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Presentation

by

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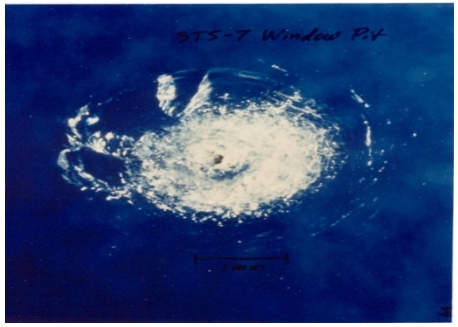

Strategic Implications

of

Removal of Space Debris

and

On-orbit Servicing of Space Objects

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Presentation Layout

- Backdrop
- The Concern
- Strategic Implications
- Appraisal

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Known facts...

- Space technology plays a central role in socioeconomic , scientific and strategic development of a nation-state
- Today's satellite is tomorrow's space debris
- On average, over the past 40 years, one piece of space junk has fallen to Earth every day
- It costs app $10,000 per kilogram to lunch anything into orbit
- Every object launched in space :potential as derbies

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few more **Known facts**...

- 60% of be orbital-debris population is owned by Russia and China add United States to this……
- Debris removal technically feasible(LEO), but costly
- Ways for clearing the sky: few projected methods look outlandish
- Debris-removal systems could have military uses. Not every country is providing details about what they have in space
- As of now, no specific customary international law governs various issues related to orbital debris totally

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Garbage in Space

- Space debris/orbital debris/ space junk/space waste is a reality
- Threat to space assets (from debris)is a reality, the question is exact quantification of the risk
- Space crafts as well as objects on ground are at risk, on-orbit servicing of space objects will also add to debris
- Cleaning exercise is a must but, one time cleaning is not sufficient and it has to be a continuous process

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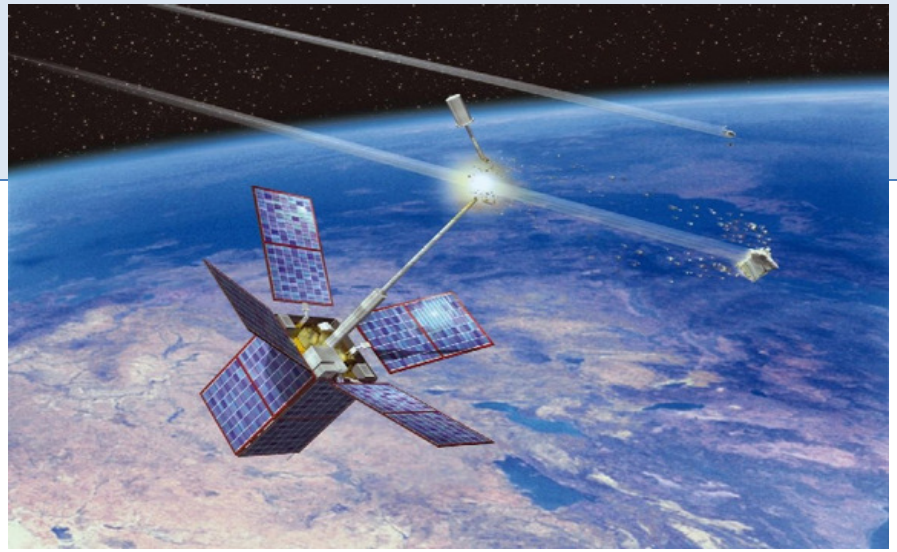
The Forecast

 # Space junk at tipping point

 # Orbital Debris Problem to Triple by 2030



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Debris Fall: Past & Present

- USSR Kosmos 954 reentered the atmosphere over Canada in 1978
- A Japanese ship hit in 1969 by pieces of space debris (Soviet origin)
- Oct 1987, a 7-foot strip of metal from a Soviet rocket landed in California
- Portions of Skylab came down over Australia in 1979
- Jan 2007 ASAT test by China
- Operation Burnt Frost, executed on 20 February 2008
- Feb 10, 2009, a decommissioned "Cosmos 2251" satellite and an operational "Iridium 33" satellite collided

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Various types of Debris

- 1 cm or smaller
- large debris items over 10 cm

- Debris in LEO
- Debris at higher altitudes

Sources of Debris

- **Dead spacecraft**
- **Lost equipment**
- **Boosters**
- **Debris from and as a weapon**

A Different way of Debris Categorization

- Non-functional payloads like satellites without fuel or wandering satellites

- Fragments, small particles, remains of broken satellites, launchers etc.

Proposals for Debris Removal

- Developing large balloon-like objects that would sweep up debris in certain orbits
- Using space shuttle or undertake planned orbital maneuvering vehicle (OMV) to capture inactive satellites and remove them form orbit
- In LEO-remove inactive payloads-the system needs to reserve fuel for this when the satellites becomes inactive lower their orbit

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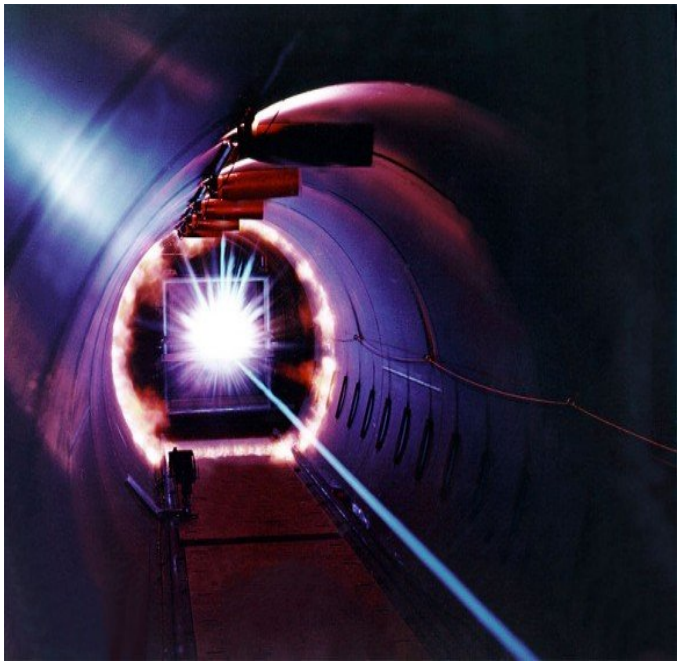
Debris Removal: Novel Solutions

- Lasers
- Solar Sails
- Tethers and Nets
- Space Mist
- Robots
- Adhesives



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Kessler Syndrome

- When the density of objects in LEO is high enough that collisions between objects could cause a *cascade* – each collision generating debris which increases the likelihood of further collisions

- Early 2009, Kessler argued that: Aggressive space activities without adequate safeguards could significantly shorten the time between collisions and produce an intolerable hazard to future spacecraft. Large constellations is the problem

- The activities could set up a situation where a single satellite failure could lead to cascading failures of many satellites in a period of time much shorter than year

Unpredictable Future

- Is addition of debris through impacts is slower than their rate of decay?
- Would it happen that the risks and costs of operating in space could make certain missions no longer profitable or safe?
- The growing importance of on-orbit servicing…could add to the debris

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The Challenge

- Activities in space will increase, new players will join in, adding of debris will be added
- On-orbit servicing will take place…add debris
- Difficult to predict exact volume of likely debris addition
- New technology development is essential for debris 'management'
- Loosing a space asset is not affordable hence on-orbit servicing would gain importance

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The Problem

- Dual use nature of debris reduction and spacecraft protection techniques
- On-orbit servicing technology- could lead towards debris creation, also misuse of technology is possible
- Existing legal regime has limitations

All such capabilities are potential ASAT

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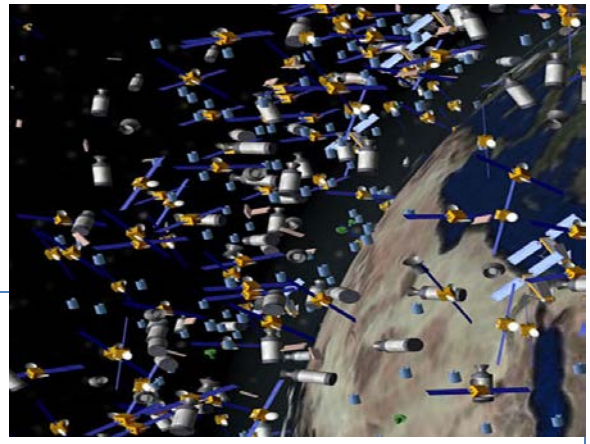
Basic Issues



- What is the definition of orbital debris?
- Who owns a particular debris? How to fix the responsibility? What is nature of jurisdiction and control over orbital debris?
- How to address debris related issues with the entry of the non-state actor in the business?
- Handling the issues arising due to the dual use nature of various proposed debris removal techniques

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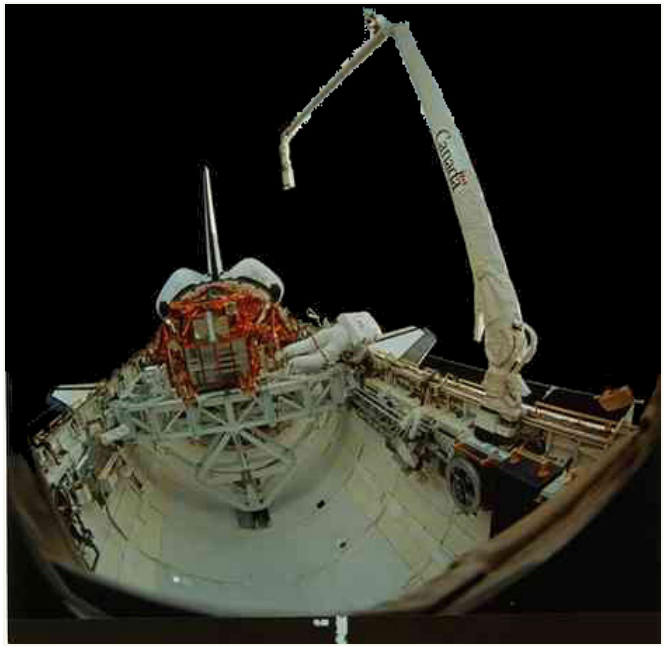
On Orbit Servicing

- Direct replacement of any nonperforming unit
- Replacement with advanced unit
- Repair
- Installation of additional hardware
- Unplanned requirements



Remote Intervention is the Key

- Satellite servicing-demand likely to increase
- Robotic activities would play a major role
- Serving beyond LEO
- Geostationary orbit has high commercial and strategic value assets
- Robot based Geostationary Service Vehicles

Strategic Implications

Wide-ranging Issues

- Overall '***strategic***' interests need to be viewed from a technological, military, international cooperation/competition and economic point of view

- Premature to look for direct military applicability while Removal of Space Debris and On-orbit Servicing of Space Objects missions are still evolving

Probable Investors

- The United States: NASA is working on this problem
- Russia: Investing $ 2b in space debris removal, is planning to build a "pod" that will knock junk out of orbit and back down to earth, pod will have a nuclear power core to keep it running for about 15 years while it orbits the earth knocking defunct satellites out of orbit
- China: Recently the Shenzhou VIII spacecraft joined onto the Tiangong-1 experimental module, demonstrates the potential of the space programme
- ESA

Recycling of Satellite Parts

(space debris becomes space resource)

- A program called Phoenix by the US
- Recycle still-functioning pieces of defunct satellites and incorporate them into new space systems inexpensively
- Robot mechanic-like vehicle with grasping mechanical arms and remote vision systems to harvest still-working antennas from retired and dead satellites
- Launching the antenna-less small satellites would be much cheaper, attach antennas in space to these satellites

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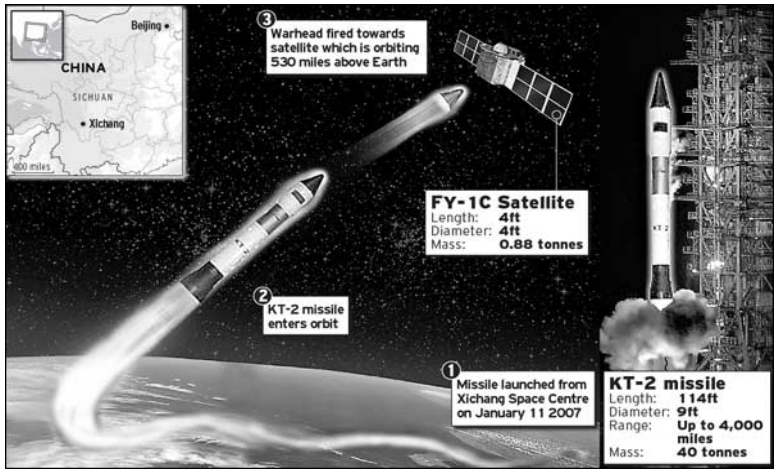
Security Approach

- There is a need for unified security approach however, none of these states…..
- Op Burnt Frost (Feb 20, 2008): The US is selling this idea as a ‘model of transparency’. But, going alone is not the answer
- China’s 2007 ASAT makes their intentions……



Demonstration Tool!!

- "Politics" behind undertaking space launches to actually demonstrate the missile development capabilities is well-known

- Debris removal and on-orbit servicing technologies: would states use them to demonstrate their ASAT capabilities?

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Space 'arms' race...

- Would major space powers use debris removal technologies as one of the instrument to start a space race? Amongst themselves and also forcing emerging players to become cautious

- The implications could be both economic and geopolitical

- Would limited "have" group of countries come together and make a convenient treaty (space-NPT)?

Weapon Potential

- The growth of technology itself presents direct or indirect benefits for the military
- Space to space and space to ground options
- Development of jamming technologies
- Testing of new technologies could be undertaken openly (covert demonstration of ASAT)

- Spin-off benefits for other projects in space

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Fringe Benefits...

- Help the development of frontier technologies: applicability includes the armed forces

- Development of Space and Radar Networks: could also help in intelligence gathering mechanisms. C4ISR capabilities could undergo a revolution

- Robotics--Logic is simple: if you can operate a robot in space, you can operate it in an enemy state or on the battlefield

- The strategic materials being developed for such missions could change the face of platform technology

Indian's View

- Re-entry of ROSAT (Oct 2011)- Bay of Bengal region
- Oct 12, 2011:PSLV-C18 launch with Megha-Tropiques satellite. A delay of one minute to preclude the "probability of space debris," smashing into the satellites
- Intentions of few states are not clear
- Collision avoidance mechanism, need for information grid
- Lack of global structures to address these issues

Appraisal

- Lack of policy both at national and international levels
- Putting satellite in a space involves 'Rocket Science'. Destroying a satellite…….
- States could have *reservations* about binding or intrusive Debris Mitigation or Remediation Regulations or Code of Conduct, since this could influence national defence and security imperatives

Appraisal *contd*

- It is important for states to appreciate that validation of ASAT capability on the ground through simulation is possible
- Need to establish collision avoidance mechanism
- Need to improve space surveillance capabilities and find means for immediate dissemination of space situational awareness

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Appraisal *contd*

- Debate “polluter pays” principle, Superfund…
- Non-state actors operating in space; need for proactive engagement
- Any legal regime should be supported by creating organisations (akin to IAEA/OPCW etc) for implementations
- States needs to be assisted to strengthen space situational awareness capability
- Geneva Vs Vienna……

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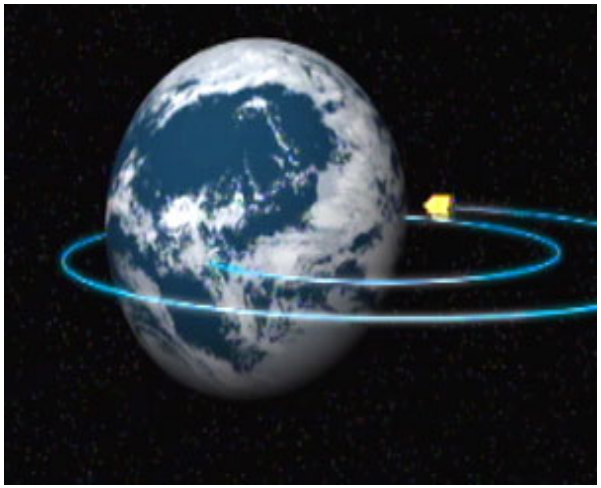

Thanks