SINGAPORE SPACE CHALLENGE 2019/2020

Challenge Statement

Topic: Space Debris

Singapore Space Challenge 2019/2020

Topic: Space Debris

Space debris is also known as orbital debris, space junk, space waste, space trash, space litter or space garbage. As of January 2019, the ESA Space Debris Office keeps tracks on about 22,300 artificial objects in orbit above the Earth, including 1,950 operational satellites.

According to NASA, More than 500,000 pieces of debris, or “space junk,” are tracked as they orbit the Earth. They all travel at speeds up to 17,500 mph, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft.

In 1996, a French satellite was hit and damaged by debris from a French rocket that had exploded a decade earlier. China's 2007 anti-satellite test, which used a missile to destroy an old weather satellite, added more than 3,000 pieces to the debris problem. On Feb. 10, 2009, a defunct Russian satellite collided with and destroyed a functioning U.S. Iridium commercial satellite. The collision added more than 2,000 pieces of trackable debris to the inventory of space junk.

Space debris has become a huge problem. Currently thousands of satellites are in orbit around Earth, providing vital services to Earth’s billions of inhabitants. **However, as the number of undisposed satellites and rocket parts in space increases, so does the risk of in-space collisions, explosions, and the negligent creation of debris. If growth continues unhindered, space debris will mean the most useful and economically vital orbital pathways around Earth will become totally unusable.**

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Challenge Statement: Space Debris

- ***Design a satellite concept of not more than 5 satellites (Servicer) that can be used to deorbit space debris.***

Mission Details & Requirements

1. Target space debris should be existing debris in Low Earth Orbit (400km - 1500 km).
2. The target debris must be at least 5 cm x 5 cm x 5 cm in size.
3. Participant can set the characteristic of the target debris. That is, target CAD model, material and surface properties are known. The report would need to state the pertinent characteristics clearly. Target that are realistic and that poses high economic or safety risks will be given more points.

   Some characteristics that you can consider are:

   i. *Target Size*
   ii. *structural integrity of target space debris*
   iii. *easy to capture, considerations of tumbling*
   iv. *ease of detection and identification; any radio frequency trace, call sign transmission, transmitting GPS data over radio frequency or beacon ?*
   v. *Ease of de-orbiting; is target in a "crowded" orbital regime/altitude?*

4. Provide an explanation of why your team has selected this target, explaining clearly the danger that target poses.
5. The evaluation would consider the type of target debris chosen, novelty of the design, price of the mission and system reliability.
6. Servicer should be able to remove more than one target debris during its mission lifetime. Target space debris can be in the same or different orbital position and planes
7. There are no limits on size and mass of Servicer, although it needs to be realistic.
8. The price of Servicer mission (satellites + launch + ground station rent + mission operations) should be kept under USD 50 million. Excellent explanation and illustration of any financial analysis will be a bonus. For reference launch prices to LEO is approx. 60k SGD/kg. So teams have to carry out suitable trade-off to size the Servicer. Note that propulsion tanks take up a lot of volume and mass budget so system calculations should be reasonable.

References

Current Concepts of De-orbiting

There are many known options for deorbiting a satellite. Some of them are:

1. Uncontrolled De-orbiting:
    a. Maneuver target to an orbit where atmospheric drag will de-orbit the target within 25 years (ESA guidelines).

2. Direct Retrieval (Controlled De-orbiting):
    a. When atmospheric destruction is incomplete or possible casualties (>0.01%), a controlled re-entry is done on a specific location.

3. Graveyard orbit disposal:
    a. Maneuver to a set disposal region wherein the target will not interfere with future space operations.
    b. Usually done for orbits above 1500km and pushed to 2500km+

Other Material

1. http://emits.sso.esa.int/emits-doc/ESTEC/News/RFI-InorbitServicing05.09.2018.pdf
2. http://www.unoosa.org/res/oosadoc/data/documents/2018/aac_1052018crp/aac_1052018crp_20_0_html/AC105_2018_CRP20E.pdf
3. http://www.unoosa.org/documents/pdf/copuos/stsc/2019/tech-21E.pdf
4. Participants can identify suitable target debris from this link: bit.ly/astriagraph
5. How To Clean Up Space Junk: https://youtu.be/6wr_Zw1uGY8
6. Space Junk: The Unknown Orbital Iceberg | Dr. Moriba Jah | AFRL Inspire: https://www.youtube.com/watch?v=Ahtt6OeSuqs

Singapore Space Challenge 2019/2020
Requirements & Challenge Deliverables

Singapore Space Challenge is designed for students from 15 – 25 years old.

Participating teams must satisfy the following conditions:

- Students must be between the ages of fifteen (15) to twenty five (25) years of age to participate.
- Students have to compose a team of four (4) participants, per team.
- Students are only allowed to register in one team each.
- All members of the Teams must have a valid e-mail address.

Deliverables Requirements

1) Mission Report (Mandatory)
Completed and final entries must include a mission report not exceeding 50 pages (without annexes and supporting information), including all illustrations, graphics and schematics. A complete bibliography is required.

2) Presentation (Mandatory)
In order for the judges to better assess the concept, students must submit a video recording of themselves presenting their report and explaining their project to the judges. The presentation recording should be 5 to 10 minutes long.

3) Computer Simulation (Mandatory)
Teams must produce a computer simulation video showing their proposed projects in action.
The recommended length of the computer simulation is between 2 and 3 minutes.

4) Mock-Up (Optional)
Students may consider constructing a mock-up to visually illustrate the key aspects of their concept.

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Judging Criteria

Entry Submission	
Technical Characteristic • Technical and scientific accuracy • Accurate calculations, illustrations and graphics • Finance and costing analysis, if applicable • Concept Viability	**30%**
Creativity • Idea, concept, design and creativity • Justification and function of design	**30%**
Concept Relevance • Possible issues, applications and relevance	**20%**
Entry Submission (Presentation) • Clarity of presentation, including mock-up where required • Adherence to Guidelines	**10%**
Entry Submission (Report) • Content & Structure • Proof Reading • Referencing	**10%**
Total	**100%**
Bonus Points	
Industry Visits & Workshops (minimum 50% attendance per team at each industry visit and workshop)	Please refer to slide 9

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Bonus Points

4 Ways to achieve Bonus Points!

1. Attend Industry Visits & Workshops
2. Report - Design Limitation – Include countermeasures
3. Report – Finance & Costing Analysis
4. Report – Additional Viable Applications

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Bonus Points

1. Industry Visits & Workshops	2. Report Design Limitation (Include countermeasures)	3. Report Finance & Costing Analysis	4. Report Additional Viable Applications
Each team's attendance at workshop/industry visit is worth **3 bonus points**	Each viable countermeasure mentioned in the report is worth up to **2 bonus points**	Finance and costing analysis of your proposed idea is worth up to **5 bonus points**	Each additional viable application mentioned in the report is worth up to **2 bonus points**
Each team must send min. 2 members to each workshop/industry visit to qualify for bonus points	• **0 Point** No countermeasure / non-viable countermeasure • **1 Point** Poorly explained but viable countermeasure • **2 Points** Well-explained and viable countermeasure	• **0 Point** - No analysis • **1 Point** - Vague analysis • **2 Points** - Simple analysis • **3 Points** - Fairly accurate analysis • **4 Points** - Accurate analysis • **5 Points** - Outstanding analysis	• **0 Point** – No application • **1 Point** – Poorly explained, but viable • **2 Points** – Well explained and viable
			*A maximum of 10 bonus points (5 viable applications) will be awarded in this section.

Industry Visits & Workshops

Scoring Example:

Scenario	Points Awarded
No. of Team Members	4 pax
Industry Visit (1)	Min attendance (2 members) = 3 Points
Industry Visit (2)	Min attendance (2 members) = 3 Points
Workshop (1)	Min attendance (2 members) = 3 Points
Workshop (2)	Min attendance (2 members) = 3 Points
Bonus Points Earned	3 points x 4 sessions = 12 bonus points

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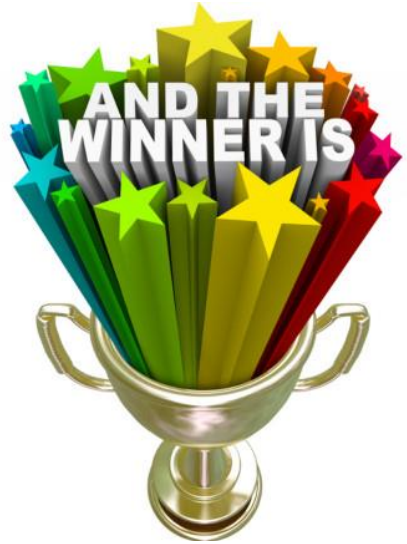
Prizes

Award Category	Prize
Grand Winner	**S$10,000**
Community Choice Award	S$1,000
Most Creative Award	S$500
Merit Award	S$500



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Judge

Mr. Cheong Chee Hoo is the Chief Executive Officer of DSO National Laboratories since July 2016. In his service to DSO and to defence, Chee Hoo developed a wide range of engineering expertise from radar engineering to satellites, from design to systems engineering.

He was one of the pioneers in radar systems development. He helped to build up radar capability in DSO and was part of the team which developed the first complete airborne radar system.

Chee Hoo then held appointments in the Directorate of Research & Development (DRD), DSTA and subsequently to the Defence Research & Technology Office (DRTech) from August 2008 to February 2012. In these capacities, he took the lead in the strategic development and implementation of the R&D plans and developments in both systems and emerging technologies.

Chee Hoo returned to DSO in February 2012 and led the Networks Division. He developed the strategy and implemented the R&D developments in communications, satellite and information security. In his career, Chee Hoo was presented with numerous awards, including the Defence Technology Prize for R&D Team and R&D Individual in 2002 and 2006 respectively.

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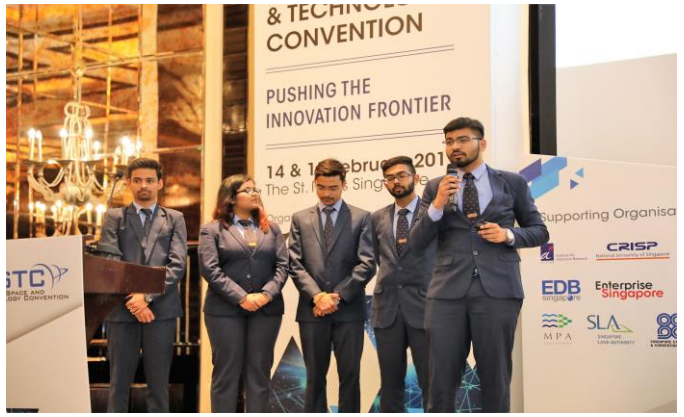
S/N	Key Milestones	Timeline
1	Registration Opens	15 May 2019
2	Registration Closes	10 August 2019
3	Webinar Briefing	30 August 2019
4	Facility Visit (1)	06 September 2019 (TBC)
5	Facility Visit (2)	31 October 2019 (TBC)
6	Mentor Workshops	01 – 22 November 2019
7	Student Submissions of Proposals	25 Nov – 6 Dec 2019
8	Screening & Judging	09 Dec 2019 – 31 Jan 2020
9	Community Choice Award Pitching	6 Feb 2020
10	Singapore Space Challenge (2019/2020) Award Ceremony	7 Feb 2020

Singapore Space Challenge

From Our Students

"We take this opportunity to thank the SSC and SSTA for giving us this chance to showcase our technical skills and talents through this competition"

SSC 2018/2019
Team Odyssey
University of Petroleum and Energy Studies, Dehradun (India)

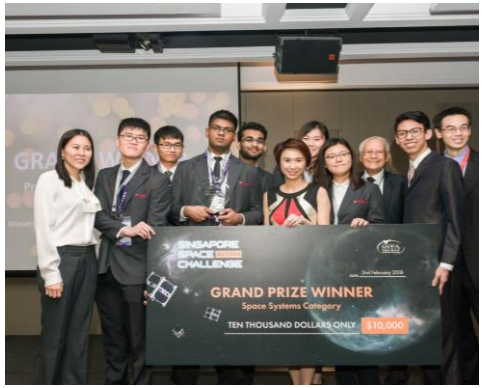


"Project Zero/0 would like to extend our sincere gratitude towards SSTA for hosting this competition. We would also like to thank the Earth Observatory of Singapore and the Centre for Remote Imaging, Sensing and Processing (CRISP) for hosting workshops and tours around your facilities, which were instrumental to the completion of our project"

SSC 2018/2019
Hwa Chong Institution

"The Singapore Space Challenge has really achieved its goals of advancing the space frontier in Singapore"

SSC 2017/2018
Team Mercury 7
Temasek Polytechnic



Thank You

We look forward to your support.

Contact us for further assistance:

Ms. Lynette Tan	Email: lynette.tan@space.org.sg	Office: 6735 7995
Ms. Brenda Toh	Email: brenda.toh@space.org.sg	Office: 6735 7995
Ms. Gillian Chin	Email: gillian.chin@space.org.sg	Office: 6735 7995