



# ***Advanced Extremely High Frequency (AEHF) Program***

## ***Mission Control Segment (MCS)***

### ***GSAW Working Group***

***Challenges in Developing and Acquiring  
Systems with Evolving Requirements***

***April 2008***

***Asya Campbell, Aerospace***

***Scott Carey, Lockheed Martin***

Charts from previously approved presentations:

GSAW 2004 - Approved for Public Release - #03-512 and GSAW 2008 - OTR20080130121122

# Agenda



- Introduction
- Process
- Design
- Customer Relationship
- Conclusion

**Authors:**

**Scott Carey**

**Delivery Program Manager, AEHF MCS Program**

**Lockheed Martin**

**Asya Campbell**

**Systems Director**

**EHF Mission Control Segment, MILSATCOM**

**The Aerospace Corporation**

**Contact Author:**

**Asya Campbell**

**(310) 336-3450**

**[Asya.campbell@aero.org](mailto:Asya.campbell@aero.org)**

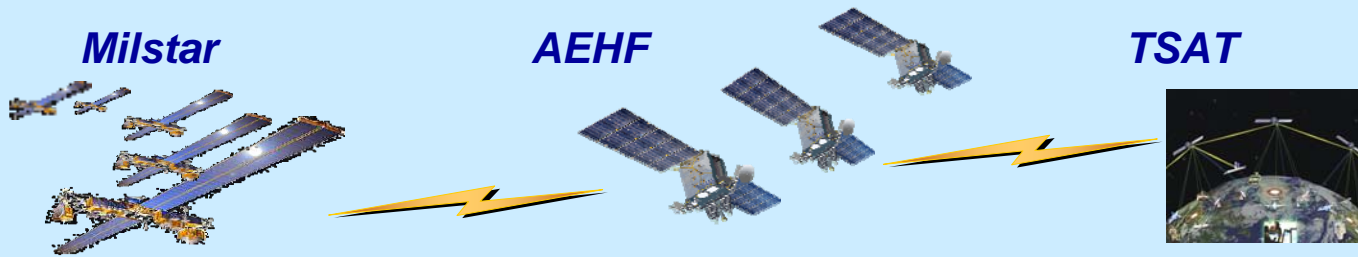
**The Aerospace Corp**

**P.O. Box 92957 – M3/218**

**Los Angeles CA 90009-2957**

**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.**

# System Overview



## AEHF Space Segment (3 Space Vehicles)

- Space Vehicle
  - System Timing
  - Autonomous Fault Detection and Correction
  - Jamming/Nuclear Protection
- Payload
  - Communication and Routing
  - Antenna Coverage/Comm Capacity



## Baseband

- Direct I/F to User
- User Interoperability
- End-to-End Services

## Terminals

- AEHF and Milstar
- International Partners
- User Comm Services
- User Resource Control

## Mission Control Segment

- Apportionment Planning
- Sustainment
- Terminal Control
- Command and Control
- Training and Simulation
- Over-the-Air Rekey
- Ground Mobiles

“TSAT Photo courtesy of Military Satellite Communications Systems Wing. Other photos reprinted courtesy of the United States Department of Defense.”

# ***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



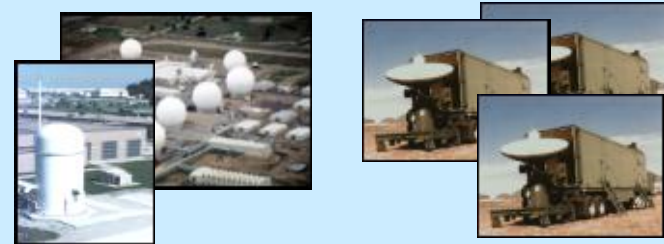
- Four Deliverable Products to Support Milstar and AEHF
  - Distributed Communications Planning
  - Modernized Command and Control
  - High Fidelity Training and Simulation
  - COTS Based Integrated Software and Database Sustainment



## Mission Operations Element (MOPS)

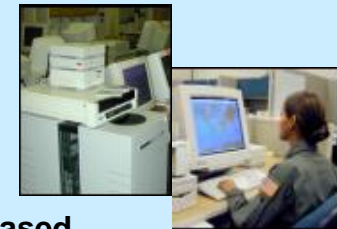
- Fixed and Three Mobile Command and Control Systems

- 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



## Operations Support and Sustainment Element (OSSE)

- Supports O&M



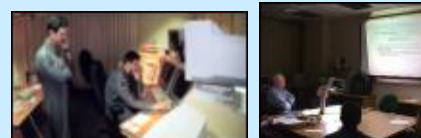
## Mission Planning Element (MPE)

- 60 Distributed PC-Based Mission Planning Systems



## Test and Training Simulation Element (TTSE)

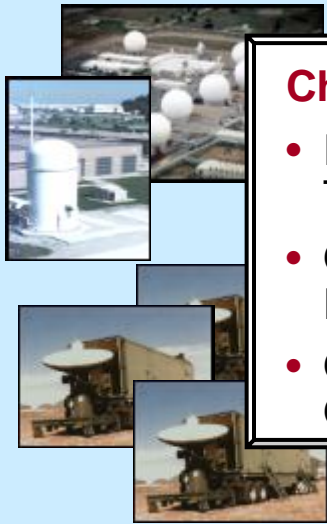
- Integrated Spacecraft Command and Control Simulator and Trainer



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

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

# AEHF MCS Mission Operations (MOPS)

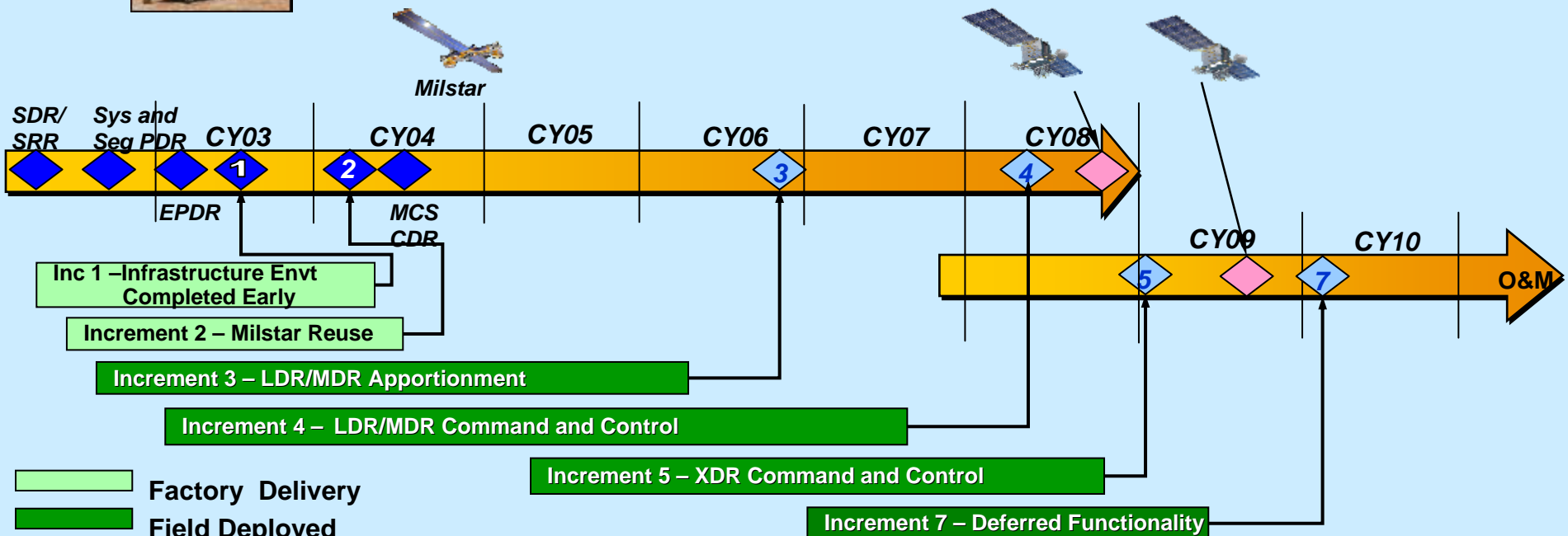


## Characteristics

- Function: Command & Control, Telemetry, etc.)
- Object Oriented / Database Driven Design
- OO, Unix, C++, FORTRAN, SCL, Oracle, SQL

## Test Program Description

- Modified waterfall
- Incremental Development
- Test Approach
  - Element test – req'ts based
  - MCS test – scenario based



Photos reprinted courtesy of the United States Department of Defense.

# 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**



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

# **AEHF MCS Startup Strategy**



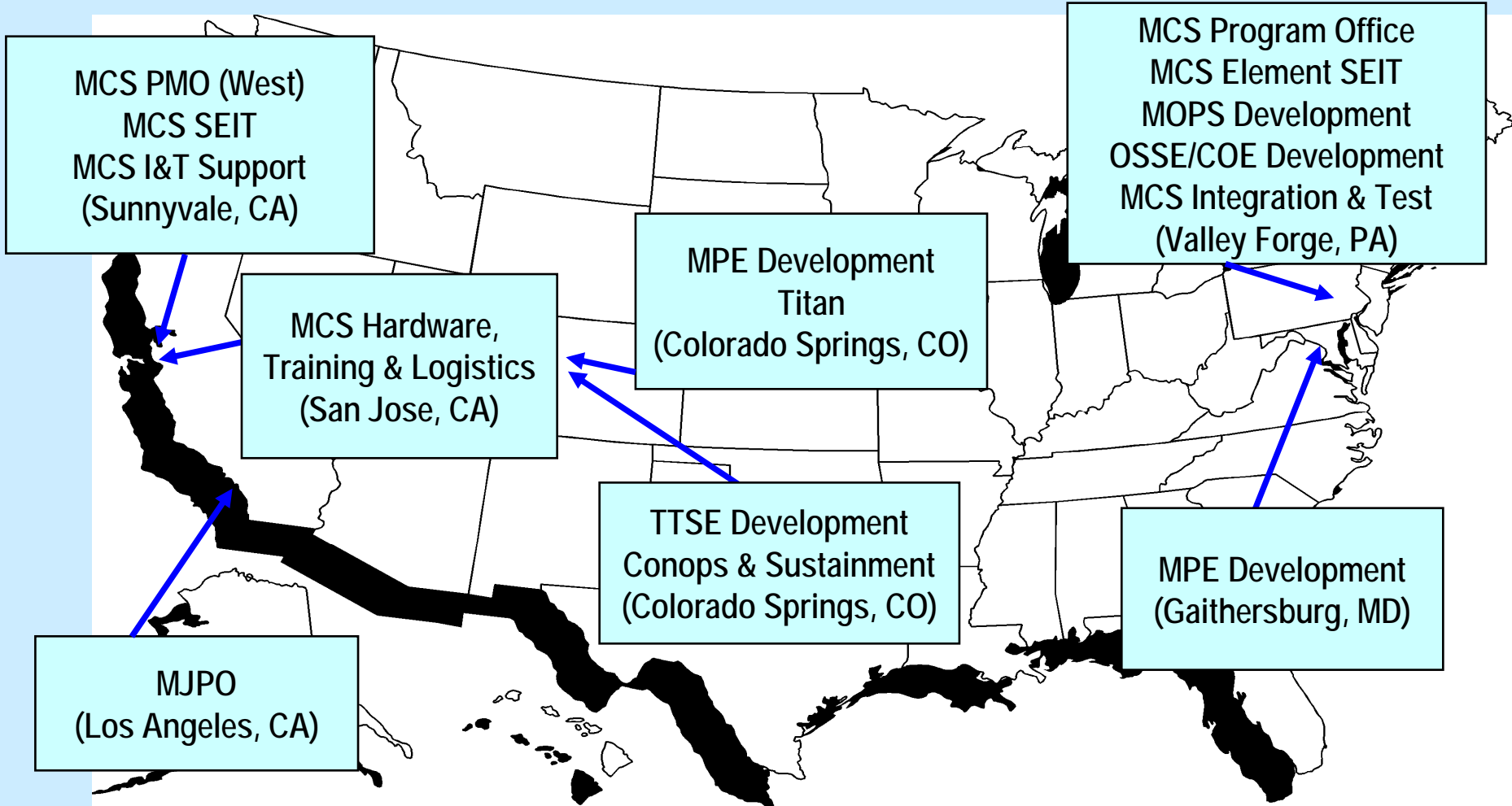
- **Establish Business Rhythms**
- **Leadership Assessment Template**
- **Smooth Staffing Ramp-up, “Best Athlete”**
- **Core Team Firm Fixed Price Training & Mindset**
- **Proactive Program Planning & Mgmt During Transition & Start-up Focused on Execution Plan**
- **Prime Integration Approach (Deputy 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**



**Focus on Startup Process Provides Basis for Successful Program**

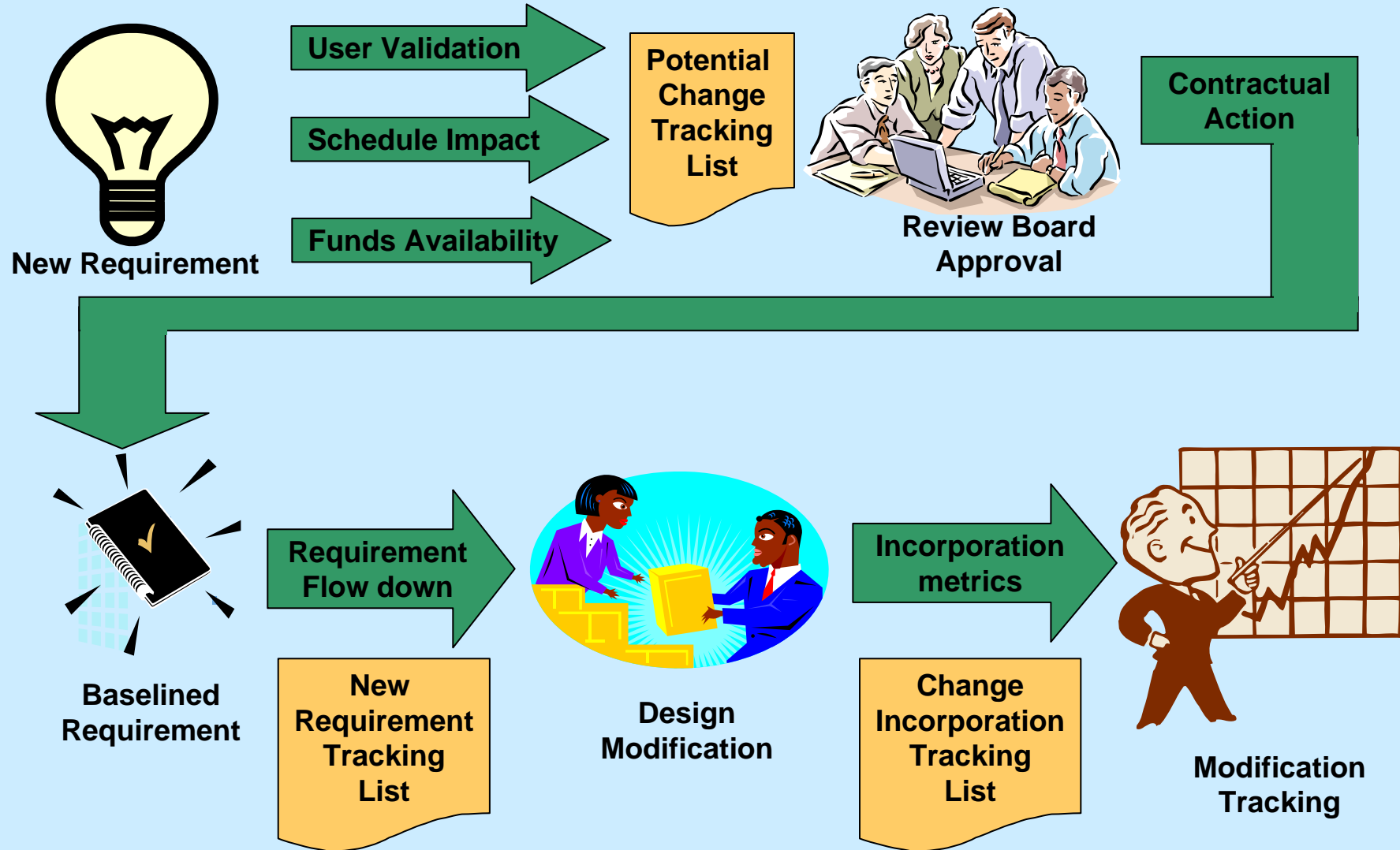


# MCS Multi-Site Development



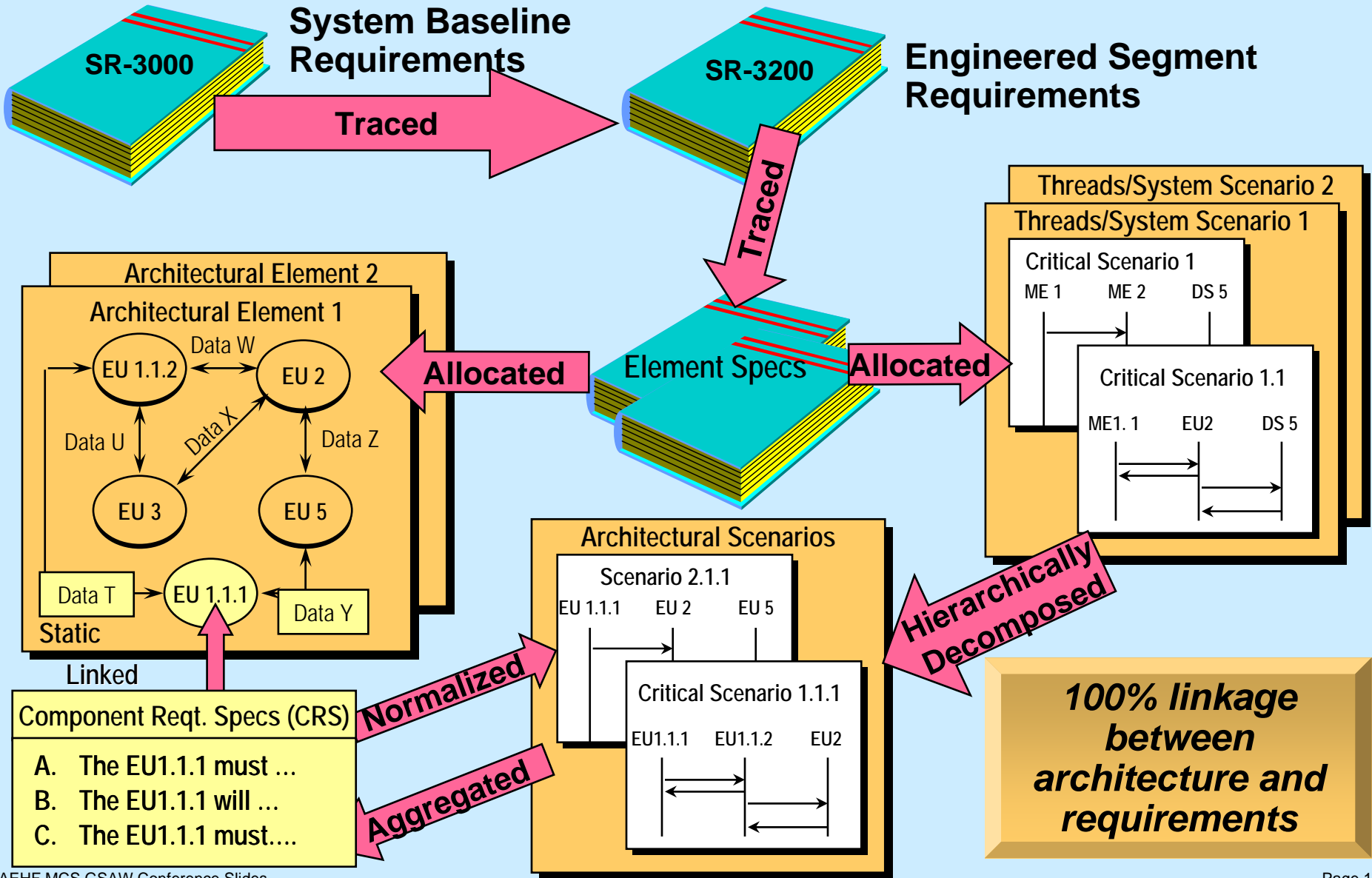
***Best athlete approach used independent of location and company***

# Baseline Management and Tracking

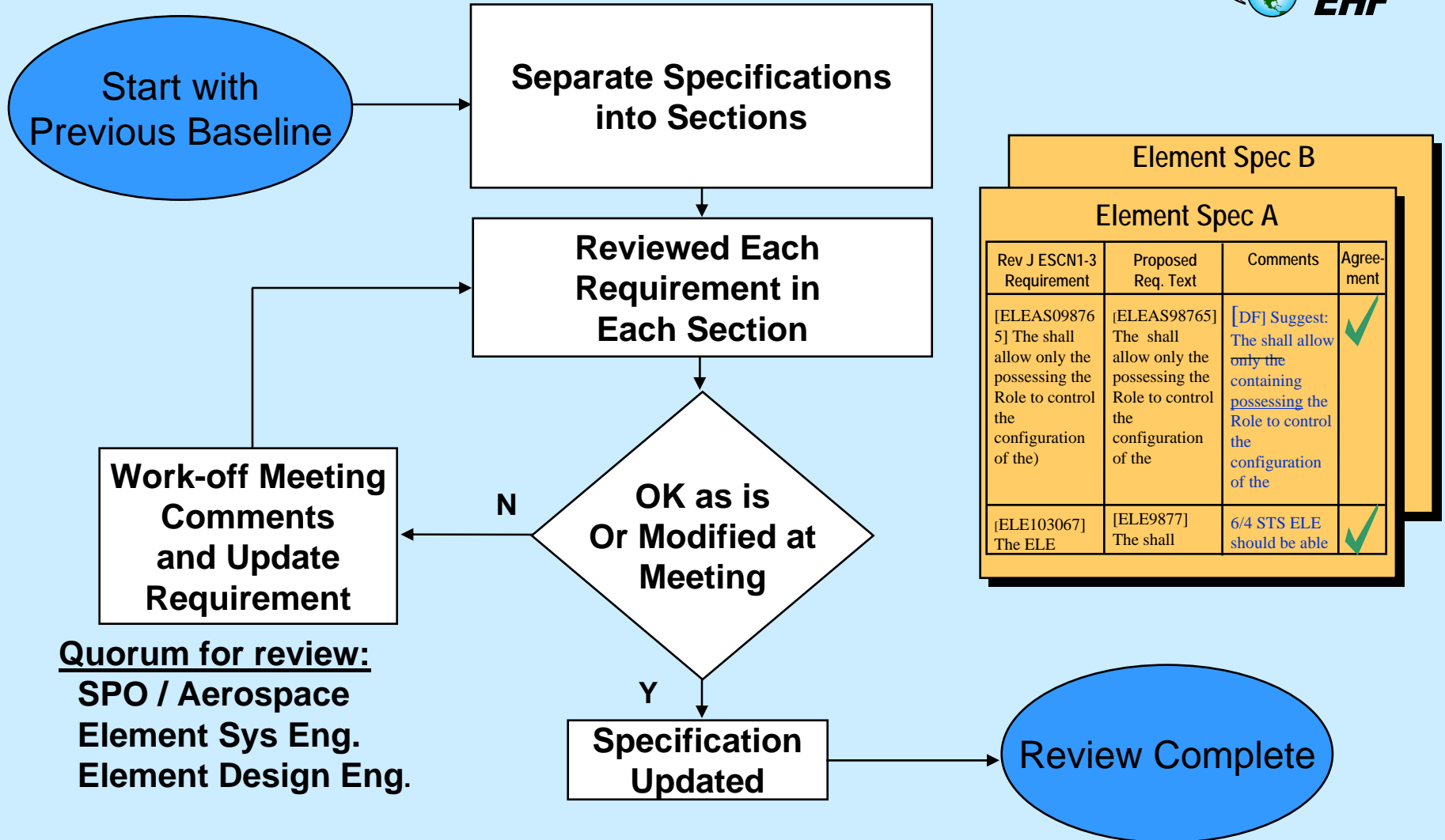


*Detailed tracking of all changes throughout life cycle*

# MCS Requirements Flow down and Architecture Integration



# Requirement Review Process



Element Spec B			
Element Spec A			
Rev J ESCN1-3 Requirement	Proposed Req. Text	Comments	Agreement
[ELEAS09876 5] The shall allow only the possessing the Role to control the configuration of the)	[ELEAS98765] The shall allow only the possessing the Role to control the configuration of the	[DF] Suggest: The shall allow <u>only the containing possessing the Role to control the configuration of the</u>	✓
[ELE103067] The ELE	[ELE9877] The shall	6/4 STS ELE should be able	✓

**Quorum for review:**  
 SPO / Aerospace  
 Element Sys Eng.  
 Element Design Eng.

**Explicit customer agreement on all requirements**

# MCS Design Reviews

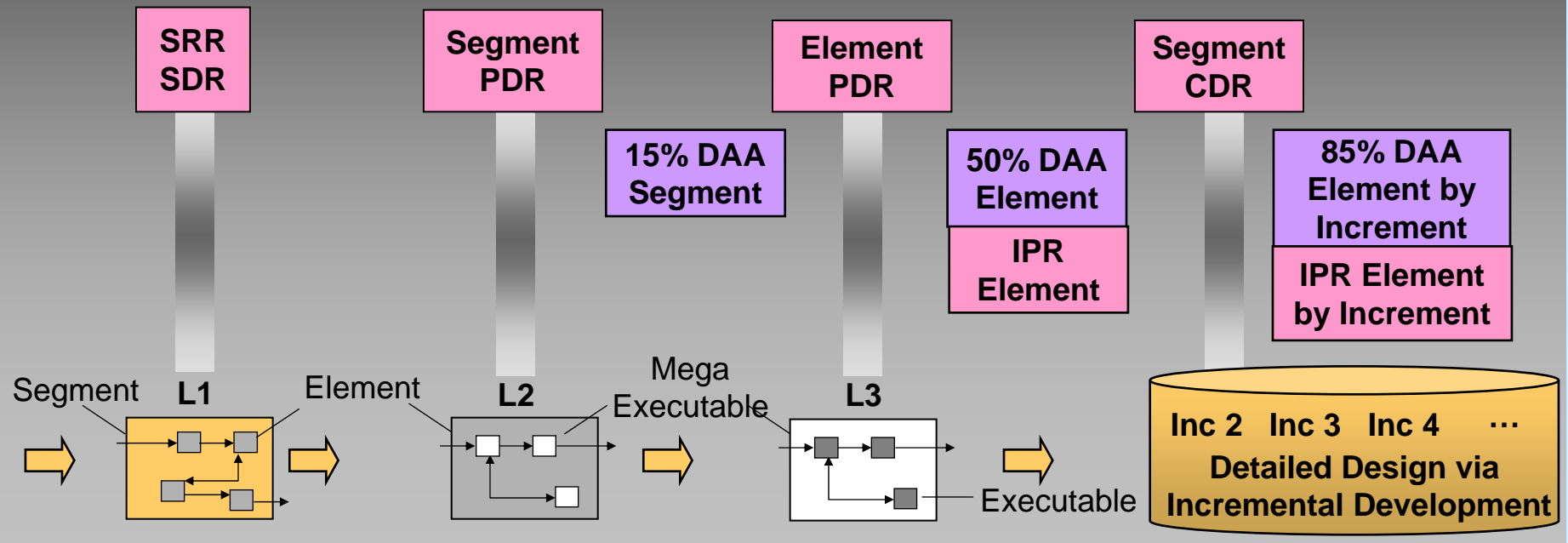


## Domain Focus

- 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**



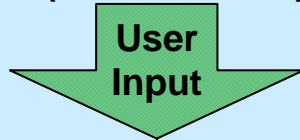
# User Engagement



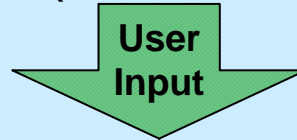
Actively pursue user input via:



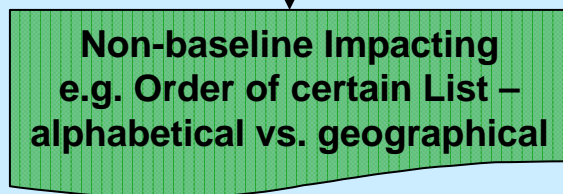
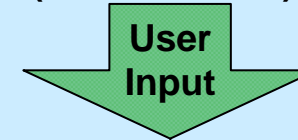
**Site Visits**  
(21 conducted)



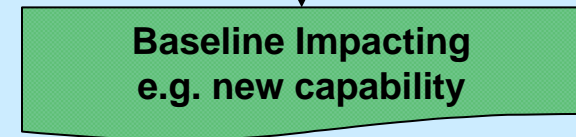
**Demos at User Sites**  
(20 conducted)



**Design and In Process Reviews**  
(19 conducted)



**Incorporated into  
evolving design**



**Processed via Baseline  
Management Process**

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



## DoD Program Receives Top 5 Recognition

from Military Satellite Communications Wing  
SMC

11/14/2007 - **Los Angeles Air Force Base** -- The Advanced Extremely High Frequency Mission Control Segment was selected as one of the Top 5 DoD Programs in 2006. Col William J. Harding, Commander, Protected Satellite Communications Group, Military Satellite Communications Systems Wing, and Mr. John Menguucci, Lockheed Martin President, Mission & Combat Support Solutions, accepted the award at a ceremony in San Diego on October 24, 2007. The Top 5 DoD Program Award is administered by the National Defense Industrial Association. OSD sponsors the award and selects the winners.

The MCS ground-based fixed and mobile stations will command and control both the AEHF and Milstar satellites on orbit, monitor satellite health, coordinate worldwide communications networks, deliver high-fidelity training and simulation, and enable software sustainment. The Lockheed Martin Information Systems & Global Services MCS team has completed 1.7 million out of 2.2 million lines of code, and has maintained cumulative Cost and Schedule Performance Indices of 1.0 or greater for 80 months.



Search  
search stories  
Advanced Search

The Advanced Extremely High Frequency Mission Control Segment, Team was selected as one of the Top 5 DoD Programs in 2006. Pictured from lower left are: John Menguucci, Lockheed Martin President, Mission & Combat Support Solutions; Todd Nygren, Principal Director, EHF Systems, The Aerospace Corp.; Maj John Mizell, AEHF Ground Segment Lead; Asya Campbell, Systems Director, EHF Mission Control, The Aerospace Corp; Rick Donaldson, LM AEHF MCS Director; Col William Harding, Commander, MILSATCOM Protected Group; Scott Carey, LM AEHF MCS Deputy Director

"MCS has been very important to the success of the \$6.7B AEHF program," said Col Harding in his acceptance speech. "I am very proud of the MCS Integrated Product Team -- it has exhibited outstanding teamwork between the government and industry."

As one of the protected satellite programs at MILSATCOM, the AEHF system will be the follow-on to the Milstar system, augmenting and improving on the capabilities of Milstar, and expanding the MILSATCOM architecture. AEHF will provide connectivity across the spectrum of mission areas, including land, air and naval warfare; special operations; strategic nuclear operations; strategic defense; theater missile defense; and space operations and intelligence. The AEHF System is a joint service satellite communications system that provides global, secure, protected, and jam-resistant communications for high-priority military ground, sea and air assets. Once on orbit, the AEHF satellite system will consist of three satellites that will be in geosynchronous earth orbit (GEO) that provides 10 times the capacity of the 1990s-era Milstar satellites.

The Space and Missile Systems Center, located at Los Angeles Air Force Base, Calif., is the U.S. Air Force's center of acquisition excellence for acquiring and developing military space systems including six wings and three groups responsible for GPS, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control network, space based infrared systems, intercontinental ballistic missile systems and space situational awareness capabilities. SMC manages more than \$60 billion in contracts, executes annual budgets of \$10 billion and employs more than 6,800 people worldwide.