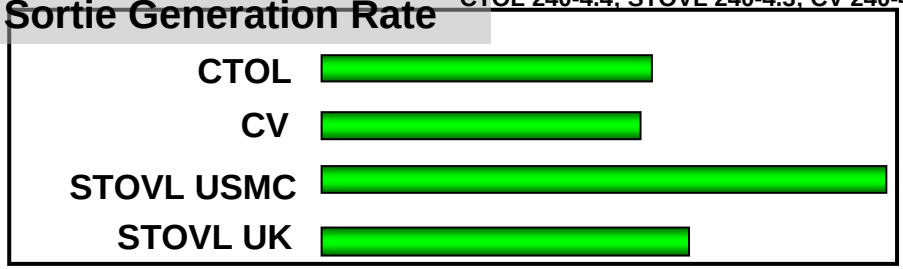
Threshold Requirement
CE Performance
- Exceeds ORD Objective
- Meets Rqmt/ExceedsTripwire
- Meets Rqmt/In Tripwire Band
- Does Not Meet Requirement

Mission Reliability

CTOL 240-4.4; STOVL 240-4.3; CV 240-4.5

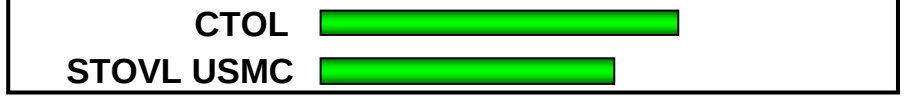
Sortie Generation Rate

CTOL 240-4.4; STOVL 240-4.3; CV 240-4.5



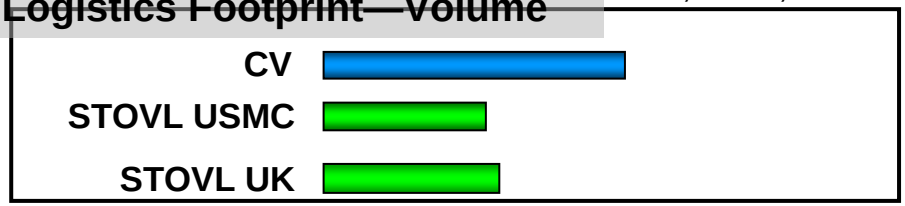
Logistics Footprint—C-17 Loads

240-4.4; 240-4.5



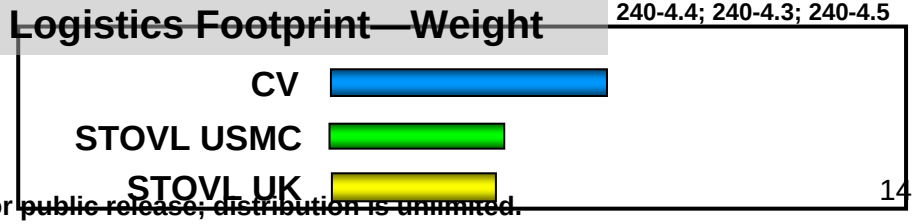
Logistics Footprint—Volume

240-4.4; 240-4.3; 240-4.5



Logistics Footprint—Weight

240-4.4; 240-4.3; 240-4.5



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The F-35 Design Requirement

Go Deep Into a Double Digit SAM Environment . . .

Surface-to-Air Missiles

SA-10

SA-12

SA-15

2S6M/SA-19

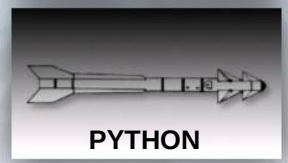
. . . Locate, Identify and Destroy Mobile/Moving Targets Through the Weather . . . While Outnumbered by Fourth Generation Fighters

Fighter Aircraft

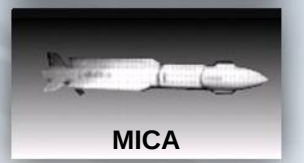
Air-to-Air Missiles

AA-10 ALAMO

AA-11 ARCHER


PYTHON

AA-12 ADDER


MICA

From Any Base At Significantly Lower Cost Than Legacy Systems

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F-35 Program Enablers

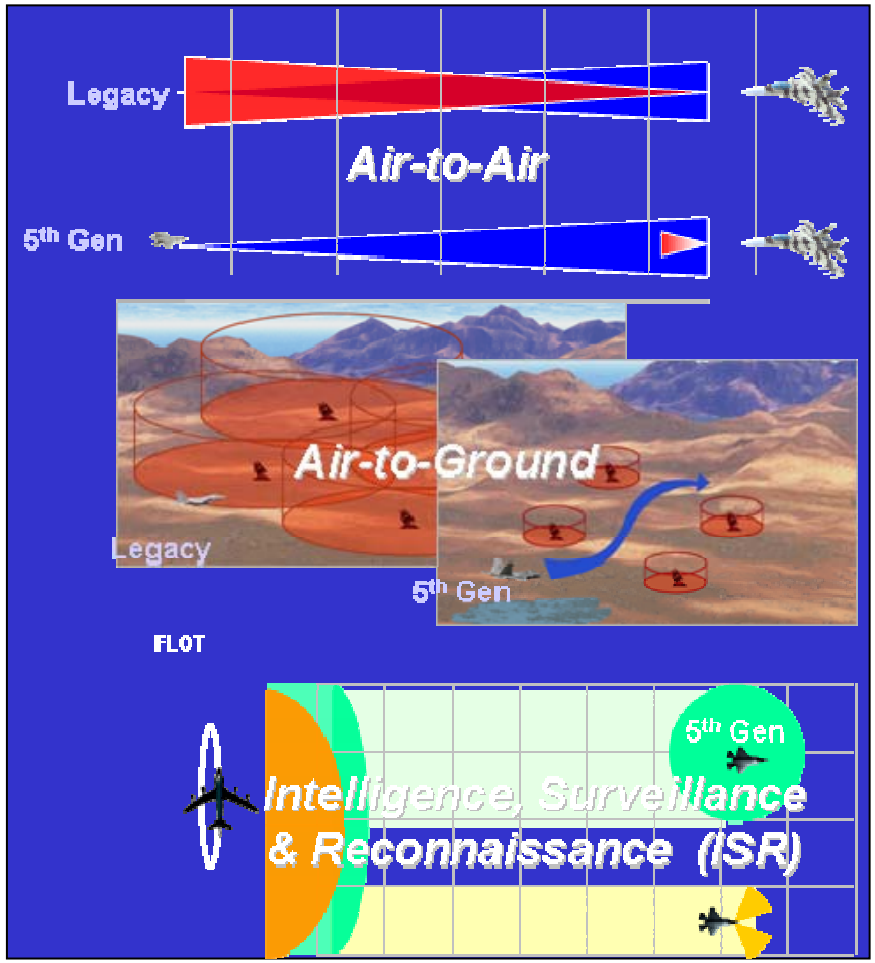
- **Stealth**
  - Surprise
  - Maintainability
- **Complex Packaging**
  - Highly Integrated Vehicle Systems
  - More Electric Architecture
  - Single Engine
- **Fully Integrated Avionics**
  - Real Time Situational Awareness
  - Information Sharing
    - **Within/Outside the Anti-Access Bubble**
    - **With foot soldier**

Unprecedented Integration Challenge

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Stealth

- **Air to Ground Design Challenging**
  - Excellent Air to Air Fallout
- **Design Drives Majority of Effectiveness**
  - Aligned Edges
  - Imbedded Antennas
  - Internal Weapons
    - Single Engine Packaging Challenge
- **Coatings Application**
  - Signature Performance vs Sustainability vs Durability
    - F-35 Advances State of the Art



Enables Tactical Advantage of Surprise

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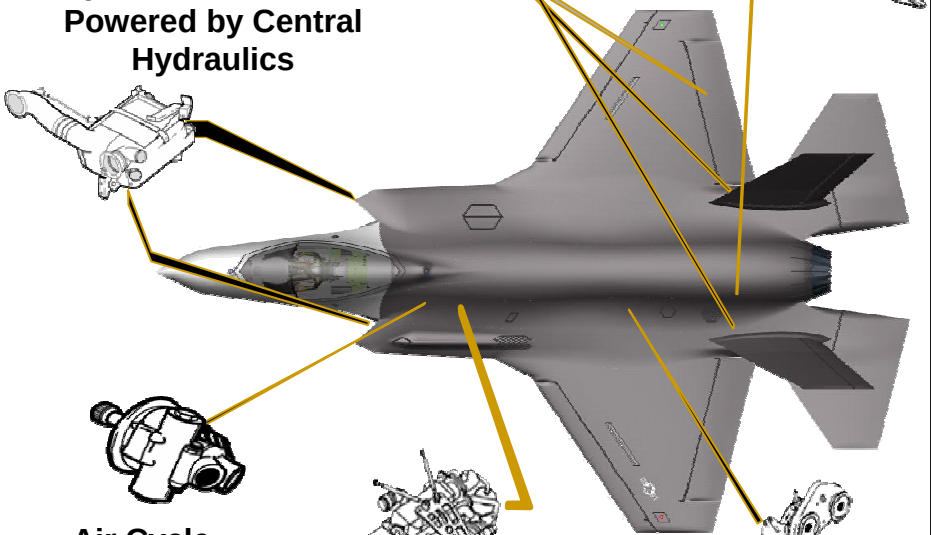
Complex Packaging

Federated Subsystems

Emergency & Auxiliary Power Units

Hydraulic Actuators Powered by Central Hydraulics



Air Cycle Environmental Control System

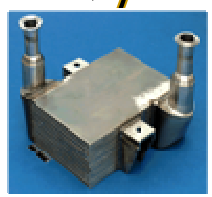
Vapor Cycle Environmental Control System

Airframe Mounted Accessory Drive

Integrated Subsystems

Electro Hydrostatic Actuators

Switched Reluctance Starter /Generators on Engine



Fan Duct Heat Exchanger

Integrated Power Package (IPP)

Drives More Electric Architecture

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Fully Integrated Avionics

Exceptional Situational Awareness

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Cooperative Avionics Test Bed - 737

First Full Fusion Flying Laboratory

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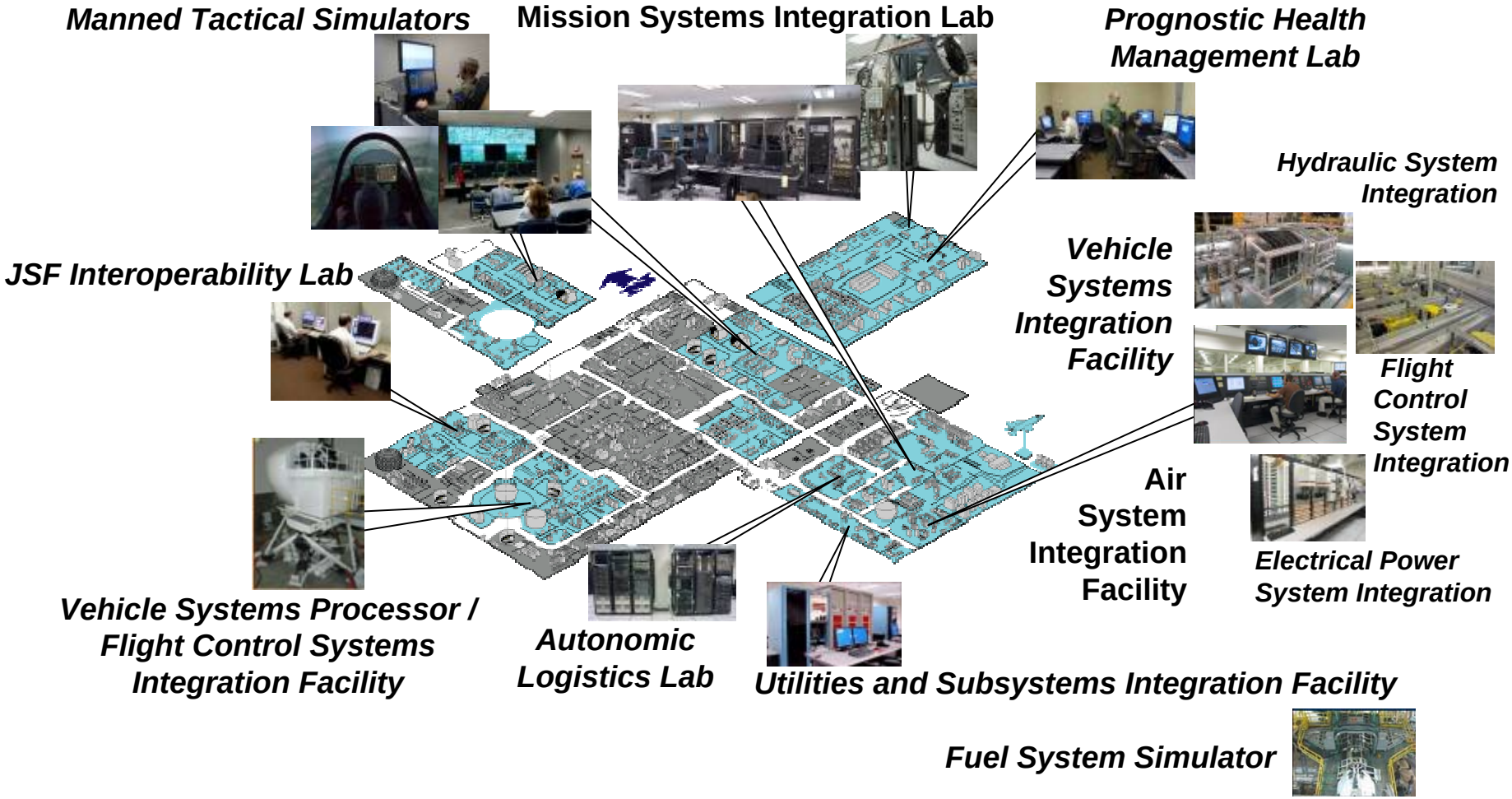
Integrated Ground Test Labs In Place



Lab Integration – Unprecedented Collocation, Coordination and Capacity

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Harnessing Computational Power and World-Wide Supply Chains and the Challenges This Presents to Lean Manufacturing

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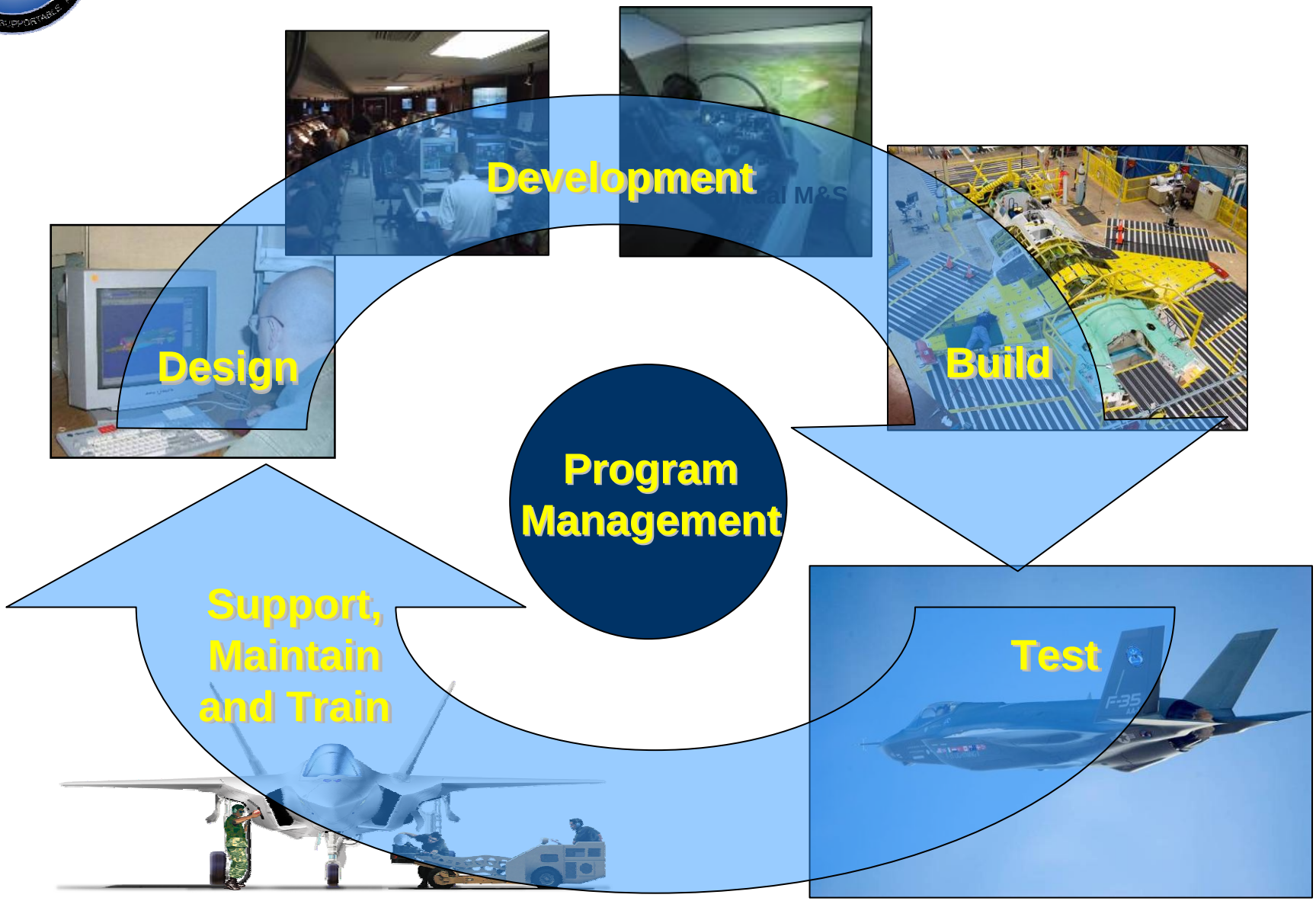
Digital Thread Throughout Life-Cycle



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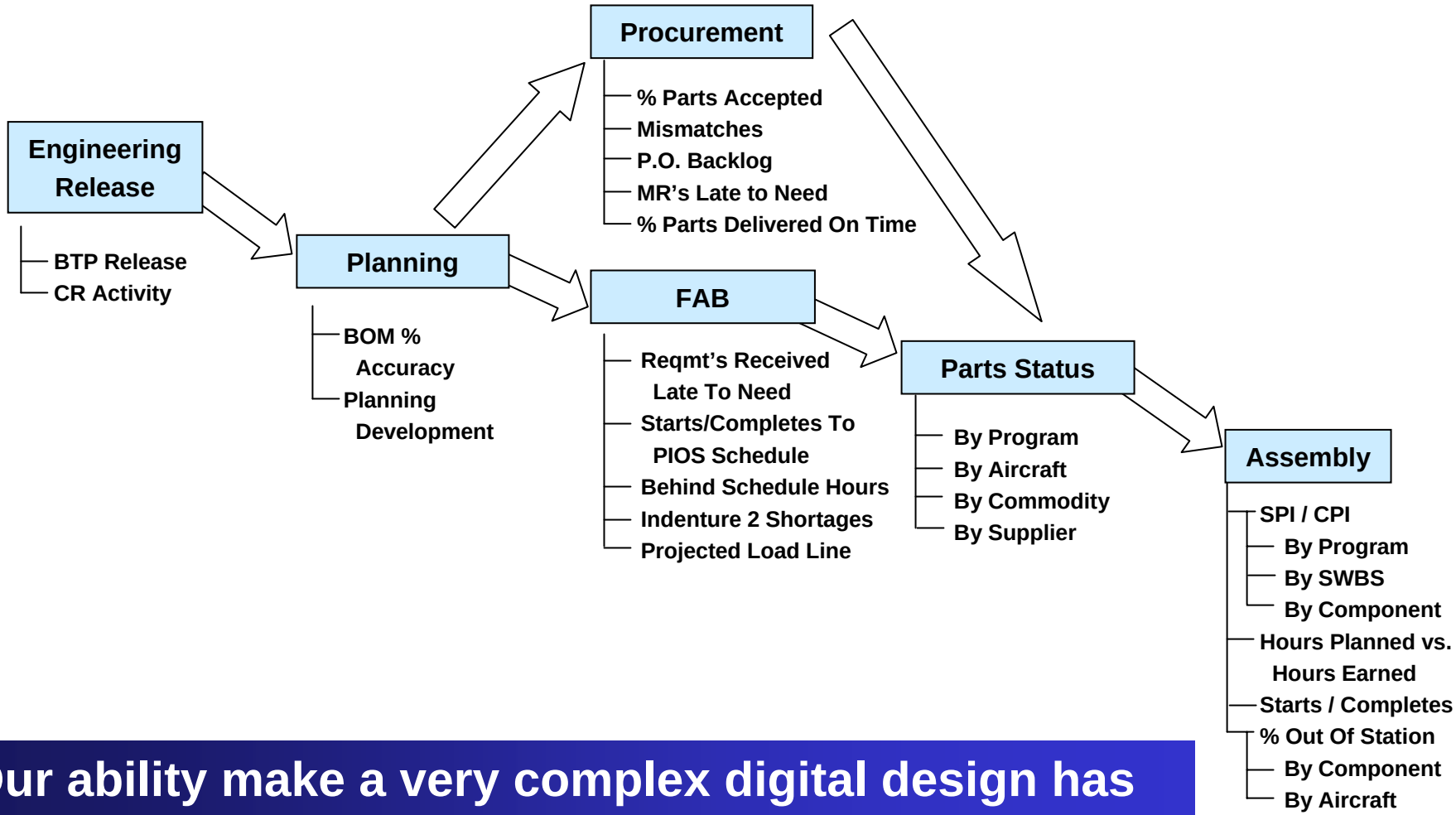
Production “Kill Chain”



Our ability make a very complex digital design has really challenged the entire production “kill chain”

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Current Production Status

Forward Fuselages (LM)
- *8 in Assembly*
- *4 Delivered*

Center Fuselages (NGC)
- *12 in Assembly*
- *4 Delivered*

Aft Fuselages (BAE)
- *7 in Assembly*
- *4 Delivered*

Wing (LM)
- *7 in Assembly*
- *4 Delivered*

Major Assembly (LM)
- *3 in Major Mate*
- *2 in Flight Ops*

All SDD and LRIP 1 Aircraft in Production

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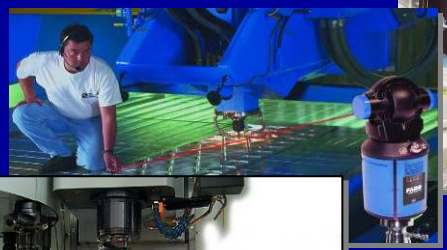
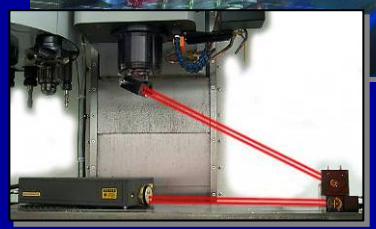
Advanced Manufacturing Technologies Required to Meet New Challenges . . .

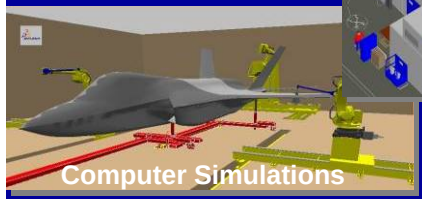
Precision Fabrication





Laser Control

Flexible/Automated Solutions



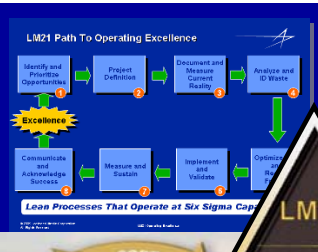
Computer Simulations

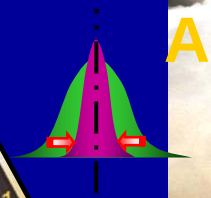
Robotic Spray

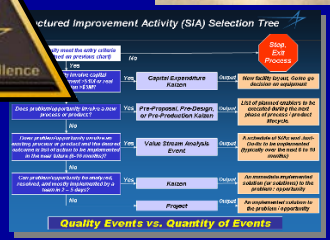
Automated Part Marking

High Quality / Affordable Solutions

Lean Practices

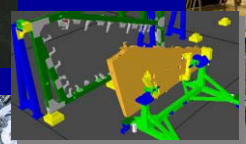






Digital Assembly

Laser Projection



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What's Working (and Not) ?

- **Successes**
  - Center Fuselage Ahead of Schedule Delivery w/min. travelled work
    - Some redesigns required for proceeding at risk without final loads
  - Forward Fuselage On-Time Delivery
  - Aft Fuselage On-Time Delivery with reduced traveled work
  - Empennage On-Time Delivery
  - 11 shipsets of Wing Bulkheads Delivered
- **Challenges**
  - Lack of Brackets for Wing Pre-Assembly
  - Inner Wing Assembly (Bulkhead Droop/Warpage, Shortages)
  - CTOL Outer Wing leading/trailing edge tolerances
  - Wing Traveled Work to Mate (Out of Station)
  - Harness Rework
  - Instrumentation Integration

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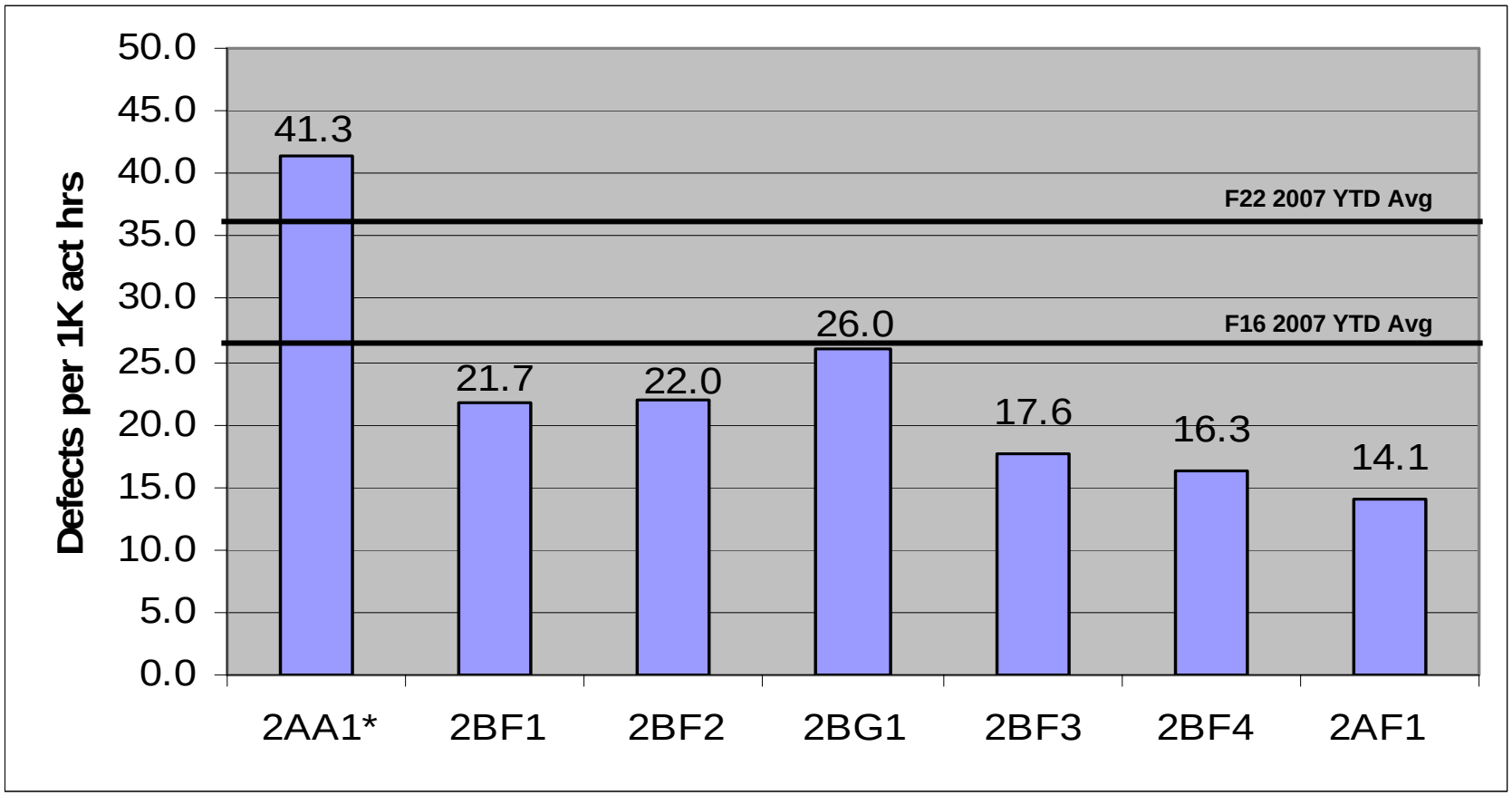
Assembly Defects per 1K act Hrs

Combined BAE, NGC, and LM Aero



Exceptional Quality Results Compared to Legacy

* 2AA1 Does not include Flight Line

As of : 12-17-07

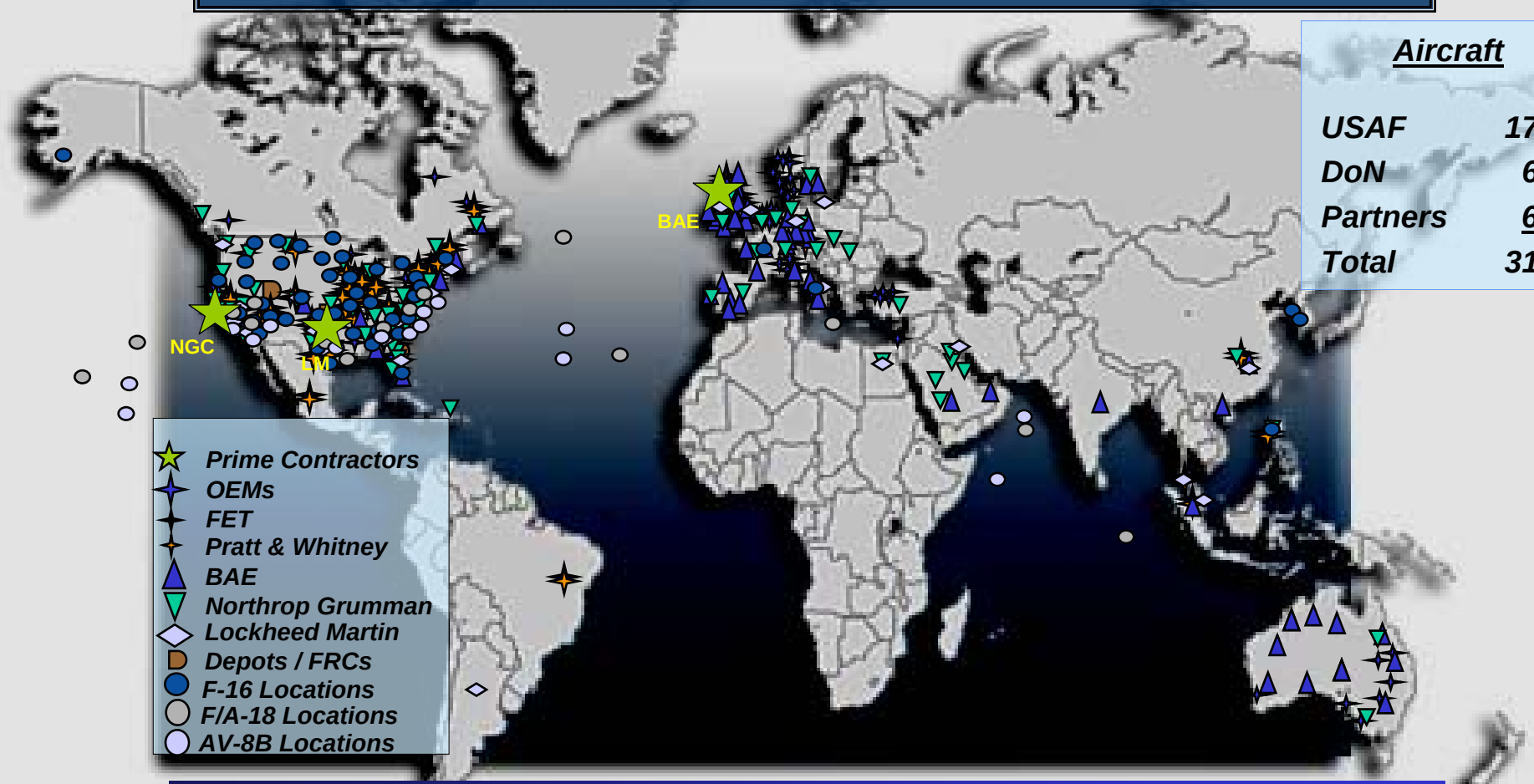
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Must Ensure Production Efficiency Improves Across The F-35 Global Supply Team

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

F-35 Global Delivery System

Operational Locations: 52 Bases, 9 Ships, 156 Squadrons



Aircraft

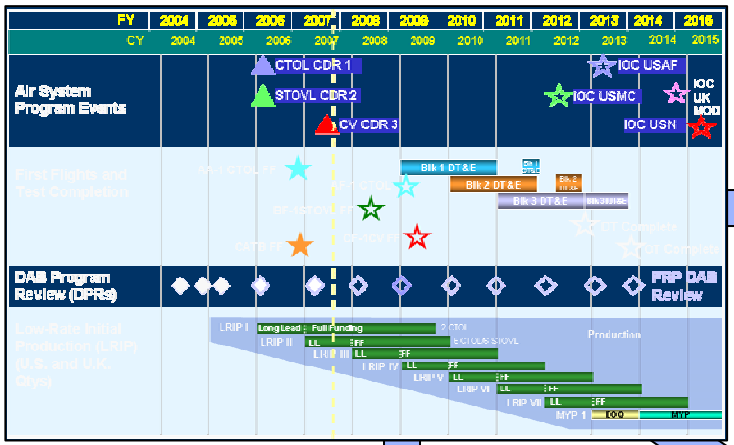
USAF	1763
DoN	680
Partners	682
Total	3125

F-35 Requires Global Supply Chain Solution

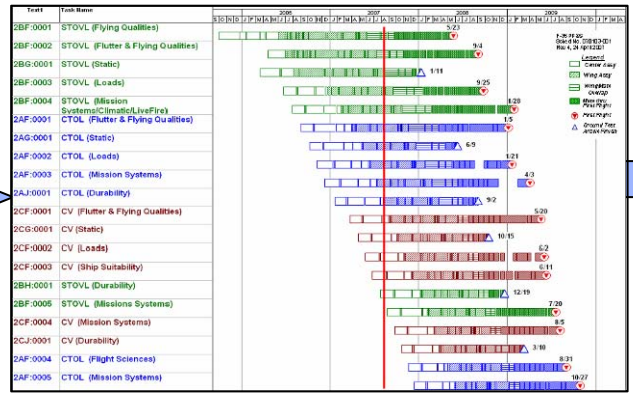
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

F-35 Strategic Initiatives

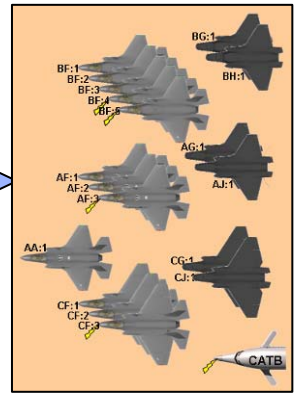
SDD Program Schedule



SDD Production Firing Order

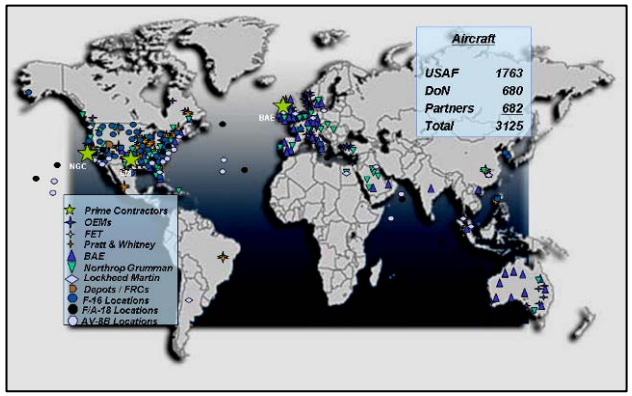


MCRR

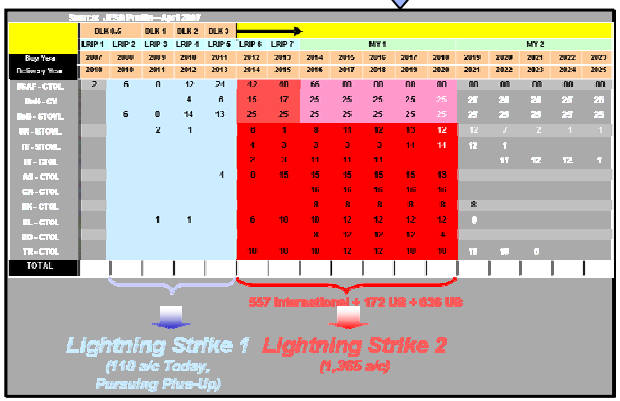


- ***Leverage JSF Investments***
- ***Replenish MR***

Global Distribution System



Lightning Strike



- ***LRIP Affordability***
- ***Partner Keep Sold***

Lead Turning the Next Set of Challenges

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

F-35 Take Away Messages

- **F-35 Is Meeting Operational Requirements**
- **F-35B STOVL Tracking to First Flight in Jun**
- **Coalition Partnership Remains Strong**
- **F-35 Program Enablers Very Challenging and Complex**
- **Manufacturing and Production Must Never be Underestimated**
- **2007 Was a Challenging Year-2008 Will Be Tougher and More Rewarding**
- **F-35 Strategic Initiatives Critical to program Success**

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