Advanced Extremely High Frequency (AEHF) Program

Mission Control Segment (MCS)

GSAW Conference Presentation

1 April 2004

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Agenda

- **Introduction**
- **Process**
- **Design**
- **Team Relationship**
- **Conclusion**

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This presentation describes work performed under IWTA-C CJ25V0801N to Lockheed Martin Space Systems Company, Space and Strategic Missiles, Sunnyvale, CA under prime contract F04701-02-C-0002 to U. S. Air Force, SMC/MCA, Los Angeles AFB, El Segundo, CA.


Introduction

Introduction : Advanced EHF Program

Space Segment

- Satellites & Payload
- Launch Support and Integration

Ground Segment (MCS)

- Mission Control
- Mission Planning
- Training/Logistics
- Sustainment

User Terminal Segment

- International partners

- AF
- Army
- Navy
- Strategic

Introduction : AEHF System

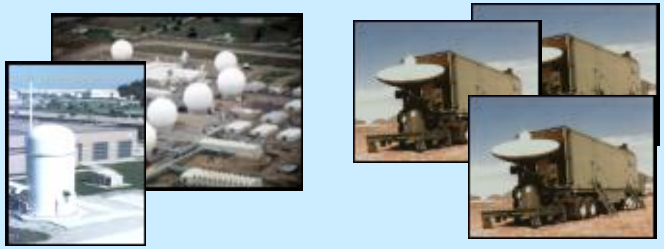
- **High Capacity**
- **Assured access to assigned resources**
  - **User resources “fenced off” from one another**
  - **Anti-jamming**
  - **Anti-Scintillation**
  - **Weather**
- **Secure Communications**
  - **Inter-Satellite Crosslinks**
  - **Encryption of communication**
  - **Terminal authentication**
- **Flexible communications**
  - **Resources configurable directly by the user “on the fly”**
  - **Wide range of user data rate available**
    - **75 bps up to 8 Mbps**
- **Wide Range of Services available**
  - **Point-to-point calls, voice and video conference networks (half and full duplex), data inter-connectivity, etc.**

Mission Control Segment

- Four Deliverable Products to Support Milstar and AEHF
  - Distributed Communications Planning
  - Modernized Command and Control
  - High Fidelity Training and Simulation
  - COTS Based Integrated Software and Database Sustainment
- Modern Architecture Provides Firm Foundation for Growth
  - Modular Design With Combination of Legacy, NDI, COTS, and GOTS Products
  - Incremental Development Allows Early Capability Fielding and Supports User Feedback Loop
  - 1.7M ELOC Architected With Proven CMMi-5 Processes

Mission Operations Element (MOPS)

- Fixed and Three Mobile Command and Control Systems

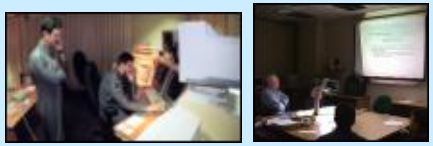


Mission Planning Element (MPE)

- 60 Distributed PC-Based Mission Planning Systems

Test and Training Simulation Element (TTSE)

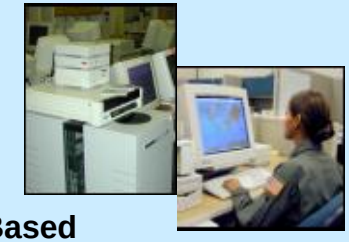
- Integrated Spacecraft Command and Control Simulator and Trainer



- Uses Actual Payload and Bus Software
- Proven Architecture Used on GPS
- Simulates Both Milstar and AEHF

Operations Support and Sustainment Element (OSSE)

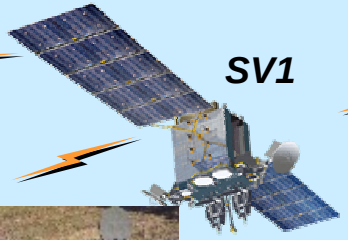
- Supports O&M



- COTS Based
- Leverages Milstar Lessons Learned by Integrating Software and Database Maintenance
- Robust Testing on Delivered Hardware

AEHF MCS Schedule

Milstar



SV1

SV2

Advanced EHF

SDR/ SRR

Sys & Seg PDR

CY03

CY04

CY05

CY06

CY07

CY08

1

2

3

4

5.1

5.2

6

O&M

EPDR

CDR

Increment 1 – Infrastructure Environment Completed Early

Increment 2 – Milstar Reuse

Increment 3 – Milstar/SV1 Apportionment

Increment 4 – Milstar/SV1 Command and Control, Resource Monitoring and Terminal Image Generation

Increment 5.1 – SV1 & SV2 Apportionment

Increment 5.2 – SV1 & SV2 Command and Control, Resource Monitoring and Terminal Image Generation

Increment 6 - International Partners

Factory Delivery

Field Deployed

International Partners

Results for MCS Program To Date

- Extremely positive
  - On cost and schedule (CPI and SPI greater than 1.0 for 37 straight months)
  - MCS Element PDR conducted for three consecutive weeks with more than 3000 viewgraphs resulted in only 14 open action items
  - Almost 1M lines of code built to CM
    - Completed 2 months ahead of schedule
    - Software productivity 25% higher than our historical averages
    - 95% fewer defects found in test than our historical averages
  - Very positive feedback from all reviews and site visits
  - One of three programs assessed successfully as part of CMMi-5 organizational certification
- Presentation focuses on those attributes that have made the program successful

Demonstrates extremely high level of design completeness and customer acceptance

AEHF MCS Triad of Success

- **Success of MCS Program rests on three legs**

- **Process – leadership and management techniques used in conducting the program**

- **Design – innovative methods used to develop and represent the technical content of the program**

- **Team Relationship – practices in cooperatively developing and validating the baseline requirement and design**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Process

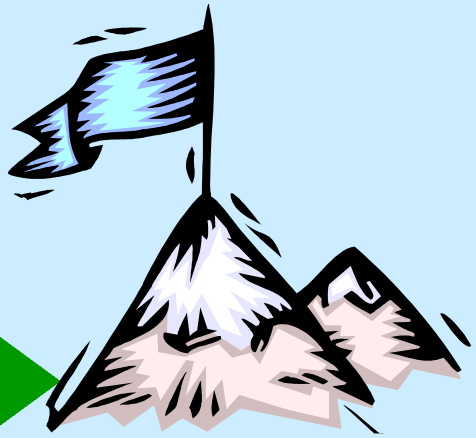
Lockheed Martin IS&S CMMi Level 5 Certification

Level	Process Characteristics	Process Areas
5 Optimizing	Focus is on quantitative continuous process improvement	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Process is measured and controlled	Quantitative Project Management Organizational Process Performance
3 Defined	Process is characterized for the organization and is proactive	Requirements Development Technical Solution Product Integration Verification Organizational Process Focus Integrated Project Management Validation Organization Process Definition Organizational Training Risk Management Decision Analysis & Resolution
2 Managed	Process is characterized for projects and is often reactive	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Product and Process Quality Assurance Configuration Management Measurement and Analysis
1 Initial	Process is unpredictable, poorly controlled, and reactive	

LM IS&S was the first company in the world to achieve CMMi Level 5 certification (AEHF MCS was one of the three focus programs)

AEHF MCS Startup Strategy

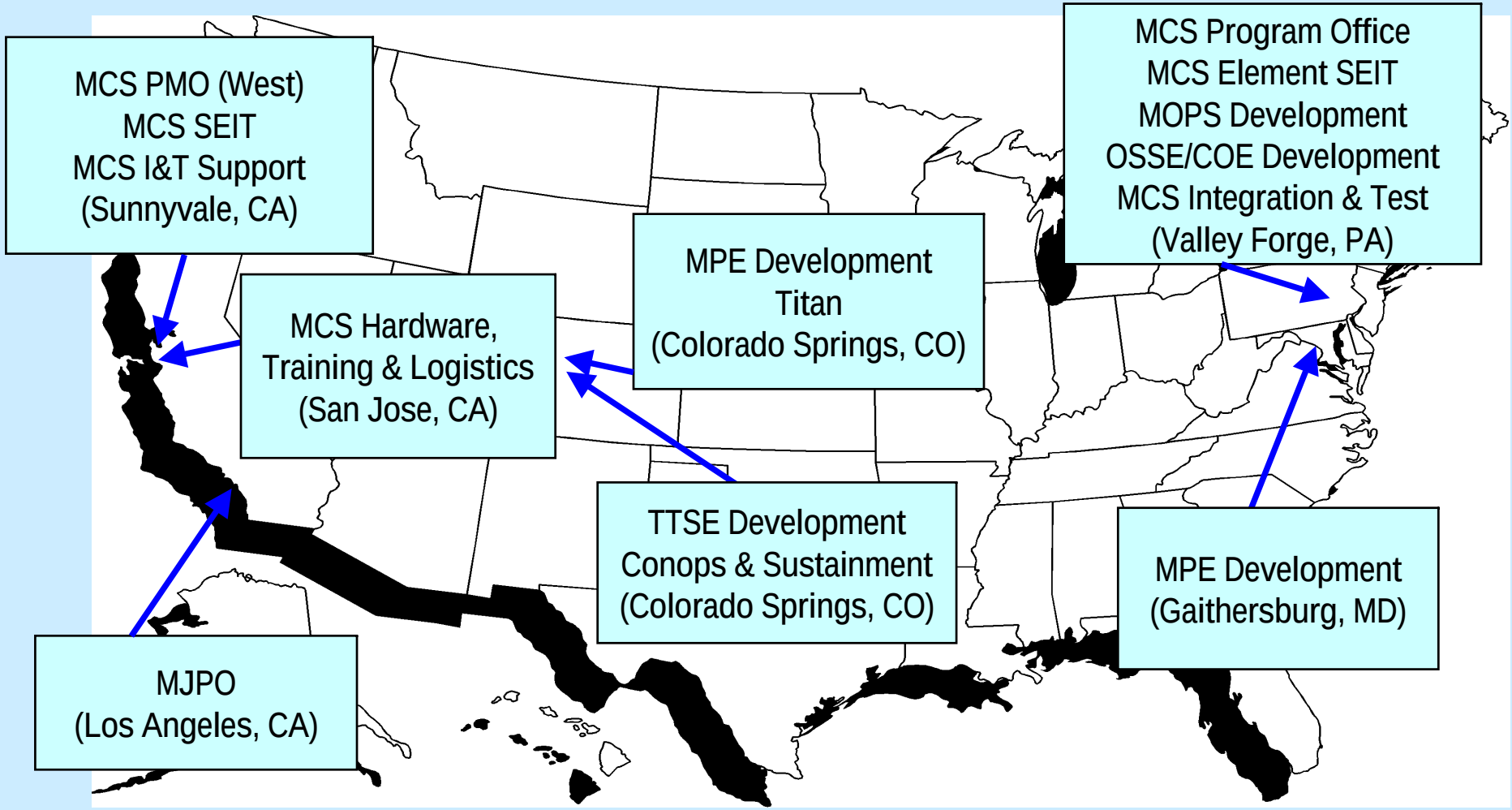
- *Establish Business Rhythms*
- *Leadership Assessment Template*
- *Smooth Staffing Ramp-up, "Best Athlete"*
- *Core Team Firm Fixed Price Training & Mindset*
- *Proactive Program Planning & Mgmt During Transition & Start-up Focused on Execution Plan*
- *Prime Integration Approach (Deputy on-site, TDY's)*
- *Definitize Major Subcontracts at Award & Treat as Teammates*
- *Customer Engagement & Communication*
- *Senior Mgmt Review & Commitment*
- *Baseline Change Control Process*
- *Schedule Management Approach*
- *Employee Awards Program*



Successful Program Startup

Focus on Startup Process Provides Basis for Successful Program

MCS Multi-Site Development



Best athlete approach used independent of location and company

MCS Team Communications

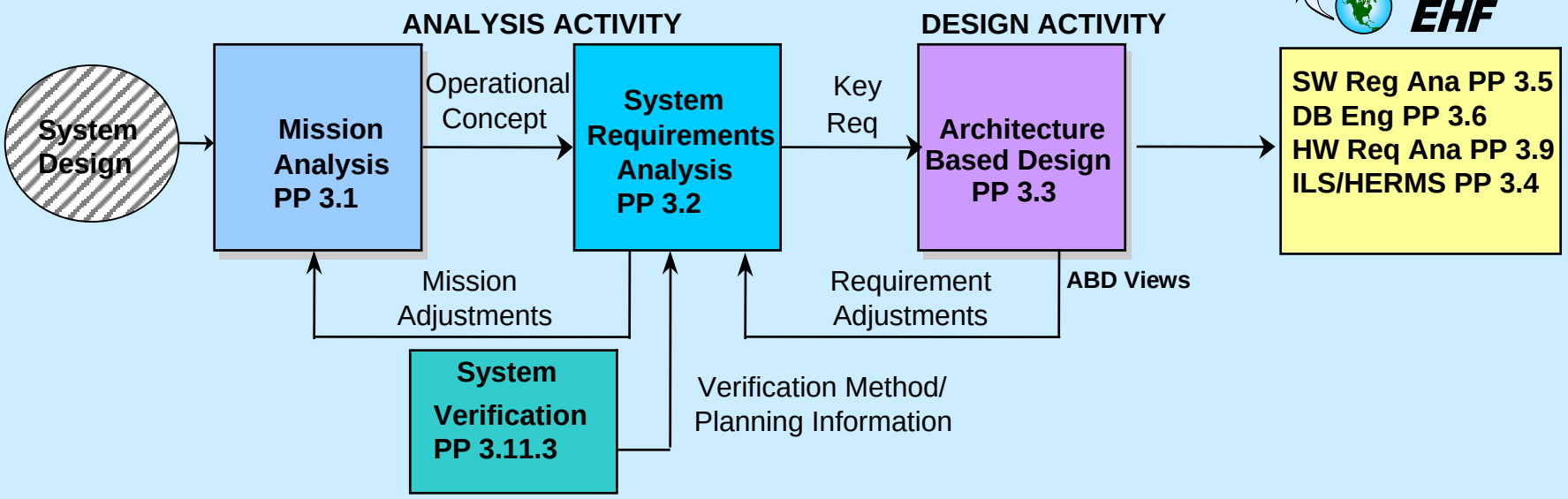
Key
- Earned Value Mgt
- Issue Resolution
- Senior Mgt Review

AEHF MCS Business Rhythms

Est	Mnt	Pac	MON	TUES	WED	THURS	FRI
0900	0700						
0930	0730		MCS Development Tagup, Daily @ 0930-0945				
1000	0800	0700	MCS PMO Weekly		MCS Architects Team Meeting / Field Coord	MCS Business Review	Monthly Program Review (Monthly)
1030	0830	0730	AEHF PM Telcon				
1100	0900	0800	AEHF Prg Coord		AEHF Program Status / CAMS Var Rvw	User Group (AMOT) / MCS Techops	
1130	0930	0830		MCS Tech Staff Mtg			
1200	1000	0900	Sub Status Review / AEHF SEIT Issues	AEHF Issues / Resolution Meeting		AEHF MJPO Tagup / Transition WG (TIWG)	TTSE WG (Biweekly)
1230	1030	0930					
1300	1100	1000	MCS Risk & Opportunity Board (ROMB)	MCS ERB	MCS Schedule ERB (SERB)	MCS-Term WG (3145)	OSSE WG (Biweekly)
1330	1130	1030					
1400	1200	1100	MCS SEIT Staff Mtg Staff	MCS Segment Status	MCS Rsrc. Intg.(RIMB) / AEHF SEIT ERB	MOPS WG	CAMS Status
1430	1230	1130					
1500	1300	1200		MCS Segment Status	MCS Iss/Res (MIRM)	MPE WG / MCS Archit WG (AWG)	
1530	1330	1230	MCS MJPO Telecon		MCS MJPO Telecon		
1600	1400	1300	MCS SEIT daily (1545) / MIRM (MCS Issue/Res)	MCS Staff Mtg	AEHF Risk Board / AEHF SEIT ASDB WG	MCS CCB / MCS CCB / MCS-Space (MSCWG)	MCS SEIT Daily Tagup
1630	1430	1330		Focus Program Review (Quarterly)			
1700	1500	1400	AEHF PM Staff Mtg		Monthly Operations Review (Monthly)	AEHF Program CCB	
1730	1530	1430					
1800	1600	1500					

Integrated Business Rhythms -
Daily, Weekly, Monthly and Enterprise Level Senior Mgt Oversight

Integrated Set of Procedures Across the Segment



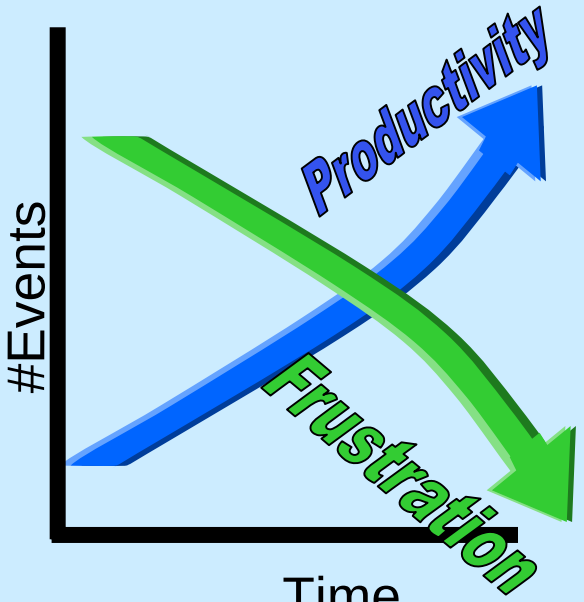
Area	SOP Title
General Process	MCS Engineering Review Board (ERB) SOP
General Process	MCS Action Item (AI) SOP
Verification	MCS Test Readiness Review SOP
Requirement Analysis	MCS To-Be-Determined/To-Be-Reviewed (TBD/TBR) SOP [IPE]
Requirement Analysis	MCS Requirements Trace SOP [IPE]
General Process	MCS Continuous Process Improvement / Lessons Learned (CPI/LL) SOP
Detailed Design	MCS Database (DB) Design, Configuration & Allocation SOP [IPE] ;
Detailed Design	MCS Security Engineering SOP
Architecture Design	Component Requirements Specification SOP
General Process	MCS Inspection SOP [IPE] (arch,des,code)
Architecture Design	MCS Architecture Design (AD) SOP
Detailed Design	MCS Critical Methods SOP
Verification	MCS Test Sub-Engineering Review Board (TERB) SOP
Detailed Design	MCS Database Validation & Verification SOP
Verification	MCS Regression Testing SOP
Architecture Design	Capability Design Document/ Increment Contract Prep SOP

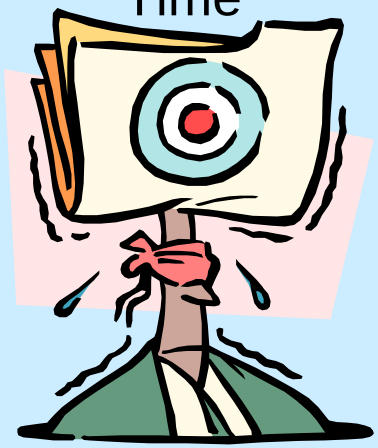
Initial focus on integrated procedures critical to successful execution

AEHF MCS Lean Event Results

Results: $ Savings, 100% Reduction in "Frustration"

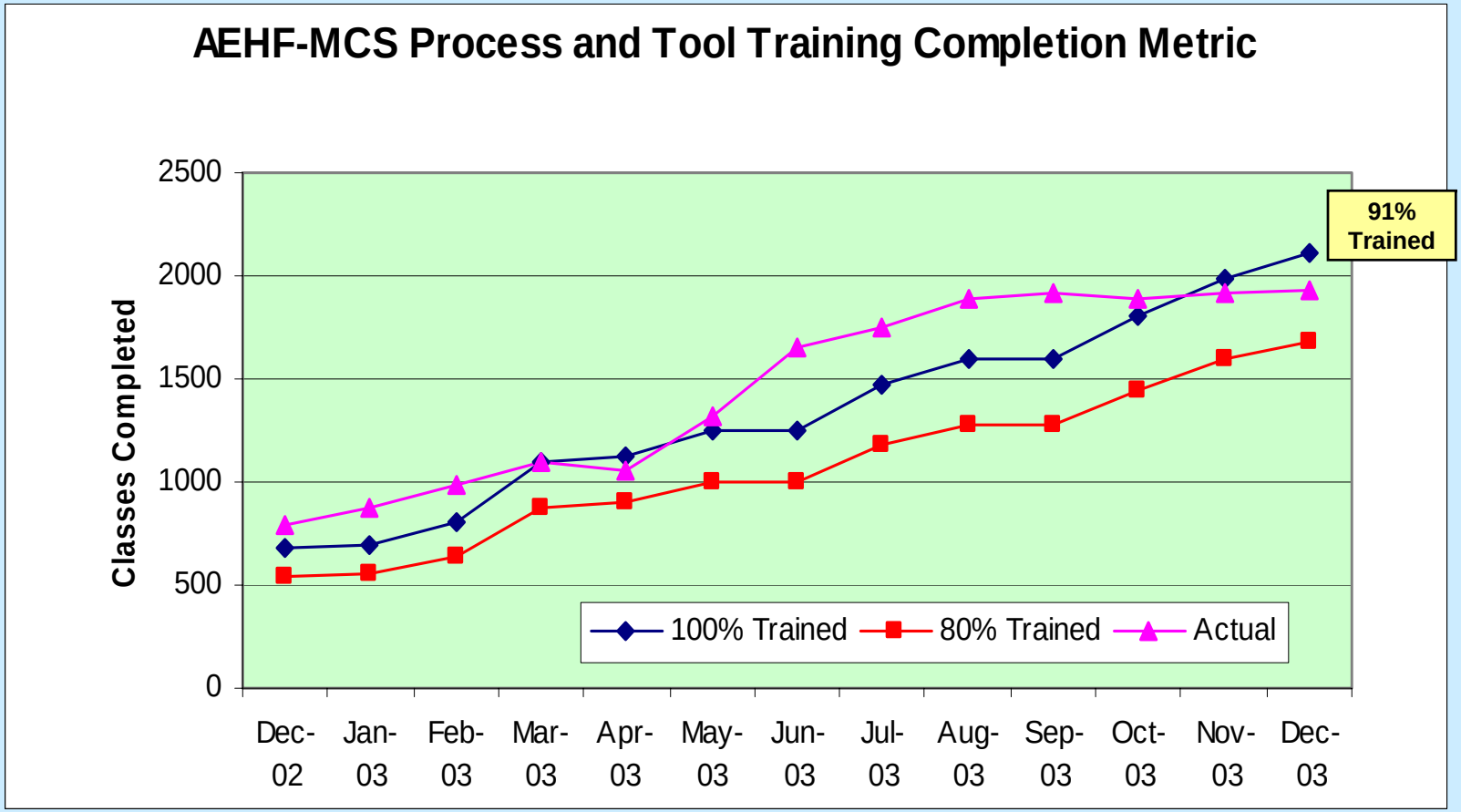
- **SA/TAU Lean Event: 62% process improvement**
- **Program Training Lean Event: 57% improvement**
- **Internal S/W Increment Contracts Lean Event: 60% process improvement**
- **MCS Cost and Schedule Lean Event: 16% process improvement**
- **MCS SW Productivity Value Stream Map: 5% to 20% Cycle Time Improvement**





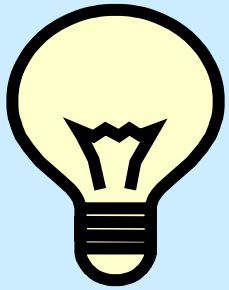
Implementation of Better, Cheaper, Faster

MCS Training Completion Metrics



All Responsible Engineers and Mega-Executable Leads trained and in place

Baseline Management and Tracking



New Requirement

User Validation

Schedule Impact

Funds Availability

Potential Change Tracking List

Review Board Approval

Contractual Action

Baselined Requirement

Requirement Flow down

New Requirement Tracking List

Design Modification

Incorporation metrics

Change Incorporation Tracking List

Modification Tracking

Detailed tracking of all changes throughout life cycle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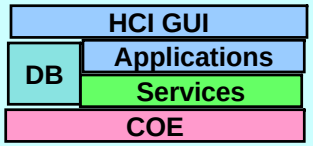
Design

Architecture-Based Design (ABD) Develops Multiple Views to Ensure an Integrated System

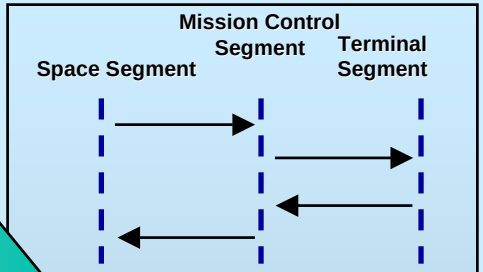
ARCHITECTURE*

Represent the SW layers



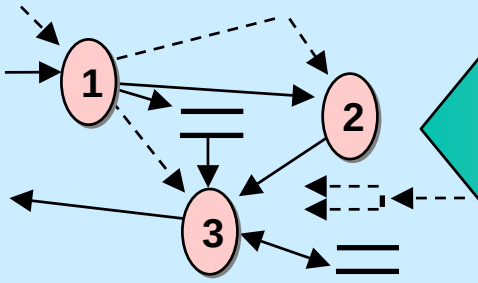
Infrastructure View

Mission Scenario View

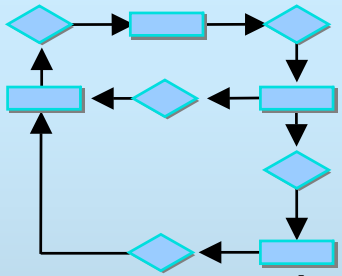


Represent as a use case diagram, interaction diagram, or event trace diagram (ETD)

Represent as block diagram or data flow diagram (DFD)



Data View



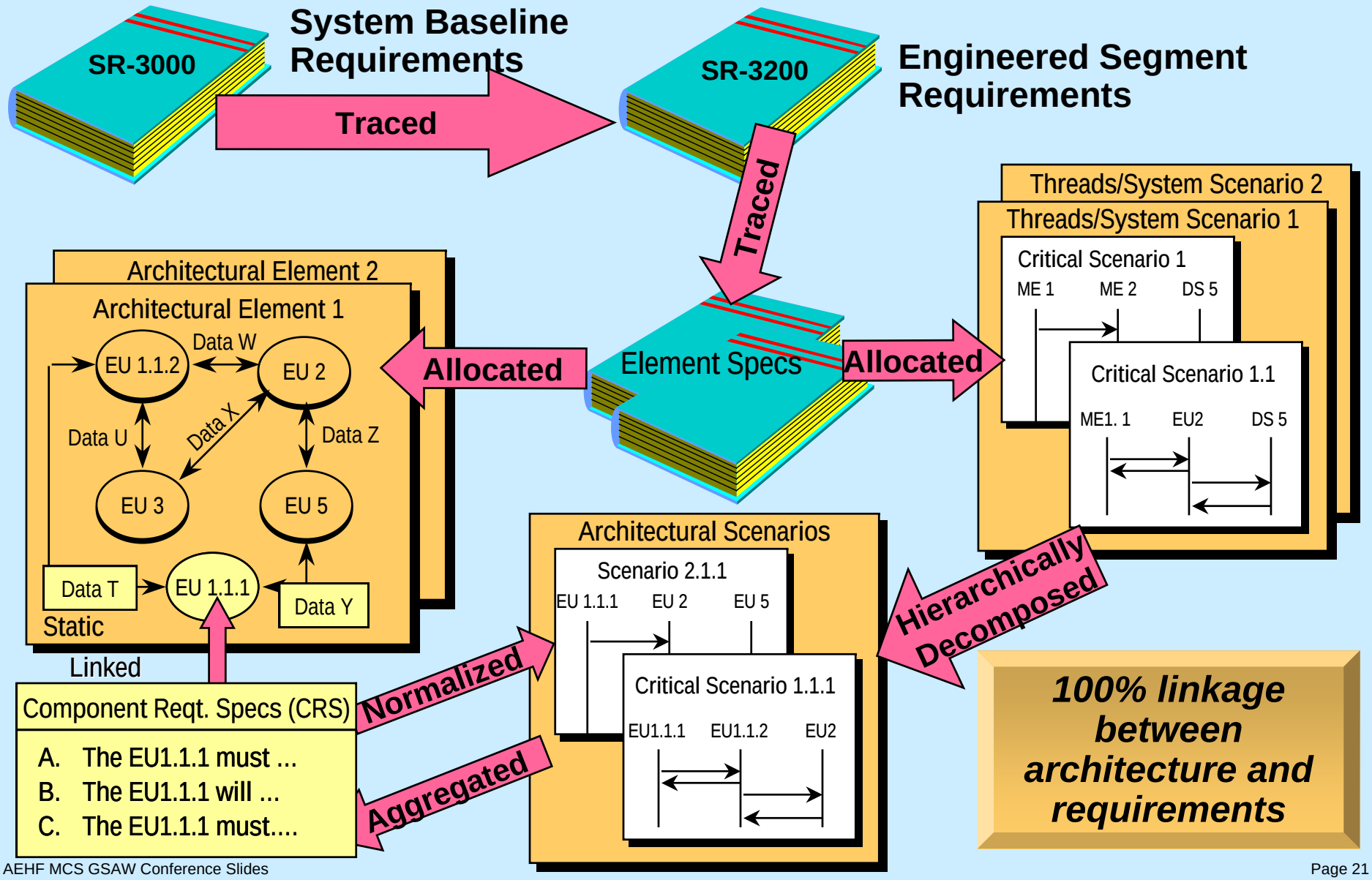
Represent as an entity relationship diagram or text description of data structure

Mission Executable View

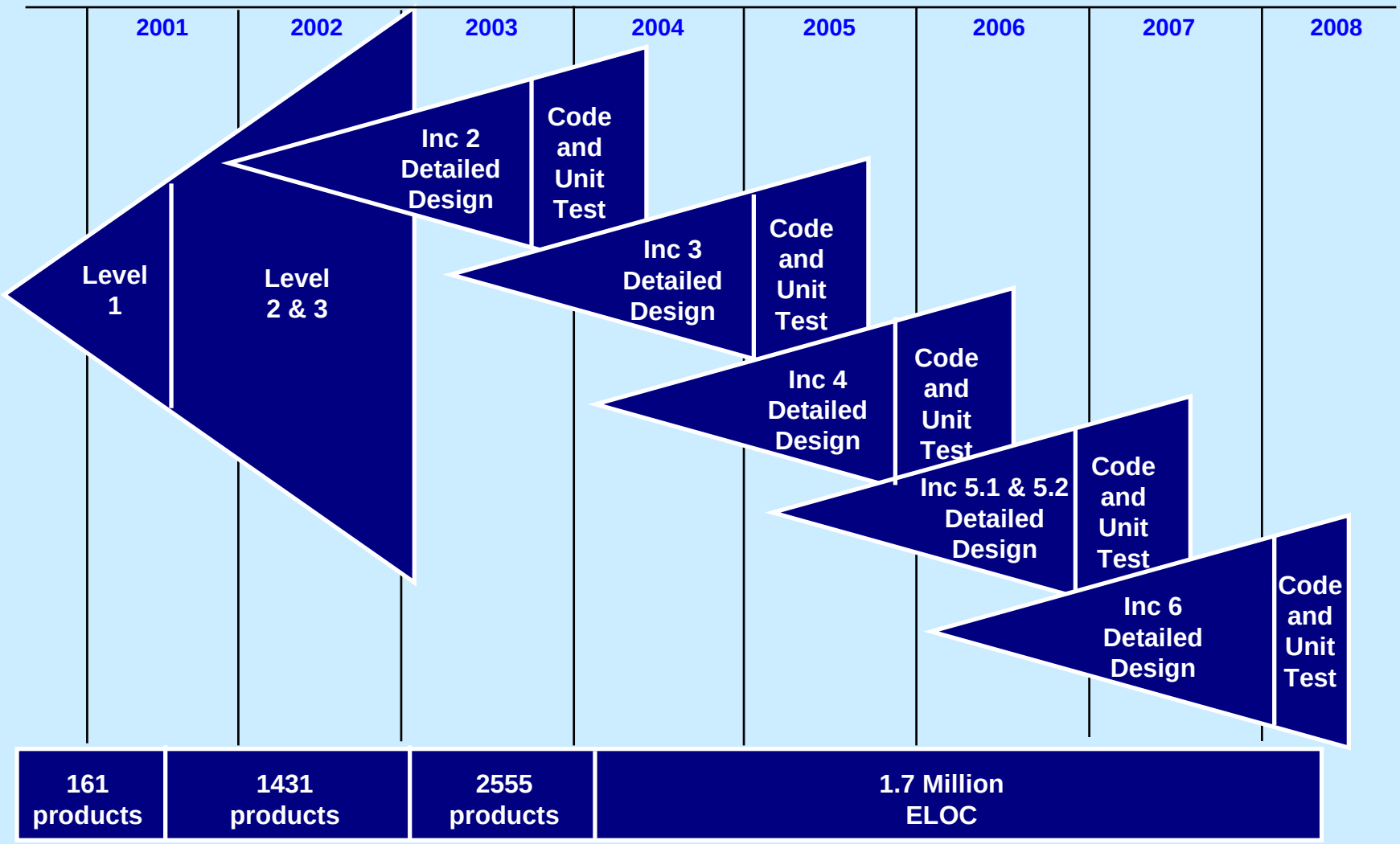
***Architecture includes all levels of design**

Multiple views ensure all aspects of the design are captured

MCS Requirements Flow down and Architecture Integration

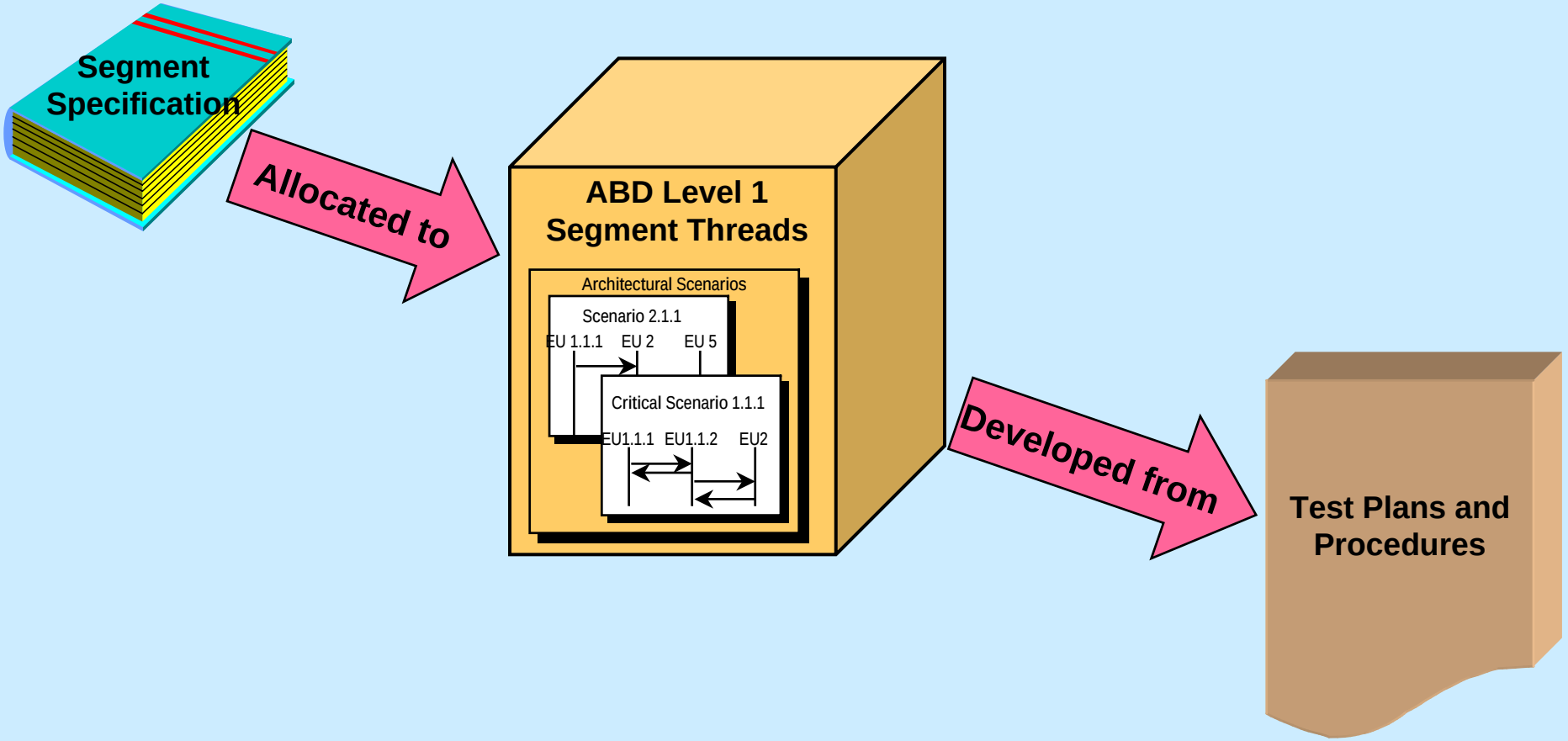


AEHF MCS Incremental Development



MCS developed architecture monolithically but detailed design performed incrementally

Scenario Based Testing



Scenario based testing ensures you "test as you fly"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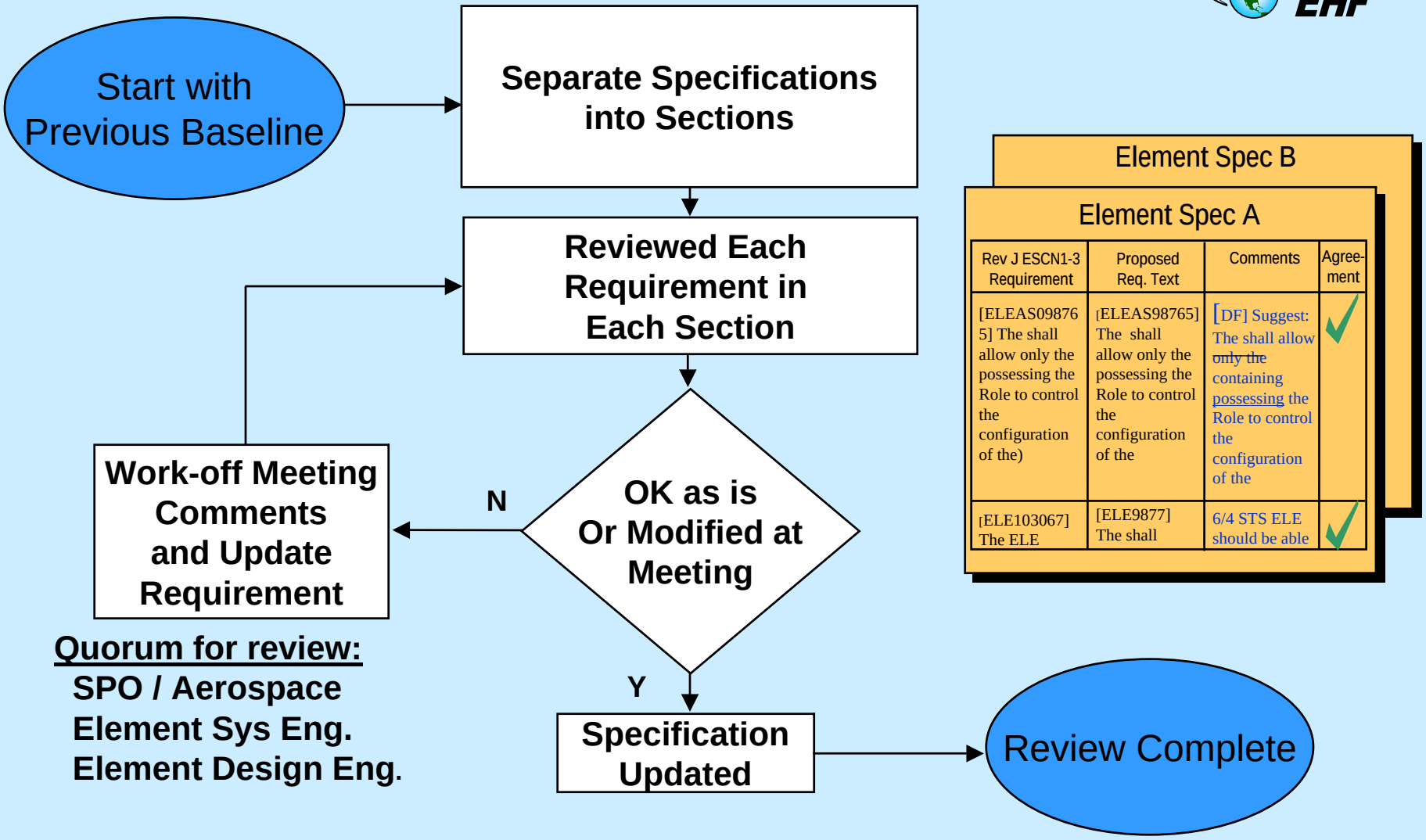
Team Relationship

Requirement Review Process



Quorum for review:

SPO / Aerospace
Element Sys Eng.
Element Design Eng.

Explicit customer agreement on all requirements

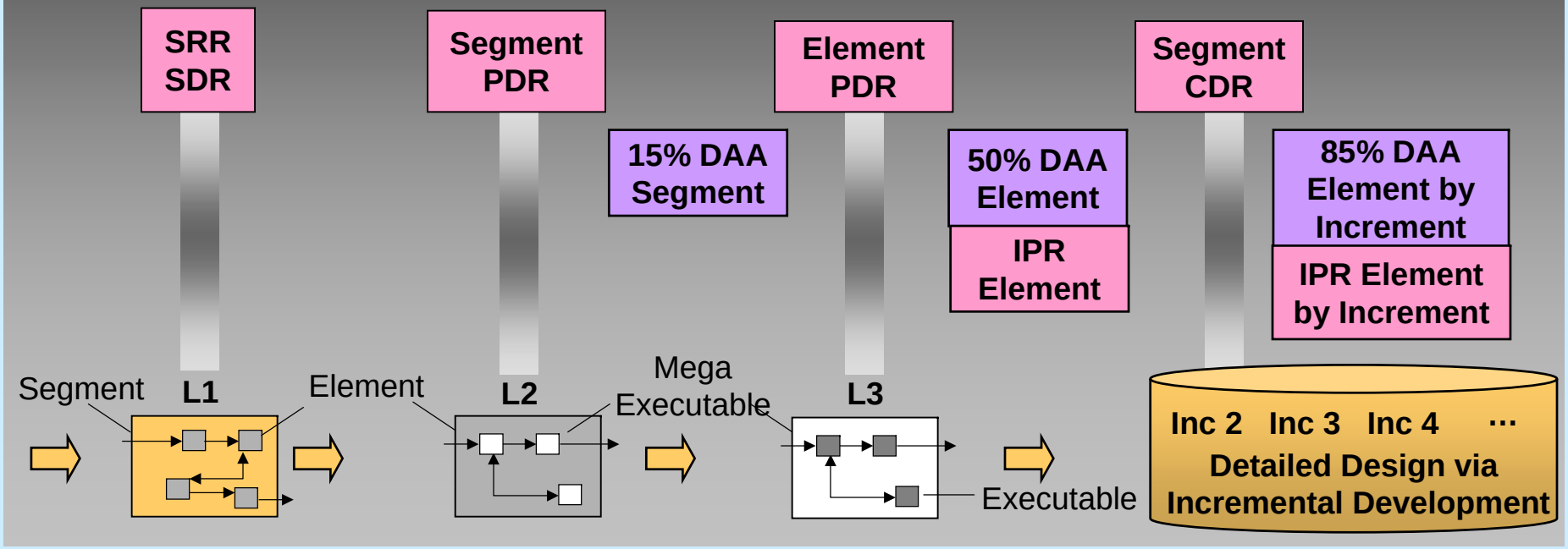
MCS Design Reviews

Domain Focus

- **Formal Design Reviews and In Process Reviews (IPR)**
  - **Use domain experts from the User and Acquisition Community**
  - **Review design from the user perspective**

Process Focus

- **Design Adequacy Assessments (DAA)**
  - **Internal reviews of the maturity of the design against design checklists**
  - **Functional management accountability of critical processes**
  - **Review the entire design**



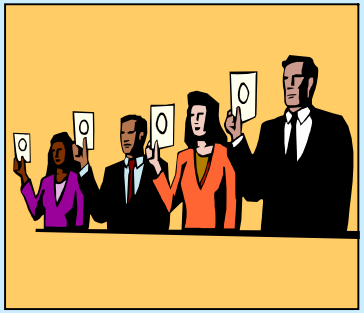
Performed the DAAs and IPRs together as a single review

User Engagement

Actively pursue user input via:

Site Visits
(21 conducted)

Demos at User Sites
(20 conducted)



Design and In Process Reviews
(19 conducted)

User Input (Site Visits)

User Input (Demos at User Sites)

User Input (Design and In Process Reviews)

Binning

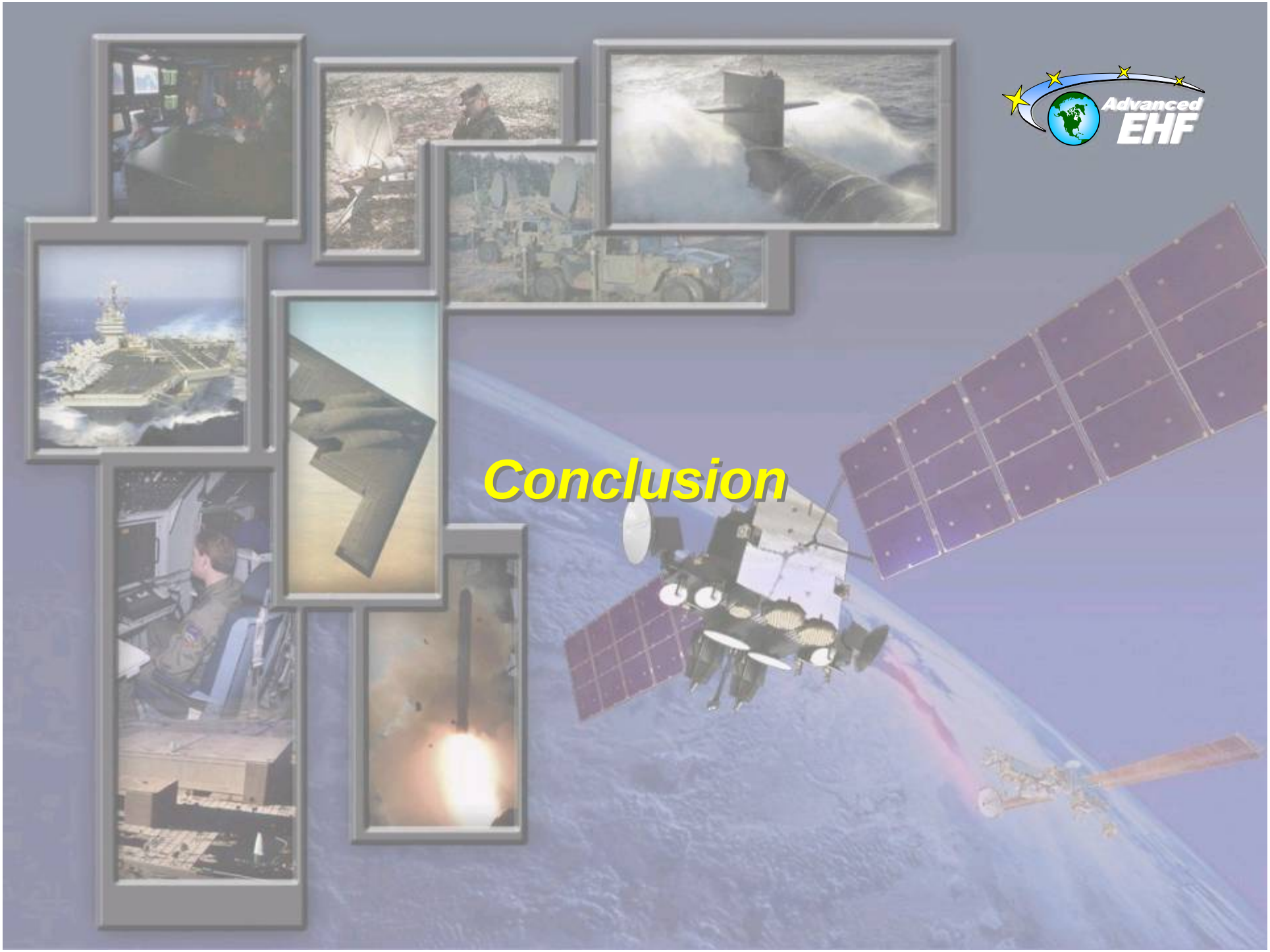
Non-baseline Impacting
e.g. Order of certain List – alphabetical vs. geographical

Incorporated into evolving design

Baseline Impacting
e.g. new capability

Processed via Baseline Management Process

Process established for handling requests for changes while at the same time maintaining the program's baseline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Conclusion

Conclusion: Results for MCS Program

- Techniques used on the MCS Program have resulted in extremely positive program performance
  - Process
    - On cost and schedule (CPI and SPI greater than 1.0 for 37 straight months)
    - One of three programs assessed successfully as part of CMMi-5 organizational certification
  - Design
    - MCS Element PDR conducted for three consecutive weeks with more than 3000 viewgraphs resulted in only 14 open action items
    - Almost 1M lines of code built to CM
      - Completed 2 months ahead of schedule
      - Software productivity 25% higher than our historical averages
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  - Team Relationship
    - Very positive feedback from all reviews and site visits
- Demonstrates extremely high level of design completeness and customer acceptance

MCS program in excellent position moving into detailed design, implementation, verification and operations