Presented to:

RAM 6 Workshop

U.S. ARMY RDECOM

The Key Role of RAM Moving Forward "The Big Vectors"

AMRDEC

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Presented by:

Mr. James Lackey (SES)

Director, Engineering Directorate

U.S. Army Aviation and Missile Research, Development, and Engineering Center

Wide Role of RAM

- **Readiness**
  - **OPTEMPO, Unit Budget, PLL Levels, Unit Training**

- **Life Cycle Cost**
  - **Developmental Cost, Sustainment cost**

- **Safety**
  - **Failure Modes and Effects, Operator Training, CSI, Fail safe**

- **Availability**
  - **Logistics time, Ready time, Administrative downtime, preventive / corrective maintenance downtime,**
  - **Quantity and proximity of spares**
  - **Tools and Manpower to the hardware item**
  - **Spares: Purchase price, Obsolescence, Logistics, Sparing, Stockage, Budget**

Engineering design characteristics to enable "more bang" (for missions) - with "less bucks" (for support)

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Infusion Into Policies
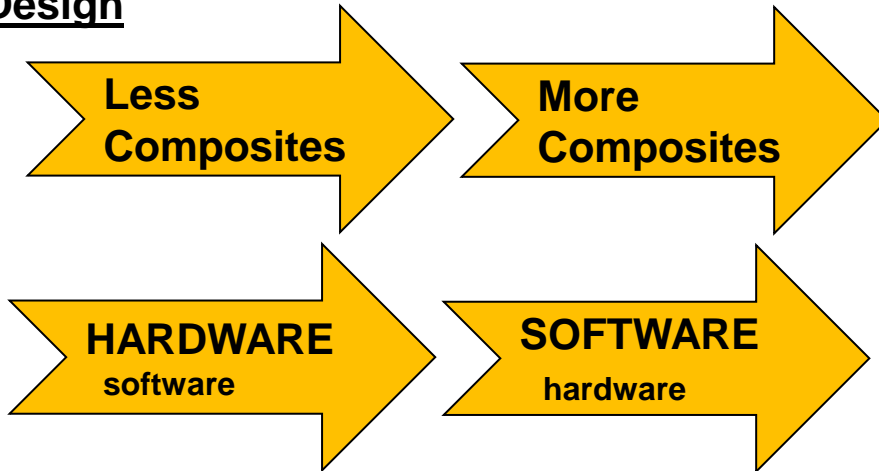# ...Elevation of Visibility
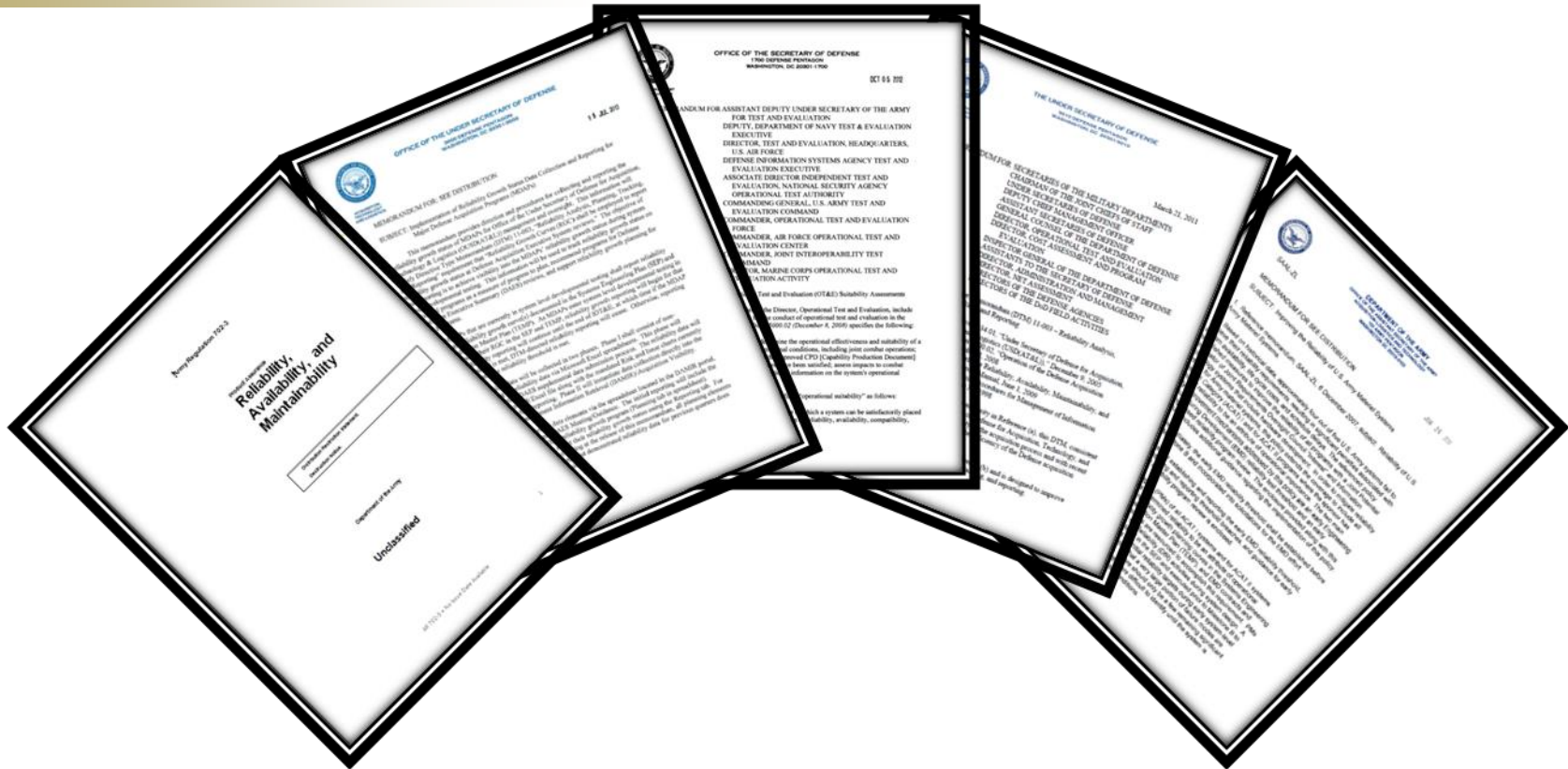
- **RAM-C formalized in acquisition process.**
- **Reliability Growth reporting to DAES.**
- **Significant changes to Reliability scoring.**
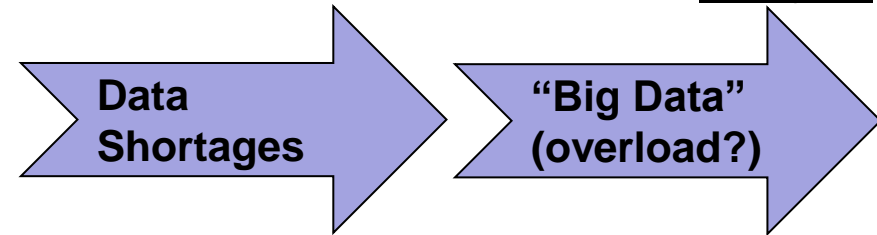- **Increased requirements for Reliability Growth Curves.**

If you do not know the latest policy, ask for help.

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"The Big Vectors"
(among other examples)

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Design

Less Composites → More Composites

HARDWARE software → SOFTWARE hardware

Analysis

Data Shortages → "Big Data" (overload?)

Budget

Less Expensive Weapons → More Expensive Weapons

Stable POM → Defense Drawdown

Programmatic

Less Program "New Starts" → More ECP's

DoD as "Big Spender" → DoD as "Minor Player"

Operational

Division Based → Task Force Based
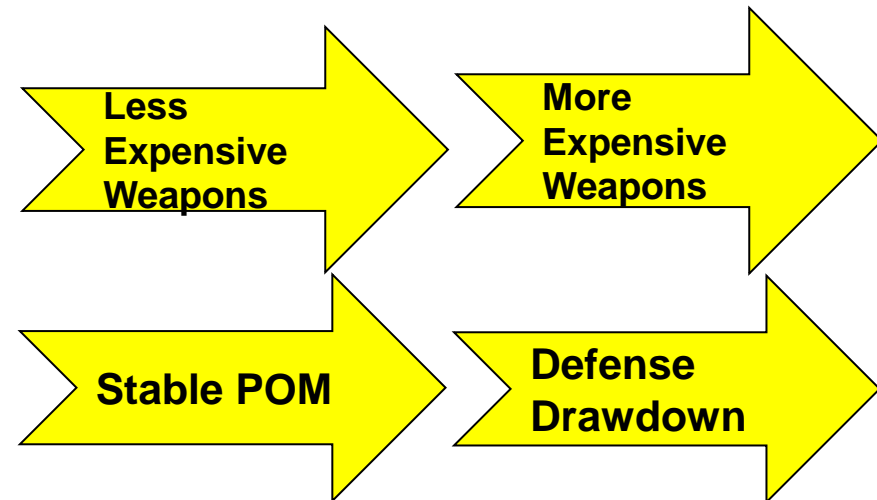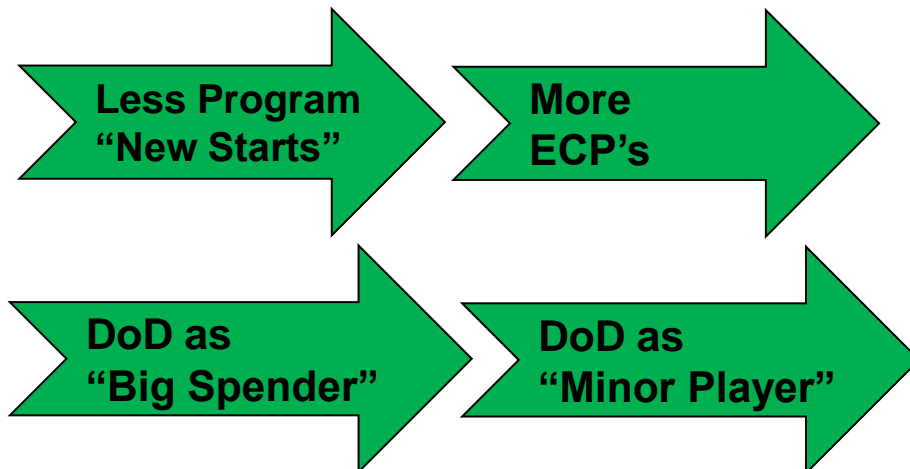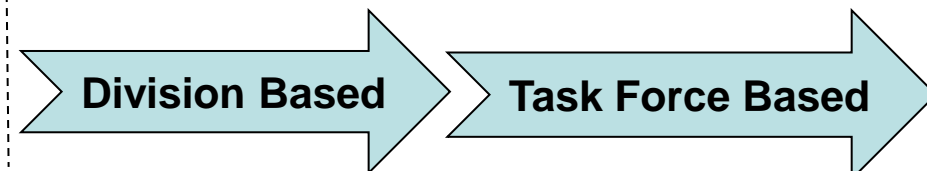
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DESIGN

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Aircraft Composite Content For Select Airframes
% of structural weight

Military Aircraft in Blue

- Next Generation Narrowbody Transport (expected ~2015)
- 787 — 50%
- A350 XWB (latest) — ~51%
- A350 (mid 2006) — ~44%
- V-22 — 40%
- EUROFIGHTER — 40%
- F-35 JSF — ~38%
- A400M — ~35%
- B-2 — ~32%
- GRIPEN — ~25%
- RAFALE — ~26%
- F/A-22 — ~24%
- A380 — ~25%
- F/A-18E/F — ~22%
- A320 — ~15%
- A330/A340 — ~13%
- 777 — ~11%
- F/A-18C/D — ~10%
- A310 — ~8%
- A300-600 — ~4%
- MD-11 — ~4%
- 757 — ~3%
- 767 — ~3%
- 737-300 — ~3%
- 747-400 — ~1%
- MD-80 — ~2%

Years: 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015

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Rising Influence of Composites ...So What?

Metals	Composites	The Implication
Fatigue Cracking	Fatigue Tolerant	Catastrophic Failure
Corrosion Prone	Corrosion Resistant	Galvanic Corrosion
Easily Damaged	Damage Tolerant	Difficult to "Identify" Damage Visually
Easy Field Repairs	Field Repair Difficult	Cleanliness and Equipment Requirements Matter
Well Understood From Design Perspective	Limited Experience for Primary Structure	Slow to accept due to "unknown risks"

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- **DoD systems are increasingly software-reliant**
  - **50% of the functional features**

- **Data Fusion driven mission systems**
  - **Mission computers**
  - **Sensors**
  - **Air Vehicle Controls**
  - **Communications**
  - **Mission planning**

- **Software**
  - **Nonlinearity**
  - **Complexity**

- **Cannot test all possible failure modes**

Chart: SLOC in thousands

- F-16A Block 1 (1974): 135
- F-16D Block 60 (1984): 236
- F-22 Raptor (1997): 1,700
- F-35 Lightning II (2006): 6,800 — Operational Software
- F-35 Lightning II (2012): 24,000 — Operational & Support Software

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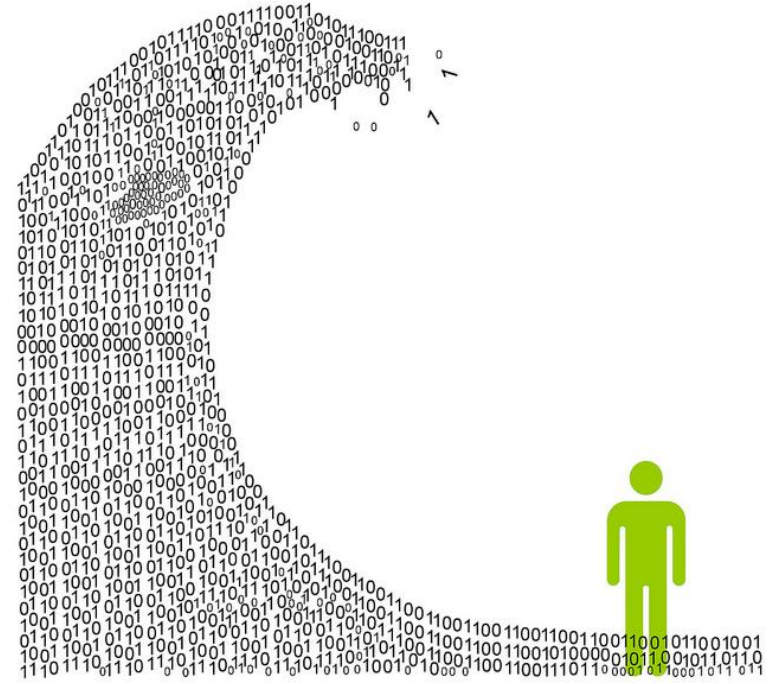# HARDWARE / software → SOFTWARE / hardware ...So What?
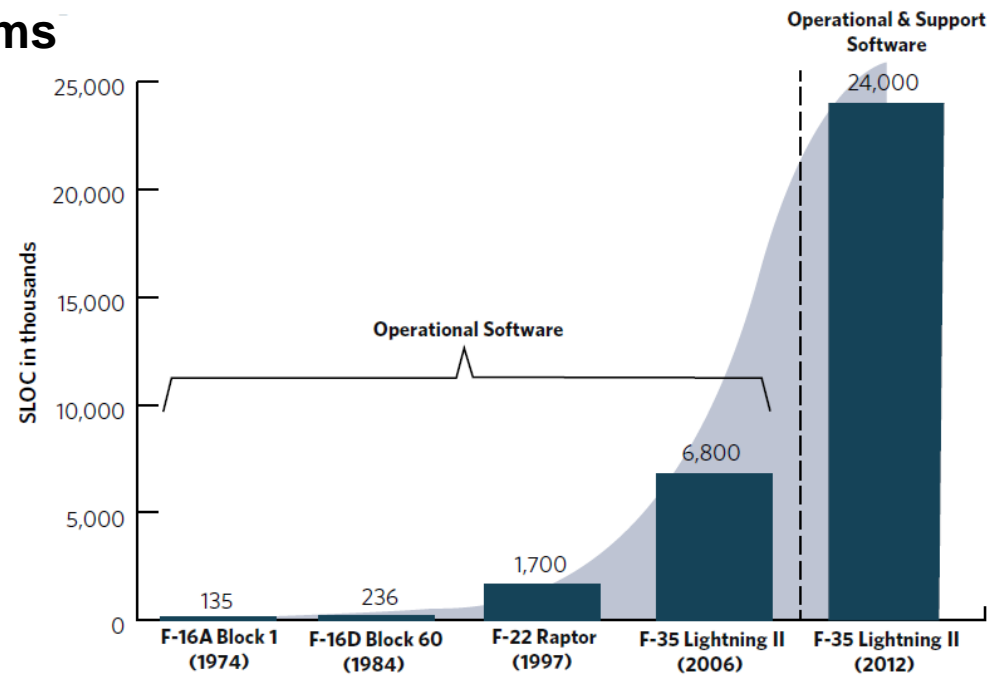
- **Army is learning**
  - RAM engineers have traditionally unfamiliar been with SW
  - PM/OEMs underestimate the required SW development schedule and resources
    - SW delivery late
    - SW development eats up development resources (schedule and hardware)

- **HW RAM Tools that _do not translate_ well to SW**
  - Reliability Growth and Predictions

- **HW RAM Tools that _do translate_ well to SW**
  - FRACAS, FMECA

- **Over 225 models have been developed to estimate SW reliability**
  - Models Based on
    - Amount of Software Lines of Code (SLOC)
    - Amount of defects per test event
      - Defect Severity
      - Test Duration
    - Amount of reuse and new code (estimate)

**Learn and Adapt
Watch One, Do One, Teach One**

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ANALYSIS

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Analysis
Data Shortage → "Big Data" Overload

The amount of telemetry coming from the system has ballooned

The amount of information the Warfighter is expected to process and integrate is taxing his capability.

Adding tasks to the Soldier
But…Are Soldier tasks capped?

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Data Shortage → "Big Data" Overload ...So What?

- **The designer/RAM engineer objectives must change**
  - **Old Goal: Get failure indication to Operator/Maintainer**
  - **New Goal: Give the right person the right information at the right time**

- **CBM pushing maintenance tasks from *Scheduled* to *Condition Based***
  - **RCM tool does this efficiently and logically**

- **Do not confuse Big Data with Big sample size!**
  - **Statistical Analysis still limited by test time or sample/fleet size (Cost)**

- **Management of Expectations**
  - **HUMS, CBM, "Big data", etc. are not Silver Bullets**
    - **Addition of Tools in RAM toolbox**
    - **Solve some of the problems, some of the time**

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PROGRAMMATIC

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Bell AH-1 Cobra

Apache AH-64

Apache AH-64D

Apache AH-64D Block 3 (Now E)

Cancelled

Comanche RAH -66

Incremental Improvement On Tail #xxxxxx

**Engineering changes evolving toward
continuous small improvements**
- ✓ **Quicker Implementation**
- ✓ **Less Bureaucracy**
- ✓ **Brick by Brick**

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- **Milestones, Reviews, and formal Data Delivery not part of Acq. Strategy**
  - Greater integration in PM day-to-day work
    - Reach-in, make a presence, add Value
  - Greater understanding of Engineering to know where RAM is needed
    ...and where not!

- **Take a *proactive role* to ensure RAM is considered**
  - Deeper RAM involvement in Systems Engineering and Trades
  - Development Life Cycle Multi-tasking
    - Some design changes in concept w/others going to fielding
    - RAM assessment will be complicated by complex configuration mgmnt.
  - Apply "Synergistic RAM Data Collection" (Piggy Back → Reduce Cost)
  - Create a coalition with Logistics / Supportability and Engineering domains

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Balance of power has shifted from Buyer (DoD) to Seller (OEM)
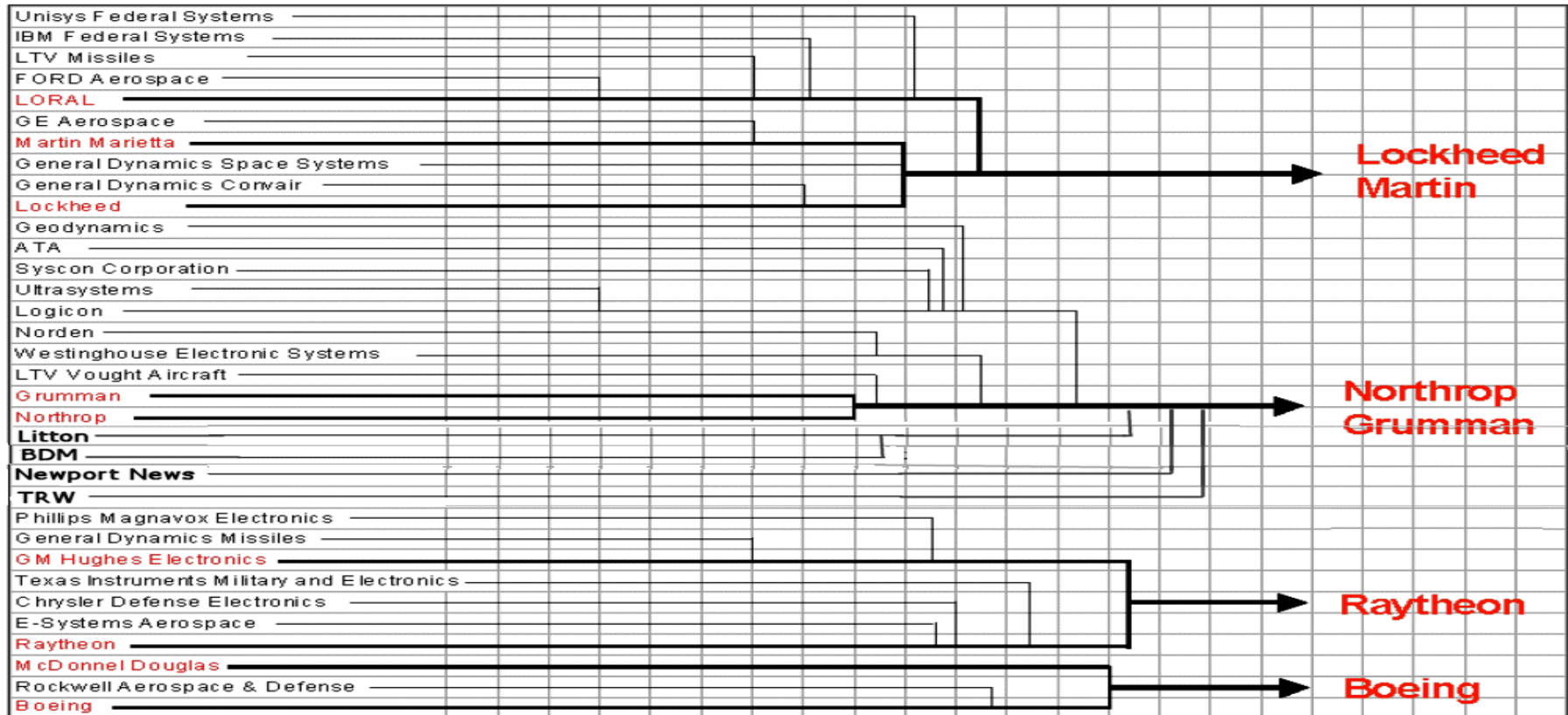
For the remaining OEMs, DoD may not be their core business (ie. Boeing Commercial)

For Big DoD OEMs, the Army may not be their big customer (ie. Lockheed Martin – JSF!)

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- **OEM competition can no longer force value**
  - Value driven by ___RAM expertise___ and ___Engineering expertise___
  - Government will perform greater role in RAM work

- **OEMs putting pressure on PMs to cut RAM/developmental testing and RAM Data**
  - Know what to fight for and what to give up ___Pick your battles___
  - ___Be sensitive to COST…appreciate what the Program Manager has to deal with___

- **The Traditional Delivery of RAM product will be challenged**
  - OEMs can deliberately price Data out of contract negotiations
  - Must go after what you need in contractor format
    - CDRL's versus informal data – what makes sense when and why?

- **New, Smaller OEMs (Unmanned Systems) getting a greater market share**
  - Fight to maintain commercial practices
  - Lack of understanding of Army RAM requirements

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BUDGET

Bell AH-1 Cobra

$ 450K

Apache AH-64 A

$ 20M

Apache AH-64 E

$ 32M

Price of aircraft has risen due to:

- Fewer numbers of OEMs – less competition
- Less quantities demanded – and qty's cut during POM cycle
- Improved capability / performance mission requirements (stealth, optics, etc.)
- Complexities of system-of-system and interoperability requirements
- Corporate Overhead Costs; Prime's increasingly acting as System Integrators
- Increased Use of Titanium, Composites, and other Materials

Tests are _too few and too expensive_ for traditional RAM development evaluation

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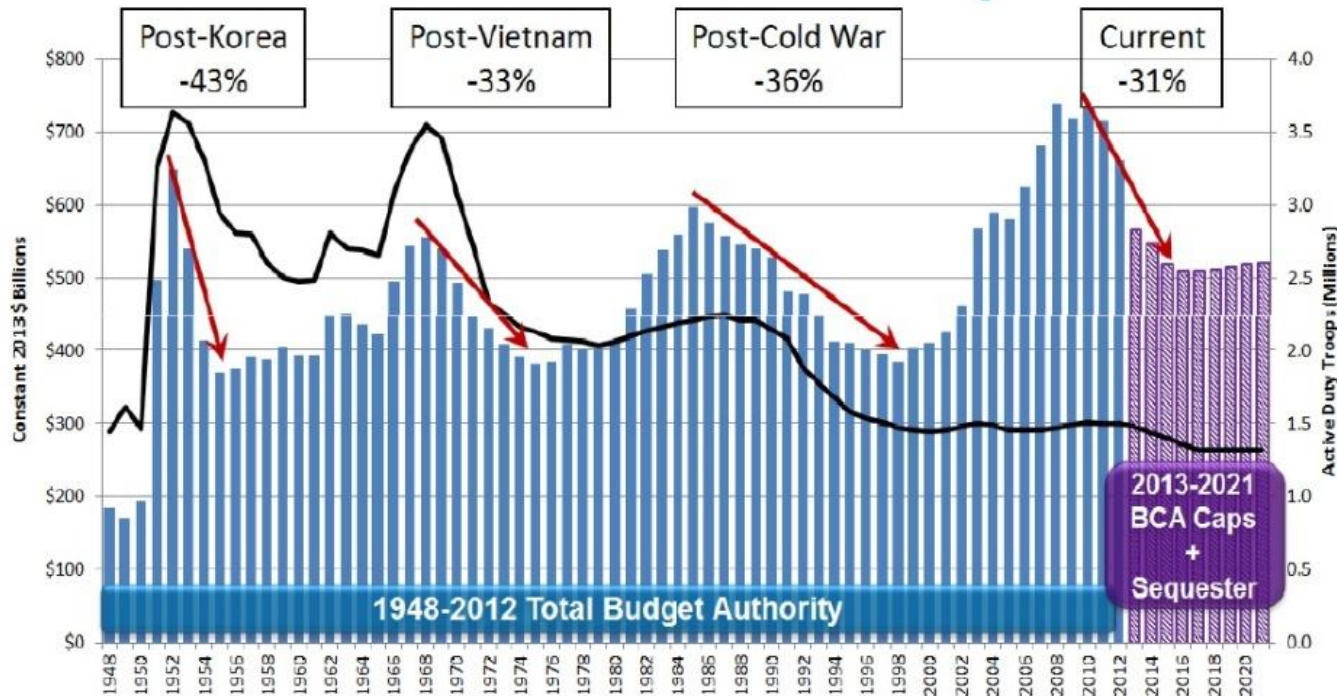
- Dedicated reliability DT that demonstrate 90% confidence → <u>too</u> <u>cost</u> <u>prohibitive</u>

- More *cost effective* approaches
  - Actively mine RAM development data form all available sources
  - Establish and preserve RAM test assets and schedule
  - Testing for Reliability Growth
  - Maintainability Demonstrations
  - Expand the RAM toolkit
    - Modeling
    - Bayesian (progressively add knowledge)
  - Extend RAM T&E past fielding. Field system assessment will
    - Close loop for linger development risks
    - Identify Areas for RAM improvement
    - Lay the groundwork for the next upgrade
    - Stockpile Reliability Programs will have to evolve

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Defense Drawdowns Compared

| Post-Korea -43% | Post-Vietnam -33% | Post-Cold War -36% | Current -31% |

1948-2012 Total Budget Authority

2013-2021 BCA Caps + Sequester

Note: Topline in out-years includes the Congressional Budget Office (CBO) estimate of overseas contingency operations (OCO) based on a phased drawdown to 30,000 troops in 2017 and remaining flat thereafter.
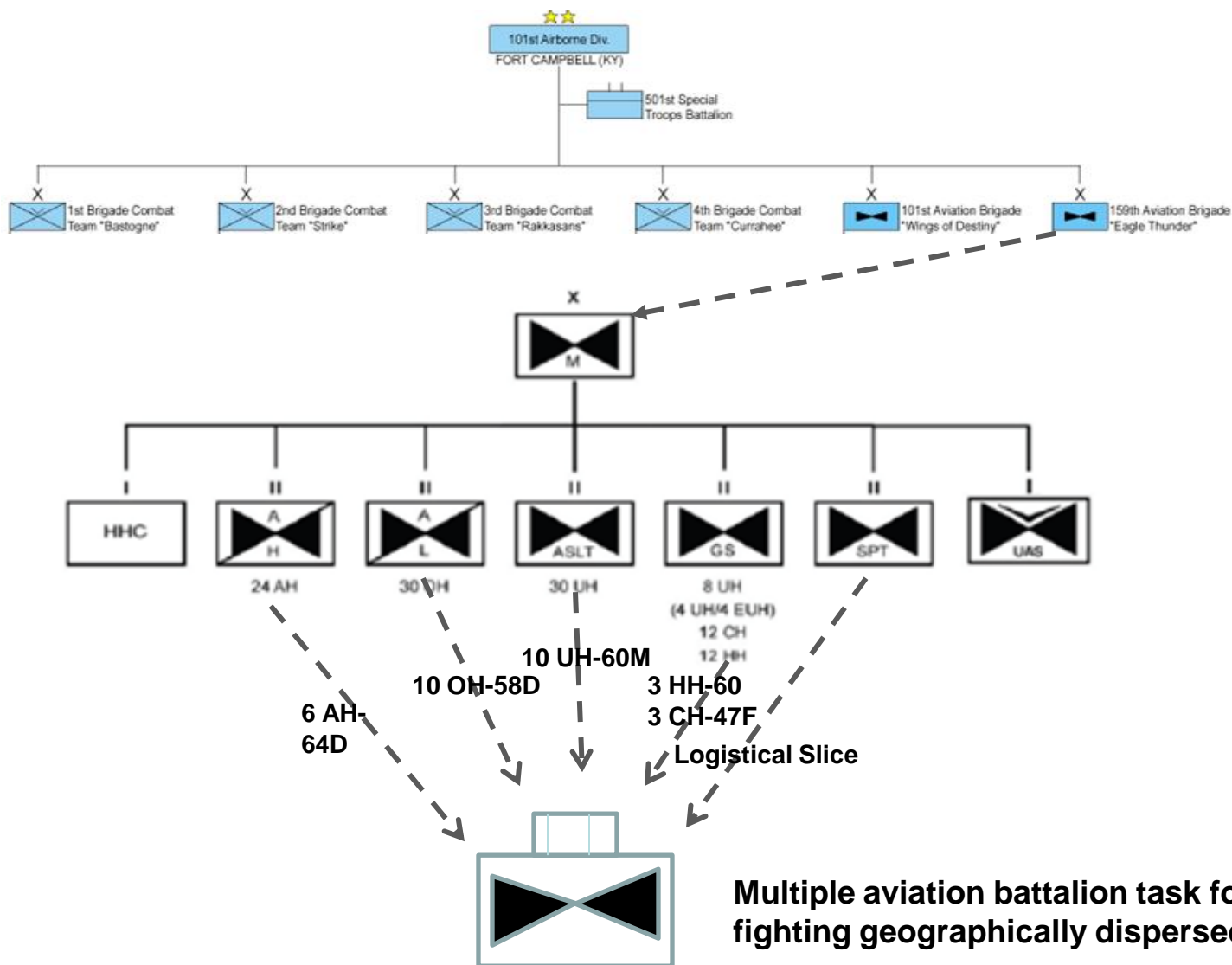
Sources: Department of Defense, *National Defense Budget Estimates for Fiscal Year 2013 (Green Book)*, Office of the Under Secretary of Defense (Comptroller), March 2012; Congressional Budget Office, Long-Term Implications of the 2013 Future Years Defense Program, July 2012. Analysis by CSIS Defense and National Security Group.

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- **Resources**
  - Stable POM → Budget secondary to winning
  - Drawdown → **All about the Dollar**
  - Generation of Warfighters who have never balanced a checkbook
    - Help them through a period of adjustment

- **Fluctuations due to force structure drawdown**
  - Data, Usage, Reliability, Parts, etc.
  - Help Warfighter through this Period of Major Adjustment
  - Trending will be difficult

- **Oh By The Way…The Pentagon is a Big Building with lots of folks (e.g., OSD)**
  - In a Defense Drawdown, a lot more will be looking for something to do…
    …Expect a Drastic increase in RAM oversight ("I'm here to Help!")

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OPERATIONAL

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Operational
Division Based → Task Force Based

Multiple aviation battalion task forces fighting geographically dispersed

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Division Based → Task Force Based ...So What?

- **Big Strain on Maintenance Test Pilots, Technical Inspectors, AMCOM Engineers, Logistics Assistance Representatives**

- **Commonality on platforms - Commonality between platforms**
  - Special tools
  - Repair parts
  - Support Equipment
  - Depot Level Repair Capability

- **Variances in platform phase maintenance**

- **Work harder to mine data**
  - JTDI increased importance

RAM Design MUST Work for the Way We Fight

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Summary

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Make yourself *VALUE ADDED* !

- **Anticipate PMO needs, ensure RAM with minimal impact to cost and schedule.**

- **Know RAM policy, work to apply it without negative impact.**

- **Look outside of design to improve RAM (Quality, Manuals maintenance, etc.).**

- **Know the system as well or better than PMO**
  - **Know what each part look like and what they do.**

- **Check your work with the Soldier**
  - **A solution that does not work in the field does not work.**

- **Get your numbers right and then stand by them!**

- **Deliver bad news early (it won't get better with time).**

- **Fight for the Soldier, get him on your side.**

> **The Soldier fights for your family due to your U.S. citizenship**
>
> **If you are *Value-Added* to the Soldier…the Soldier will recognize!**

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