X-37B Orbital Test Vehicle Fact Sheet

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Main Author: Brian Weeden, bweeden@swfound.org **www.swfound.org**

Summary

The X-37B OTV is a technology demonstrator and experimental vehicle which is likely to be used for flight testing new reusable space launch vehicle (SLV) technologies (such as guidance and thermal protection) and on-orbit testing of new sensor technologies and satellite hardware primarily for space-based remote sensing. While it does have some capability for orbital inspection, repair, and retrieval, it is unlikely to perform these functions given its limited payload bay and altitude range. It has near zero feasibility as an orbital weapons system for attacking targets on the ground.

Background

- X-37B is an experimental re-usable spaceplane, very similar to the Shuttle but much smaller and completely robotic and using more advanced technologies
- The X-37B is 29 feet long and has a wingspan of just over 14 feet across. It stands just over 9-1/2 feet tall and weighs nearly 11,000 pounds. By comparison, the Space Shuttle is 122 feet long, 78 feet across, and 58 feet tall and weighs 172,000 pounds. The X-37B's payload bay is about the size of a pickup truck bed. The Space Shuttle payload bay is 15 feet by 60 feet, large enough to fit two X-37Bs inside [1]
- X-37B uses its own solar array and lithium ion batteries to generate power, instead of Shuttle's fuel cells, a major reason why it can stay on orbit for much longer
- X-37B is designed to be launched into space on top of a standard space launch vehicle, stay on orbit for up to 270 days, and then re-enter and land like the Shuttle
- X-37B has thrusters for on-orbit maneuvering and de-orbit, but no engines for powered flight in the air—it is a glider in the atmosphere
- X-37B started life as a NASA program in 1999, but transferred to DARPA in 2004. DARPA transferred it to the USAF in 2006 after more budget issues

Image credit: Boeing

- Total program costs and budget line are classified
- Eventual size of the X-37 fleet is "unknown," according to USAF, but construction of a second X-37B is already underway [2]
- The first X-37B, OTV-1, was launched on 22 April, 2010 into an orbit probably around 430-450 km in altitude and 28 and 40 degrees in inclination.[3] The Center upper stage which placed it into orbit performed a fuel depletion burn which placed it in orbit around the Sun.[3]
- Secrecy surrounding the actual on-orbit activities and payload is almost certainly due to presence of NRO hardware being tested or evaluated

Debate Over Mission and Reason for this Program

Official objectives of the X-37B program include "space experimentation, risk reduction and concept of operations development for reusable space vehicle technologies."[4] However, none of the potential missions posited by the US military appear to justify the program's existence, especially on a cost basis, and this has led to speculation about what the "real" mission may be.

X-37B as an on-orbit sensor platform and test bed (Feasibility: high)

Concept

- X-37B payload bay would contain various sensors used for intelligence collection of the Earth from space, potentially including radar, optical, infrared, and signals/electronic intelligence (SIGINT/ELINT) suites to flight-test and evaluate new sensors and hardware
- Could also be done in response to crises/warfighter needs for Operationally Responsive Space (ORS)
- USAF: "What it offers that we have seldom had is the ability to bring back payloads and experiments to examine how well the experiments performed on-orbit," said Gary Payton, the undersecretary of the Air Force for space programs. "That's one new thing for us." [5]

Advantages

- Ability to flight test and return experimental sensors and satellite hardware would be of significant benefit to the US military
- This is a mission that has been done in the past using the Shuttle [6] and it is likely that the US military has realized it will need this capability after Shuttle retirement
- Ability to re-configure the payload bay contents for various sensor packages would make it much more flexible than having to procure multiple satellites
- X-37B could be more maneuverable once in orbit than many ORS satellites or existing satellites, allowing for more flexible ground coverage

Artist's rendition of how the X-37B will deploy on orbit, including the solar panels used for electrical power. Image credit: Boeing

Drawbacks

- Prompt response is questionable given that it is tied to an EELV booster and associated processing timelines and launch pad availability requirements
- Not very cost effective given the estimated average cost of close to $100 million per EELV launch (based on the Atlas V version 501 configuration used for the April 20, 2010 launch) [7]

X-37B as a deployment platform for ORS satellites (Feasibility: medium)

Concept

- X-37B could be launched into orbit and deploy multiple small satellites on a very timely basis to support time sensitive warfighter needs
- USAF: "We could have an X-37 sitting at Vandenberg or at the Cape, and on comparatively short notice, depending on warfighter requirements, we could put a specific payload into the payload bay, launch it up on an Atlas or Delta, and then have it stay in orbit, do the job for the combatant commander, and come back home," Payton said. "And then the next flight, we could have a different payload inside, maybe even for a different combatant commander." [8]

Advantages

- Flexibility in payload configuration, as you don't need to integrate each new satellite to the booster. The satellites get integrated to the X-37B, which then gets integrated to the booster
- Deployment could be done in a semi-stealthy manner, potentially avoiding tracking by amateurs

Drawbacks

- Not very timely as you still are dependent on an EELV time requirements for launch
- The costs for a single EELV launch is equal to or more than the entire ORS budget in FY10 and beyond [9]
- The payload bay for the X-37B can only carry a couple of small satellites, giving very little "bang for the buck"
- It would be much more efficient to just launch several ORS payloads on their own smaller booster
- Deployment could be done out of sight of amateur community, but very unlikely to be able to conceal from military space situational awareness capabilities

X-37B as an on-orbit repair vehicle (Feasibility: low)

Concept

- X-37 could be used to rendezvous with malfunctioning satellites and repair or refuel them, or in some cases capture and return them to Earth for a post-mortem analysis

Advantages

- Could help the US military solve the problem of figuring out what went wrong when a satellites dies
- Return of hardware from space could help with research into effects of space weather, debris, and micrometeoroids

Drawbacks

- X-37B is limited in altitude—it has been rumored that it will have a maximum altitude range of 700 or 800 km (about 500 nautical miles), potentially high enough to access most Sun-synchronous satellites, but this is unconfirmed
- Not many existing operational military satellite components will fit in the X-37B cargo bay
- Would almost certainly need human tele-presence link to control on-orbit repairs and activities

Image credit: Boeing

X-37B as an on-orbit inspection or ASAT platform (Feasibility: low)

Concept

- X-37 could be used to rendezvous and inspect satellites, either friendly or adversary, and potentially grab and de-orbit satellites

Advantages

- Existing on-orbit inspection satellites (XSS-11, MiTEx) have a fixed set of sensors, X-37 sensor package could be upgraded or modified as needed on a per-mission basis
- Existing satellites can only access satellites close to their existing inclination and do not have the potential to capture and return
- Could provide the capability to disable adversary satellites on-orbit without creating a large amount of debris

Drawbacks

- Other platforms such as XSS-11 and MiTEx already have this capability and can stay on orbit for much longer

- X-37B is much larger than the XSS-11 or MiTEx, which increases the chances that an adversary would detect an unauthorized rendezvous
- The X-37B cargo bay is much smaller than many operational satellites, and most of that space is likely to be filled by the required robotic arm and other gear

X-37B as a Conventional Prompt Global Strike (CPGS) weapon or delivery system (Feasibility: zero)

Concept

- X-37B could be launched in response to a pending crisis and remain on orbit for a length of time to respond to high value/ very time sensitive targets
- X-37B could either drop "rods from god" out of its payload bay or re-enter and become a weapon itself

Advantages

- Would eliminate political issues over using ballistic missiles launched from the ground for CPGS missions

Drawbacks

- Hyperkinetic weapons dropped from bay would need to be equipped with thrusters capable of performing a huge de-orbit burn, very difficult given small bay size [10]
- X-37B itself re-enters like the space shuttle landing at an estimated 200 mph (321 kph)[11], which means it travels in the atmosphere much slower than an RV on a ballistic arc or a hyperkinetic weapon. Thus it would need to carry conventional explosives to do any significant damage
- X-37B after re-entry would be a slow moving, not-very-maneuverable glide bomb, easy prey for any air defense system along its path to the target
- Having only a few X-37Bs would not provide very timely coverage of potential ground targets [12]

Endnotes

1. http://en.wikipedia.org/wiki/Space_Shuttle_orbiter
2. Clark, Stephen, "Air Force spaceplane is an odd bird with a twisted past," Spaceflight Now, 2 April 2010 http://www.spaceflightnow.com/atlas/av012/100402x37update/
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5. Clark, Stephen, "Air Force spaceplane is an odd bird with a twisted past," Spaceflight Now, 2 April 2010 http://www.spaceflightnow.com/atlas/av012/100402x37update/
6. NASA Mission Summary for STS-39 http://science.ksc.nasa.gov/shuttle/missions/sts-39/mission-sts-39.html
7. "NASA Awards Launch Services Contract for Four Missions," http://www.nasa.gov/home/hqnews/2009/mar/HQ_C09-011_Launch_Services.html
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9. Samson, Victoria, and Black, Sam, "Space Security Programs of Interest in the FY2011 Department of Defense Budget Proposal," http://bit.ly/beO501
10. Wright, David, "The Physics of Space Security," page 57 http://www.ucsusa.org/assets/documents/nwgs/space_security.pdf
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