China Satellite Update - 2014 In Review

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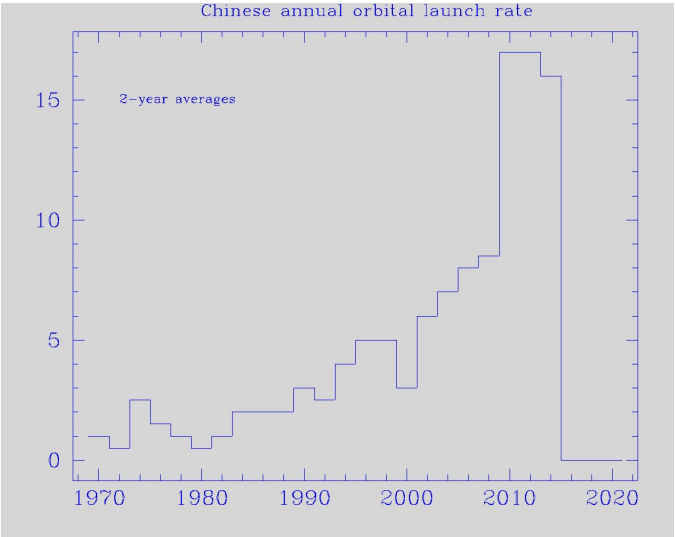
This document is a sequel to 'China Satellite Update – 2014' which I published in June 2014 at http://planet4589.org/space/papers. The present edition includes data up to 2014 Dec 31. Some of the descriptive text is repeated, so that the document may be read without reference to the previous one.

Launches this year

Following China's first satellite launch, China's orbital launch rate remained relatively low at about one to two launches per year for 20 years. In around 1990, that rate began to increase gently and fairly steadily until 2011 when the 2-year-average launch rate leapt by a factor of two. *(Note: one deep space launch in 2007 and one in 2010 were inadvertently omitted from the plot in the 2014 edition. All known orbital launch attempts, even if unsuccessful, are included in the histogram.)*



Let us consider the year 2014 in detail. There were 16 Chinese orbital launches, including the second launch of the new Kuaizhou solid fuel launch vehicle from the Jiuquan Space Center. The remaining launches were all by rockets of the Long March (Chang Zheng) family, which comes in several variants, some built by the Beijing-based CALT and some by the Shanghai Academy of Space Technology. There were no launches of the human-crewed Shenzhou in 2014. No orbital launch failures occurred. *However, there were three rumoured endoatmospheric flights of an experimental hypersonic vehicle from Taiyuan Space Center, of which one may have been a failure. Suborbital and endoatmospheric missions are hard for open source analysts to assess, since their flights may remain entirely within the launch nation's territory and no orbital data is available. .*

2014 Chinese orbital launches by rocket type and launch site				
	Jiuquan	Xichang	Taiyuan	Total
Kuaizhou	1	0	0	1
CZ-2C	3	0	1	4
CZ-2D	2	0	0	2
CZ-2F	0	0	0	0
CZ-3A	0	1	0	1
CZ-3BE	0	0	0	0
CZ-3C	0	1	0	1
CZ-4B	0	0	4	4
CZ-4C	2	0	1	3
Total	8	2	6	16

Spacecraft launched this year

In 2014 the 16 successful launches put 23 Chinese-owned and -manufactured spacecraft in orbit, including the joint Chinese-Brazilian CBERS 4 remote sensing satellite. In addition, the small Hevelius satellite was carried as a secondary payload for Poland. There were no Chinese commercial geostationary launches for foreign customers in 2014. Two Chinese satellites reentered: Yaogan 5 and Tiantuo 1. The Reentry Return Test Vehicle (see below) was recovered, but its service module remained in deep space; I count these as two separate spacecraft.

The ability for a launch vehicle to carry multiple satellites means that you must be careful to state whether you are counting orbital launches (how many rockets) or satellites launched (how many payloads). Totals for satellites depend on definitional choices; for example, 2011's Yinghuo-1 payload remained attached to the doomed Fobos-Grunt satellite throughout its stay in space - is it a Chinese satellite, or just a Chinese package aboard a Russian one? Several US-owned Flock-1b spacecraft were taken to the ISS aboard one cargo ship and later returned aboard another without having been deployed - should these be counted as satellites launched, even though they never orbited independently? The Chinese Yutu rover was deployed on the lunar surface, and never operated separately from its parent spacecraft in Earth orbit. I have chosen to omit all of these marginal cases from the totals in this year's assessment.

In addion, three Hong Kong-owned, US-manufactured spacecraft were launched during 2014: ABS-2, Asiasat-8 and Asiasat-6. I include these in the 'Chinese' totals below, but separately, since Hong Kong based commercial satellite operators remain essentially separate from the main Chinese government space program and their satellites are usually launched by non-Chinese launch providers.

Chinese and US orbital launch activity (2010-2014)						
	2010	2011	2012	2013	2014	
Chinese launches	15	19	19	15	16	
US launches	15	19	16	20	24	
Chinese sats, number						
Hong Kong	0	1	1	0	3	
Other	20	17	24	17	23	
US sats, number	41	39	35	85	110	
Chinese sats, tonnage (est.)	33	47	53	29	36	(metric tons)
US sats, tonnage	420	407	100	87	86	(metric tons)

Note 1: One Chinese failure in 2011 and one in 2013.
(Kunpeng-7 high energy suborbital launch not included.)

Note 2: One US failure in each of 2011, 2013 and 2014.

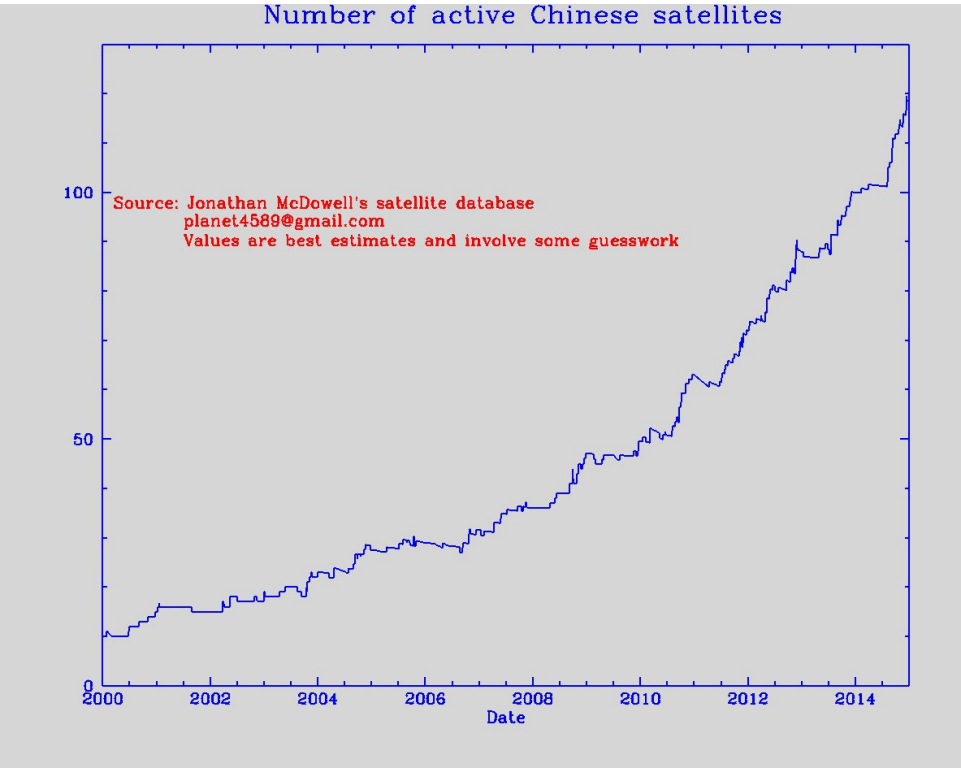
Note 3: US figures include Sea Launch (1 in 2011, 3 in 2012, 1 in 2013).

Note 4: Figures for satellites do not include launch failures

Note 5: 2011 US tonnage figures include Space Shuttle Orbiters

Active Chinese Spacecraft

Although China does launch occasional satellites for other customers, the bulk of its launches are of domestic Chinese-owned satellites, also mostly but not exclusively Chinese-manufactured. This has led to a corresponding increase in the number of active Chinese satellites in orbit. Here we show the rise since the year 2000:



The data for this figure are created by estimating the end-of-life dates for each Chinese satellite (launch dates are well known). For geostationary satellites this is easy enough - when the satellite stops stationkeeping manuevers and/or sent to a graveyard orbit it is considered to be dead. This kind of analysis works for manuevering low orbit satellites too; but Chinese LEO satellites at 500 km or above often do not manuever. End of life dates for some (civilian) satellites in such orbits are made public, but for others we must guess their operational lifetimes based on typical Chinese satellite lifetimes measured for the other categories, or noting their replacement by new satellites in the same orbital plane. Nevertheless I believe that the estimates given here are good to plus or minus 10 percent of the total. They are most likely a slight overestimate; some older military satellites I have kept as active may no longer be.

Another uncertainty is in the definition of 'active'. The end of a satellite's life is sometimes abrupt - a power supply failure, a reentry while still active - but can also be gradual, with a move to reserve status, then formal retirement, perhaps still with a tracking beacon active, or even repurposed for flight controller training, before finally falling completely silent. My definition of 'active' includes any form of transmission between the satellite and its ground controllers. This contrasts for example with statistics from the Union of Concerned Scientists (http://www.ucsusa.org/nuclear_weapons_and_global_security/solutions/space-weapons/ucs-satellite-database.html) which I believe tends to use retirement from an active constellation as an end-of-life value and so counts fewer satellites as active. Therefore, readers should not expect estimates of the statistics of active satellites from different sources to agree exactly.

With these caveats, here are my estimates for the current state of Chinese space: (last year's document gave a June estimate, but for annual review purposes a year-end value seems more useful). The total number of Chinese satellites in space, working and dead, is nominally an exact value; the scare quotes remind the reader that there can be disagreement, as discussed above, about which objects count as a separate satellite payload. I have also sloppily lumped together the (small number of) deep space probes with the Earth orbiting satellites; in future editions I plan to separate these out.

Chinese Satellites, 2014 Dec 31 2359UTC, Hong Kong included		
	Best Estimate	Estimate Range
China: Total still in space	183	'Exact'
China: Total still active	122	95 to 130 ?
World: Total still active	1324	1200 to 1400 ?
US: Total still active	566	500-600?
Russia: Total still active	132	120-140?

What are these satellites doing? China's 122 satellites which I estimate to be active are itemized below. I divide the satellites into civilian government, military/intelligence, commercial, and non-profit (university and amateur, a category which is significant for other countries but not yet for China). The case of Beidou is tricky, as for GPS in the US. The GPS system was developed for the US military, but is now also a key part of our civilian infrastructure - if you, gentle reader, are like most of my friends, you probably couldn't find your way to a local restaurant for dinner if GPS went down. I therefore consider GPS to be a true case of what is often called 'dual-use' - military and civilian. Beidou I assess to be similar, although its civilian uses in China are essentially all governmental for the time being. It is true that many other satellites whose intent is mostly civil return data that is of military use, and it is possible that some mainly military-intelligence imaging satellites return data that is sometimes used by civil government agencies. It is also true that the

management of many space activities that I consider 'civil', such as human spaceflight, are in China the responsibility of parts of the defense establishment. Depsite these complicating factors I think it is usually fairly clear, and usefully meaningful, to distinguish civil and military satellites. We may contrast the environmental research satellites such as HJ-1A, whose work is described in open papers, with the Yaogan series for which neither detailed satellite descriptions nor resulting data are available. My conclusion is that the Chinese space sector has a strong military component, but not one dominated by military activities; the balance is similar to that in the rest of the world.

- **1 non-profit**: HOPE-1 amateur radio sat
- **17 commercial and semi-commercial**:
  - 9 Hong Kong based commercial - Asiasat, Apstar, ABS
  - 8 semi-commercial comms - Chinasat/Chinastar
- **39 civilian**:
  - 3 civil GEO comms - Tian Lian (TDRS equivalent)
  - 4 civil LEO comm - Chuanxin, Linqiao
  - 4 civil GEO weather - FY-2
  - 3 civil LEO weather - FY-3
  - 12 mostly civil LEO imaging and remote sensing (HY, China-DMC, HJ-1A/B, CBERS, GF-1)
  - 1 mostly civil LEO radar imaging (HJ-1C)
  - 3 civil deep space (Chang'e 2,3/Yutu,RRFTV Service Module)
  - 1 civil human spaceflight related (Tiangong)
  - 8 mostly civil technology (SJ-7, 9, 15, 16; Shiyan 4, 5, TT-2)
- **51 military**:
  - 5 mostly military GEO comms (ZX-1,2,20,22)
  - 7 probably military early warning (SJ-11)
  - 14 mostly military LEO imaging (Yaogan, ZY-3, KZ-1/2)
  - 6 mostly military LEO radar (Yaogan)
  - 19 military LEO signals intelligence (SJ-6, Yaogan)
- **14 military/civilian** navigation constellation (Beidou)

In the longer term, with the opening of the Hainan launch site, the development and flight test of several new launch vehicles, China's satellite launch rate may increase significantly. Perhaps the most significant development of 2014 was the continued delay in introducing these new generation vehicles.

Special topic: Reentry Return Flight Test Vehicle

Referred to in the previous edition as the Chang'e-5 Flight Test Device and in some Western publications as CE5-T1, this spacecraft, launched on 2014 Oct 23, was described in Chinese publications as 'zairu fanhui feixing shiyan qi' (Reentry Return Flight Test Vehicle) in the 'zhongguo tanyue gongcheng san qi' (Chinese Lunar Exploration Program Phase III). The spacecraft consisted of a large service module (SM), similar to the Chang'e-2 lunar orbiter, and a small reentry vehicle (RV),

of mass 335 kg and size 1.2m height and 1.2m diameter. It carried out a complex mission whose events are tabulated below.

Date	Event
2014 Oct 23	SM/RV Launch from Xichang
2014 Oct 23	SM/RV insertion into translunar trajectory
2014 Oct 27	SM/RV circumlunar flyby, closest approach to Moon 11300 km
2014 Oct 31	SM/RV separation, 5000 km from Earth
2014 Oct 31	RV landing in China
2014 Oct 31	SM divert burn to escape trajectory
	SM again leaves vicinity of Earth
2014 Nov 28	SM enter Lissajous orbit around Earth-Moon L2 Lagrange point
2015 Jan 4	SM depart Earth-Moon L2
2015 Jan 11	SM enter lunar orbit
2015 Jan 13	SM in low 200 x 200 km lunar orbit
2015 Feb-Mar	SM carries out rendezvous and docking maneuvers
	with simulated (imaginary) lunar ascent vehicle

Acknowledgements

The data presented here are extracted from my satellite and launch database, generated from open source media reports combined with analysis of US Space-Track orbital elements. My understanding of the Chinese satellite program, however, depends critically on the work of many other people. I acknowledge in particular conversations with Brian Weeden, Jeffrey Lewis, Gregory Kulacki, Alanna Krolikowski, Laura Grego, David Wright, Igor Lissov, Phillip Clark, Wang Ting, Rui Barbosa and posters on the forums at nasaspaceflight.com.

The author is an employee of the Smithsonian Institution, but the work reported here was performed independently and does not represent the views of the Smithsonian.