Systems Engineering Advancement Research Initiative

SEAri Working Paper Series

Title: *Comparison of Past MATE Studies to Actual Systems*

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Comparison of Past MATE Studies to Actual Systems

The following sections provided a few examples of MATE studies compared with actual systems developed by industry. The text is rough, but enough to get across the point that MATE enables engineers, which are students in the MIT MATE studies, to quickly locate "good" designs, without relying upon extensive feasibility studies and decades of experience.

More examples will be added as time and opportunity permits.

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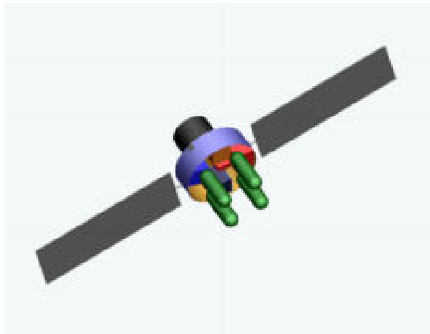
SpaceTug

Spacetug vs CX-OLEV



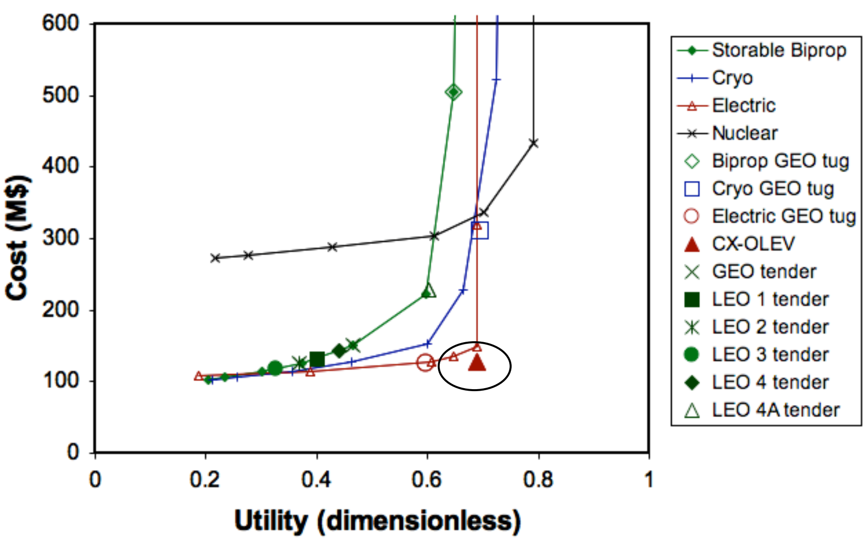
	Electric Cruiser (2002 study)	CX-OLEV (2009 launch)
Wet Mass kg	1405	1400
Dry Mass kg	805	670*
Propellant kg	600	730*
Equipment kg	300	213*
DV m/s	12000 – 16500***	15900**
Utility	0.69	0.69
Cost	148	130*

* back-calculated using Spacetug tradespace tool

** calculated based on stated 3 km/s capability attached to target, normalized to spacetug "self-deltaV" (ability to move self in orbit)

*** higher figure is using original 3000 sec thrusters, lower uses 2200 assumed by CX-OLEV; other numbers unchanged by this assumption

The differences up to this point can be entirely simulated on the MATE tool by reducing the equipment mass and using all the savings for fuel. This is something we suggested in the paper (well, we said that the performance was sensitive to equipment weight and it should be minimized). On the tradespace:



Seriously – our very simple study correctly and accurately identified the spot in the tradespace worth looking at further – this stuff works petty well!

In all honesty, some of the ICE model details came out a little different:

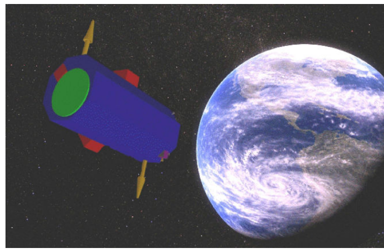
	Electric Cruiser	CX-OLEV (2009 launch)
ISP (sec)	3000	2200
Power w	3600	5000
Dimensions	2.0 m x 1 m (approx)	2.6 m x 0.9 m
Solar panels	GA 10 m^2	GA 15 m span, c 24 m^2
Comm	Ku band, 0.5m parabolic	S band 2x1m hemisphere

DATA SOURCES
Spacetug data from paper and MATE worksheet

CX-OLEV specs from:
http://www.orbitalrecovery.com/index.htm
http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=17870
http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=13584

X-TOS

XTOS vs Streak




	XTOS (2002 study)	Streak (Oct 2005 launch)
Wet Mass kg	325 - 450	420
Lifetime (yrs)	2.3 - 0.5	1
Orbit	300 -185 km @ 20°	321a-296p -> 200 @ 96°
LV	Minotaur	Minotaur
Utility	0.61 - 0.55	0.57 - 0.54*
Modified Utility**	0.56 - 0.50	0.59
Cost $M	75 - 72	75***
Instruments	Three (?)	Ion gauge and atomic oxygen sensor

* back-calculated using XTOS final utility
** calculated by reversing the weightings of latitude diversity and equator time
*** estimate based on Spacetug cost model for vehicle ($55M) plus $20M launch cost

The big difference is the choice of a polar orbit. Clearly, the relative utility of the attributes of latitude diversity and time near the equator were ultimately different than the ones used in the XTOS study. A modified utility is estimated by flipping the weights of these utilities (so latitude diversity is more important). Adam has also noted that the XTOS team may have missed an attribute – data collected at the terminator has extra worth, and streak's orbit is at the terminator *all the time* (its in a sun synchronous orbit), maximizing this (unused) attribute.

Another difference comes down to altitude. The range in mass, lifetime, and altitude in XTOS is due to differing results from the MATE and ICE studies. The MATE study suggested first 200, then 300 km orbits (depending on the utility weights used); the higher orbit gave more lifetime. The ICE study, which had finer resolution of altitude, suggested lowering the altitude to 185 (for a short life) to maximize the value of the data. Streak will get the best of both worlds by starting at 300 km (apparently, a slightly elliptical 321 apogee, 296 perogee), and then, at the option of the operators, descending as low as 200 km to collect more valuable low-altitude data as it nears its end of life.

<u>DATA SOURCES</u>
XTOS data from XTOS report

Streak info from:
Aviation Week and Space Technology, Oct. 3, 2005, pg 18
http://nssdc.gsfc.nasa.gov/spacewarn/spx623.html
http://www.spaceflightnow.com/minotaur/stpr1/