TIROS SPACE INFORMATION
NEWS BULLETIN
68TH IAC ADELAIDE 2017

Vol. 41 No.11, August 2016
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Launch costs (via In The Black, June 2016)

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The *Tiros Space Information (TSI) - News Bulletin* is published to promote the scientific exploration and commercial application of space through the dissemination of current news and historical facts.
In doing so, Tiros Space Information continues the traditions of the Western Australian Branch of the Astronautical Society of Australia (1973-1975) and the Astronautical Society of Western Australia (ASWA) (1975-2006).
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Calling card...

Remember that during the 1990s, we saw a splurge of proposals for large constellations of satellites for communications and Earth observations. Most of these proposals fell by the wayside because the market for such commercial services was not big enough. Only a few proposals, such as Iridium and Orbcomm, reached an operational status.
At that time these proposals also gave rise to a number of proposed launch vehicles that were to place this large number of satellites into orbit. Like the satellite proposals, the majority if these launch vehicles never saw the light of day.

These days we once again see proposals for such communications and Earth resources constellations but, with the size of such satellites these days, the range of proposals for new launch vehicles is not apparent this time, indicating that the current range of launch vehicles is expected to be able to cope with these large numbers.

Add to this the fact that, based on a report by Goldman Sachs Global Investment Research, the per kg cost to launch a payload has come down in the last five years and the financial feasibility for large constellations to provide services becomes more evident.

The report, referred to in the Australian CPA's *In The Black* of June 2016, states the "Space launches now cost 11 times less than five years ago" and "Satellites can cost 100 times less. Our ability to get to space has changed more in the last five years than during the entire prior period of space exploration"
The researchers further predict that costs could plummet by 90% again in the next five years.

Jos Heyman

V band constellation

Boeing has suggested that regulators relax constraints on low-orbiting satellite broadband constellations operating in the C- and V-band.
In particular Boeing referred to a network comprising 1396 to 2956 V-band satellites that would operate from an altitude of 1200 km.
The first deployment of 1396 satellites, would have these satellites placed in 35 planes orbiting at 45^{o} inclination relative to the equator, and six planes at 55^{o}.
At a later stage the remaining 1560 satellites would be launched, adding 12 more planes at 55^{o} inclination at the same 1200 km orbit, and 21 planes inclined at 88^{o} and orbiting at 1000 km in altitude.
Boeing does not intend to be the operator of such a constellation.

East-Asian natural disaster monitoring

The Japanese Hokkaido University and Tohoku University will establish a network of 50 microsatellites for monitoring natural disasters in the East Asian region. In particular the Philippines, Vietnam, Indonesia, Malaysia, Myanmar, Bangladesh, Thailand and Mongolia have joined the project.

The satellites will be about 50 kg each and will be fitted with cameras with a resolution of 3 to 5 m. They will be launched with Japanese launch vehicles or deployed from ISS. The network is expected to be established by 2020.

Electron

Planet (formerly known as Planet Labs) has ordered three Electron launches to place between 20 to 25 Flock or Dove Earth observation satellites in orbit on each launch. Each of these satellites has a mass of about 5 kg.

The Electron launch vehicle is being developed by Rocket Lab., a US/New Zealand company. Whilst the first launch of the Electron launch vehicle has not yet taken place, Planet expects the satellites to be in a sun-synchronous orbit by the second quarter of 2017.

Iridium Next

The first 10 of 81 Iridium Next mobile communications satellites are expected to be launch on 11 September 2016 with a Falcon 9 from Vandenberg. Each satellite has a mass of 860 kg
A second batch of 10 is scheduled for December 2016 with another five launches of 10 each following at two months' intervals. The operational constellation requires a total of 66 satellites, with 11 in six orbital planes.
The 81 satellites are being built by Thales Alenia Space.

Satellite Update

Launches in June 2016

Int.Des.	Name	Launch date	Launch vehicle	Country	Notes
1998 067JX	Flock 2e-11	1-Jun-2016	ISS	USA	Earth Observ
1998 067JY	Flock 2e-12	1-Jun-2016	ISS	USA	Earth Observ
1998 067JZ	Flock 2e'-09	1-Jun-2016	ISS	USA	Earth Observ
1998 067KA	Flock 2e'-10	1-Jun-2016	ISS	USA	Earth Observ
1998 067KB	Flock 2e'-11	2-Jun-2016	ISS	USA	Earth Observ
1998 067KC	Flock 2e'-12	2-Jun-2016	ISS	USA	Earth Observ
2016 034A	GEO IK 2-2	4-Jun-2016	Rokot/Briz KM	Russia	Geodetic
2016 035A	Intelsat-31	9-Jun-2016	Proton M/Briz M	Intelsat	Communications
2016 036A	Orion-7	11-Jun-2016	Delta 4 Heavy	USA	Signal intell.
2016 037A	Beidou 2-G7	12-Jun-2016	CZ 3C	China	Navigational
2016 038A	Eutelsat 117 West-B	15-Jun-2016	Falcon 9 v.1.2	Eutelsat	Communications
2016 038B	ABS-2A	15-Jun-2016	Falcon 9 v.1.2	Hong K	Communications
2016 039A	BRISat	18-Jun-2016	Ariane 5ECA	Indones.	Communications
2016 039B	Echostar-18	18-Jun-2016	Ariane 5ECA	USA	Communications
sub-orbital	New Shepard Test-5	19-Jun-2016	New Shepard	USA	Test
2016 019B	Lemur-2 Bridgeman	21-Jun-2016	Cygnus Orb-6	USA	Communications
2016 019C	Lemur-2 Dr Muzz	21-Jun-2016	Cygnus Orb-6	USA	Communications
2016 019D	Lemur-2 Nate	21-Jun-2016	Cygnus Orb-6	USA	Communications
2016 019E	Lemur-2 Cubecheese	21-Jun-2016	Cygnus Orb-6	USA	Communications
failed	Lemur-2 (?)	21-Jun-2016	Cygnus Orb-6	USA	Communications
2016 040A	Cartosat-2C	22-Jun-2016	PSLV XL	India	Earth Observ
2016 040B	SathyabamaSat	22-Jun-2016	PSLV XL	India	Technology
2016 040C	SkySat-3	22-Jun-2016	PSLV XL	USA	Technology
2016 040D	GHGSat-D	22-Jun-2016	PSLV XL	Canada	Technology
2016 040E	Lapan A-3	22-Jun-2016	PSLV XL	Indones	Technology
2016 040F	BIROS/BeeSat-4	22-Jun-2016	PSLV XL	Germany	Technology
2016 040G	M3MSat	22-Jun-2016	PSLV XL	Canada	Technology
2016 040H	Flock 2p-6	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040J	Swayam	22-Jun-2016	PSLV XL	India	Technology
2016 040K	Flock 2p-11	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040L	Flock 2p-2	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040M	Flock 2p-9	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040N	Flock 2p-4	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040P	Flock 2p-10	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040Q	Flock 2p-8	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040R	Flock 2p-12	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040S	Flock 2p-7	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040T	Flock 2p-5	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040U	Flock 2p-1	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 040V	Flock 2p-3	22-Jun-2016	PSLV XL	USA	Earth Observ
2016 041A	MUOS-5	24-Jun-2016	Atlas V-551	USA	Communications
2016 042A	DFFC	25-Jun-2016	CZ 7	China	Technology
2016 042B	Aoxiang Zhixing	25-Jun-2016	CZ 7	China	Technology
2016 042C	Tiange Feixingqi-1	25-Jun-2016	CZ 7	China	Technology
2016 042D	Tiange Feixingqi-2	25-Jun-2016	CZ 7	China	Technology
2016 042E	Aolong-1	25-Jun-2016	CZ 7	China	Technology
2016 042F	ZGZ Shiyan Zhuangzhi	25-Jun-2016	CZ 7	China	Technology
2016 043A	SJ-16-2	29-Jun-2016	CZ 4B	China	Scientific

Other updates

Int. Des.	Name	Notes
1998 067GG	Flock 1e-4	Re-entered 24 June 2016
1998 067GK	Flock 1e-8	Re-entered 22 June 2016
1998 067GL	Flock 1e-5	Re-entered 20 June 2016
2015 076A	Soyuz TMA-19M	Re-entered 18 June 2016
2016 019A	Cygnus Orb-6	Re-entered 22 June 2016

Rosetta

ESA's Rosetta mission will end on 30 September 2016 with the landing of the spacecraft on the core of comet 67P/Churyumov-Gerasimenko.

Launched on 2 March 2004 and arriving at the comet on 6 August 2014, it has been observing the comet as it cruised into the inner solar system to a point where it was a mere 186 million km from the Sun. The comet is now on an orbit that will take it to the outer solar system, beyond Jupiter, over a period of 6.6 years. At that distance the power systems of Rosetta would not provide sufficient power to operate. Rosetta was not designed for a landing.

Juno

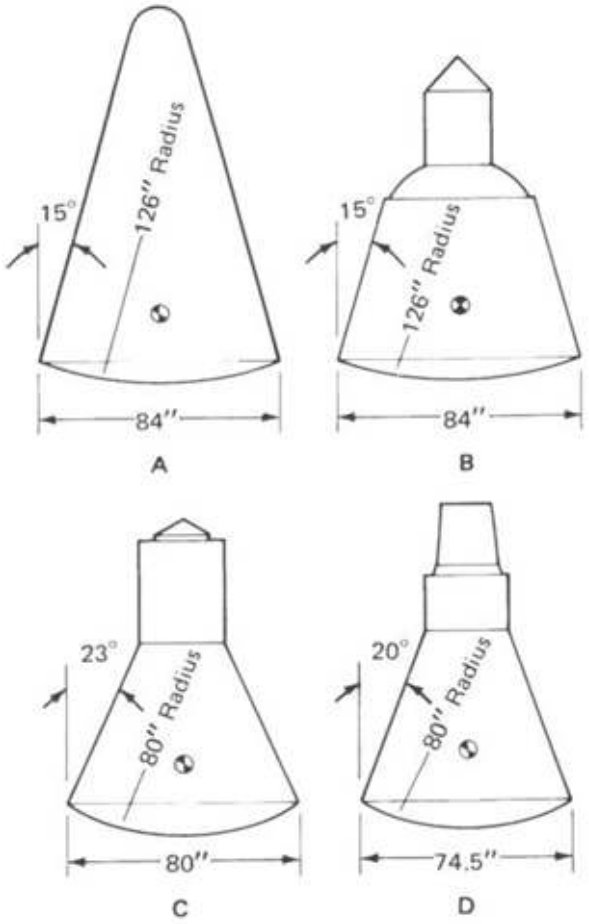
On 4 July 2016 NASA successfully placed the Juno spacecraft in an orbit around Jupiter.
Launched on 5 August 2011, Juno has been travelling a distance of 2.7 billion km since then with an ultimate speed of 209,200 km/hour
Over the next 54 days the spacecraft will lower its orbit to a 5000 km orbit lasting 14 days to begin its science phase that will lasts 16 months.

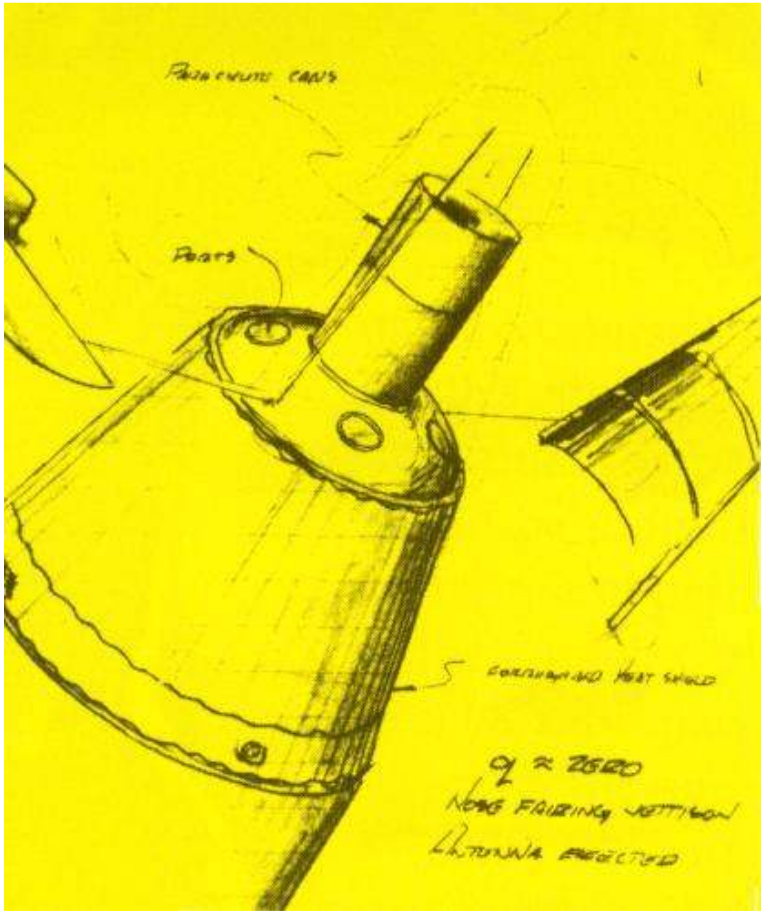
Cancelled Projects: Mercury proposals

By Jos Heyman

Although the McDonnell built Mercury spacecraft is not a cancelled spacecraft, after all nine were launched between 29 July 1960 and 1 May 1963, there were several designs by competing aerospace companies that were rejected by NASA and as such, represents cancelled projects for those companies.

To get towards the Mercury spacecraft a NASA Space Task group headed by Max Faget and Caldwell Johnson, studied various configurations and eventually proposed a blunt capsule to be launched by an Atlas rocket. This shape allowed the spacecraft to re-enter the atmosphere by creating a shock wave in front of the heatshield.





Eventually this led to a cone-shaped design with a cylindrical top that contained the parachute. On top of this there was to be an escape system, should there be problems during the launch.

The preliminary specifications were sent to forty companies on 23 October 1958. Of these thirty-eight companies attended a bidder's conference at Langley on 7 November 1958.

By mid-November 1958 nineteen companies had expressed their interest and were provided with further specifications dated 14 November 1958.

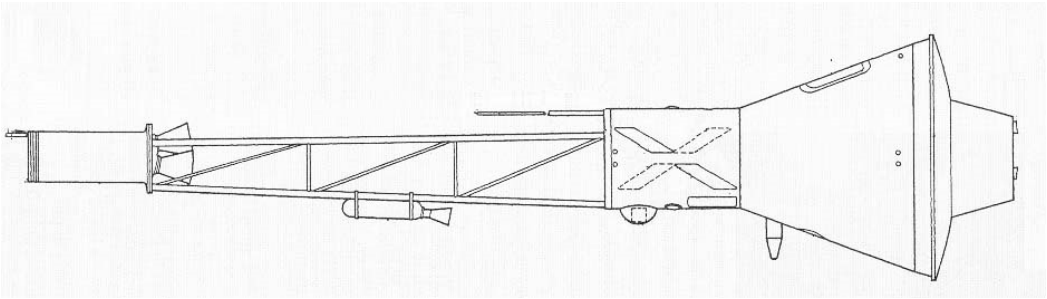
By 11 December 1958 eleven of these companies submitted their bids. They were Avco, Convair, Lockheed, McDonnell, Martin, North American, Northrop, Republic, Douglas, Grumman and Chance Vought. A twelfth company, Winzen Research, submitted an incomplete late bid, that was also accepted.

The latter company had built balloons in the 1950s and 1960s that were used by the US Navy in its Projects Helios, Skyhook, and Strato-Lab. It also built high altitude balloons for the US Air Force for use in Project Manhigh and for a secret reconnaissance mission, called Moby Dick, to overfly the Soviet Union.
Two leading companies that did not submitted bids were Boeing and Bell, which were busy with the X-20 Dyna Soar project.

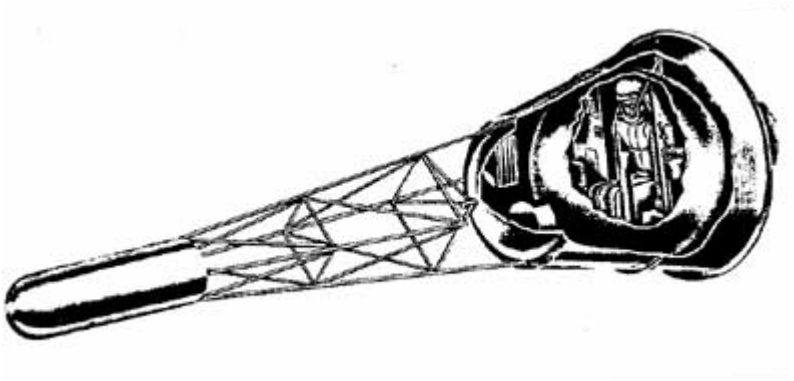
Of these four were eliminated before the proposals went to the Management, Cost and Production Assessment Committee that eliminated another four leaving the final selection of two contenders to a Source Selection Board. These two contenders were Grumman and McDonnell. In January 1959 McDonnell was selected as the primary contractor.

Details of the not successful proposals are rare, possibly as a result of the short time frame in which the proposals had to be submitted as well as the fact that NASA had more or less specified the configuration. In the selection process this configuration was strictly adhered to and, for instance, the Martin submission that featured a nose mounted escape system that fired along the side of the spacecraft was dropped in the early selection as this design violated the NASA specification for separate escape and retro-rocket motors.

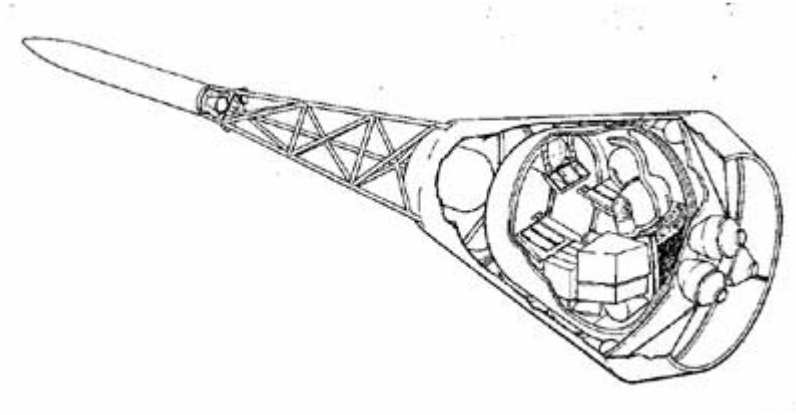
The following illustrations have been tracked down from various sources.



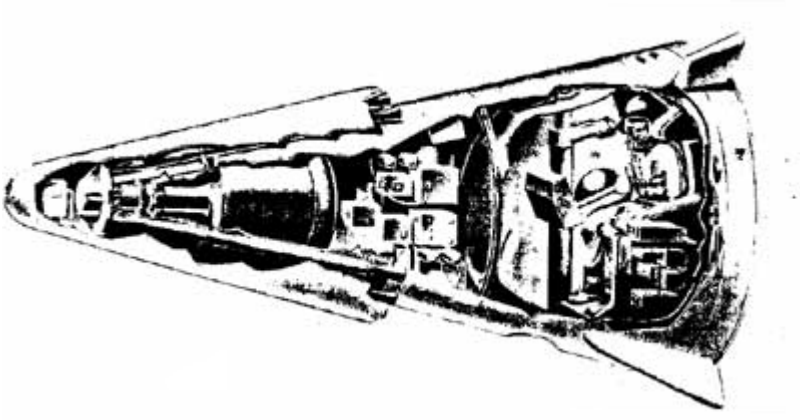
Lockheed CL-434



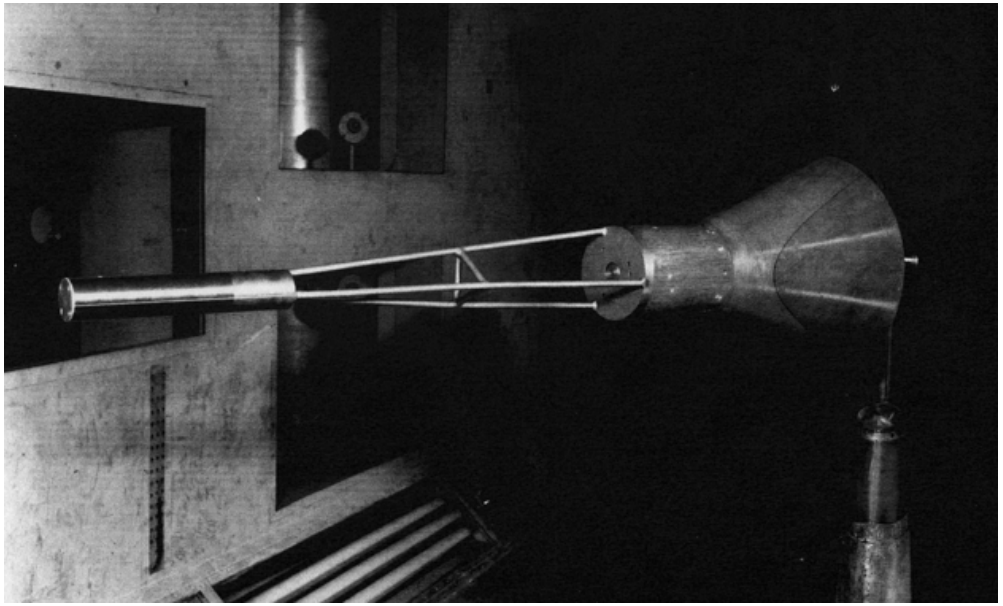
Avco



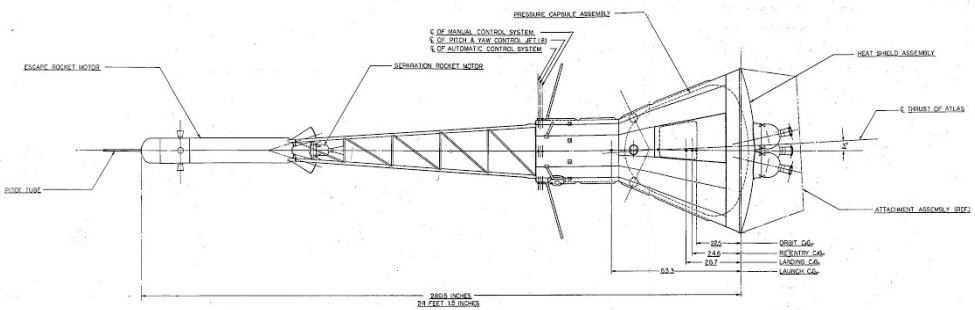
Douglas



Martin



Grumman G-214



Northrop N-227

As far as the other submissions are concerned, it is known that the Vought submission was identified as V-426. No details have been found concerning the North American, Republic, Convair and Winzen submissions.

<u>References:</u>
Catchpole, J., Project Mercury, Chichester 2001, p.152
Day, Dwayne A, Mercury Rising, Spaceflight September 2002, p. 384.
Chong, T., The Might-Have-Been Mercury - The Grumman G-214

SES/O3b

Luxembourg based SES communications satellite operator has acquired O3b, a rival that operates communications satellites at a lower orbit.
The O3b network of communications satellites provides high-speed, low-cost, low-latency Internet and telecommunications services using 12 Ka band transponders. Through local gateways the services reached the end-users within the 45º latitude north and south of the equator, an area with insufficiently connected markets in Latin America, Africa, the Middle East, Asia and the Pacific and a collective population of over 3 billion people.

The name ‘O3b’ stands for "[The] Other 3 Billion", referring to the population of the world where broadband Internet is not available without help. O3b Networks, a Jersey based company with operating headquarters in The Netherlands, currently operates a network of twelve 700 kg satellites built by Thales Alenia and they were placed in 8063 km circular equatorial orbits from which orbit local gateways were within reach of each satellite for 3 hours each day, giving a full 24 coverage with 8 satellites.

Vector 1

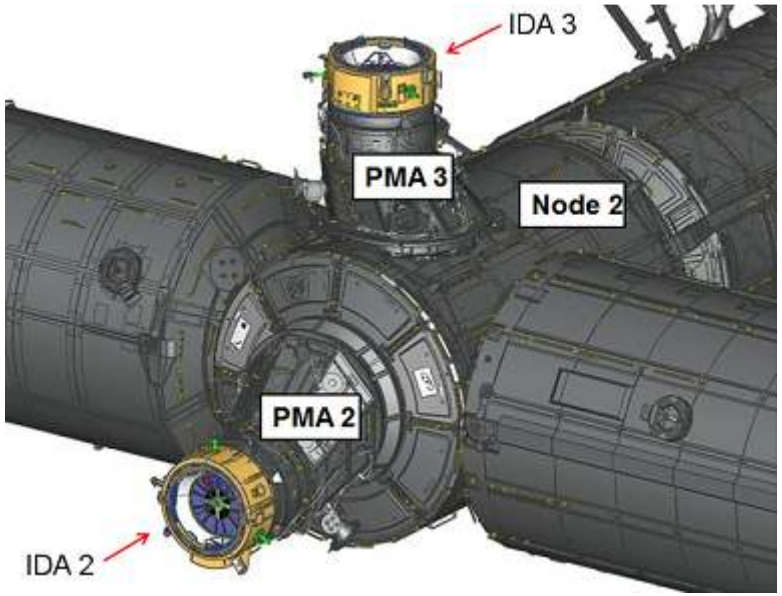
Vector Space Systems of Tucson, Arizona, hopes to conduct the first launch of its Vector 1 launch vehicle in 2018.
Aimed at the micro satellite market, the two stage launch vehicle will be capable of placing 45 kg payloads into a low-inclination orbit and 25 kg into a 400 km polar orbit.
Based on the work by Garvey Spacecraft Corp., a California company that had been working on a small launch vehicle for some time, the Vector 1 will have a length of 12 m and a diameter of 1.1 m. It is intended to recover and re-use the first stage which will be recovered by parachute.
A sub-orbital test of the second stage engine has been scheduled for 30 July 2016 and will be conducted from an amateur rocket site in the Mojave Desert. A further test will take place in September 2016 from Kodiak in Alaska followed by further sub-orbital tests during 2017. Three orbital test launches are planned for 2018 and another 12 for 2019.

Audacy

Audacy, a Silicon Valley start up company, plans to develop a communications network that will support up to 2000 cubesats in Earth orbit. The Audacy network will consist of three satellites and two ground stations and is expected to be operational by 2019, provided the funding can be raised.

IDA-2

The Dragon CRS-9 cargo spacecraft that docked with the Harmony module of ISS on 20 July 2017, brought the International Docking Adapter (IDA)-2 to the space station.



IDA locations

This is the first of two IDAs that will allow the future Boeing CST-1200 Starliner and the SpaceX Crew Dragon spacecraft to dock with ISS simultaneously. Having been built to international standards, the two IDAs feature built-in systems for automated docking and uniform measurements, meaning any spacecraft, including Russian and any future spacecraft, can be docked at those ports.

It is intended that the space station's robotic arm will pick IDA-2 from the spacecraft on 16 August 2016 following which, on 18 August 2016, astronauts Williams and Rubins will perform an EVA to install the new docking port on the PMA-2 port of the Harmony module.

IDA-1, a similar docking module, was lost on 28 June 2015 when the Dragon CRS-7 cargo spacecraft failed to achieve orbit.
A replacement IDA has been ordered from Boeing and is expected to be delivered in 2018. IDA-3 will be located at the PMA-3 port.

Falcon 9 1st stage recovery

Following the launch of Dragon CRS-9 the first stage of the Falcon 9 launch vehicle was successfully recovered at the Cape Canaveral Landing Zone.

The following table lists the 1st stage recoveries to date.

Mission	Date	Launch site	Recovery site	Notes
Cassiope-1 etc	29-Sep-2013	Vandenberg	Descent test only	Partial failure
Dragon CRS-3 etc	18-Apr-2014	Cape Canaveral	Descent test only	Failed
Orbcomm FM-109 etc	14-Jul-2014	Cape Canaveral	Descent test only	Successful
Dragon CRS-4	21-Sep-2014	Cape Canaveral	Descent test only	Successful
Dragon CRS-5	10-Jan-2015	Cape Canaveral	Atlantic Ocean barge	Failed
DSCOVR	11-Feb-2015	Cape Canaveral	Atlantic Ocean barge	Cancelled
Dragon CRS-6	14-Apr-2015	Cape Canaveral	Atlantic Ocean barge	Failed
Orbcomm FM-114 etc	22-Dec-2015	Cape Canaveral	Cape Canaveral	Successful
Jason-3	17-Jan-2016	Vandenberg	Pacific Ocean barge	Failed
SES-9	4-Mar-2016	Cape Canaveral	Atlantic Ocean barge	Failed
Dragon CRS-8	8-Apr-2016	Cape Canaveral	Atlantic Ocean barge	Successful
JC Sat-14	6-May-2016	Cape Canaveral	Atlantic Ocean barge	Successful
Thaicom-8	27-May-2016	Cape Canaveral	Atlantic Ocean barge	Successful
Eutelsat 117 W-B etc	15-Jun-2016	Cape Canaveral	Atlantic Ocean barge	Failed
Dragon CRS-9	18-Jul-2016	Cape Canaveral	Cape Canaveral	Successful

Separately SpaceX conducted eight Grasshopper and three Falcon 9R-Dev tests at its McGregor facility in Texas.