



Flight Software Intern

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About Me

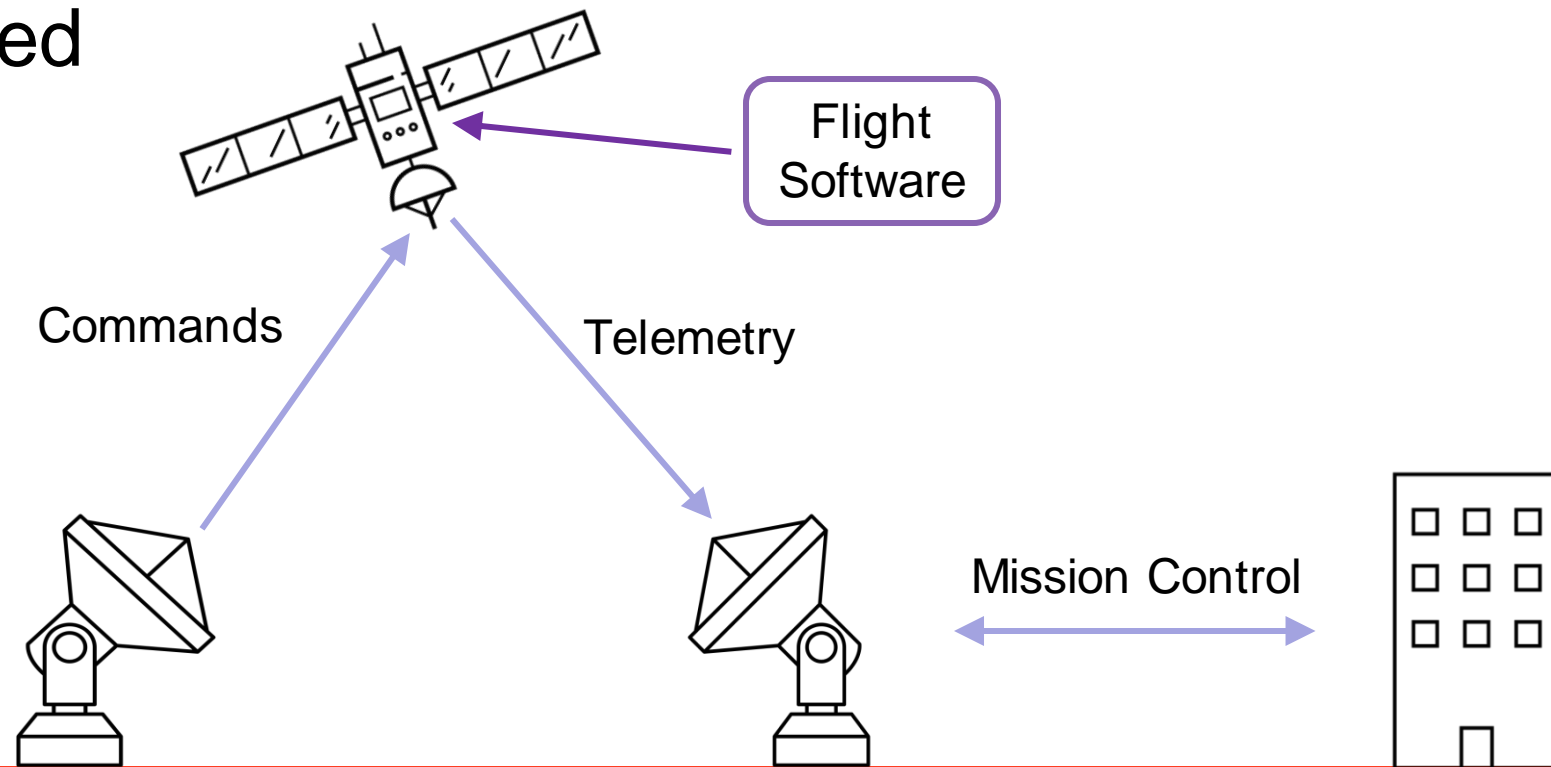
- Double Major
 - Computer Science
 - Applied Mathematics
- Interests
 - Robotics
 - Hiking
 - Reading



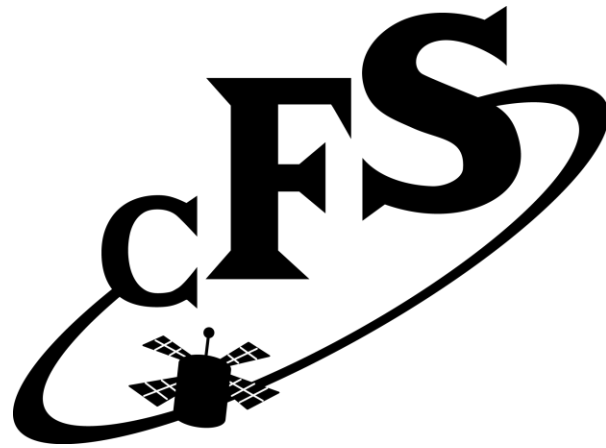
NC STATE
UNIVERSITY

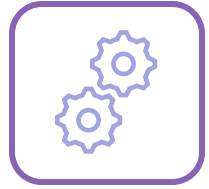
Flight software basics

- Real-time
- Embedded

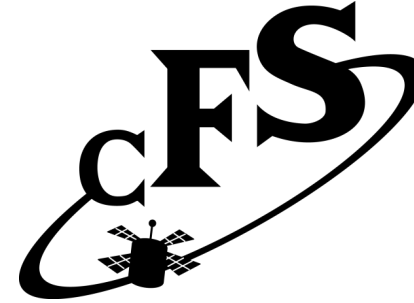


core Flight System

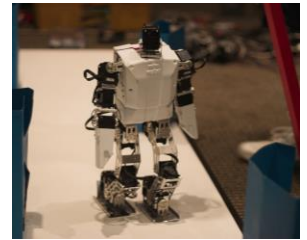
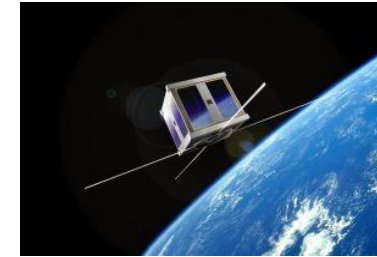




Flight App



cFS as an
“adapter”



Multiple Embedded, Real-Time
Operating Systems and Platforms

Apps & Libraries

Some App



...

Other App



Libraries



FRAMEWORK

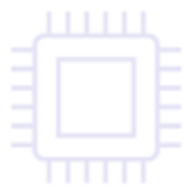
Executive (cFE)

Operating System
Abstraction Layer

Platform Support
Package



Tools



Computer

Operating System

Platform

Responsibilities

- Enhance Automated Testing
- Create Functional Unit Tests
- Support DARPA AMP Challenge

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- Enhance Automated Testing
- Create Functional Unit Tests
- **Support DARPA AMP Challenge**

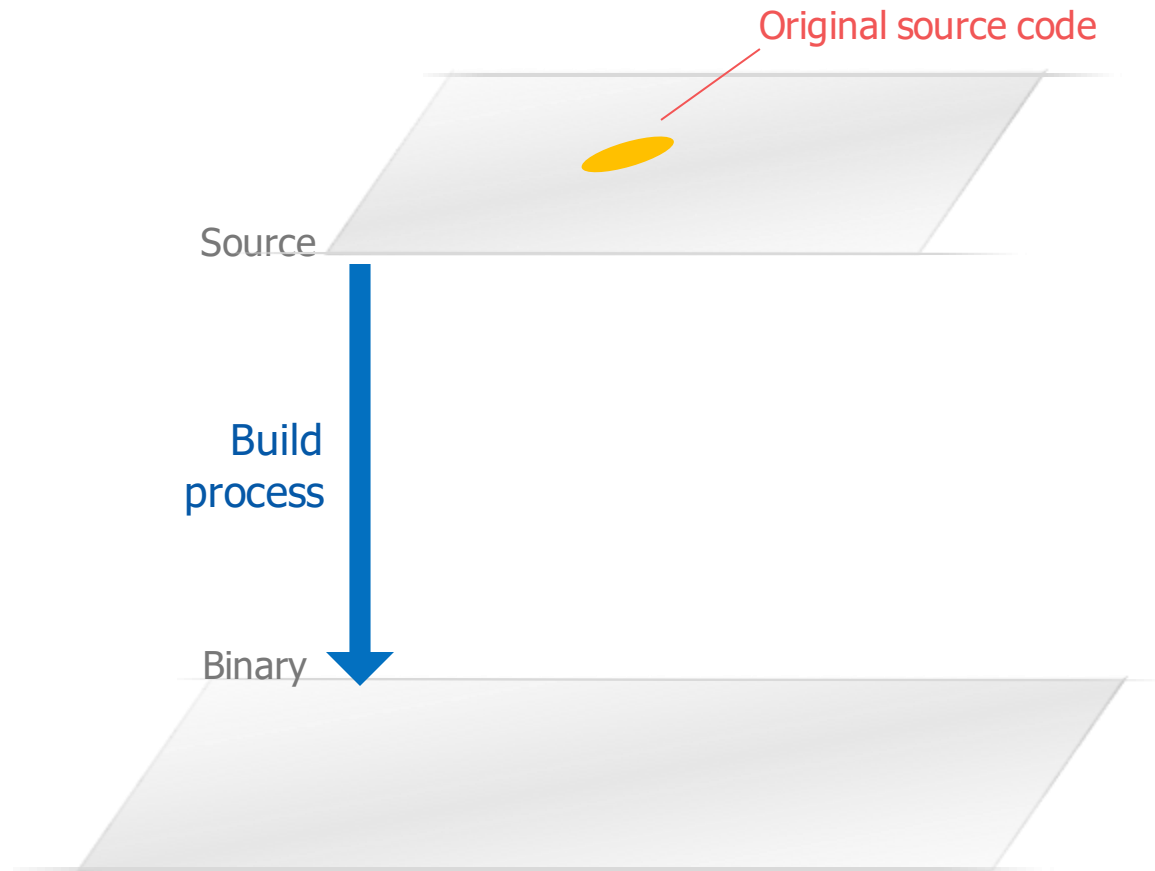
DARPA Assured Micro Patching (AMP)

- Modernizing software patching

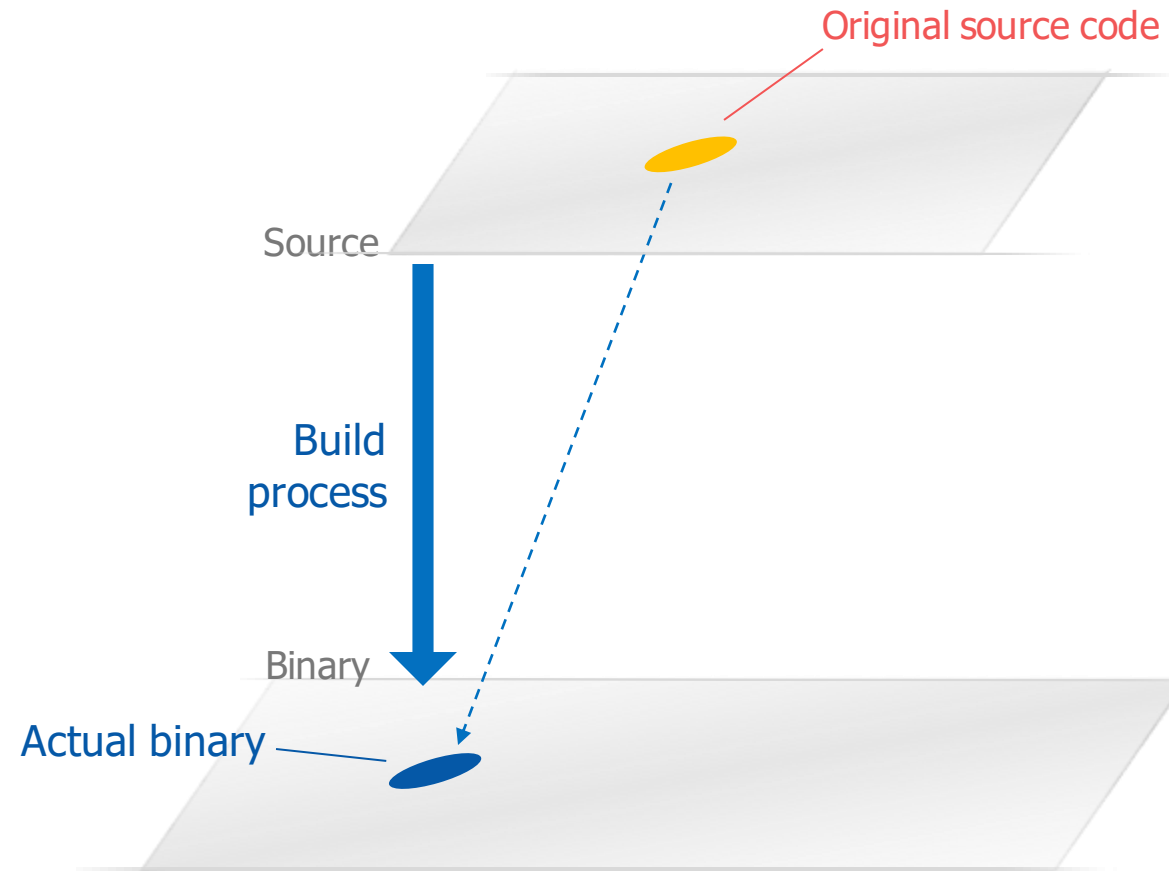
DARPA AMP



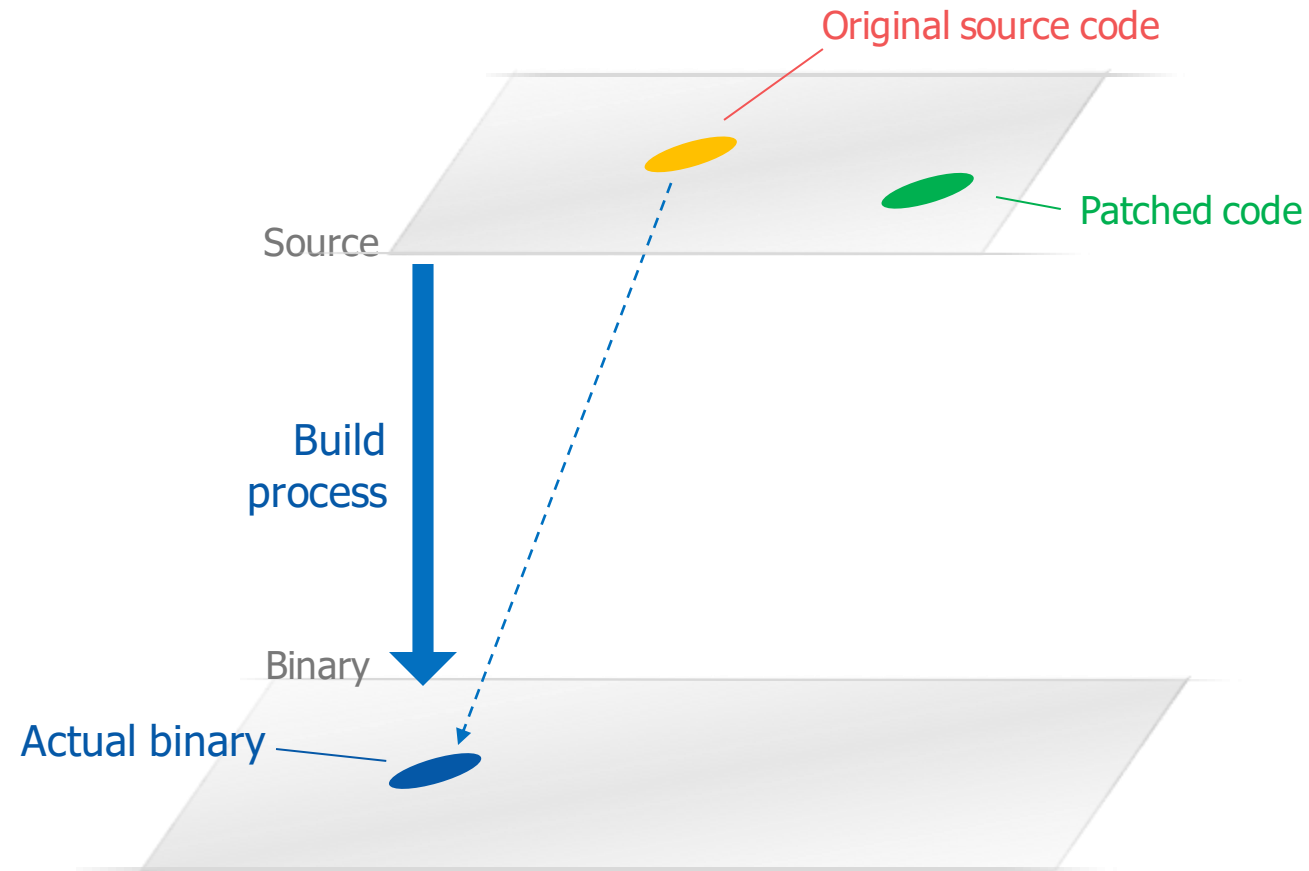
DARPA AMP



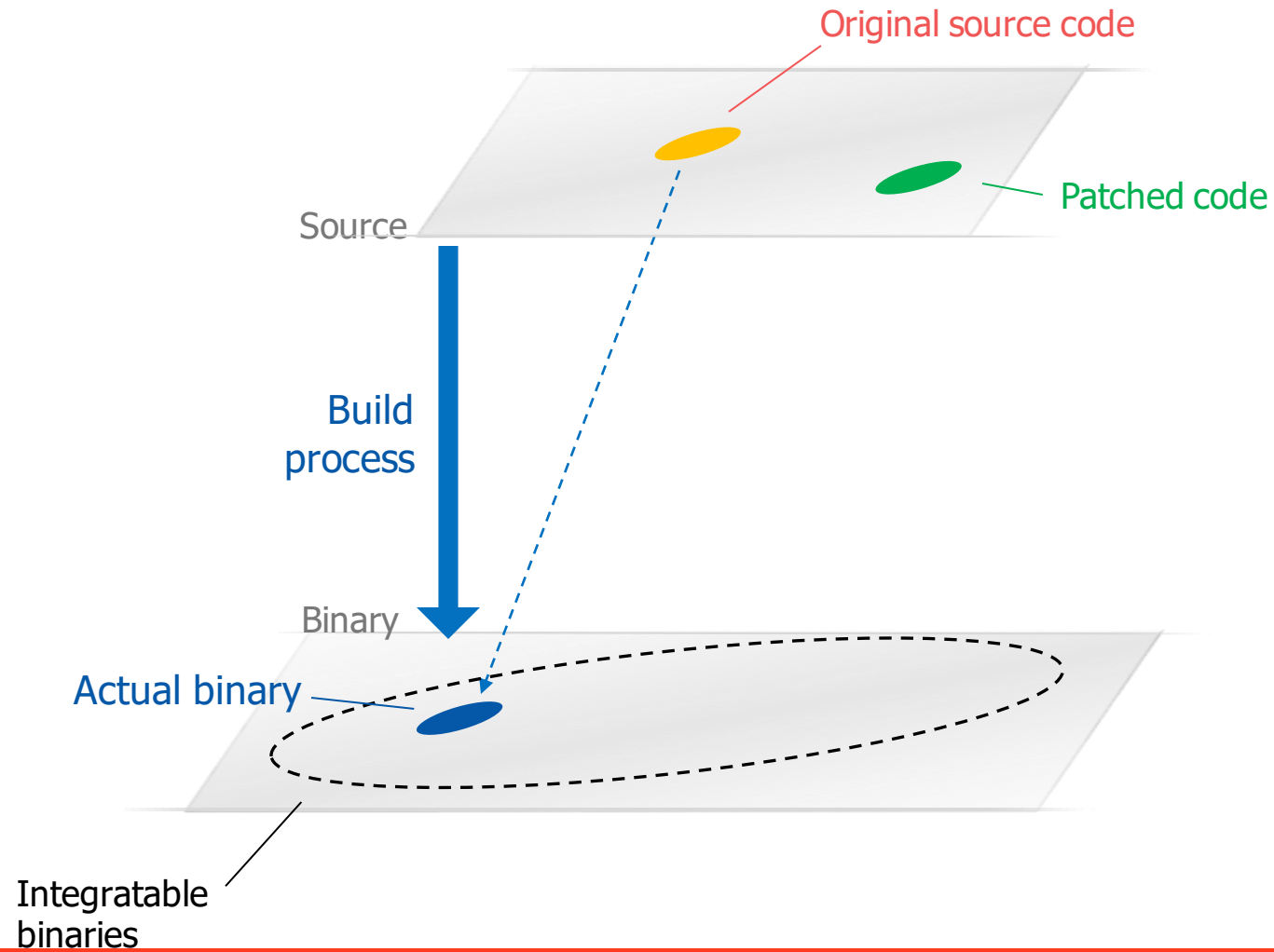
DARPA AMP



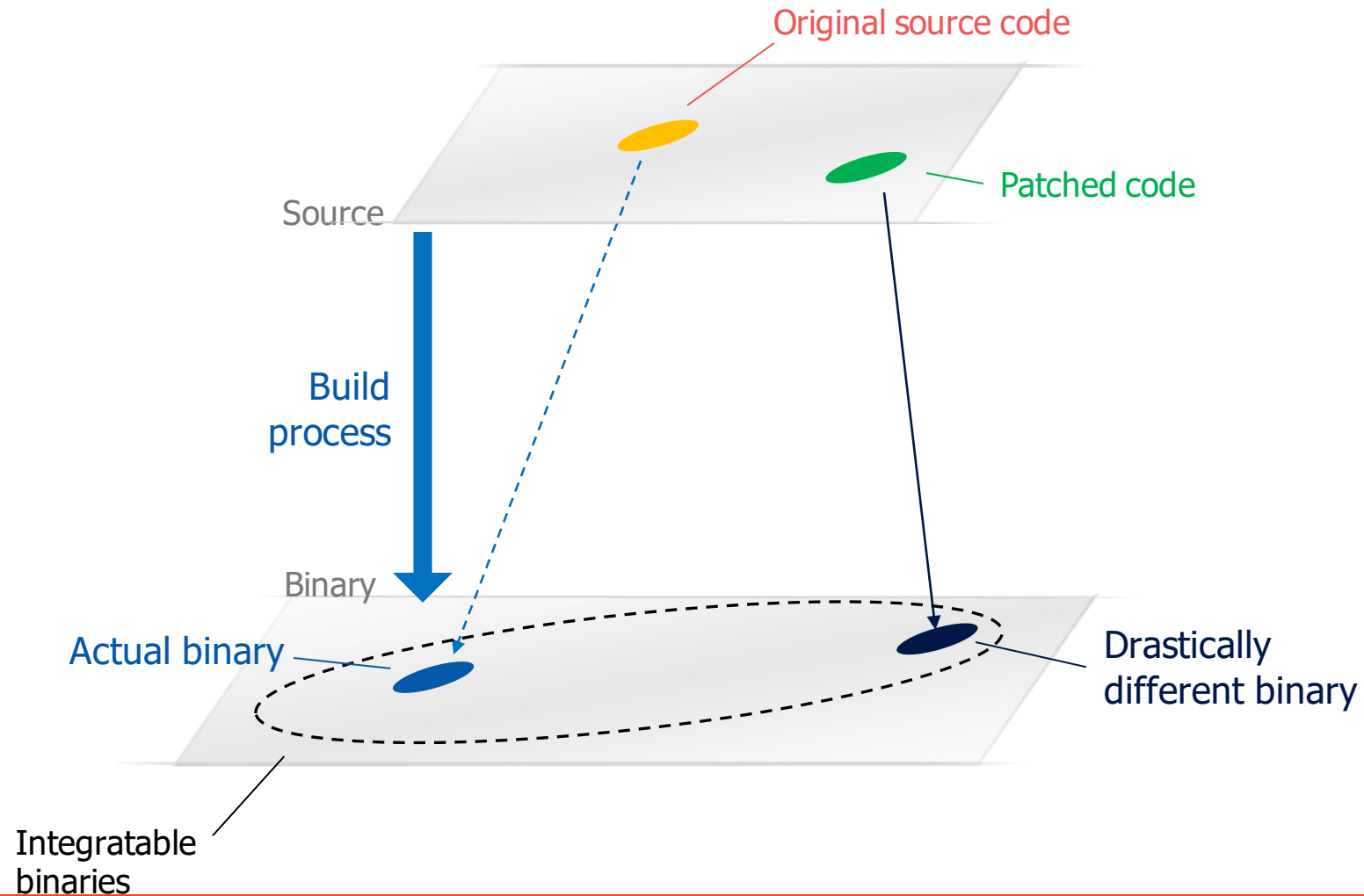
DARPA AMP



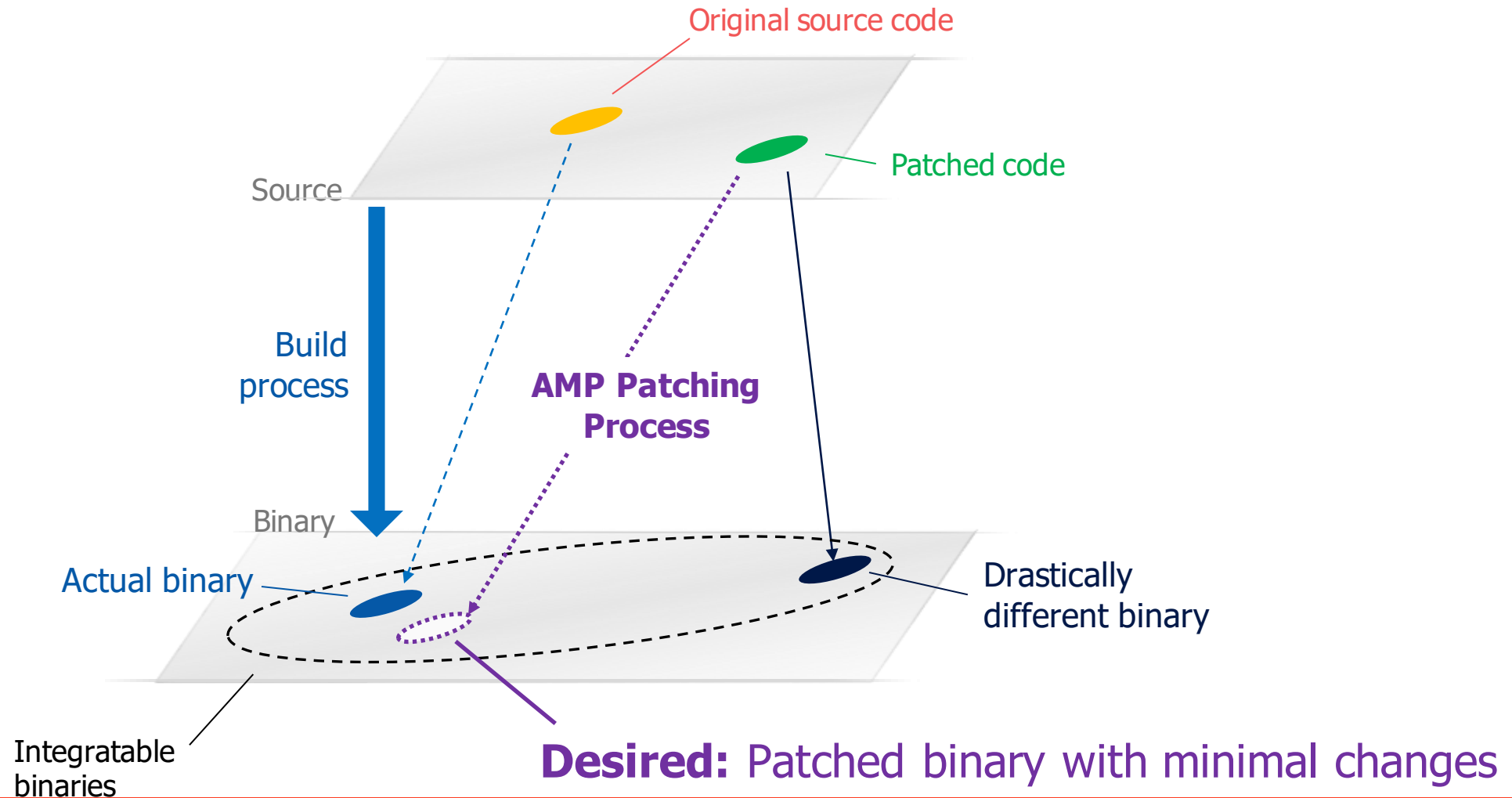
DARPA AMP



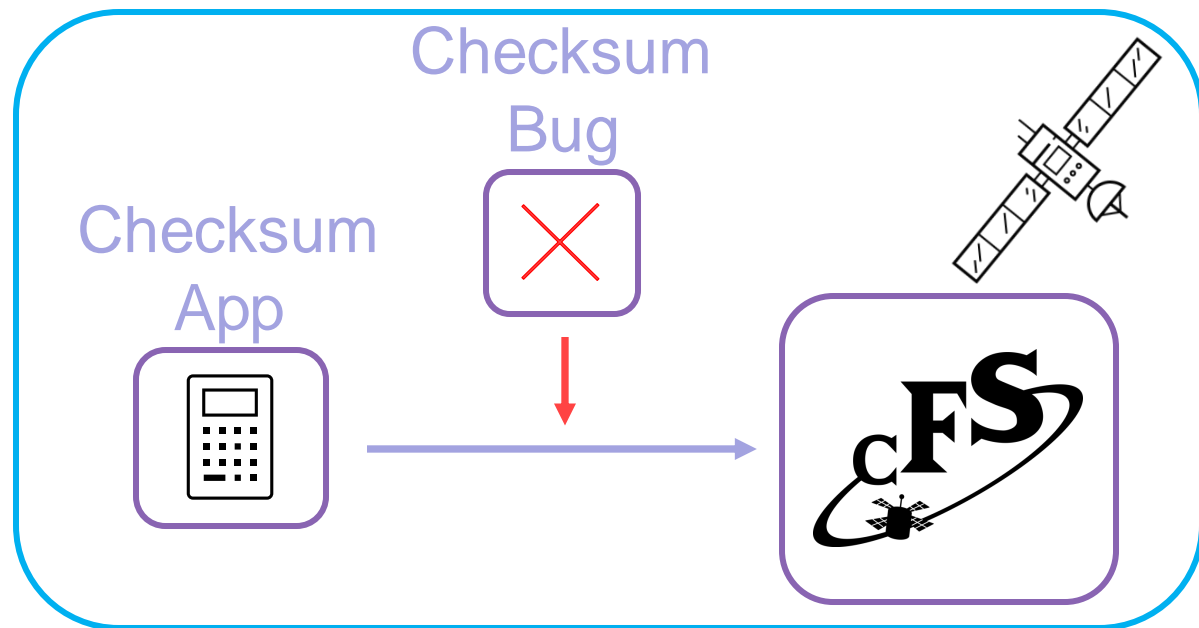
DARPA AMP



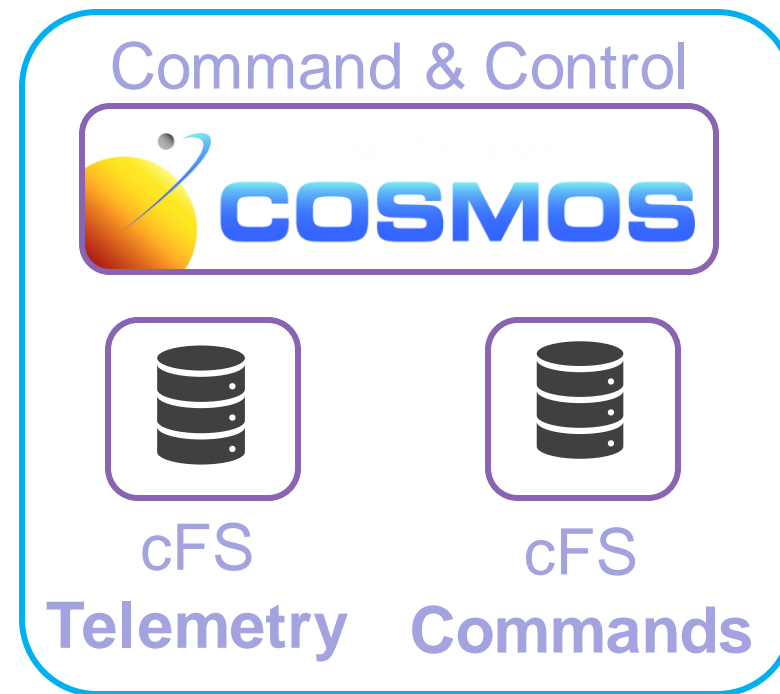
DARPA AMP



cFS Environment



Mission Control



CS CS_SCREEN

CCSDS HEADER

Primary Header

STREAM_ID:

0x08A4

SEQUENCE:

0xC005

PKT_LEN:

65

Secondary Header

SECONDS:

1001019

SUBSECS:

13

Overview

CMD_CNT:

0

CMD_ERRS:

0

Checksum Status

Checksum State

ENABLED

Recompute in Progress

0

Oneshot in Progress

0

Table Being Checksummed

0

Entry in Table Being Checksummed

0

Number of Times Checksum has Passed all Tables

0

Checksum States

Eeprom Checksum State

ENABLED

Memory Checksum State

ENABLED

App Checksum State

ENABLED

Tables Checksum State

ENABLED

OS Checksum State

ENABLED

Cfe Core Checksum State

ENABLED

Checksum Errors

Eeprom Checksum Error Count

0

Memory Checksum Error Count

0

App Checksum Error Count

0

Tables Checksum Error Count

0

OS Checksum Error Count

0

Cfe Core Checksum Error Count

0

Checksum Baselines

Baseline Eeprom Checksum

0x0

Baseline OS Checksum

0x0

Cfe Core Checksum

0x0

Last One Shot Info

Address

0x0

Size

0

Maximum Bytes

0

Checksum

0

CFE EVS_SCREEN

CCSDS HEADER

Primary Header

STREAM_ID:

0x0808

SEQUENCE:

0xC00C

PKT_LEN:

161

Secondary Header

SECONDS:

877006592

SUBSECS:

2203

Messages

Application Name

TO_LAB_APP

Event ID

0x3

Event Type

INFORMATION

TO telemetry output enabled for IP

COSMOS Command and Telemetry Server - Demo Configuration

Cmd Packets

Tlm Packets

Routers

Logging

Status

connect

Connected?

Clients

Tx Q Size

Rx Q Size

Bytes Tx

Bytes Rx

Cmd Pkts

connect

true

0

0

0

24

1848

1

0C0000230000000

ERROR: LOCAL - Unknown 156 byte packet starting: 0801C00500953B460F000200000001000001010

000002000100

ERROR: LOCAL - Unknown 44 byte packet starting: 0805C00500253B460F00030000000E033FFF2000

FB0300000000030040420F00000000000

2021/08/04 13:58:38.770 ERROR: LOCAL - Unknown 48 byte packet starting: 0803C00500293B460F00070000000000000D0

000000000000000000000000000003052173E

2021/08/04 13:58:38.770 ERROR: LOCAL - Unknown 304 byte packet starting: 0804C00501293B460F0009000000000000000B

00

2021/08/04 13:58:38.771 ERROR: LOCAL - Unknown 36 byte packet starting: 0884C005001D3B460F000A00000000010000000

000000000010000000000000000000000000

1080-012-14:03:20-000000-ES Startup: Calling CFE_TBL_EarlyInit

EVS Port1 42/1/CS 143: CS Memory Table verification results: good = 0, bad = 0, unused = 16

EVS Port1 42/1/CS 107: CS Memory Table: No valid entries in the table

EVS Port1 42/1/CS 142: CS Apps Table verification results: good = 0, bad = 0, unused = 24

EVS Port1 42/1/CS 108: CS Apps Table: No valid entries in the table

EVS Port1 42/1/CS 139: CS Tables Table verification results: good = 2, bad = 0, unused = 22

EVS Port1 42/1/CS 127: OS Text Segment disabled due to platform

EVS Port1 42/1/CS 1: CS Initialized. Version 2.4.2.0

1980-012-14:03:20.30310 ES Startup: CFE_ES_Main entering APPS_INIT state

1980-012-14:03:20.30311 ES Startup: CFE_ES_Main entering OPERATIONAL state

EVS Port1 42/1/CFE_TIME 21: Stop FLYWHEEL

EVS Port1 42/1/TO_LAB_APP 3: TO telemetry output enabled for IP

cFS + COSMOS Environment

The image displays two windows from the cFS + COSMOS Environment: **CS CS_SCREEN** and **CFE EVS_SCREEN**. Red boxes and arrows highlight specific data points across these windows.

CS CS_SCREEN Data:

- CCSDS HEADER:**
 - Primary Header: STREAM_ID: 0x0BA4, SEQUENCE: 0xC024, PKT_LEN: 65
 - Secondary Header: SECONDS: 1001143, SUBSECS: 17
- Overview:** CMD_CNT: 0, CMD_ERRS: 0
- Checksum Status:**
 - Checksum State: ENABLED
 - Recompute in Progress: 0
 - Oneshot in Progress: 0
 - Table Being Checksummed: 0
 - Entry in Table Being Checksummed: 0
 - Number of Times Checksum has Passed all Tables: 2
- Checksum States:**
 - Eeprom Checksum State: ENABLED
 - Memory Checksum State: ENABLED
 - App Checksum State: ENABLED
 - Tables Checksum State: ENABLED
 - OS Checksum State: ENABLED
 - Cfe Core Checksum State: ENABLED
- Checksum Errors:**
 - Eeprom Checksum Error Count: 0
 - Memory Checksum Error Count: 0
 - App Checksum Error Count: 0
 - Tables Checksum Error Count: 0
 - OS Checksum Error Count: 0
 - Cfe Core Checksum Error Count: 1
- Checksum Baselines:**
 - Baseline Eeprom Checksum: 0x0
 - Baseline OS Checksum: 0x0
 - Cfe Core Checksum: 0xAEA
- Last One Shot Info:**
 - Address: 0x0
 - Size: 0
 - Maximum Bytes: 0
 - Checksum: 0

CFE EVS_SCREEN Data:

- CCSDS HEADER:**
 - Primary Header: STREAM_ID: 0x0808, SEQUENCE: 0xC00D, PKT_LEN: 161
 - Secondary Header: SECONDS: 2739277568, SUBSECS: 6912
- Messages:**
 - Application Name: CS
 - Event ID: 0x1F
 - Event Type: ERROR
 - Checksum Failure: cFE Core, Expected: 0x00000AEA, Calculated: 0x00000AEB

Callouts:

- A red box highlights the **Messages** section of the **CFE EVS_SCREEN** window, with an arrow pointing to a larger callout box.
- A red box highlights the **Cfe Core Checksum State** and **Cfe Core Checksum Error Count** fields in the **CS CS_SCREEN** window, with an arrow pointing to a larger callout box.

Callout Box 1 (from CFE EVS_SCREEN Messages):

- Application Name: CS
- Event ID: 0x1F
- Event Type: ERROR
- Checksum Failure: cFE Core, Expected: 0x00000AEA, Calculated: 0x00000AEB

Callout Box 2 (from CS CS_SCREEN Checksum Status):

- Cfe Core Checksum State: ENABLED
- Cfe Core Checksum Error Count: 1
- Checksum Baselines:
 - Baseline Eeprom Checksum: 0x0
 - Baseline OS Checksum: 0x0
 - Cfe Core Checksum: 0xAEA
- Last One Shot Info:
 - Address: 0x0
 - Size: 0
 - Maximum Bytes: 0
 - Checksum: 0

CS CS_SCREEN

CCSDS HEADER

Primary Header		Secondary Header	
STREAM_ID:	0x08A4	SECONDS:	1001051
SEQUENCE:	0xC00D	SUBSECS:	24
PKT_LEN:	65		

Overview

CMD_CNT:	0
CMD_ERRS:	0

Checksum Status

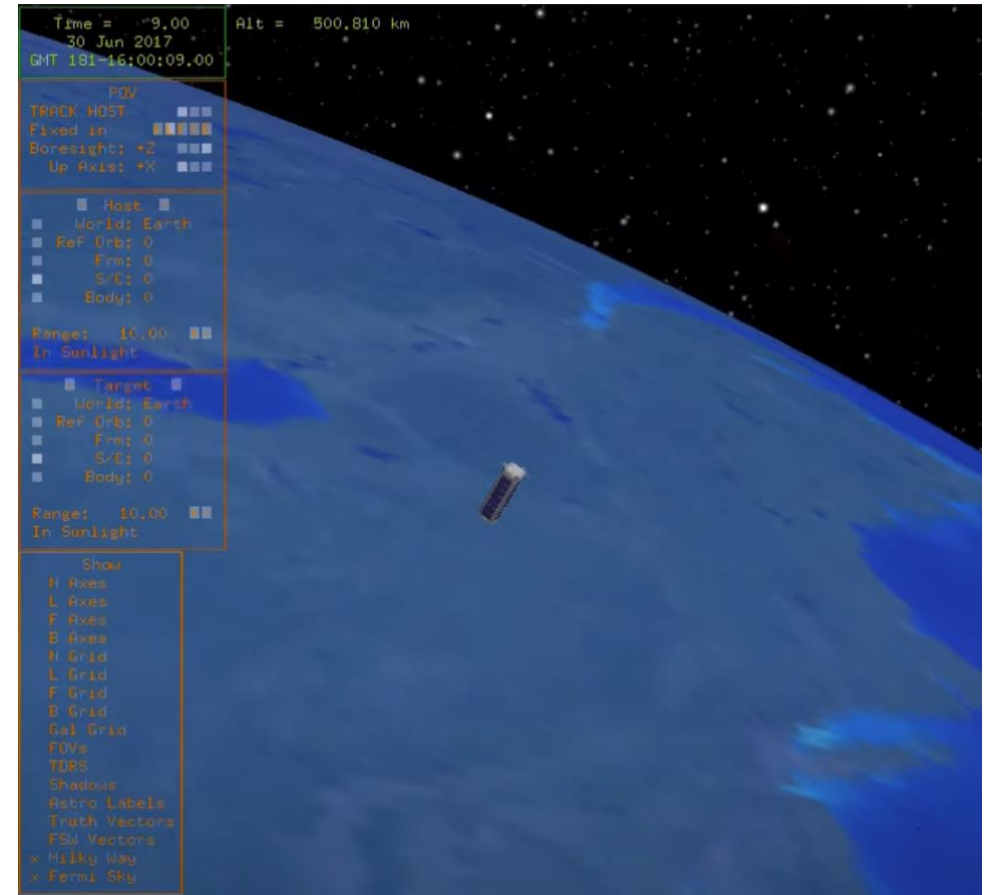
Checksum State	ENABLED
Recompute in Progress	0
Oneshot in Progress	0
Table Being Checksummed	0
Entry in Table Being Checksummed	0
Number of Times Checksum has Passed all Tables	0

Checksum States		Checksum Errors	
Eeprom Checksum State	ENABLED	Eeprom Checksum Error Count	0
Memory Checksum State	ENABLED	Memory Checksum Error Count	0
App Checksum State	ENABLED	App Checksum Error Count	0
Tables Checksum State	ENABLED	Tables Checksum Error Count	0
OS Checksum State	ENABLED	OS Checksum Error Count	0
Cfe Core Checksum State	ENABLED	Cfe Core Checksum Error Count	0

Checksum Baselines		Last One Shot Info	
Baseline Eeprom Checksum	0x0	Address	0x0
Baseline OS Checksum	0x0	Size	0
Cfe Core Checksum	0x0	Maximum Bytes	0
		Checksum	0

Future Work

- Integrate challenges with [NOS3](#) to simulate spacecraft motion
- Limit communication window with spacecraft



Lessons Learned

- Flight Software Development
- Experience testing and finding issues in cFS
- Docker containers



Thank you!



Questions?

Image References

Icons:

- Satellite by Juan Pablo Bravo from the Noun Project
- Building by fahmionline from the Noun Project

Images:

- COSMOS: <https://cosmosc2.com>
- NOS3: <http://www.stf1.com/NOS3Website/Nos3MainTab.php>