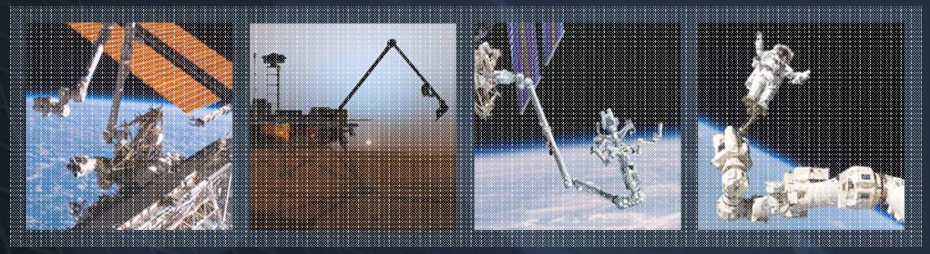
Information Systems Group



On-Orbit Satellite Servicing and Active Debris Removal

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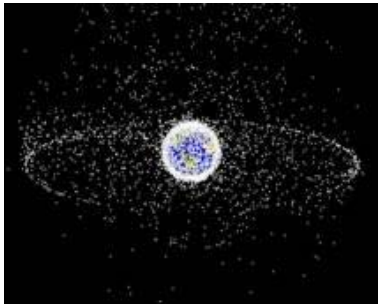
February 20th, 2013

Secure World Foundation Conference

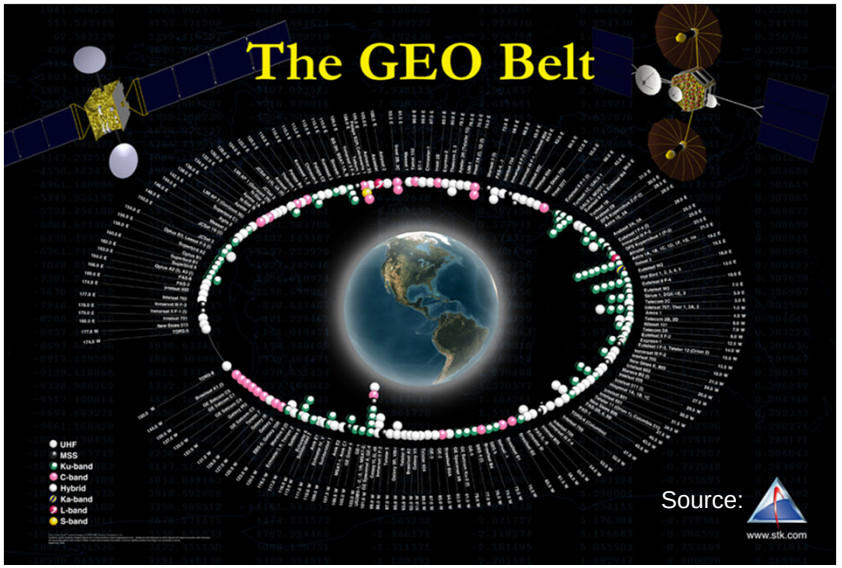
www.mdacorporation.com

The Global Challenge

- Billions of people depend on satellites and on-orbit assets for everyday needs => an essential infrastructure in Space
  - Communications services
  - TV and radio broadcasts
  - GPS navigation
  - Weather forecasting
  - Earth observation
  - Space Exploration
  - Space Science



- Over 20,000 debris > 10 cm tracked and additional 670,000 smaller ones exist, already many incidents & close calls
- Guidelines & Practices for mitigation
  - Limitation of debris released during normal operations
  - Minimization of the potential for on-orbit break-ups
  - Post-mission disposal
  - Prevention of on-orbit collisions



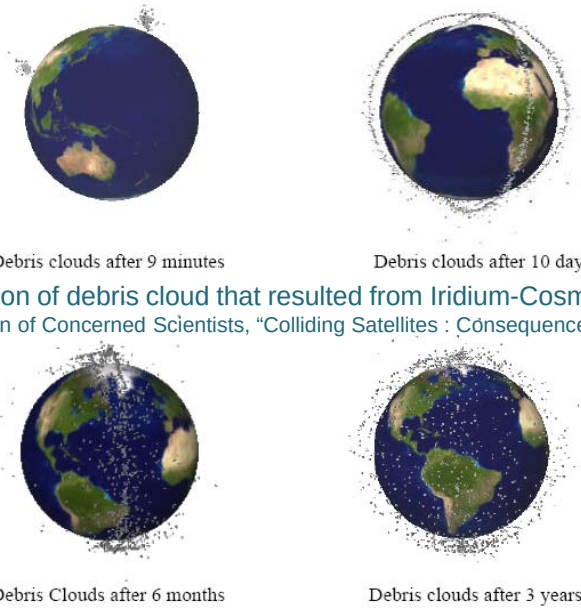
The Global Challenge
Preservation of the previous space environment for generations to utilize

Currently there is no on-orbit space debris removal or spacecraft servicing operational capability for space environment preservation and protection

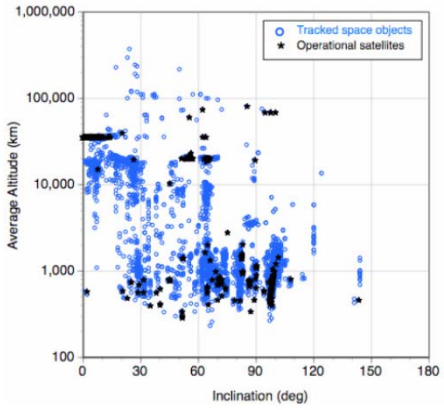
Collision Debris Propagation ("Kessler Syndrome")

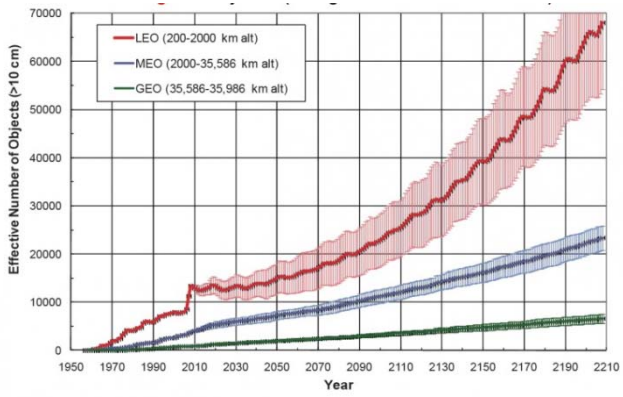
- As demonstrated by the Iridium-Cosmos collision in 2009; following the collision of two objects in space, their debris cloud will spread and threatens <u>all satellites at that altitude</u> for a long time

- It is postulated that such collisions and their resulting debris will eventually reach a critical density where a cascading collision effect will occur



Propagation of debris cloud that resulted from Iridium-Cosmos collision
Credit: Union of Concerned Scientists, "Colliding Satellites : Consequences and Implications"



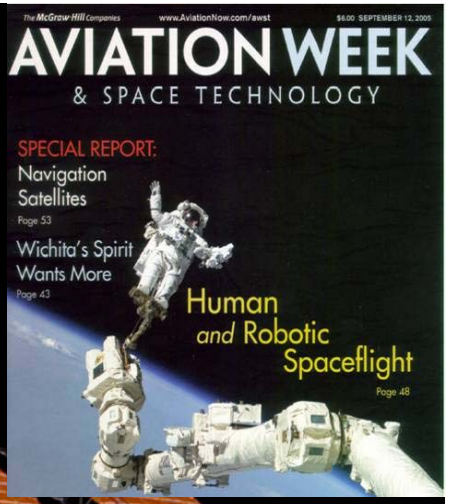


Canada is uniquely positioned to make a difference

> 90 Shuttle Missions with Robotic Operations

> 10 years of ISS robotic assembly and support operations

Shuttle and ISS experience provides foundation for the design and execution of future Servicing/ADR Missions



Dexterous Robotic Servicing

MDA

Technologies for spacecraft capture, handling and robotic servicing already exist

Dragon Capture

XSS-11 Autonomous Rendezvous

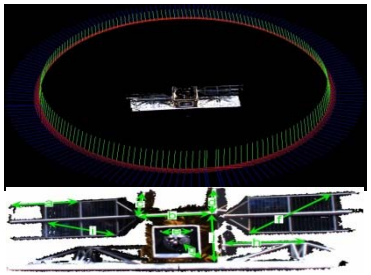
Orbital Express robotic spacecraft servicing

ISS Robotic Refueling Demo

S131E007752

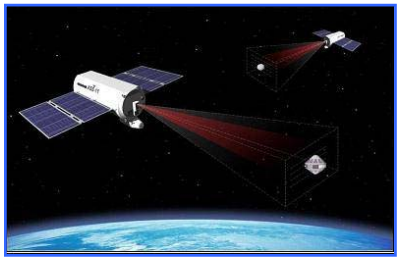
MDA

Technologies for handling unprepared spacecraft/debris

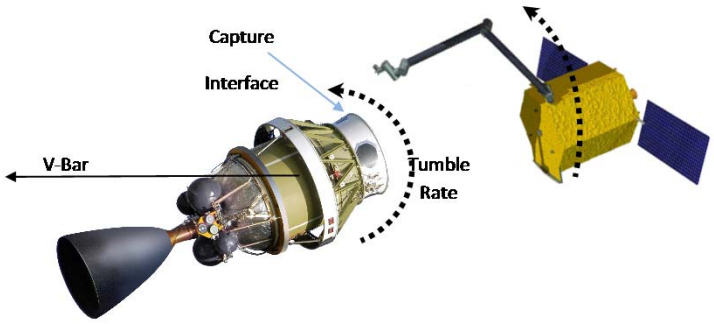


3D Imaging & Survey

Adaptive Capture and Mating



"Targetless" Rendezvous & Sensing

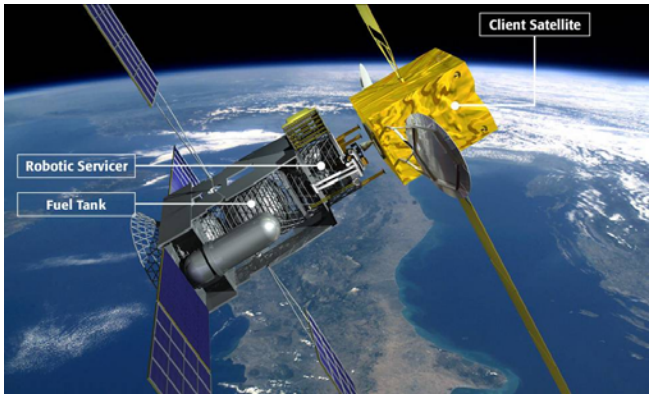


Autonomous Track, Capture and Tow

Supervised to Autonomous Mission Planning and Execution

A “4R” Proposition for a Sustainable Space Environment

- Use existing space assets longer via satellite servicing
- Design and produce future space assets that are more service & capture friendly
- Deploy on-orbit means to responsibly remove dead satellites, hazards and debris
  - Both SSO (predominantly government) and GSO (predominantly commercial) orbits are good places to start
  - Start by removing large debris
- Continue to deploy means to track and monitor space debris

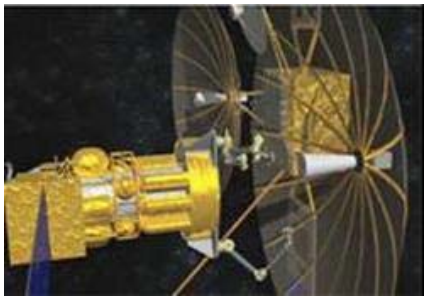


4Rs:
Replenish
Repair
Repurpose
Reduce

(Top) MDA Space Infrastructure Servicing (SIS)

(Right) Envisat capture & safe de-orbiting

(Below) DARPA Phoenix

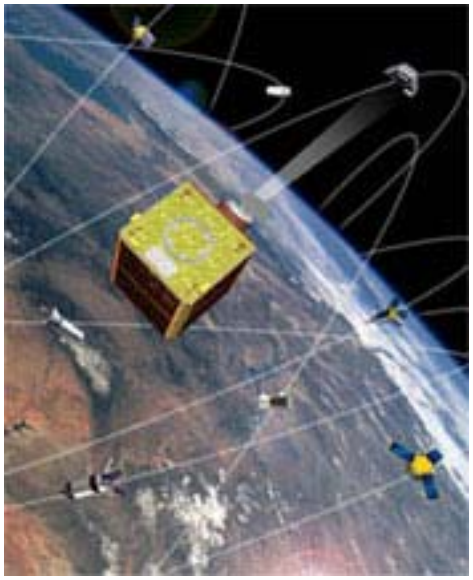


Sapphire ~ another Canadian contribution

Sapphire is a key element of the Canadian Space Surveillance System, and will be a contributing sensor to the US Space Surveillance Network. It is a space-based electro-optical system that will provide accurate and timely tracking data to the Canadian Department of National Defence (DND) on space objects at orbit altitudes between 6,000 km and 40,000 km.

MDA is prime contractor for the Sapphire mission, including launch and the first three years of operation.

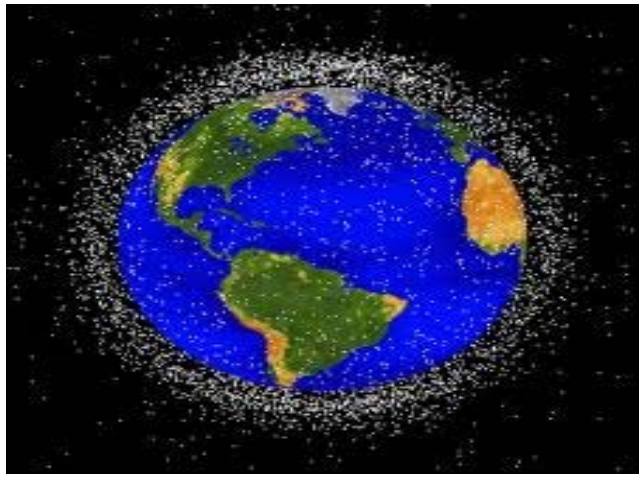
Sapphire is expected to launch on February 25th along with Canada's NEOSat



Conclusions

- Technologies already exist to implement 4Rs for Space Environmental protection and preservation

- **Key Challenges**
  - Costs & Affordability
  - Who's responsible?
  - Who pays?
  - Legal & Regulatory



- Space is too precious and important an environment for present and future generations
  - Need a concerted global effort to responsibly utilize and protect

Questions & Comments?