



SMALL SATELLITE LAUNCH SERVICES BROKERAGE IN RUSSIA

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WHY BROKER?

When booking a ticket for a particular destination, we are not often concerned with the make of the vehicle, whether car, train, ship or aircraft, but with the quality of the service provided for the price of the ticket. We are also very much concerned with the difficulty of obtaining the ticket, the reliability of the booking agency, the information it provides and the reliability of the transportation system itself. We also worry about whether we have made the right choice and whether there may have been a better one.

The last point is particularly relevant to the space sector where no general brokers, equivalent to a terrestrial travel agency, exist. Luckily, the FSU has a sufficient variety of launchers to enable such a service to work. From 1995, the launches of 81 small satellites have been managed so far on 5 different launch vehicles. SSTL is CST's most important customer and uses CST's full service which runs from the initial competitive tendering exercise to the management of the launch campaign.

Brokering improves the business of all parties, including the launcher providers.



GOING DIRECT

The usual procedure is for a customer to go direct to a launcher operator or their agent. The disadvantage of this traditional method is that the customer pays more because:

- Agents only add to the price because they have to charge a percentage to the launcher operator.
- Agents seldom offer any other value added service
- Neither agents or launcher operators are interested in reducing the final price
- Neither agents or the launcher operators are motivated to construct the launch service agreement (LSA) in a way that saves the customer money



WHAT LAUNCH PROVIDERS DON'T TELL

Potential Delays

- Launch vehicle or main satellite readiness
- Incomplete bureaucracy such as drop-zone arrangement
- Problems with others in manifest
- Customs clearance
- Transport of equipment after launch campaign
- Etc

Hidden Costs

- Accommodation costs at range
- Transportation to range
- Delayed or repeat launch campaigns
- Facilities for VIPs
- Customs duties
- Etc.



IN GENERAL

- CST is on good terms with all launcher providers since it has a 34 year record of bringing business, brokers fairly and ensures the satisfaction of both parties.
- CST services are paid for by its customers and not the launch providers. It therefore, again, brokers fairly and ensures that the customers are taken care of.
- CST has experience of doing business in Russia going back to 1987.
- CST has never accepted exclusivity with either customers or suppliers, depending on its reputation for honest brokering. In any case, after the end of the Soviet Union in 1991 and the opening up of the market, the idea is no longer appropriate.
- Russia is introducing several new launch systems, including Soyuz-2.1V, Air Launch and Angara, which will also be included in CST's brokerage/ management services.
- While CST specialises in small satellites mainly in sun-synchronous low earth orbits, all types of satellite and orbit can be brokered, including escape.



CST LAUNCH BROKERAGE ACHIEVEMENTS

- 81 small satellites have had launches brokered and managed by CST so far (including 3 cubesats and 48 nanosatellites).
- CST is contracted for the brokerage and management of launching services for many more satellites on several different launchers over the next 3 years and negotiating others beyond that time.
- All current types of FSU launchers are brokered. So far, CST has managed launches on 5 different launchers from 3 different spaceports.
- CST has negotiated several pioneering contracts such as the first Dnepr launch, first Cosmos to SSO, first Dnepr to SSO, etc.
- Further innovation will be introduced over the next 5 years, both in style of service and with the new launchers that will be introduced.



HISTORY OF LAUNCH ARRANGMENTS

YEAR	DATE	LAUNCHER (MODE)	SATELLITE(S)
1995	August 31	Tsyklon (1 piggy-back)	Fasat Alpha
1998	July 10	Zenit (2 piggy-back)	Fasat Bravo + TM Sat
1999	April 21	Dnepr (1 dedicated)	Uo Sat 12 (first commercial use of SS-18)
2000	June 28	Cosmos (2 piggy-back)	Tsinghua 1 +Snap (first SSO flight of Cosmos)
2000	September 26	Dnepr (1 piggy-back)	Tiung Sat
2002	November 28	Cosmos (main in cluster)	Alsats-first Disaster Monitoring Constellation (DMC)
2003	September 27	Cosmos (3 in cluster)	NigeriaSat-1, BilSat-1 and UK-DMC (all DMC)
2004	June 29	Dnepr (main in cluster)	Demeter (CNES, first SSO flight of Dnepr)
2005	October 27	Cosmos (3 in cluster)	TopSat, ChinaSat (DMC), SSETI Express+cubesats
2008	August 29	Dnepr (5 in cluster)	RapidEye constellation
2009	July 29	Dnepr (2 in cluster)	UK-DMC2 + DEIMOS-1 (both DMC)
2009	September 17	Soyuz/Fregat (1 piggy-back)	SumbandilaSat (South Africa, first piggy-back from this launcher combination)
2010	June 15	Dnepr (1 of a pair)	Picard (CNES, paired with Prisma)
2011	August 17	Dnepr (2 in cluster)	NigeriaSat-2 and NigeriaSat-X
2012	July 22	Soyuz/Fregat (1 piggy back)	ADS-1B
2014	June 19	Dnepr (1 in cluster)	KazEOSat-2
2014	July 8	Soyuz/ Fregat (2 piggy back)	TechDemoSat-1 (TDS-1), UKube-1
2017	July 14	Soyuz-2.1a/Fregat	Kanopus-V-IR as a main payload, Planet's (USA) Flock-2k - 48 Dove CubeSats constellation



CST BROKERAGE SERVICES INCLUDE

Launcher brokerage in straightforward way ‘across the board’ for both ‘piggy back’ and dedicated launch services achieving the best achievable prices and conditions.

Local management on the spot and the conducting of progress meetings and handling bureaucratic processes for clients, can save a great deal of time and money for clients.

Contract services include CST’s interpretation and translation skills as well as its understanding of the Russian approach, which is vital for support in all technical and programmatic meetings.

Consultancy services on all aspects of FSU space industry and technology which enable potential customers to assess the technologies, stocks, associations, current situation and ability to do business of the organisations that they wish to deal with.

Insurance and other financial services can be arranged because of CST’s experience and consultancy work for financial, legal and insurance groups in London and Moscow.



THE EXPERIENCED CST RUSSIAN TEAM CAN FACILITATE

Customs clearance and transportation of satellite and equipment to cosmodrome

Payment stages: CST can negotiate a better payment spread, together with more easy transferral terms than usually asked and can also arrange for work to begin when money leaves the clients bank.

Launch price negotiations - we have often negotiated worthwhile reductions on the last 'firm' offer to the customer.

Logistics of staying in Baikonour, Plesetsk or Yasny for launch preparation are taken care of.

Translation, interpretation and 'minding' services.

The vital step of negotiating the launch services agreement (LSA) is handled firmly and in an optimum way by CST since it has a friendly working relationship with all Russian and Ukrainian launching organisations.

Compromises are needed at all stages of launch negotiations by both sides and as 'two way cultural interpreters' we are able to see that both sides are best and optimally served.



TYPICAL CST LAUNCH CONTRACT

A TYPICAL CONTRACT (WHETHER PIGGY-BACK OR DEDICATED) DIVIDES THE WORK NATURALLY INTO 4 MAIN STAGES:

Stage 1	Location of suitable launch options, preliminary price negotiations, report to customer
Stage 2	Construction of Launch Services Agreement (LSA)
Stage 3	Management of LSA through ICD, fit check and other meetings
Stage 4	Management of launch campaign up to integration of payload with launcher

- Historically, Stages 1& 2 have saved customer more than CST fees
- Contract can be abandoned after Stage 1 if no suitable launch is found
- Stages are usually sub-divided into several parts



CONTRACTING WITH CST - 1

1. Feasibility

A potential customer contacts CST with a description of the satellite, orbit, time of launch and other constraints and special requirements.

It will be very necessary to discuss budget constraints and whether a piggy-back, cluster or dedicated launch will be needed.

If CST agrees that the project is viable, an authorisation letter enabling CST to act on behalf of the customer will be required.

2. Signing of Contract with CST

The customer and CST then sign a contract as outlined on page 10.

3. Definition of Options

CST then conducts a brokerage exercise and reports to customer.

The report will give approximate prices of the various options, together with their advantages and disadvantages.

4. Selection of Options

The one or two best options are jointly selected and CST then proceeds to a firm written quote from the launch provider(s).



CONTRACTING WITH CST - 2

5a. Selection of Launch Provider

The launch price is agreed and CST then negotiates an MOU between the customer and launch provider confirming price and willingness to proceed to construct a Launch services Agreement (LSA)

5b. Customer Withdrawal

If, at this point, the conditions look unfavourable to the customer and they don't wish to sign the MOU, they may withdraw. The total cost to the customer will be the payment of stage 1 of CST's contact (page10).

6. Construct of LSA

This is the most critical phase, when all of CST skill and experience outlined on pages 6 to 9, comes into play.

7. Execution of LSA

As the customer representative CST now manages the LSA through the ICD meetings, fit checks and to the launch campaign.



LAUNCHING MODES – 1

1. PIGGY-BACK

Perceived as the cheapest option. Not always is. Customer is a poor partner of the main satellite. Customer has to go with a main payload and conform to its requirements. Has to be ready on time. No direct control over orbit or time of launch (control only by selection of best willing partner).

LEO PIGGY-BACKING IN THE FSU

A variety of vehicles - particularly to LEO

All vehicles can piggy back

Near all orbits available - often visited

But equatorial LEO orbits are difficult

LEO market is settled (GEO market developing)

By careful brokerage using opportunities and experience, very competitive prices still achievable

New launchers will enter the field soon

Multiple payload carriers for small launchers have been developed

CST experience with TSYKLON, ZENIT, COSMOS, DNEPR, SHTIL, etc., as well as its data-base and specialists



LAUNCHING MODES – 2

2. SHARED

With a variety of customers on hand and in negotiation as well as an internal knowledge of ongoing arrangements CST can arrange a fit with other satellites in shared or cluster launches.

If customers, at extra cost, wish to have the chief satellite position in the cluster, thus ensuring their required orbit and time of launch, then CST can help ensure the required number of other satellites to enable the mission to take place.

3. DEDICATED

Using its long association with launch providers and its experience in the field, CST can negotiate the best terms with any launch provider.

Very good terms can be arranged for launches that are designated as tests or promotional. The additional technical risks for the launches can be very low, they will be insurable and CST can advise on this for each specific case.

Using the same skills as employed for arranging shared or cluster launches, CST can negotiate 'guest' payloads to enable the defrayment of costs.

New small launchers entering the market, such as Angara-1, Soyuz-1 and Swift which will be able to provide dedicated missions at very economical prices



EVOLUTION OF CAPABILITIES

- 1983 Consultancy begins (insurance, BNSC, etc)
- 1987 UK/Russia (via customer in Finland)
- 1991 Soviet Union ends. Employment of Russian nationals possible
- 1993 CST Moscow office established Brokering of FSU small launchers (as adjunct to consultancy) begins
- 1995 First launch (for SSTL)
- CST launcher brokerage achieves many firsts – see table on page 7
- 2008 Management of interface of UK-Russian companies for manufacture of satellites begins (SSTL/VNEIIM for Canopus)
- 2010 Procurement of components for major European project (Galileo) begins
- 2011 Brokering of new generation Russian launchers begins
- 2011 Launch of NigeriaSat-2 and NigeriaSat-X, 25th and 26th satellite launch managed
- 2012 Launch of ADS-1B. Soyuz/Fregat
- 2014 Launch of KazEOSat-2. Dnepr rocket (1 in cluster)
- 2014 Launch of TechDemoSat-1(TDS-1),UKube-1. Soyuz/Fregat rocket (2 piggy back)
- 2017 Launch of Kanopus-V-IR as a main payload, Planet's (USA) Flock-2k – 48 Dove CubeSats constellation



THE CURRENT INVENTORY OF RUSSIAN (AND OTHER FSU) SMALL LAUNCH VEHICLES

Launch vehicle	Developer (by its current appellation)/m anufacturer	Year of maiden launch	Launch mass, tons	Propellant	Number of stages	Max. payload capability, kg (orbit)	Type of launch facility	Launch site	Operator	Estimated launch price, US\$ mln	Notes
Volna	Makeev SRC	1995 (sub-orbital)	35.3	Liquid (NT+UDMH)	2	100 (circ. H=200km, i=0-25deg.)	Submarine	Barents Sea	Makeev SRC	Less than 1.0	Was used for sub-orbital missions only
Shtil-1	Makeev SRC	1998	46	Liquid (NT+UDMH)	3	2x80 (circ. H=200km, i=70deg.)	Submarine	Barents Sea	Makeev SRC	Around 2.0	-
Shtil-2.1	Makeev SRC	Was ready in 2007	46+	Liquid (NT+UDMH)	3	100-200 (circ. H=200km, i=0-25 deg.)	Submarine	Barents Sea	Makeev SRC	Around 5	Maiden launch planned
Start-1	MIT/Votkinsk Machinebuilding Plant	1993	47	Solid	4	420 (circ. H=300km, I=90deg.)	Surface, mobile or transportable	Svobodny Plesetsk	Puskovye Uslugi	Around 10	-
Start	MIT/Votkinsk Machinebuilding Plant	1995	60	Solid	5	645 (circ. H=300km, I=90deg.)	Surface, transportable	Plesetsk	Puskovye Uslugi	Over 10?	2 nd launch announced
Strela	NPO M	2003	105	Liquid (NT+UDMH)	2 (+Post-Boost Stage)	1400 (circ. H=200km, I=65deg.)	Silo	Baikonur	NPO M	Around 15	No launches since 2003
Cosmos-3M	“Yuzhnoye” NPO/”Polyot” PO	1964	109	Liquid (nitric acid+UDMH)	2	1400 (circ. H=180km, i=65deg.)	Surface	Plesetsk, Kapustin Yar	Puskovye Uslugi, Rosoboron-export	10-14	A few bits left
Rockot	Khrunichev	1994	107	Liquid (NT+UDMH)	3	1900 (circ. H=200km, i=63deg.)	Surface	Plesetsk	Eurockot	20+	Shortage of ‘Breeze’ stages
Dnepr	“Yuzhnoye” NPO	1999	211	Liquid (NT+UDMH)	3 (+Post-Boost Stage)	4500 (circ. H=200km, i=46.2deg.)	Silo	Baikonur, Yasny	Kosmotras	20+	-

There are problems with all of these launchers. Pink, discontinued; green, out of life 2015-2017; blue, difficulties with launch facilities (Submarines, Svobodny)



THE NEXT FEW YEARS

- Several new small launchers are coming into service between 2014 and 2018 and Strela, Rokot and Dnepr will begin retirement by this time.
- It is likely that Strela, Rokot and Dnepr will all be fully retired by 2018
- 3 new systems (Angara, Soyuz-1 and Air Launch) are being developed.
- In addition, Zenit and Soyuz-Fregat will remain available for piggy-backing when their missions allow and further launcher evolution will occur (e.g. For the new Vostochny cosmodrome).
- Thus, a very different inventory of more efficient launchers will be available after 2017 and CST is well placed and already has appropriate arrangements to continue to broker across the board.



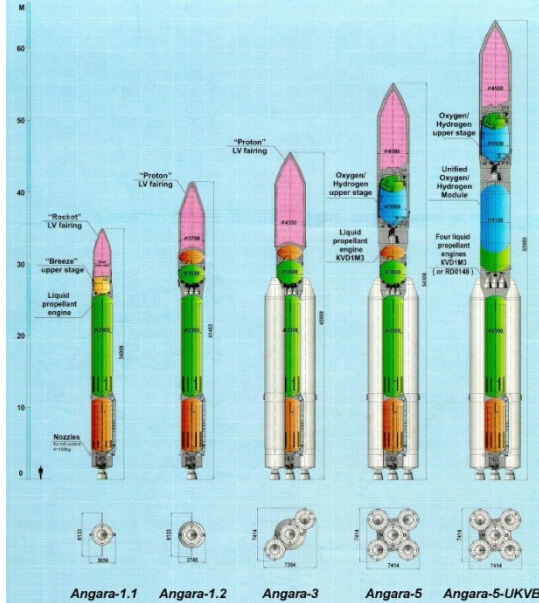
IN DEVELOPMENT

- **The “Angara”** launch vehicle family that is being currently realized on a state order includes two options of the “Angara-1” small launch vehicle. This launch family, which could be put into operation by 2013, could substitute for almost all of the current launch vehicles. Developer is Khrunichev.
- **The “Soyuz-2.1v”** launch vehicle (previously called Soyuz-1) will be launched from Soyuz facilities at Plesetsk. Performance somewhere between Angara 1.1 and 1.2. Under active development by TsSKB Samara and chasing Angara 1.1 closely. Will probably have its test launch first.
- **The “Air Launch”** project that is being developed on a private basis would provide, in the case of its realization, a new sort of launch service – the injection of small satellites into GTO and GEO in dedicated launches at relatively low launch prices. Bases on equator (Indonesia) and in Europe (Munich).



FUTURE LAUNCHERS

The Angara Launch Vehicle Family



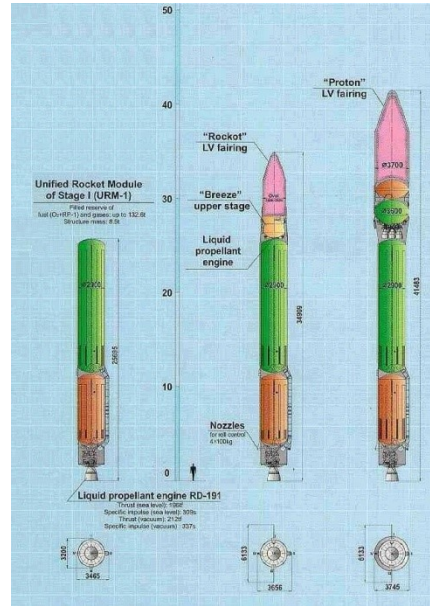
Soyuz-2.1v

• This promising small launcher is being produced by the Russian Samara Space Centre as a replacement for the Cosmos and other light launchers to be phased out. It has environmentally cleaner propellants (LOX/Kerosene) which should ease problems with ground operations and drop-zones.

• A 'Soyuz' launch facility has been adapted for its use at the Plesetsk cosmodrome and its heaviest payload from there will be 2,400 kg into an LEO of 200 km x 62.7°.

• Soyuz 2.1v has been developed on the basis of the core stage of the Soyuz 2.1B adapted for the NK-33-1 engine, an almost unchanged second stage and the use of one of the serially produced 'Soyuz' fairings.

• The vehicle has 2 stages, is about 44m long and weighs around 136 tons at lift off. The fairing has a diameter of 3m.

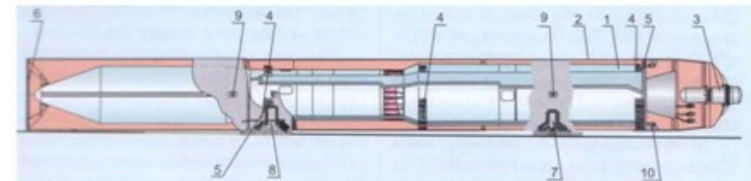


Designs of the URM-1 module, "Angara-1.1" and Angara-1.2" launch vehicles (left to right)

Angara 1.1 & 1.2

- Part of larger family
- Definite schedule for introduction
- URM-1 ready, URM-2 nearly ready
- URM-1 already proved in South Korean launcher
- Surface launch from Plesetsk
- Replacement for Rockot and Dnepr

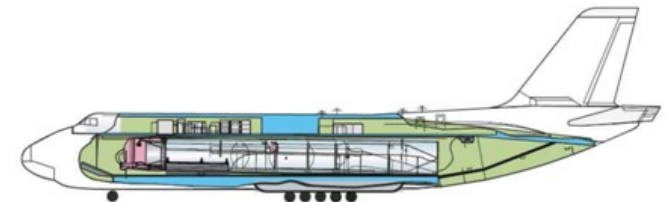
Air Launch Project



Accommodation of the "Polyot" launch vehicle in its TLC

Performance:

- To LEOs 3-4 tons
- To GTO 1.65 tons
- To GEO 0.8 tons



Accommodation of the TLC with the "Polyot" launch vehicle inside it in the "Ruslan" carrier airplane



SUMMARY TABLE OF RUSSIAN SMALL LAUNCHERS IN DEVELOPMENT

Launch vehicle (system)	Developer	year of first launch	Launch mass, tons	Payload capability, tons (orbit)	Propellant	Launch site or basic airfield	Operator	Possible launch price, US\$ mln	Status of development
Angara-1.1	Khrunichev	2013	145	2.0(circ. H=200km, i=63deg.)	LOX + Kerosene	Plesetsk	ILS?	About 25	Final on-ground testing, launch site in construction
Angara-1.2	Khrunichev	2013	167	3.5(circ. H=200km, i=63deg.)	LOX + Kerosene	Plesetsk	ILS?	About 30	The same as for Angara-1.1 but second stage in development
Soyuz-2.1v	TsSKB Progress	2012	136	2.4(circ. H=200km I=63deg)	LOX + Kerosene	Plesetsk	TSENKI	About 25	Final on-ground testing, uses slightly modified soyuz launch site
Polyot (Air Launch)	Makeev SRC	2010	102	3.0 (circ. H=200km, i=90deg.) 1.65(GTO) 0.8 (GEO)	LOX + Kerosene	Khorol, Biak Island	Air Launch AC	25 LEO to 40 GEO	Completion of design development, carrier aircraft were purchased

- All Russian
- All have environmentally clean propellants



FACTORS INFLUENCING FUTURE OUTCOME

- **FSU organisations are incorrigible launcher designers/developers**
- **Political enthusiasm and technical skill exists**
- **As market evolves ‘niches’ will open up, giving opportunities for the realisation of certain of the many existing designs, some of which have been carried near to the level of production**
- **Examples of mature projects ‘waiting in the wings’ are ISHIM (Kazakhstan), M-55x (Russia), Mayak (Ukraine) and Swift (Russia)**
- **Russian concepts of the market remain idiosyncratic and often subject to internal pressures not apparent to customers**
- **World market prices important but political factors, environmental considerations, etc may be crucial influences on designs – e.g. the Baikal reusable stage**



GETTING INFORMATION ON LAUNCHERS

- **Potential users of launch services, insurers and others may task CST to assess any launcher programme, system or technology worldwide.**
- **From 1993, with the beginning of its launcher brokerage service, CST has had access to Russian as well as UK and European specialists.**
- **Comparative analyses, market surveys, etc have been undertaken for many commercial customers as well as UKSA, ESA, NASA and CNES.**
- **Because of its continuing work in the launcher field over many years, CST has built-up a comprehensive data base. Using this, assessments of any system world-wide can be produced economically and very quickly, usually within weeks.**
- **In its launcher brokerage and consultancy services, CST has enjoyed and learned from every contract and has never failed to deliver to the customer's satisfaction. We look forward to and welcome your enquiries.**