JOINT STRIKE FIGHTER

13 June 2001

Colonel Bob Lyons, USAF
Joint Strike Fighter Program Office

VISION

BE THE MODEL ACQUISITION PROGRAM FOR JOINT SERVICE AND INTERNATIONAL COOPERATION

DEVELOP AND PRODUCE AN AFFORDABLE NEXT GENERATION STRIKE FIGHTER WEAPON SYSTEM AND SUSTAIN IT WORLDWIDE

SERVICE NEEDS

- **USN 480**
  - Multi-role, stealthy strike fighter to complement the F/A-18E/F

- **USAF 1763**
  - Multi-role (primary air-to-ground) fighter to replace the F-16 and A-10 and to complement the F-22

- **USMC 609**
  - Multi-role, short takeoff, vertical landing strike fighter to replace the AV-8B and F/A-18C/D

- **UK (RN and RAF) 150**
  - Supersonic STOVL replacement for the Sea Harrier and GR-7

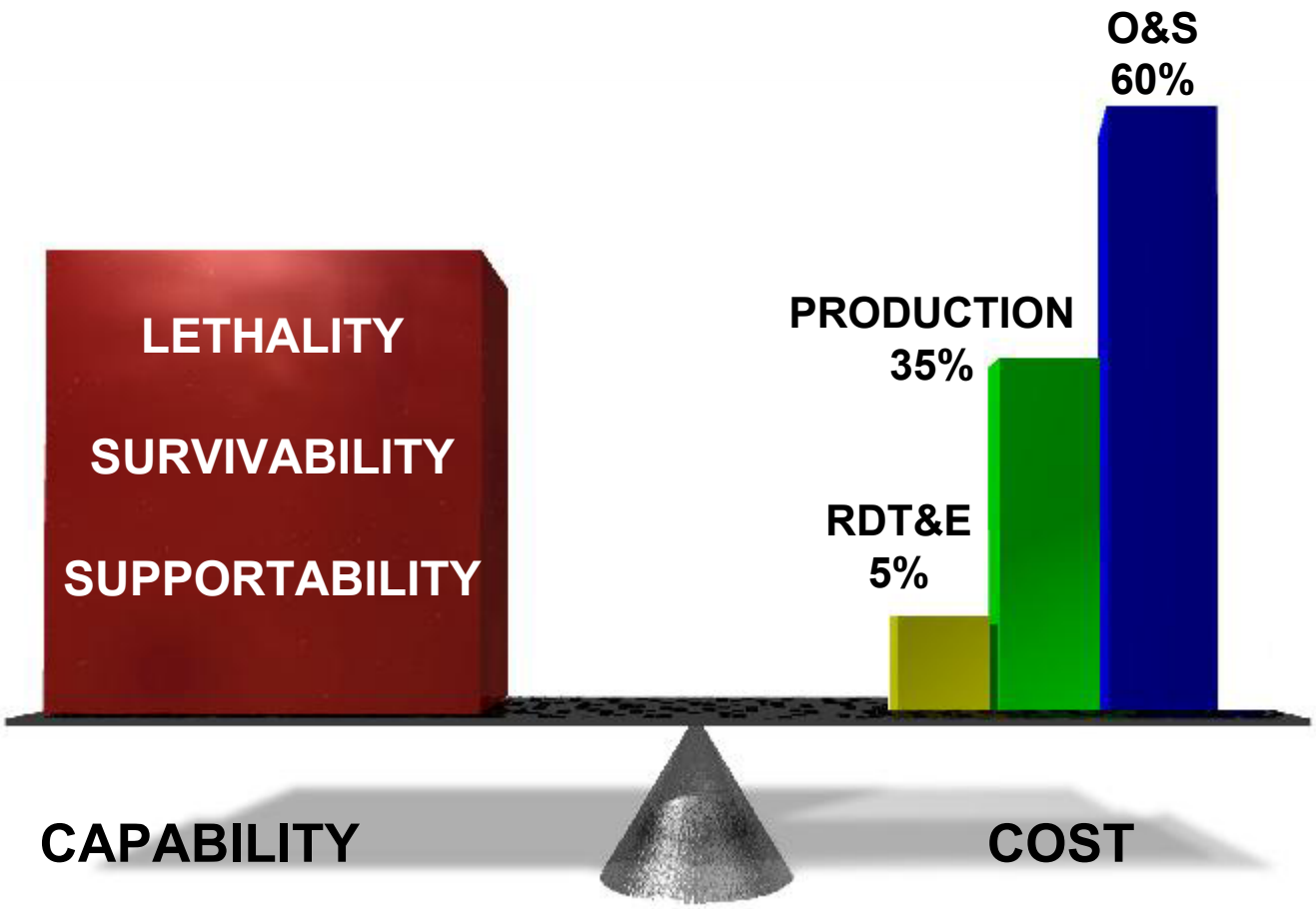
3002 US/UK JSFs

JOINT STRIKE FIGHTER
DoD FLAGSHIP PROGRAM

AFFORDABILITY IS KEY

- Requirements vs Cost
- Maturing Technology Prior to EMD
- Family of Aircraft -- High Degree of Commonality
- Interchangeable Engine Program
- International Participation
- Concept Demonstrator Aircraft

TACTICAL AIRCRAFT AFFORDABILITY OBJECTIVE

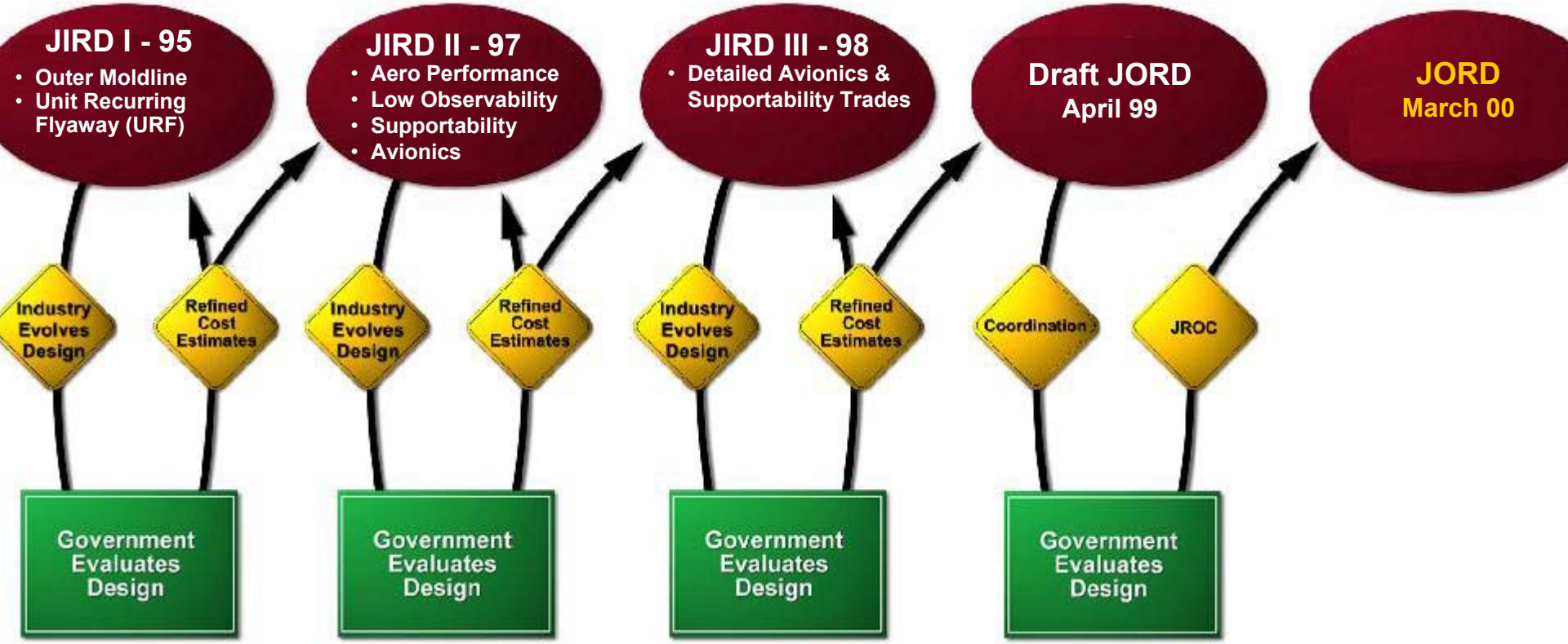


Affordability

Cost Objectives Shall Be Set To Balance Mission Needs With Projected Out-Year Resources, Taking Into Account Anticipated Process Improvements In Both DOD And Defense Industries

ROADMAP TO THE JORD

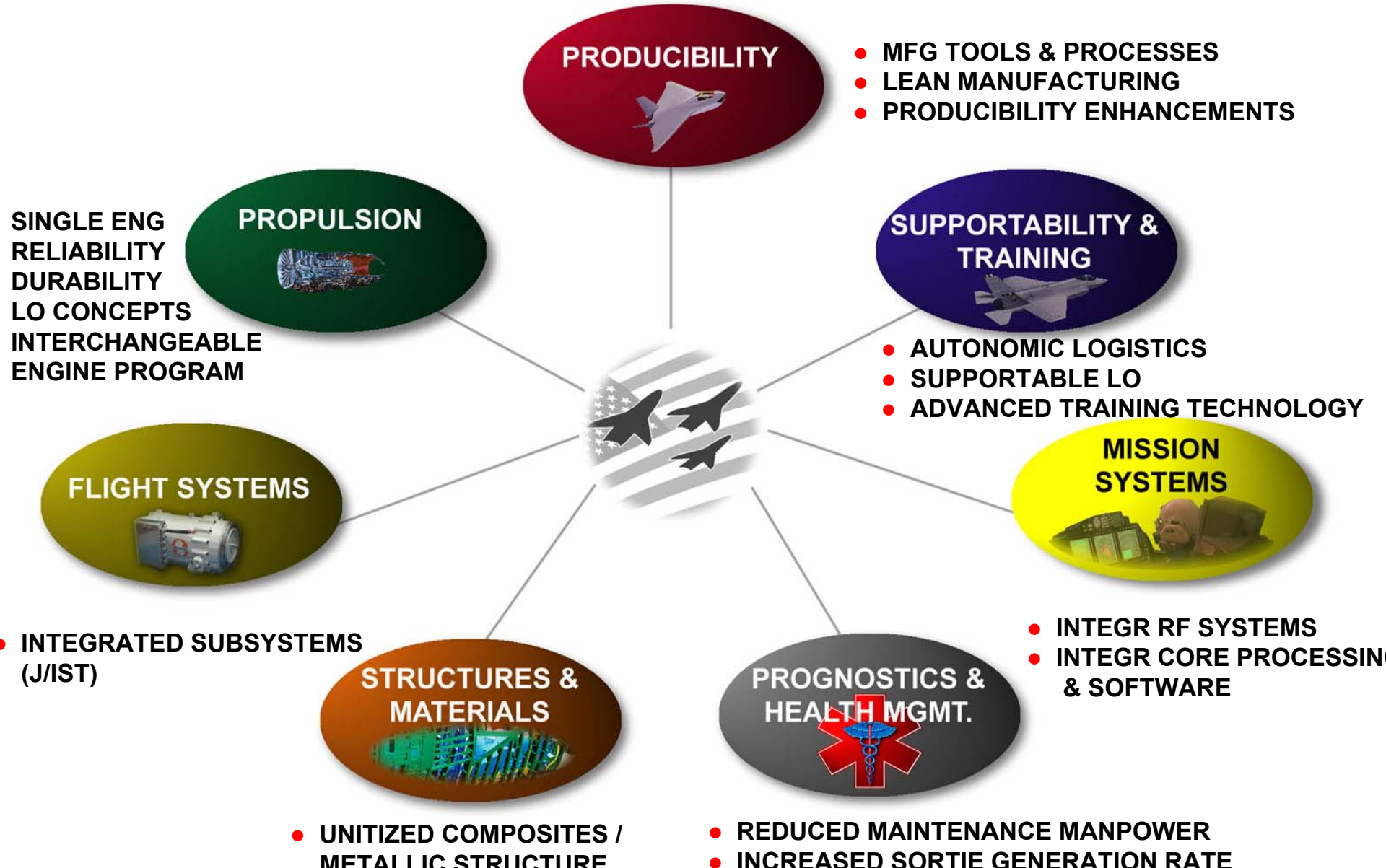
‘COST & OPERATIONAL PERFORMANCE TRADES’ — AOA



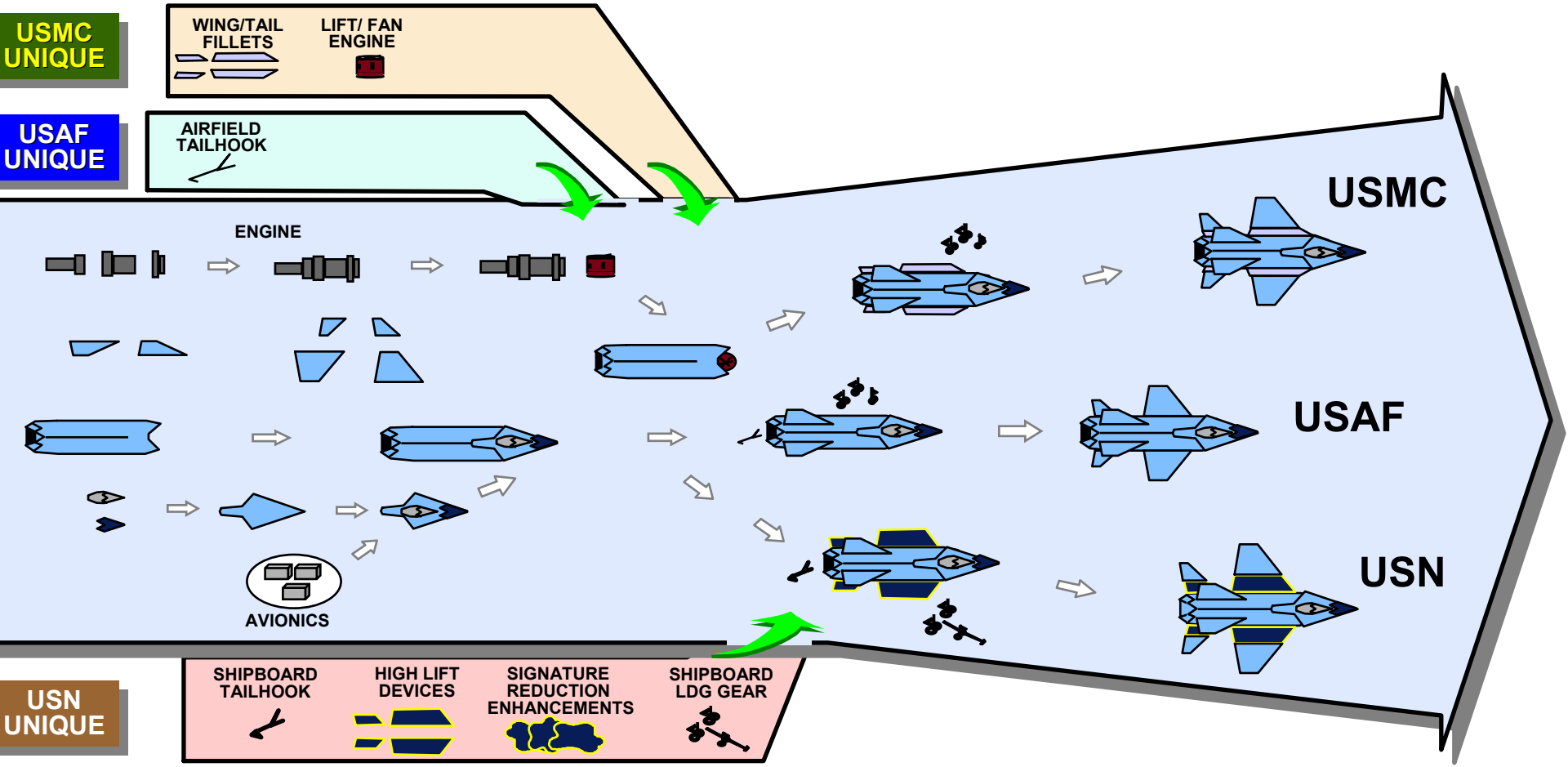
Feedback & Reiteration Loop Throughout Process

FIVE YEAR EFFORT!!

KEY TECHNOLOGY MATURATION PROGRAMS



A FAMILY OF THREE AIRCRAFT



A COMMON PRODUCTION LINE TO ACHIEVE AFFORDABILITY

BOEING

USAF CTOL

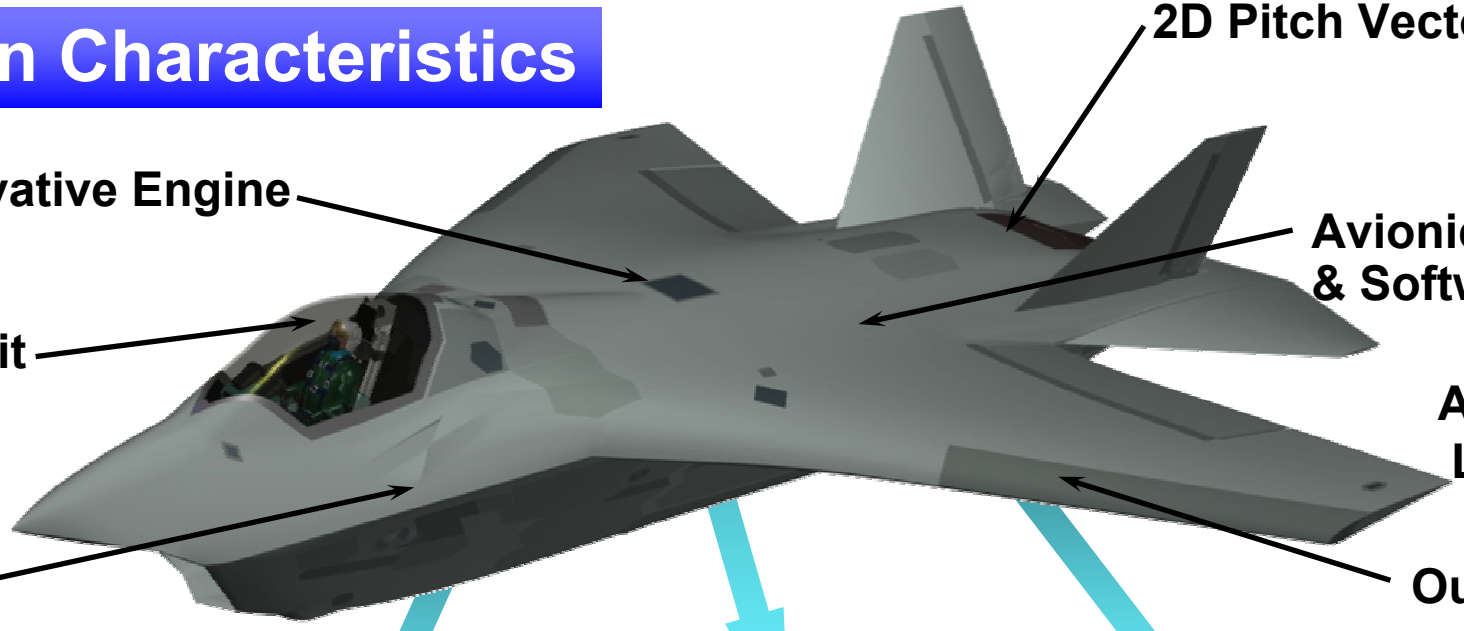
USN CV

USMC STOVL

UK STOVL

MULTI-SERVICE PREFERRED DESIGN CONCEPT

ommon Characteristics



ervice Tailoring

TOL

ternal 27mm Gun

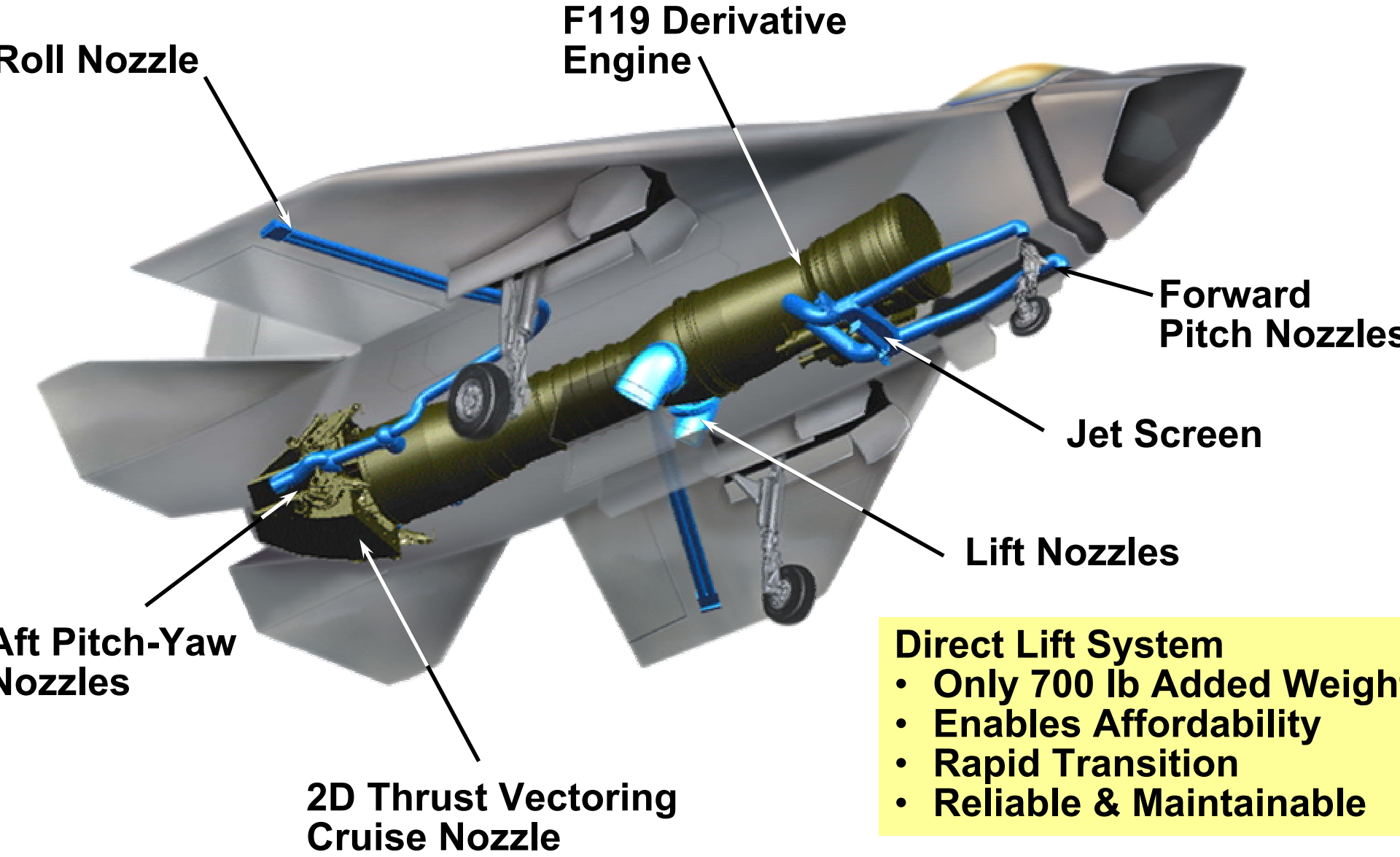
STOVL

- Direct Lift System

CV

- Dual Nose Gear, Arresting Ho

BOEING PROPULSION SYSTEM



Direct Lift System

- Only 700 lb Added Weigh
- Enables Affordability
- Rapid Transition
- Reliable & Maintainable

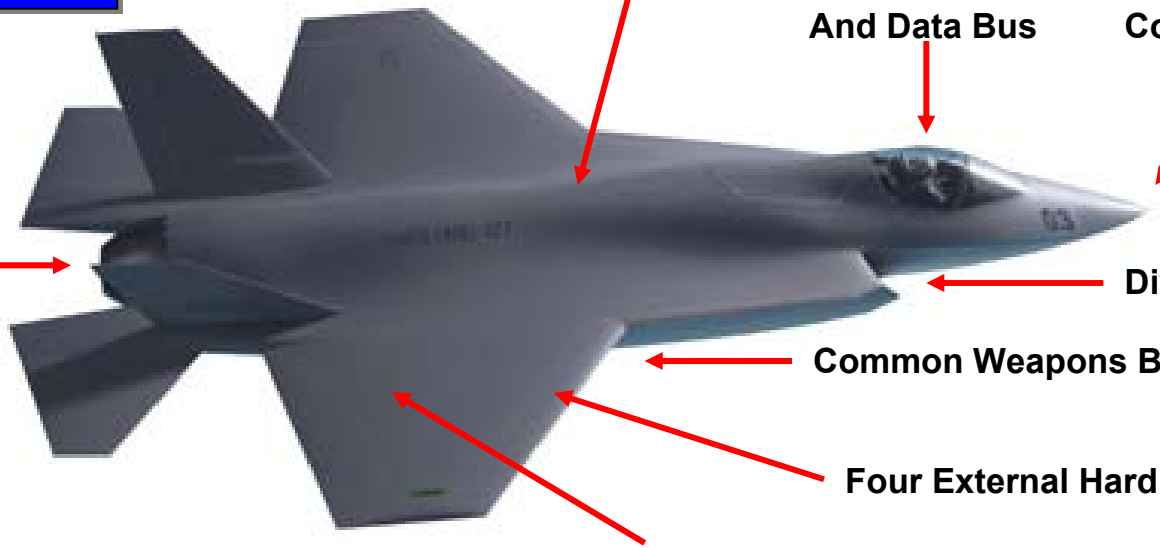
LOCKHEED MARTIN

USAF CTOL

USN CV

MULTI-SERVICE PREFERRED DESIGN CONCEPT

Common Characteristics



STOVL

- Lift Fan
- 3 Bearing Swivel Nozzle
- Missionized Gun

CTOL

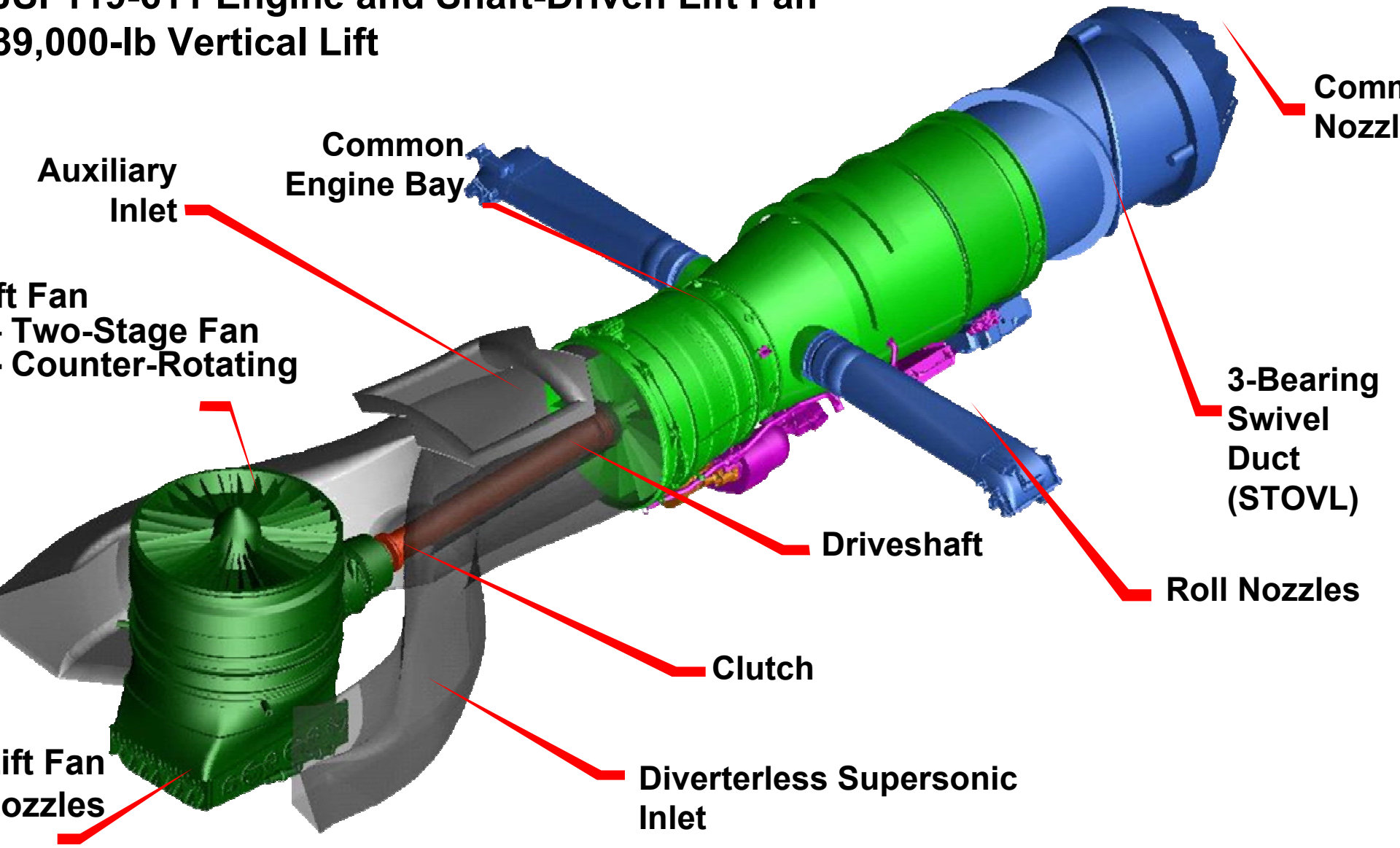
- Lo Axi Nozzle
- Internal Gun

CV

- Wing Tip Fold
- Higher Strength Gear
- Unique Control Surfaces
- Missionized Gun

LOCKHEED MARTIN PROPULSION SYSTEM

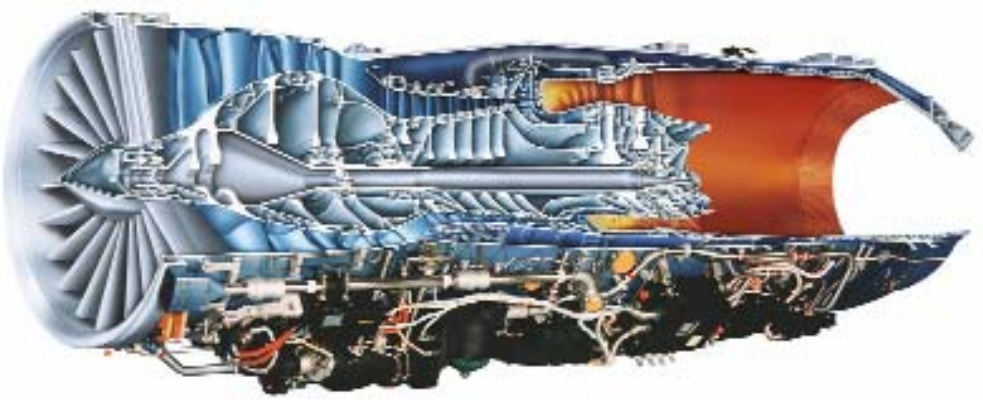
JSF119-611 Engine and Shaft-Driven Lift Fan
39,000-lb Vertical Lift



JSF ENGINES

Primary

F119 Derivative



Interchangeable

F120 Derivative

JSF engines - - common core for aircraft variants, competition in production

JSF INTERNATIONAL PROGRAM

COLLABORATIVE PARTNER

UNITED KINGDOM

INFORMED PARTNERS

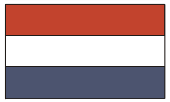
CANADA

ITALY

ASSOCIATE PARTNERS

DENMARK

NETHERLANDS



NORWAY

FOREIGN MILITARY SALES CUSTOMERS

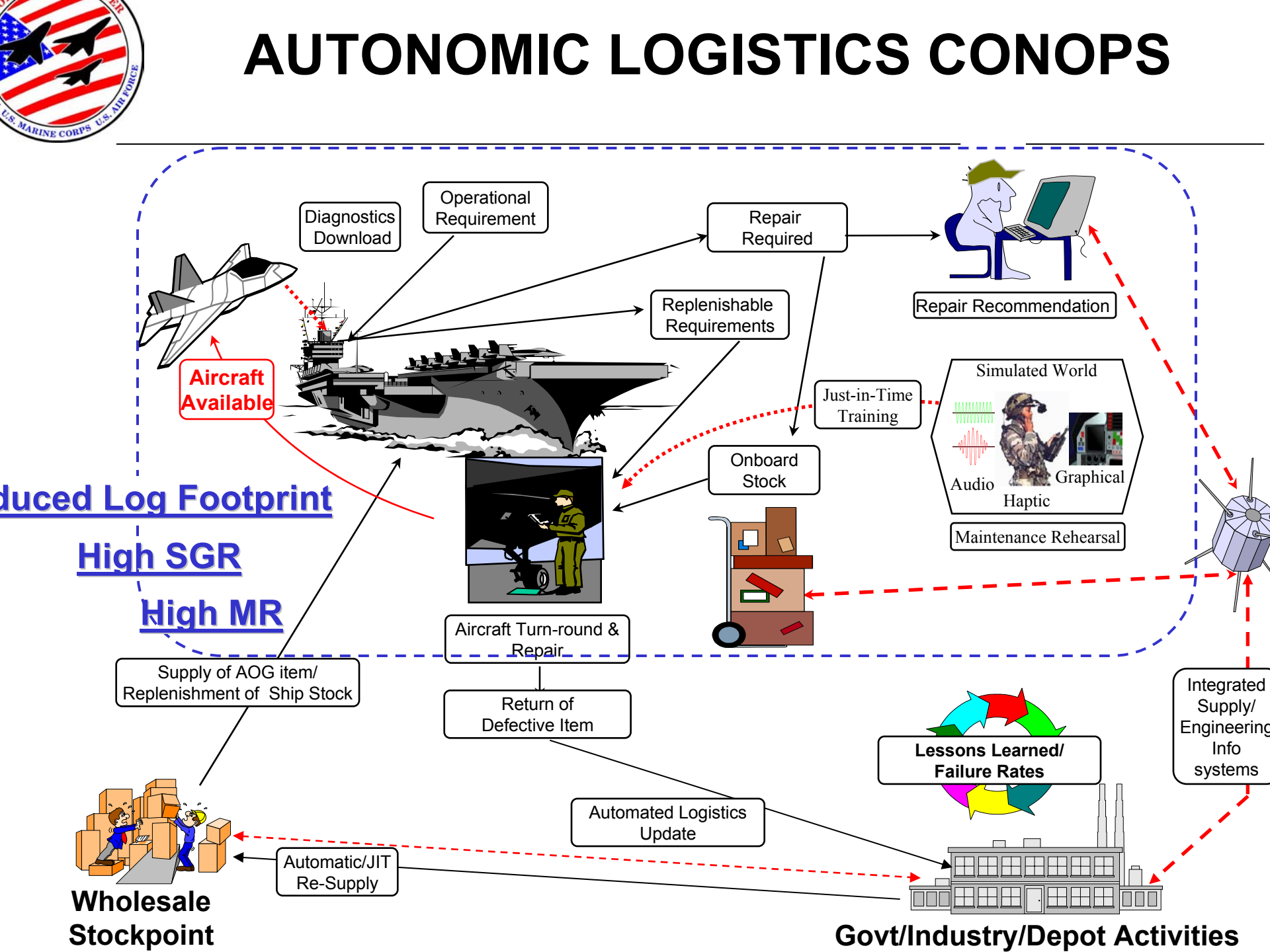
SINGAPORE

TURKEY

ISRAEL

Up To 3000 International JSFs

AUTONOMIC LOGISTICS CONOPS



AUTONOMIC LOGISTICS VISION

- **A comprehensive logistics support environment for the JSF which has these key features:**
  - A highly reliable aircraft which encompasses Prognostics and Health Management
  - A technologically enabled warfighter
  - A Joint Distributed Information System
  - A logistics infrastructure that is sufficiently responsive to support requirements

CONCEPT DEMONSTRATION PHILOSOPHY

X-32A First Flight
18 Sep 2000

X-35A First Flight
24 Oct 2000

- **Two teams - Designations assigned**
  - Boeing X-32A (CV/CTOL), B(STOVL)
  - Lockheed Martin X-35A/B (CTOL/STOVL), C (CV)

- **Two aircraft per team - Sufficiently representing the PWSC to satisfy demonstration objectives**
  - Commonality/Modularity for an affordable family of multi-service variants
  - Successful short takeoff, vertical landing, hover and transition
  - Satisfactory low-speed carrier approach flying and handling qualities

WHERE ARE WE TODAY?

JSF CONCEPT DEMONSTRATION PHASE

FY 94 | FY 95 | FY 96 | FY 97 | FY 98 | FY 99 | FY 00

Requirements Evolution/Cost as an Independent Variable (

Initial Req. Document

JIRD II

JIRD III

Draft JORD

JORD Signed

EMD START

Concept Exploration

Concept Development

Concept Demonstration & Flying Demonstrators

1st Flight

MS II

RFP | PROP | SS | Concepts X-32 & X-35 | CFI | PROP | SS

High-Lev Tech & Demos

Structures & Materials

Flight Systems

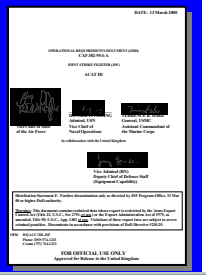
Manufacturing & Production

Mission Systems

Supportability

Propulsion

- Joint ORD Validated by JROC Mar 2000



- CDP Flight Testing On-Going

- EMD CFI Released
- Source Selection Activities On-Going

- Successfully Leveraged Technologies

TECHMAT SUCCESSES

Integrated Flight and Propulsion Controls
- CTOL Demo Successfully Completed Fall 2000
- STOVL Demo Scheduled for Spring 2001

Propulsion
- Completed Advanced Augmenter Tech Program
- Risk Reduction Effort on Improved Hot Section Components

JSF Integrated Subsystem Technology (J/IST)
- First Flight 24 Sep 2000

Supportable Low Observable (LO)

Avionics/Open System Architecture
- Contractor Flights Completed

Prognostics & Health Management
- Propulsion Seeded Fault Test

EMD INTERNATIONAL PARTICIPATION

- **Cooperative Partner**

  Level I - UK Memorandum of Understanding (MOU)
  Signed 17 Jan 2001

- **On-Going Negotiations**

  Level II - Italy

  Netherlands

  Turkey

  Level III - Canada

  Denmark

  Norway

BOEING X-32A (USAF / USN)

FLIGHT TEST:

- CTOL/CV First Flight on 18 Sep 2000
- 66 Flights, 50.4 Hours
- CTOL/CV Flight Test Completed 5 Feb 2

SIGNIFICANT ACCOMPLISHMENTS (CTO

- Supersonic on 21 Dec 2000
- Aero Performance
- Completed CTOL Flying Qualities
- Afterburner Ignition Completed
- 6 Pilots (Boeing, USAF, USMC, USN, RN
- Weapons Bay Acoustic Testing Comple
- Flew to Palmdale, CA for Storage

BOEING X-32A (USAF / USN)

SIGNIFICANT ACCOMPLISHMENTS (CV

- **All Field Carrier Landing Practice (FCLP) Completed**
- **Auto Throttle Flying Qualities Successfully Evaluated**
- **Completed CV Flying Performance an Qualities**

BOEING X-32B (USMC / UK)

FLIGHT TEST:

- **First Flight on 29 Mar 2001**
- **21 Flights, 21.3 Hours**

SIGNIFICANT ACCOMPLISHMENTS:

- **Basic Air Worthiness Testing**
- **First STOVL Flights (at altitude) 13 Apr 20**
- **X-32B arrived at Patuxent River, NAS on 11 May 2001, where it will conduct the STOVL portion of the Flight Test Program**

LOCKHEED MARTIN X-35A (USMC / USAF

FLIGHT TEST:

- CTOL First Flight on 24 Oct 2000
- 27 Flights, 27.4 Hours
- CTOL Flight Test Completed 22 Nov 200

SIGNIFICANT ACCOMPLISHMENTS:

- Aero Performance
- Qualified for KC-135 Inflight Refueling
- Flight Handling Qualities
- Supersonic Flight
- 6 Pilots (LM, USAF, USMC, RAF, BAE)
- All CTOL Objectives Met
- Complete Engine Checkout to Include F
  Afterburner Employment

LOCKHEED MARTIN X-35B (USMC / UK)

FLIGHT TEST:

- First Flight Planned for Late June/Early July 2001

SIGNIFICANT ACCOMPLISHMENTS:

- STOVL Propulsion System Completed Development, Qualification and Endurance Testing
- X-35B STOVL Variant Modifications fro X-35A CTOL Configuration Complete
- Flight Ready STOVL Propulsion Systen Installed & Full Power STOVL Engine Tests Complete
- Final Integrated Software Qualification Underway

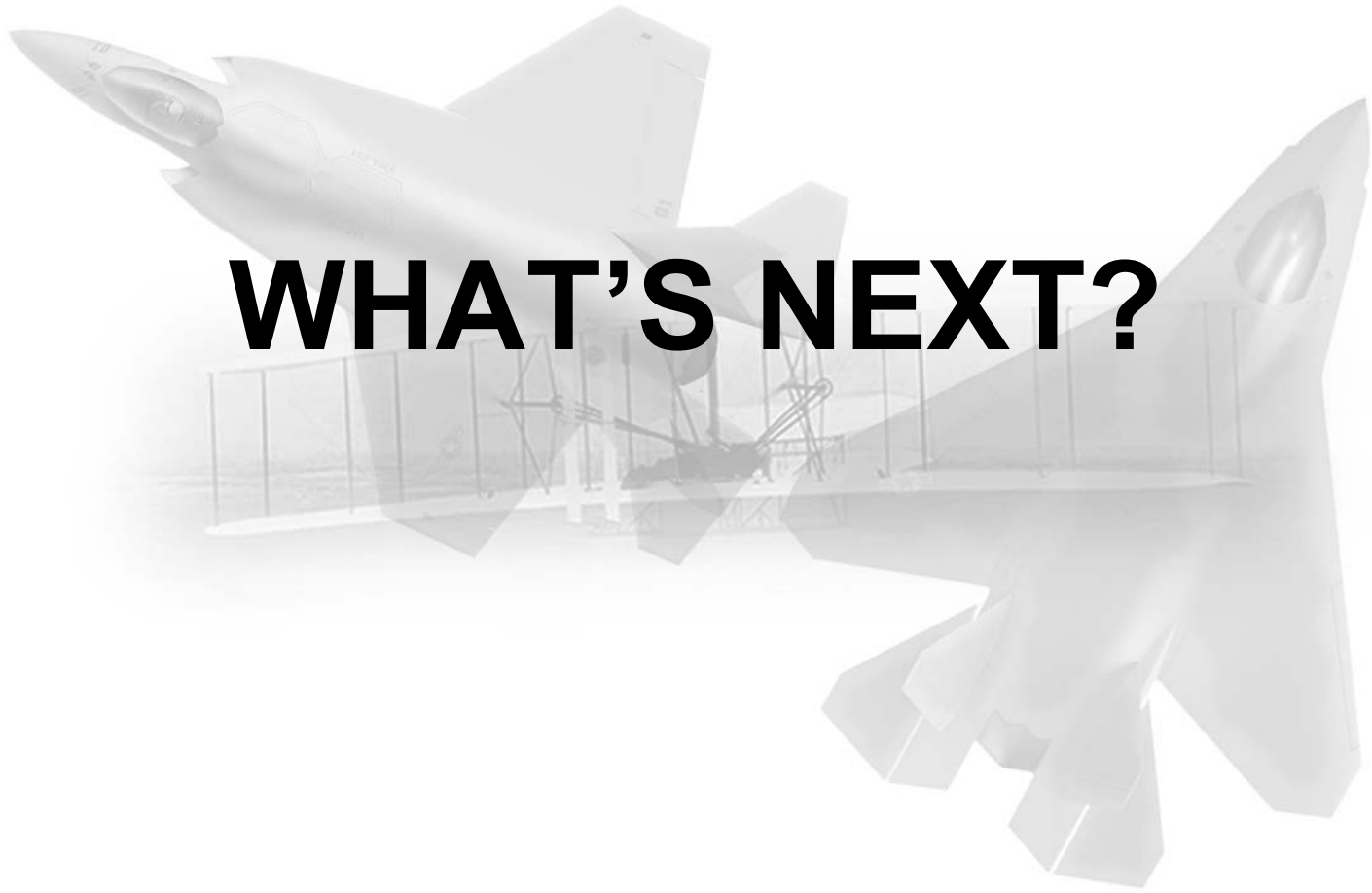
LOCKHEED MARTIN X-35C (USN)

FLIGHT TEST:

- CV First Flight on 16 Dec 2000
- 73 Flights, 58 Hours
- CV Flight Test Completed 10 Mar 2001

SIGNIFICANT ACCOMPLISHMENTS:

- Field Carrier Landing Practices (FCLP)
- Aero Performance
- Flight Handling Qualities
- 8 Pilots (LM, USN, USAF, USMC, UK, BA
- Engine Checkout to Include Full Afterburner Employment
- Qualified for KC-10/KC-135 Inflight Refueling
- Supersonic Flight
- Transcontinental Ferry Flight to Patuxe



WHAT'S NEXT?

SPIRAL DEVELOPMENT VS EVOLUTIONARY ACQUISITION

Spiral Development

Requirements + Product } Continuously Evolve Together

Evolutionary Acquisition

JSF CDP

Requirements + Product Concept + Tech Mat } Evolve Together

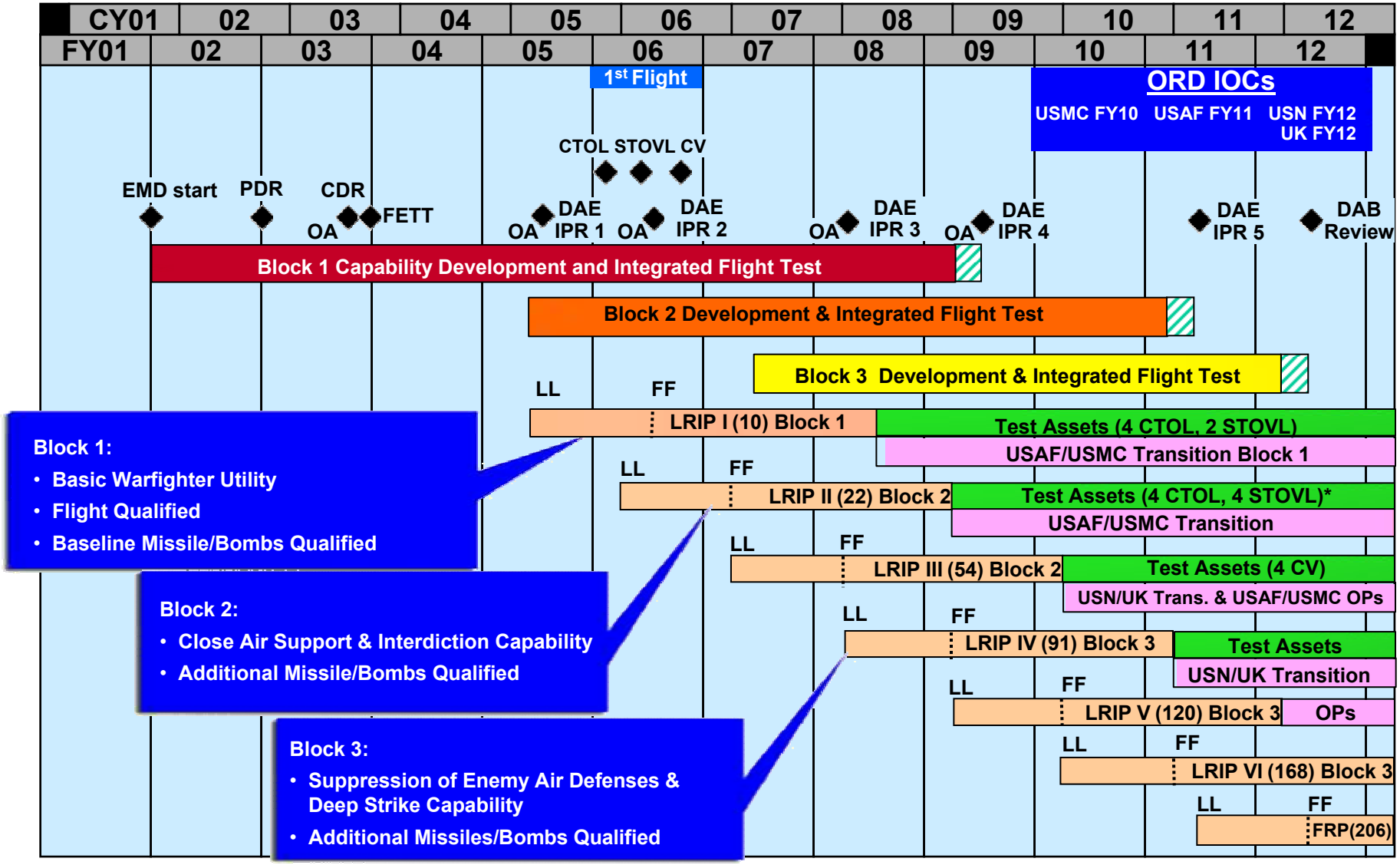
JSF EMD

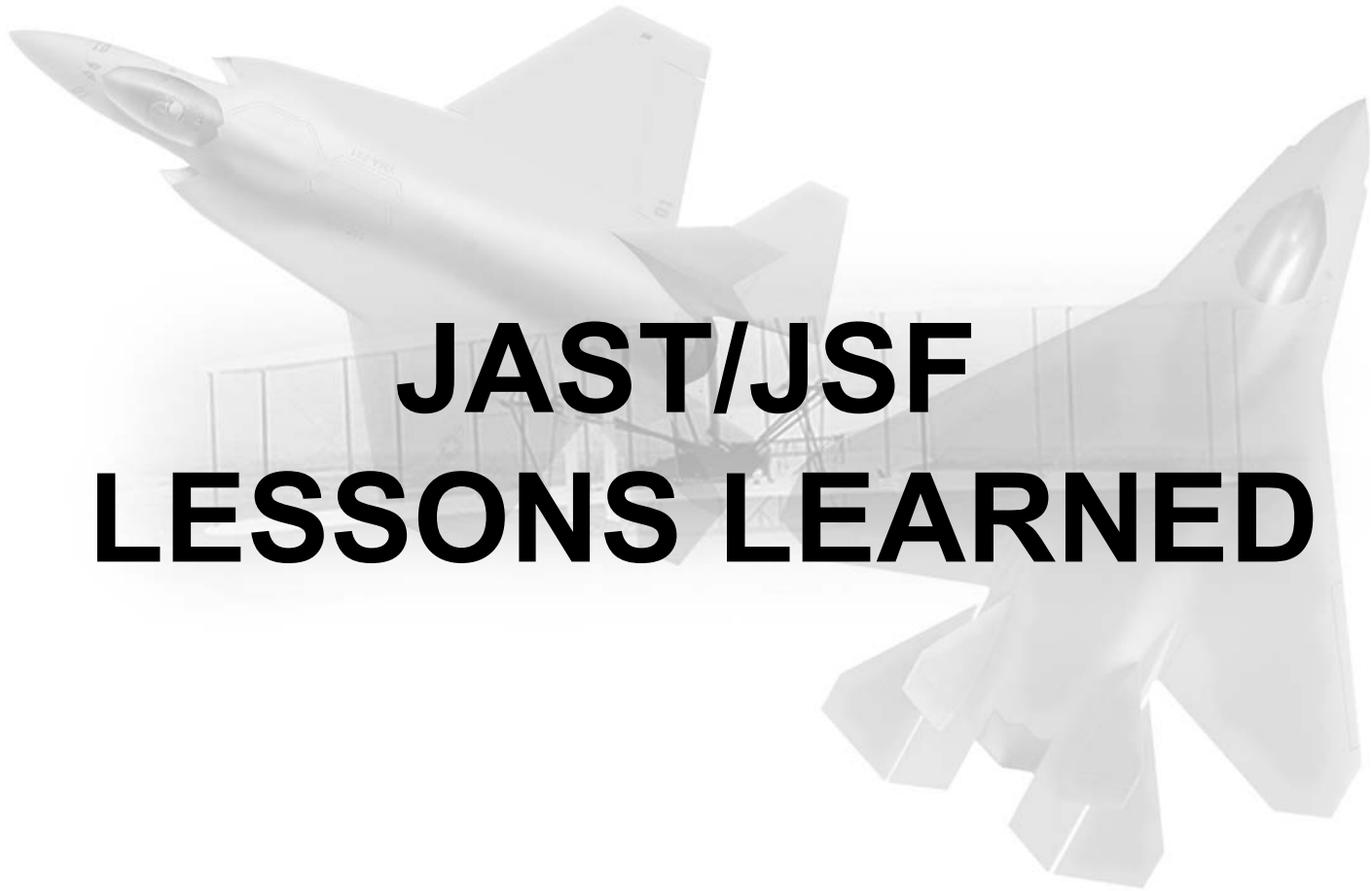
Requirements Done

Product Implementation in 3 Increments

94 — CJCS 3170.01A — 02

JSF EMD SCHEDULE





JAST/JSF
LESSONS LEARNED

ATTRIBUTE & TECHNOLOGY HIERARCHY PROCESS ISSUES/LESSONS LEARNED

- **Supportability attributes did not score well against warfighting tasks: because they are mainly peacetime based**
  - Exceptions—Sortie Generation Rate (SGR), Logistics Footprint
    - System Commonality, Maintainability, Reliability
- **Solution: Additional supportability attributes were defined and voted on separately by maintainer-warfighters**
- **Each attribute definition MUST be agreed to and documented**
- **QFD worked well—But better/more robust methods exist — e.g., Analytical Hierarchy Process (AHP) and Linear Programming**

AFFORDABILITY/COST GOALS LESSONS LEARNED

- **Cost Goals Need to realistic, aggressive and defendable!**
- **JSFs $28 Million (FY94) CTOL Unit Recurring Flyaway (URF) served it's purposed extremely well…!!!!!!!!!!**
  - However, to some it did not leave enough design space for achieving/defining "Best Value"
- **Set a Range of Values—"Threshold" and "Goal"**
  - Competition is a great motivator to achieve the "Goal" Costs
  - Once a number is published it might as well be carved in stone
- **Accepted advanced cost estimating is a joint industry & Gov effort**
  - Industry team has the best handle on technology impacts
  - Government performs the "Reasonableness" cost assessments

REQUIREMENTS DEFINITION ISSUES & LESSONS LEARNED

- **The vast majority of the JSF Requirements are stated in a Performance Based Specification(PBS) format vice a Detailed Technical Specification**

- **PBS format is the only way one can define the requirements "Thresholds" and give the contractor the <u>design space</u> to optimize their design for "Best Value"**
  - Requirement Thresholds/Objectives/Goals are all defined in the ORD

- **Writing a Performance Based Specification was a lot harder than many initially thought**
  - Need early DT and OT community involvement in defining requirements to help ensure "Testability"

Performance Based Spec Tells The Contractor

What It Has To Do...Not How to Do It!

CAIV LESSONS LEARNED

- **Need to develop and execute a disciplined and structured requirements and trade study approach early if affordability is a requirement**
  - Requires significant up-front investment in terms of time and money
  - Requires some lead time in the schedule for requirements analysis
    - Define the design space before the designers start designing
  - Keeps all players on the same field working as a team

CAIV LESSONS LEARNED (CONT.)

- **Without cost, and performance goals/constraints:**
  - Warfighters/Users revert to business as usual “More is Better”-- Wants become needs
  - Engineers strive for perfection with more design iterations, more tests and push the latest technology
- **Warfighters/Users must prioritize requirements**
  - Prioritization must be updated with increased knowledge

“Better is the enemy of good enough!”

SUMMARY

- It's a Multidimensional problem. Cost is influenced by multiple performance parameters
- Performance and cost shape the design solution space
- System performance and cost are typically driven by a few subsystems and components
- Concentrate on key design performance and cost/manning drivers -- avoid working the margins
- Cost and performance dynamics must be understood

Cost, Performance and Supportability Must Be Linked, And Linked Early to Influence the Design

BOTTOM LINE

- **Operators (Pilots & Maintainers), and Developers (Engineers & Cost and Operational Analysts) need to work continuously as a team:**
  - To fully understand cost and performance impacts
  - Perform continuous trades required to define "Best Value" solutions

- **The sooner you institute the CAIV process the more benefits you will realize**

CAIV is a philosophy that must be lived every day of a program and at every level in the program

JOINT STRIKE FIGHTER

The Next Generation Strike Fighter