Space Activities in 2015

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Preface

In this paper I present some statistics characterizing astronautical activity in calendar year 2015. In the 2014 edition of this review, I described my methodological approach and some issues of definitional ambguity; that discussion is not repeated here, and it is assumed that the reader has consulted the earlier document, available at http://planet4589.org/space/papers/space14.pdf (This paper may be found as space15.pdf at the same location).

Orbital Launch Attempts

During 2015 there were 87 orbital launch attempts.

	2009-2013 Average	2014	2015
USA	19.0	24	20
Russia	30.2	32	26
China	14.8	16	19
France		*11*	*12*
Japan		*4*	*4*
India		*4*	*5*
Israel		*1*	*0*
N Korea		*0*	*0*
S Korea		*0*	*0*
Iran		*0*	*1*
Other	15.0	20	22
Total	79.0	92	87

There were three Arianespace-managed Soyuz launches from French Guiana which are counted as French. The IXV/AVUM Vega launch reached orbit and is so counted, although it was erroneously neither UN-registered nor given an international designation.

2015 saw the long-awaited first flight of the new generation of Chang Zheng (Long March) launch vehicles. The CZ-5/6/7 family, based on LOX/kerosene core stages, is expected to replace the N2O4/UDMH-based CZ-2/3/4 family. The smallest of the new family, the CZ-6, orbited a cluster of small satellites in September. A new solid fuel small launch vehicle, the CZ-11, made its first flight a week later. 2016 is expected to see the first flight of the heavy CZ-5 rocket and the orbital inauguration of the Hainan spaceport.

Launch failures

There were five orbital launch failures during the year, tabulated below. To evaluate average launch vehicle reliability I allocate each launch a score between 0.0 (total failure) and 1.0 (success). Failures which nevertheless reach orbit get an intermediate score.

The Proton failure came almost exactly a year after a previous identical failure. Investigation revealed a well-hidden design issue which linked the two failures to a third one all the way back in 1969.

A Soyuz-2-1A rocket reached the intended orbit on Apr 28 but coupled vibrations in the payload and third stage caused an explosion at the time of payload separation, wrecking the propulsion system of the Progress M-27M cargo ship. Payload separation is generally considered to be part of the launch process and, if unsuccessful, is counted by me as a launch failure. Earlier Progress launches used the Soyuz-FG and Soyuz-U rockets with the 11S510 third stage; this launch and the successful Progress M-25M used the Soyuz-2-1A with the 14S54 third stage. The switch to a new third stage was done without adequate study of the changes to Progress/stage interaction.

The Falcon 9 rocket suffered its first failure on Jun 28 when an internal structural failure in the second stage caused its destruction shortly before the end of the first stage burn. The Dragon cargo ship was destroyed.

The new Super Strypi all-solid launch vehicle flew in the first orbital attempt ever launched from Hawaii, but its flight ended rapidly when the vehicle started coning and broke up. At this writing there has been no official word on the cause of the failure. The rocket was developed as part of an experimental USAF program and I suspect the project is unlikely to continue.

In December the second flight of the Soyuz-2-1V reached orbit and successfully released a small passive calibration satellite, Kosmos-2512, into a 684 x 693 km orbit. However the primary payload, the Kosmos-2511 (Kanopus-ST) Earth observation satellite, did not separate from the upper stage payload adapter. The upper stage made a planned orbit lowering burn to reduce orbital life at the end of the launch sequence; it seems that the satellite finally did separate due to aerodynamic forces in a low 104 x 564 km orbit shortly before reentry on Dec 8.

2014 Orbital Launch Failures

Designation	Date	LV State	LV	Payload	Type of failure	Launch Score
2015-F01	May 16	Russia	Proton-M/Briz-M	MexSat-1	Stage 3 underburn, impact Russia	0.00
2015-024	Apr 28	Russia	Soyuz-2-1A	Progress M-27M	Explosion during payload sep	0.30
2015-F02	Jun 28	USA	Falcon 9	Dragon CRS-7	Stage 2 destroyed during stage 1 burn	0.00
2015-F03	Nov 4	USA	Super Strypi	Hiakasat/ORS-4	Off course during stage 1, destroyed	0.00
2015-071	Dec 5	Russia	Soyuz-2-1V	Kosmos-2511	Primary payload sep failed	0.44

Commercial Launches

Of the 87 orbital launch attempts, 47 were carried out by governments; 25.5 by commercial companies under contract to their host governments, and 19.5 for commercial customers, including foreign governments.

I count the CZ-6 and CZ-11 launches as Chinese government launches; their payloads were mostly small unversity-developed satellites, but the management and funding appears to have been as part of government space programs.

Launch provider	Launches	Type	Customers
US Launch providers			
ULA/Boeing Delta 2	1	CSP	US Gov
ULA/Boeing Delta 4	2	CSP	US Gov
ULA/LM Atlas 5	9	CSP	8 US Gov, 1 Comm
SpaceX Falcon 9	7	FCS	4 US Gov, 3 Comm
USAF Super Strypi	1	GOV	1 US Gov
European Launch providers			
Arianespace Vega	3	FC?	3 Eur gov.
Arianespace Ariane 5	6	FC	1 Eur gov, 5 comm/for.
Arianespace Soyuz	3	FC	3 Eur gov
Russian Launch providers			
Kosmotras Dnepr	1	FC	1 Comm
ILS Proton	4	FC	4 Comm
Khrunichev Proton	4	GOV	4 Ru.gov (of which 3 semi-comm)
Khrunichev Rokot	2	GOV	2 Ru.gov
Roskosmos Soyuz	9	GOV	9 Ru.gov (civil)
VVKO Soyuz	5	GOV	5 Ru.gov (military)
Roskosmos Zenit	1	GOV	1 Ru.gov
Chinese Launch providers			
CALT CZ-3B/3C	9	GOV	7 Chinese gov, 1 comm, 1 foreign
CALT CZ-6	1	GOV	Chinese gov
CALT CZ-11	1	GOV	Chinese gov
SBA CZ-2D/4B/4C	8	GOV	Chinese gov
Other Launch providers			
MHI H-IIA/B	4	CSP	3 Japan gov, 1 comm
ISRO/Antrix PSLV/GSLV	5	GOV+FC	3 In.gov, 2 Comm
IRSA Safir	1	GOV	1 Iranian gov

Here GOV = Government; CO = Commercial operation; CM = Commercial manufacture; CSP = Commercial service provision to government; FCS = Fully commercial service (but customers may include govt); FC = Fully commercial (no govt involved); A = Amateur, academic, non-profit. See the 2014 document for full discussion.

Satellite Launch Statistics

2013 and 2014 saw a dramatic increase in the numbers of satellites deployed, thanks to the launch of several clusters of cubesats. The 219 satellites launched in 2015 include 115 with masses above 100 kg.

Failures to reach orbit are not included here. 14 satellites launched in 2014 and deployed from ISS in 2015 are counted in the 2014 totals. 20 satellites currently aboard ISS are included in the 2015 totals.

	Payloads launched			
	2012	2013	2014	2015
USA	35	85	110	94
Russia	22	29	34	27
China	25	17	26	43
Other	50	75	85	55
Total	132	206	255	219

Let us break this down by class for 2015 (first the launch powers, then other countries). In 2015 the satellites launched were owned by 24 countries and three European organizations: ESA, the European Union and EUMETSAT.

2015 payloads launched, by owner country and class					
	A Academic/NonProfit	B Business/Commercial	C Civil	D Defense	Total
USA	10	58	6	20	94
China	22	4	7	12	45
Russia	0	3	13	11	27
ESA/EU/EUM	0	0	10	0	10
Japan	1	0	1	2	4
India	0	0	3	1	4
AR Argentina	0	1	0	0	1
AU Australia	0	1	0	0	1
BR Brazil	1	1	1	0	3
CA Canada	0	2	0	0	2
DK Denmark	1	1	0	0	2
F France (+EUTELSAT)	0	1	0	0	1
I Italy	0	0	0	1	1
ID Indonesia	0	0	1	0	1
IR Iran	0	0	1	0	1
KR S Korea	0	0	1	0	1
LA Laos	0	0	1	0	1
MC Monaco	0	0	1	0	1
MX Mexico	0	2	1	0	3
N Norway	0	1	0	0	1
SA Saudi Ar.	0	1	0	0	1
SG Singapore	4	2	0	0	6
TR Turkey	0	0	1	0	1
UK	1	6	0	0	7
Total	40	84	48	47	219

Most countries build only very small (cubesat) satellites, purchasing their larger satellites from one of the main space powers. Here I tabulate the manufacturers of 2014 satellites with masses of 100 kg or more. HSF is 'Human spaceflight', including related robotic missions such as cargo ships to support ISS. 'Surv.' is surveillance, including early warning and space debris surveillance; visible and radar imaging recon satellites and weather sats are under 'Imaging'. Microgravity research and planetary probes are included under Sci (Science). Satellites built in the UK, France, Germany, Italy, Spain and the Netherlands are lumped together as 'Europe' to reflect the integration of the western European aerospace industry.

2014 payloads by manufacturer country - 100 kg and up only									
	HSF	Comms	Imaging	Nav	SIGINT	Surv.	Sci	Tech	Total
USA	3	23	0	3	2	0	6	1	38
Russia	9	8	5	0	0	1	0	0	23
Europe	0	9	5	6	0	0	1	1	22
China	0	5	8	4	0	0	1	2	20
Japan	1	1	2	0	0	0	0	0	4
India	0	2	0	1	0	0	1	0	4
Singapore	0	0	2	0	0	0	0	0	2
Argentina	0	1	0	0	0	0	0	0	1
S Korea	0	0	1	0	0	0	0	0	1

Scientific Space Programs

The major atmospheric science payload launched in 2015 was SMAP, NASA's Soil Moisture Active/Passive mission which carried a radiometer and a radar; however, the radar failed on Jul 7, compromising the mission. Four NASA Magnetospheric Multiscale Spacecraft were launched on a single Atlas rocket into elliptical Earth orbit to perform joint studies of the magnetosphere. NOAA's DSCOVR probe was launched to the Earth-Sun L1 point to perform an operational space weather monitoring mission. However, for the time being I continue to classify space weather studies as scientific rather that meteorological, despite their quasi-operational nature. Similarly problematic are the LEMUR satellites launched by the commercial company Spire, which perform GPS-radio-occultation meteorology. Although the results are meteorological, unlike traditional weather satellites the payloads do not take images and it doesn't make sense to me to lump them with payloads like Meteosat and GOES. I am tentatively defining a new MET-RO category for such satellites.

Three significant astronomy payloads were launched in 2015. The long-awaited ASTROSAT is India's first space observatory, and features the capability to make simultaneous measurements in a very broad waveband stretching from the ultraviolet through X-ray to gamma-ray. China's Wukong (DAMPE) satellite is a particle physics experiment measuring the energy spectrum of cosmic rays. ESA's LISA Pathfinder mission is testing technology for a future multi-spacecraft observatory that would study gravitational waves.

Military Space Activities

Military satellites include navigation, communications, and technology development missions in addition to the intelligence gathering activities that I report here.

Editorial comment: Further shady geostationary activities

In my 2014 report I noted the secretive mission of the US GSSAP satellites. In 2015, US defense sources noted, with a show of alarm, the orbital manuevers of Russia's 2014-launched Luch (Olimp-K), which made multiple relocations in GEO and may have come close to payloads of other countries. While this concern is legitimate, it's a bit strange that US officials would complain about this given that the US itself has several spacecraft performing analogous secretive GEO orbital relocations and maneuvers; the PAN and CLIO satellites are in this category as well as the GSSAP missions. In the spirit of the UN registration convention, orbital behaviour of ALL such satellites, both US and Russian, should be reported publicly, promptly and accurately.

Reconnaissance and Signals Intelligence

In 2015 Japan carried out the launch of both radar and optical imaging satellites to replenish its spy constellation.

As in 2014, Russia launched a single Kobal't-M recoverable imaging satellite (Kosmos-2505), which flew a 104-day mission from Jun to Sep. The third Persona digital imaging satellite was launched to a 700 km orbit in March. The first new-generation Bars-M cartography satellite (Kosmos-2503) went up, as well as the first Kanopus-ST ocean surveillance mission (Kosmos-2511), which failed.

The only dedicated US spy satellite launch of 2015 was the USA 264 mission, which placed two payloads in 1100 km orbit to perform ocean surveillance electronic intelligence. The program is thought to be codenamed INTRUDER, and seems to have been the only signals intelligence mission launched by any country in 2015.

In May the US also launched the 4th X-37B spaceplane mission. The X-37B is thought to be testing new sensors, but their nature is unknown. The spaceplane was still in orbit as of early 2016. One of the CRYSTAL imaging satellites, USA 161, is now thought to have been deorbited in Nov 2014, leaving USA 186, 224 and 245 as the primary imaging systems.

China launched three Yaogan series satellites, two optical imaging and one radar. Three high-resolution Gao Fen satellites were also orbited, of which two (GF-8 and GF-9) are suspected to have a military or partly military observation mission. The quick-response Kuaizhou-1 satellite was deorbited in September after a 2 year mission, having been replaced in 2014 by Kuaizhou-2.

Space Surveillance and Early Warning

Russia launched the first of a new generation of early warning satellites in November. EKS No. 1 (Kosmos-2510) entered a Molniya-type orbit like its predecessors in the old Oko system.

Orbital Debris and Orbital Decay

At the end of 2015 there were 17427 cataloged objects in orbit; the number of reentries decreased slightly as the solar activity declined. The total known mass in orbit increased to 8700 tonnes.

Debris in orbit 2013-2015						
	Debris 2013		Debris 2014		Debris 2015	
	Number	Mass (t)	Number	Mass (t)	Number	Mass(t)
Active Payloads	1200	1527	1324	1567	1442	1712
Dead Payloads	2613	3508	2637	3530	2641	3669
Rocket bodies	1893	3079	1922	3102	1930	3188
Operational debris	1658	-	1690	-	1655	116?
PRC ASAT/FY-1C debris	3026	-	2932	-	2887	-
Strela/Iridium debris	1764	-	1610	-	1512	-
Other fragment debris	5034	-	4990	-	5359	-
Spurious catalog entry	1	-	1	-	1	-
Total cataloged	17189	8114	17106	8199	17427	8687

Here are the reenties in 2015, not including deliberate deorbit and landing.

Reentries 2014-2015				
	Reentries 2014		Reentries 2015	
	Number	Mass (t)	Number	Mass(t)
Active Payloads	56	0.3	40	1.7
Dead Payloads	15	19.8	15	21.1
Rocket bodies	47	89.7	34	60.0
Operational debris	70	3.0?	58	2.5?
PRC ASAT/FY-1C debris	94	-	52	-
Strela/Iridium debris	155	-	94	-
Other fragment debris	132	-	115	-
Total cataloged	570		408	-

41 of the reentering objects in 2015 had mass more than 500 kg.

Controlled deorbits and landings

In addition to natural reentries, there were 10 controlled landings and 5 controlled deorbitings of spacecraft during 2015, representing the safe removal of around 106 tonnes from the orbital environment. 4 Russian Soyuz ships landed in Kazakhstan. and two Dragon spacecraft splashed down in the Pacific near California. The Kosmos-2505 spy satellite landed near Orenburg in Russia on Sep 17, and its two small film capsules were recovered sometime in July-August. Europe's IXV spacecraft splashed down after a single orbit of the Earth.

Five ISS cargo ships (one Japanese HTV, one ESA ATV and three Progress) were deorbited over the South Pacific east of New Zealand.

In addition, ten rocket stages were deorbited after only one or two Earth orbits (two Centaur, 1 Delta 2, 1 Falcon 9, 1 Vega AVUM, 1 Japanese H2, four Chinese CZ-2D). Of these, only Centaur AV-054 was assigned a US satellite catalog number. The total dry mass of these rocket stages was 26 tonnes. A further 23 rocket stages were inserted into slightly suborbital trajectories that ensured controlled disposal without the need for a deorbit burn (Ariane EPC, Vega Z9A, Proton stage 3, PSLV stage 3, some Soyuz-2 stage 3).

Retirements in the GEO belt

During 2015 12 satellites were retired to the graveyard above the GEO belt: Leasat 5, Superbird C, Astra 1E, Koreasat-2/ABS-1A, Sirius 3, Himawari-6, EUTELSAT 16B/Hot Bird 4, Garuda 1, INTELSAT 603, Ekpress 6A/A2, Globus-1 No. 18, and DSCS III B-12. A Blok-DM upper stage

was also sent to the graveyard and a Chinese apogee motor left there in 2014 was detected and cataloged. One Briz-M upper stage and two debris objects from the Meteosat 11 satellite were left in an orbit below the GEO belt.

The four MMS science satellites are in elliptical inclined orbit with a synchronous orbital period; they were launched by the Centaur AV-053 rocket which was left in a sub-synchronous elliptical orbit.

One satellite, Israel's Amos-5, failed without being moved to a safe orbit. and remains drifting in the GEO belt.

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