



to reduce development and operational costs by an order of magnitude.

**Enable rapid path to new ventures:** Leverage Blue Origin's unique breadth of suborbital and orbital capabilities, empowering startups with a faster path to de-risk and deploy innovative and disruptive commercial LEO ventures.



**Market-driven definition:** Determine likely markets through analysis of previous studies, interviews, demand-driven market analysis. Define market-based technical requirements (for example volume, cost, power, utilisation) that close a sustainable commercial business case.

**Investigate habitats:** Investigate habitats based on a combination of commercially available hardware and Blue Origin manufacturing capabilities, with innovations

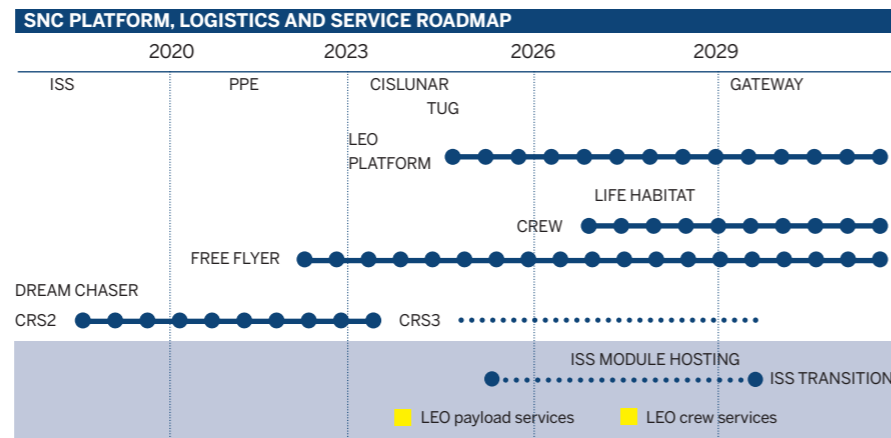
YEAR 1	YEAR 2	YEAR 3
● ATP	● SSR	● PDR ● CDR
● ACR		● PRR ● SVR
		● HFCR
MISSION 1 ●		
CONCEPT DEFINITION		
REQUIREMENTS DEFINITION		
PRELIMINARY DESIGN		
DETAILED DESIGN		
PRODUCTION PLANNING		
ASSEMBLY AND TEST		
LV INTEGRATION		

ACR Architectural concept review PRR Production readiness review SVR System verification review HFCR Human flight certification review



**Vision and approach:**

- Modify Dream Chaser Cargo for powered payload and crew configurations; up-mass, downmass, and human transport.
- LEO platform for long duration activities, capable of hosting partner modules or ISS elements with additional life past decommission.
- Modular, flexible, and reuse-oriented architecture with services focus, adaptive to future market directions.
- Utilise LEO as an integration point for all Cislunar activities in a hub and spoke network-reduce overall costs through economies of scale.



**Vision:** To make living and working in space commonplace as a means to sustained human deep space exploration and for the improvement of life on Earth.

**Approach:** Build, launch and operate a commercial space station to follow the ISS.  
**Imperatives:** Create a robust LEO market for

goods and services in space. Provide a sound and reliable transition from ISS to a commercial human rated platform for astronauts, research, manufacturing and other markets.

**Schedule**

**Phase 1 – 2020-2023:** Provide flight opportunities for commercial astronauts including mission planning, training, operations, logistics, utilisation and transportation.

**Phase 2 – 2023-ISS EOL:** Launch Axiom modules to ISS for early construction for Axiom Station.

Expand operations, crew, research, manufacturing and exploration capabilities. Gradual transfer of work and hardware on ISS to Axiom modules.

**Phase 3 – ISS EOL onwards:** Axiom Station operating independently following separation from ISS.



**Vision:** Lockheed Martin envisions a vibrant LEO marketplace with both domestic and international government and commercial customers.

**Approach:** Employ alternative business models that enable a transition from a government owned and operated platform to a lower cost commercial marketplace that maintains National Lab status for scientific pursuits, assured government access, and international partner objectives. Down select between a range of solutions for ISS evolution to better position for commercialisation of a habitable platform in LEO. Encourage private sector towards LEO

through stable government investments, streamlined process, and reliable launch cadence along with near term risk reduction demonstrations of new technologies that will catalyse activity in LEO (eg ISMA).



**Schedule:**

TASK/ACTIVITY	CALENDAR YEAR								
	2018	2019	2020	2021	2022	2023	2024	2025	
<b>Risk reduction</b>									
LM ISMA		ISMA planning	ISMA Ground Demo	ISMA Flight Demo		On ramp commercial applications			
MIS ZBLAN	In-space 3D print		ZBLAN flight Demo	ZBLAN extended flight demo					
LRI in-space vacuum deposition	Vacuum deposition flight demo			Variable mirror on-orbit production					
<b>Privatisation and Evolution</b>				Transition period				Commercial operations	

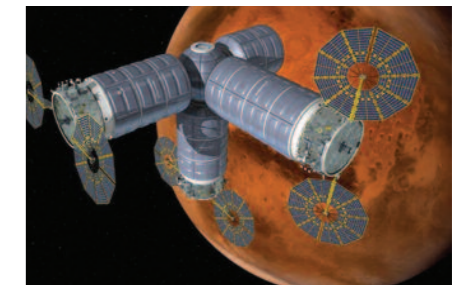


**Vision and approach:** Evolutionary roadmap using Northrop Grumman Innovation Systems' (NGIS) Cygnus, and Cygnus-derived vehicles, to develop a sustainable LEO market.

- **Long-Duration Cygnus:** Capable of operations and hosting of commercial payloads as an attached or free-flying module with flights of one year or more.
- **Augmentation Module:** Cis-lunar vehicle in formulation for NextSTEP-2 adapted for LEO operation with habitation, node, and logistics capabilities.
- **Augmenting ISS:** Optimise utilisation of the ISS by augmenting with AM capabilities with habitable space,

outfitting, checkout of cislunar systems, and as the first elements of a co-orbiting, complementary commercial platform.

- **NGIS Commercial LEO Station:** Augmentation Module-based commercial station to provide complementary services to ISS as a free-flying platform, and the basis for a future evolved commercial platform.



**Schedule:**



**Vision and approach:**

- Development of a set of commercial ecosystems comprising repurposed upper stages from multiple providers, to ensure market resiliency.
- The technique of reusing existing on-orbit hardware enables a lowering of prices, and an opening of access to a broader array of commercial customers.
- Nanoracks does not seek a "killer app" but rather facilitating a "killer ecosystem"
- Multiple outposts, multiple orbits, crewed and uncrewed, attached and detached from ISS.

orbital tests and function as basic science platforms.

**2022 – 2025:** Technical concept reaches maturity; multiple uncrewed platforms in orbit conducting commercial activities with full ecosystem of services; crewed platforms



performing tourism and other commercial astronaut functions.

**NANORACKS PROJECTED SCHEDULE – CENTAUR SPECIFIC**

Demo / Op	Upper Stage	Crewed	2019	2020	2021	2022	2023	2024	2025
Demo	Centaur 3	Uncrewed							
Demo	Centaur 3	Uncrewed							
Op	Centaur 3	Uncrewed							
Demo	Centaur 5	Uncrewed							
Op	Centaur 5	Uncrewed							
Op	Centaur 3	Crewed							
Op	Centaur 5	Crewed							
Op	Centaur 5	Crewed							
Op	Centaur 5	Crewed							