

Space Docking Fundamentals

2 crafts connect in orbit to form a physical and functional union.

- Assembling • Trustee (fuel, cargo, crew).

PHASES

1. Rendezvous

- crafts gradually approach each other using orbital mechanics.
- Achieved by thrusters guided by Navigation sensors.

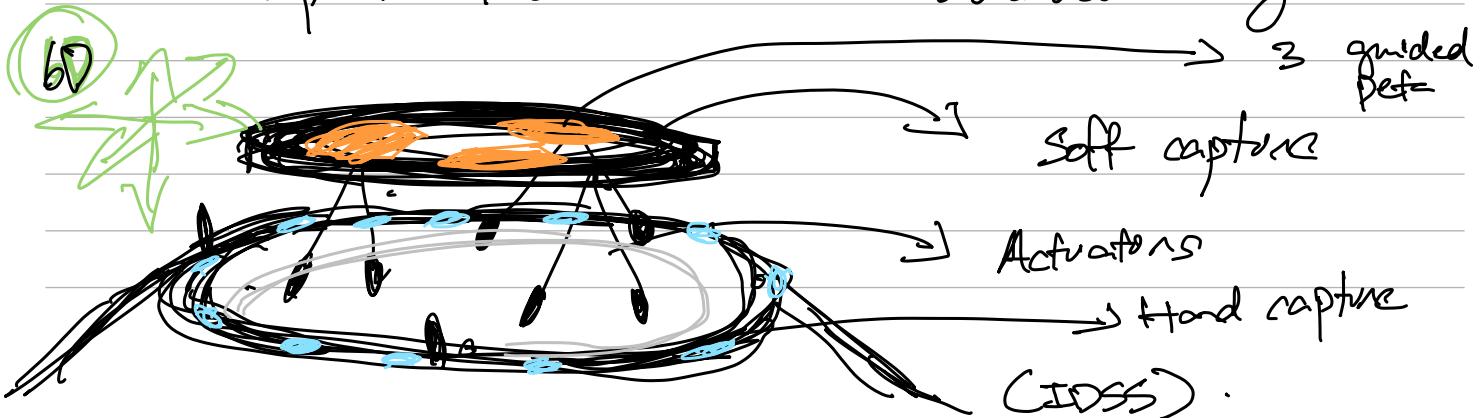
2. Proximity Operations

- few hundred mtrs → an accuracy required.
- Relative velocity reduced to cm/s

3. Soft Capture (Initial contact)

- First mechanical contact → flexible latches, dampers or guides engage.

- Impact force must be absorbed safely.



4. Hard capture (structural lock)

- Rigid latches engage.
- 2 crafts → single mech structure.

5. Sealing & Pressurization

- Redundant O-rings on metallic seals ensures no leaks.

6: Undocking : Rev. process

Types of Docking Mechanisms

(a) Probe - & - Drogue (Apollo - Soyuz)

one craft : Probe : Extendable rod.

other craft : Drogue : cone shaped receptacle

Probe enters drogue → Latches

Limitation : Non - Androgynous

(b) Androgynous Docking system

- Both crafts : Identical rings , Any vehicle can dock any other .

eg : APAS (Androgynous Peripheral Attach S/m)
used in Apollo - Soyuz , shuttle Min , shuttle - ISS

IDSS (International Docking s/m std) : Current unr. std.

soft capture : aligns and dampens

Hard capture : latches lock.

Advantages : standardization, flexibility,
modular assembly in space

Key ENGINEERING CHALLENGES

→ Precision : • Orbital velocity : $\sim 7.8 \text{ km/s}$

• Docking Approach $\leq 0.1 \text{ m/s}$

Misalignment Tolerance $\leq 1^\circ$

→ Impact forces

→ Structural loads (Docked parts should handle axial loads, Tension/shear).

→ Thermal cycling ($-150^\circ \leftrightarrow +150^\circ$ every orbit).

convection/expansion, seals & latches should survive.

→ Vacuum sealing.

→ Redundancy & safety.

Now mostly used gm is

IDSS

IDSS

- International Docking System standard
- Androgynous design



- Load capacity : 20 tonnes .
- Interface ring : 1.25m dia .
- Sealing type : Redundant O-rings

Beathing brings : Robotic arm captures and brings to docking port .

CubeSat : std class of small modular satellites ($10 \times 10 \times 10$ cm) : 1U

PROJECT
IDEA !

Design & Prototype of
a Miniature Androgynous
Docking Ring for cubesats

