LASER RANGING FOR THE PRECISION ORBIT DETERMINATION AND REMOTE MANEUVER OF SPACE DEBRIS

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The Problem

• 3,000+ operational satellites in orbit around Earth, worth about 1 trillion dollars and growing
• Also 300,000+ space debris objects, greater than 1 cm across, and up to 1 million smaller objects (objects include spent rocket casings, nuts and bolts and an astronaut’s glove)
• A collision between one piece of debris and a satellite causes severe damage or destruction AND creates more debris.
• Space may be unusable within 20-30 years (Kessler syndrome)

Damage to space shuttle window caused by a fleck of paint
The Problem

Modern societies are now fundamentally depend on assured and secure access to space assets for many basic requirements.

Space debris presents a devastating societal threat.
The Orbital Debris Environment: Before 1957

Low Earth Orbit (LEO)  Geostationary Earth Orbit (GEO)
1960

LEO

GEO
Less than 5% of the 300,000 debris objects >1 cm are shown.
A Collision in Space:
Two satellites on collision course over Russia

10 February 2009

40 seconds before impact
A Collision in Space:

The two satellites are now only space debris

Debris created:
- 1,800 pieces > 15 cm [shown]
- 7,000+ pieces > 1 cm

80 seconds after impact
Debris from Iridium – Cosmos collision (2009)

Debris from Chinese Anti-Satellite Test (2007)

Debris is now increasing through collisions in space
Optical Space Tracking in EOS

- 1997-1998 Technology demonstrators
- 1999-2002 Laser tracking of 15 cm debris
- 2003-2004 Total loss of facility to wildfires
- 2005-2009 Upgrades to 5 cm and entire catalogue, at all altitudes
- 2010-2013 Automation, cost, scaling and interoperability factors
- 2014-2018 Network for collision mitigation [announced August 2014]

Breakthroughs in optical tracking allow the technology to deploy for collision mitigation and provide a platform for debris removal technologies.
Large-scale commercial tracking networks will reduce risk and buy time.

However we may have less than 20 years to the tipping point, even with collision mitigation.

Technology to remove debris must be accelerated.
1. What is a CRC [Cooperative Research Centre]?

SEM CRC is an international PPP involving governments, universities and industry. Led by industry, but funded by government and operating under statute as a quasi-government agency.

2. CRC Lifetime?

5 years plus extensions, subject to progress [typically 10 years]

3. Funding?

A$60M over 5 years, plus priority access to $100M of new infrastructure.

A proposal to form a CRC for space debris, based on a $20M contribution from EOS, was implemented, and funded to $60M from 1 Oct 2014. The CRC is called the “Space Environment Research Centre” and is a non-profit agency legally prohibited from ever passing any benefits to members.
CRC Participation

1. EOS Space Systems [AUS]
2. Lockheed Martin Corporation & NASA [USA]
3. Australian National University [AUS]
4. National Institute of Information and Communications Technology [Japan]
5. RMIT University [AUS]
6. Optus [AUS]

Participants leverage synergies from many existing international research efforts and embed links to space users in all segments.
1. Tracking

We will research accurate, low-cost optical-tracking sensors and management strategies which may enable affordable monitoring of 100% of the threat.

2. Orbits

We will improve orbit determination technology to extend the tracking interval to at least 2 days and reduce the future cost of debris tracking infrastructure.
3. Collisions

Improve collision avoidance prediction at least 10-fold

We will make collision avoidance maneuver cost-effective

4. Maneuver

Develop a practical demonstration to modify the orbits of space debris from Earth using CW lasers

We can already maneuver many satellites to avoid collisions, but we now need to maneuver debris to limit debris growth
Research Program Relationships

Programs 1-3 delay Kessler and support Program 4 which removes debris
The research programs will each have a strong impact on the development of collision mitigation technology.
SERC Resources

$60M over 5 years is not much funding:

• World best practice is our starting point

  World leaders are in the CRC, bringing current programs

• $100M+ in new facility investment is available to CRC

  Facilities at Mt Stromlo ($30M) & Tokyo ($30M) as well as major facilities with other partners are now available

• Multi-lateral collaboration is achieved efficiently

  Private sector management implemented for research

The CRC already has the infrastructure access it needs
SERC Resource Requirements

- Program managers
  These are initially provided by members from current staff

- Post-doctoral Fellows and PhD students
  Around 10 vacancies are now available with more in 2015/16

- Research Scientists
  Affiliation with major universities allows sabbaticals

www.serc.org.au