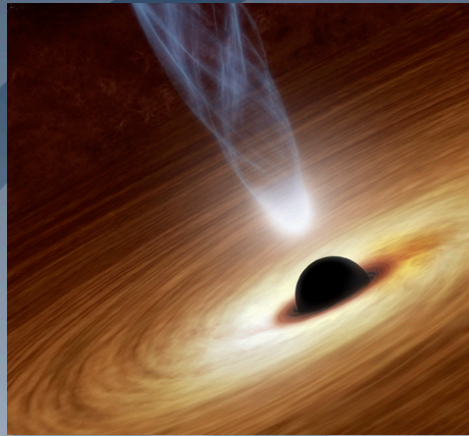


Astrophysics

Approach to Serviceability in Decadal Mission Studies



Decadal Studies Pause and Learn Session

John Gagosian

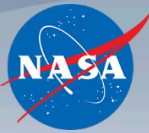
Exoplanet Exploration Program Executive

Astrophysics Division

Science Mission Directorate

October 21, 2016

The Statutory Requirement



From *National Aeronautics and Space Administration Authorization Act of 2010*:

PUBLIC LAW 111-267—OCT. 11, 2010

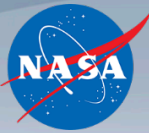
124 STAT. 2833

SEC. 804. IN-SPACE SERVICING.

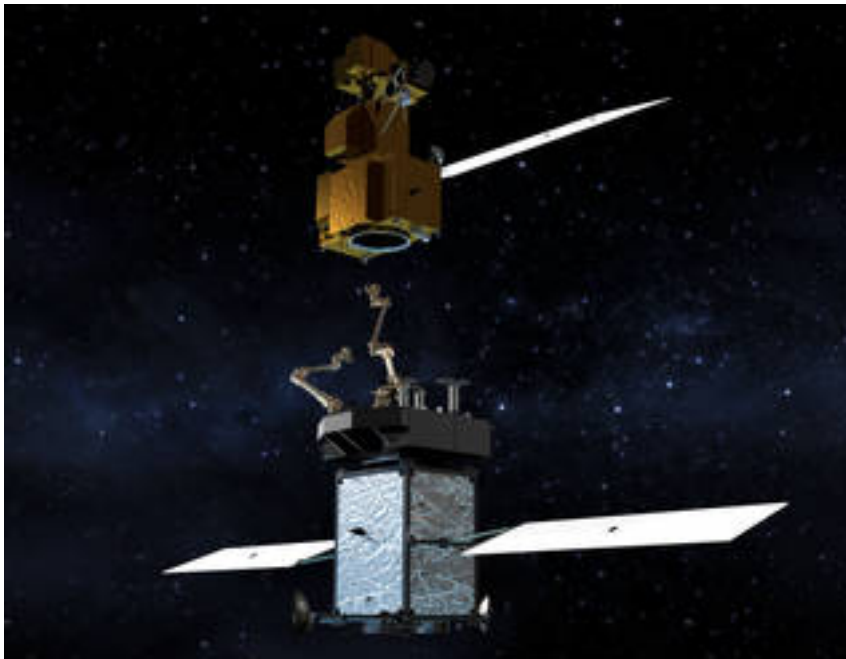
42 USC 18383.

The Administrator shall continue to take all necessary steps to ensure that provisions are made for in-space or human servicing and repair of all future observatory-class scientific spacecraft intended to be deployed in Earth-orbit or at a Lagrangian point to the extent practicable and appropriate. The Administrator should ensure that agency investments and future capabilities for space technology, robotics, and human space flight take the ability to service and repair these spacecraft into account, where appropriate, and incorporate such capabilities into design and operational plans.

Three Observations



- Law requires that “provisions be made” for servicing, but does *not* require servicing actually to be performed;
- Applies to spacecraft in earth orbit *and* at Lagrange points;
- Applies “to the extent practicable and appropriate.”



Artist's concept of Restore-L Servicing Mission

WFIRST Approach to Serviceability



WFIRST is implementing a modular observatory design, with mechanical features (fasteners, connectors, grappling fixtures) to facilitate servicing. WFIRST has also defined a high-level notion of servicing ops.

Aside from the limited items above, WFIRST is *not* designing or developing any flight hardware, ground support equipment, operations products, processes, or procedures necessary to conduct an actual servicing mission.

WFIRST's Level 1 serviceability requirement is stated as follows:

BTR6: The WFIRST flight system shall be implemented with mechanical features designed to facilitate a potential future robotic servicing mission.

*-- WFIRST Preliminary Program Level Requirements Appendix (PLRA), Draft Version,
Dated 13 January 2016, Paragraph 4.1.2*

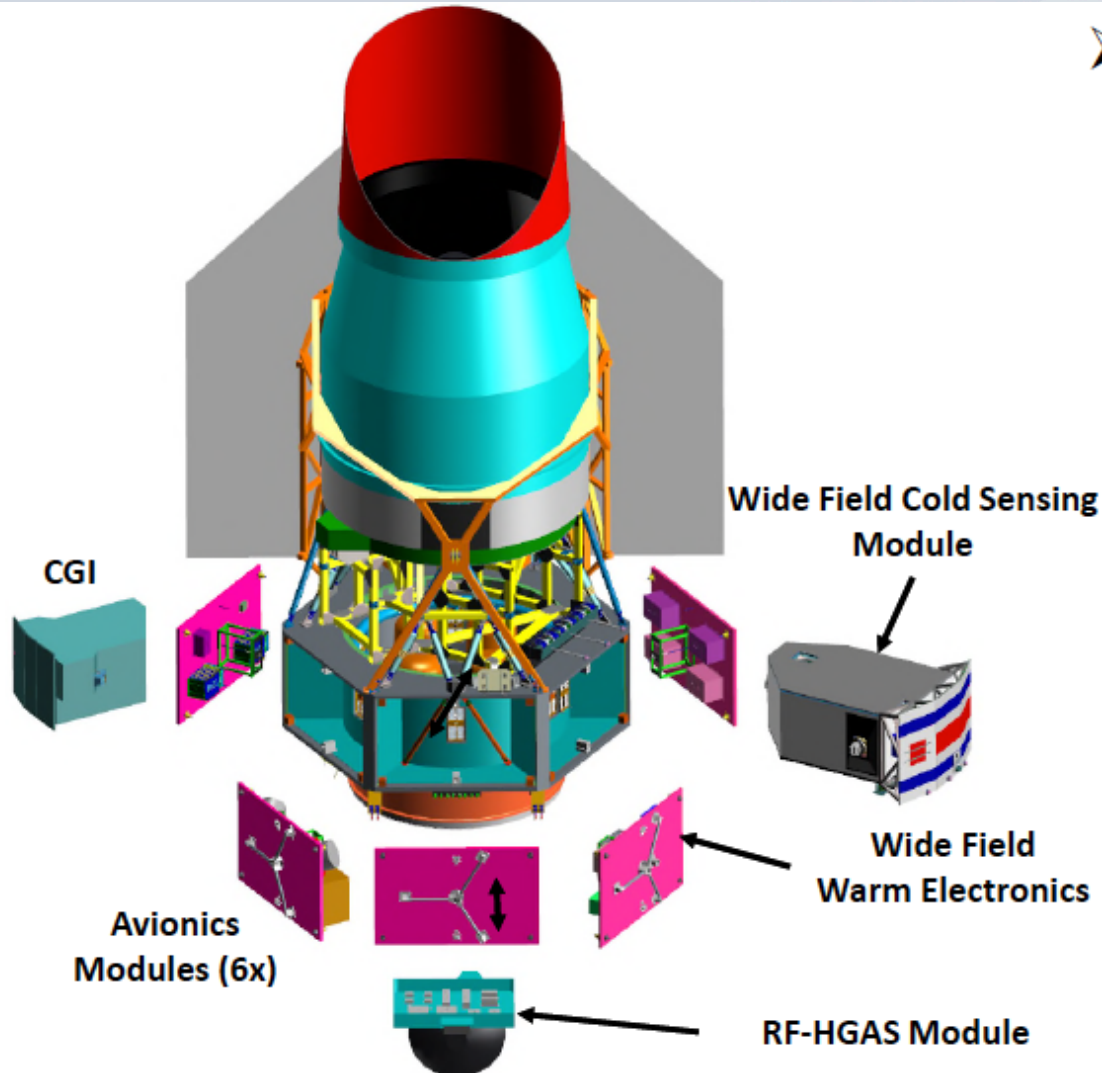
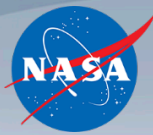


➤ On-Orbit Servicing

- NASA HQ direction to design for on-orbit serviceability of WFIRST Mission
- On-orbit servicing has been incorporated into the WFIRST concept design
 - Sufficient design detail to define the top-level servicing challenges, point design, ops concept, open issues, and path forward; further refinement in Phase A
 - Servicing at a Module level
- WFIRST mission will be designed, tested and launched with the understanding that servicing WILL NOT be required as part of the primary mission
 - Same NASA guidelines/standards for nominal missions will apply
- Future servicing lifecycle support currently not funded or planned by the WFIRST project
 - No additional GSE or infrastructure outside of that needed for initial WFIRST I&T and launch will be developed
 - Existing assets (breadboards, simulators, mockups, spares, etc) developed for WFIRST (and not needed for on-orbit flight maintenance) will be made available
- Working with SSCO (Satellite Servicing Capabilities Office) to define servicing (and servicer) reqs
 - Documented in draft “servicing assumptions” document, serves as initial ICD
 - Defines the WFIRST design and capabilities that a prospective servicer will need to meet

WFIRST Serviceability Approach (2/3)

as presented at Mission Concept Review (MCR), December 2015



➤ Serviceability is at the module level

▪ Payload

- Wide Field Instrument
 - Cold Sensing Module & Warm Electronics Module
- Coronagraph Instrument
- Telescope electronics in a S/C module

▪ Spacecraft Components

- Avionics components in serviceable modules
- RF-HGAS Module (bottom of Spacecraft)
- Trading location of star trackers/SIRU, intend to make serviceable
- Propulsion system can be refueled

WFIRST Serviceability Approach (3/3)

as presented at Mission Concept Review (MCR), December 2015



Notional Servicing Ops Concept

➤ WFIRST will:

- Remain powered for all servicing ops except during power module servicing.
- Switch off power to any module/instrument being serviced.
- Maintain S-band comm with the ground (except for comm servicing)
- Maintain thermal control of itself using power from either WFIRST or the servicing vehicle.

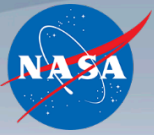
➤ The servicing vehicle will:

- Provide attitude control of the mated servicer/WFIRST vehicle
- Provide power to WFIRST when the power module is being serviced.

Conclusions



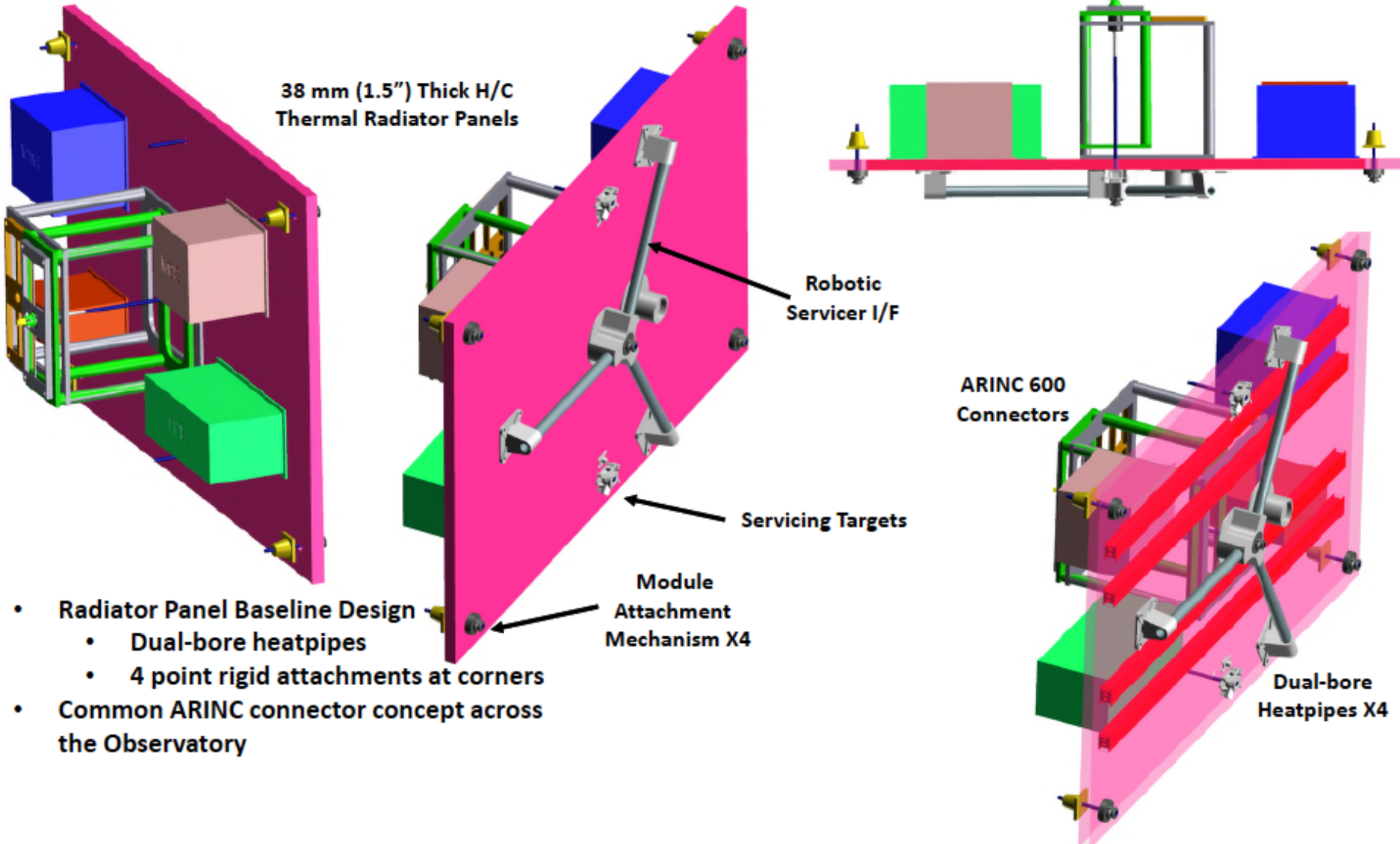
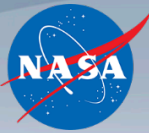
- Serviceability should not drive the mass, power, or cost of the large mission concepts currently under study
- Study teams should account for serviceability in their reports, but should not dedicate significant resources to developing servicing concepts
- Servicing considerations should not drive NASA to do anything outside the realm of “practicable and appropriate.”



Backup

WFIRST Serviceability Approach

as presented at Mission Concept Review (MCR), December 2015



38 mm (1.5") Thick H/C Thermal Radiator Panels

Robotic Servicer I/F

Servicing Targets

Module Attachment Mechanism X4

ARINC 600 Connectors

Dual-bore Heatpipes X4

- Radiator Panel Baseline Design
 - Dual-bore heatpipes
 - 4 point rigid attachments at corners
- Common ARINC connector concept across the Observatory

WFIRST Serviceability Approach

as presented at Mission Concept Review (MCR), December 2015



- Using common servicing designs for instruments
- Mechanical Interface
 - 3-2-1 latch restraint
 - Leverages HST designs for radial instruments, scaled up for larger WFI mass
- Electrical Interface
 - ~1600 wires will cross the boundary between the WFI and the spacecraft
 - Performed study of press-fit connectors to assess current capabilities
 - Selected ARINC 600 connector
 - Concept uses two connectors on a plate which is driven by the servicer (separates mechanical mate from electrical mate). Wide Field cold sensing module has 6 connectors (3 separate mates) and the Coronagraph has 2 connectors (1 mate).

