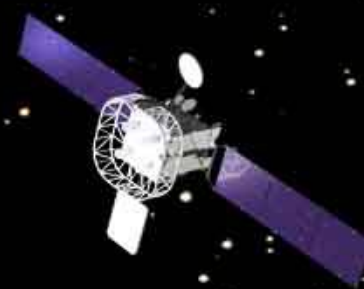


# Communications Satellite Program Office (PMW-146)



## Managing Requirements to Manage Scope in the Case of MUOS

25 October 2007

**CDR Trip Braund**  
MUOS Systems Engineer

**Christy Howard**  
Maxim Systems, Inc

**Debra Shannon**  
Maxim Systems, Inc

Distribution Statement A: Approved for  
public release, distribution unlimited (04 Oct  
07).

PMW-146-D-07-0184

**CLASSIFICATION (U)**  
Classified by: PMW-146



# Agenda

---

- Our Goal for Today
- MUOS in a Nutshell
- Our Challenges
- Our Approach to Requirements Management
- Lessons Learned
- Challenges Ahead





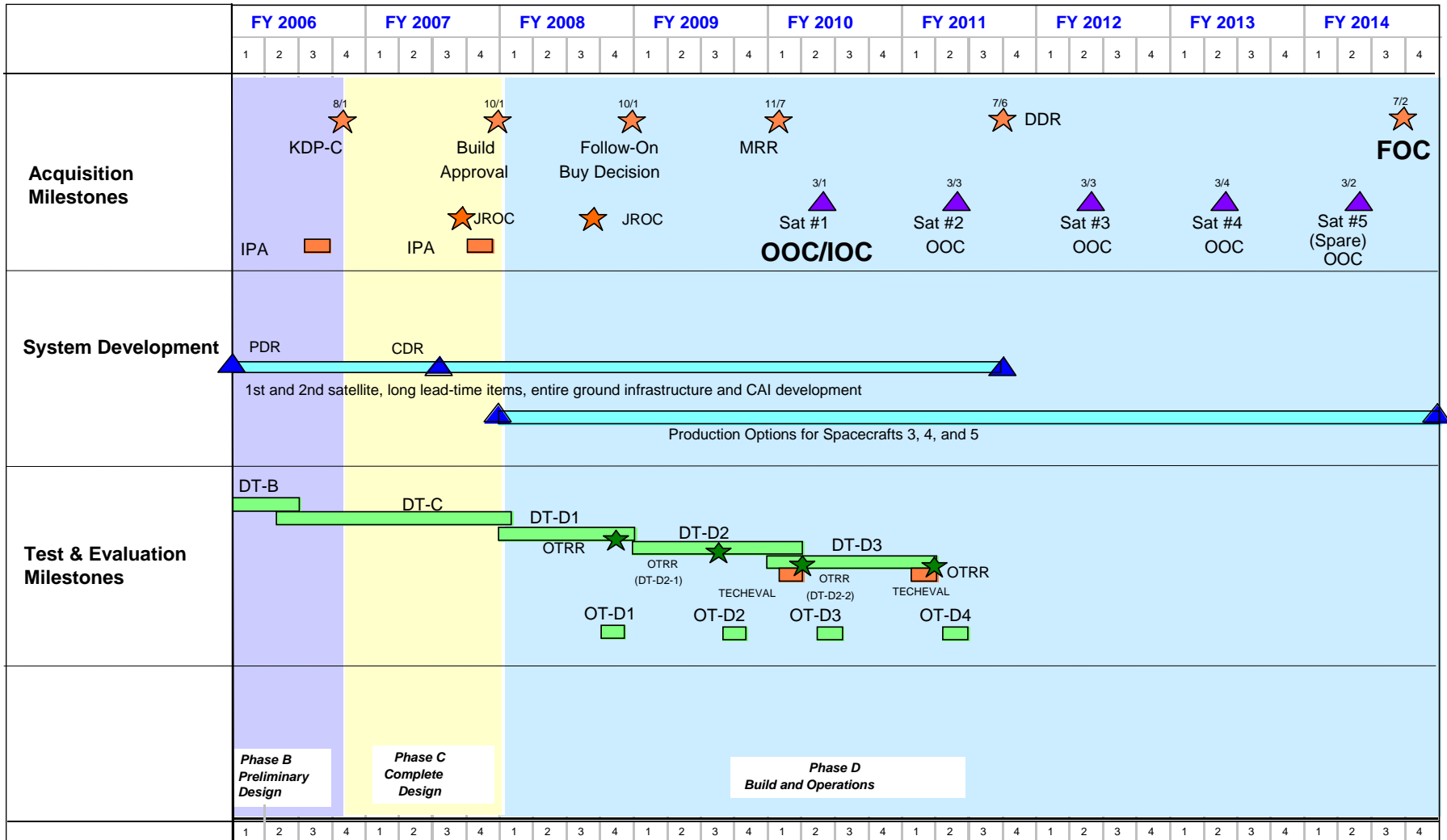
# Mobile User Objective System

- A Major Space Defense Acquisition Program
- Tomorrow's Narrowband SATCOM constellation to replace current Ultra High Frequency (UHF) Follow-On (UFO) constellation
  - Will provide 10x legacy capacity and significantly improved availability
  - On Orbit Capability (OOC) in 2010
  - Full Operational Capability (FOC) in 2014
- Critical Design Phase initiated in Nov 05/completed May 07
  - Contract for MUOS Development awarded to Lockheed Martin Team, including Boeing Satellite Systems and General Dynamics
  - Development of MUOS satellites, ground systems, and user terminal waveform
- Key Decision Point (KDP) – C board completed Aug 06

**The MUOS program remains on budget and schedule through KDP-C and the critical design phase**



# MUOS Program Schedule

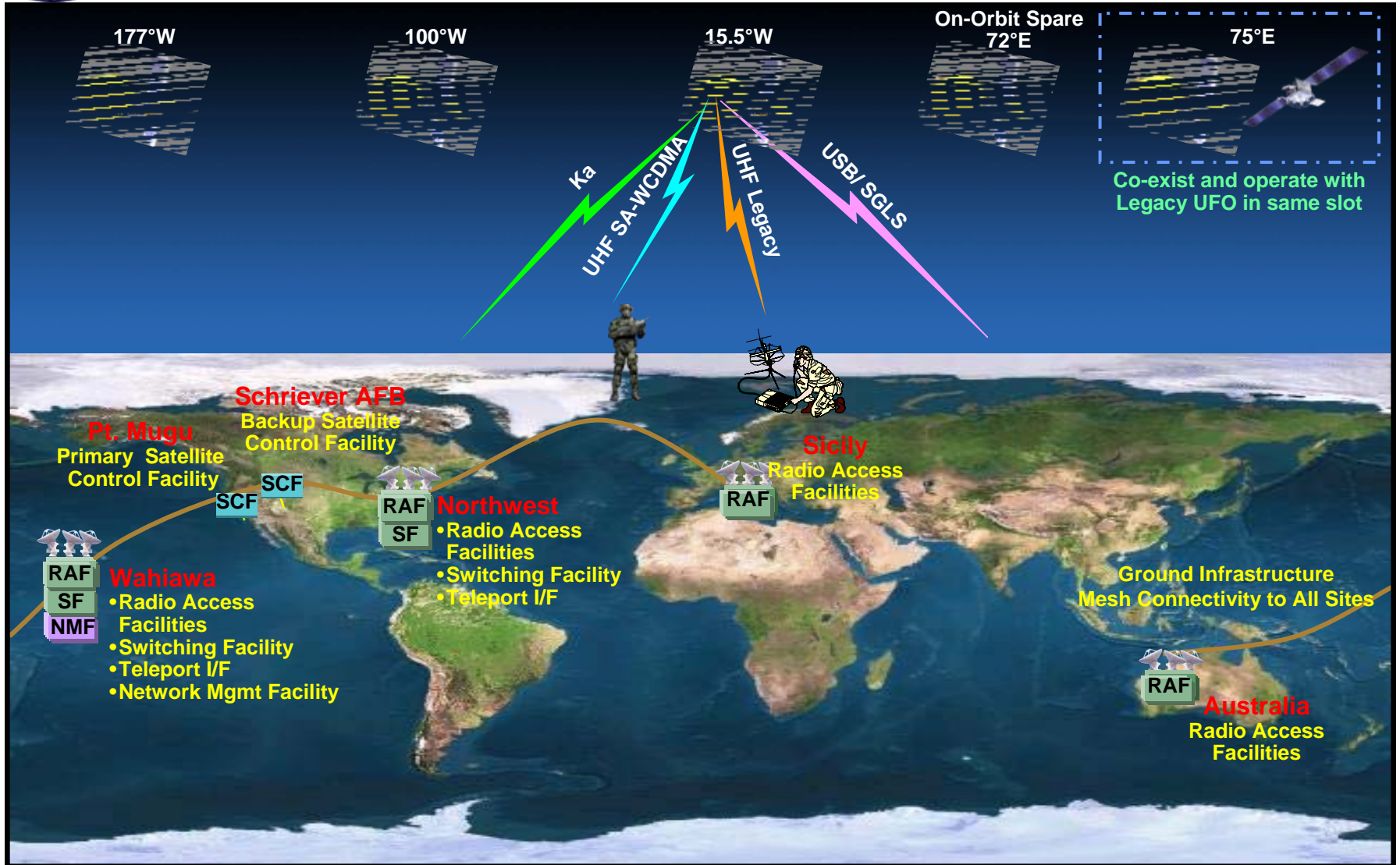


OOC: 2010

FOC: 2014



# MUOS Architecture





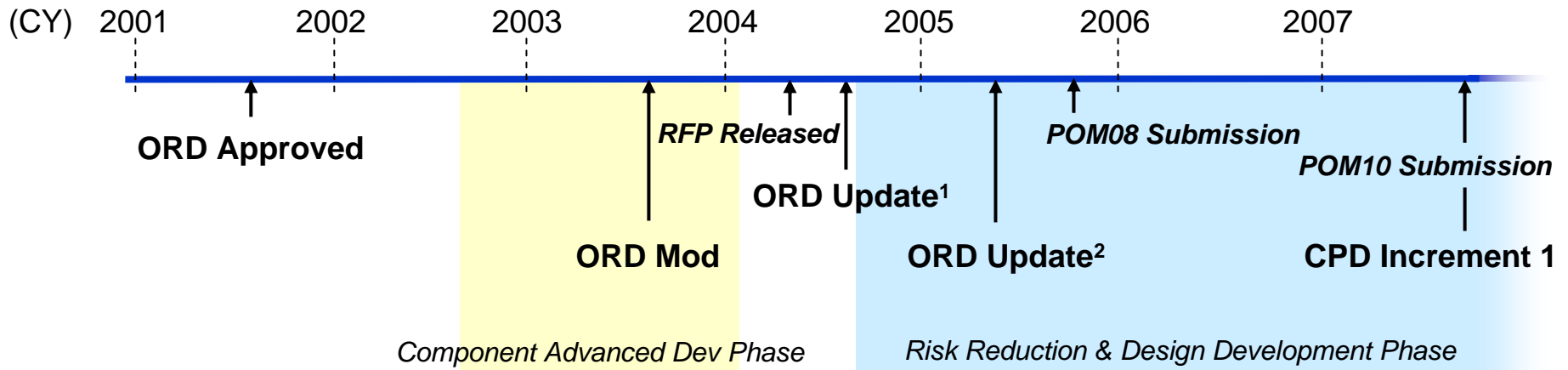
# Our Challenges

---

- Fixed Project Schedule and Budget
  - Aging legacy constellation drives 2010 need date for MUOS capabilities
  - Budget is always limited
- System-of-Systems
  - MUOS is not a stand-alone system
  - End-to-end capability dependent on user terminals (JTRS) and DoD Teleports
- Changing Requirements
  - MUOS ORD has been updated two times since release of contract RFP
- Shifting Strategic Directions
  - Introduction of the Net-Ready KPP
  - Evolution of the Global Information Grid (GIG)
  - Movement toward packet-switched technologies
- Large and Complex Project With a Distributed Team



# MUOS Requirements Timeline



<sup>1</sup> MUOS was grandfathered from having to convert to a CDD; this update addressed only non-key performance parameter (KPP) requirements.

<sup>2</sup> This ORD update replaced the Interoperability KPP with the Net-Ready KPP.





# Our Approach to Requirements Mgmt

## *The Big Picture*

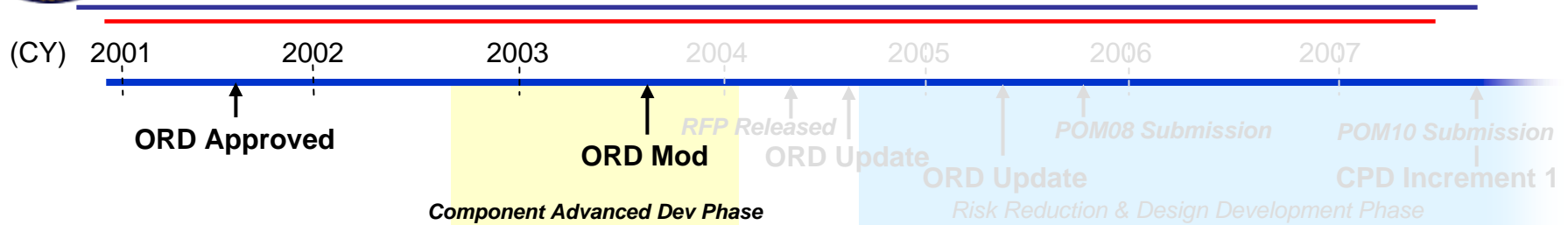
---

- MUOS Program Management is committed to controlling scope
  - Managing requirements is key to controlling scope, but...
  - A degree of flexibility is critical
- Our Requirements Management goes well beyond simply maintaining documents and databases
  - Our team includes technical experts to manage the *content* of the requirements
  - We utilize and customize tools to provide the program office comprehensive insight and oversight of requirements
- Requirements are being managed throughout the program's entire life cycle



# Our Approach

## *Unachievable Requirements...*

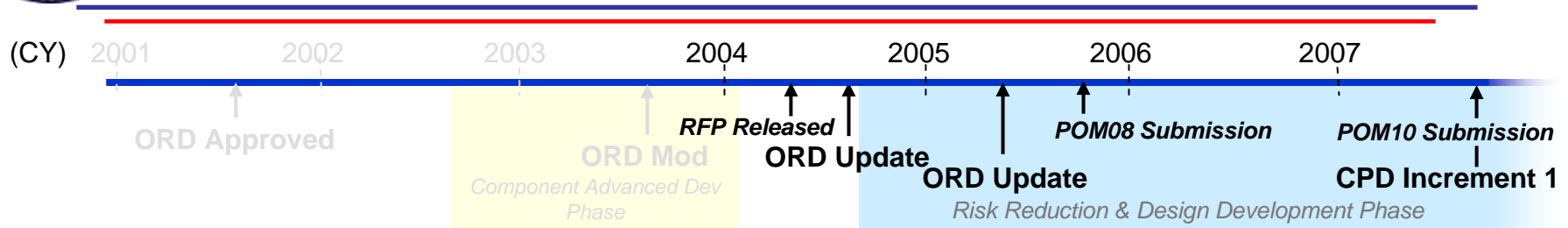


- We participated in all early operational requirements meetings with warfighter representatives (COCOMS, services, OSD, etc.)
  - Raised issues with requirements that were deemed to push the limits of technology at the time, which influenced the initial operational requirements (ORD)
- CAD phase was an opportunity for us to further refine the requirements with 2 contractor teams
  - Provided insight into how the requirements were driving the architectures
- As potential architectures matured, we worked with the resource sponsor and user community to address requirements that were significantly impacting architecture designs and costs
  - Successfully reduced 2 requirements (1 a key performance parameter) as a result of both cost as an independent variable (CAIV) and technical feasibility studies



# Our Approach

## Changing and Emerging Requirements...

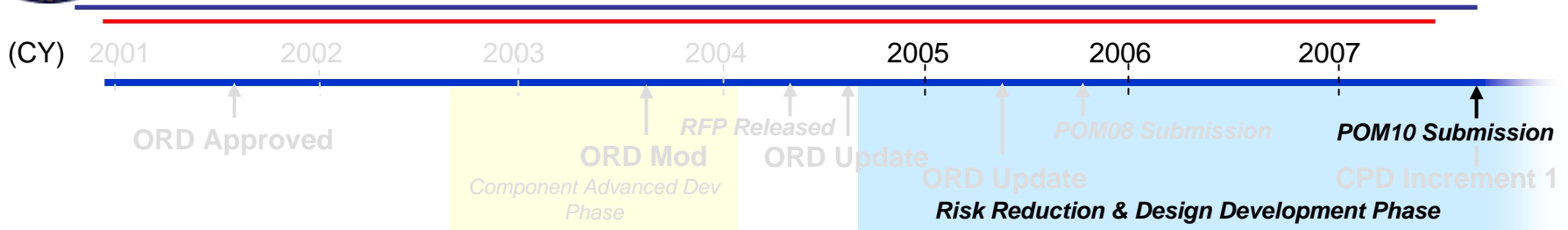


- MUOS has successfully managed 2 post-RFP ORD updates
  - Contractor performed impact assessment of new & changed requirements
  - Results allow us to make informed budget, schedule, performance and risk decisions and elevate issues
    - We are allocating requirements to 2 Increments
      - Current capability is documented in the MUOS CPD Increment 1
      - Remaining requirements, when funded and contracted, will go into CPD Increment 2
    - Requesting funds through resource sponsor via POM inputs
- We track applicable policies and DoD directives and work closely with NSA...
  - incorporating derived requirements, when possible
  - raising issues, as necessary



# Our Approach

## Changing and Emerging Requirements...

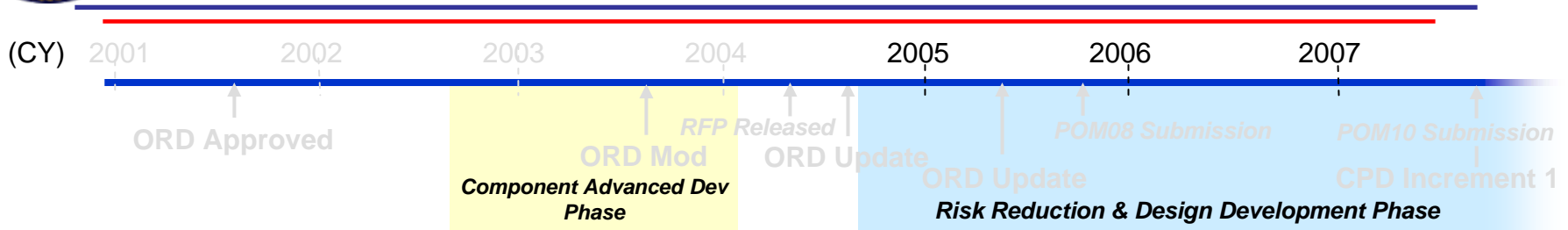


- We acknowledge we are part of a system-of-systems
  - We work hard to remain aware of JTRS and Teleport architecture development and changes and address issues as early as possible
    - Established the MUOS Acquisition Council
    - Active Interface Control Working Groups
  - We stay ahead of Net-Centric directives to minimize impacts while making smart decisions – i.e., evolving with our environment within our constraints
    - Example is early decision to change to an entirely packet-switched architecture
- Moving ahead, we continue to communicate with the user community on emerging requirements
  - Conducted meeting with warfighter reps to understand their priorities, which will influence POM10 submission and future allocation of funds



# Our Approach

## *Contractor oversight by the program office...*

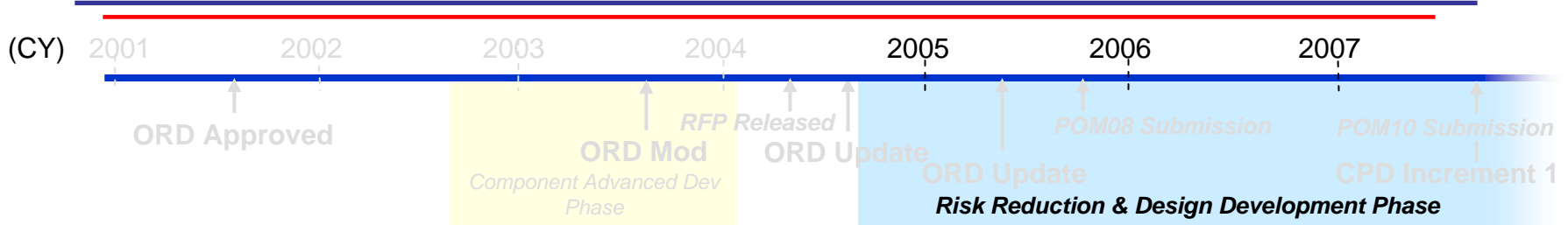


- We translated the operational requirements into more detailed and testable requirements via the contract performance specification
  - Frequently requested clarifications of the requirements by participating in every ORD meeting, email, phone calls, etc.
  - Involved subject matter experts across the program office team
- We have a very productive relationship with STRATCOM's MUOS representative, ensuring we consider the user's perspective
  - He frequently participates in IPT meetings and attends design conferences
- We continually foster frank and open communications with the contractor
  - Contractor not only requests clarification of requirements, but also...
  - Contractor has proposed refinements to requirements to allow improved design and/or cost savings



# Our Approach

## *Contractor oversight by the program office...*

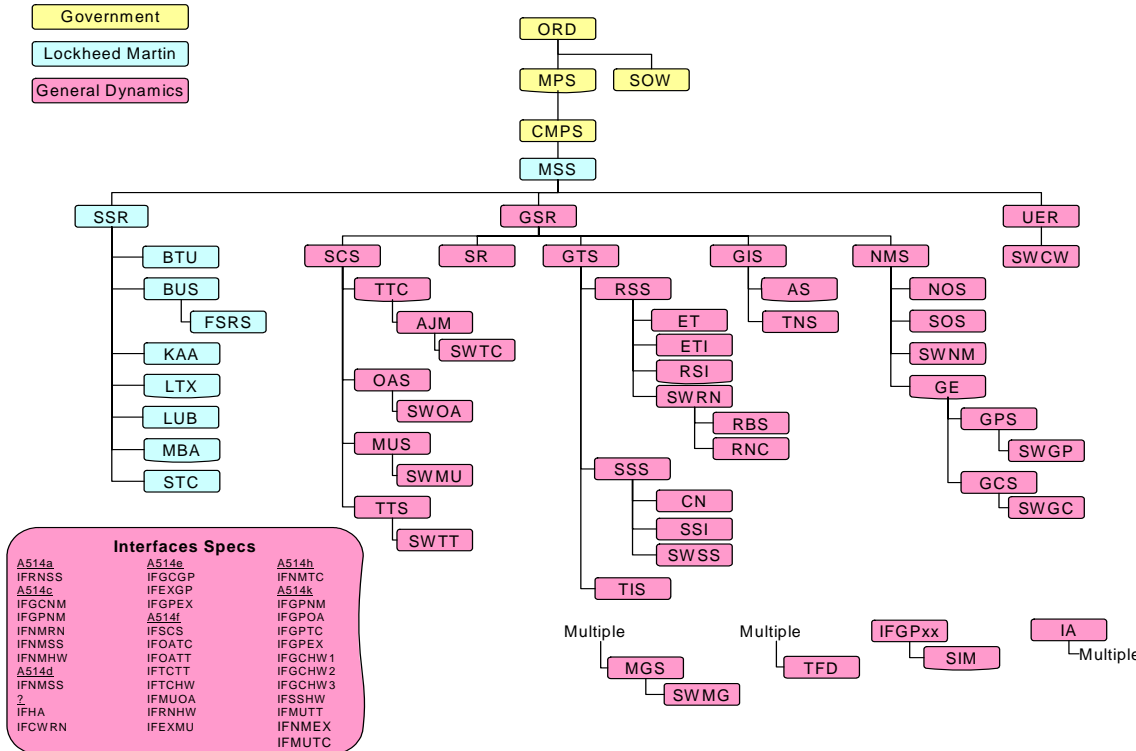


- We work very closely with the developer to ensure proper treatment of contract requirements
  - Tracking requirements flow and interpretation through all levels of specification: system, segment, subsystem, software and hardware
    - Are contract specifications fully captured?
    - Have extraneous requirements been added?
    - What are the implications of a high-level requirements change or a low-level design change?
  - Strong participation in and oversight of requirement verification plan development
- Tools are key to our processes



# Requirements Management Tool

## Utilize and Customize



- **Large Program**
    - 160 specifications
    - 500,000 rqmts
  - **Distributed Team**
    - 3 DOORS databases
    - weekly integrations
- ➔ **21,000 lines of code**

**Tools are a must!**



# Requirements Management Tool Involve the Requirements Managers



## Requirement Managers

- active IPT members
- help the IPTs use the tools

**Collaborate to use the tools**





# Requirements Management Tool Customized Reports

- Tabular traces
- Hierarchical traces
- Pivot tables

SWGP/SWGC	CMPS Short text
[SWGPI010] Geo Processing CSCI shall archive received Mission Support Data, including:	[SYS058], [SYS510]
1. MUOS ep 2. UFO eph 3. Deleted 4. IERS data, 5. Smoothed 6. active gro	
[SWGPI015] requests in ac Processing Se	
[SWGPI020] archive in acc Processing Se	
[SWGPI025] results in acc Software Des	
[SWGPI030] between the p	
[SWGPI030] receive intern Appendix B o Description (r	
[SWGPI050] two simultane	
[SWGPI055] timeline that i time, stop tim	
[SWGPI060] Processing co	
[SWGPI065] run a task to p	

A	B	C	D	E	F	G	H	
1	Drop Page Fields Here							
2								
3								
4	MOE ID	CMPS All VTEs						
5	[MOE 10-1 (O)]	(blank)						
6	[MOE 10-1 (T)]	TS064 (SPT4-Post-Environmental, N/A,						
7	[MOE 10-2 (O)]	SCS010 (Build 1 (SCS) GS FAT)						
8		SCS050 (Build 1 (SCS) GS FAT, SPT4-						
9		TS120 (Build 2 GS FAT, Build 1 GS FAT,						
10		(blank)						
11	[MOE 10-2 (T)]	SYS620 (Build 1 GS FAT)						
12	[MOE 1-1 (O)]	(blank)						
13	[MOE 1-1 (T)]	(blank)						
14	[MOE 2-1 (O)]	(blank)						
15	[MOE 2-1 (T)]	SYS490 (Build 3 GS FAT, Build 1 UES						
16		(blank)						
17	[MOE 2-2 (O)]	SYS090 (Build 3 GS FAT, Build 1 UES						
18		SYS105 (Build 3 GS FAT, Build 3 GTS						
19	[MOE 2-2 (T)]	SYS090 (Build 3 GS FAT, Build 1 UES						
20	[MOE 3-1 (T)]	SYS574 (Build 3 GS FAT)						
21		SYS580 (Build 3 GS FAT)						
22		SYS582 (Build 3 GS FAT)						
23		SYS588 (Build 3 GS FAT)						
24		UES015 (Build 1 UES FQT)						
25		(blank)						
26	[MOE 3-2 (T)]	SYS052 (Build 2 GS FAT, Component						
27		SYS053 (Component Test (COMP), SPT4-						
28		SYS058 (Component Test (COMP), SPT4-						
29		TS030 (Build 1 GS FAT, Build 2 GS FAT,						
30		Build 3 GS FAT, Build 1 UES FQT, SPT4-						
31	[MOE 3-3 (O)]	(blank)						
32	[MOE 3-3 (T)]	(blank)						
33	[MOE 4-1 (O)]	(blank)						
34	[MOE 4-1 (T)]	SYS081 (Build 1 GS FAT, Build 3 GS						
35		SYS110 (Build 3 GS FAT)						

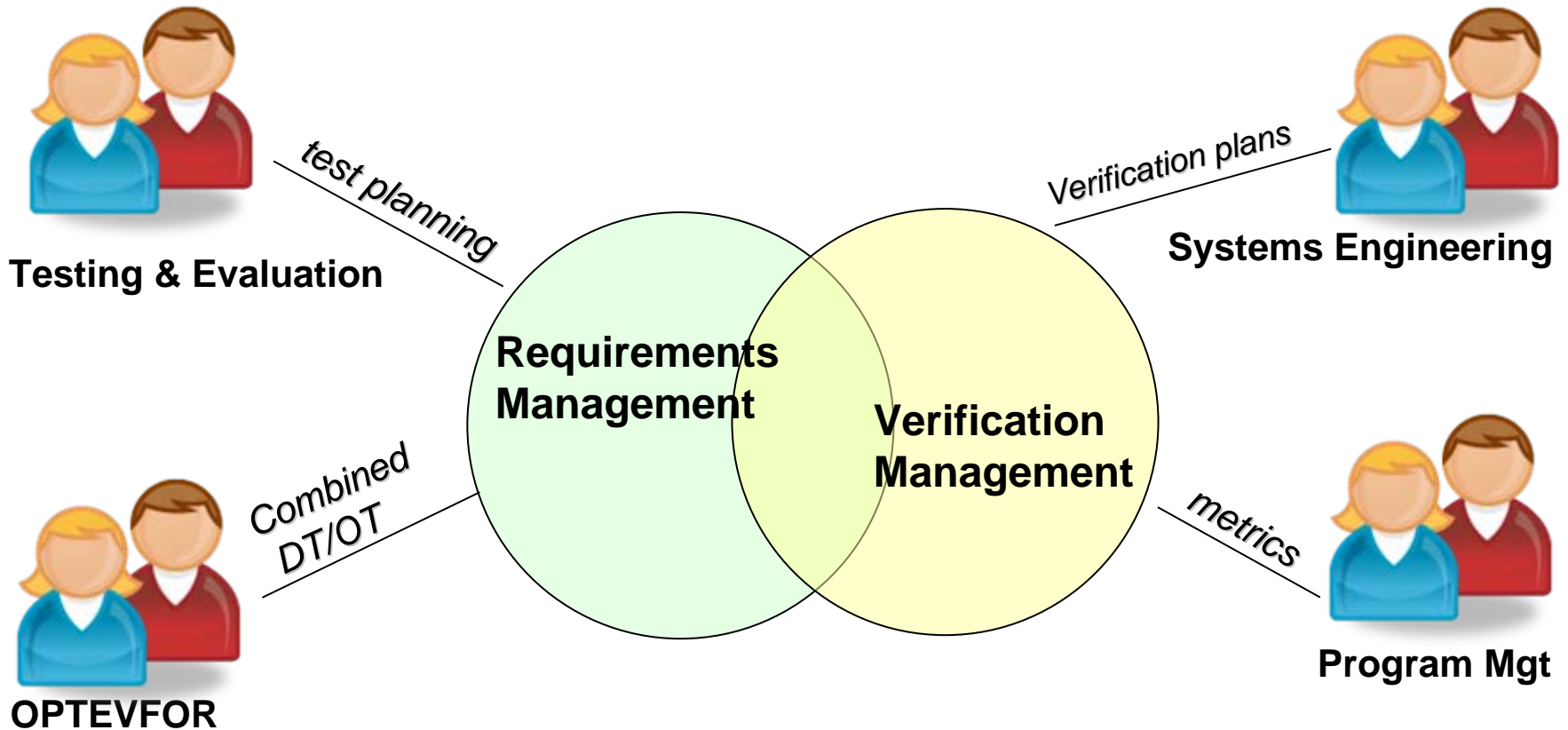
MOE ID	CMPS All VTEs
[MOE 10-1 (O)]	(blank)
[MOE 10-1 (T)]	TS064 (SPT4-Post-Environmental, N/A,
[MOE 10-2 (O)]	SCS010 (Build 1 (SCS) GS FAT)
[MOE 10-2 (T)]	SYS620 (Build 1 GS FAT)
[MOE 1-1 (O)]	(blank)
[MOE 1-1 (T)]	(blank)
[MOE 2-1 (O)]	(blank)
[MOE 2-1 (T)]	SYS490 (Build 3 GS FAT, Build 1 UES
[MOE 2-2 (O)]	SYS090 (Build 3 GS FAT, Build 1 UES
[MOE 2-2 (T)]	SYS090 (Build 3 GS FAT, Build 1 UES
[MOE 3-1 (T)]	SYS574 (Build 3 GS FAT)
[MOE 3-2 (T)]	SYS052 (Build 2 GS FAT, Component
[MOE 3-3 (O)]	(blank)
[MOE 3-3 (T)]	(blank)
[MOE 4-1 (O)]	(blank)
[MOE 4-1 (T)]	SYS081 (Build 1 GS FAT, Build 3 GS

Customized reports have become a central aspect to the daily management of MUOS



# Requirements Management Tool

## Customize the Requirements Database



**Expanded existing tools to address changing Program office needs**



# Lessons Learned

---

- The Positive
  - Program management must be committed to managing project scope, yet have enough flexibility to respond to the changing environment
    - Examples: change to IP technology, evolving interfaces with DISN services
  - Rigorous interaction with the requirements community is crucial
    - Manage expectations by ensuring requirements are feasible, affordable and understood
  - Meticulous oversight of top to bottom requirements is a necessity
    - Tools are essential here: requirements traces, verification pivot tables, etc.
  - Invest in a robust Requirements Management System
  - Foster a cooperative environment that is receptive to change
    - Cooperation among SETA contractors significantly enhances productivity
    - Development contractor suggestions have resulted in many improvements
- Needs Improvement
  - Escalation of process problems
    - At times we wasted months trying to resolve process issues with the developer
  - Coordination with other projects
    - No overarching integrator



# Challenges Ahead

---

- Broader systems engineering issues to keep our large, highly complex project on budget and schedule
  - We're already facing issues that are impacting budget and schedule
    - Technical issues
    - Security issues
- Continued reliance on other projects
  - User terminal developments are well behind MUOS development
  - Teleport funding is out of sync with MUOS development
  - Lack of an overarching integrator increases this challenge
- Dealing with future new requirements
  - New requirements have been proposed
  - We are currently working through a process to address these, potentially developing a CDD for a block upgrade