



Wide Field Infrared Survey Telescope (WFIRST):

Establishing Interfaces... from Teams to Space Telescopes

Jody L. Davis

WFIRST Deputy Payload Systems Engineer

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Why Are You Here?



Presentation Objectives

- ✓ Learn a little about the WFIRST mission
- ✓ Understand the complexity of technical interfaces and the roadblocks to their development
- ✓ Understand the importance of organization and communication
- ✓ Learn ways to improve and manage communication and bridge organizational differences to support interface development...or any aspect of a project!



Outline



- Why WFIRST?
- What is WFIRST?
 - WFIRST Organization
 - WFIRST Payload
- Where is WFIRST?
- WFIRST Interface Overview
 - Technical Interfaces
 - Management Process
- Why are Interfaces so Complex?
- Establishing Interfaces
 - What Works?
 - What Doesn't?
- Key Takeaways

Science Objectives

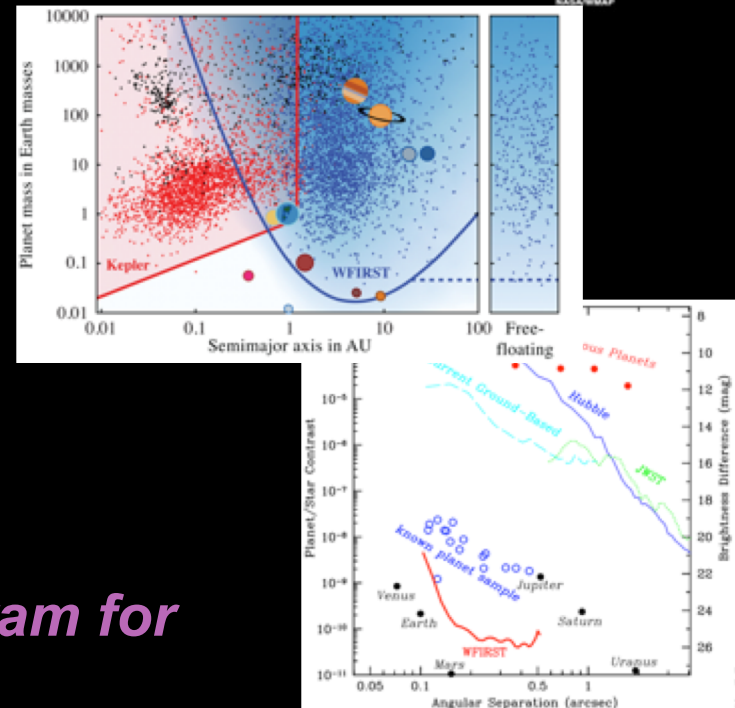
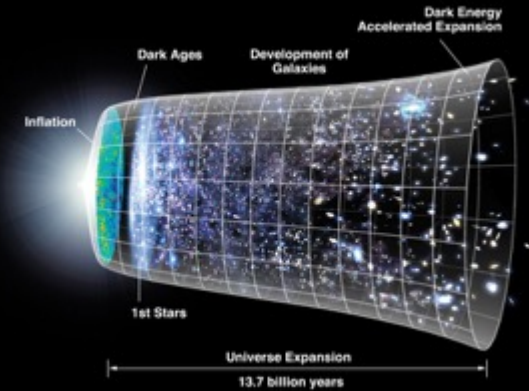
1. *How did we get here?*

- Measure acceleration of the expansion (the expansion history) of the Universe and...
- Characterize the growth of large-scale structures within it

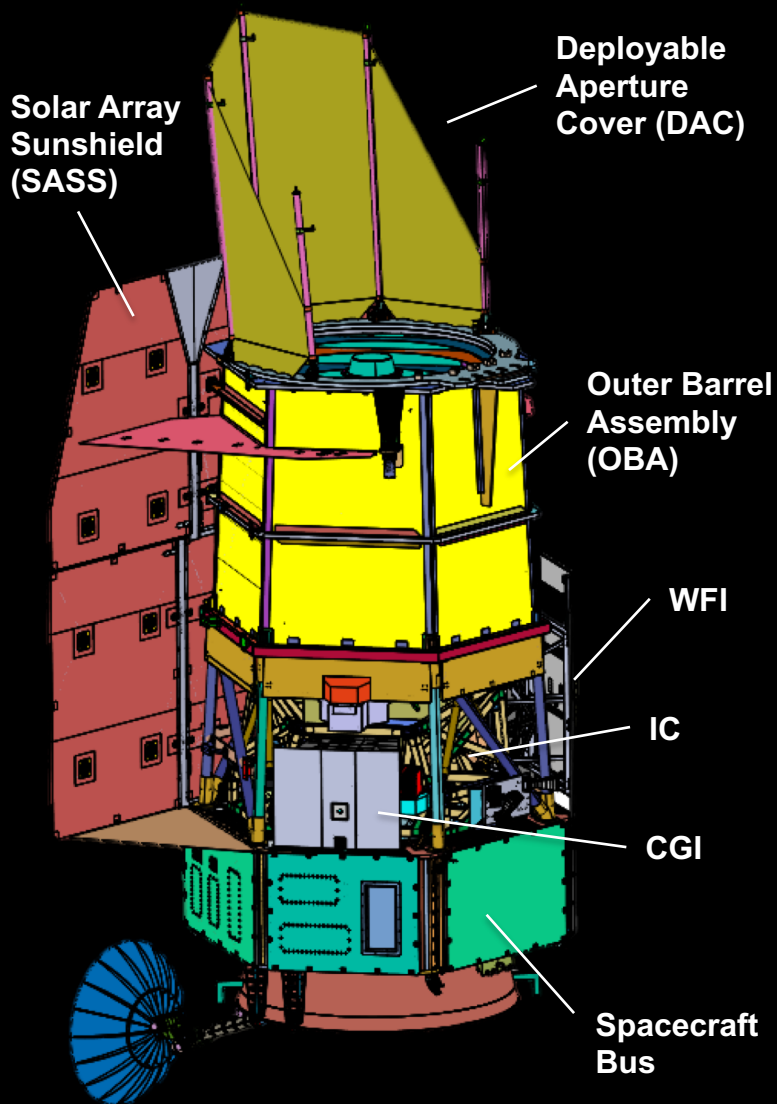
2. *Are we alone?*

- Search for extra-solar planets (exoplanets) and complete the census of exoplanets in our galaxy
- Develop and fly a coronagraph instrument technology demonstration is used for direct imaging and spectroscopy of nearby exoplanets and debris disks

3. *Host a Guest Observer (GO) program for general astrophysics*



What is WFIRST?



Mission Overview

Mission Life: 5 years (+ 90-day checkout)

Mission Orbit: Sun-Earth L2

Launch Vehicle: Heavy class

Mission Classification:

- Class A Overall
- Class C Coronagraph technology demonstration

Observatory:

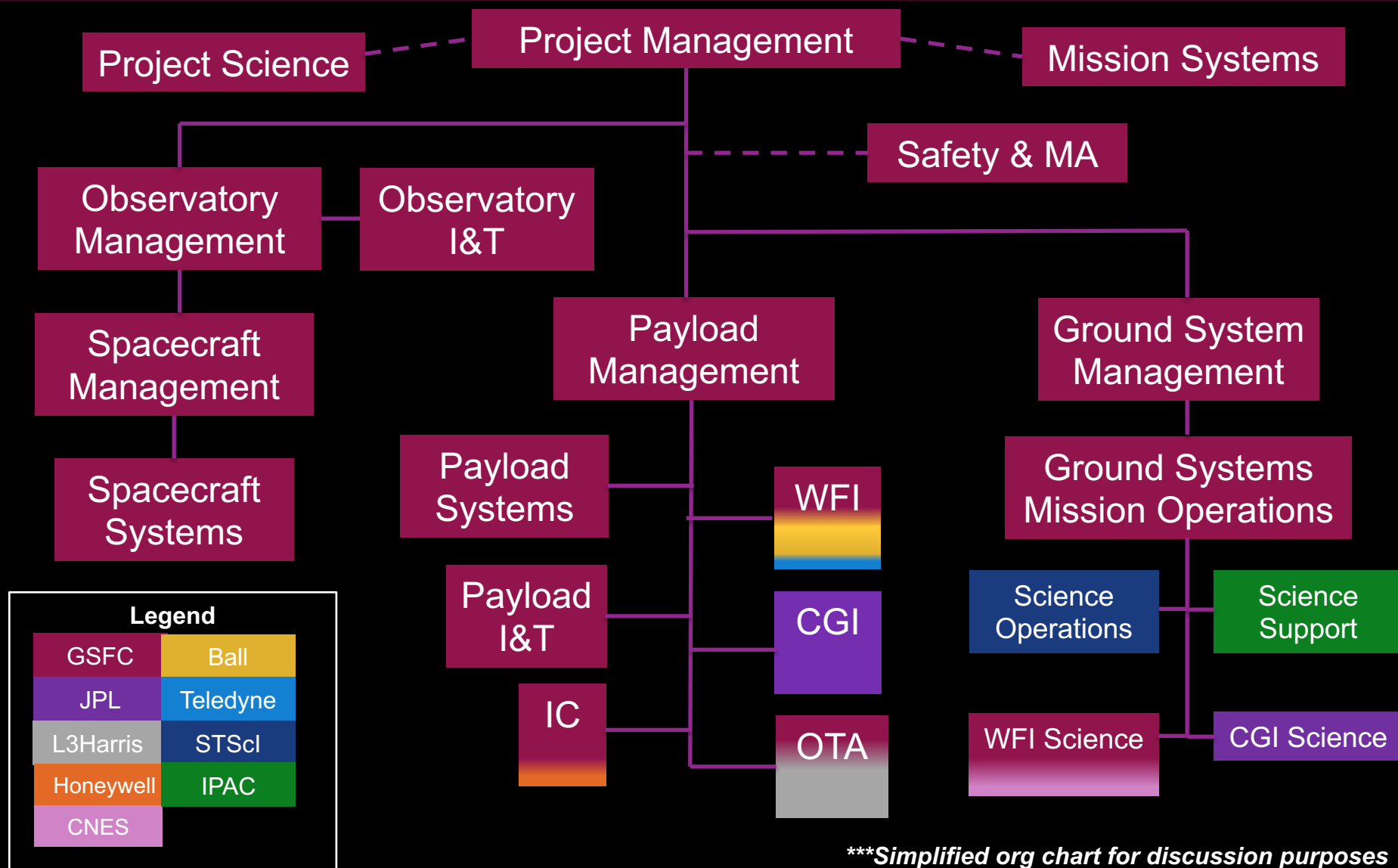
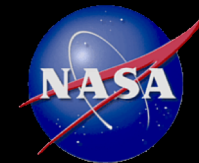
- 2.4 m primary mirror Telescope (existing)
- Wide Field Instrument (WFI)
- Coronagraph (CGI)
- Instrument Carrier (IC)
- Spacecraft (SC) Bus
- Serviceable Design

Ground System: Dual site dedicated ground stations

- Northern GS- White Sands, Southern GS- Punta Arenas

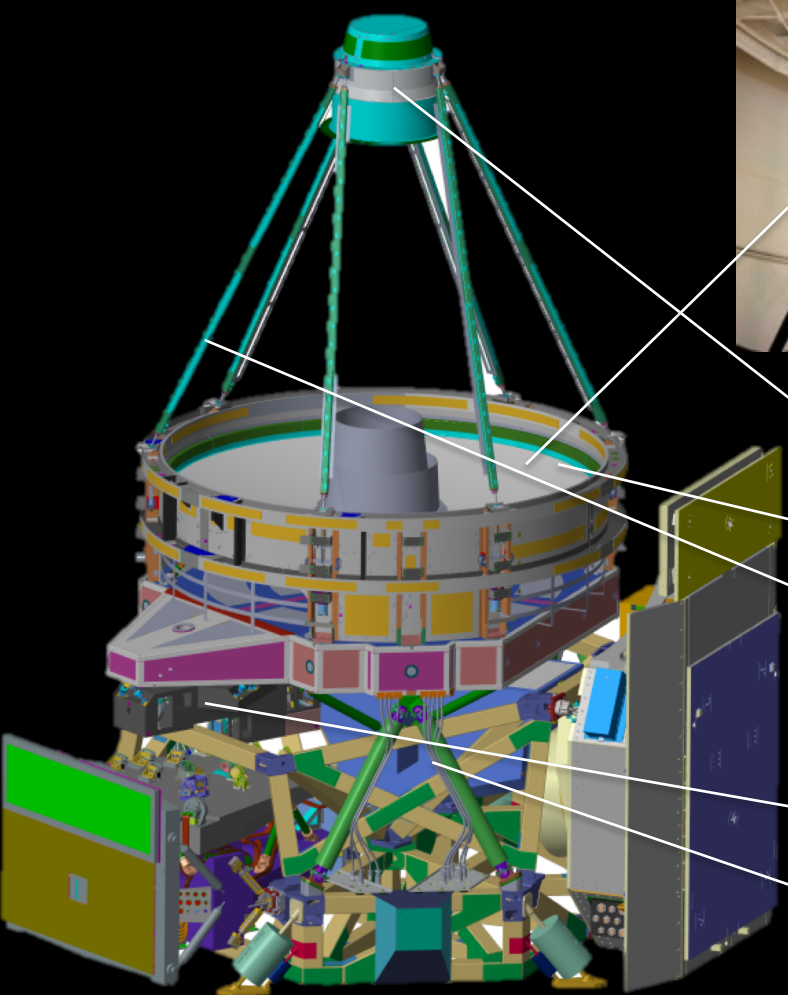




WFIRST Organization



***Simplified org chart for discussion purposes

The WFIRST Payload

Optical Telescope Assembly (OTA):

- Existing Forward Optical Assembly (FOA)
 - 2.4 m primary (PM) and secondary mirror (SM) (prescription for WFIRST)
 - Secondary mirror support tubes and baffling (new for WFIRST)
- Tertiary Collimator Assembly (TCA) relay optics for CGI (5 mirrors)
- Aft Optics Module (AOM) relay optics for WFI (3 mirrors)
- Telescope Control Electronics (TCE)

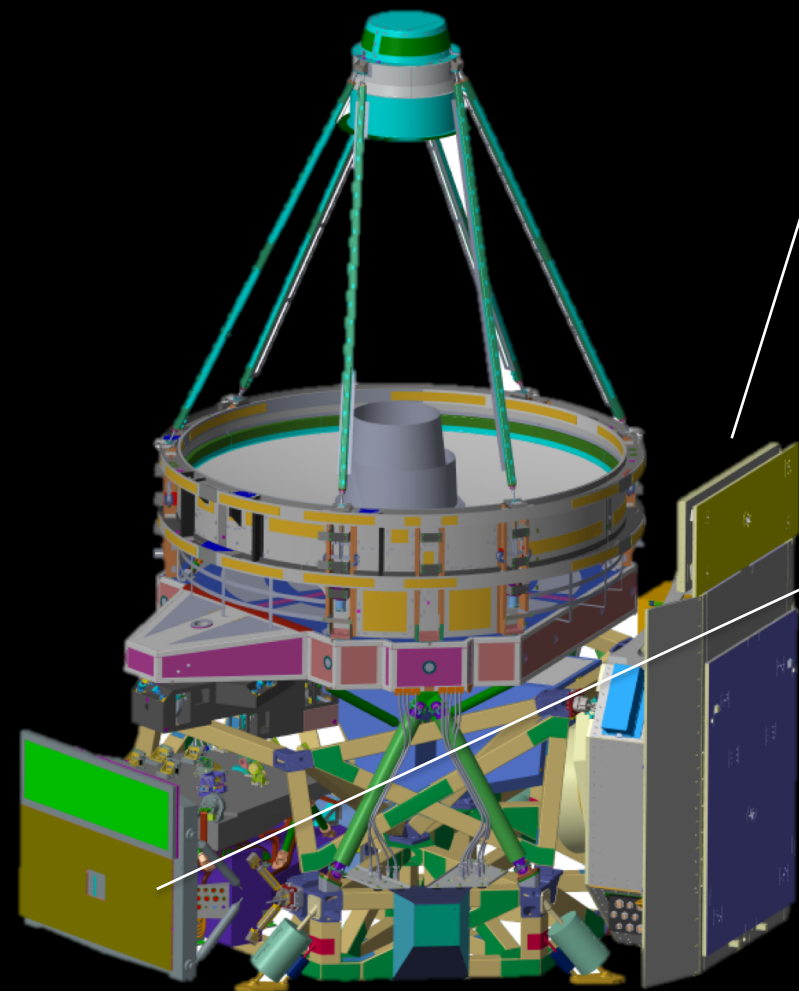
The WFIRST Payload

WFI:

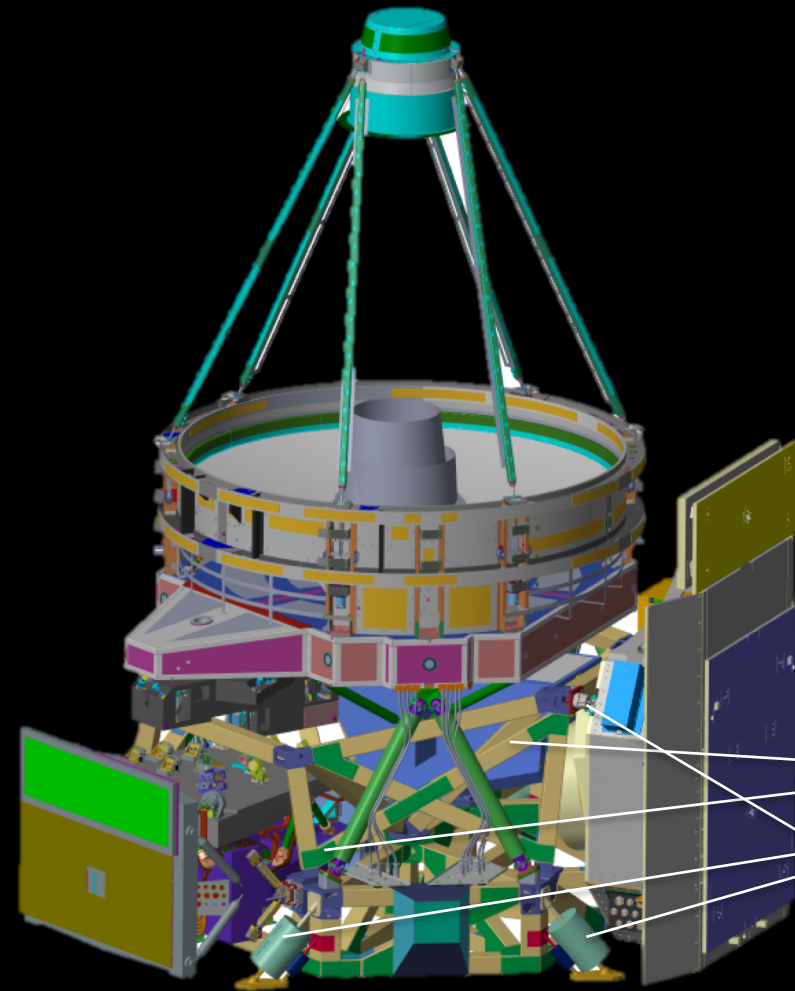
- 18 H4RG detector Focal Plane Array (FPA) with Alignment Compensation Mechanism (ACM)
 - $\lambda = 0.48$ to $2.0\mu\text{m}$
 - 0.28 deg^2 active area
- 11 filter Element Wheel Assembly (EWA)
- Relative Calibration System (RCS)
- Focal Plane Electronics & Warm Electronics Module

CGI:

- 2 Deformable Mirrors (DM) and Fast Steering Mirror (FSM)
- Focus Correction and Precision Alignment Mechanisms
- High/Low –order wavefront (H/LOWFS) sensing and control
- LOWFS Camera & Direct Imaging Camera
 - $\lambda = 546$ to 980 nm



The WFIRST Payload



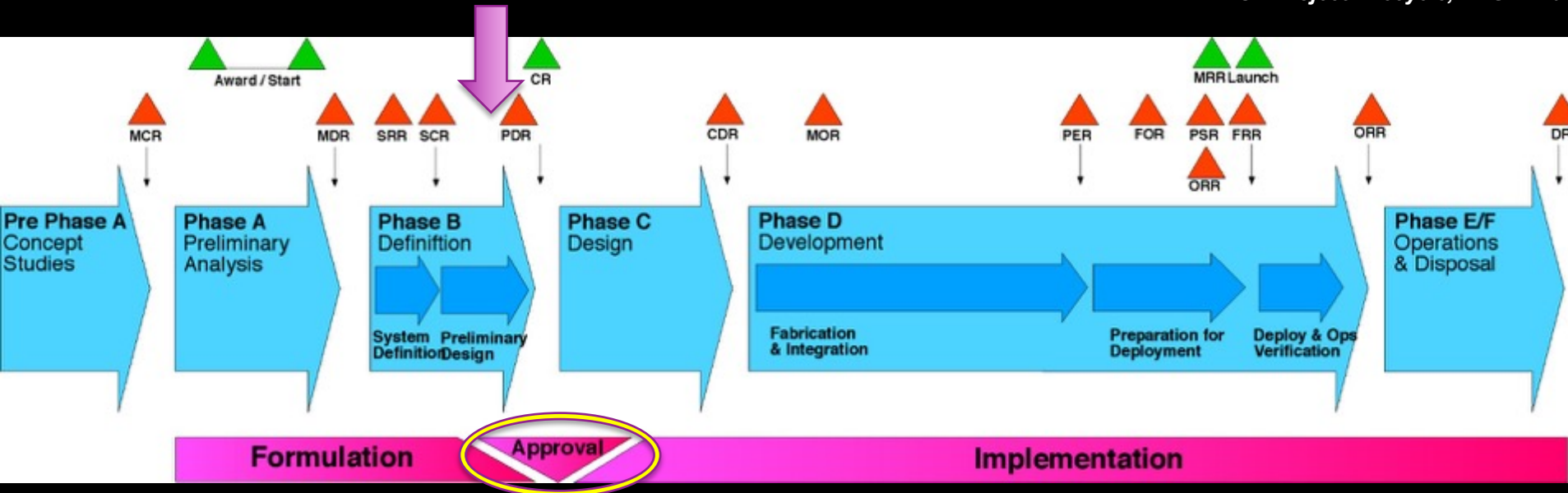
IC:

- Similar construction to JWST Integrated Science Instrument Module (ISIM)
- Composite structure with titanium nodes
- Launch Lock and Vibration Isolation System (LLVIS)
- Science Instrument Interface Plates (SIIPs)

Where is WFIRST?

YOU ARE HERE

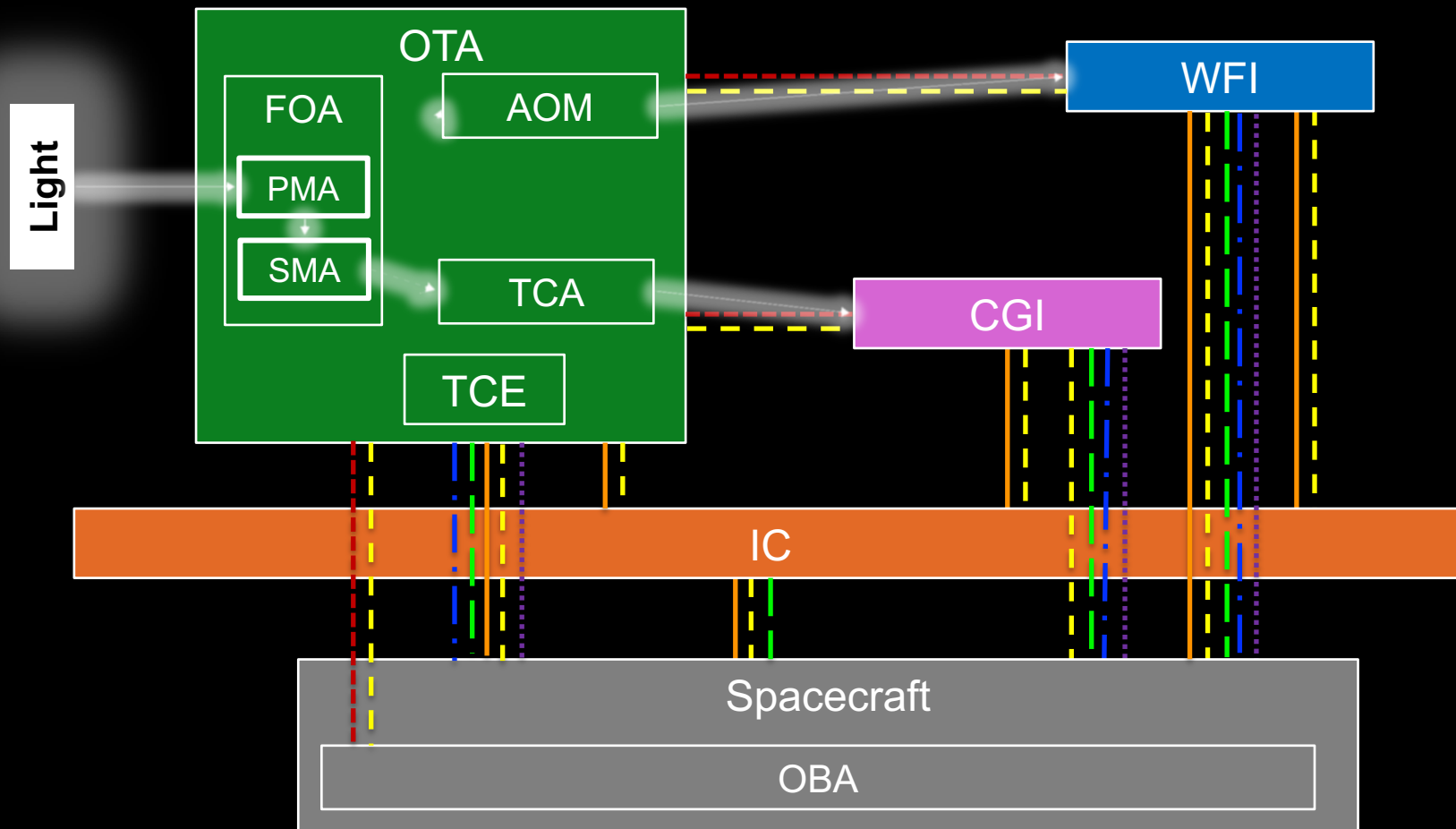
*Systems Engineering Handbook, SP-6105
NASA Project Lifecycle, NPG-7120*



- ✓ IC PDR (May 2019)
- ✓ WFI PDR (June 2019)
- ✓ OTA PDR (Aug 2019)
- CGI PDR (Sept 2019)
- Mission PDR (Oct 2019)
- **KDP-C (Nov 2019)**

Developing and baselining technical interfaces

WFIRST Interface Overview



Interfaces

Optical



Mechanical



Thermal



Electrical



Data



Environmental





WFIRST Interface Overview

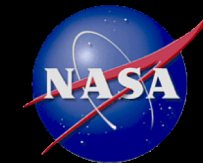


- **How does WFIRST document interfaces?**
 - Interface requirements between Elements (OTA, WFI, CGI, IC and SC) live in the Element Requirements Documents (or IRD's)
 - Interface Control Documents/Drawings (ICD's) contain agreements on the interface design solution and implementation to meet those requirements, not the interface requirements themselves
 - ICD's also include hardware responsibilities of each side of the interface...agreeing to who's providing what

There's more than one way to do it...it's what works best for you



WFIRST Interface Overview



Document #	Interface Control Document (ICD)	Opt	Mech*	Therm	Elec	Data	Env
WFIRST-PYLD-ICD-0027	WFI-OTA	✓	N/A	✓	N/A	N/A	N/A
WFIRST-PYLD-ICD-0017	CGI-OTA	✓	N/A	✓	N/A	N/A	N/A
WFIRST-PYLD-ICD-0022	IC-OTA	✓	✓	✓	N/A	N/A	N/A
WFIRST-PYLD-ICD-0028	IC-WFI	N/A	✓	✓	N/A	N/A	N/A
WFIRST-PYLD-ICD-0021	IC-CGI	N/A	✓	✓	N/A	N/A	N/A
WFIRST-SYS-ICD-0018	SC-WFI	N/A	✓	✓	✓	✓	✓
WFIRST-SYS-ICD-0016	SC-CGI	N/A	N/A	✓	✓	✓	✓
WFIRST-SYS-ICD-0003	SC-OTA	✓	✓	✓	✓	✓	✓
WFIRST-SYS-ICD-0004	SC-IC	N/A	✓	✓	✓	✓	✓

* **Mechanical Interface Control Drawings (MICD's)** document mechanical interfaces, volumes, stay-out zones, sensor locations, metrology targets, etc.



WFIRST Interface Overview



- **How does WFIRST manage interfaces?**
 - Both sides of the interface (eg., WFI-OTA or WFI-SC) work to define a design to meet requirements and draft documentation with the oversight of Mission/Payload Systems Engineering
 - All ICD's follow signature-controlled release process for documents and drawings using WFIRST Project Configuration Management tool
 - Once ICD's are baselined, any changes needed are communicated, then require review and stakeholder signatures to revise and release documentation
 - Mission/Payload Systems Engineering maintain an ICD schedule and progress tracker to ensure interface agreements are documented and released to support key milestones (eg., design reviews, procurements, etc)

Organization and sticking to the process is critical for interface control



Why are Interfaces so Complex?



“The definition, management, and control of interfaces are crucial to successful programs or projects. Interface management is a process to assist in controlling product development when efforts are divided among parties...”

- Systems Engineering Handbook, SP-6105, Section 6.3, Interface Management

You think you're only developing the technical interfaces, but more importantly, you're developing the people interfaces



Why are Interfaces so Complex?



- There are varying levels of interface complexity and so many interfaces are coupled with each other...

Example: The WFI latch and instrument interface plate bolted interface factors not only into mechanical performance such as interface loading, but optical and thermal performance, such as pupil/instrument alignment and thermal conduction

- Making the right interface design decision involves all appropriate disciplines to be a part of the decision... this can take time to come to agreement if all necessary factors are considered



Why are Interfaces so Complex?



- Some of the challenges are not technical and include organizational differences, when working with multiple external partners...

Example: Cultural differences between organizations sometimes set up a siloed work effort, in which engineers work their part of the design ...before putting forward their solutions to the team

- Disadvantage of this is having to spend time and money reworking an interface design if team communication isn't consistent during the design process and the wrong thing is designed



Why are Interfaces so Complex?



- And everyday roadblocks can take their toll...

Example: Differences in time zones can seem superfluous but can hinder progress, such as scheduling interface meetings with teams on the East Coast and West Coast

Example: Ability to access to the most accurate, up-to-date project documentation and configuration change process can be detrimental if external partners don't have appropriate access to Project Configuration Management tools

Don't worry... there's solutions to manage the complexity

Interfaces: What Works?

Consistent communication is key!

- Helpful to have not only weekly interface meetings, but periodic face-to-face time with external partners for collaboration, especially in the early stages of interface development
- Team interactions/discussions coordinated at Mission, Payload and Element levels to facilitate interface design progress, enable coordination and agreement, and work interface design details and issues
- Don't assume, just pick up the phone and call the person, fostering engineering-level communication is critical to work the right design



Credit: <http://clipart-library.com>

Tip: Spend the time and travel money to have periodic Face-to-Face meetings, especially early on in the development, with external partners

Interfaces: What Works?

Good organization enables progress!

- Tracking spreadsheets are your friend...

Interface Control Document (ICD)	PLSE POC	Authors			Schedule							
		Driver	Side 1	Side 2	Draft Status		SCoRes Draft Due		Table Top		Release Target Date	
WFIRST-PYLD-ICD-0027, WFI-OTA ICD	JD	WFI CDR	GD	AR	Wed	9/11/19	Fri	10/11/19	Fri	11/1/19	Fri	11/15/19
WFIRST-PYLD-ICD-0022, OTA-IC ICD	JD	IC Procurements	LM	AR	Wed	8/14/19	Fri	9/13/19	Fri	10/4/19	Fri	10/18/19
WFIRST-PYLD-ICD-0017, CGI-OTA ICD	AB	CGI Flight Mask Design	CN	AR	Wed	10/2/19	Fri	11/1/19	Fri	11/22/19	Fri	12/6/19
WFIRST-PYLD-ICD-0028, WFI-IC ICD	JD	IC Procurements	LM	GD	Wed	8/7/19	Fri	8/30/19	Fri	9/20/19	Fri	9/27/19
WFIRST-PYLD-ICD-0021, CGI-IC ICD	AB	IC Procurements	LM	AS	Wed	8/7/19	Fri	8/30/19	Fri	9/20/19	Fri	9/27/19
WFIRST-SYS-ICD-0003, SC-OTA ICD	JD	OBA Structure CDR	JP	AR	Wed	10/9/19	Fri	11/8/19	Fri	11/29/19	Fri	12/13/19
WFIRST-SYS-ICD-0018, SC-WFI ICD	JD	SC Primary Structure CDR	GD	JP	Wed	9/18/19	Fri	10/18/19	Fri	11/8/19	Fri	11/22/19
WFIRST-SYS-ICD-0016, SC-CGI ICD	AB	SC Primary Structure CDR	UW	JP	Wed	11/13/19	Fri	12/13/19	Fri	1/3/20	Fri	1/17/20
WFIRST-SYS-ICD-0004, SC-IC ICD	JD	IC Procurements	LM	JP	Wed	8/14/19	Fri	9/13/19	Fri	10/4/19	Fri	10/18/19

- Hold people accountable—assign action items and work to the deadlines

Face-to-Face Meeting							
ID	Action	Section/Topic	Group	POC	Due Date	Complete	Status Comments
1	Coordinate with John about laser tracker restrictions of MU used during alignment (general and may apply to multiple interfaces/ICD's)	Thermal Interfaces	GSFC	Joe/Mary	3/22/19		3/2/19: Met with John and documented LT restrictions for MU in ICD
2	Instrument to look at changing connector layout prioritizing connectors on the side to optimize/extend harness length, as far away from SC deck as possible for strain relief and vibration isolation	Harness Routing & Supports	JPL	Sarah/Scott	3/1/19		2/20/19: Instrument team conducted study changing connector layout and reviewed at Mission Systems meeting

Tip: Develop and manage an interface schedule and progress tracker with responsible team members and assign due dates

Remove the roadblocks!

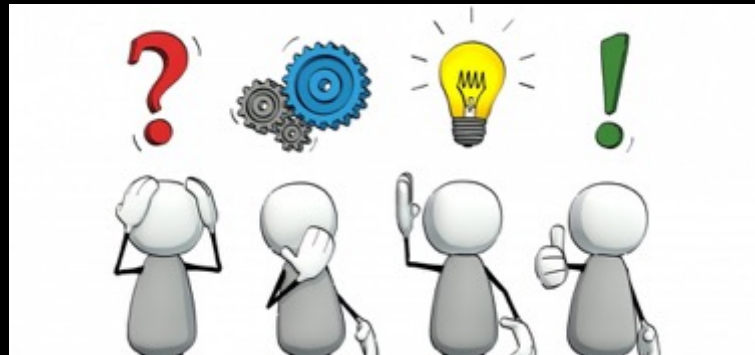


- Set up designated meeting time slots that are agreeable for all team locations/time zones

Tip: If working on the East Coast, with a West Coast partner, enforce an 11am - 4 pm designated timeslot for meetings that works for both locations where that partner is involved

- Ensure all appropriate team members have NDA's in place ahead of time when working with external partners to be able to share necessary information (eg., CAD models, analysis packages, etc)
- Work to have appropriate access to Project Configuration management tools for external partners as early as possible

- Assuming the other person (or other side of the interface) is working under the same constraints or understanding of the requirements—do you define terms the same way?



Credit: Getty Images

- Not having the right people in the room when making design decisions
- Just because you're working in your envelope or design space, doesn't mean no one else cares if you change something



*All of this can be applied to
other areas of development on
any project...
not just interfaces
...and not just WFIRST*

Key Takeaways

WFIRST is a cool and complex mission!

1. Consistent communication is key

- ✓ Pick up the phone, support face-to-face time
- ✓ Don't assume everyone is working to the same assumptions and constraints
- ✓ Make sure the right people are in the decision-making room

2. Good organization enables progress

- ✓ Tracking spreadsheets are your friend
- ✓ Hold people accountable
- ✓ Define what works for you and stick to the process

3. Remove the roadblocks

- ✓ Ensure the team has the resources they need to work the interface or issue

... And try to have a little humor during the process... not everything will go how you planned...

Thank You!

Hubble

Questions?

WFIRST