

## Homework v1

- (a) Technical requirements list and flowchart
- (b) Product breakdown structure for vehicle
- (c) List of required analyses

We can directly convert the first draft of the Customer Expectations into technical requirements. The Customer Expectations/Mission Requirements v1 state that the reboost vehicle must:

- (a) Launch on an existing US launcher from Cape Canaveral into the HST orbit

### Requirement 1

Reboost vehicle must be launched on existing US launcher from Cape Canaveral into the HST orbit.

### Requirement 2

Reboost vehicle must be able to withstand temperature conditions of launch and orbit.

### Requirement 3

Reboost vehicle must be able to withstand vibration conditions and g-loading of launch.

- (b) Rendezvous and dock with HST using robotic-arm grapple fixture

- Use HST or rebooster ADCS to orient combined spacecraft for reboost

### Requirement 4

Reboost vehicle must communicate with HST to orient combined spacecraft.

- Reboost thrust must result in solar array boom deflection of no more than 50cm

### Requirement 5

Reboost vehicle thrust must not cause a solar array boom deflection of more than 50cm.

- Undock from HST and destructively de-orbit into atmosphere

### Requirement 6

Reboost vehicle must have sufficient fuel to dock and reboost HST, and de-orbit into atmosphere.

- Send and receive state-vector, attitude, and system health telemetry to/from HST

### Requirement 7

Reboost vehicle must be able to exchange information with HST.

- Send and receive state-vector, attitude, and system health telemetry to/from NASA Mission Control Center (MCC), either directly, or indirectly via HST and or TDRS satellites

**Requirement 8**

Reboost vehicle should be able communicate with TDRS in case of communication failure with HST.

- Be able to recover from one Single Event Upset per hour in the onboard Command and Control Computer

**Requirement 9**

Reboost vehicle must be able to recover from one Single Event Upset per hour in the onboard Command and Control Computer.

- No requirement on duration of mission
- Power and thermal requirements not specified to be determined by design to meet mission objectives

**Requirement 10**

Reboost vehicle must have sufficient power and thermal specifications to meet mission objectives.

- Main body of spacecraft bus must include MMOD shielding (impact spec TBD)

**Requirement 11**

Reboost vehicle must include bus with MMOD shielding (impact spec TBD).

- ADCS must be able to recover from/override both jet-fail-on, and jet-fail cases during proximity operations without collision of mission failure

**Requirement 12**

Reboost vehicle ADCS system must be able to recover from/override both jet-fail-on, and jet-fail cases during proximity operations without collision of mission failure.

- Loss of communications between rebooster and HST or MCC must not result in collision

**Requirement 13**

Reboost vehicle must not collide with HST.

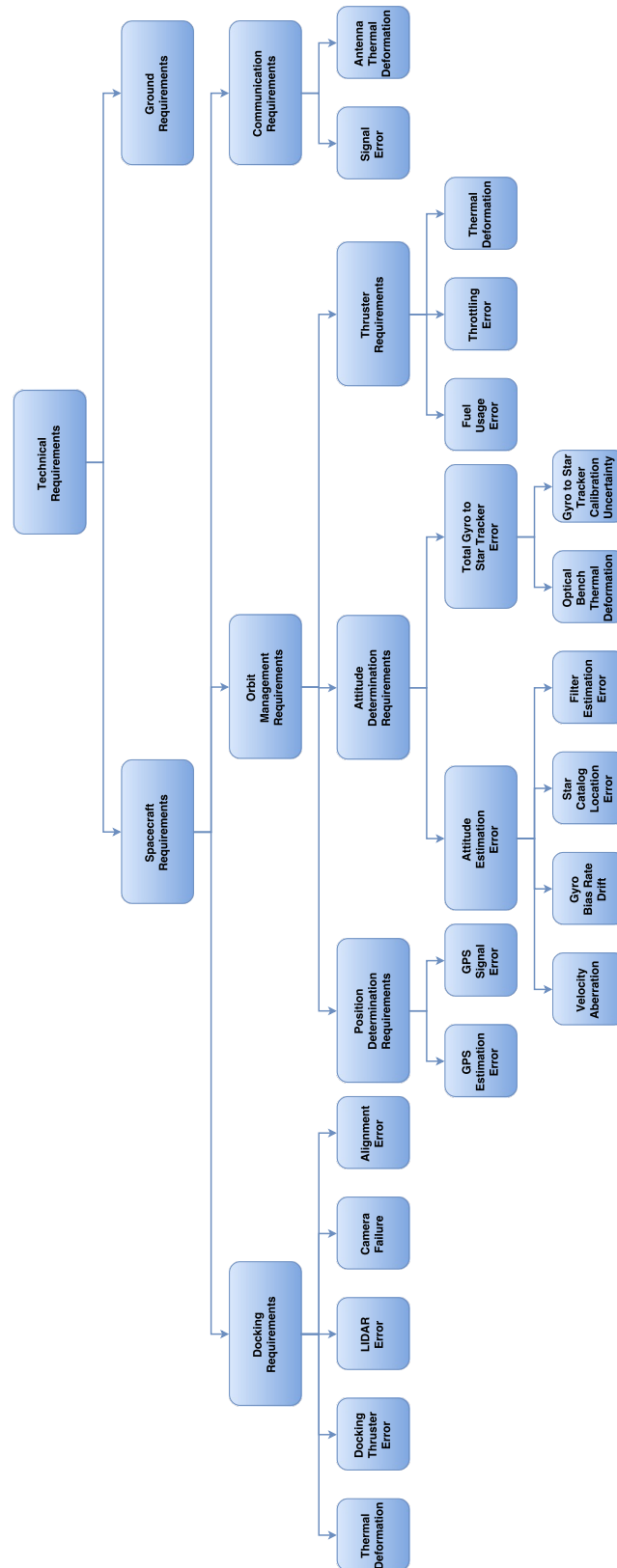


Figure 1: Technical Requirements

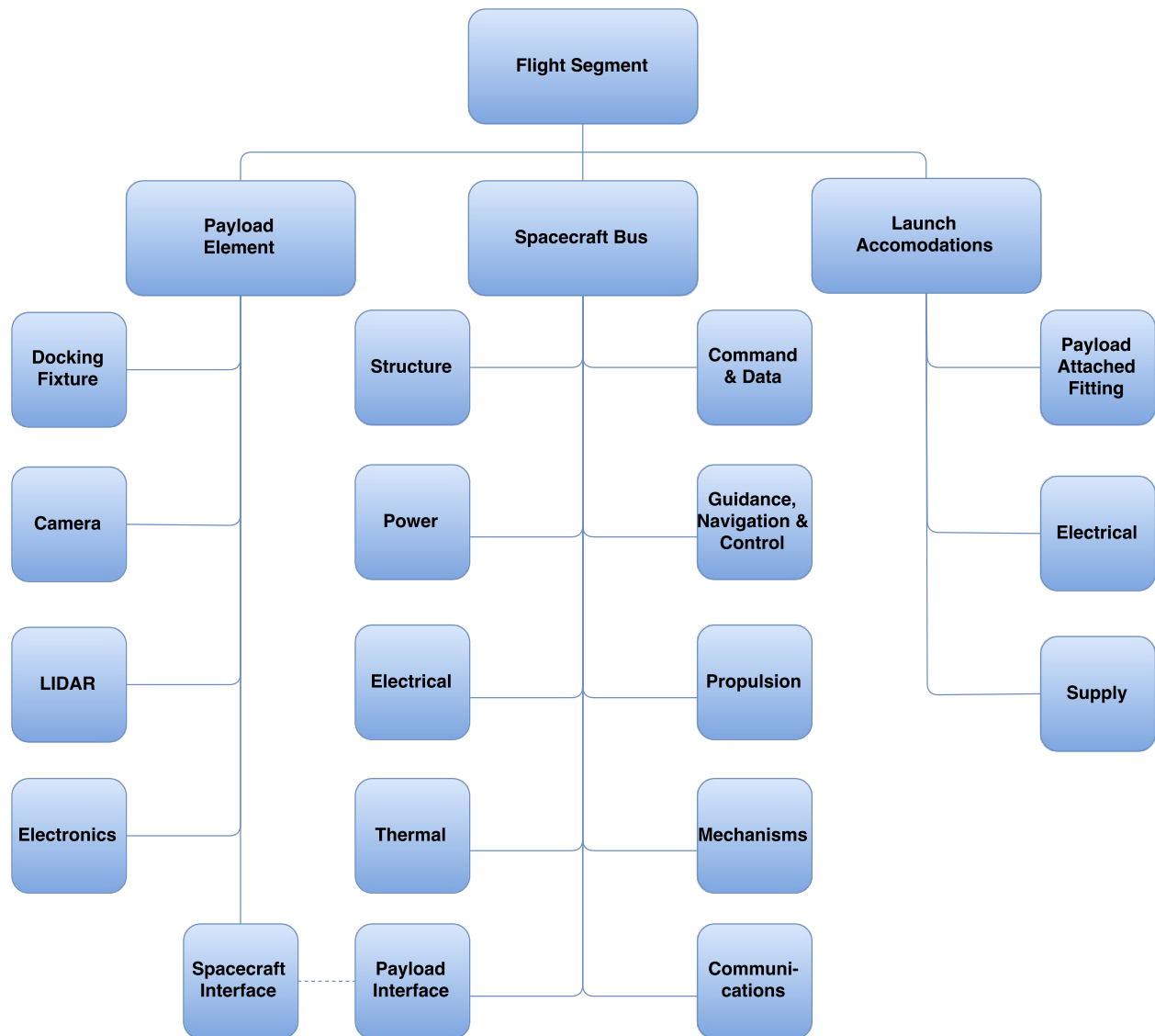


Figure 2: Product Breakdown

To complete the mission requirements, analyses must be completed to answer the following questions:

- (a) What are the mass requirements for a reboost vehicle to reboost the HST spacecraft to circular orbit so that orbital decay is extended to 5 years beyond the JWST 10/23 launch date, i.e. to 10/28 (currently estimated HST end-of-life is 2020) and then de-orbit in the atmosphere?
- (b) What existing US launcher can launch an appropriately sized reboost vehicle into the HST orbit?
- (c) What thermal and vibrational conditions must the spacecraft be able to withstand?
- (d) How does HST communicate, and how close to HST does the reboost vehicle need to be to communicate with HST?
- (e) How much force at the robotic-arm grapple fixture point causes a 50cm solar array boom deflection?
- (f) How do satellites communicate with TDRS, and what kind of power requirements are necessary to do this?
- (g) What kinds of redundant computer systems are necessary to recover from one Single Event Upset per hour in the onboard Command and Control Computer?
- (h) How much MMOD shielding is necessary to meet the impact spec?
- (i) What are the most effective ways to negate jet-fail-on, and jet-fail cases during proximity operations without collision of mission failure?