ALSET - Japanese Air Launch System Concept and Test Plan

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ALSET[1)] is a Japanese government-funded (funded by METI[2)]) project, whose purpose is to study air launch orbital payload delivery systems and related technologies as a first step toward an operational commercial air launch system. Air launch has been selected instead of ground launch for the following primary reasons:

- ✓ To get rid of launch period restrictions for fishing right and to get improved safety by avoiding flight near and over occupied island
- ✓ To get flexibility of launch point selection to meet demand for various orbits
- ✓ To reduce total cost of ground operations achieved through decreased infrastructure

  (Telemetry station and command station → communication satellite, ranging station → GPS/INS)

[1)] ALSET: Air Launch System Enabling Technology

[2)] METI: Ministry of Economy, Trade and Industry

Air Launch System Technologies

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(1) Air launch system overall concept definition
(2) Air launch technology research and method selection
(3) Air launch system operations study
(4) GPS ranging and satellite-based TT&C study
(5) Low-cost and light-weight avionics study of launch vehicle

Air launch method selection:

(1) Air drop
(2) Subsonic horizontal launch
(3) Supersonic zoom launch

The air drop method has been selected for ALSET because of aircraft availability and minimal aircraft modification.

Overall Concept

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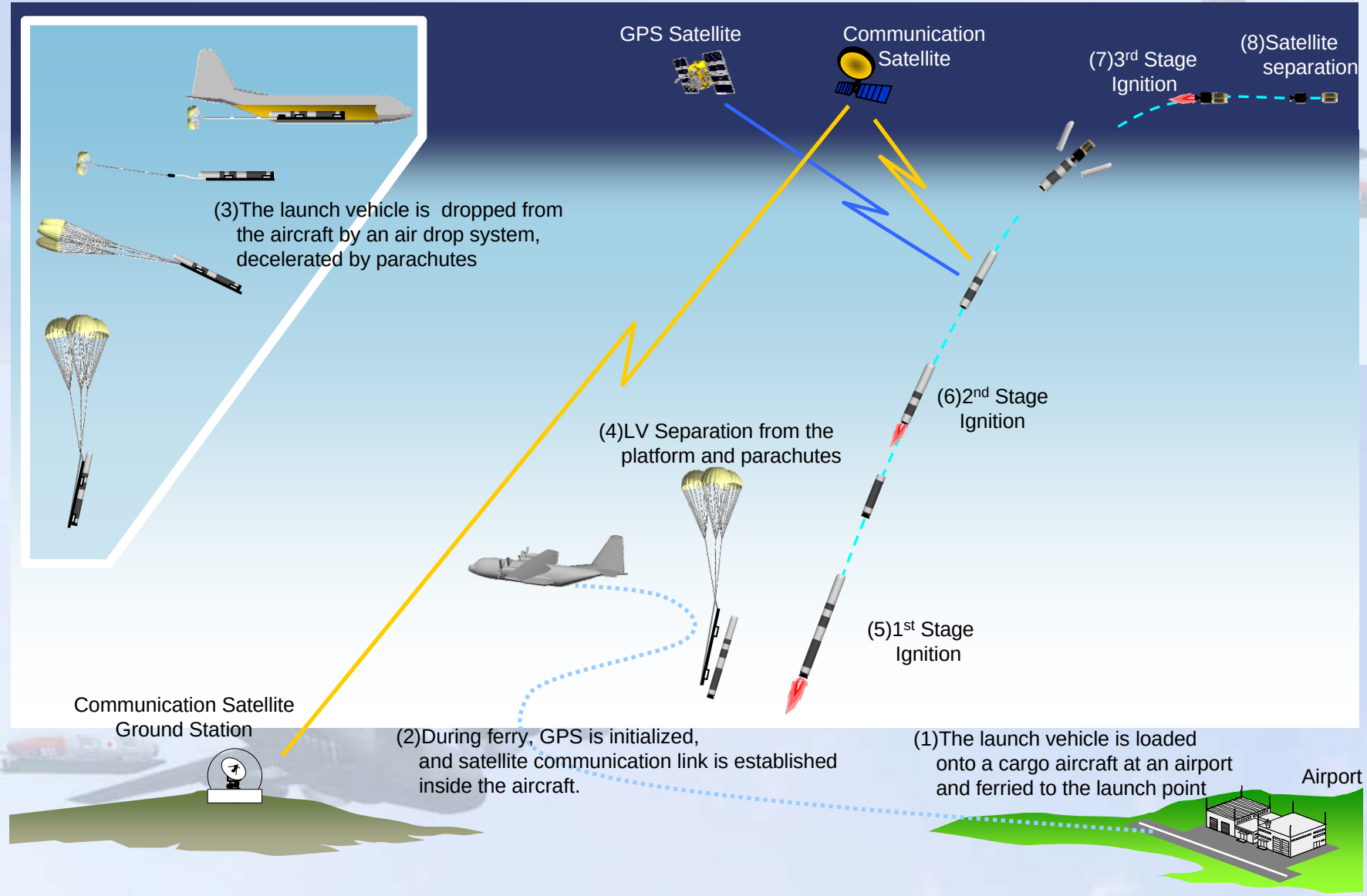
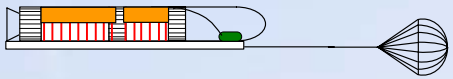
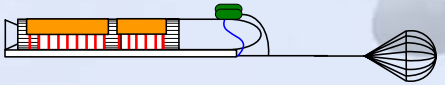
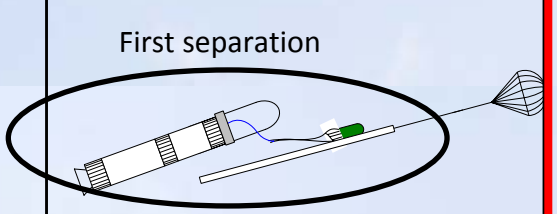
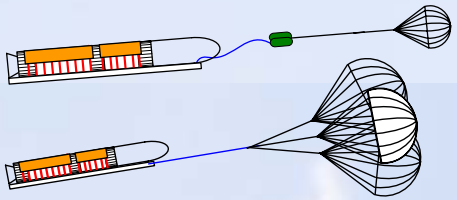
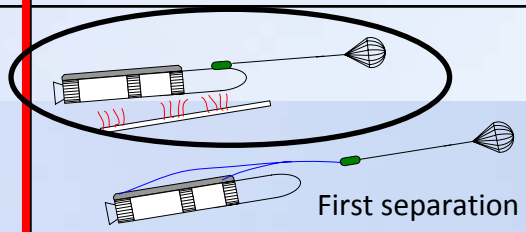
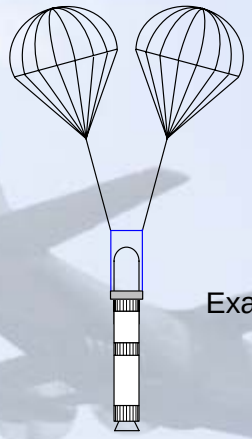
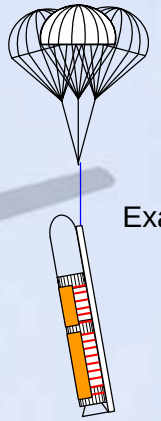
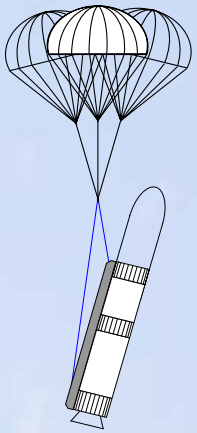
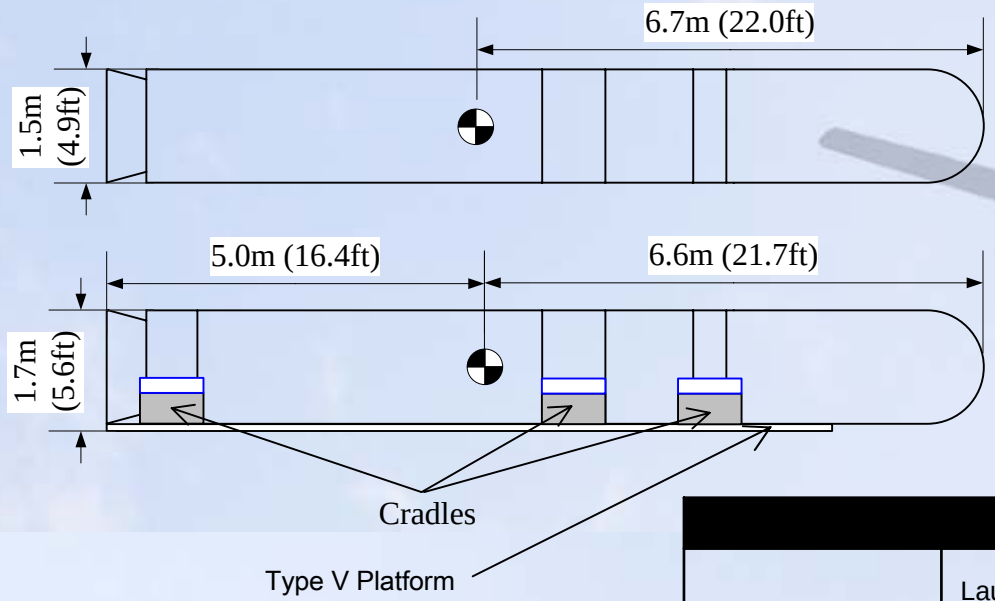


Air Drop System Selection

The SRALT, MRALT, LRALT and Raptor method has been selected and will be employed as assembly, loading and separation method because of lower probability of collision and simpler configuration.

Method	Minuteman, Altair, JDTV Type	SRALT, MRALT, LRALT, Raptor Type	Hoisting Attachment Type
Assembly Extraction			
Separation/ Deployment			
Attitude establishment Followed by Separation Before 1st stage ignition			
	- Separate twice - Using hoisting attachment	- Separate once - Using platform for loading point	- Separate twice - Using hoisting attachment

Launch Vehicle and CES Preliminary Design



CES: Carriage Extraction System
(Platform, parachutes and cradles)

<Target launch capability>
100 to 200 kilograms
into Low Earth Orbit (LEO)

Item			Value
Dimension	Launch Vehicle		ϕ 1.5 m x 11.6 m (ϕ 4.9 ft x 38.1 ft)
	Launch Vehicle and CES		1.7 m (H) x 2.7 m (W) x 11.6 m (L) (5.6 ft (H) x 8.9 ft (W) x 38.1 ft (L))
Mass	Launch Vehicle		16,500 kg (36,400 lb)
	Launch Vehicle and CES		19,000 kg (41,900 lb)
Center of Gravity	Launch Vehicle		6.7 m from the tip of the LV (22.0 ft)
	Launch Vehicle and CES		6.6 m from the tip of the LV (21.7 ft)
Moment of Inertia	Launch Vehicle	Ixx	4,744 kg-m^2 (112,577 lb-ft^2)
		Iyy	137,356 kg-m^2 (3,259,507 lb-ft^2)
		Izz	137,356 kg-m^2 (3,259,507 lb-ft^2)

Extraction and Deceleration System Preliminary Design

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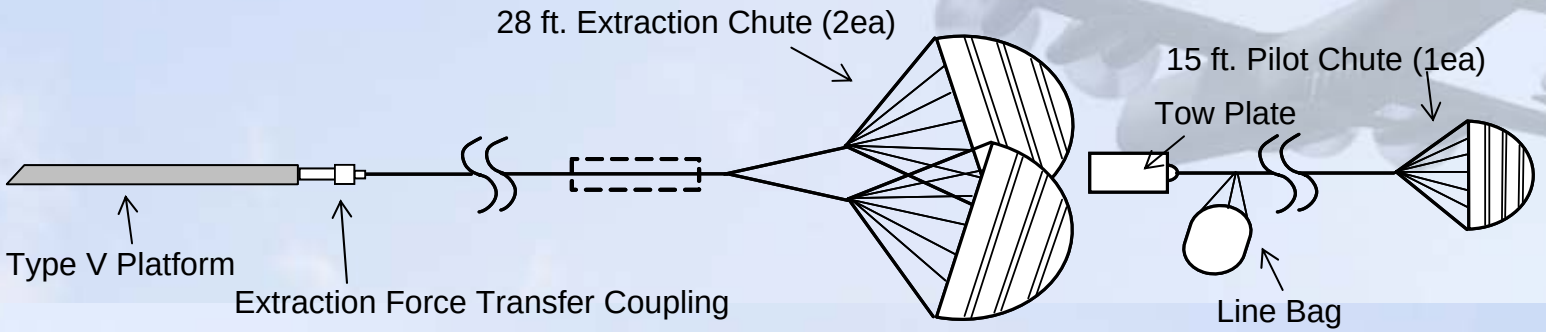
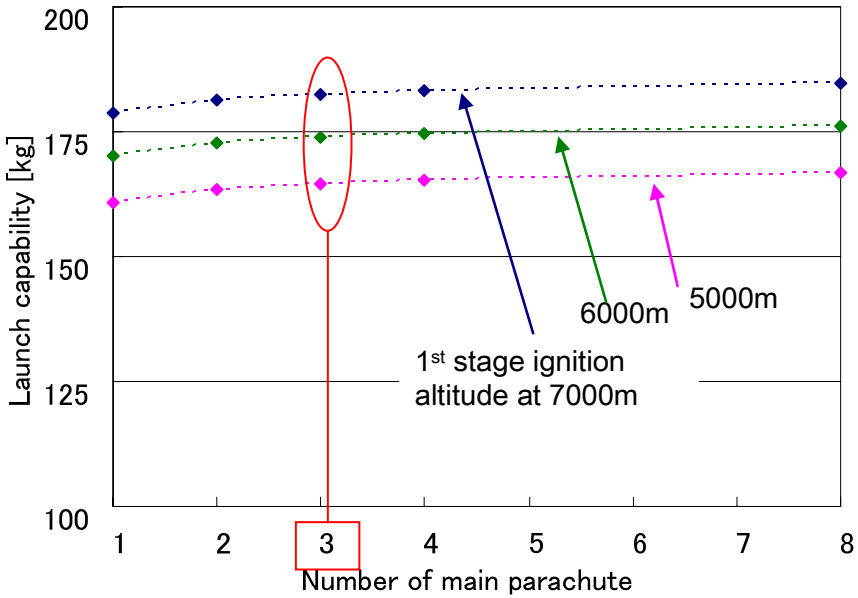
A 15-foot parachute is a pilot parachute to pull extraction parachute, tow plate is connection/separation instrument between aircraft and pilot parachute line, 28-foot parachutes are extraction parachutes, and EFTC is instrument to transfer force from extraction to deployment of cargo parachutes.

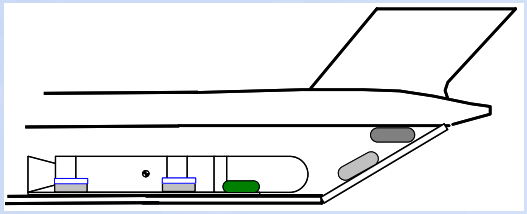


Right figure shows the sensitivity analysis results of number of main (cargo) parachutes (G-11, 100-foot flat parachute).

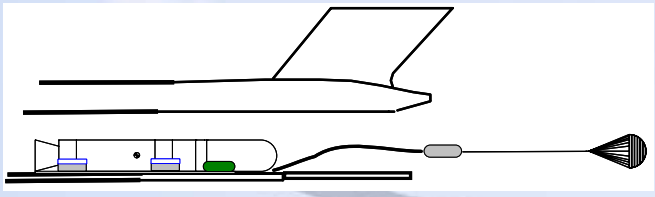
The nominal number of cargo parachutes is set to three because of small difference for launch capability between two through four parachutes.



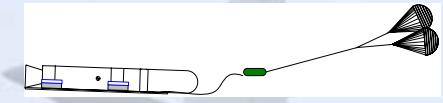
Sequence of Events



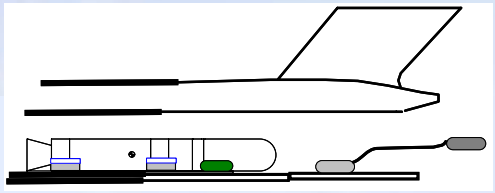
(1) Loading and ferry to the launch point



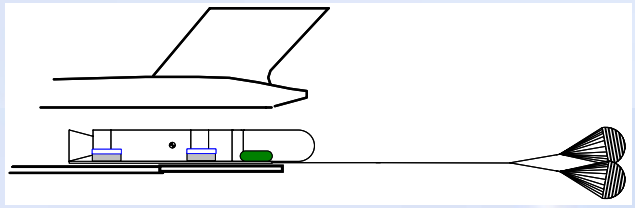
(4) Draw extraction chutes out



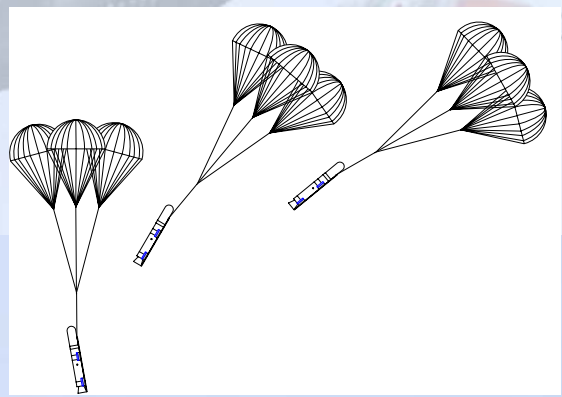
(7) Deploy cargo chutes



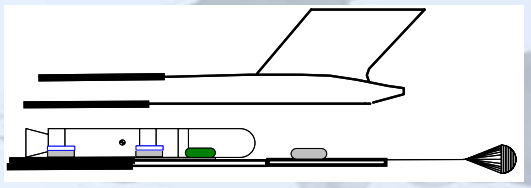
(2) Open the cargo door and release the pilot chute



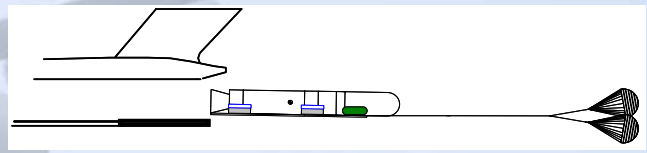
(5) Start extraction of LV and platform



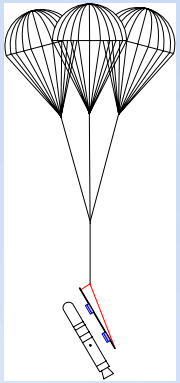
(8) Drop and decelerate



(3) Confirm the full opening of the pilot chute



(6) Complete extraction of LV and platform

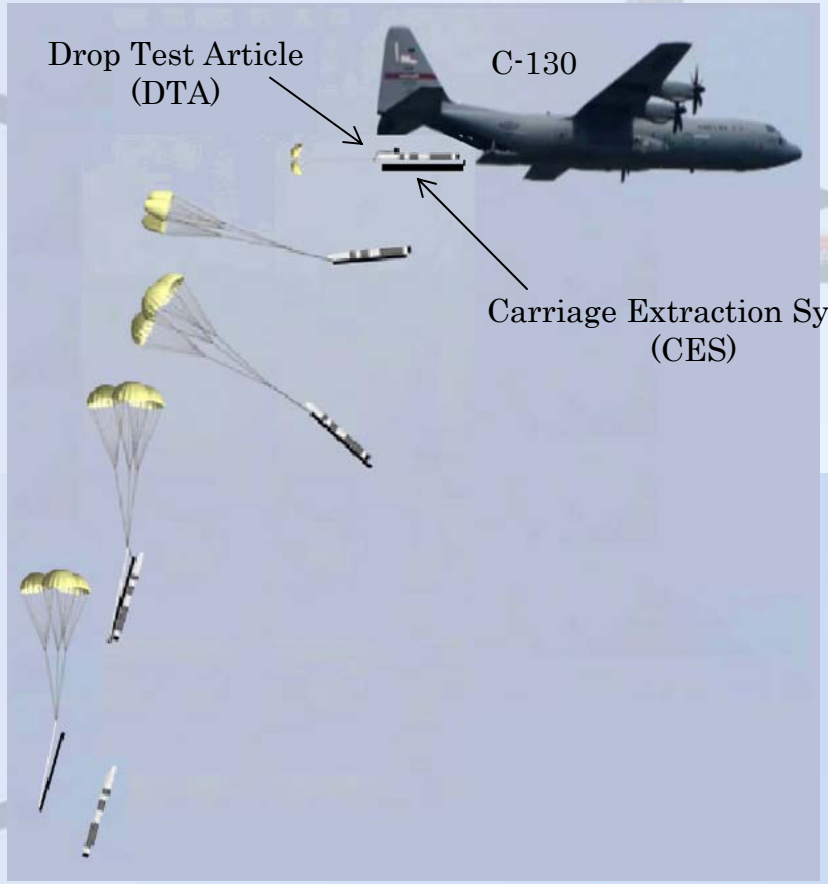


(9) LV separation

Drop Test Plan (1/2)

To demonstrate and evaluate air launch technologies, we plan to conduct an initial air drop test of an instrumented inert rocket in the United States, including extraction of the Drop Test Article (DTA) from the cargo aircraft, stabilization by cargo parachutes, and separation of the DTA from the CES.

The baseline drop test scenario is planned to be conducted at an altitude of 7,000 meters (23,000 feet). The C-130 E/H model has been selected, and Yuma Test Center (YTC) operated by the US Army in Arizona has been selected as a baseline.



Drop Test Plan (2/2)

The primary objective of the ALSET drop test is to verify that the designed air launch rocket and extraction system will descend stably and will separate as envisioned.

The objectives for drop test data collection broadly fall into four categories as follows:

1. Demonstrate the air drop sequence of events,
2. Collect engineering data on the dynamics of the air drop,
3. Collect environment data under which the test is conducted and
4. Collect photos and video

No.	Test Objective
1	**Demonstrate Sequence of Events**
1.1	Verify extraction start
1.2	Verify activation of EFTC
1.3	Verify cargo parachute bag release
1.4	Verify platform separation
2	**Collect Engineering Data**
2.1	Measure 3-axis angle
2.2	Measure 3-axis angular rate
2.3	Measure 3-axis angular acceleration
2.4	Measure 3-axis linear acceleration
2.5	Measure extraction force
2.6	Measure cargo parachute load
3	**Collect Environment Data**
3.1	Measure location
3.2	Measure atmospheric pressure
3.3	Measure atmospheric temperature
3.4	Measure wind velocity and direction
4	**Collect Still Photos and Video**
4.1	Take video images
4.2	Take photographic images

ALSET Drop Test Organization and Responsibilities

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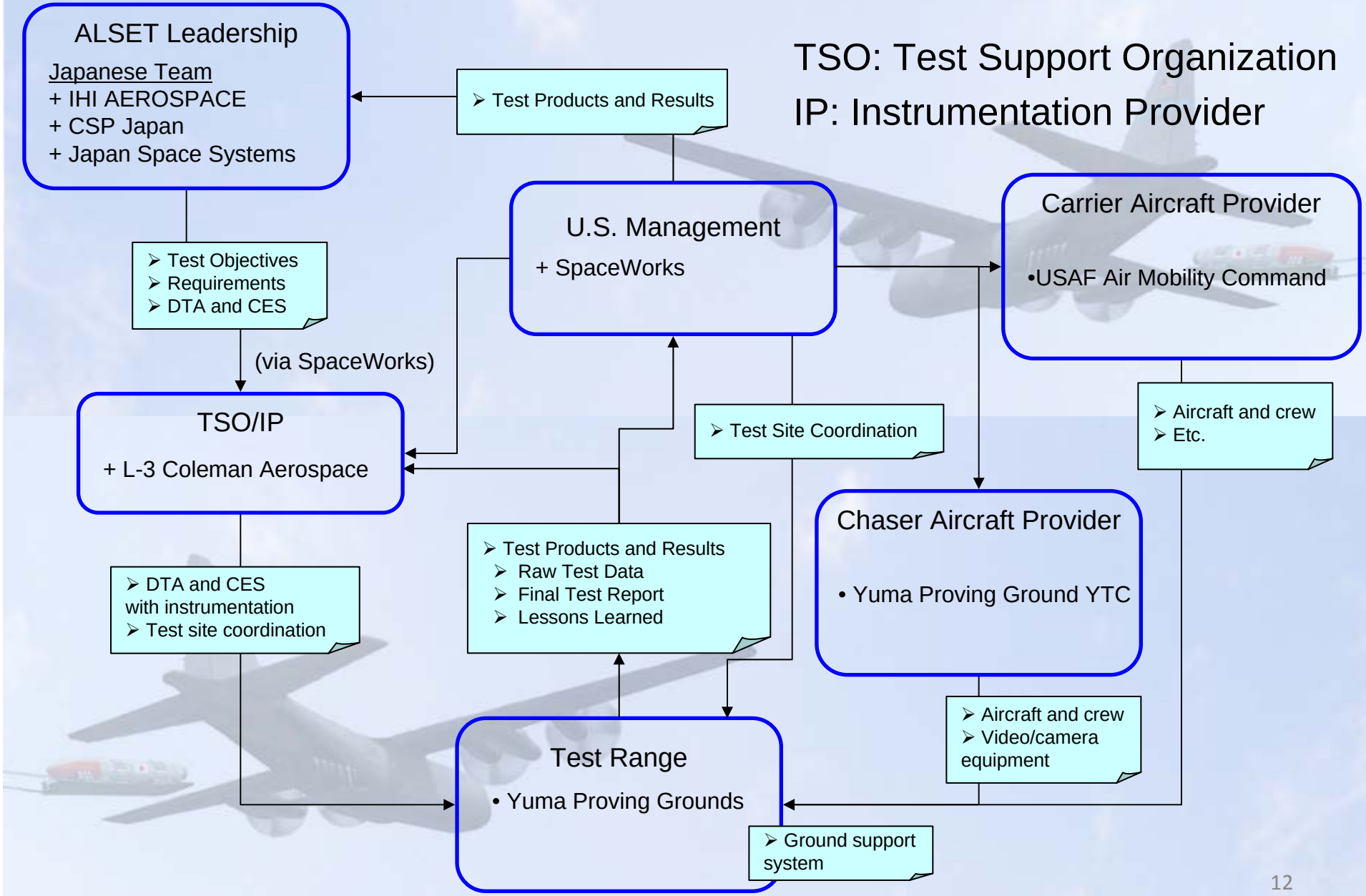

Conclusion

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For ALSET Project:

- ✓ Air drop type system
- ✓ SRALT type configuration
- ✓ Baseline sequence has been decided
- ✓ Concept design has been performed
- ✓ Test plan and organization/responsibilities