Applications of Ultra Wide Band technology: An UWB Lunar Mission Demonstration.

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- UWB description of its characteristics, pros and cons, and area of applications
- Lunar mission objectives and description.
- UWB Module description and testing.
- Summary

Ultra Wide Band Wireless Technology

Ultra Wide Band (UWB) wireless technology is a short range communication protocol that uses electromagnetic waves in short pulses (1-2ns).

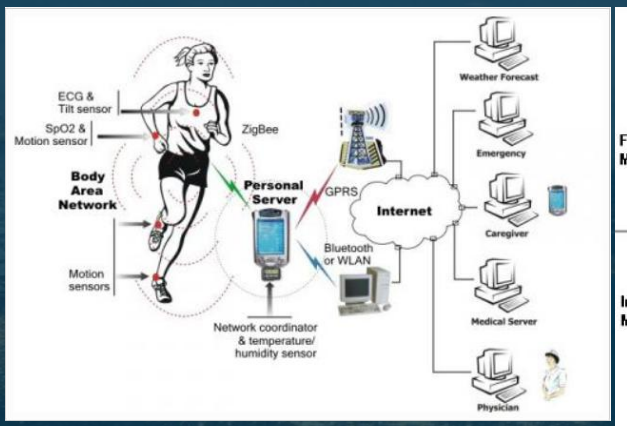
The UWB bandwidth is larger than 500MHz, up to 1.2 GHz.

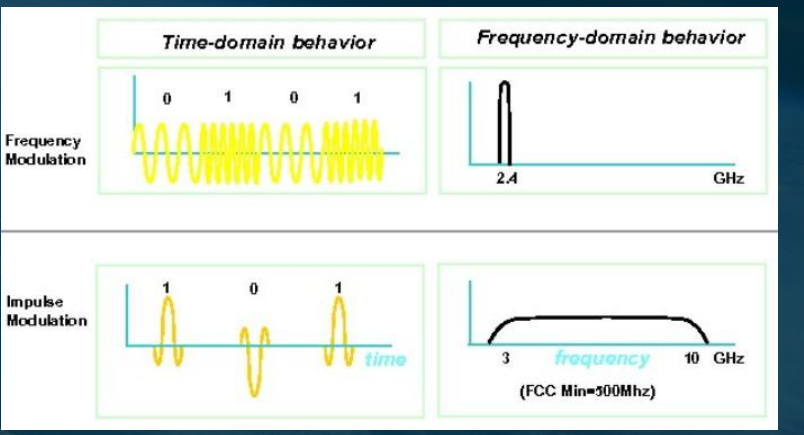
Physical Layer Specifications follow the IEEE 802.15.4 a/z specification

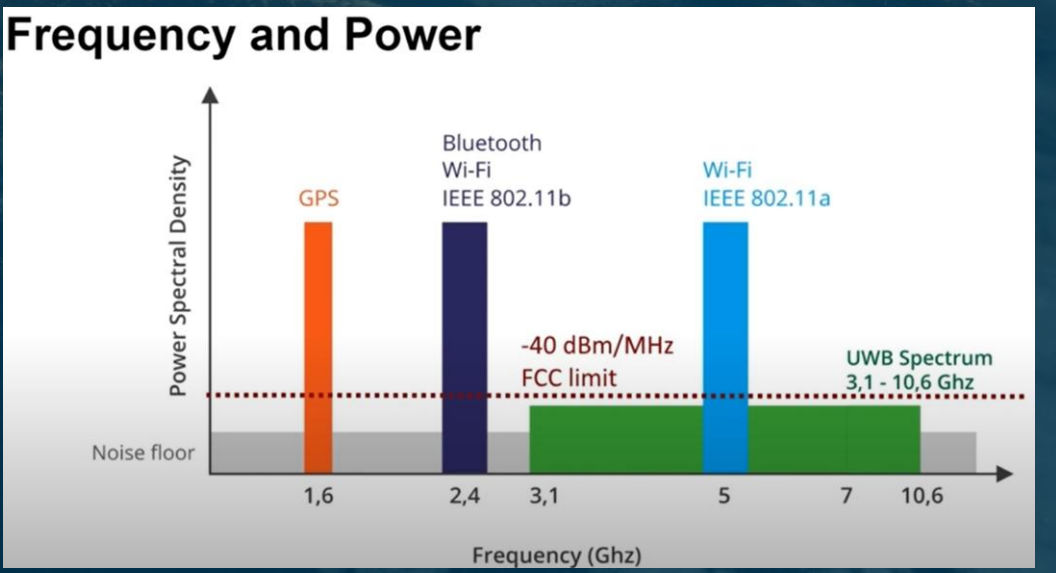
It is also specified in IEEE 802.15.6 for Wireless Body Area Network (WBAN).

Theoretically, 500Mbps data rates can be achieved. In practice the maximum is 27Mbps.

10 meters distance between node and gateway reliable transmissions. But up to 200m is possible.







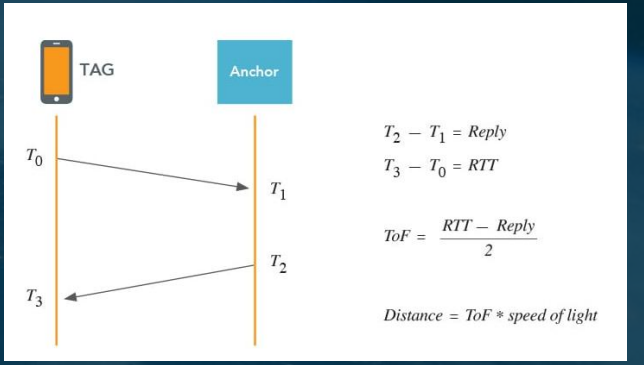
Comparison Table of several wireless technologies

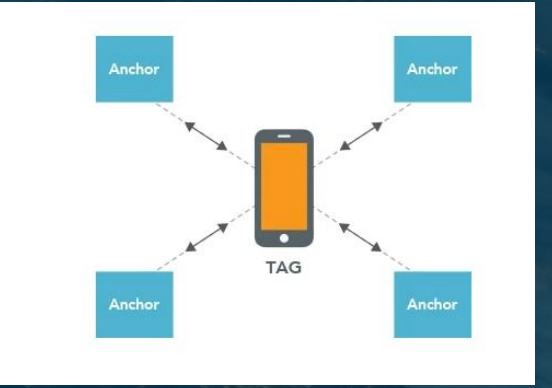
Standard	Bluetooth	UWB	ZigBee	WiFi
IEEE spec	802.15.1	802.15.4a/z	802.15.4	802.11a/b/g
Frequency band	2.4GHz	3.1-10.6GHz	2.4GHz	2.4GHz; 5GHz
Max signal rate	1Mbps	27Mbps	250kbps	54Mbps
Nominal range	10m	100m	100m	30m
Nominal Tx power	0-10dBm	-41.3dBm/MHz	0-30dBm	15-20dBm
# of RF channels	79	15	16	3 (2.4GHz)
Channel bandwidth	1MHz	500MHz; 1.2GHz	250kHz	22MHz
Modulation type	GFSK	BPM-BPSK	BPSK(+ASK); O-QPSK	BPSK; QPSK; COFDM; CCK; M-QAM
Spreading	FHSS	??? DS-UWB, M-OFDM	DSSS	DSSS, CCK, OFDM
Coexistence	Adaptive frequency hopping	Channel codes	Dynamic frequency allocation	Dynamic frequency allocation, transmit power control
Encryption	EO steam cipher	AES	AES	RC4, AES
Authentication	Shared secret	CBC-MAC9CCM)	CBC-MAC(CCM)	WPA2
Data integrity	16bit CRC	32bit CRC	16bit CRC	32bit CRC

Source: IEEE Industrial Electronics Society

Properties of UWB technology

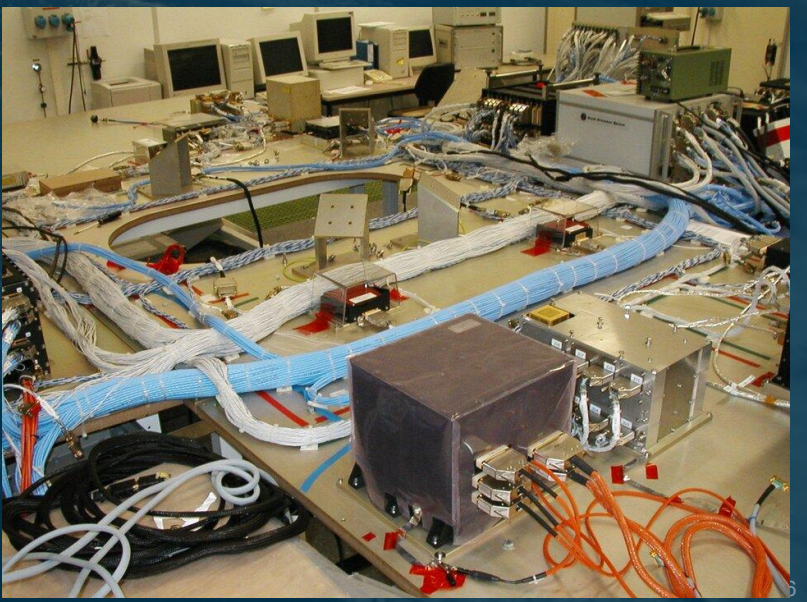
- Low Power (<1mW)
- High Data Rates can be achieved
- Security. Difficult to intercept.
- Positioning/Localization (about 10cm accuracy)
- Ranging/Radar type applications
- Indoor utilization
- Robustness to interference and multipath





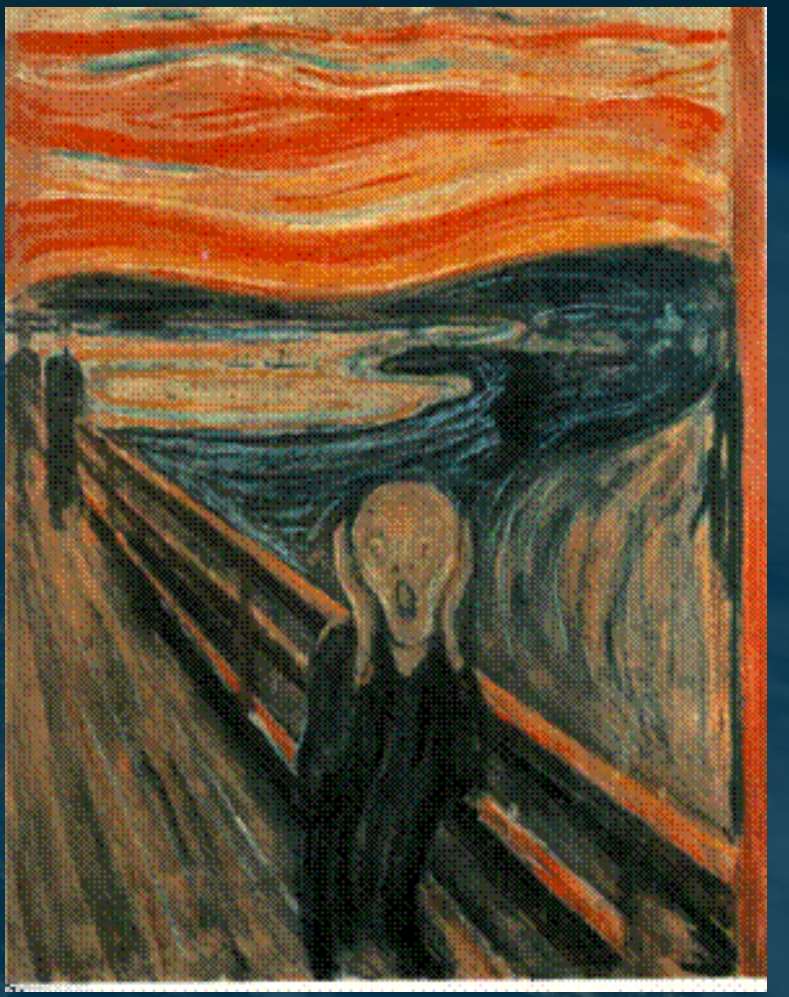
Why? The reason behind of using wireless technology (WT). The positive effects.

- Reduction of dry mass due to harnessing.
- Less complexity in assembly, integration and testing.
- No restriction in physical dimensions (i.e. volume, bending angle, etc)
- Elimination of any cost due to late design changes.
- Reduction of total risk since there are no connectors and cables.
- Elimination of manpower allocated to harnessing (i.e. shielding, connectors, brackets, fasteners, etc)
- Man made errors in design and AIT are eliminated and controlled.
- Flexibility in connectivity.



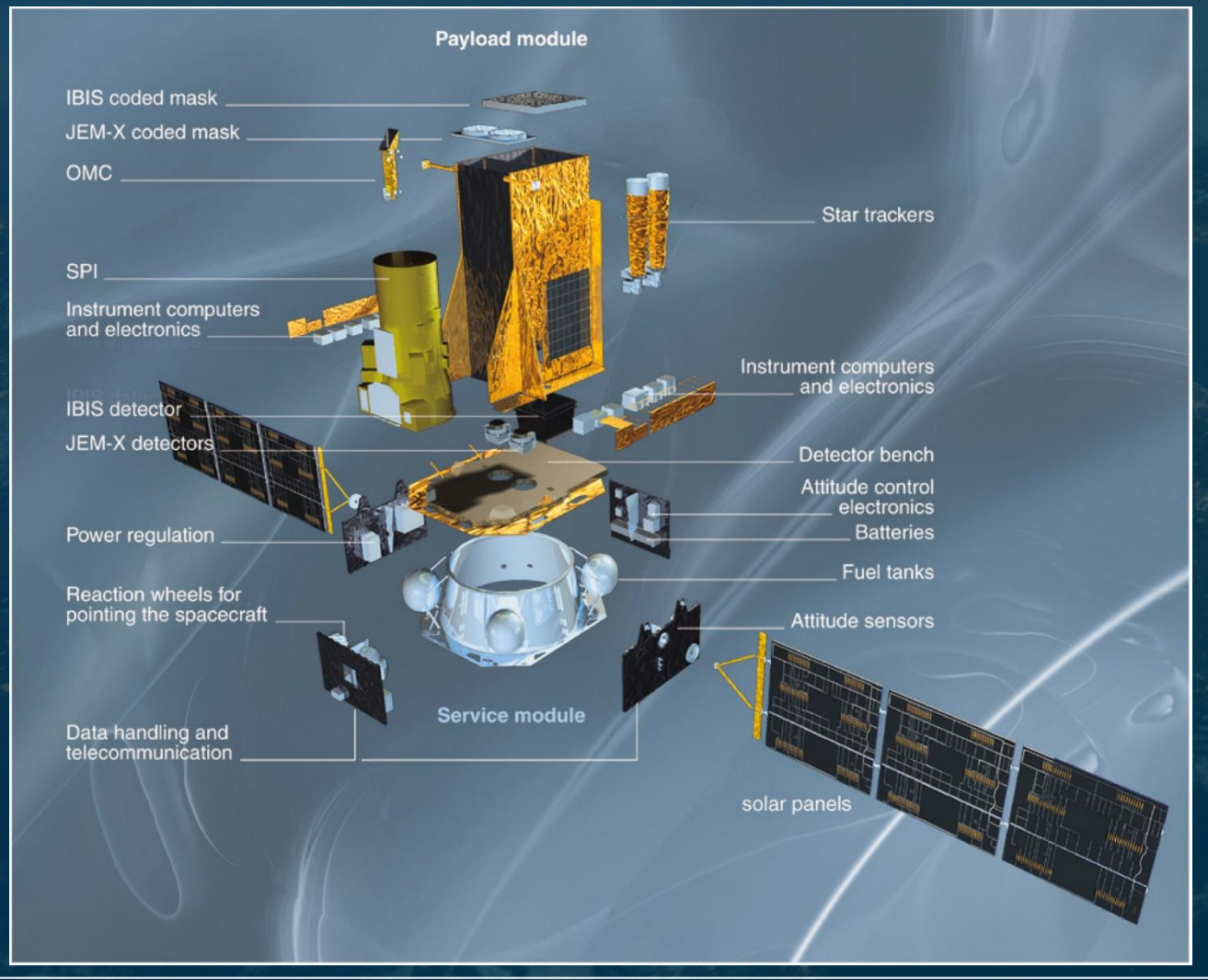
Effects that might be worrying.

- Electromagnetic Interference or EMI.
- Not mature technology (for space). Currently TRL6/7. No space flight inheritance (yet).
- Introduction to new concepts in design and operations.
- Not Space qualified components (yet). Radiation tolerant UWB IC is on going.
- Power constraints.
- Standards still under construction.



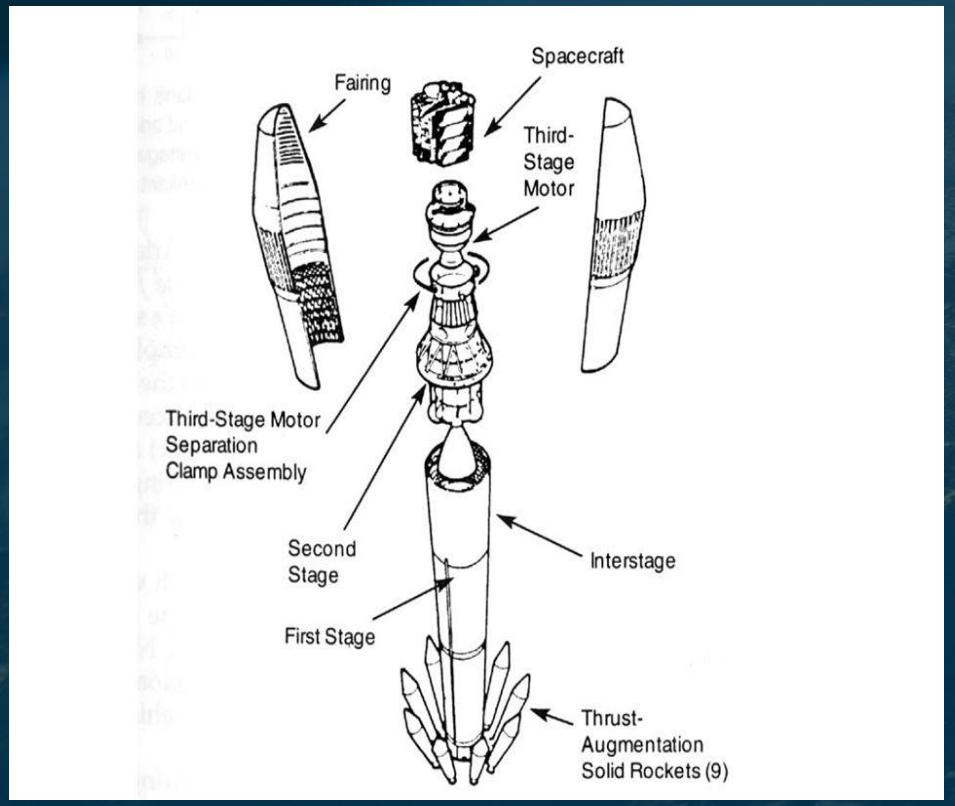
Applications in Space

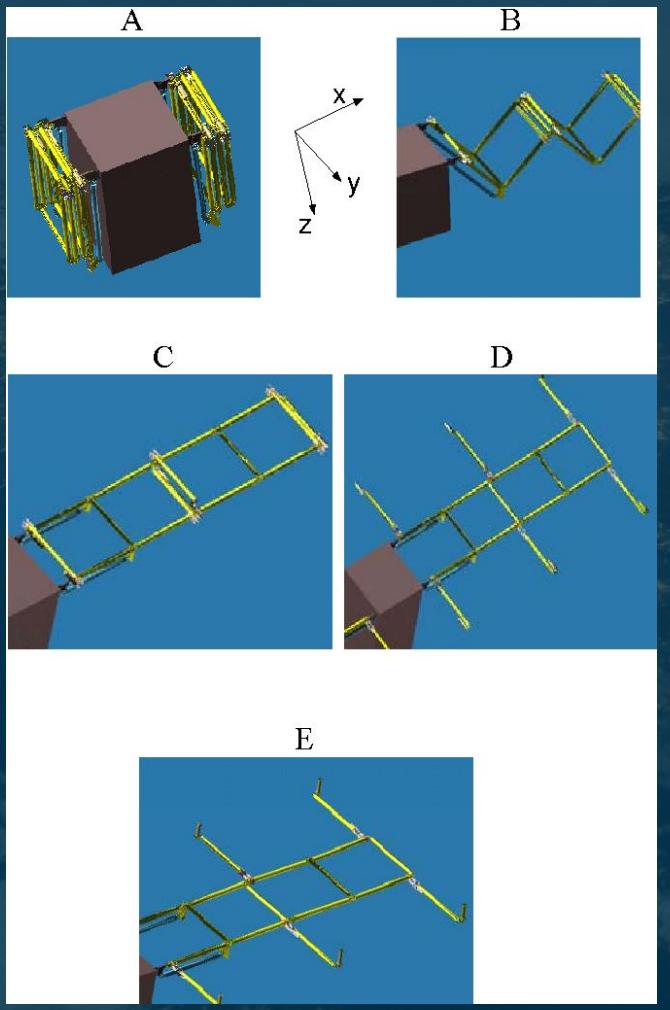
Intra-spacecraft communications

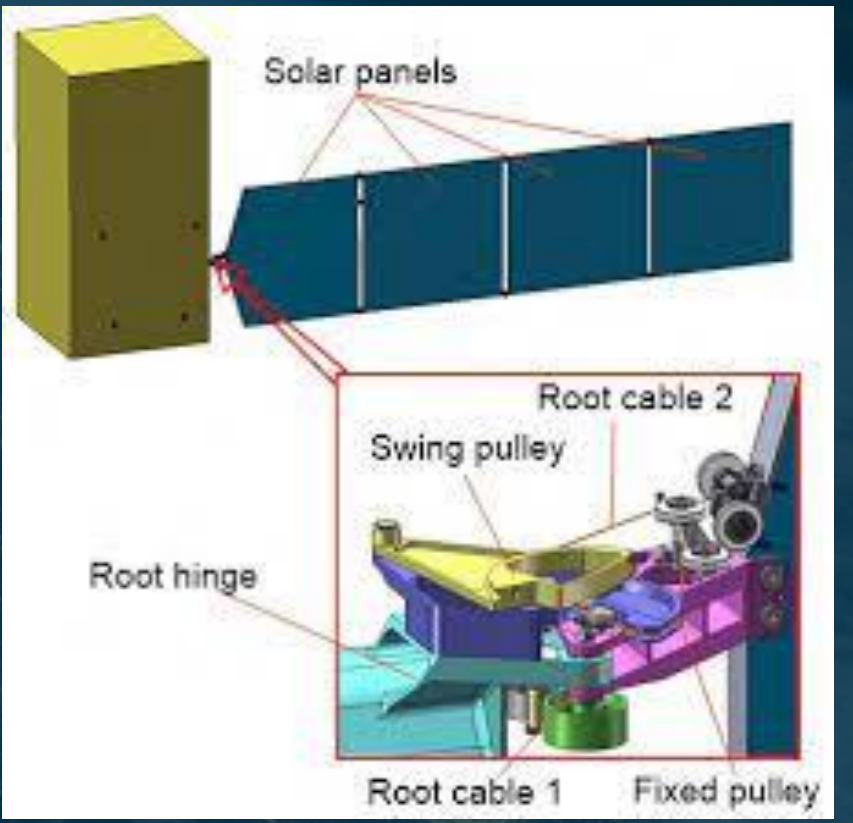


Applications in space

Controlling or acquire information from mobile structures.

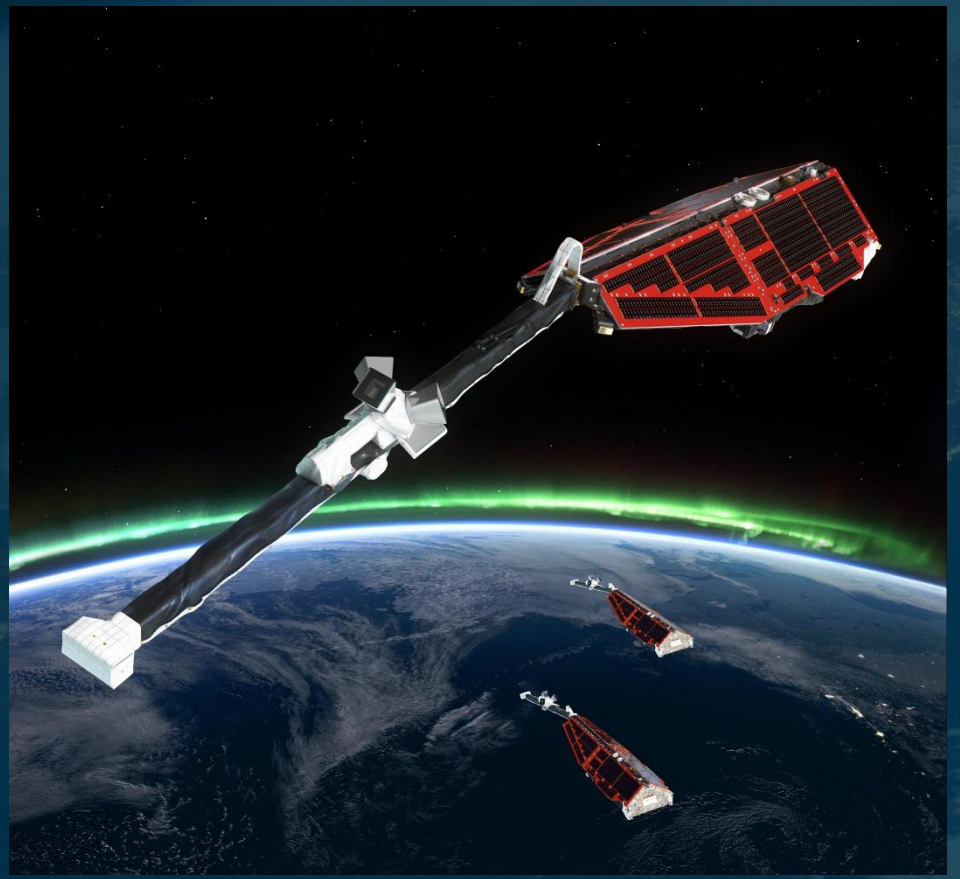






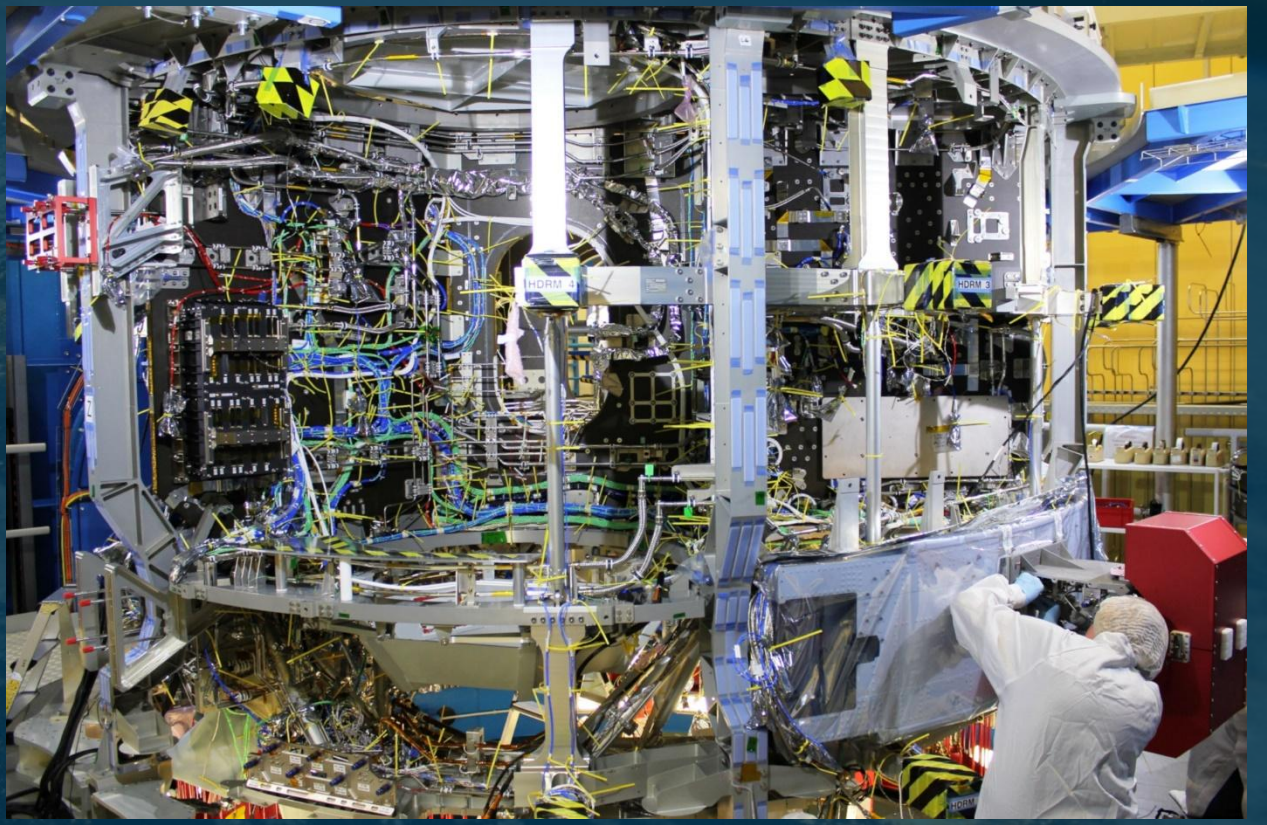
Applications in Space

Cubesat or microsat for small constellation communications

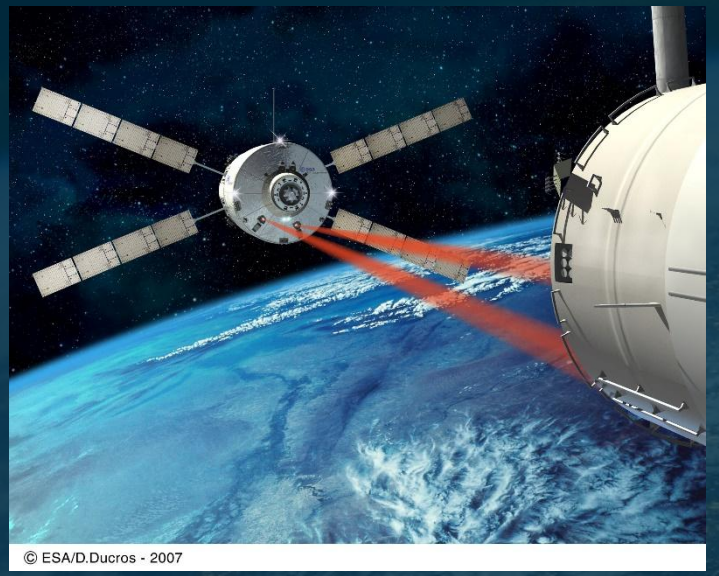


Space Applications

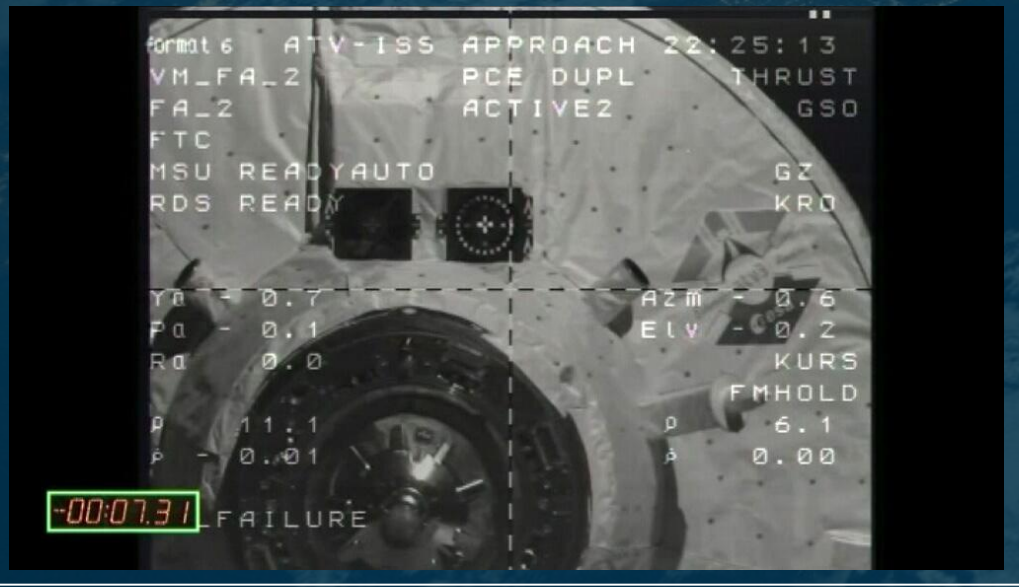
Assembly, Integration, Testing (AIT) Phase in Space Projects



Space Applications

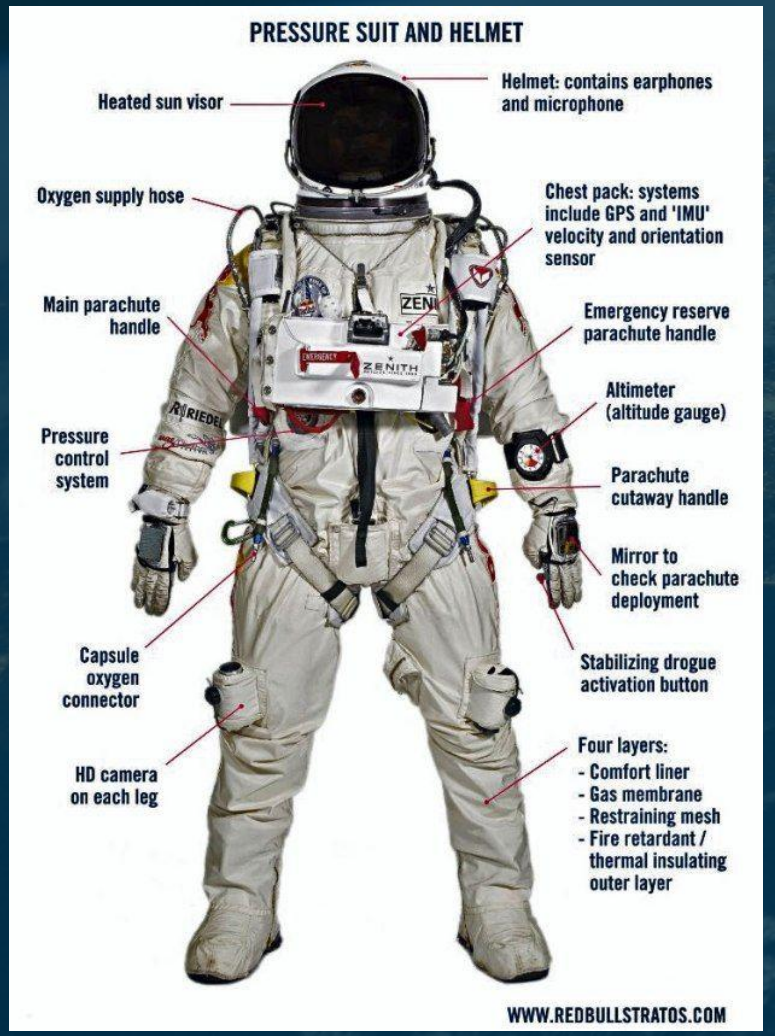


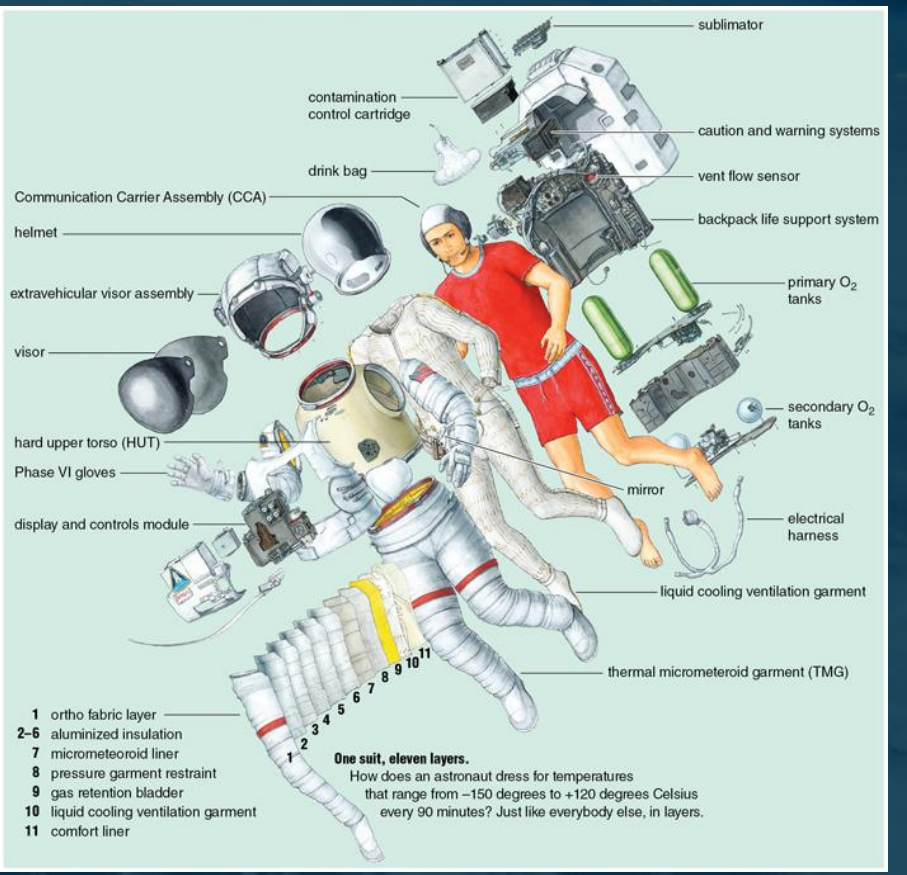
Docking & Rendezvous



Space Applications

WBAN for Astronauts.





Lunar mission partners.

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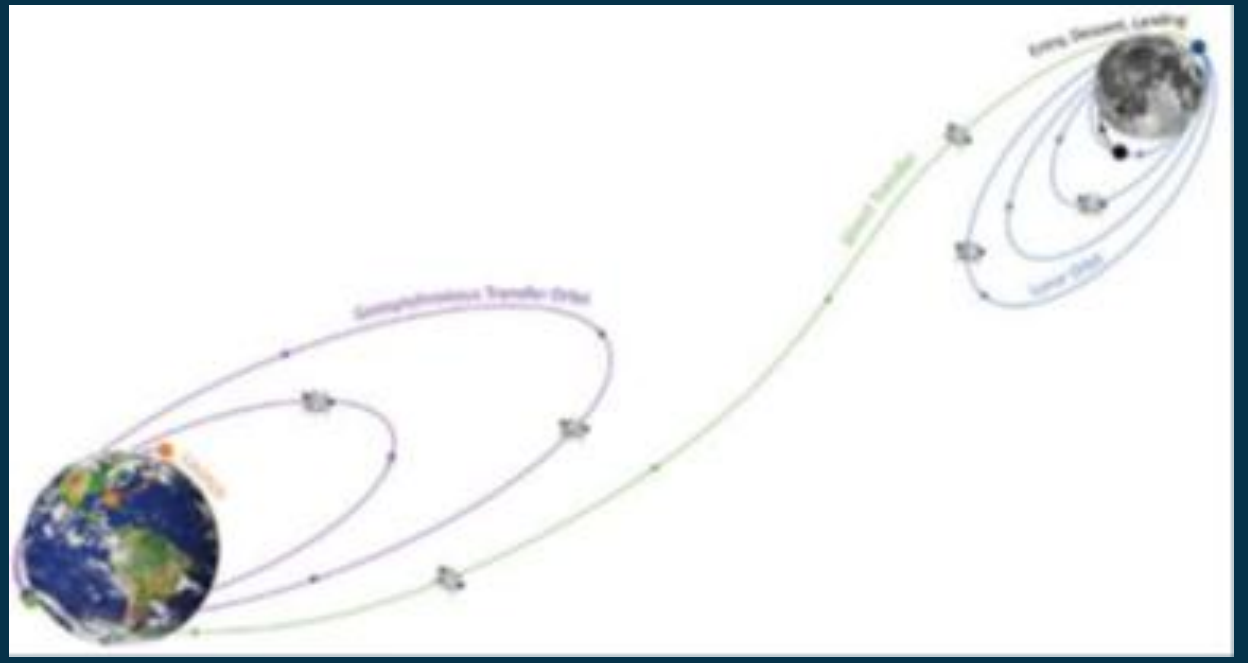
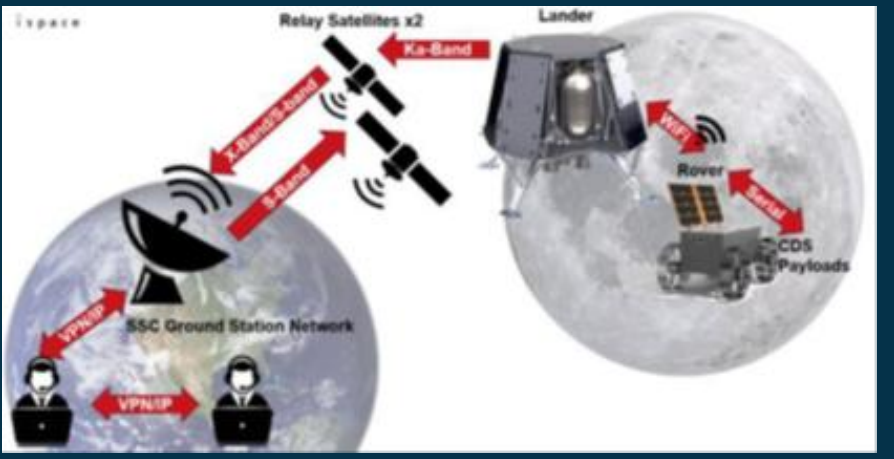
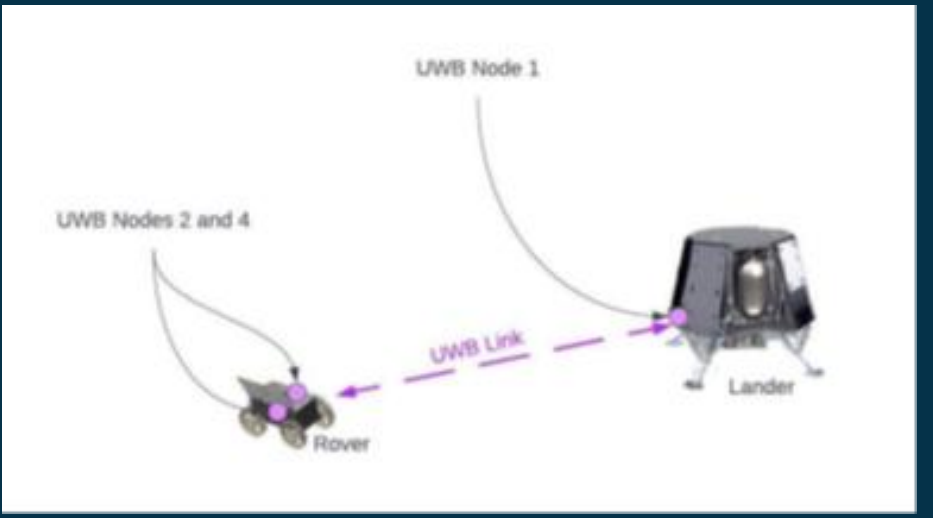
CDS

ispace

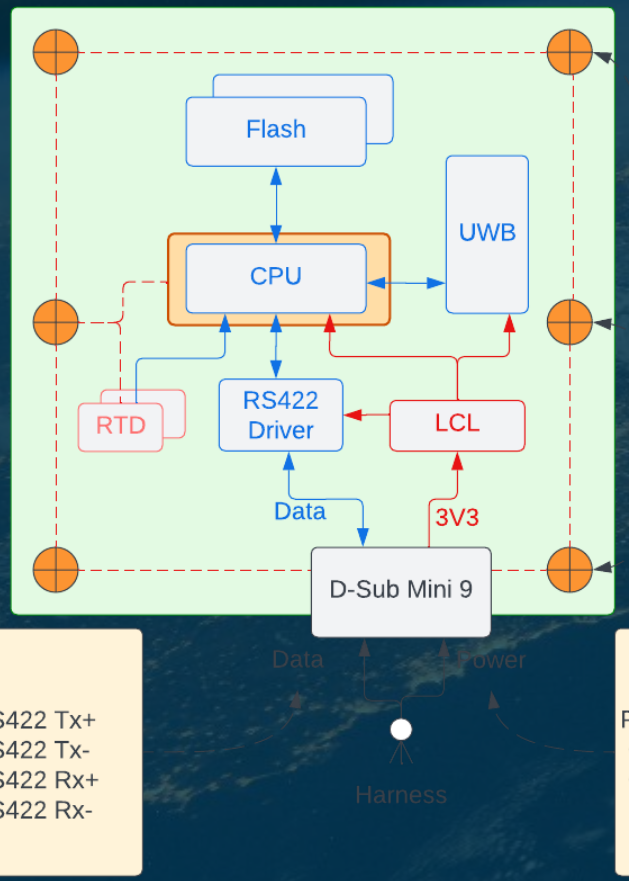
Lunar Mission





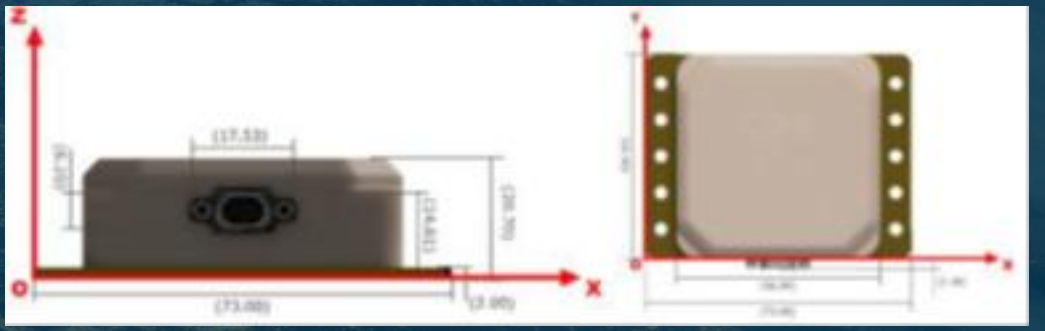


Hardware description



Data
Power
Thermal

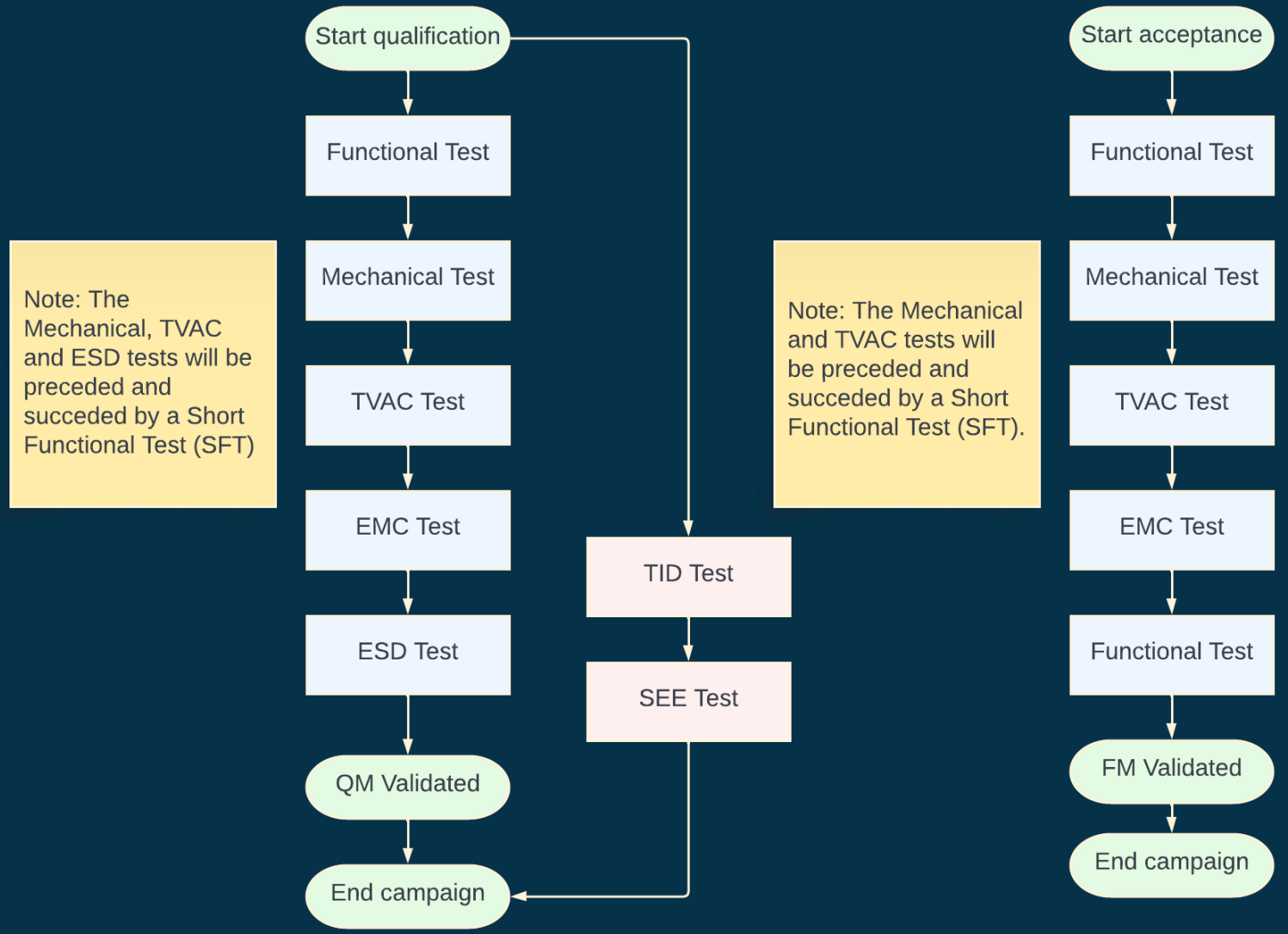
Fixture points
- Mechanical fix
- Thermal Reference Points
- Connected to enclosure



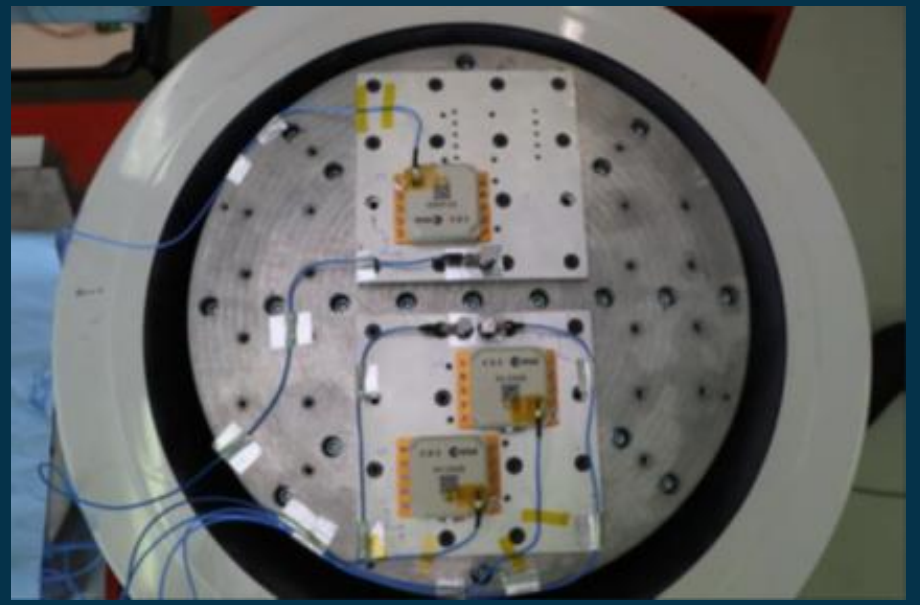
Data
- RS422 Tx+
- RS422 Tx-
- RS422 Rx+
- RS422 Rx-

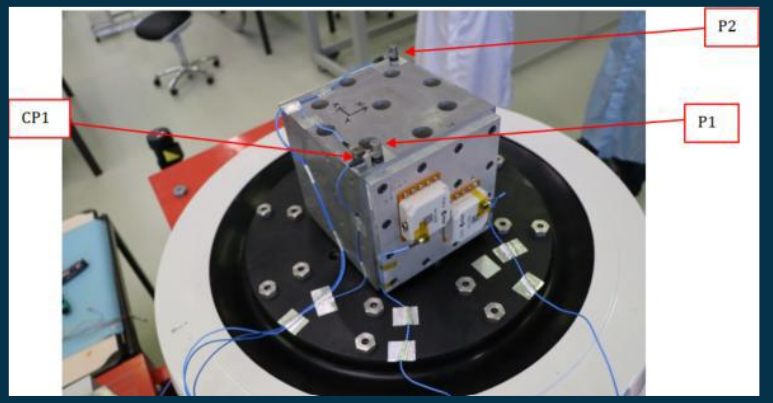
Power
- 3V3 regulated
- GND isolated

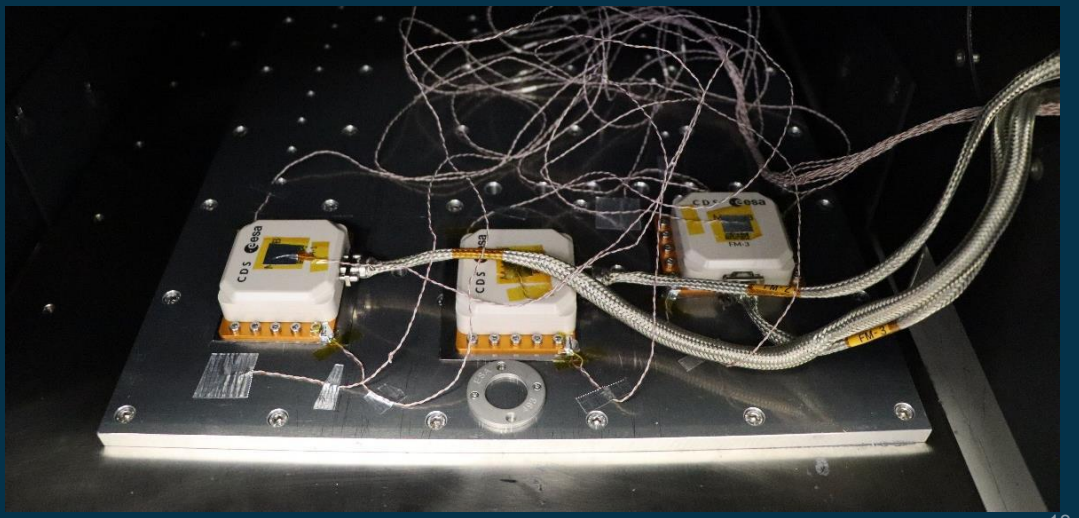
Testing work flow



Testing







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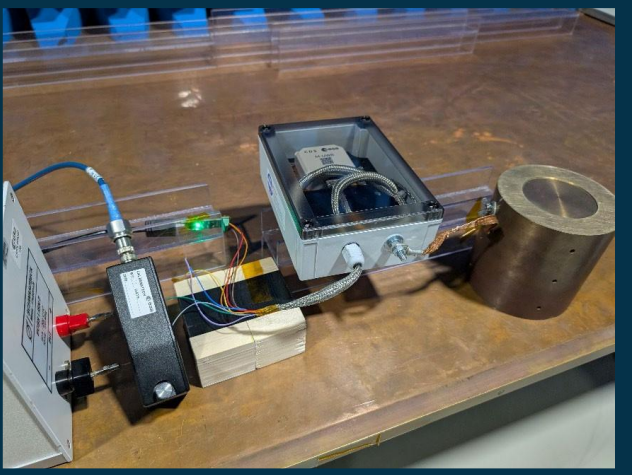

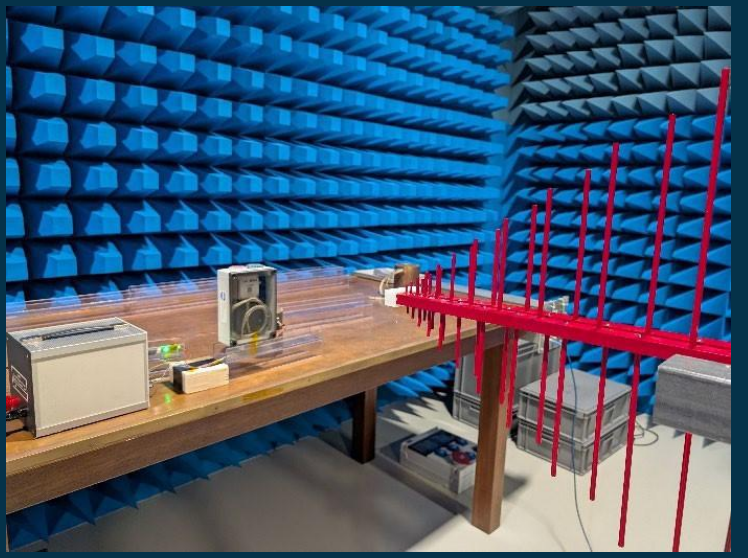

Conclusion

- **Vibration Testing** : The DUTs were subjected to sinusoidal and random vibration across all three axes. No structural damage, functional degradation, or resonance anomalies were observed. All mechanical test objectives were fulfilled in line with [MUWB-ENV-0040] through [MUWB-ENV-0080].
- **Thermal Vacuum Testing**: The DUTs successfully completed four thermal cycles between –35°C and +80°C under vacuum conditions (<1E-5 mbar). Functional testing during and after the cycles confirmed full operational stability. The test met all applicable thermal and pressure requirements, including [MUWB-ENV-0010] to [MUWB-ENV-0030].
- **EMC Testing:** The DUT was evaluated for both conducted and radiated emissions per ECSS-E-ST-20-07C and MIL-STD-461G standards. All measurements remained within specified limits, with expected intentional UWB transmission observed only at the carrier frequency. No spurious emissions or electromagnetic susceptibility issues were recorded.

Thanks for your time and attention.