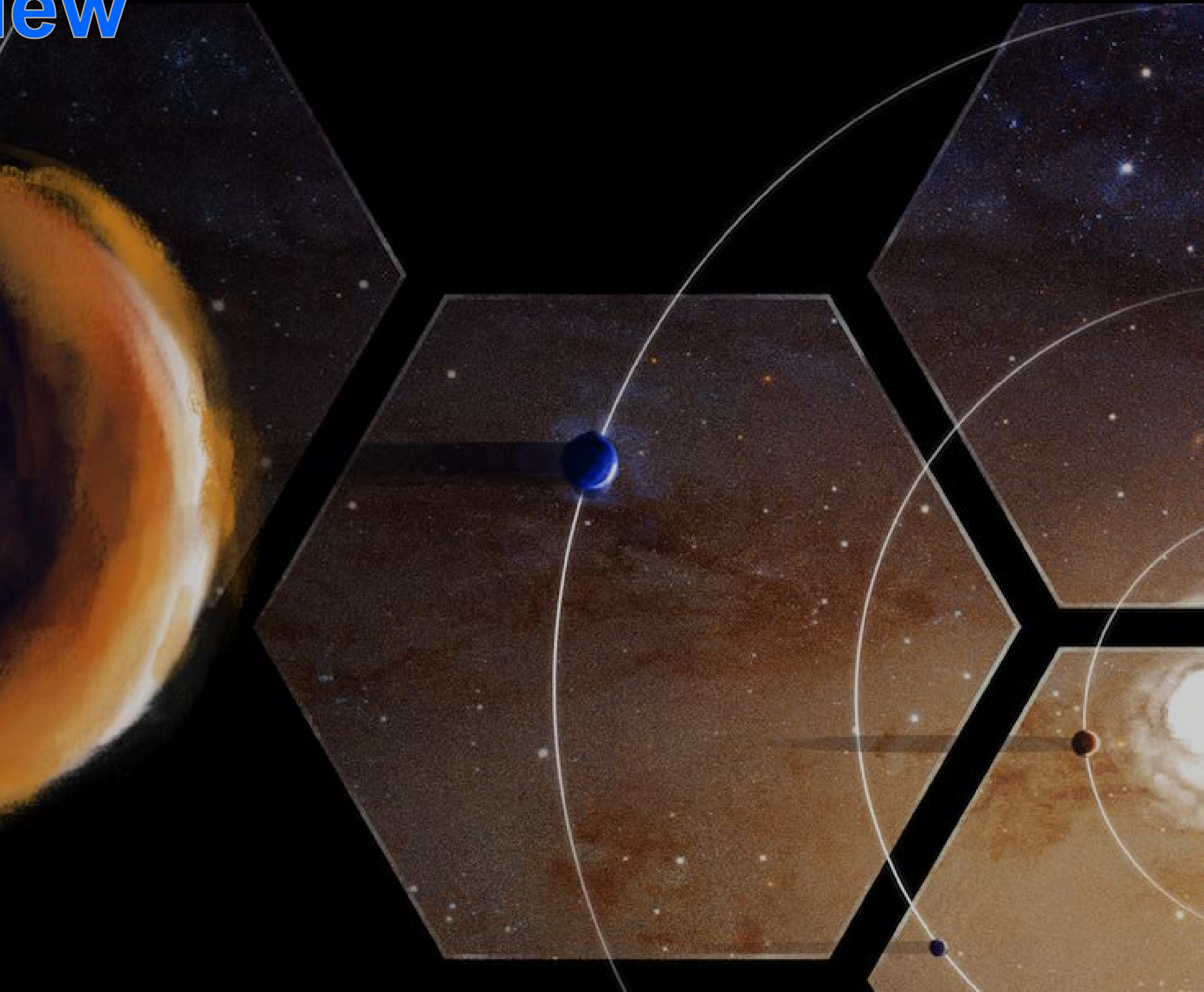
LUVOIR: Engineering Design & Technology Overview



Matthew R. Bolcar, NASA GSFC
On behalf of the LUVOIR Study Team

SPIE Optics & Photonics
San Diego, CA
12 August 2019

11115-24

The LUVOIR Mission

Launch in 2039 aboard an SLS Block 1B/2

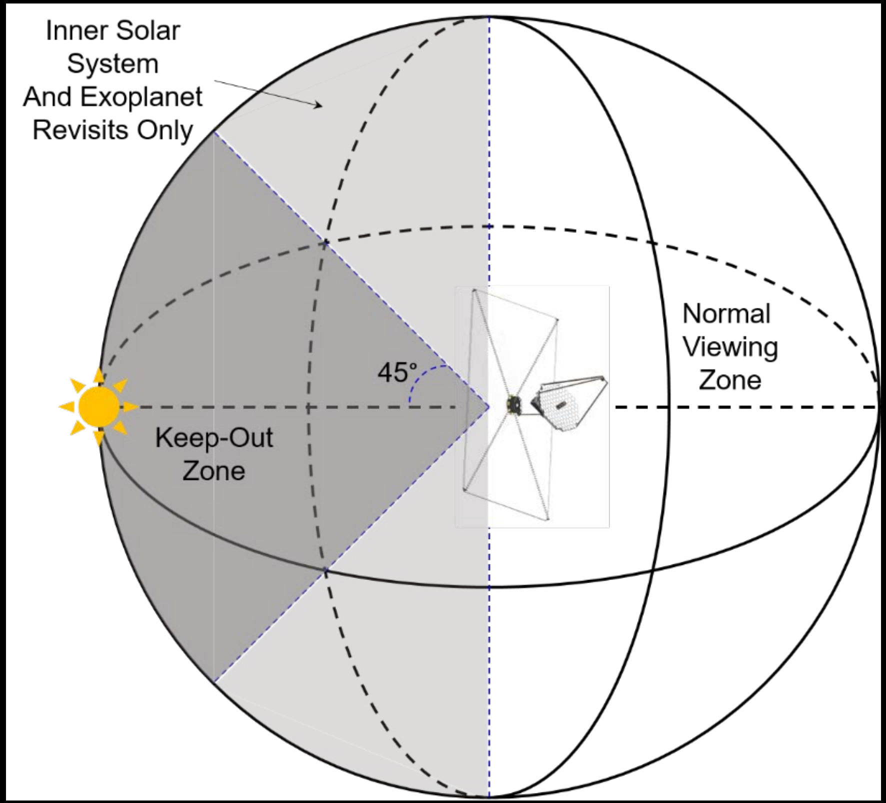
SpaceX Starship and Blue Origin New Glenn are viable alternatives

5-year primary mission, designed to be serviceable for a 25+ year lifetime

Operate in Sun-Earth L2 orbit

Can view entire sky except for a 45° cone about the sun-spacecraft axis

- 3° / min slew rate
- 60 arcsec / sec tracking rate



One Architecture, Two Concepts

Single *scalable* architecture responds to future uncertainties:

- Available launch vehicles
- Budget constraints
- Infrastructure availability
- Technological capability

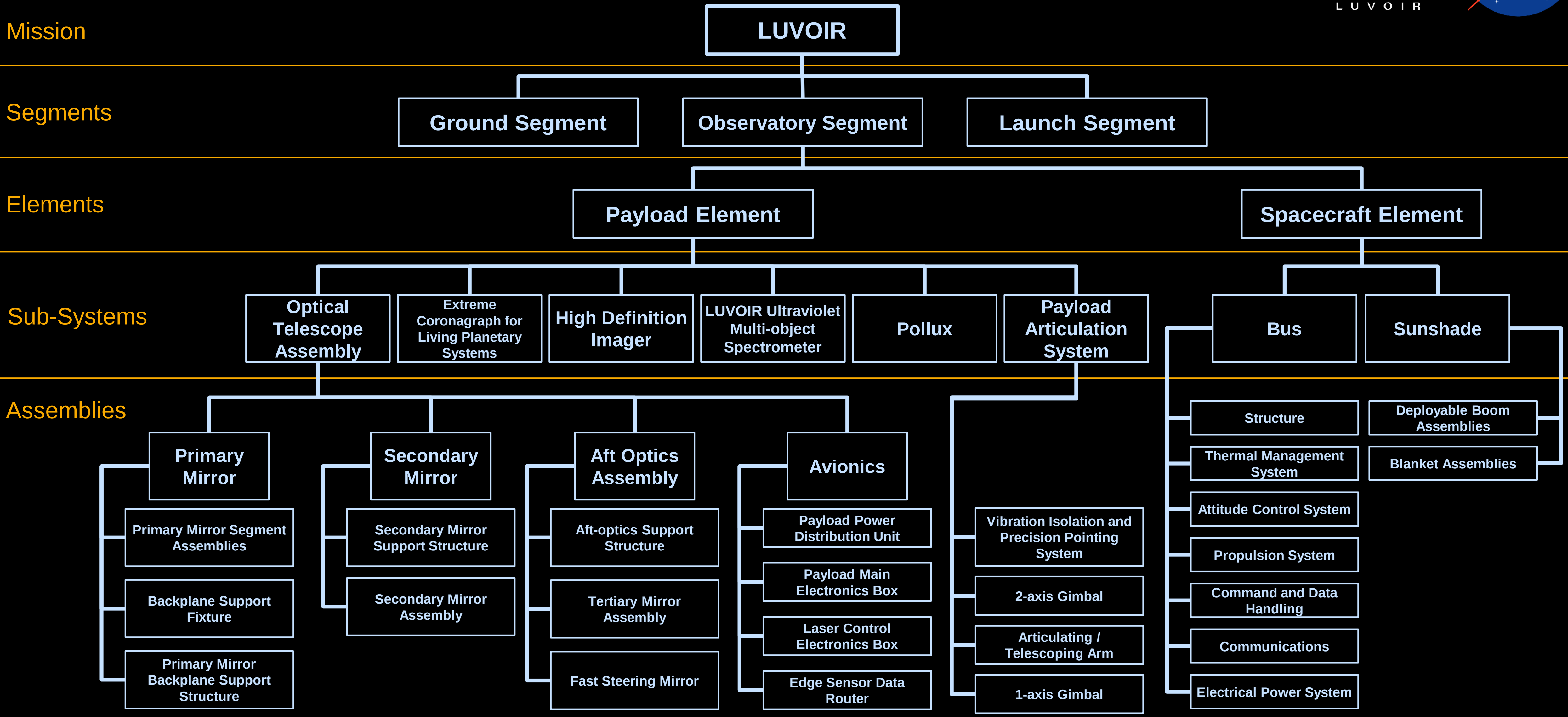
Two LUVOIR concepts bracket a range of scientific capability, cost, and risk

Credit: D. Jones, NASA/GSFC

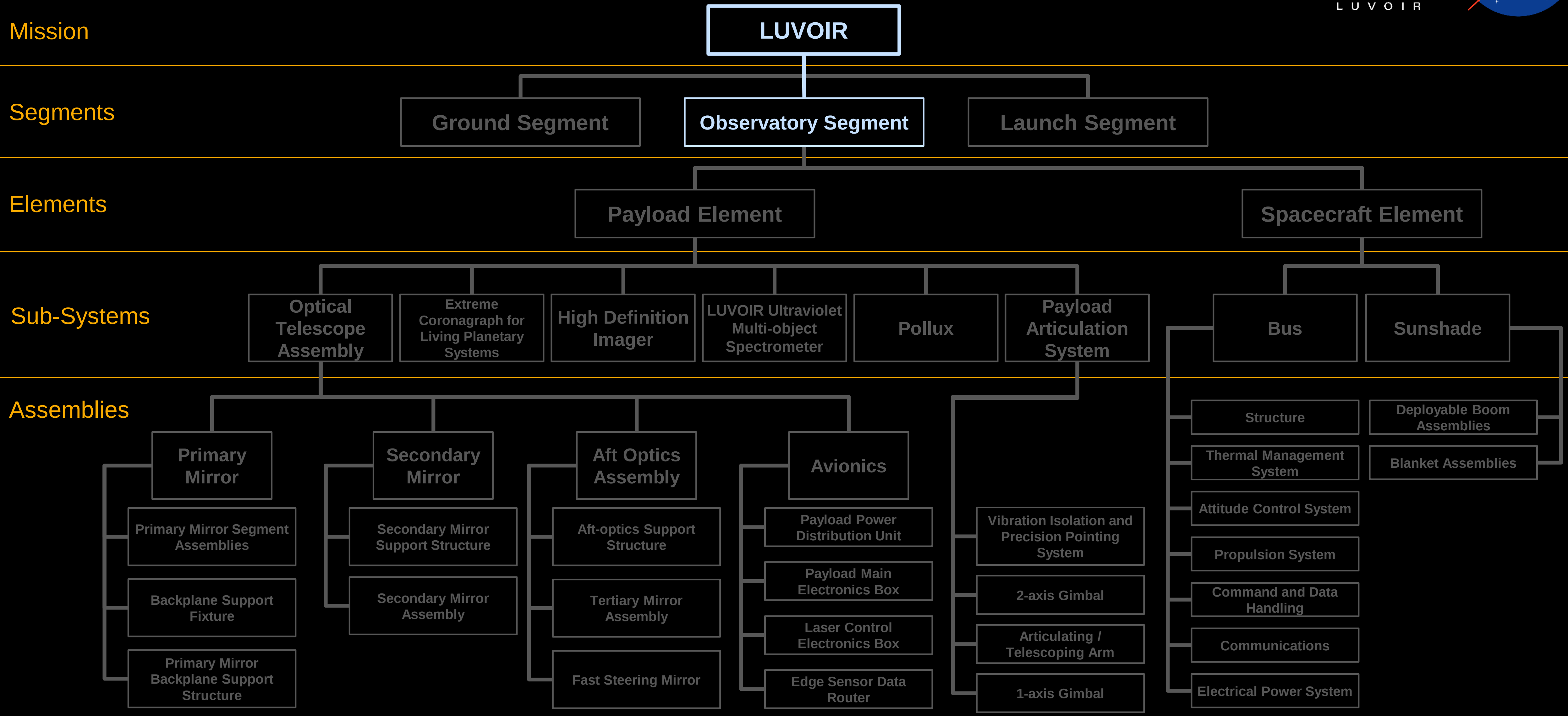
LUVOIR-A in 8.4-m Fairing

LUVOIR-B In 5-m Fairing

A Scalable Architecture



A Scalable Architecture



LUVOIR-A

15-m, on-axis telesc

- 120 segments, 1.2
- 155 m^2 collecting

Four instruments

- Extreme Coronag
  Planetary System
- LUVOIR UV Multi-
  Spectrograph (*LU*
- High Definition Im
- *Pollux* (CNES-cor
  design)

LUVOIR-B

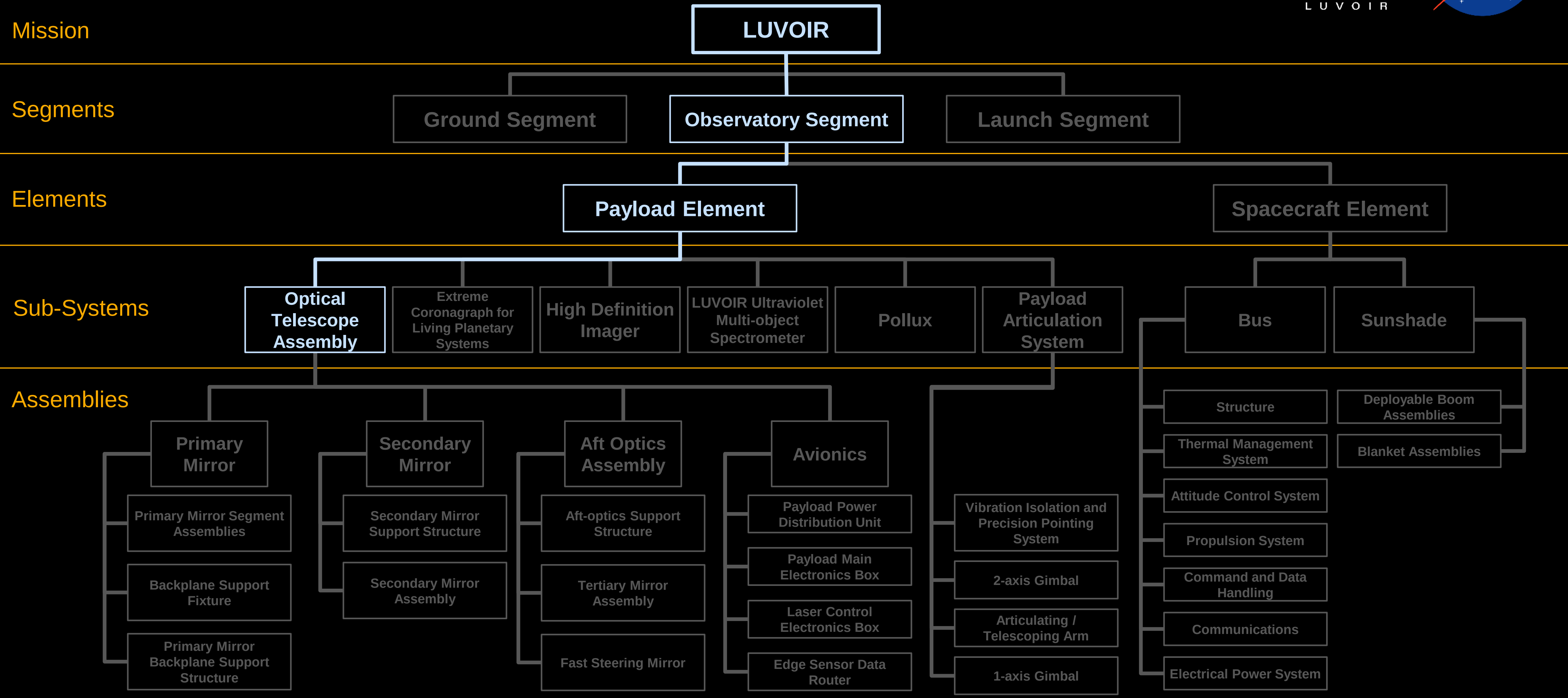
8-m, off-axis telesco

- 55 segments, 0.95
- 43.4 m^2 collecting

Three instruments

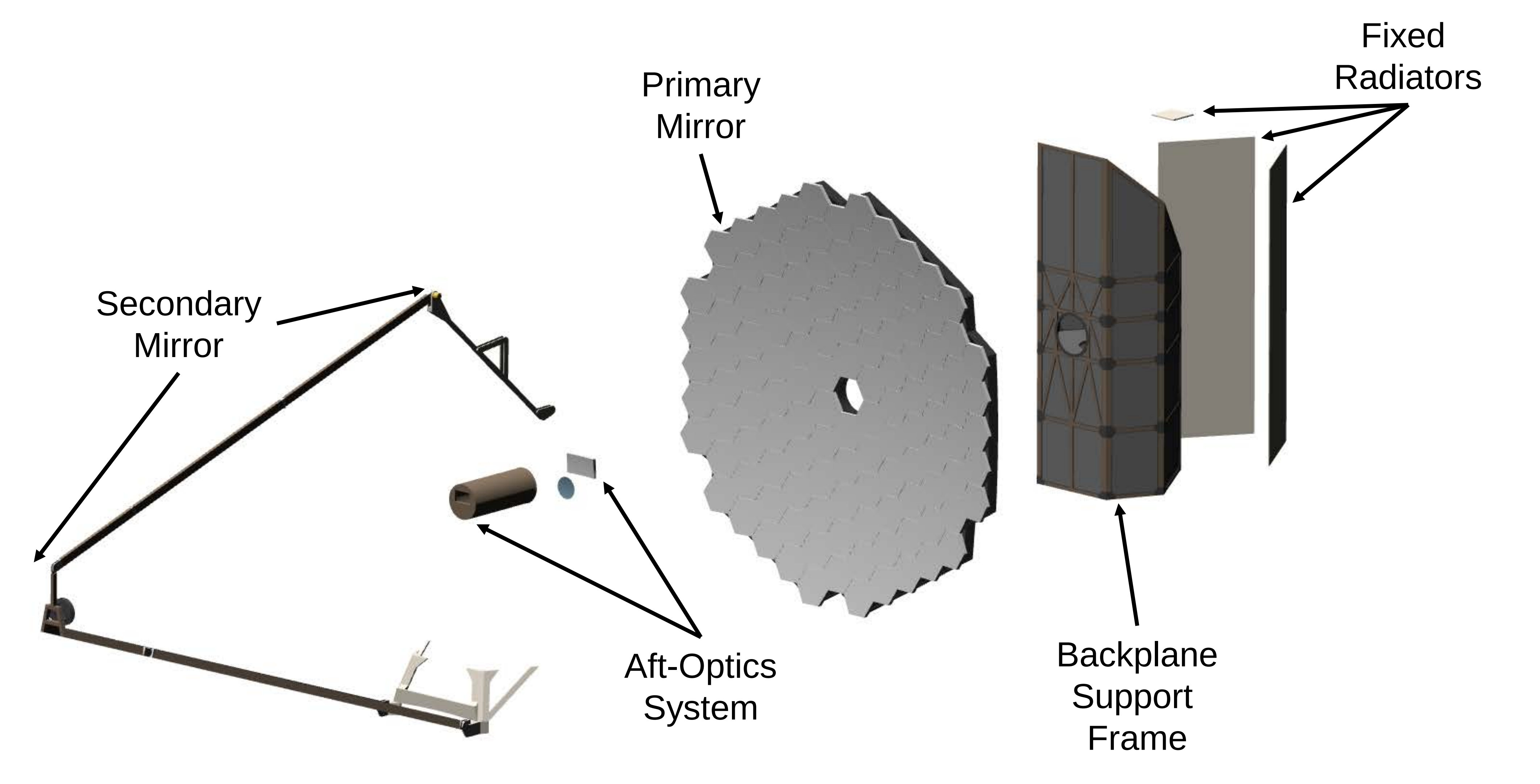
- Extreme Coronag
  Planetary System
- LUVOIR UV Multi-
  Spectrograph (*LU*
- High Definition Im

A Scalable Architecture



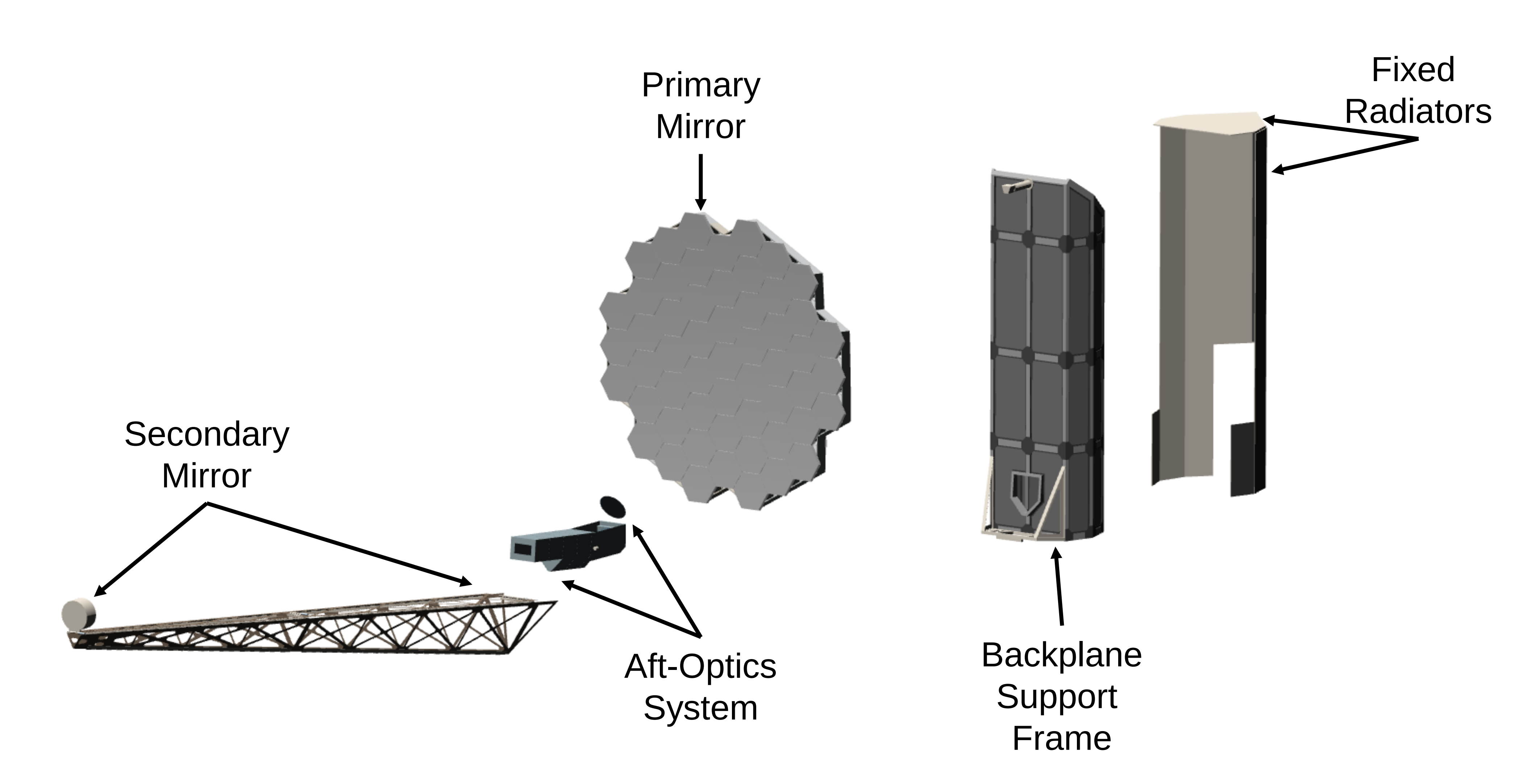
OTA-A Mechanical Design

Credit: D. Jones, NASA/GSFC



OTA-B Mechanical Design

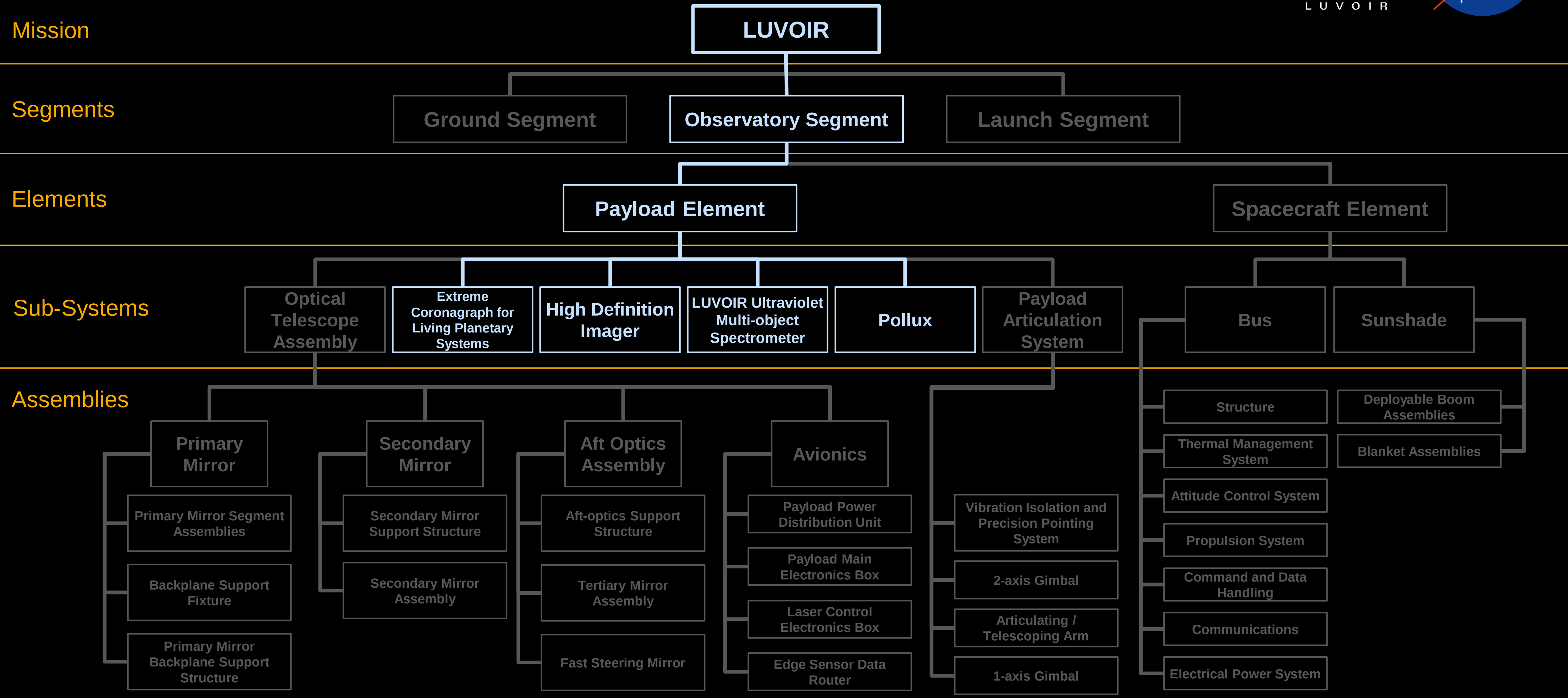
Credit: D. Jones, NASA/GSFC



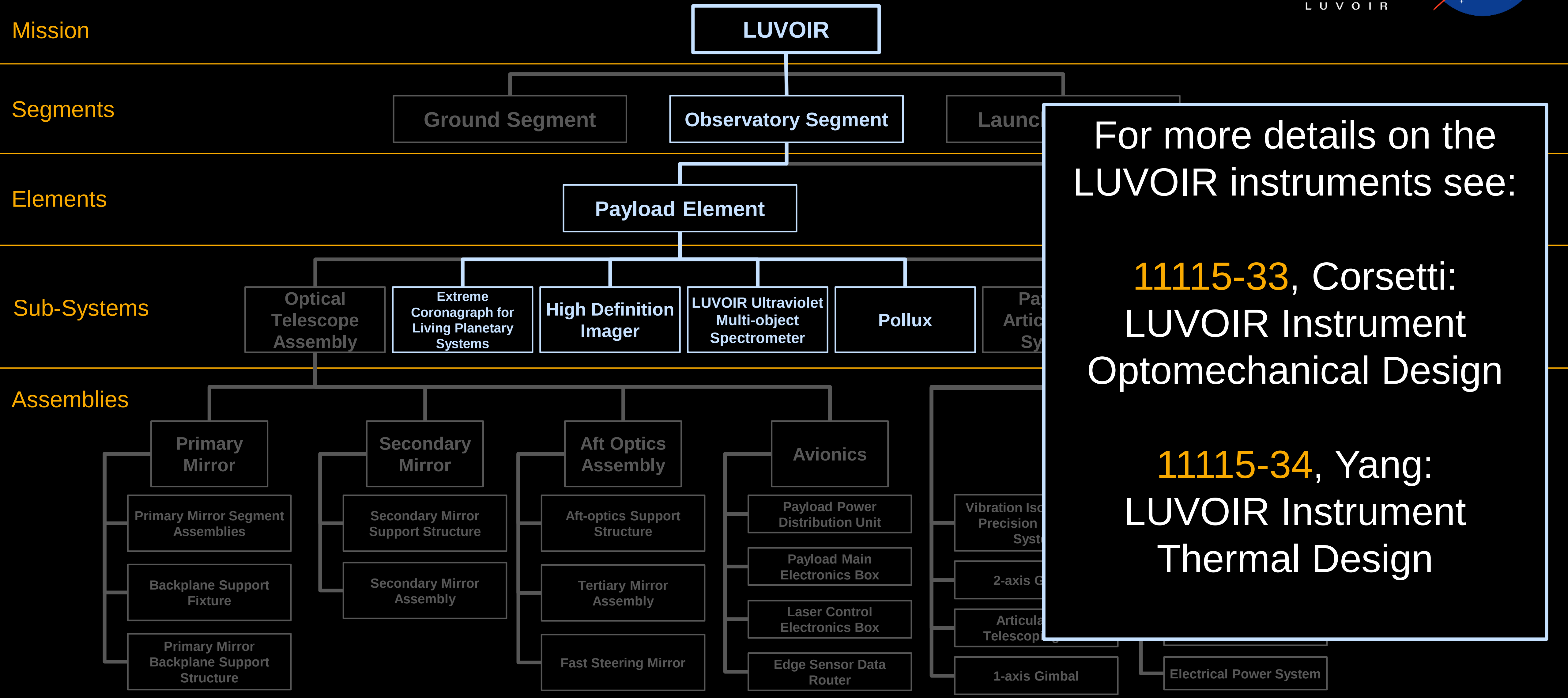
OTA Specifications

Parameter	Units	Value		Notes
		LUVOIR-A	LUVOIR-B	
Field-of-View	arcmin	10 x 8	10 x 8	Accommodates all instrument fields-of-view.
Plate Scale	arcsec /mm	0.694	0.699	Driven by LUMOS single-microshutter field-of-view.
F/#	-	19.8	36.88	Larger F/# allows more clearance between instruments, but larger optics within the instruments.
Max. Angle of Incidence for ECLIPS FOV	degrees	11.77	12.00	Limits polarization aberration and contrast leakage in ECLIPS.
Average RMS Wavefront Error	nm	6.25	3.33	Image quality allocation.
Max. 100% Spot Diameter	µm	15.7	4.9	Blur spot at LUMOS microshutter must be smaller than a shutter.
Max. Marginal Ray Height at SM	mm	486	-	Limit secondary mirror obscuration.
Max. Marginal Ray Height at PM Hole	mm	446.9	-	Limit primary mirror hole obscuration.
Max. Distance Between PM and SM Vertex	m	18.3	20.0	Packaging constraint for folding inside of fairing.
Max. Distance Between PM and TM Vertex	m	3.06	2.00	Packaging constraint for keeping tertiary mirror inside fairing.

A Scalable Architecture



A Scalable Architecture

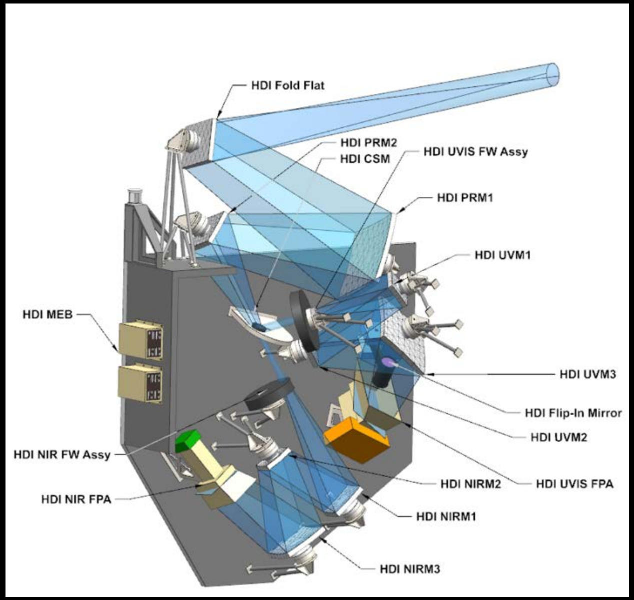


For more details on the LUVOIR instruments see:

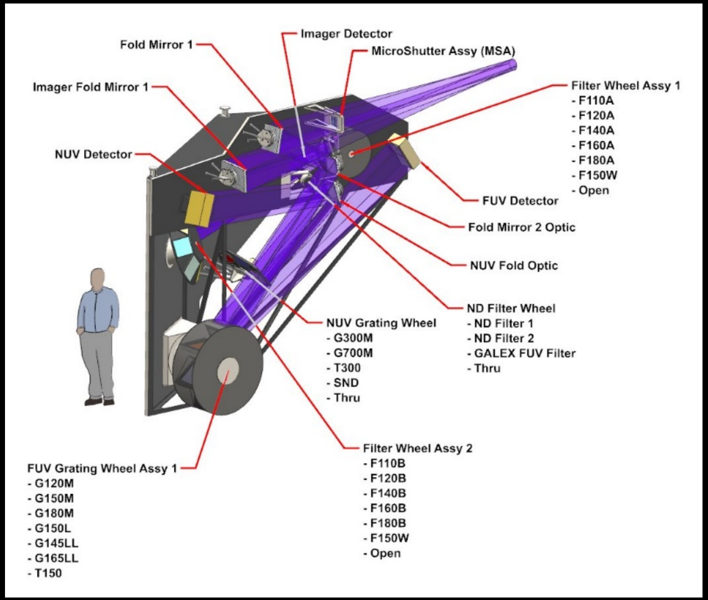
11115-33, Corsetti: LUVOIR Instrument Optomechanical Design

11115-34, Yang: LUVOIR Instrument Thermal Design

LUVOIR Instruments

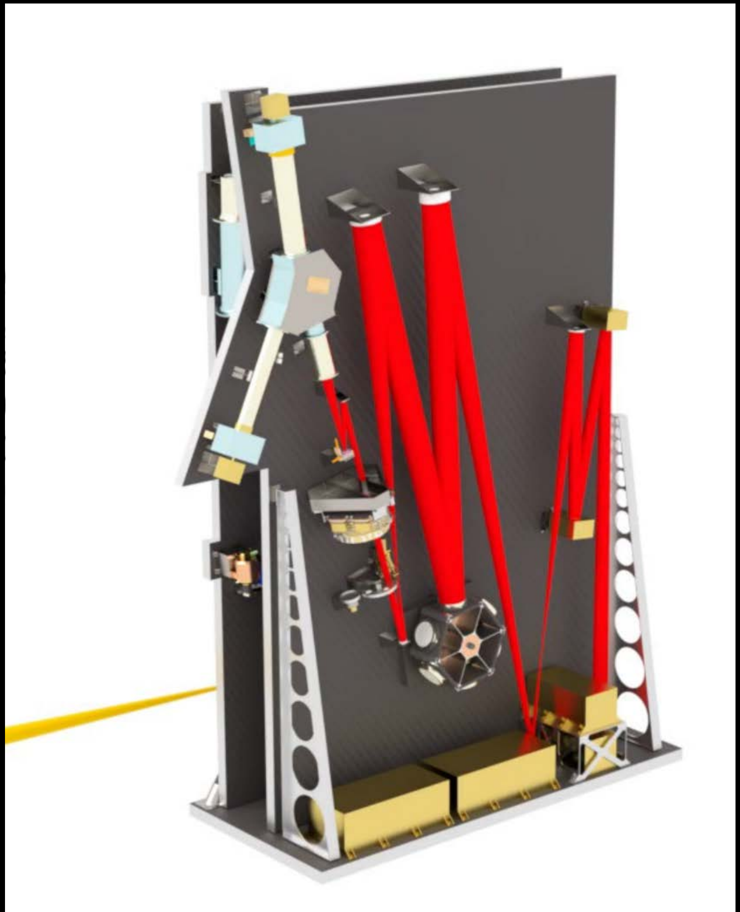


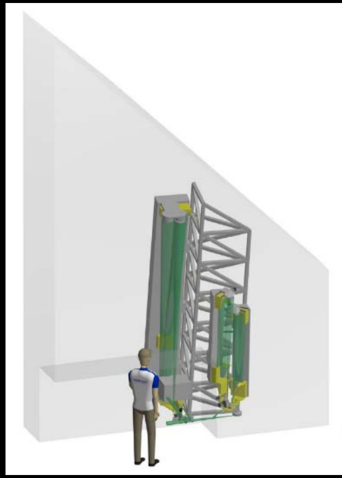
High Definition Imager



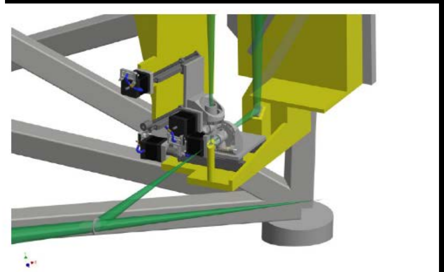
LUVOIR UV Multi-object Spectrograph

Extreme Coronagraph for Living Planetary Systems

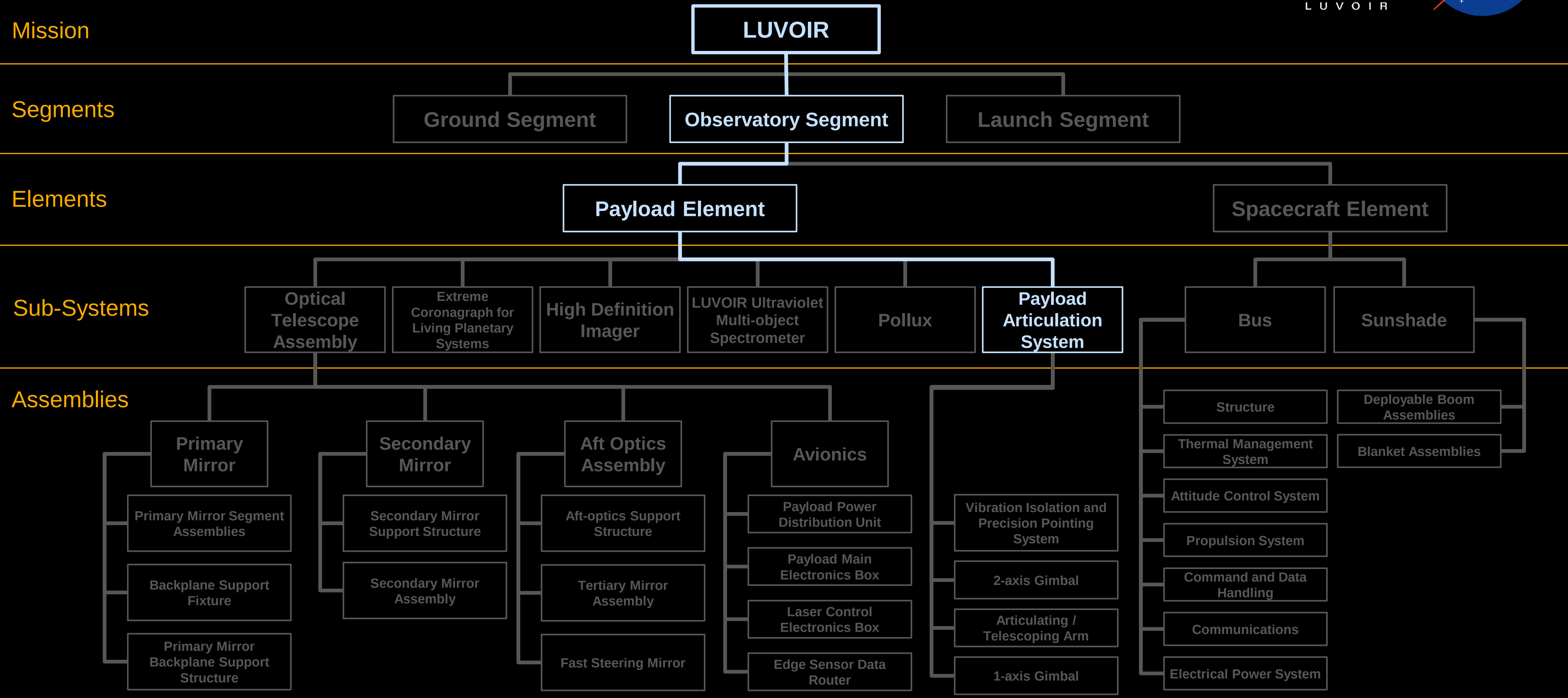




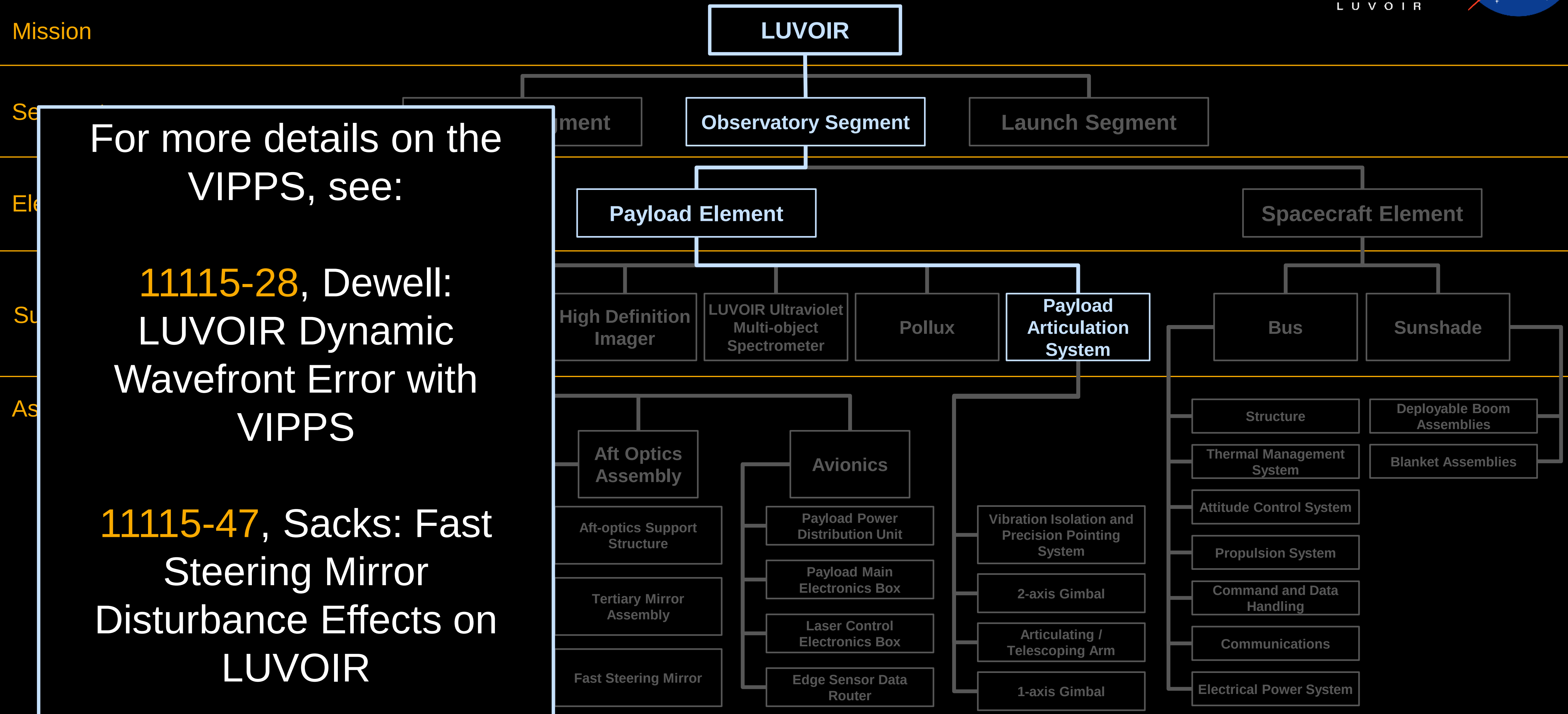
Pollux



A Scalable Architecture



A Scalable Architecture



For more details on the VIPPS, see:

11115-28, Dewell: LUVOIR Dynamic Wavefront Error with VIPPS

11115-47, Sacks: Fast Steering Mirror Disturbance Effects on LUVOIR

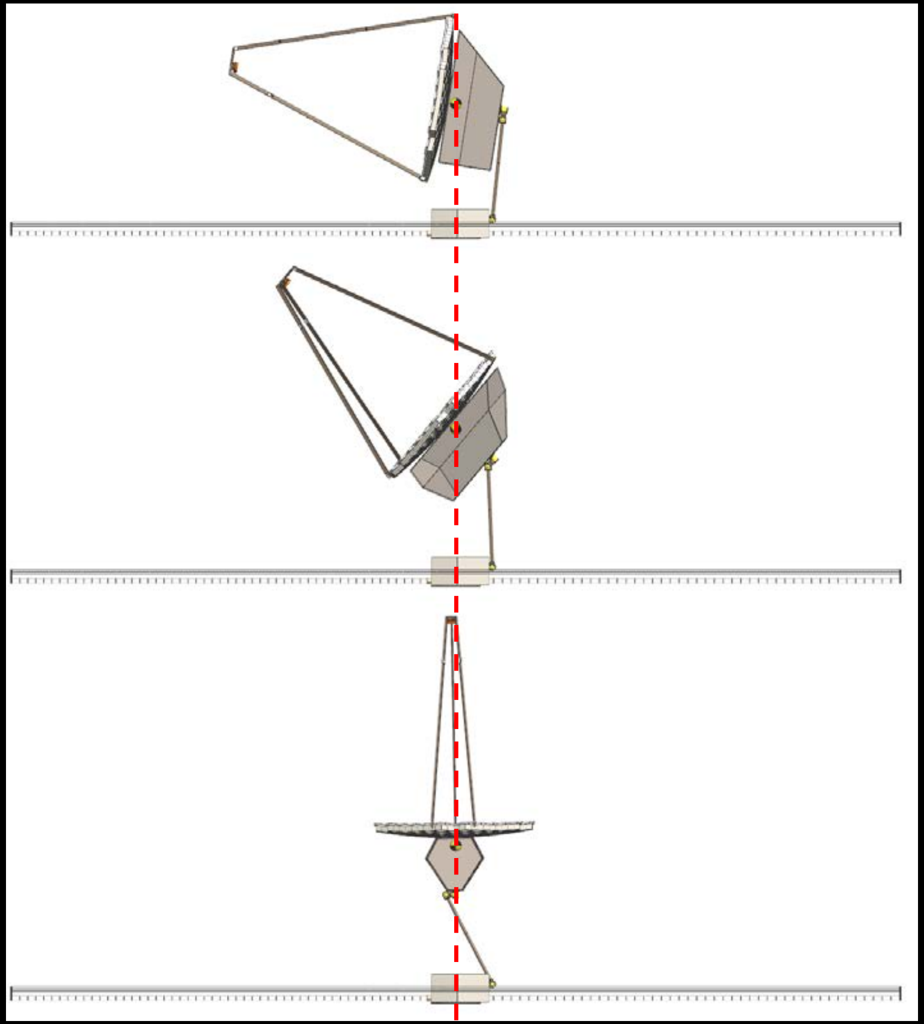
Payload Articulation System

Used to point telescope independently of sunshade

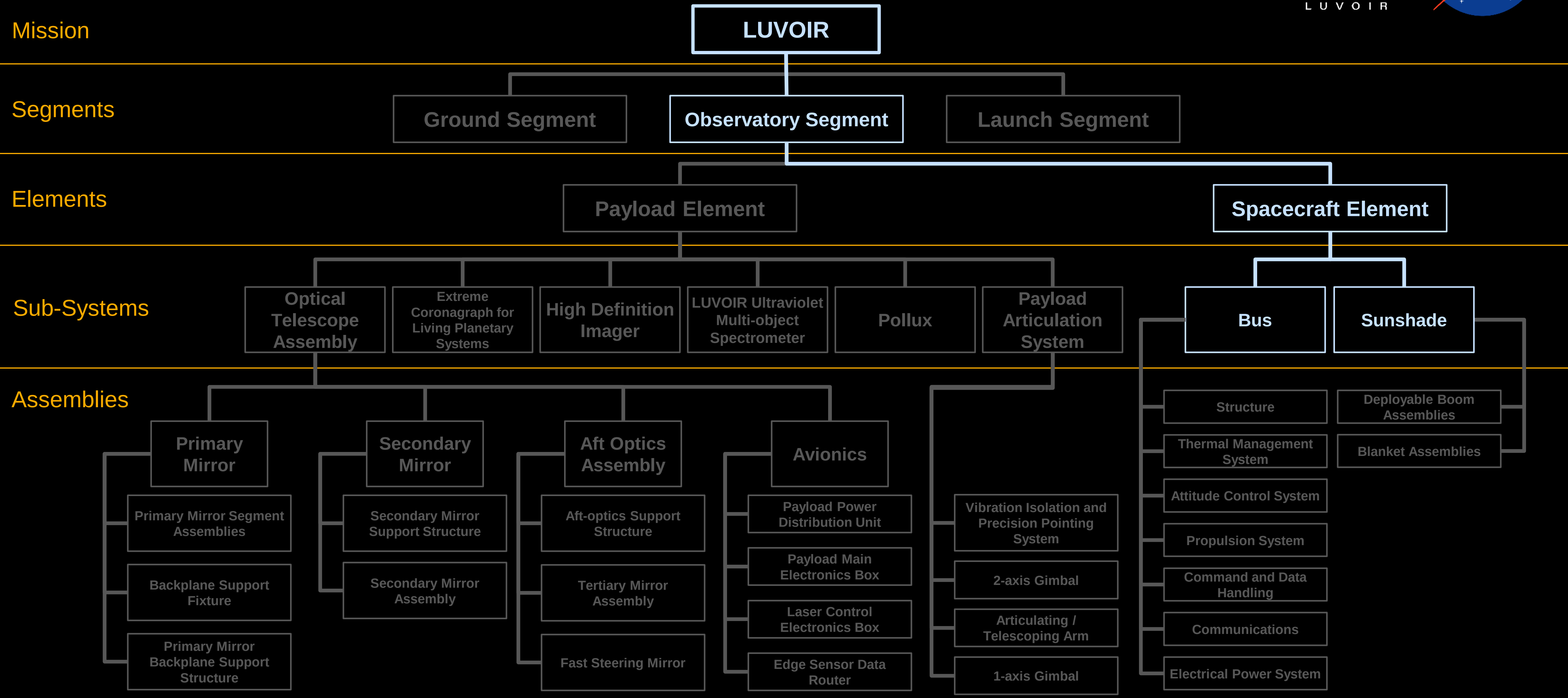
- Improved thermal stability
- Improved dynamic stability
- Fast repointing

Also maintains alignment of center-of-gravity with center-of-pressure

- Better momentum management for fewer stationkeeping maneuvers



A Scalable Architecture



Spacecraft Bus & Sunshade

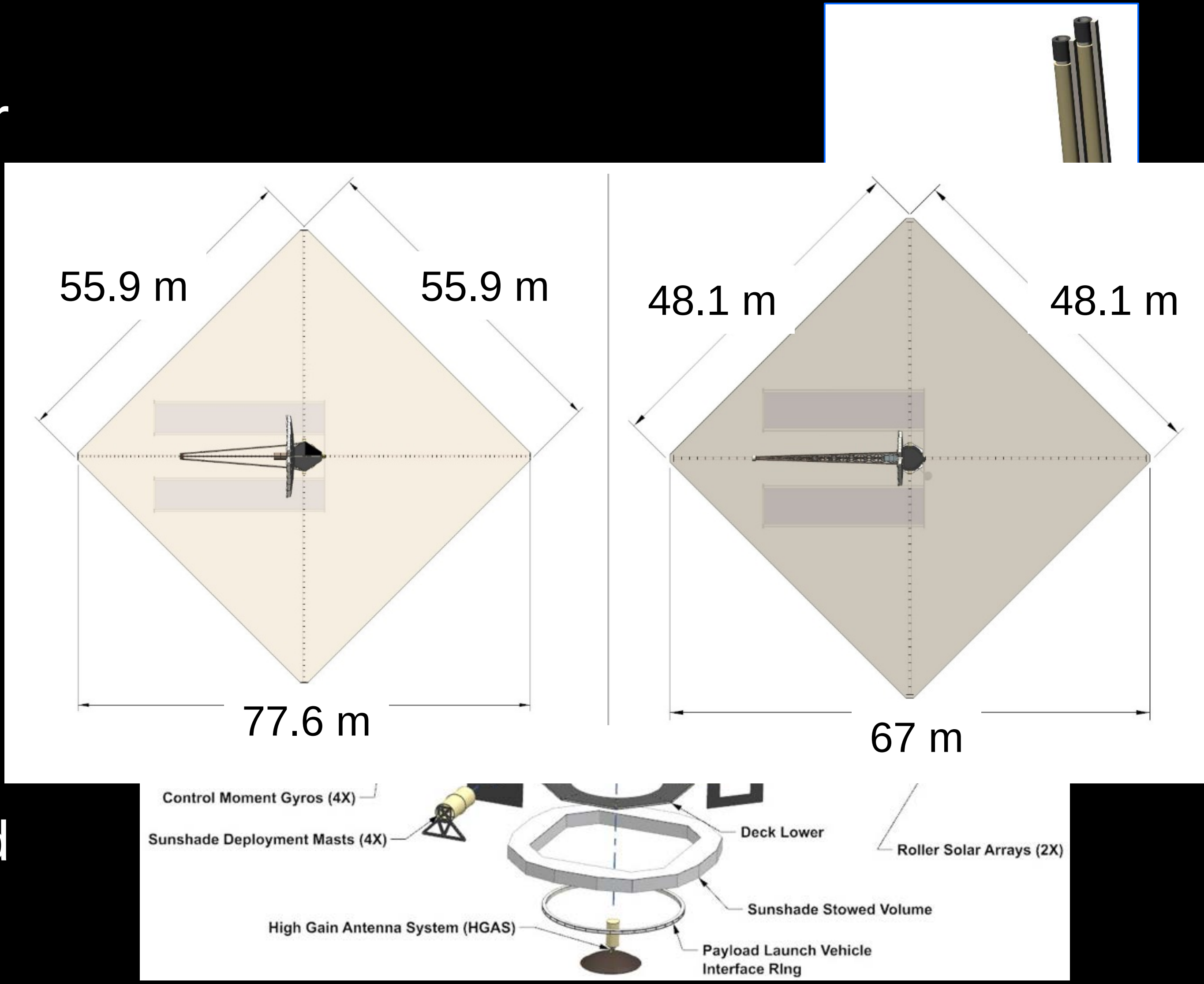
Octagonal bus, with systems mounted to external panels for easy access / servicing

Sun***shade*** is simpler than JWST's sun***shield***

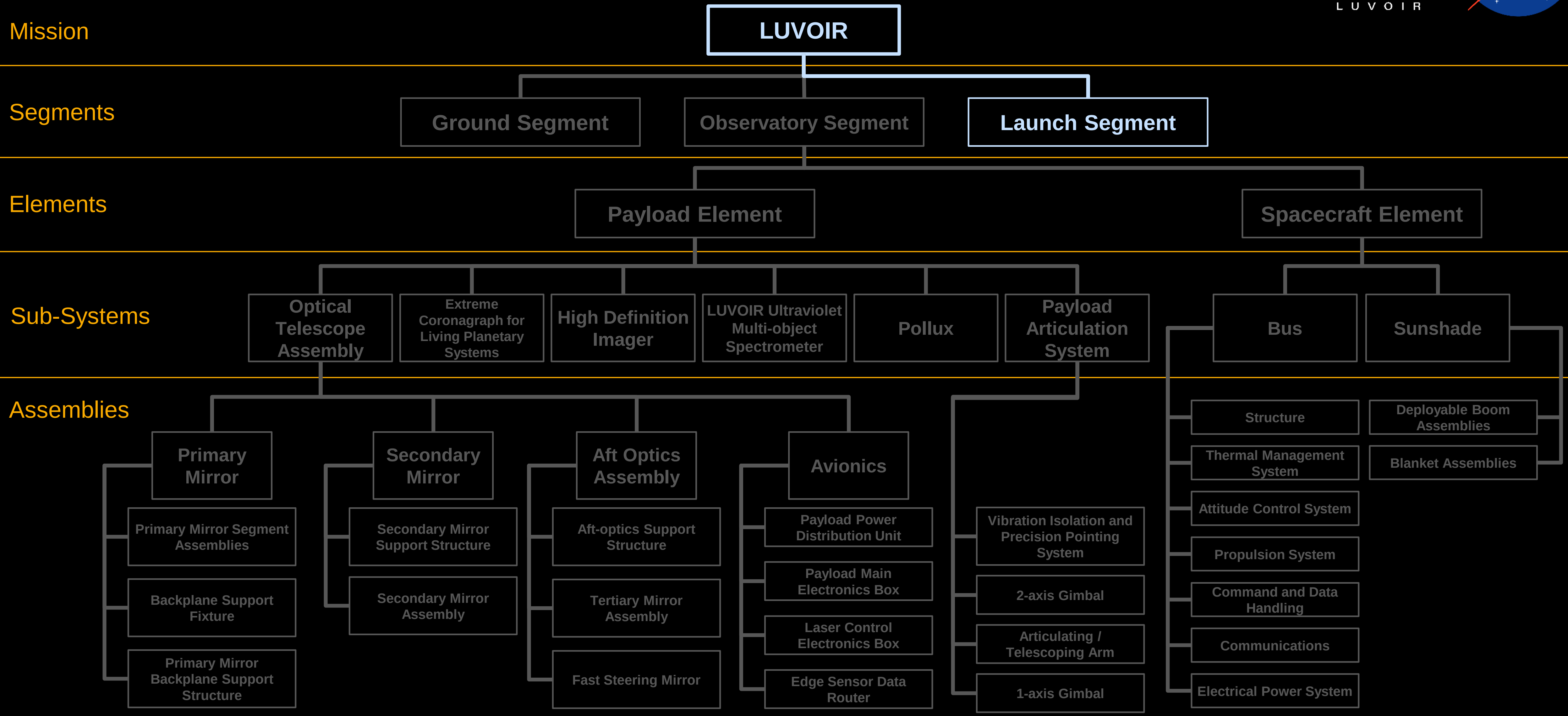
- Three layers, not five
- Relaxed deployment tolerances

…But it is much bigger

- New challenges with testing and verification



A Scalable Architecture



The Launch Segment

Baseline launch vehicle is Space Launch System (SLS)

LUVOIR-A: SLS Block 2 with 8.4 x 27.4 m fairing

LUVOIR-B: SLS Block 1B with 5 x 19.1 m fairing

Alternatives:

	SLS Block 1		SLS Block 1B		SLS Block 2		SpaceX Starship		Blue Origin New Glenn	
	Mass	Volume	Mass	Volume	Mass	Volume	Mass	Volume	Mass	Volume
LUVOIR-A	No	No	Yes*	Yes	Yes	Yes	Yes	Yes**	No	No
LUVOIR-B	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

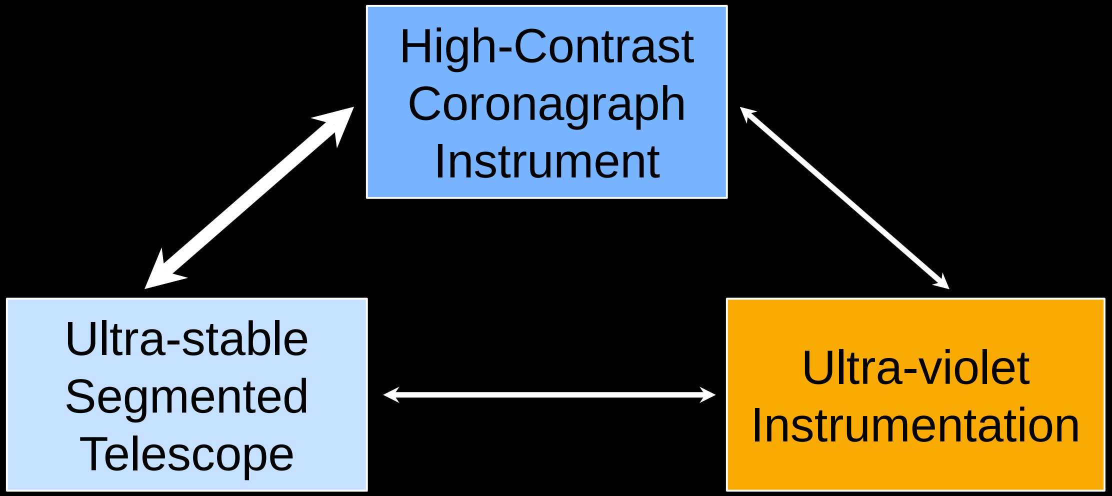
*with anticipated upgrades to boosters and RS25 engines in 2030

**with feasible modifications of Starship fairing

LUVOIR Technology Development

Technology Development

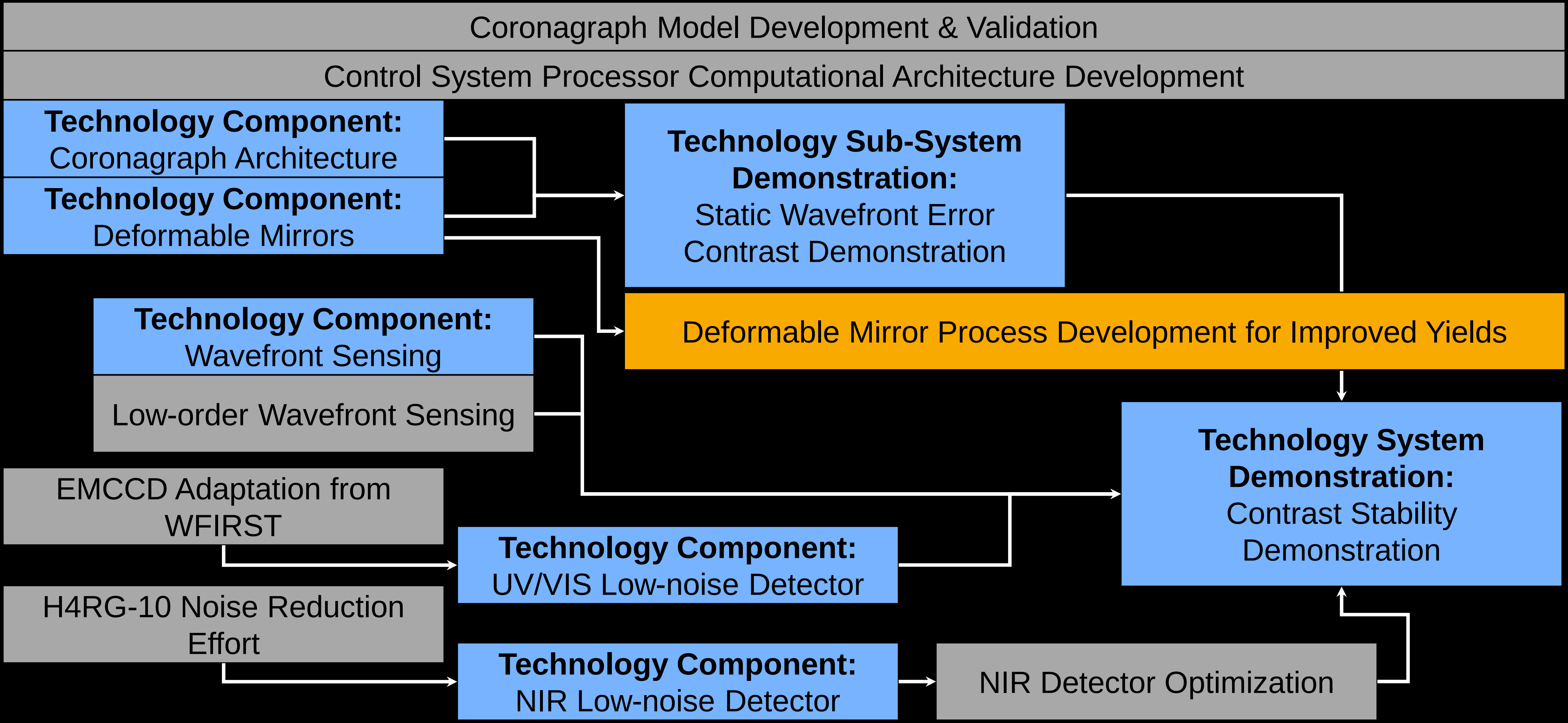
Technologies are organized into three technology systems:



Three development paths mature each of the technologies at the ***system*** level

Technology systems are coupled, and must be developed in parallel with cross-validation

High-Contrast Coronagraph Instrument



Ultra-stable Segmented Telescope

System-level Model Development & Validation

Thermal Sensing & Control Development

e Material Process Development and Optimization

Parallelized Mirror Fabrication Facilities

Assembly Demonstration:
Full-scale Mirror Segment Assembly

Sub-System Demonstration
Metrology & Control Sub-system

Technology System Demonstration:
Ultra-stable Segmented Telescope System

gy Component:
tion Isolation

For more details on the Ultra-stable System Technology Development, see:

11115-28, Dewell: Dynamic Wavefront Error with Non-contact Isolation

11115-27, Coyle: Large Ultrastable Telescope System Study

Ultraviolet Instrumentation

Contamination Control Process Development

VIS and NIR Coating Optimization

Freeform Optic Development

Technology Component:
Far-UV Broadband Coating

Parallelized Mirror Coating Process Development

Technology Component:
Next-gen Microshutter Arrays

Technology Component:
Large-format Microchannel Plate Detectors

Technology Component:
Large-format High-resolution UV/VIS Focal Plane Arrays

δ-doping / UV Detector Enhancement

One-of-a-Kind, First-of-Its-Kind

Like any flagship-level mission, LUVOIR is a highly complex, nested, system-of-systems that has never been built before

Like any flagship-level mission, it will encoun
design and implementation

Must use ***and adapt*** what we have learned o
Hubble, JWST, WFIRST, MAVEN, OSIRIS-R
others to overcome these challenges

For more details on flagship management strategies, see:

11115-37, Crooke: Evolving management strategies to improve NASA flagship cost & schedule performance

Questions?