Geostationary Loop Port geoport.ods 2018/06/12 KHL

Injection velocity for an equatorial launch loop into circular geostationary orbit. The capture speed is quite high; this is not a good way to do it. The other sheet, construction, works much better.

398600	km3/s2	mu	Earth standard grav param	82655	scale
6378	km	Re	Earth radius		
42164	km	Rg	GEO radius	**y**	**x**
86164	sec	Tg	GEO stellar period	*geo orbit*	
3.07466	km/s	Vg	GEO orbital velocity	-0.510	-0.510
80	km		Loop exit altitude	0.510	0.510
6458	km	Rp	perigee radius		
26	hours	T	passenger orbit (next perigee to west)		
6.7128E-5	rad/sec	omega	omega angular frequency		
44556	km	S	semimajor axis	*transfer orbit*	
82655	km	Ra	apogee	-0.078	-0.280
0.85506		e	eccentricity	1.000	0.280
0.28061			1+e cos(theta)		
-0.84134			cos(theta)		
2.57055	radians	theta	theta		
1.52187	radians	E	eccentric anomaly		
1.05970	radians	M	mean anomaly		
5.76821	km/s	V0	characteristic velocity		
2.66590	km/s	Vrad	radial velocity		
1.61860	km/s	Vtan	tangential velocity		
3037.616	m/s	Vdel	delta velocity		
4.39	hours	t	transit time		

Construction Port Change Plane 7.5d geoport.ods 2018/06/17 KHL

Injection velocity for an equatorial launch loop into a highly elliptical geosynchronous construction orbit. A construction orbit is synchronous with and inclined to the launch loop latitude. This ignores a small correction for apsidal precession of the construction orbit.

398600	km³/s²	mu	Earth standard grav param	3.7E+4	scale
6378	km	Re	Earth radius	y	x
42164	km	Rg	GEO (semimajor)	*GEO*	
86164	sec	Tg	GEO stellar period	-1.137	-1.137
80	km		Loop exit altitude	1.137	1.137
6458	km	Rp0	exit perigee radius	*launch*	
8	deg	Lat	exit latitude, orbit inclination	-0.174	-0.597
2000	km		construction orbit perigee altitude	2.049	0.597
8378	km	Rp1	construction orbit perigee radius	*construction*	
75950	km	Ra1	construction orbit apogee radius	-0.226	-0.681
2.2980E-8	rad/s	omega	omega angular frequency	2.049	0.681
41204	km	S0	transfer orbit semimajor axis	*transfer orbit time*	
0.90695	km/s	Va0	transfer orbit apogee velocity	41619.06	sec
1.02118	km/s	Va1	construction orbit apogee velocity	0.483021	sd
0.11423	km/s	DVa	velocity change at apogee		

Slow cargo orbit. Launch some of the mass to a very high apogee, 12 hours later. The cargo orbital plane will be tilted at twice the latitude away from the construction orbit; **this requires a large plane change**. Does this save delta V?

294733	km	Rac0,1	cargo orbit apogee	10.52	10.20
6458	km	Rpc0	cargo orbit initial perigee	*cargo 0*	
150596	km	Rsc0	cargo orbit initial semimajor axis	0.174	-1.177
0.24082	km/s	Vac0	cargo orbit initial apogee velocity	-7.951	1.177
290803	sec	Tc0	cargo orbit initial half orbit time	*cargo 1*	
75950	km	Rpc1	cargo orbit new perigee	2.049	-2.049
185342	km	Rsc1	cargo orbit new semimajor axis	-2.049	2.049
0.59021		e1	cargo orbit new eccentricity		
0.74444	km/s	Vac1	cargo orbit new apogee velocity		
2.88890	km/s	Vpc1	cargo orbit new perigee velocity		
0.50362	km/s	DVc1	cargo orbit first velocity change at apogee		
1.81667	km/s	V1C	cargo orbit tangential velocity		
0.50566	km/s	DVc2	cargo orbit second plane change to construction orbit		
1.00929	km/s	DVc0	cargo orbit total delta V cost		
1.86772	km/s	DVc	cargo orbit relative arrival velocity		
397046	sec	Tc1	cargo orbit last half orbit time		
0.06116		Rc/d	ratio of cargo to direct payload	0.0E+0	delta sec
58.17	m/s	DVsc	cargo orbit scaled delta V cost	7.0	delta sd
687848.98	secs	Tc	cargo orbit transit time	7.983021	sd

Construction Port Change Plane 8.5 geoport.ods 2018/06/17 KHL

Injection velocity for an equatorial launch loop into a highly elliptical geosynchronous construction orbit. A construction orbit is synchronous with and inclined to the launch loop latitude. This ignores a small correction for apsidal precession of the construction orbit.

398600	km³/s²	mu	Earth standard grav param	4.0E+4	scale
6378	km	Re	Earth radius	y	x
42164	km	Rg	GEO (semimajor)	*GEO*	
86164	sec	Tg	GEO stellar period	-1.059	-1.05854
80	km		Loop exit altitude	1.059	1.059
6458	km	Rp0	exit perigee radius	*launch*	
8	deg	Lat	exit latitude, orbit inclination	-0.162	-0.556
2000	km		construction orbit perigee altitude	1.907	0.556
8378	km	Rp1	construction orbit perigee radius	*construction*	
75950	km	Ra1	construction orbit apogee radius	-0.210	-0.633
2.2980E-8	rad/s	omega	omega angular frequency	1.907	0.633
41204	km	S0	transfer orbit semimajor axis	*transfer orbit time*	
0.90695	km/s	Va0	transfer orbit apogee velocity	41619.06	sec
1.02118	km/s	Va1	construction orbit apogee velocity	0.483021	sd
0.11423	km/s	DVa	velocity change at apogee		

Slow cargo orbit. Launch some of the mass to a very high apogee, 12 hours later. The cargo orbital plane will be tilted at twice the latitude away from the construction orbit; **this requires a large plane change**. Does this save delta V?

322373.937	km	Rac0,1	cargo orbit apogee		
6458	km	Rpc0	cargo orbit initial perigee	*cargo 0*	
164416	km	Rsc0	cargo orbit initial semimajor axis	0.162	-1.145
0.22038	km/s	Vac0	cargo orbit initial apogee velocity	-8.093	1.145
331739	sec	Tc0	cargo orbit initial half orbit time	*cargo 1*	
75950	km	Rpc1	cargo orbit new perigee	1.907	-1.907
199162	km	Rsc1	cargo orbit new semimajor axis	-1.907	1.907
0.61865		e1	cargo orbit new eccentricity		
0.68667	km/s	Vac1	cargo orbit new apogee velocity		
2.91461	km/s	Vpc1	cargo orbit new perigee velocity		
0.46630	km/s	DVc1	cargo orbit first velocity change at apogee		
1.80064	km/s	V1C	cargo orbit tangential velocity		
0.50120	km/s	DVc2	cargo orbit second plane change to construction orbit		
0.96750	km/s	DVc0	cargo orbit total delta V cost		
1.89343	km/s	DVc	cargo orbit relative arrival velocity		
442274	sec	Tc1	cargo orbit last half orbit time		
0.06033		Rc/d	ratio of cargo to direct payload	0.0E+0	delta sec
55.05	m/s	DVsc	cargo orbit scaled delta V cost	8.0	delta sd
774012.97	secs	Tc	cargo orbit transit time	8.983021	sd

Construction Port Change Plane 30.5 geoport.ods 2018/06/17 KHL

Injection velocity for an equatorial launch loop into a highly elliptical geosynchronous construction orbit. A construction orbit is synchronous with and inclined to the launch loop latitude. This ignores a small correction for apsidal precession of the construction orbit.

398600	km³/s²	mu	Earth standard grav param	8.7E+4	scale
6378	km	Re	Earth radius	y	x
42164	km	Rg	GEO (semimajor)	*GEO*	
86164	sec	Tg	GEO stellar period	-0.487	-0.48674
80	km		Loop exit altitude	0.487	0.487
6458	km	Rp0	exit perigee radius	*launch*	
8	deg	Lat	exit latitude, orbit inclination	-0.075	-0.256
2000	km		construction orbit perigee altitude	0.877	0.256
8378	km	Rp1	construction orbit perigee radius	*construction*	
75950	km	Ra1	construction orbit apogee radius	-0.097	-0.291
2.2980E-8	rad/s	omega	omega angular frequency	0.877	0.291
41204	km	S0	transfer orbit semimajor axis	*transfer orbit time*	
0.90695	km/s	Va0	transfer orbit apogee velocity	41619.06	sec
1.02118	km/s	Va1	construction orbit apogee velocity	0.483021	sd
0.11423	km/s	DVa	velocity change at apogee		

Slow cargo orbit. Launch some of the mass to a very high apogee, 12 hours later. The cargo orbital plane will be tilted at twice the latitude away from the construction orbit; **this requires a large plane change**. Does this save delta V?

790303.379	km	Rac0,1	cargo orbit apogee		
6458	km	Rpc0	cargo orbit initial perigee	*cargo 0*	
398381	km	Rsc0	cargo orbit initial semimajor axis	0.075	-0.825
0.09042	km/s	Vac0	cargo orbit initial apogee velocity	-9.123	0.825
1251205	sec	Tc0	cargo orbit initial half orbit time	*cargo 1*	
75950	km	Rpc1	cargo orbit new perigee	0.877	-0.877
433127	km	Rsc1	cargo orbit new semimajor axis	-0.877	0.877
0.82465		e1	cargo orbit new eccentricity		
0.29739	km/s	Vac1	cargo orbit new apogee velocity		
3.09452	km/s	Vpc1	cargo orbit new perigee velocity		
0.20697	km/s	DVc1	cargo orbit first velocity change at apogee		
1.69596	km/s	V1C	cargo orbit tangential velocity		
0.47206	km/s	DVc2	cargo orbit second plane change to construction orbit		
0.67903	km/s	DVc0	cargo orbit total delta V cost		
2.07334	km/s	DVc	cargo orbit relative arrival velocity		
1418416	sec	Tc1	cargo orbit last half orbit time		
0.05510		Rc/d	ratio of cargo to direct payload	0.0E+0	delta sec
35.46	m/s	DVsc	cargo orbit scaled delta V cost	30.0	delta sd
2669620.77	secs	Tc	cargo orbit transit time	30.98302	sd

Construction Port Same Plane 2018/06/15 KHL geoport.ods

Same plane, superhigh apogee. Injection velocity for an equatorial launch loop into a highly elliptical geosynchronous construction orbit. A construction orbit is synchronous with and inclined to the launch loop latitude. This ignores a small correction for apsidal precession of the construction orbit. **Not very useful.**

Direct launch of time-sensitive vehicles to the construction port

398600	km³/s²	mu	Earth standard grav param	8.8E+4	scale
6378	km	Re	Earth radius	0.073	
42164	km	Rg	GEO (semimajor)	0.479	
86164	sec	Tg	GEO stellar period		
80	km		Loop exit altitude		
6458	km	Rp0	exit perigee radius		
8	deg	Lat	exit latitude		
2000	km		construction orbit perigee altitude	*destination*	
8378	km	Rp1	construction orbit perigee radius	-0.095	-0.287
75950	km	Ra1	construction orbit apogee radius	0.864	0.287
41619	sec	T1	direct time to construction orbit	0.4830	sd
2.2980E-8	rad/s	omega	omega angular frequency		
41204	km	S0	transfer orbit semimajor axis		
0.90695	km/s	Va0	transfer orbit apogee velocity		
1.02118	km/s	Va1	construction orbit apogee velocity		
0.11423	km/s	DVa	velocity change at apogee		

Slow cargo orbit IN THE SAME PLANE, double delta V. (0) Launch some of the mass to a very high apogee. (1) raise first perigee to a new higher apogee. (2) drop former apogee to a new perigee at the Loop-port.

439699.53	km	Rac0	(0) cargo orbit apogee > lunar radius!	*launch*	
6458	km	Rpc0	(0) cargo orbit perigee (loop exit)	-5.000	-0.606
223078.765	km	Rsc0	(0) cargo orbit initial semimajor axis	0.073	0.606
0.16200	km/s	Vac0	(0) cargo orbit initial apogee velocity		
524286	sec	Tc0	(0) cargo orbit initial half orbit time		
				cargo 1	
439700	km	Rpc1	(1) cargo orbit new “perigee”	-5.000	-5.000
439700	km	Rac1	(1) cargo orbit apogee	5.000	5.000
439700	km	Rsc1	(1) cargo orbit semimajor axis	30	Δ sd
0.95212	km/s	Vac1	(1) cargo orbit apogee velocity	0.0E+0	Δ sec
0.95212	km/s	Vpc1	(1) cargo orbit perigee velocity		
0.79012	km/s	DVc1	(1) from (0) cargo orbit apogee velocity change		
1450825	sec	Tc1	(1) cargo orbit second half orbit time		
75950	km	Rpc2	(2) cargo orbit new perigee (construction apogee)		
439700	km	Rac2	(2) cargo orbit apogee	*cargo 2*	
257825	km	Rsc2	(2) cargo orbit semimajor axis	-5.000	-2.078

0.51677	km/s	Vac2	(2) cargo orbit apogee velocity	0.864	2.078
2.99171	km/s	Vpc2	(2) cargo orbit perigee velocity		
-0.43535	km/s	DVc2	(2) from (1) cargo orbit apogee velocity change		
651431	sec	Tc2	(1) cargo orbit second half orbit time		
1.97053	km/s	DVc3	cargo orbit relative arrival velocity		
1.22547	km/s	DVc	cargo orbit total delta V cost		
0.05797		Rc/d	ratio of cargo to direct payload	0.0E+0	delta se
75.16	m/s	DVsc	cargo orbit scaled delta V cost	30.0	delta sd
2626542	sec	Tc	cargo orbit transit time	30.48302	sd

More delta V. This doesn't work as well as a 16 degree plane change.

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Propellant Velocities geoport.ods 2018/06/12 KHL

Propellant	LH/LOX	**RP4/LOX**	
Velocity	4.43	3.25	km/s
Earth standard grav param mu	398600	398600	km^3/s^2

Geostationary Loop Port

Thrust adds angular momentum to fixed velocity station

Station velocity	3.07	3.07	km/s
Retrograde propellant velocity	1.36	0.18	km/s

Exhaust falls to earth!

Construction Port change plane 7 day

Cargo orbit perigee boost thrust

Cargo orbit initial apogee velocity	0.24	0.24	km/s
Cargo orbit final apogee velocity	0.74	0.74	km/s
Cargo orbit apogee radius	294733	294733	km
Construction orbit escape velocity	1.64	1.64	km/s
Retrograde propellant velocity			
max	4.19	3.01	km/s
min	3.69	*2.51*	km/s
propellant to escape velocity	**all**	**all**	
Propellant V∞ min	3.30	1.89	

Most of the low-ISP propellant atoms will escape. Depending on the velocity range, some may end up in higher orbits. Very few atoms will move slowly enough to drop below loop port apogee. Some of the orbiting propellant atoms may interact with the Moon and drop into lower orbits. **TBD.**

Cargo orbit plane change

Cargo orbit second perigee radius	75950	75950	km
Radius at plane change	120777	120777	km
Tangential velocity at plane change	1.82	1.82	km/s
eccentricity	0.59		
Radial velocity at plane change	1.07	1.07	km/s
Total propellant velocity	3.83	3.50	km/s
Escape velocity	2.57	2.57	km/s
Propellant V∞	**2.83**	**2.38**	**km/s**