System Engineering Challenges for Satellite Hosted Payloads

Commercially Hosted Infrared Payload (CHIRP)

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Colonel Bob Newberry

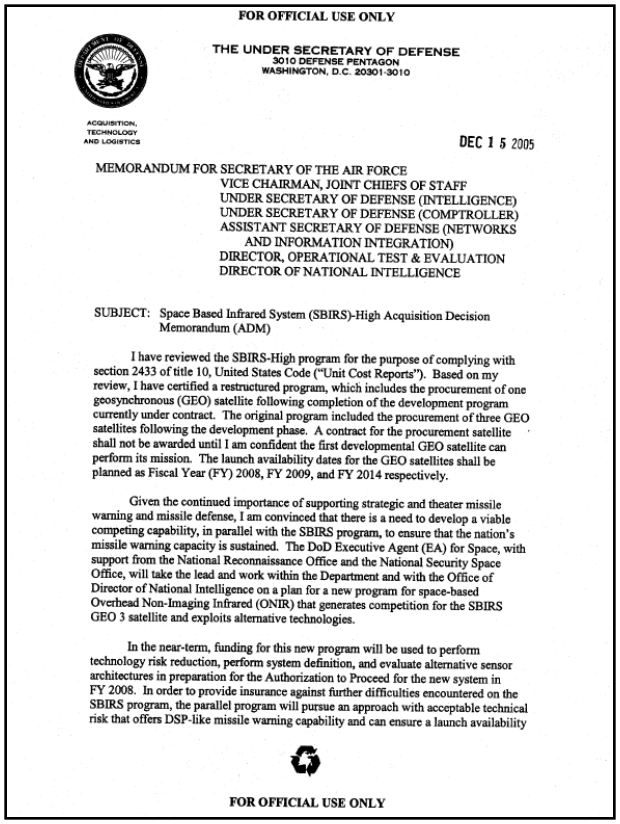
Introduction

- The US Government has flown four hosted satellite payloads within the past decade
  - 2005: FAA, GPS Wide Area Augmentation System (WAAS)
  - 2008: USCG, Maritime Automatic Identification System (AIS)
  - 2009: OSD, Internet Router In Space (IRIS)
  - 2011: USAF, Commercially Hosted IR Payload (CHIRP)
- These program present unique Program Management challenges which emphasize the need for robust System Engineering
- This briefing reviews the most recent of these programs with the Air Force's CHIRP program

Background

- **The CHIRP program originated as risk mitigation for the AF's missile warning satellite program in 2005**
  - **The Space Based Infrared System (SBIRS) had experienced substantial cost and schedule delays**

SBIRS Satellite



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THE UNDER SECRETARY OF DEFENSE
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WASHINGTON, D.C. 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

DEC 15 2005

MEMORANDUM FOR SECRETARY OF THE AIR FORCE
VICE CHAIRMAN, JOINT CHIEFS OF STAFF
UNDER SECRETARY OF DEFENSE (INTELLIGENCE)
UNDER SECRETARY OF DEFENSE (COMPTROLLER)
ASSISTANT SECRETARY OF DEFENSE (NETWORKS AND INFORMATION INTEGRATION)
DIRECTOR, OPERATIONAL TEST & EVALUATION
DIRECTOR OF NATIONAL INTELLIGENCE

SUBJECT: Space Based Infrared System (SBIRS)-High Acquisition Decision Memorandum (ADM)

I have reviewed the SBIRS-High program for the purpose of complying with section 2433 of title 10, United States Code ("Unit Cost Reports"). Based on my review, I have certified a restructured program, which includes the procurement of one geosynchronous (GEO) satellite following completion of the development program currently under contract. The original program included the procurement of three GEO satellites following the development phase. A contract for the procurement satellite shall not be awarded until I am confident the first developmental GEO satellite can perform its mission. The launch availability dates for the GEO satellites shall be planned as Fiscal Year (FY) 2008, FY 2009, and FY 2014 respectively.

Given the continued importance of supporting strategic and theater missile warning and missile defense, I am convinced that there is a need to develop a viable competing capability, in parallel with the SBIRS program, to ensure that the nation's missile warning capacity is sustained. The DoD Executive Agent (EA) for Space, with support from the National Reconnaissance Office and the National Security Space Office, will take the lead and work within the Department and with the Office of Director of National Intelligence on a plan for a new program for space-based Overhead Non-Imaging Infrared (ONIR) that generates competition for the SBIRS GEO 3 satellite and exploits alternative technologies.

In the near-term, funding for this new program will be used to perform technology risk reduction, perform system definition, and evaluate alternative sensor architectures in preparation for the Authorization to Proceed for the new system in FY 2008. In order to provide insurance against further difficulties encountered on the SBIRS program, the parallel program will pursue an approach with acceptable technical risk that offers DSP-like missile warning capability and can ensure a launch availability

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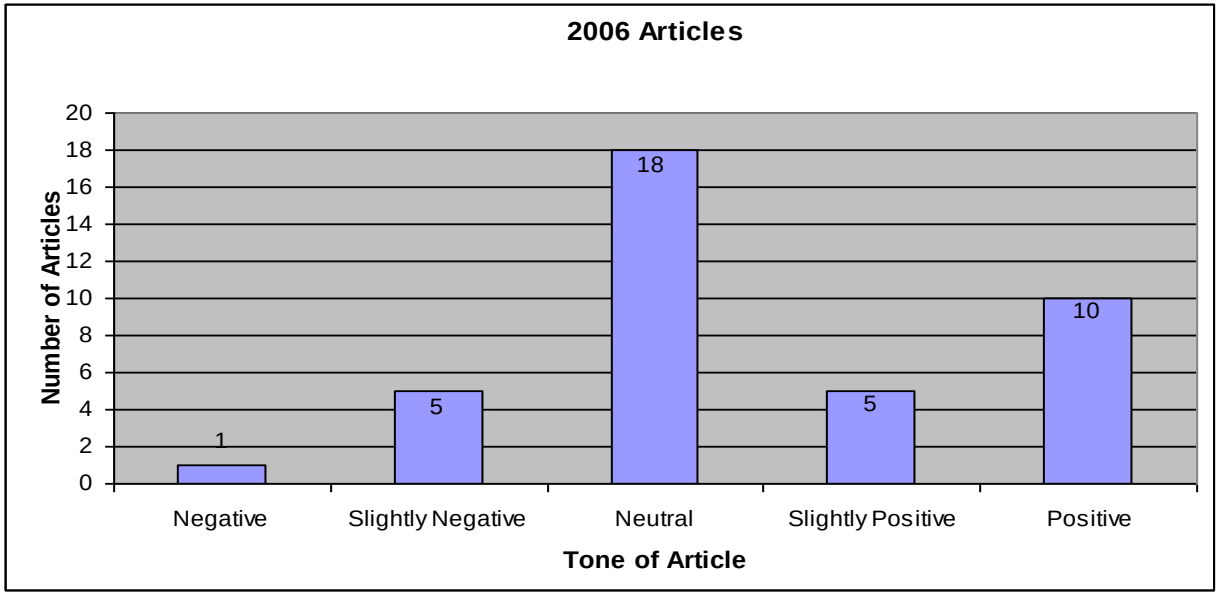
AT&L Acquisition Decision Memo

- **Director for Acquisition, Technology and Logisitics (AT&L) directed the AF to undertake an alternative program**
  - "develop a viable competing capability"
  - "perform technology risk reduction, perform system definition, and evaluate alternative sensor architectures"
- **Program evolution:**
  - 2005: Alternative Infrared Satellite System (AIRSS)
  - 2007: Redesignated as 3rd Generation IR System (3GIRS)
  - 2008: CHIRP contract awarded to SES Americom
  - 2009: 3GIRS descoped; funds moved to developmental planning budget via Operationally Responsive Space
  - 2010: Funds moved to SBIRS budget
  - 2011: CHIRP launch

Programmatic Challenges

1. **Intense scrutiny from external reviewers**
   - **Program drew immediate attention within and outside the AF**
   - **76 Distinguished Visitors briefings early in program**
   - **40 budget re-plan options through FY07**
   - **39 media articles in 1st year**
     - **1st SMC Industry Day covered by the media**
   - **2 GAO reviews in first 2 years**

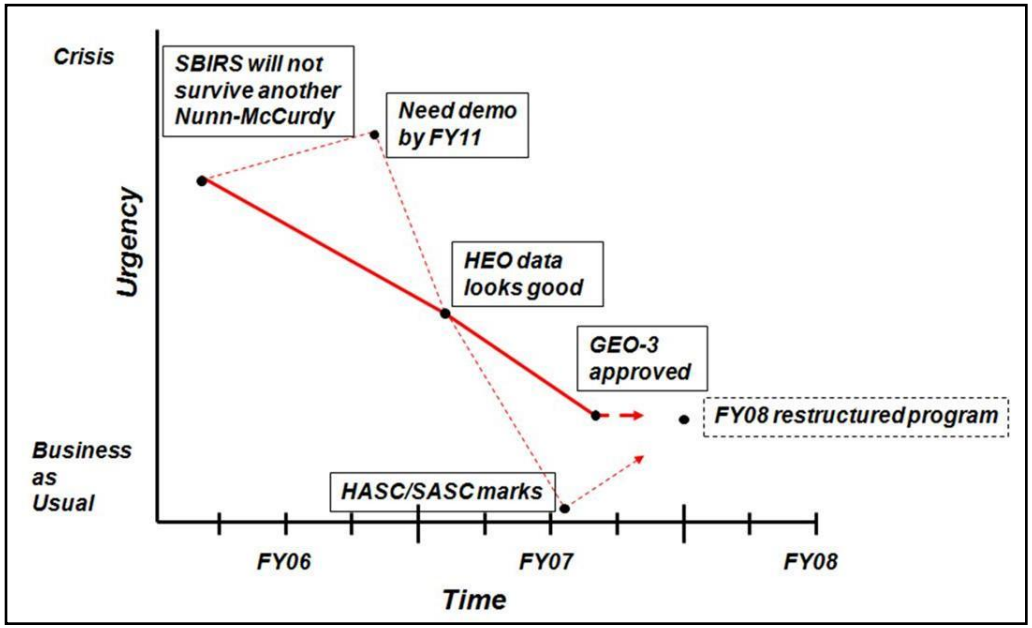


Media Coverage of AIRSS Program

Programmatic Challenges

2. Constant budget turbulence

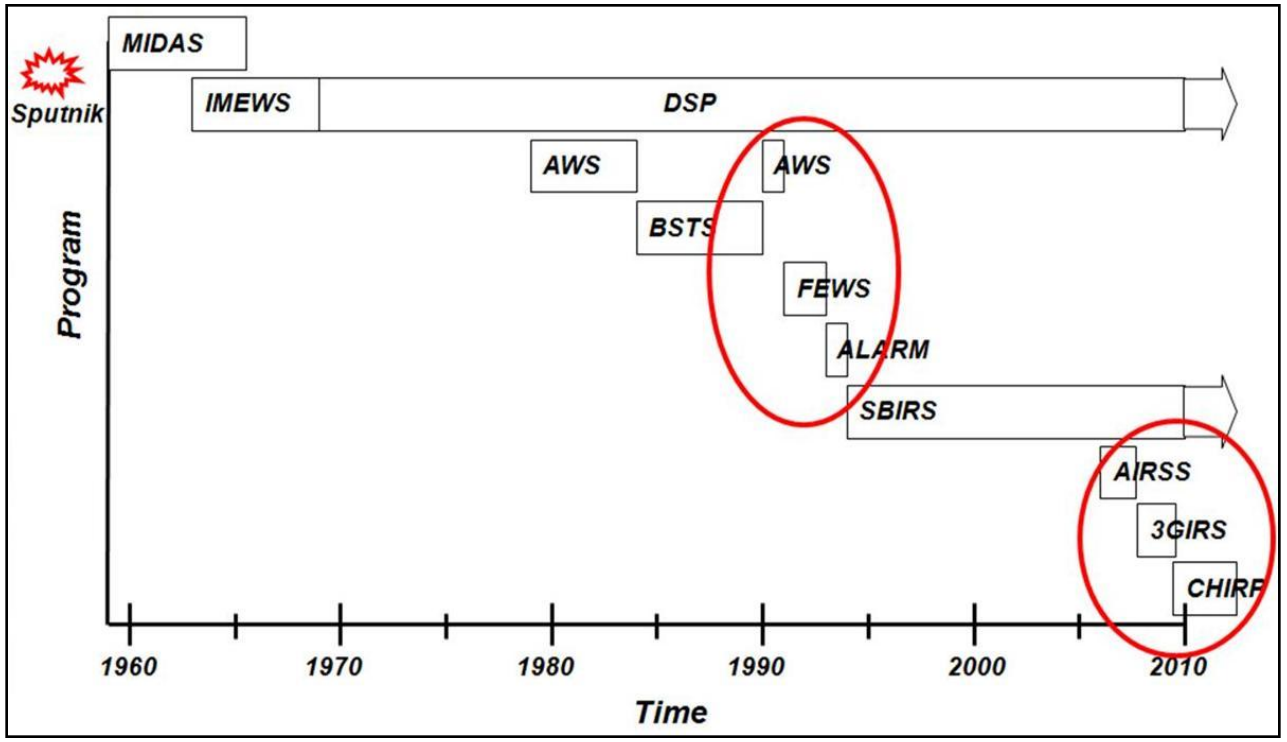
- **FY06: Started with no funding**
  - Reprogrammed $7.2M
- **FY07: 34% budget cut**
  - From $103M to $68M
- **FY08: 67% budget cut**
  - From $225M to $75M
- **FY09: Program cancelled**
  - Minimally funded for liabilities
- **FY10: Minimally funded**
  - Covered contract liabilities
- **FY11-12: Minimally funded**
  - Funded CHIRP fly-out



Program Budget Mirrored Waning Sense of Urgency

Programmatic Challenges

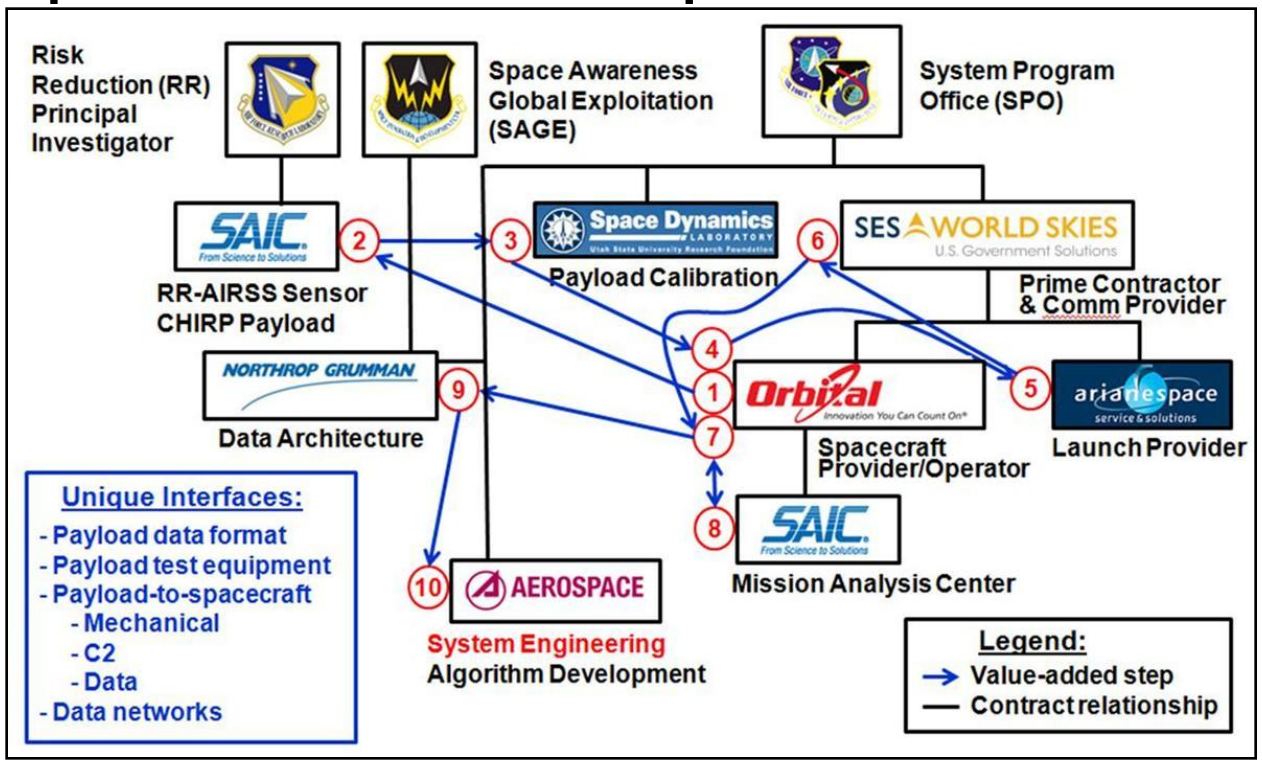
3. **Program started as a "bolt from the blue"**
   - **No planning prior to program start**
   - **No cadre in-place to staff program office**
   - **No technical requirements defined for program**
   - **No agreements in place for teaming**



Program Transitions Have Proven to be Turbulent

System Engineering Challenges

- Programmatic challenges overshadowed program
- General commercial practices defined interfaces at start
- Immature data standards
- Contractors initially working separately
  - Multiple contractor interfaces persisted after CHIRP award



Program Flow

System Engineering Challenges

- **Adding CHIRP to a commercial COMSAT sounded easy but…**
  - Spacecraft unable to handle heat from CHIRP (added a radiator)
  - CHIRP telescope baffle interfered with host UHF antenna (6” cut off baffle)
  - Limited ability to test CHIRP after integrated on host
  - Initial launch load estimates were unrealistic (i.e. 28G’s)
  - Unknown contamination risk during launch (minor concern to COMSATs)
  - Needed host telemetry data merged into CHIRP data stream
  - CHIRP data to be encrypted leaving host (government supplied equipment)
  - Needed encrypted link to move CHIRP data to mission ground station
- **The combined system engineering team solved these problems, and many others**

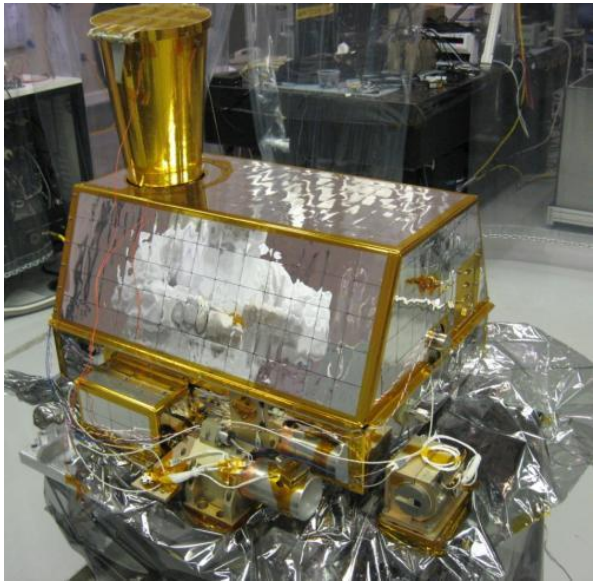
Hosted payloads are attractive but the technical hurdles are significant

System Engineering Practices

- Use of commercial best practices despite cultural barriers
- Well documented test plans
- Rigorous Configuration Control Boards (CCB)
- Timely Failure Review Boards
  - On call 24/7
  - Staffed by government, contractor and Aerospace
- Aerospace published Terms of Reference (TOR) for:
  - Sensor handling
  - Contamination mitigation
- Government SE on-site support for critical tests
- Daily 8am telephone tag-ups
  - Government, contractor and Aerospace participation

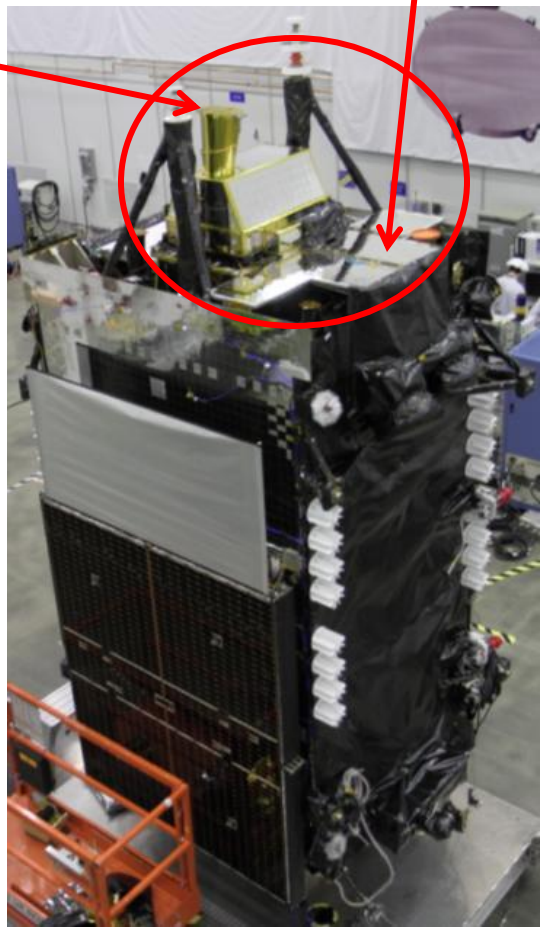
CHIRP Results

- Jul ‘08: Contract award
- Jun ‘09: Started environmental/calibration tests
- Jul ‘10: Delivery to Orbital
- Dec ‘10: Mated to SES-2
- Jun ‘11: Spacecraft I&T completed
- 21 Sep ‘11: Launch



CHIRP Payload

Ariane-5 at Kourou



CHIRP on SES-2