#### Manned Systems

### Briefing

Dragon is a fully autonomous, reusable capsule designed to initially deliver cargo to the International Space Station (ISS) at low earth orbit (LEO) and ultimately crews of astronauts to the facility. The capsule can be used for a variety of mission applications, including highly responsive payload hosting; sensors/apertures up to 3.5 meters in diameter; instruments and sensor testing; spacecraft deployment; space physics and relativity experiments; radiation effects research; microgravity research; life science and biotech studies; earth sciences and observations: materials and space environments research; rendezvous and inspection; and robotic servicing.

A prototype of the spacecraft—the Dragon C1 completed a demonstration flight aboard a Falcon 9 rocket on December 8, 2010. Previously, a structural model of the capsule had been used as the dummy payload for the maiden launch of the Falcon 9 on June 4, 2010. Since 2010, three Dragon missions have been launched, including Dragon C2 (May 22, 2012), which docked with ISS for the first time, and two commercial ISS resupply services flights-Dragon CRS-1, and

## Executive

SpaceX Corp. 1 Rocket Road Hawthorne, CA 90250 tel: +1 (310) 363-6000 fax: +1 (310) 363-6001 (owner & operator)



CRS-2, CRS-3, CRS-4, CRS-5 and CRS-6 on October 8, 2012; March 1, 2013; April 18, 2014; September 21, 2014; January 10, 2015; and April 14, 2015 respectively. The CRS-7 mission attempted on June 28, 2015 failed when its Falcon 9 v1.1 launch vehicle experienced an overpressure anomaly in its upper stage and exploded about 139 seconds into flight.

#### **Recent Developments**

The 27<sup>th</sup> Dragon resupply capsule (CRS-25) was successfully launched to the ISS July 15, 2022 aboard a Falcon 9 v1.2 rocket from Cape Canaveral, FL. It carried a payload mass of 2,630 kg. The next Dragon resupply mission (CRS-26) to the ISS is scheduled for November 18, 2022. It will carry the iROSA 1A and iROSA 3B solar arrays, produced by Boeing.

# Manufacturers

SpaceX Corp. 1 Rocket Road Hawthorne, CA 90250 tel: +1 (310) 363-6000 fax: +1 (310) 363-6001 (prime contractor)

# **Specifications**

Mass (dry):	4,200 kg
Height (with Trunk):	7.2 m
Diameter:	3.7 m
Mission duration:	1 wk - 2 yr
Command uplink:	300 Kbp/s
Telemetry/data downlink:	300 Mbit/s
Volume	
Total launch payload:	25 m <sup>3</sup>
Return launch payload:	11 m <sup>3</sup>
Spacecraft payload:	11 m <sup>3</sup>
Trunk payload:	14 m <sup>3</sup>
Payload launch capacity:	6,000 kg
Payload return capacity:	3,000 kg

\* 34 m<sup>3</sup> with extended trunk

## **Subsystems**

#### Frame

The capsule is made up of three primary segments: the Nosecone, which provides pro- tection during ascent; the Space- craft, which houses the pressur-	ized cargo and eventually the crew, along with the service sec- tion which contains the avionics, the reaction control system (RCS), parachutes, and other	support infrastructure; and the Trunk, which provides stowage for unpressurized cargo and sup- port for the solar arrays and thermal radiators.
The Dragon capsules have	and Falcon 9 v1.1 rockets, built	will be used for future Dragon
been launched by Falcon 9 VI.0	by <u><i>Spaces</i></u> . The Falcon 9 v1.2	missions.
Guidance & Control		
Attitude control and maneu-	thyl hydrazine fuel and nitrogen	flight computer system consists
vering is provided by 18 Draco	tetroxide oxidizer. generate 400	of three pairs of computers.
thrusters, built by SpaceX. The	newtons of force. They have a	
thrusters, which run on monome-	multiple start capability. The	
Power		
Twin solar panels generate an		
average of 1,500 watts of electri-		

cal power; 4,000 watts at peak.

# Launch History

Date	Payload	Mass	Launch Vehicle	Orbit	Launch Site
Mission 1					
12/08/10	Dragon C1	4,900 kg	Falcon 9 v1.0	low earth	Cape Canaveral AFS
Mission 2					
05/22/12	Dragon C2	6.650 kg	Falcon 9 v1.0	low earth	Cape Canaveral AFS
Mission 3		-,g			
10/08/12	Dragon CRS-1	6 650 kg	Falcon 9 v1 0	low earth	Cape Capaveral AFS
10/00/12	Orbcomm-NG 1	142 kg		low cartin	Cape Canaverar Ar C
Mission 4		5			
03/01/13	Dragon CRS-2	6 650 kg	Falcon 9 v1 0	low earth	Cape Canaveral AES
Mission 5	Bragon onto 2	0,000 kg			
04/18/14	Dragon CPS 3	6 650 kg	Ealcon 0 v1 1	low oarth	Capa Capavoral AES
04/10/14	KiekSet 1	0,000 kg		low earth	Cape Canaveral AFS
		5.5 Kg			
	SporeSat 1	5 kg			
	TechCube 1	4 kg			
	LMRSat	2 kg			
	TestSat-Lite (TSAT)	2 kg			
	Hermes 2	1 kg			
	Phonesat 2.5	1 kg			
	Sprite 1 – Sprite 104	.01 kg (ead	ch)		
Mission 6					
09/21/14	Dragon CRS-4	6,650 kg	Falcon 9 v1.1	low earth	Cape Canaveral AFS
	ISS-RapidScat	589 kg			
	Spinsat	57 Kg			
Mission /					
01/10/15	Dragon CRS-5	6,650 kg	Falcon 9 v1.1	low earth	Cape Canaveral AFS
	Dove 98 (Flock-1d' 1)	494 Kg 5 kg			
	Dove 99 (Flock-1d' 2)	5 kg			
	AESP-14	1 kg			
Mission 8		0			
04/14/15	Dragon CRS-6	6 650 kg	Falcon 9 v1 1	low earth	Cape Canaveral AFS
	Dove 100 (Flock-1e 1)	5 kg			
	Dove 101 (Flock-1e 2)	5 kg			
	Dove 102 (Flock-1e 3)	5 kg			
	Dove 103 (Flock-1e 4)	5 kg			
	Dove 104 (Flock-1e 5)	5 kg			
	Dove 105 (Flock-1e 6)	5 kg			
	Dove 106 (Flock-1e 7)	5 kg			
	Dove 107 (Flock-1e 8)	5 kg			
	Dove 109 (Flock-1e 10)	5 kg			
	Dove 110 (Flock-1e 11)	5 kg			
	Dove 111 (Flock-1e 12)	5 kg			
	Dove 112 (Flock-1e 13)	5 kg			
	Dove 113 (Flock-1e 14)	5 kg			
	Arkyd-3R	4 kg			
	Centennial 1	1 kg			
Mission 9					
06/28/15*	Dragon CRS-7	6,650 kg	Falcon 9 v1.1	low earth	Cape Canaveral AFS
		521 kg			
	Dove 114 (Flock-1f 1)	5 kg			

Page 4	
--------	--

	Dove 115 (Flock-1f 2)	5 kg			
	Dove 116 (Flock-1f 3)	5 kg			
	Dove 117 (Flock-1f 4)	5 kg			
	Dove 118 (Flock-1f 5)	5 ka			
	Dove 119 (Flock-1f 6)	5 kg			
	Dove $120$ (Flock-1f 7)	5 kg			
	Dove 121 (Flock-1f 8)	5 kg			
Mission 10		ong			
		C CEO ka	Falaan 0 v1 2	low oorth	Cana Canavaral AFS
04/06/16	BEAM	0,000 Kg 1 360 kg	Faicon 9 VI.2	low earth	Cape Canaveral AFS
Mission 11	DEAM	1,000 Kg			
		0.050 km		laur a anth	
07/18/16	Dragon CRS-9	6,650 Kg	Falcon 9 V1.2	low earth	Cape Canaveral AFS
	IDA 2	525 KY			
Mission 12					
02/19/17	Dragon CRS-10	6,650 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
	STPSat-5 (Houston 5)	200 kg			
	SAGE III	76 kg			
Mission 13					
06/03/17	Dragon CRS-11	6,650 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
	NICER	372 kg			
	ROSA	325 kg			
	MUSES	305 kg			
	Bird B (BRAC Onnesha)	1 kg			
	Bird G (GhanaSat 1)	1 kg			
	Bird J (Toki)	1 kg			
	Bird M ((Mazaalai)	1 kg			
	Bird N ((Nigeria EduSat 1)	1 kg			
Mission 14	(( ) )	0			
08/14/17	Dragon CRS-12	6 650 ka	Falcon 9 v1 2	low earth	Cane Canaveral AES
00/14/11	CREAM	1 258 kg	1 410011 0 11.2	low cartin	
	Kestrel Eve 2M	1,200 kg			
		12 kg			
	ASTERIA	12 Kg			
		TU Kg			
	031813-30	Эку			
Mission 15					
12/15/17	Dragon CRS-13	6,650 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
		363 kg			
	Space Debris Sensor (SDS)	25 kg			
Mission 16					
04/02/18	Dragon CRS-14	6,650 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
	MISSE-FF 1	435 kg			
	ASIM	330 kg			
	PFCS	107 kg			
	RemoveDEBRIS (RemDeb)	100 kg			
	DebrisSat 1	50 kg			
	DebrisSat 2	50 kg			
	RemDeb Net	20 kg			
	UBAKUSAT	4 kg			
	1KUNS-PF	1 kg			
	Irazú (Batsú-CS 1)	1 kg			
Mission 17		~			
16/29/18	Dragon CRS-15	6 650 kg	Falcon 9 v1 2	low earth	Cape Capaveral AFS
00/23/10	FCOSTRESS	100 kg			Cape Canaveral Aro
	Riarri-Squad 1	400 kg A ka			
	Biarri Squad 2	4 kg			
		4 kg			
	Dialiti-Squau S	4 KY			
	Dird DTN (DLuter 4)	1			

# Dragon

	Bird MYS (UiTMSAT 1) Bird PHL (MAYA 1)	1 kg 1 kg			
Mission 18		-			
12/05/18	Dragon CRS-16 GEDI RRM3 UNITE	6,650 kg 4 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
	TechEdSat 8 (TES) CAT (CATsat) 1 CAT (CATsat) 2	2.5 kg			
	Delphini (AUSAT) 1 Quantum Radar 1 Quantum Radar 2	1 kg			
Mission 19					
05/04/19	Dragon CRS-17 Red-Eye 1 (Pinot) OCO 3 STP-H6	6,650 kg 100 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 20					
07/25/19	Dragon CRS-18 IDA 3 ORCA RFTSat 1 Quantum Radar 3 NARSScube 2	6,650 kg 526 kg 1kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 21					
12/05/19	Dragon CRS-19 HISUI CIRIS MiniCarb (CNGB) SORTIE VPM	6,650 kg 500 kg 6 kg 8 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
	CryoCube 1 QARMAN (QB50 BE05) AztechSat 1 EdgeCube MakerSat 1	4 kg 1 kg 1 kg 1 kg			
Mission 22					
03/07/20	Dragon CRS-20 Bartolomeo (CEPHFISS) Lynk 4 (Lynk the World) Gundam Satellite Quetzal (Guatesat) 1	6,650 kg 500 kg 10 kg 3 kg 1 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 23					
12/06/20	Dragon CRS-21 Nanoracks Bishop Airlock	6,650 kg 1,050 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 24					
06/03/21	Dragon CRS-22 iROSA 2B iROSA 4B Gundam Satellite RamSat SOAR MIR-Sat 1	6,650 kg 600 kg 600 kg 3 kg 2 kg 2 kg 1 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 25					
08/29/21	Dragon CRS-23 IOD-AMBER	6,650 kg 6 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS

	CAPSat SPACE-HAUC CUAVA PR_CuNaR 2 Maya 3 Maya 4 Binar 1	4 kg 4 kg 3 kg 3 kg 1 kg 1 kg 1 kg			
Mission 26					
12/31/21	Dragon CRS-24 STP-H7 STP-H8 DAILI Light 1 PATCOOL TARGIT GASPACS GT 1 FEES 2	6,650 kg n/a n/a 6 kg 3 kg 3 kg 3 kg 1 kg 1 kg 0.3 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS
Mission 27					
07/15/22	Dragon CRS-25 EMIT BeaverCube CLICK A D3 JAGSAT 1 CapSat 1 FUTABA HSU-SAT 1 TUMnanoSAT	6,650 kg n/a 3 kg 2 kg 2 kg 1 kg 1 kg 1 kg 1 kg	Falcon 9 v1.2	low earth	Cape Canaveral AFS

\* launch failure

# **Contract Briefs**

Date	Source	Value	Details
Space Explorat	ion Technologies		
08/18/06	NASA	\$278,000,000	Phase I contract for the Commercial Orbital Transportation Ser- vices (COTS) developmental program to provide commercial re- supply services to the International Space Station. Contract condi- tioned on meeting all specified milestones.
12/23/08	NASA	\$1,600,000,000	Commercial Resupply Services 1 (CRS-1) contract to provide 12 resupply flights to the International Space Station carrying a mini- mum of 20,000 kg.
04/18/11	NASA	\$75,000,000	Phase II contract for the Commercial Crew Development 2 (CCDev 2) program to develop an ISS crew transportation vehicle.
01/14/16	NASA	\$1,500,000,000*	Commercial Resupply Services 2 (CRS-2) contract extension to provide seven resupply flights to the International Space Station through 2024.
10/16/20	NASA	_	Commercial Resupply Services 2 (CRS-2) contract extension to provide two resupply flights to the International Space Station through 2024.
03/25/22	NASA	_	Commercial Resupply Services 2 (CRS-2) contract extension to provide six resupply flights to the International Space Station through 2026.

Estimated cost of a Dragon flight is \$150 million.

# **Teal Group Evaluation**

The first launch of the Dragon on December 7, 2012 was a demonstration flight meant to test its systems in space and be recovered in the ocean. By all accounts, it was a successful mission. The big test for the capsule, however, took place on May 22, 2012 when it rendezvoused and docked with ISS to deliver supplies. That was the first operational flight, and it was successful, opening the way for Dragon commercial resupply services (CRS) missions-27 of which have been completed. One of the commercial missions ended in failure. Among the key tests during the maiden docking flight was to determine if the capsule's robotic systems were able to abort docking activities in the event of a malfunction or

Dragons have been used to carry payloads for the following

**Past Customers** 

agencies, companies, organizations, or universities: NASA

# Launch Forecast

(payload units)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Dragon	3	3	3	3	3	3	3	—	—	

problem. As it approaches ISS, Dragon must be able to automatically orient itself and place itself in a position to be grappled and hauled in by the station's Canadarm2 robotic arm. It is hard to overemphasize the importance of the first Dragon docking with ISS—both to NASA and the United States, as it represented the first time a commercial US robotic capsule had ever flown to the station. Up to until then, these types of missions had been reserved for the Space Shuttle and Russia's Soyuz and Progress capsules.

The success of the first docking flight did nothing less than mark the beginning of an entirely new era for spaceflight. It began the transition from a time when NASA-owned and -operated vehicles dominated the space industry to one in which private companies with their own rockets and capsules lead the way in providing access to space and creating new markets... driven by both the technological challenges and the profit motive. Over the past decade, SpaceX has been focused on delivering cargo to ISS, essentially eliminating US dependency on Russia's Progress supply capsule. As of last year, the company has begun also transporting astronauts to and from the station, eliminating NASA's dependency on Russian Soyuz rockets and capsules for that function as well. That's where SpaceX's human-rated variant of Dragon called "Dragon V2" has filled the need.

\* Teal Group estimate

