A Brief History of Rideshares (and Attack of The CubeSats)

Michael A. Swartwout
St. Louis University
3450 Lindell Blvd
St. Louis, MO 63103
314-977-8214
mswartwo@slu.edu

Abstract—Rideshares ("piggyback" launches) go almost back to the first satellite launches, with the first one in 1960. Given the extraordinary cost of launch, it is natural to seek out ways to share costs, or to make use of the unused capacity of a larger launch vehicle. One tool that would be of use to mission planners is a statistical look at past rideshares to help understand the opportunities and obstacles for prospective future rideshares. The purpose of this paper is to begin to collect the data necessary for such analyses, and to start identifying the fundamental issues. [1 2]

One such issue that needs study is the effect of the new CubeSat class of satellites, which are very small (1-5 kg) spacecraft that use a standard motorized launch container. Seventy CubeSat-class missions have been flown in just seven years. Dozens more are being proposed by a very diverse group: NRO, the U.S. Air Force, ESA, the National Science Foundation and the U.S. Army.

The CubeSat class is worth study for two reasons. First, the sheer number of recent and proposed missions means that CubeSats could dominate the rideshare market to the point of taking away opportunities for larger spacecraft. Secondly, significant investment in subsystem technologies by U.S., European and Japanese government, industry and academia is enabling new CubeSat capabilities that were not available even three years ago. In particular, it would be beneficial to examine the long-term statistical trends in rideshare missions to better identify the effects that CubeSats will have on the rideshare market.

In this paper, we will review the launch and operational history of rideshare spacecraft, with particular emphasis on the relative performance of CubeSats against larger spacecraft. We will focus on the launch history since 1990, when rideshares began to yield countable numbers. Using launch manifests, mission reports and the public archives, we will quantify rideshare missions along such dimensions as mass, nation, mission utility and launch system. These parameters will be studied to identify long-term trends and, especially, to assess the impact of CubeSats against both rideshare opportunities and mission opportunities.

We expect to show that CubeSats are both a help and a hindrance; the CubeSat class will help enable new types of missions (e.g., low-cost student demonstrations, flight qualification and missions involving large numbers of disposable sensors). At the same time, CubeSats will hinder flight opportunities for missions requiring larger rideshare platforms, as both launch providers and spacecraft developers will chase the CubeSat market.

TABLE OF CONTENTS

1. INTRODUCTION

Launches are expensive. Published launch costs begin at \$20M for low-Earth orbit rockets, and upwards of \$100M for a geostationary ride. And even with new systems such as the SpaceX Falcon family promising to reduce those costs by a factor of 2-3, it will still be extremely expensive to put hardware in space. At the same time, almost every launch vehicle lifts off with extra capacity – tens to hundreds of kilograms.

Not surprising, then, is the idea of rideshares: to fly a second spacecraft on the same launch vehicle, making use of the launch capacity not required by the primary payload. The first rideshare mission was the 20-kg SOLRAD-1, which accompanied the 100-kg Transit 2A flight in June 1960; both were Navy experiments. The first multi-agency rideshare was the University of Iowa's 16-kg Injun-1, launched with Transit 4A and SOLRAD-3 in June 1961. It wasn't until the early 1980s that commercial rideshares became common; the second flight attempt of the Ariane-1 launch vehicle carried the AMSAT Phase-3A spacecraft. Since that time, there have been hundreds of rideshares.

The purpose of this paper is to define the rideshare market at the close of 2010, looking at the kinds of opportunities available now for rideshares and in the near future. We have discovered that the rideshare market is in a state of flux: a new type of rideshare, the CubeSat, was introduced in 2003, and nearly six dozen CubeSats have flown in the

[1] 978-1-4244-7351-9/11/$26.00 ©2011 IEEE.
[2] IEEEAC paper #1518, Version 2, Updated January 11, 2011

intervening 7 years ("overnight" in aerospace time). With CubeSats, we believe that the rideshare market is about to bifurcate: the majority of rideshares will be in the 1-5 kg CubeSat class, and a smaller fraction will be commercial/military missions in the 100-200 kg class. We expect that both spacecraft providers and launch providers will move away from rideshares in the 10-100 kg class.

In this paper, we will examine the history of rideshares, with a focus on the last 20 years. Using launch manifests and published information, we will compile a detailed list of all the rideshare missions since 1990. We will then analyze this set, looking for trends or discriminators among factors such as mass, orbit, launch vehicle, sponsoring organization and mission.

First, we will define our terms and provide a very brief review of CubeSats.

Definition: Rideshare

For the purposes of this paper, a "rideshare" is a mission that is not the primary customer/payload on a launch vehicle. To automate the process of sifting through the 2500 missions flown over the past 20 years, we use the following heuristics to identify the rideshares:

- There must be at least two spacecraft on the launch vehicle; the heaviest payload is assumed to be prime, and the rest could be rideshares. The spacecraft's COSPAR number is a good indicator; typically, the primary payload is given the "A" designation. Exceptions were made in the case of certain Dnepr launches where there may be as many as 17 payloads, and no one payload dominates the mass budget; all of the payloads could be rideshares.
- The spacecraft is not in GEO; to our knowledge, the GEO "rideshares" require millions of dollars, which is outside our definition. GTO orbits (available on some Ariane and EELV flights) are eligible.
- The spacecraft must have a launch mass of less than 500 kg. This restriction further enforces the philosophy of rideshares as secondary launches.
- Missions involving the launch of identical/ complimentary spacecraft are not rideshares. The Iridium, Orbcomm, Globalstar and Glonass constellations often stuff 3-6 spacecraft onto one rocket. This is less a rideshare than a primary customer making efficient use of the available launch space. This restriction eliminated more than 120 Russian military surveillance/communication spacecraft, as well as dozens of constellation spacecraft noted above.

CubeSats

Until the early part of this century, most rideshares operated as miniature versions of the primary payload; they were bolted onto the last stage by a custom separation ring. However, in 2003, a new launch system debuted: the Poly Picosatellite Orbital Deployer (P-POD) [1]. The P-POD (Figure 1) is a standard ejection system containing multiple spacecraft with a combined size of 10x10x30 cm and aggregate mass of 4 kg (Figure 2). A spring-actuated system opens the door upon launch vehicle command and releases all the spacecraft contained within.

The spacecraft carried by P-PODs are called CubeSats, and the standard CubeSat size (or 1U) is 10x10x10 cm. Several other systems operate on the same fundamental ideas: the DoD MEPSI system [2], the X-POD developed by the University of Toronto's Space Flight Laboratory [3] and the J-POD used by Japanese universities. The advantage to all of these systems is standardization and containment: the P-POD serves as a robust firewall between the CubeSat payload and the launch vehicle, and the flight qualification process for subsequent P-POD flights becomes much easier. It also possible to fly multiple P-PODs on the same rocket.

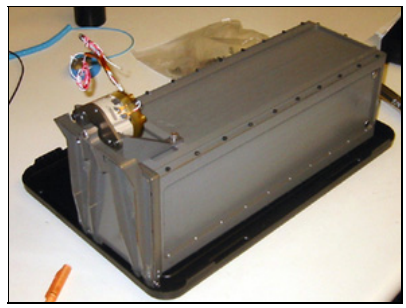


Figure 1 – P-POD Ejector (Mk II) [courtesy www.cubesat.org]

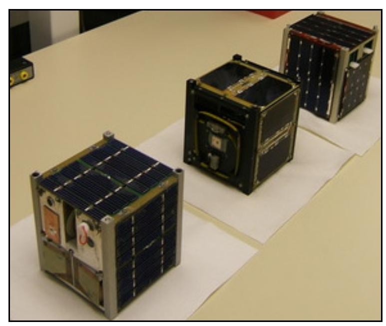


Figure 2 – Typical CubeSats awaiting flight integration [courtesy www.cubesat.org]

The first CubeSats were launched in 2003; by the end of 2010, that number has reached 70, with many more on the way. The CubeSat/P-POD idea was conceived as a means for universities to gain launch access for their student-built spacecraft; this author (among others) was surprised to learn that 40% (28) of CubeSat-class missions launched were professional, including missions by NASA Ames, NRO, the U.S. Army, the Aerospace Corporation and Boeing.

2. DATA ANALYSIS

This paper is based on a review of the launch history from 1990 until 2010. Spacecraft information was collected from several online databases [4-7] and assembled into one master list of the 2562 spacecraft launched since the beginning of 1990. We include launch failures in this list, since the missions had already committed to the rideshare. From this list, the subset of rideshares was identified using the rules defined above. This left 316 rideshare missions launched between 1990 and 2010. Each mission was noted for parameters such as orbit, launch mass, sponsoring nation, rideshare launch vehicle and mission type.

A few broad trends are readily identified. The overwhelming majority of rideshares are to low-Earth orbit (LEO); only 16 of the 316 identified rideshares have an apogee above 2000 km. Thirteen rideshares have been geostationary transfer orbits (GTO), and the interplanetary orbits are the rare exceptions (ESA's SMART-1 to the Moon, and the recent Japanese mission to Venus). Second, a common perception of rideshares is that they fly on experimental or other high-risk launchers. In fact, only 29 rideshares (9%) have been lost to launch failures – and half of those were on a single rocket (a Dnepr launched in 2006). The list of launch failures – as well as all rideshares used in this analysis – are available in the Appendix.

The average number of rideshares from 1990-2001 was 14.4; as shown in Figure 3, that average number has been the lower bound on rideshares since the late '90s. The manifest log appears to be moving towards an average of 25 or more in the coming decade.

First Observation: Mass

When the manifest is further subdivided by mass (Figure 4), an notable bifurcation emerges. The majority of rideshares from 1990-1999 were in the 10-100 kg range (63 of 87 manifested). But, since 2000, there is a migration to the high end (> 100 kg) and low end (< 10 kg) of the range; the midrange has dropped from 72% of the missions to 43%. CubeSats, which didn't exist in 2000, account for half the rideshare missions launched in the last three years.

A review of the heavy end of the manifest indicates that these missions can be roughly categorized into three types: Earth-observing missions developed by mid-sized contractors – most notably Surrey Satellites' (SSTL) newer Disaster Monitoring Constellation spacecraft, dual-manifested government/military payloads on Russian & Chinese rockets (missions who are on the fringe of meeting our "rideshare" definition), and technology "missions of opportunity" where a program took advantage of a rideshare capability to carry out an ambitious science or technology definition mission. Examples of the latter include the aforementioned SMART-1 electric ion mission to the Moon, and Japanese rideshares to Venus and Sweden's MANGO and TANGO formation flight mission.

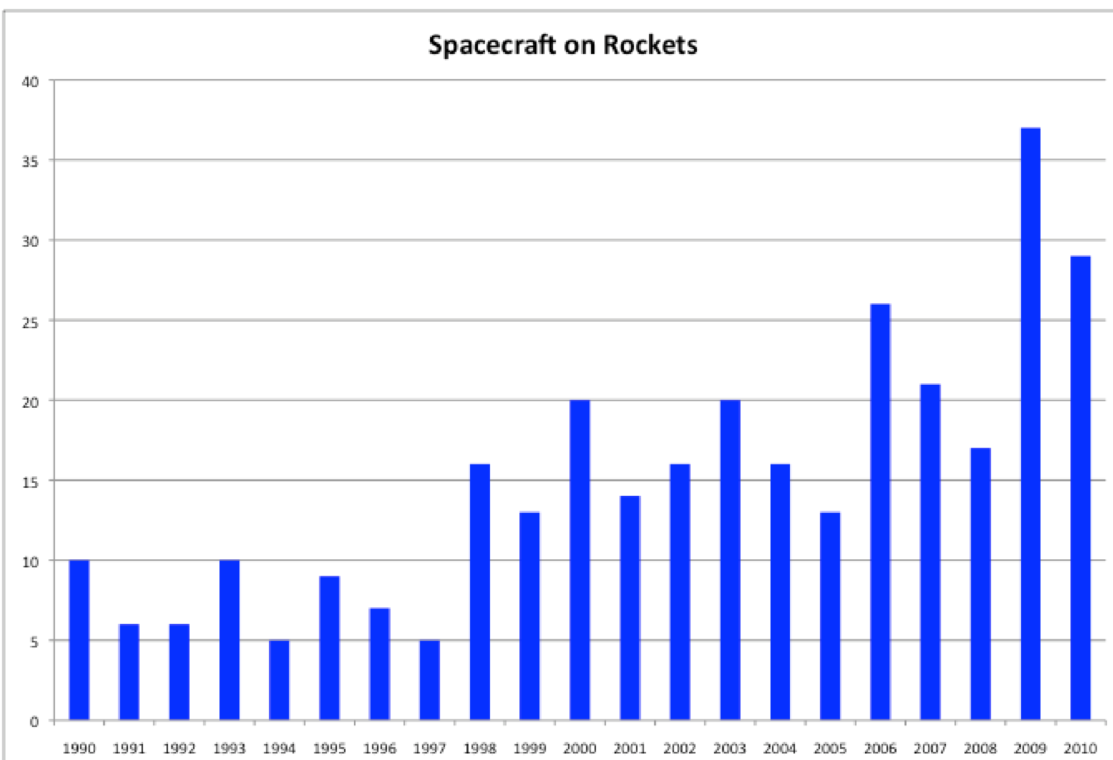


Figure 3 – Number of Rideshare Missions Launched by Year

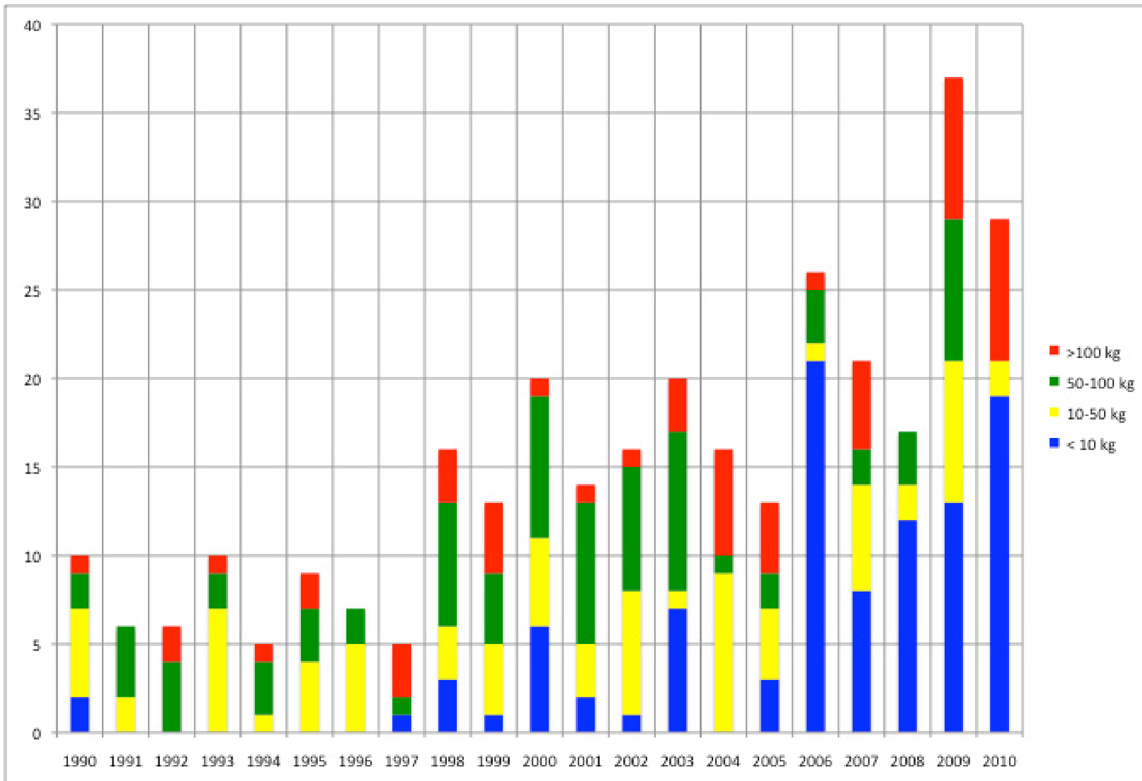


Figure 4 – Rideshare Missions by Launch Mass

While it is too early to draw strong conclusions, it does appear that the rideshare market is shifting into the CubeSat and large rideshare categories. We did not include the scheduled manifest for 2011 in our analysis (forecasts are always subject to significant change, and launch schedules always slip), but the next year's manifest is significant for two factors. If the published manifest holds (which, again, we know it will not), more than 50 rideshares will fly in 2011. Most will be CubeSats, with several doezen on the first flight of Arianespace's Vega rocket and on NASA's COTS demonstration flights. Moreover, less than 5 of the 50 rideshares will be between 10-100 kg; and most of those will be part of the 12-kg LatinSat constellation.

Again, one cannot draw long-term conclusions from a single year's data. Rather, we note this issue as one to watch over the next few years.

Rideshare Providers and Customers

It is also beneficial to identify the sources of rideshares. As shown in Table 1, a broad range of rockets have provided rideshares, with the Ariane family (via the ASAP platform), the Dnepr, PSLV, H-II and Minotaur being among the most productive. (The U.S. Space Shuttle was also a consistent source of rideshares.)

But, if we sort the rideshares according to the nation providing the rideshare and the nation of the rideshare customer, we see that not all of these launch systems are readily available.

As shown in Figure 5, there are six main providers of rideshares: the US, Russia, Japan, India, China and Europe. (Brazil has had one rideshare launch attempt with Brazilian payloads on the VLS-1 rocket, and it is included for completeness.) Russia and the U.S. have provided the bulk of the rideshares since 1990, but it is important to note that Japan and India have been increasing their rate of rideshares since 2005. Europe used to be almost the sole provider of rideshares in the early '90s, but those numbers have fallen off. It is unclear whether that is a cause of price competition between the ASAP platform and the Indian/Russian systems, or merely if the Ariane 5 primes have not fielded LEO missions of primary interest to rideshares. With the advent of the Vega rocket next year, the Europeans should pick up a share of the CubeSat market.

In Figure 6, we present the tally of rideshare customers by sponsoring/operating nation. The United States and Europe are the dominant customers, with about one-sixth of the rideshare customers coming from the "Other" category of nations who do not have their own launch systems (primarily South American and Canadian programs).

Russia, for one, does not operate many rideshares, and Japan flies about as many rideshares as it provides.In fact, if we sort the rideshare manifest by launching nation and customer (Table 2), we note that certain nations are "importers" of rideshares, and others are "exporters".

Table 1. Rideshare Launch by Year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Athena												3										3
Atlas																		5				5
Delta		1		1		1			1	2				2								8
Falcon																			4		8	12
Minotaur											11	1					1			4	6	23
Pegasus	1			1					2	2												6
Shuttle		1	1		1		1		3	1		2	1				5		1	3		20
Taurus					1				1	1		3										6
Titan							2															2
ISS																1						1
Shtil									2													2
Dnepr											5		6		8	1	17	13		6	2	58
Kosmos						2	1	1	1	1	4		3	6		8				1		28
Molniya						2	2															4
Rokot														8					1	1	2	12
Soyuz			2					2	1	1		1				1				6		14
Start						2																2
Tsiklon		1		1	1										1							4
Zenit									5			4										9
CZ	2		1							2			1	1	1				2	1	2	13
PSLV										2						1		3	9	6	4	25
M-V																	2					2
H-1	2																					2
H-II							1						4							7	5	17
VLS-1														2								2
Ariane	5	3	2	7	2	2		2		1			1	1	6	1	1			2		36

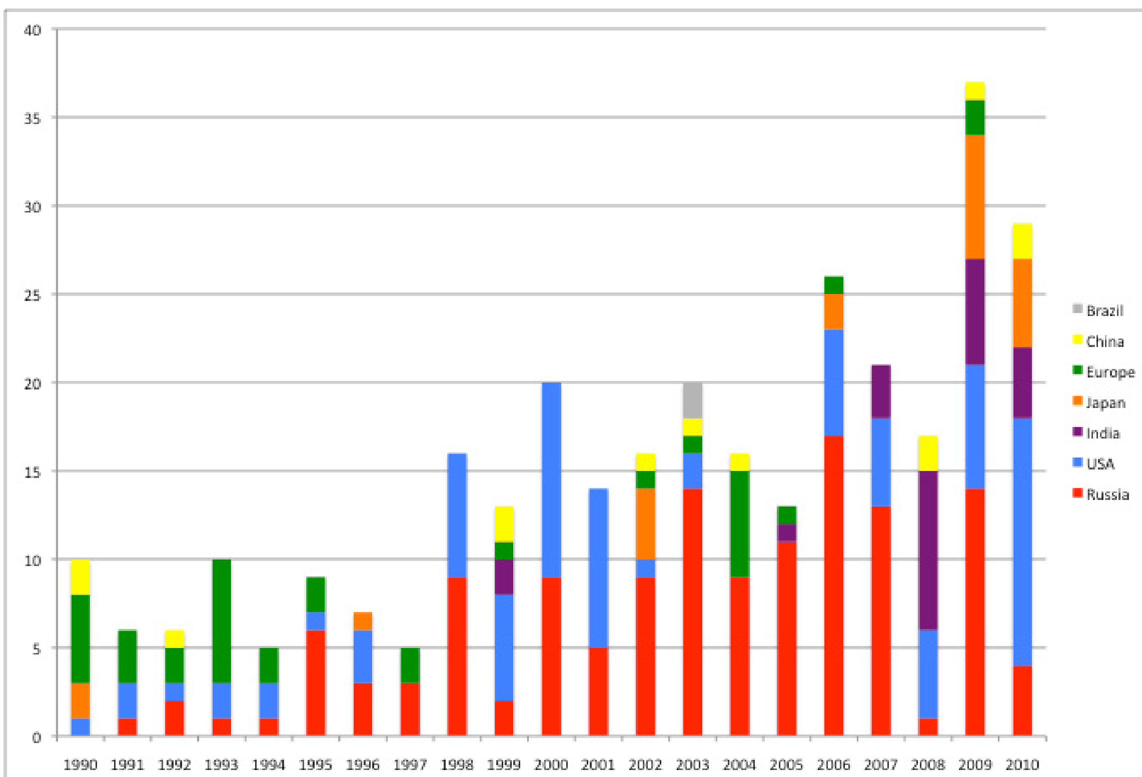


Figure 5 – Rideshare Providers by Launching Nation

Table 2. Customer and Launching Nations. The rows are the rideshares provided by a nation; the columns are the rideshare missions flown by a nation. For example, the US has placed 22 rideshares on Russian rockets.

	Customer Nation								
	USA	**Russia**	**China**	**India**	**Japan**	**Europe**	**Brazil**	**Other**	**Totals**
USA	80					3		2	**85**
Russia	22	25	2		4	42		39	**134**
China			11			1	1		**13**
India				7	2	12		4	**25**
Japan					20			1	**21**
Europe	3				1	28	1	3	**36**
Brazil							2		**2**
Totals	**105**	**25**	**13**	**7**	**27**	**87**	**4**	**49**	**316**

Russia, in particular, flies payloads from many other nations. By contrast, Japan and China do not offer rideshares to international customers; most of their rideshares go to indigenous missions and, similarly, most of their nation's missions fly on their own rockets. The U.S. flies most of its missions domestically, offering few to other nations but flying about 25% of its rideshares on international rockets. India is on the other end; all of its local rideshare missions have flown domestically, but it is building up a robust international rideshare business for its launchers. These trends are summarized in Figure 7 and in Figure 8.

At the risk of oversimplifying, the numbers indicate that India and Russia are the main options for purchasing rideshares; the American, European, Japanese and Chinese rideshare providers primarily supply domestic needs.

3. Conclusions

One of the most important questions regarding rideshares is their future availability: what kinds of rideshares will be available in the next few years? The sheer number of rideshares indicates that regular opportunities exist. However, a large fraction of those opportunities (roughly half) appear to be "in-house", that is, missions that are sponsored by a particular nation and launched on domestic rockets. Unsurprisingly, then, government-sponsored rideshare missions seem to find government-sponsored launches. What about the rest of us?

Among paying customers, the next decade appears to have two options: relatively large (100+ kg) rideshares on Russian and Indian vehicles, or very small (CubeSat-class) rides on a dizzying array of launch vehicles. The following launch vehicles have flown CubeSat-class spacecraft or are manifested with CubeSats in 2011: Falcon 1, Falcon 9, Minotaur, Shuttle, Taurus, Dnepr, Kosmos, Rokot, PSLV, H-II, and Vega. By contrast, the rockets that have flown international 100-kg-class rideshares since 2005 are: Atlas, Dnepr, Kosmos, PSLV, and Ariane. (The Atlas, Rokot and Soyuz rockets have flown domestic military missions, and the H-II has flown JAXA tech demos.)

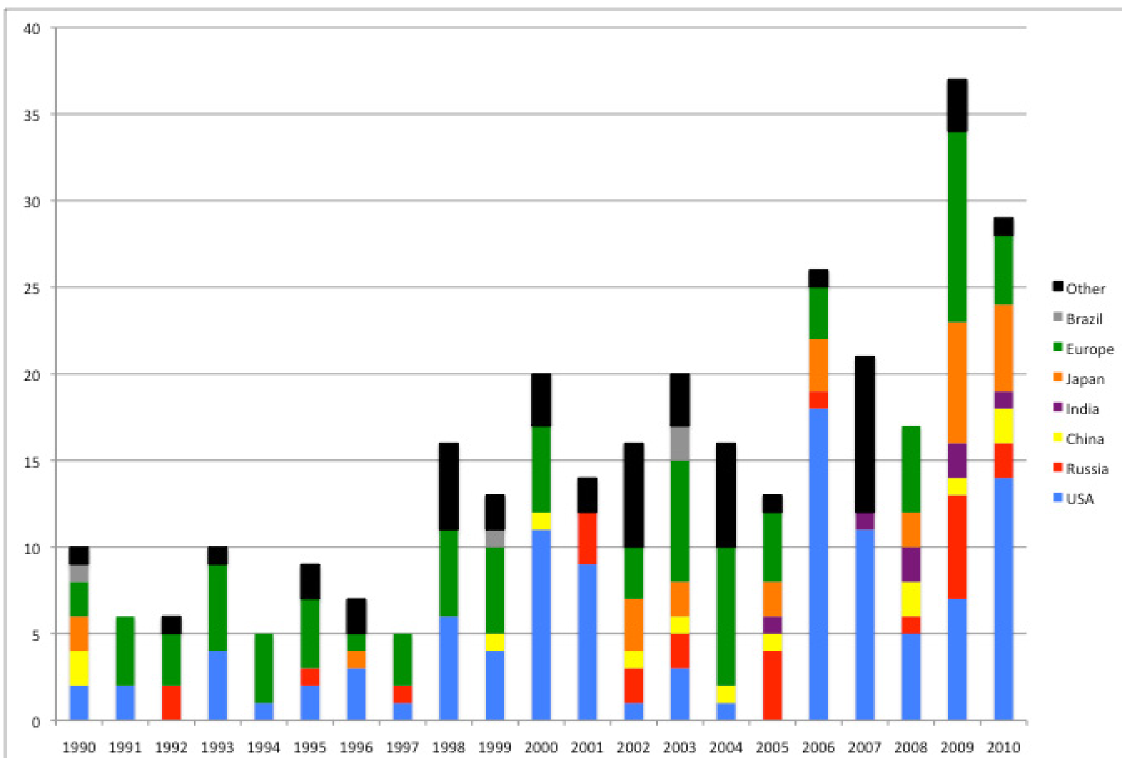


Figure 6 – Rideshare Customers by Sponsoring/Operating Nation

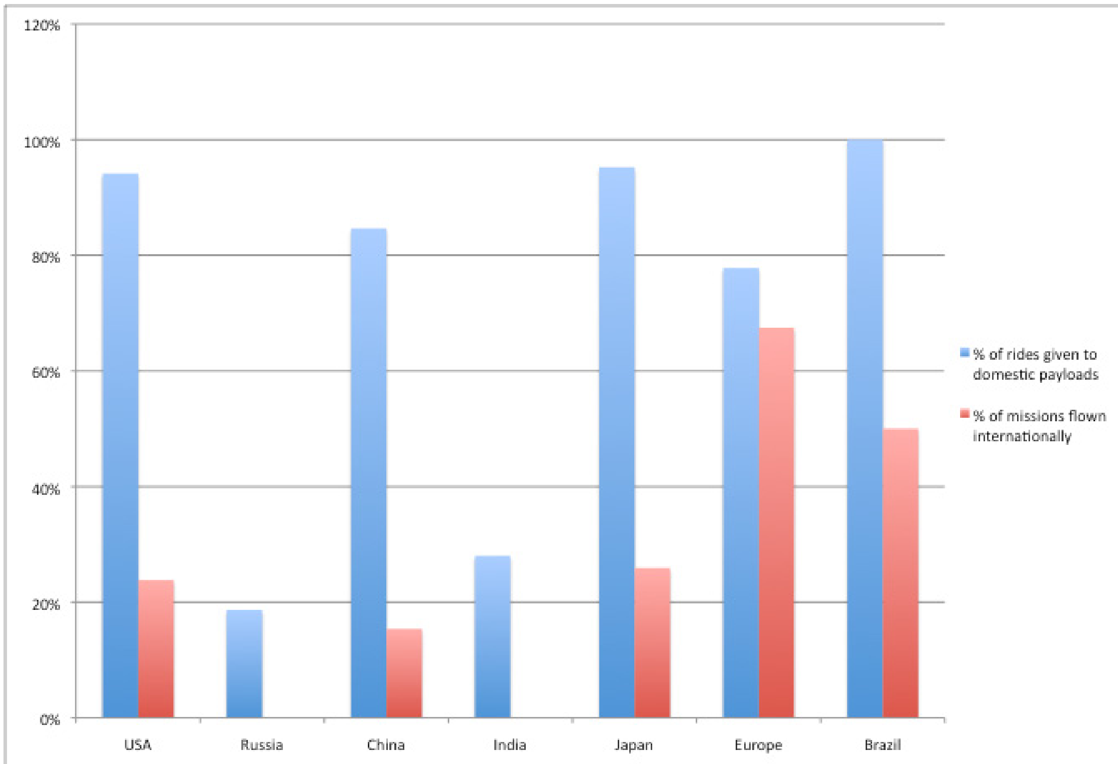


Figure 7 – International Ridesharing. The bar in blue is the fraction of rideshares a nation provides to its own payloads against the total number of rideshares provided by that nation; a low percentage indicates that the nation accepts many customers from other nations. The bar in red is the fraction of a nation's rideshare missions developed domestically and launched by other nations; a low percentage indicates that most missions are launched domestically.

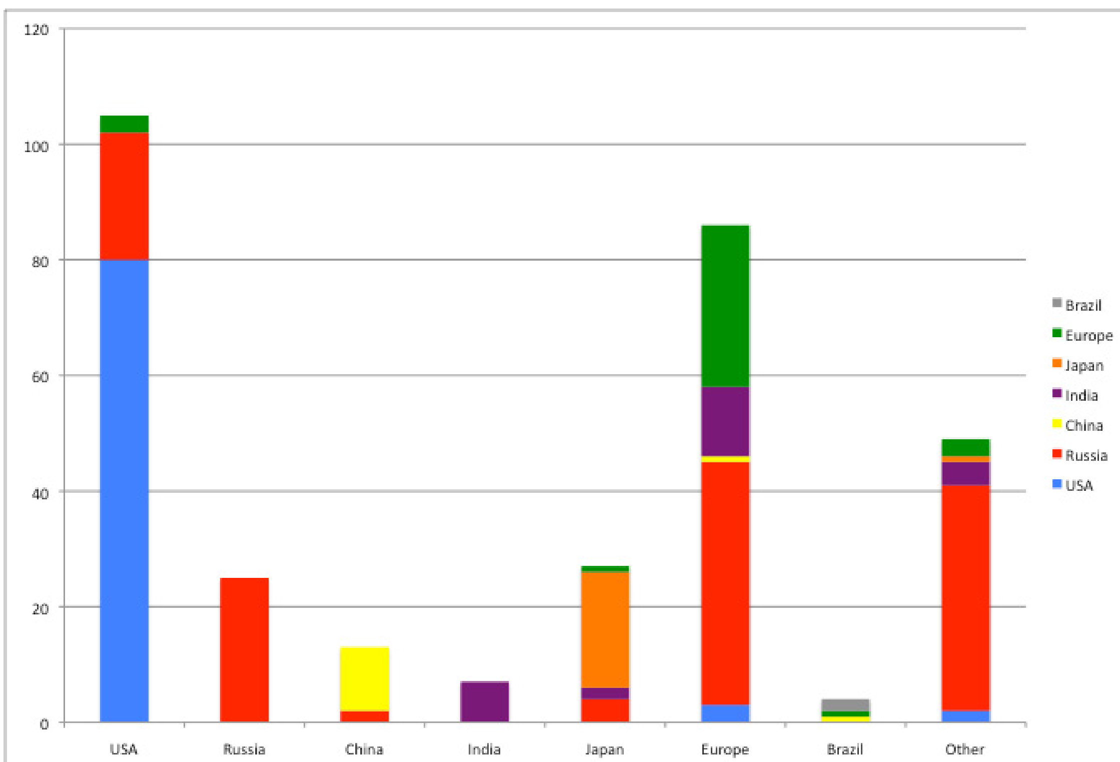


Figure 8 – Number of Rideshares Flown by Each Sponsoring Nation, Subdivided by Rideshare Launch Nation. For example, the US has operated 105 rideshare missions; 80 were launched by US rideshare providers, 22 by Russian rockets, and 3 on European rockets.

We speculate that the rise of CubeSats signals a major shift in the rideshare market. We believe that the mid-range rideshares (10-100 kg) will disappear; the ease of design and integration of CubeSats, coupled with the continued improvement of miniaturized components, will cause mid-sized missions to scale down to fit a CubeSat (or a team of CubeSats). Alternately, mid-size missions will scale up to the 100-kg class, where the same benefits in miniaturization allow for highly capable, cost-effective spacecraft in a package that is still quite small by normal spacecraft standards. The great success of SSTL in building such spacecraft (and, in particular, the fact that recent SSTL missions have grown from 70-80 kg to 100-200 kg) is an indicator of such a future.

Again, driven by CubeSats, we predict a much larger total number of rideshares, beginning with the still-anecdotal list of nearly 50 CubeSats manifested for 2011. What remains to be seen is where the upper bound on CubeSats lies; are we merely burning through the backlog of available CubeSat missions, or is there sufficient mission capability to produce dozens per year?

Future Work

This work has been focused on the launch data; the political and economic context has been ignored. For example, the U.S. restrictions on the export of satellite and launcher technology can help explain our lack of international rideshare participation.

More importantly, the very manner by which launches are procured affects the opportunities for rideshares; in the United States, it is typical for the primary customer to purchase the rocket itself as opposed to purchasing a "ride" from the launch provider. Therefore, it is entirely rational for the primary customer to limit rideshares that provide no benefit while increasing risk. This does work both ways; NASA has mandated that SpaceX fly CubeSats on the NASA-sponsored COTS test flights, and thus several dozen U.S. CubeSats will fly in the next two years. By contrast, primary customers on the Ariane, Russian and Indian rockets purchase the launch service, and thus the rocket company has incentive (and freedom) to offer revenue-producing rideshares. These issues should be studied in greater detail.

While it has been beneficial to group mission by mass and nation, a few other classifications would improve this analysis. For example, in the United States, there is a significant difference in the opportunities available to military rideshares compared to universities or commercial programs; the Space Test Program exists to broker rideshares for DoD payloads, while the other groups must fund their own or find a sponsor. It would be further useful to divide the rideshare customers into civil, military, commercial and university categories, and sift the data accordingly. Another, smaller, statistical study would be to classify the launches by rideshare type (e.g., dual-payloads such as were flown by Pegasus, P-PODs, or the ESPA platform on the EELV) or by orbit inclination.

Because of limitations in time, this study only considered the last 20 years. While that is probably the most useful interval for understanding the near-term future of rideshares, there is benefit to extending the analysis back to 1960. If nothing else, it will bring the long-term trends into focus and help identify the CubeSat phenomenon as being an extraordinary event. The attempts to incorporate the economic and political backgrounds into the analysis would also benefit; we could, for example, compare the Soviet/Russian rideshares before and after the breakup of the Soviet Union (where the Russian systems took on paying Western customers). It would also help us track the history of rideshares related to the advent of new rockets: do launch systems carry more rideshares during the beginning (test) phase, mature operations, or drawdown?

Finally, this rideshare study has been focused more on the launch than the missions themselves. This work can be expanded to consider mission lifetimes, failure rates and other factors of utility. Such studies will provide further insight into the surprisingly-large rideshare market.

References

[1] J. Puig-Suari, C. Turner, and W. Ahlgren, "Development of the Standard CubeSat Deployer and a CubeSat Class Picosatellite," IEEE Aerospace Conference Proceedings, vol. 1, 2001, pp. 1347-1353.

[2] D. Hinkley, D. Williamson, "MEPSI on STS-1 13 Post Flight Report," Space 2004 conference, San Diego, CA, Sept, 2004, AIAA paper 2004-5847.

[3] S. Eagleson, K. Sarda, S. Mauthe, T. Tuli and R. Zee, "Adapatable, Multi-Mission Design of CanX Nanosatellites", 20th AIAA/USU Conference on Small Satellites, Logan, UT, August 2006, SSC06-VII-3.

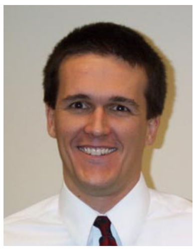
[4] Space Track, http://www.space-track.org (subscription required).

[5] Encyclopedia Astronautica, http://www.astronautix.com/ .

[6] Gunter's Space Page, http://space.skyrocket.de/.

[7] Union of Concerned Scientists, "UCS Satellite Database (1 November 2010)", http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html

BIOGRAPHY



Michael Swartwout is an assistant professor of Aerospace & Mechanical Engineering at St. Louis University. His primary research interests are in the intersection of operations, design, economics and organizational behavior, with a particular interest in the development of low-cost experimentation in space. Michael earned his PhD from Stanford, where he was the project manager for the Sapphire student satellite launched in 2001. His BS and MS are from the University of Illinois.*

APPENDIX

The names and basic information on all 316 rideshare missions used in this analysis are provided. Launch/deployment failures are indicated in **boldface**.

Name	COSPAR	Sponsor	Launch Date	Launch Site	Mass (kg)	Launch Vehicle
OSCAR 14 (UOSAT 3)	1990-005B	UK	1/22/90	Europe	46	Ariane 40
OSCAR 15 (UOSAT 4)	1990-005C	UK	1/22/90	Europe	48	Ariane 40
OSCAR 16 (PACSAT)	1990-005D	US	1/22/90	Europe	12	Ariane 40
OSCAR 17 (DOVE)	1990-005E	BRAZ	1/22/90	Europe	12	Ariane 40
OSCAR 19 (LUSAT)	1990-005G	ARGN	1/22/90	Europe	12	Ariane 40
DEBUT (ORIZURU)	1990-013B	JPN	2/7/90	Japan	50	H-1
JAS 1B (FUJI 2)	1990-013C	JPN	2/7/90	Japan	50	H-1
PEGSAT	1990-028A	US	4/5/90	USA	178	Pegasus
QQW-1	1990-081B	PRC	9/3/90	China	4	CZ-4A
QQW-2	1990-081C	PRC	9/3/90	China	4	CZ-4A
MPEC	1991-031C	US	4/28/91	USA	70	Shuttle
LOSAT X	1991-047B	US	7/4/91	USA	75	Delta 7925
OSCAR 22 (UoSAT 5)	1991-050B	UK	7/17/91	Europe	50	Ariane 40
TUBSAT A	1991-050D	GER	7/17/91	Europe	38	Ariane 40
SARA	1991-050E	FR	7/17/91	Europe	26	Ariane 40
MAGION 3	1991-086E	CZCH	12/18/91	Russia	52	Tsiklon-3
OSCAR 23 (KITSAT 1)	1992-052B	SKOR	8/10/92	Europe	50	Ariane 42P
S80/T	1992-052C	FR	8/10/92	Europe	50	Ariane 42P
PION 5	1992-056C	CIS	8/19/92	Russia	50	Soyuz 11A511U
PION 6	1992-056D	CIS	8/19/92	Russia	50	Soyuz 11A511U
FREJA	1992-064A	SWED	10/6/92	China	214	CZ-2C
LAGEOS 2	1992-070B	IT	10/22/92	USA	400	Shuttle
OXP 1	1993-009A	US	2/9/93	USA	14	Pegasus
SEDS 1	1993-017B	US	3/30/93	USA	25	Delta 7925
ARASENE	1993-031B	FR	5/12/93	Europe	154	Ariane 42L
TEMISAT	1993-055B	IT	8/31/93	Russia	42	Tsiklon-3
STELLA	1993-061B	FR	9/26/93	Europe	48	Ariane 40
KITSAT B	1993-061C	SKOR	9/26/93	Europe	49	Ariane 40

POSAT 1	1993-061D	POR	9/26/93	Europe	50	Ariane 40
HEALTHSAT 1	1993-061E	US	9/26/93	Europe	48	Ariane 40
ITAMSAT	1993-061F	IT	9/26/93	Europe	50	Ariane 40
EYESAT A	1993-061G	US	9/26/93	Europe	12	Ariane 40
TUBSAT B	1994-003B	GER	1/25/94	Russia	40	Tsiklon-3
BREMSAT	1994-006H	GER	2/3/94	USA	63	Shuttle
USA 102	1994-017B	US	3/13/94	USA	203	ARPA Taurus
STRV 1A	1994-034B	UK	6/17/94	Europe	50	Ariane 44LP
STRV 1B	1994-034C	UK	6/17/94	Europe	53	Ariane 44LP
ASTRID	1995-002B	SWED	1/24/95	Russia	26	Kosmos 11K65M
FAISAT	1995-002C	US	1/24/95	Russia	115	Kosmos 11K65M
CERISE	1995-033B	FR	7/7/95	Europe	50	Ariane 40
UPM/LBSAT	1995-033C	SPN	7/7/95	Europe	47	Ariane 40
MAGION 4	1995-039F	CZCH	8/2/95	Russia	50	Molniya 8K78M
SURFSAT	1995-059B	US	11/4/95	USA	55	Delta 7920-X
SKIPPER	1995-072B	US	12/28/95	Russia	250	Molniya 8K78M
Techsat 1 (GO-29)	**1995-F02B**	**ISRL**	**3/28/95**	**Russia**	**48**	**Start**
Unamsat a	**1995-F02C**	**MEX**	**3/28/95**	**Russia**	**17**	**Start**
TIPS Ralph	1996-029E	US	5/12/96	USA	38	Titan 403A
TIPS Norton	1996-029F	US	5/12/96	USA	15	Titan 403A
PAMS STU	1996-032D	US	5/19/96	USA	49	Shuttle
JAS 2 (FO-29)	1996-046B	JPN	8/17/96	Japan	50	H-II
MICROSAT	1996-050A	ARGN	8/29/96	Russia	32	Molniya 8K78M
MAGION 5	1996-050B	CZCH	8/29/96	Russia	58	Molniya 8K78M
UNAMSAT	1996-052B	MEX	9/5/96	Russia	10	Kosmos 11K65M
FAISAT 2V	1997-052B	US	9/23/97	Russia	110	Kosmos 11K65M
SPUTNIK JR	1997-058C	CIS	10/5/97	Russia	4	Soyuz 11A511U
INSPEKTOR	1997-058D	GER	10/5/97	Russia	72	Soyuz 11A511U
TEAMSAT	1997-066C	ESA	10/30/97	Europe	350	Ariane 5G
EQUATOR S	1997-075B	GER	12/2/97	Europe	250	Ariane 44P
SNOE	1998-012A	US	2/26/98	USA	115	Pegasus XL
BATSAT	1998-012B	US	2/26/98	USA	112	Pegasus XL
TUBSAT N	1998-042A	GER	7/7/98	Russia	8	Shtil-1/1N
TUBSAT N1	1998-042B	GER	7/7/98	Russia	3	Shtil-1/1N
FASAT B	1998-043B	CHLE	7/10/98	Russia	50	Zenit-2
TMSAT	1998-043C	THAI	7/10/98	Russia	50	Zenit-2
TECHSAT 1B	1998-043D	ISRA	7/10/98	Russia	50	Zenit-2
WESTPAC	1998-043E	AUS	7/10/98	Russia	24	Zenit-2
SAFIR 2	1998-043F	GER	7/10/98	Russia	60	Zenit-2
ATEX	1998-055C	US	10/3/98	USA	53	ARPA Taurus
SEDSAT 1	1998-061B	US	10/24/98	USA	41	Delta 7326-9.5
SPUTNIK 41	1998-062C	CIS	10/25/98	Russia	4	Soyuz 11A511U
PAN SAT	1998-064B	US	10/29/98	USA	70	Shuttle
SAC A	1998-069B	ARGN	12/4/98	USA	68	Shuttle
MIGHTYSAT 1	1998-069C	US	12/4/98	USA	320	Shuttle
ASTRID 2	1998-072B	SWED	12/10/98	Russia	30	Kosmos 11K65M
ORSTED	1999-008B	DEN	2/23/99	USA	62	Delta 7920-X
SUNSAT	1999-008C	SAFR	2/23/99	USA	63	Delta 7920-X
SPUTNIK JR 3	1999-015C	CIS	4/2/99	Russia	4	Soyuz 11A511U
MEGSAT	1999-022B	IT	4/28/99	Russia	35	Kosmos 11K65M

SJ-5	1999-025B	PRC	5/10/99	China	300	CZ-4B
TERRIERS	1999-026A	US	5/18/99	USA	125	Pegasus XL/HAPS
MUBLCOM	1999-026B	US	5/18/99	USA	48	Pegasus XL/HAPS
KITSAT 3	1999-029A	SKOR	5/26/99	India	110	PSLV
TUBSAT	1999-029B	GER	5/26/99	India	45	PSLV
STARSHINE	1999-030B	US	5/27/99	USA	39	Shuttle
SACI 1	1999-057B	BRAZ	10/14/99	China	60	CZ-4B
CLEMENTINE	1999-064B	FR	12/3/99	Europe	50	Ariane 40
ACRIMSAT	1999-070B	US	12/21/99	USA	115	Taurus 2110
JAWSAT	2000-004A	US	1/27/00	USA	64	Minotaur 1
OCS	2000-004B	US	1/27/00	USA	22	Minotaur 1
OPAL	2000-004C	US	1/27/00	USA	13	Minotaur 1
FALCONSAT	2000-004D	US	1/27/00	USA	52	Minotaur 1
ASUSAT	2000-004E	US	1/27/00	USA	5	Minotaur 1
PICOSAT 1&2 (TETHERED)	2000-004H	US	1/27/00	USA	0	Minotaur 1
PICOSAT 3	2000-004J	US	1/27/00	USA	68	Minotaur 1
PICOSAT 4	2000-004K	US	1/27/00	USA	68	Minotaur 1
PICOSAT 5	2000-004L	US	1/27/00	USA	1	Minotaur 1
PICOSAT 6	2000-004M	US	1/27/00	USA	0	Minotaur 1
TZINGHUA 1	2000-033B	PRC	6/28/00	Russia	50	Kosmos 11K65M
SNAP 1	2000-033C	UK	6/28/00	Russia	6	Kosmos 11K65M
MITA-O (NINA)	2000-039A	IT	7/15/00	Russia	170	Kosmos 11K65M
BIRD-RUBIN/SL-8	2000-039C	GER	7/15/00	Russia	82	Kosmos 11K65M
PICOSAT 7&8 (TETHERED)	2000-042C	US	7/19/00	USA	0.4	Minotaur 1
SAUDISAT 1A	2000-057A	SAUD	9/26/00	Russia	50	Dnepr
MEGSAT 1	2000-057B	IT	9/26/00	Russia	50	Dnepr
UNISAT	2000-057C	IT	9/26/00	Russia	10	Dnepr
TIUNGSAT 1	2000-057D	MALA	9/26/00	Russia	10	Dnepr
SAUDISAT 1B	2000-057E	SAUD	9/26/00	Russia	10	Dnepr
SIMPLESAT 1	2001-035B	US	8/10/01	USA	52	Shuttle
STARSHINE 3	2001-043A	US	9/30/01	USA	67	Minotaur 1
PICOSAT 9	2001-043B	US	9/30/01	USA	67	Athena-1
PCSAT	2001-043C	US	9/30/01	USA	67	Athena-1
SAPPHIRE	2001-043D	US	9/30/01	USA	67	Athena-1
KOLIBRI	2001-051C	CIS	11/26/01	Russia	21	Soyuz FG
STARSHINE 2	2001-054B	US	12/5/01	USA	40	Shuttle
KOMPASS	2001-056B	CIS	12/10/01	Russia	80	Zenit-2
BADR B	2001-056C	PAKI	12/10/01	Russia	70	Zenit-2
MAROC TUBSAT	2001-056D	GER	12/10/01	Russia	45	Zenit-2
REFLECTOR	2001-056E	CIS	12/10/01	Russia	8	Zenit-2
QuikTOMS	**2001-F01B**	**US**	**9/21/01**	**USA**	**166**	**Taurus-2110**
SBD	**2001-F01C**	**US**	**9/21/01**	**USA**	**73**	**Taurus-2110**
Celestis 05	**2001-F01D**	**US**	**9/21/01**	**USA**	**0.1**	**Taurus-2110**
DASH/VEP 3	2002-003B	JPN	2/4/02	Japan	70	H-IIA 2024
IDEFIX/ARIANE 42P	2002-021B	FR	5/4/02	Europe	12	Ariane 42P
HAIYANG 1	2002-024A	PRC	5/15/02	China	360	CZ-4B
MEPSI	2002-052B	US	11/24/02	USA	2	Shuttle
ALSAT 1	2002-054A	ALG	11/28/02	Russia	80	Kosmos 11K65M
MOZHAYETS	2002-054B	CIS	11/28/02	Russia	80	Kosmos 11K65M

RUBIN 3/SL-8	2002-054C	GER	11/28/02	Russia	80	Kosmos 11K65M
FEDSAT	2002-056B	AUS	12/14/02	Japan	65	H-IIA 202
WEOS	2002-056C	JPN	12/14/02	Japan	58	H-IIA 202
MICRO LABSAT	2002-056D	JPN	12/14/02	Japan	50	H-IIA 202
RUBIN 2	2002-058A	GER	12/20/02	Russia	12	Dnepr
LATINSAT B	2002-058B	ARGN	12/20/02	Russia	12	Dnepr
SAUDISAT 1C	2002-058C	SAUD	12/20/02	Russia	10	Dnepr
UNISAT 2	2002-058D	IT	12/20/02	Russia	10	Dnepr
TRAILBLAZER 2	2002-058E	US	12/20/02	Russia	45	Dnepr
LATINSAT A	2002-058H	ARGN	12/20/02	Russia	12	Dnepr LV
CHIPSAT	2003-002B	US	1/13/03	USA	85	Delta 7320-10
XSS 10	2003-005B	US	1/29/03	USA	28	Delta 7925-9.5
MIMOSA	2003-031B	CZCH	6/30/03	Russia	51	Rokot
DTUSAT	2003-031C	DEN	6/30/03	Russia	1	Rokot
MOST	2003-031D	CA	6/30/03	Russia	66	Rokot
CUTE-1	2003-031E	JPN	6/30/03	Russia	1	Rokot
QUAKESAT	2003-031F	US	6/30/03	Russia	3	Rokot
AAU CUBESAT	2003-031G	DEN	6/30/03	Russia	1	Rokot
CANX-1	2003-031H	CA	6/30/03	Russia	1	Rokot
CUBESAT XI-IV	2003-031J	JPN	6/30/03	Russia	1	Rokot
MOZHAYETS 4	2003-042A	CIS	9/27/03	Russia	100	Kosmos 11K65M
RUBIN 4/SL-8	2003-042B	GER	9/27/03	Russia	100	Kosmos 11K65M
NIGERIASAT 1	2003-042C	NIG	9/27/03	Russia	80	Kosmos 11K65M
UK-DMC	2003-042D	UK	9/27/03	Russia	80	Kosmos 11K65M
BILSAT 1	2003-042E	TURK	9/27/03	Russia	64	Kosmos 11K65M
LARETS	2003-042F	CIS	9/27/03	Russia	64	Kosmos 11K65M
SMART 1	2003-043C	ESA	9/27/03	Europe	370	Ariane 5G
CHUANG XIN 1 (CZ-1)	2003-049B	PRC	10/21/03	China	88	CZ-4B
SATEC	**2003-E01A**	**BRAZ**	**8/22/03**	**Brazil**	**65**	**VLS-1**
UNOSAT 1	**2003-E01B**	**BRAZ**	**8/22/03**	**Brazil**	**8.8**	**VLS-1**
NAXING 1	2004-012B	PRC	4/18/04	China	25	CZ-2C
APRIZESAT 2	2004-025A	US	6/29/04	Russia	12	Dnepr
DEMETER	2004-025C	FR	6/29/04	Russia	125	Dnepr
SAUDICOMSAT 1	2004-025D	SAUD	6/29/04	Russia	12	Dnepr
SAUDICOMSAT 2	2004-025E	SAUD	6/29/04	Russia	12	Dnepr
SAUDISAT 2	2004-025F	SAUD	6/29/04	Russia	35	Dnepr
APRIZESAT 1	2004-025G	US	6/29/04	Russia	12	Dnepr
UNISAT 3	2004-025H	IT	6/29/04	Russia	12	Dnepr
AMSAT ECHO	2004-025K	US	6/29/04	Russia	12	Dnepr
NANOSAT(1)	2004-049B	SPN	12/18/04	Europe	20	Ariane 5Gp
ESSAIM-1	2004-049C	FR	12/18/04	Europe	120	Ariane 5Gp
ESSAIM-2	2004-049D	FR	12/18/04	Europe	120	Ariane 5Gp
ESSAIM-3	2004-049E	FR	12/18/04	Europe	120	Ariane 5Gp
ESSAIM-4	2004-049F	FR	12/18/04	Europe	120	Ariane 5Gp
PARASOL	2004-049G	FR	12/18/04	Europe	125	Ariane 5Gp
MK-1TS	2004-052C	CIS	12/24/04	Russia	66	Tsiklon-3
TATIANA	2005-002C	CIS	1/20/05	Russia	30	Kosmos 11K65M
SLOSHSAT	2005-005C	ESA	2/12/05	Europe	127	Ariane 5ECA
TNS-0	2005-007C	CIS	2/28/05	Russia	5	Soyuz 11A511U
HAMSAT	2005-017B	IND	5/5/05	India	42	PSLV

INDEX	2005-031B	JPN	8/23/05	Russia	60	Dnepr
SUITSAT	2005-035C	CIS	9/8/05	Russia	20	ISS
BEIJING 1 (TSINGHUA)	2005-043A	PRC	10/27/05	Russia	140	Kosmos 11K65M
TOPSAT	2005-043B	UK	10/27/05	Russia	108	Kosmos 11K65M
UWE-1	2005-043C	GER	10/27/05	Russia	1	Kosmos 11K65M
SINAH 1	2005-043D	IRAN	10/27/05	Russia	160	Kosmos 11K65M
SSETI-EXPRESS	2005-043E	ESA	10/27/05	Russia	80	Kosmos 11K65M
CUBESAT XI-V	2005-043F	JPN	10/27/05	Russia	1	Kosmos 11K65M
MOZ.5/SAFIR/RUBIN 5/SL-8	2005-043G	GER	10/27/05	Russia	45	Kosmos 11K65M
CUTE 1.7	2006-005C	JPN	2/21/06	Japan	3	M-V
HITSAT	2006-041F	JPN	9/22/06	Japan	1	M-V
LDREX 2	2006-043C	JPN	10/13/06	Europe	180	Ariane 5ECA
MEPSI	2006-055B	US	12/10/06	USA	2	Shuttle
RAFT	2006-055C	US	12/10/06	USA	5	Shuttle
MARSCOM	2006-055D	US	12/10/06	USA	5	Shuttle
ANDE MAA SPHERE 1	2006-055F	US	12/10/06	USA	50	Shuttle
ANDE FCAL SPHERE 2	2006-055J	US	12/10/06	USA	75	Shuttle
GENESAT	2006-058C	US	12/16/06	USA	4	Minotaur 1
Baumanets 1	**2006-F03B**	**CIS**	**7/26/06**	**Russia**	**50**	**Dnepr**
Unisat 4	**2006-F03C**	**CIS**	**7/26/06**	**Russia**	**12**	**Dnepr**
PicPot	**2006-F03D**	**-**	**7/26/06**	**Russia**	**2**	**Dnepr**
CP 1 (K7RR-Sat)	**2006-F03E**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
CP 2	**2006-F03F**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
HAUSAT 1	**2006-F03G**	**-**	**7/26/06**	**Russia**	**1**	**Dnepr**
ICECube 1	**2006-F03H**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
ICECube 2	**2006-F03I**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
ION	**2006-F03J**	**US**	**7/26/06**	**Russia**	**2**	**Dnepr**
KUTESat-Pathfinder	**2006-F03K**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
Mea Huaka'i	**2006-F03L**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
MEROPE	**2006-F03M**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
Ncube 1	**2006-F03N**	**NRWY**	**7/26/06**	**Russia**	**1**	**Dnepr**
Rincon 1	**2006-F03O**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
SACRED	**2006-F03P**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
SEEDS	**2006-F03Q**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
AeroCube 1	**2006-F03R**	**US**	**7/26/06**	**Russia**	**1**	**Dnepr**
LAPAN-TUBSAT	2007-001A	INDO	1/10/07	India	56	PSLV
PEHUENSAT 1	2007-001D	ARGN	1/10/07	India	6	PSLV
MIDSTAR 1	2007-006B	US	3/9/07	USA	120	Atlas V 401
OE (NEXTSAT)	2007-006C	US	3/9/07	USA	250	Atlas V 401
STPSAT 1	2007-006D	US	3/9/07	USA	170	Atlas V 401
FALCONSAT 3	2007-006E	US	3/9/07	USA	50	Atlas V 401
CFESAT	2007-006F	US	3/9/07	USA	159	Atlas V 401
SAUDISAT 3	2007-012B	SAUD	4/17/07	Russia	35	Dnepr
SAUDICOMSAT 7	2007-012C	SAUD	4/17/07	Russia	12	Dnepr
SAUDICOMSAT 6	2007-012E	SAUD	4/17/07	Russia	12	Dnepr
CSTB 1	2007-012F	US	4/17/07	Russia	1	Dnepr
SAUDICOMSAT 5	2007-012H	SAUD	4/17/07	Russia	12	Dnepr
SAUDICOMSAT 3	2007-012J	SAUD	4/17/07	Russia	12	Dnepr
MAST	2007-012K	US	4/17/07	Russia	3	Dnepr
SAUDICOMSAT 4	2007-012L	SAUD	4/17/07	Russia	12	Dnepr

LIBERTAD 1	2007-012M	COL	4/17/07	Russia	1	Dnepr
CP3	2007-012N	US	4/17/07	Russia	1	Dnepr
CAPE 1	2007-012P	US	4/17/07	Russia	1	Dnepr
CP4	2007-012Q	US	4/17/07	Russia	1	Dnepr
AEROCUBE 2	2007-012R	US	4/17/07	Russia	1	Dnepr
AAM/PSLV	2007-013B	IND	4/23/07	India	185	PSLV
CANX-6	2008-021B	CA	4/28/08	India	1	PSLV
CUTE-1.7+APD II	2008-021C	JPN	4/28/08	India	4	PSLV
IMS-1	2008-021D	IND	4/28/08	India	60	PSLV
COMPASS 1	2008-021E	GER	4/28/08	India	1	PSLV
AAUSAT CUBESAT 2	2008-021F	DEN	4/28/08	India	1	PSLV
DELFI C3	2008-021G	NETH	4/28/08	India	1	PSLV
CANX-2	2008-021H	CA	4/28/08	India	1	PSLV
SEEDS	2008-021J	JPN	4/28/08	India	1	PSLV
RUBIN 8/PSLV	2008-021K	GER	4/28/08	India	7	PSLV
YUBILEINY	2008-025A	CIS	5/23/08	Russia	45	Rokot
BX-1	2008-047G	PRC	9/25/08	China	40	CZ-2F
CHUANG XIN 1-02(CX-1-02)	2008-056B	PRC	11/5/08	China	88	CZ-2D
PSSC	2008-059B	US	11/15/08	USA	9	Shuttle
Trailblazer	**2008-F01A**	**US**	**2/8/08**	**USA**	**83.5**	**Falcon-1**
PreSat	**2008-F01B**	**US**	**2/8/08**	**USA**	**4**	**Falcon-1**
Nanosail D	**2008-F01C**	**US**	**2/8/08**	**USA**	**4**	**Falcon-1**
Celestis 07	**2008-F01D**	**US**	**2/8/08**	**USA**	**0.1**	**Falcon-1**
PRISM (HITOMI)	2009-002B	JPN	1/23/09	Japan	5	H-IIA 202
SPRITE-SAT (RISING)	2009-002C	JPN	1/23/09	Japan	100	H-IIA 202
KAGAYAKI	2009-002D	JPN	1/23/09	Japan	50	H-IIA 202
SOHLA-1 (MAIDO-1)	2009-002E	JPN	1/23/09	Japan	50	H-IIA 202
SDS-1	2009-002F	JPN	1/23/09	Japan	28	H-IIA 202
STARS (KUKAI)	2009-002G	JPN	1/23/09	Japan	5	H-IIA 202
KKS-1 (KISEKI)	2009-002H	JPN	1/23/09	Japan	3	H-IIA 202
SPIRALE A	2009-008C	FR	2/12/09	Europe	117	Ariane 5ECA
SPIRALE B	2009-008D	FR	2/12/09	Europe	117	Ariane 5ECA
ANUSAT	2009-019B	IND	4/20/09	India	40	PSLV CA
PHARMASAT	2009-028B	US	5/19/09	USA	5	Minotaur 1
CP6	2009-028C	US	5/19/09	USA	1	Minotaur 1
HAWKSAT 1	2009-028D	US	5/19/09	USA	1	Minotaur 1
AEROCUBE 3	2009-028E	US	5/19/09	USA	1	Minotaur 1
DRAGONSAT	2009-038B	US	7/15/09	USA	5	Shuttle
ANDE POLLUX SPHERE	2009-038E	US	7/15/09	USA	50	Space Shuttle (STS 127)
ANDE CASTOR SPHERE	2009-038F	US	7/15/09	USA	25	Space Shuttle (STS 127)
STERKH	2009-039B	CIS	7/21/09	Russia	160	Kosmos 11K65M
DEIMOS 1	2009-041A	SPN	7/29/09	Russia	90	Dnepr
DUBAISAT 1	2009-041B	UAE	7/29/09	Russia	190	Dnepr
DMC 2	2009-041C	UK	7/29/09	Russia	95	Dnepr
APRIZESAT 4	2009-041D	US	7/29/09	Russia	12	Dnepr
NANOSAT 1B	2009-041E	SPN	7/29/09	Russia	22	Dnepr
APRIZESAT 3	2009-041F	US	7/29/09	Russia	12	Dnepr
STERKH 2	2009-049B	CIS	9/17/09	Russia	160	Soyuz 2-1b
FREGAT/IRIS	2009-049C	CIS	9/17/09	Russia	-	Soyuz / Fregat ST

TATIANA 2	2009-049D	CIS	9/17/09	Russia	90	Soyuz 2-1b
UGATUSAT	2009-049E	CIS	9/17/09	Russia	35	Soyuz 2-1b
SUMBANDILA	2009-049F	SAFR	9/17/09	Russia	81	Soyuz ST / Fregat ST
BLITS	2009-049G	CIS	9/17/09	Russia	7	Soyuz ST / Fregat ST
SWISSCUBE	2009-051B	SWTZ	9/23/09	India	1	PSLV CA
BEESAT	2009-051C	GER	9/23/09	India	1	PSLV
UWE-2	2009-051D	GER	9/23/09	India	1	PSLV
ITUPSAT 1	2009-051E	TURK	9/23/09	India	1	PSLV
RUBIN 9.1/RUBIN 9.2/PSLV	2009-051F	GER	9/23/09	India	16	PSLV CA
PROBA 2	2009-059B	ESA	11/2/09	Russia	130	Rokot
XIWANG-1 (HOPE-1)	2009-072B	PRC	12/15/09	China	50	CZ-4C
HAYATO (K-SAT)	2010-020A	JPN	5/20/10	Japan	1	H-IIA 202
WASEDA-SAT2	2010-020B	JPN	5/20/10	Japan	1	H-IIA 202
NEGAI	2010-020C	JPN	5/20/10	Japan	1	H-IIA 202
IKAROS	2010-020E	JPN	5/20/10	Japan	315	H-IIA 202
UNITEC-1	2010-020F	JPN	5/20/10	Japan	16	H-IIA 202
PICARD	2010-028A	FR	6/15/10	Russia	100	Dnepr
PRISMA (MANGO)	2010-028B	SWED	6/15/10	Russia	180	Dnepr
STUDSAT	2010-035B	IND	7/12/10	India	1	PSLV CA
AISSAT 1	2010-035C	NOR	7/12/10	India	6	PSLV CA
ALSAT 2A	2010-035D	ALG	7/12/10	India	116	PSLV CA
TISAT 1	2010-035E	SWIT	7/12/10	India	1	PSLV CA
Strela 3	2010-043B	CIS	9/8/10	Russia	225	Rokot-KM
Rodnik	2010-043C	CIS	9/8/10	Russia	225	Rokot-KM
ZHEDA PIXING 1B	2010-047B	PRC	9/22/10	China	2.5	CZ-2D
ZHEDA PIXING 1C	2010-047C	PRC	9/22/10	China	3.5	CZ-2D
RAX	2010-062A	US	11/20/10	USA	3	Minotaur-4 HAPS
O/OREOS	2010-062B	US	11/20/10	USA	5	Minotaur-4 HAPS
Fastsat-hsv01	2010-062C	US	11/20/10	USA	140	Minotaur-4 HAPS
Falconsat 5	2010-062D	US	11/20/10	USA	130	Minotaur-4 HAPS
FAST 1 (USA 222)	2010-062E	US	11/20/10	USA	15	Minotaur-4 HAPS
NanosailD2	**2010-062F**	**US**	**11/20/10**	**USA**	**4**	**Minotaur-4 HAPS**
QBX2	2010-066A	US	12/8/10	USA	5	Falcon-9
SMDC ONE	2010-066B	US	12/8/10	USA	4	Falcon-9
Perseus 003	2010-066C	US	12/8/10	USA	1	Falcon-9
Perseus 001	2010-066D	US	12/8/10	USA	1	Falcon-9
QBX1	2010-066E	US	12/8/10	USA	5	Falcon-9
Perseus 002	2010-066F	US	12/8/10	USA	1	Falcon-9
Perseus 000	2010-066G	US	12/8/10	USA	1	Falcon-9
Mayflower	2010-066H	US	12/8/10	USA	5	Falcon-9