ORBITAL DEBRIS*: WHAT ARE THE BEST NEAR-TERM ACTIONS TO TAKE?* A VIEW FROM THE FIELD.

2nd Manfred Lachs International Conference on Global Space Governance

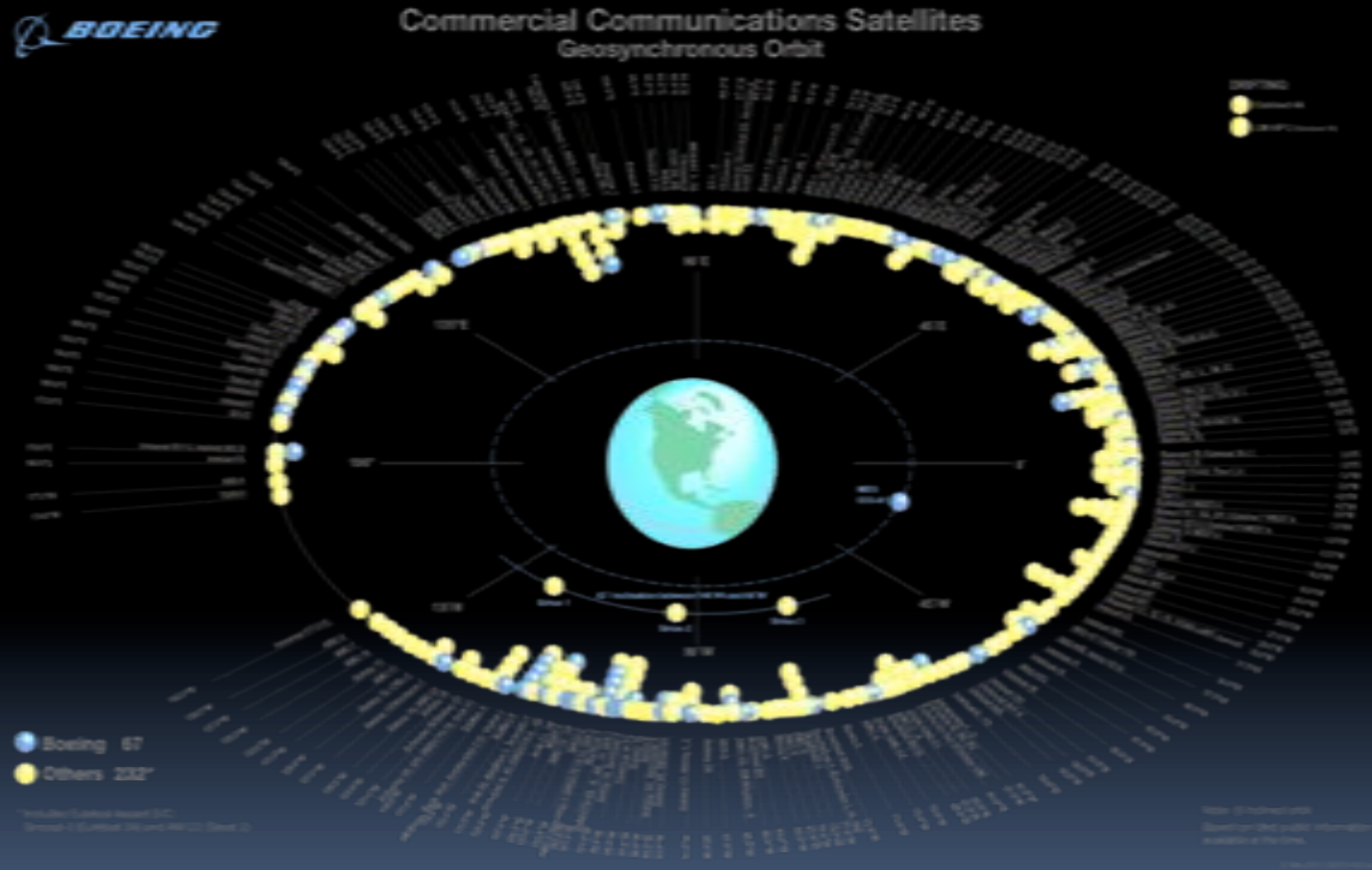
30 May 2014

Dr. Mark A. Skinner

Agenda

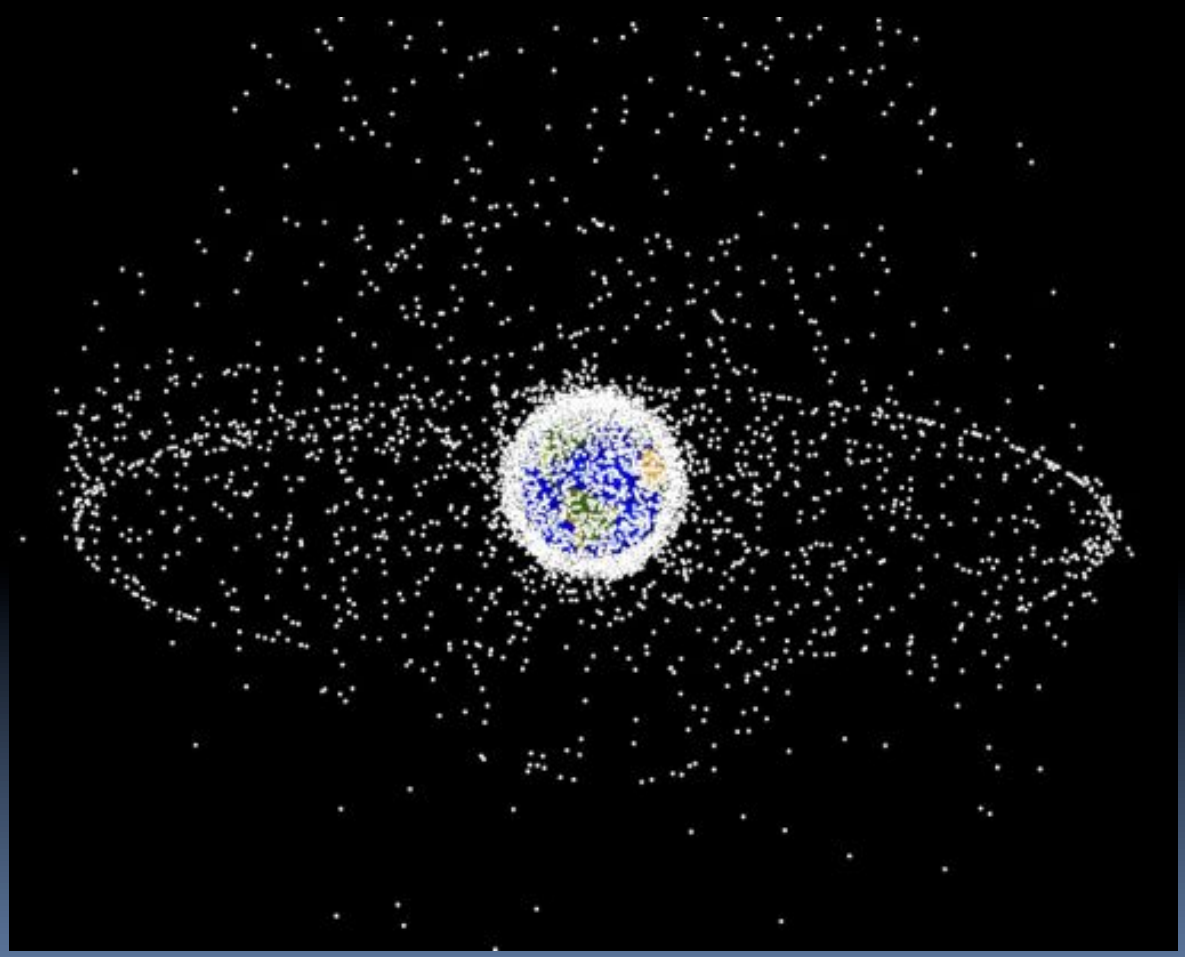
- What are we trying to protect?
- So what's the problem?
  - Detritus of the Space Age
  - Debris begets debris: the Kessler syndrome
- So what can we do about it?
  - International cooperation
  - SSA
  - Data sharing
  - Debris removal
- Next best steps
- Conclusions

How to assure continued use of space for the future?

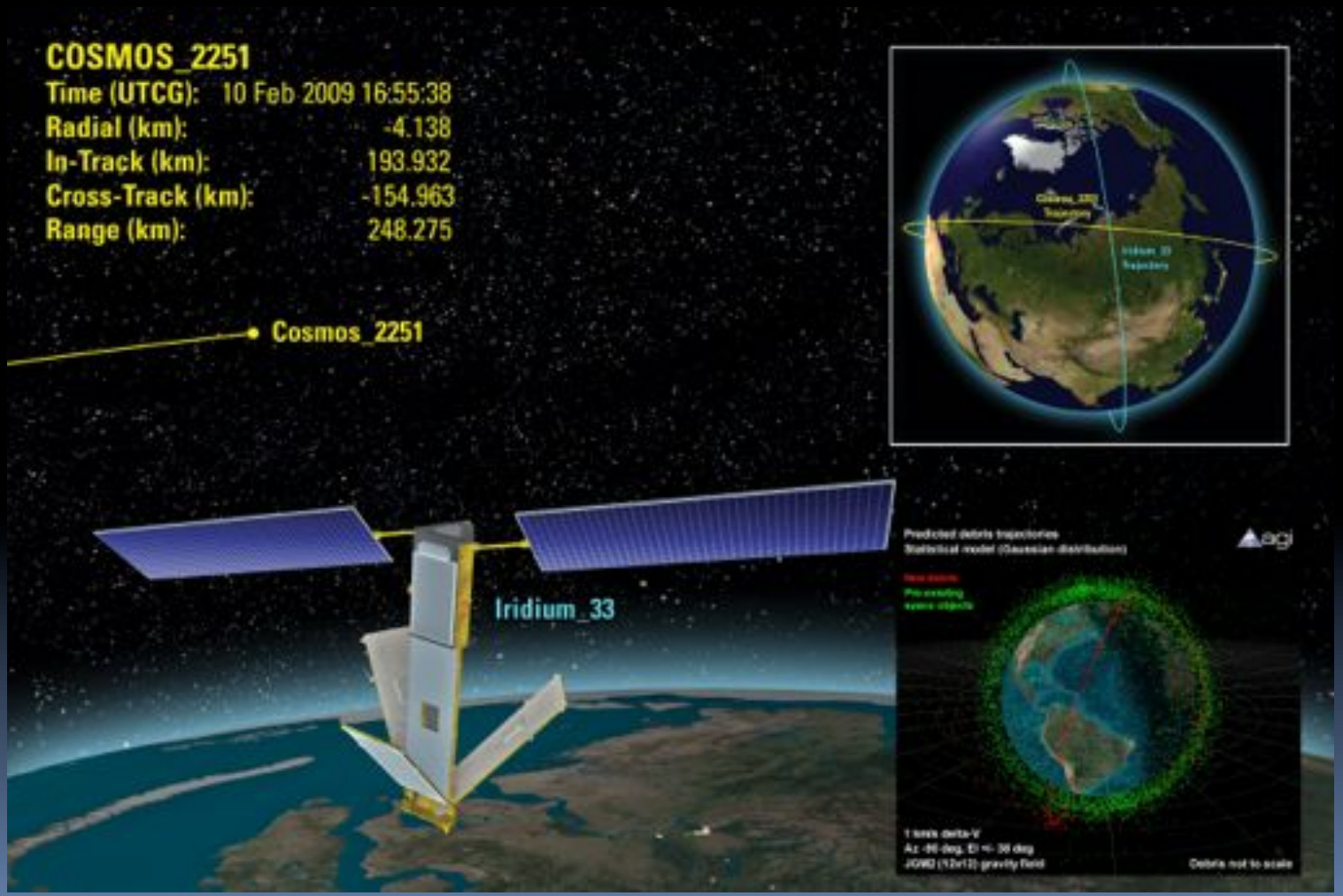


Man-made debris dominates Earth's near-space region

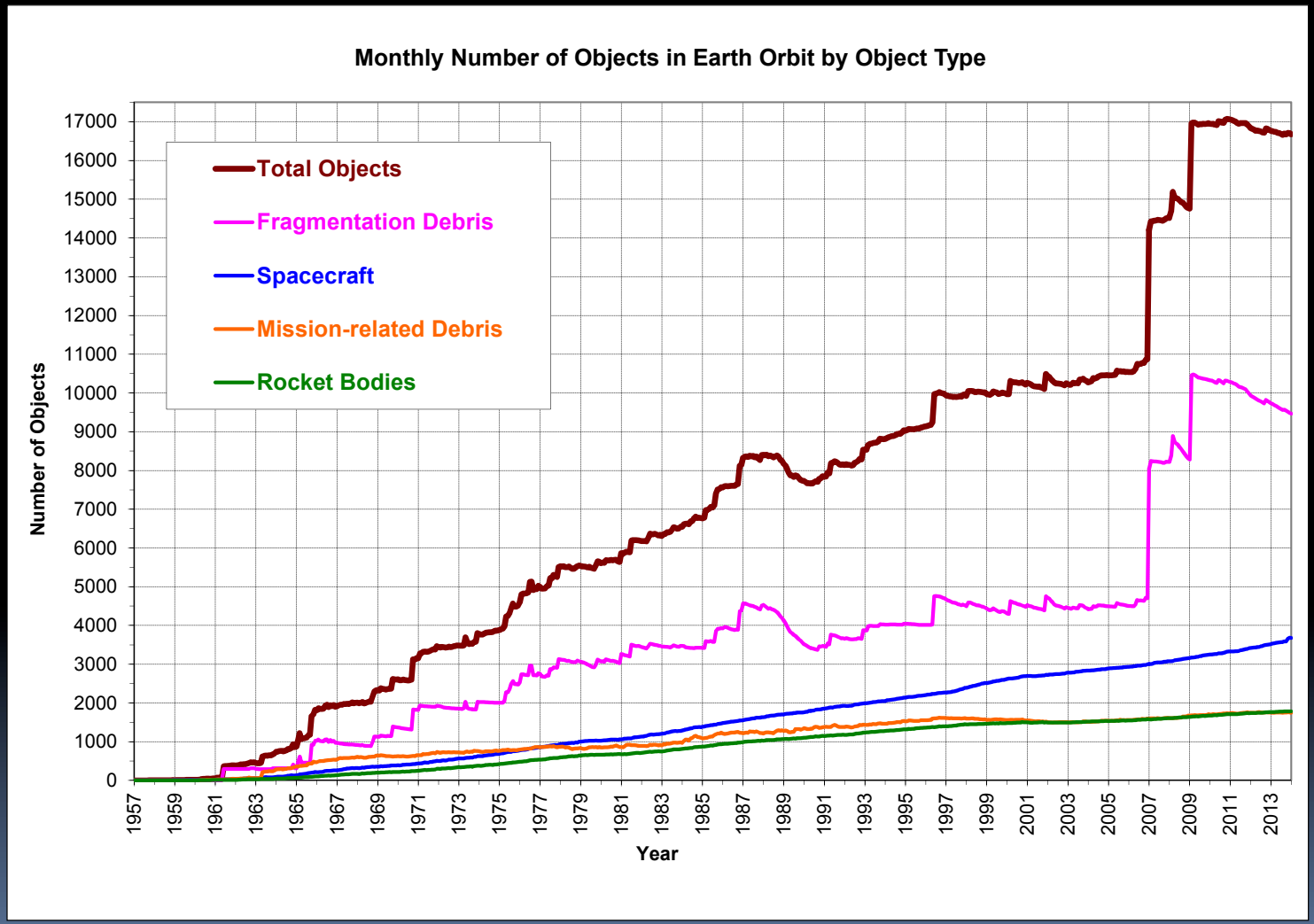
- Computer-generated images shows objects currently tracked by US Space Command
- 95% of objects in image are space debris
- There exist additional debris populations at GEO that are not shown on this image
- Image courtesy of the NASA Orbital Debris Program Office



How to create more space debris…

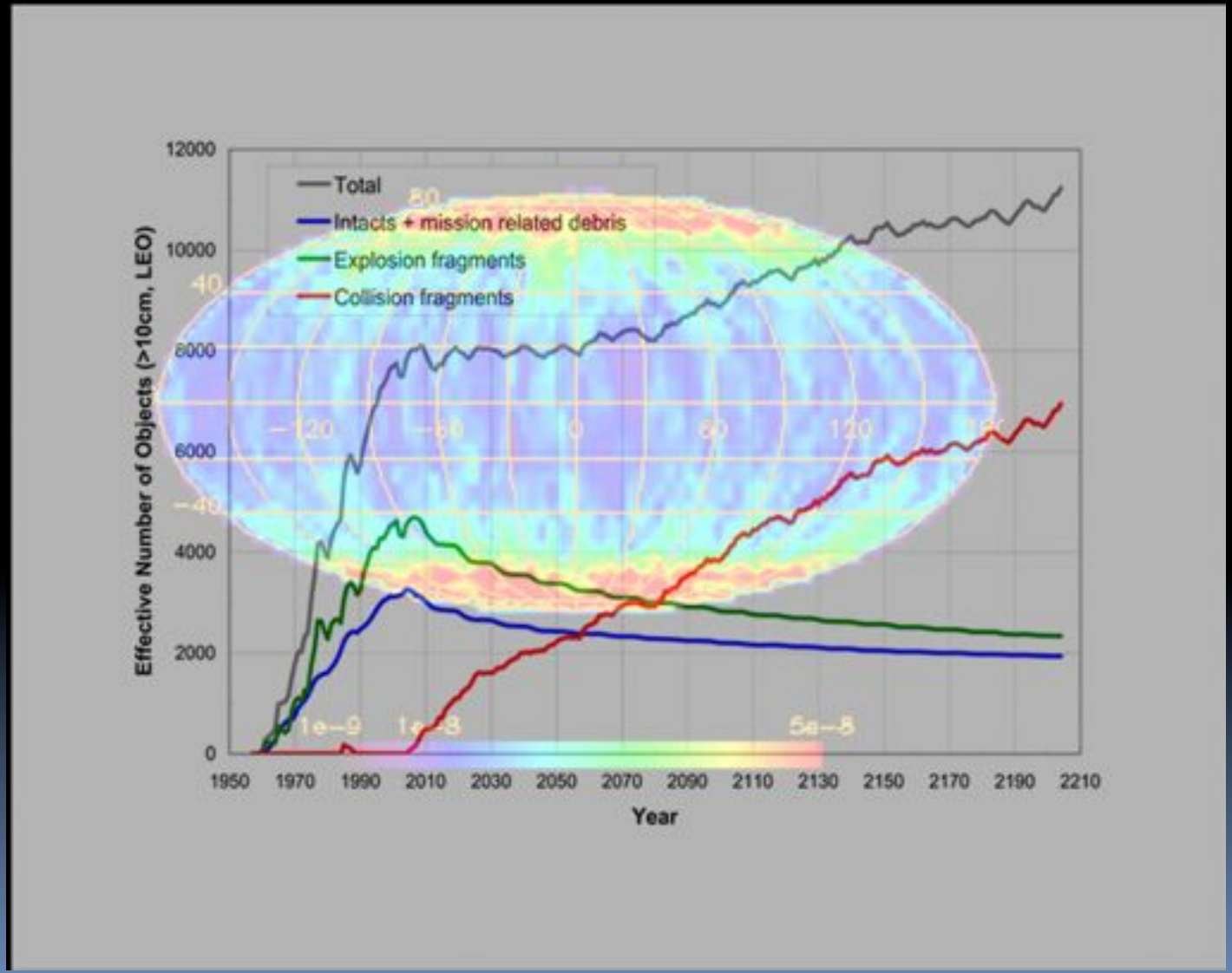


How is the amount changing over time?



Monthly Number of Cataloged Objects in Earth Orbit by Object Type: This chart displays a summary of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. "Fragmentation debris" includes satellite breakup debris and anomalous event debris, while "mission-related debris" includes all objects dispensed, separated, or released as part of the planned mission.

The Kessler Syndrome: a run-away cascade of space debris…



What can we do about it?

SPACE DATA ASSOCIATION

Range of options, and their relative costs and time-scales

- International cooperation
  - Inexpensive, but medium-term
    - Not fixing existing problem, but for a better future
- Data sharing
  - Inexpensive, short-term
    - With some limitations
- Additional SSA
  - Inexpensive, short-term
- Debris Removal
  - Expensive, long-term
    - But needs to be researched now…

International Cooperation

UN (HQ, NYC)

UNIDIR* (GVA)

Military/Disarmament issues

-Space-related-

COPUOS (VIE)

1959; 76 members

Legal SC

Science & Tech SC

-Secretariat is UNOOSA-

Outer Space Treaties
Principles of use of NPS in space
Capacity building in Space Law
National mechanisms for space debris
National legislation on peaceful uses of space

Nuclear Power Systems
SPIDER+ (disaster management)
Space Debris
Space Weather
Use of GEO
Long-term sustainability

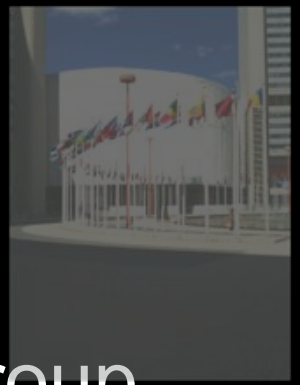
Decisions are reached by absolute consensus

+United Nations Platform for Space-based Information for Disaster Management and Emergency Response

*United Nations Institute for Disarmament Research

UNOOSA United Nations Office for Outer Space Affairs

COPUOS



Long Term Sustainability Working Group

LTS Working Group integrates discussions on space sustainability in COPUOS
Chair: Dr. Peter Martinez (South Africa)

"deliberative fora"

Expert Group A
Sustainable space utilization supporting sustainable development on Earth

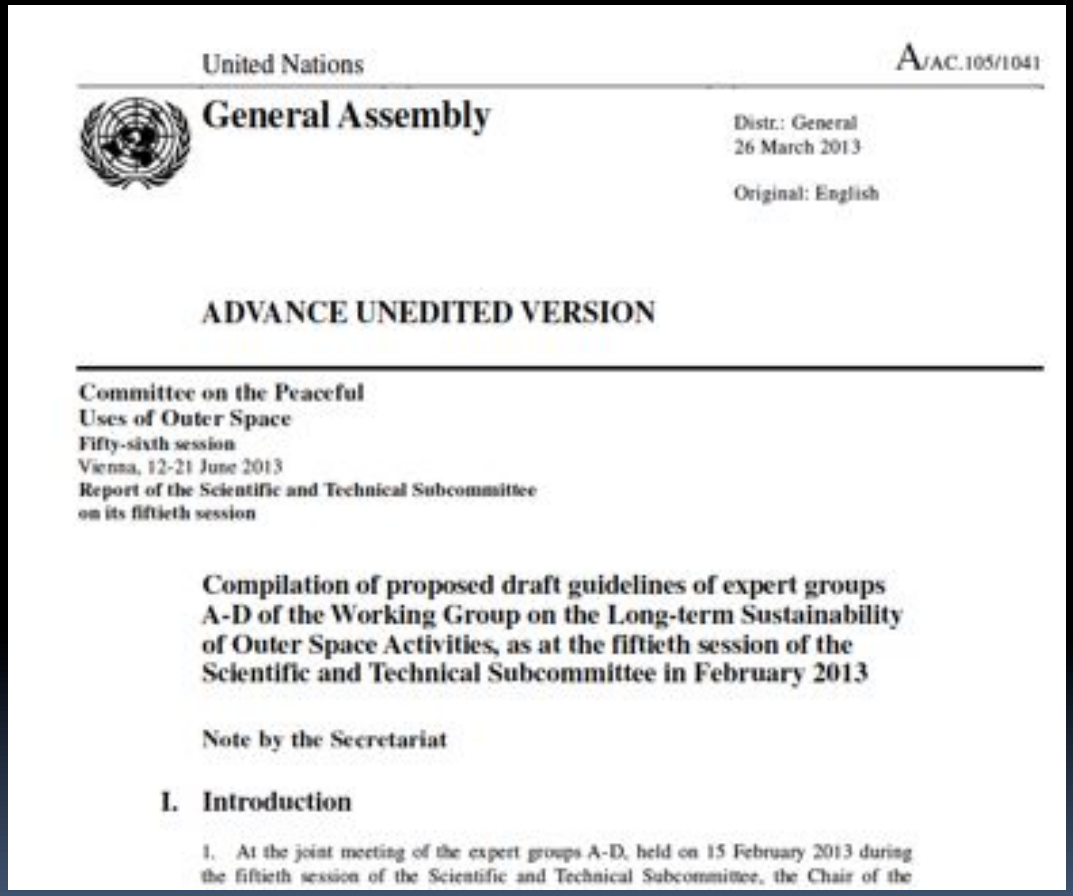
Expert Group B
Space Debris, Space Ops and Tools to Support Collaborative SSA

Expert Group C
Space Weather

Expert Group D
Regulatory Regimes and Guidance for Actors In the Space Arena

The objective of the Working Group is to examine and propose measures to ensure the safe and sustainable use of outer space for peaceful purposes, for the benefit of all countries.

The output: guidelines under discussion…



United Nations A/AC.105/1041

General Assembly

Distr.: General
26 March 2013

Original: English

ADVANCE UNEDITED VERSION

Committee on the Peaceful Uses of Outer Space
Fifty-sixth session
Vienna, 12-21 June 2013
Report of the Scientific and Technical Subcommittee on its fiftieth session

Compilation of proposed draft guidelines of expert groups A-D of the Working Group on the Long-term Sustainability of Outer Space Activities, as at the fiftieth session of the Scientific and Technical Subcommittee in February 2013

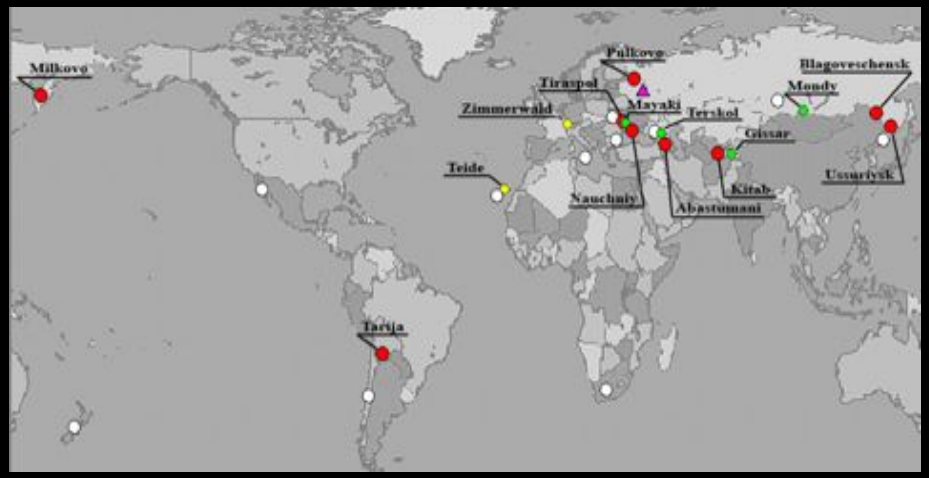
Note by the Secretariat

I. Introduction

1. At the joint meeting of the expert groups A-D, held on 15 February 2013 during the fiftieth session of the Scientific and Technical Subcommittee, the Chair of the

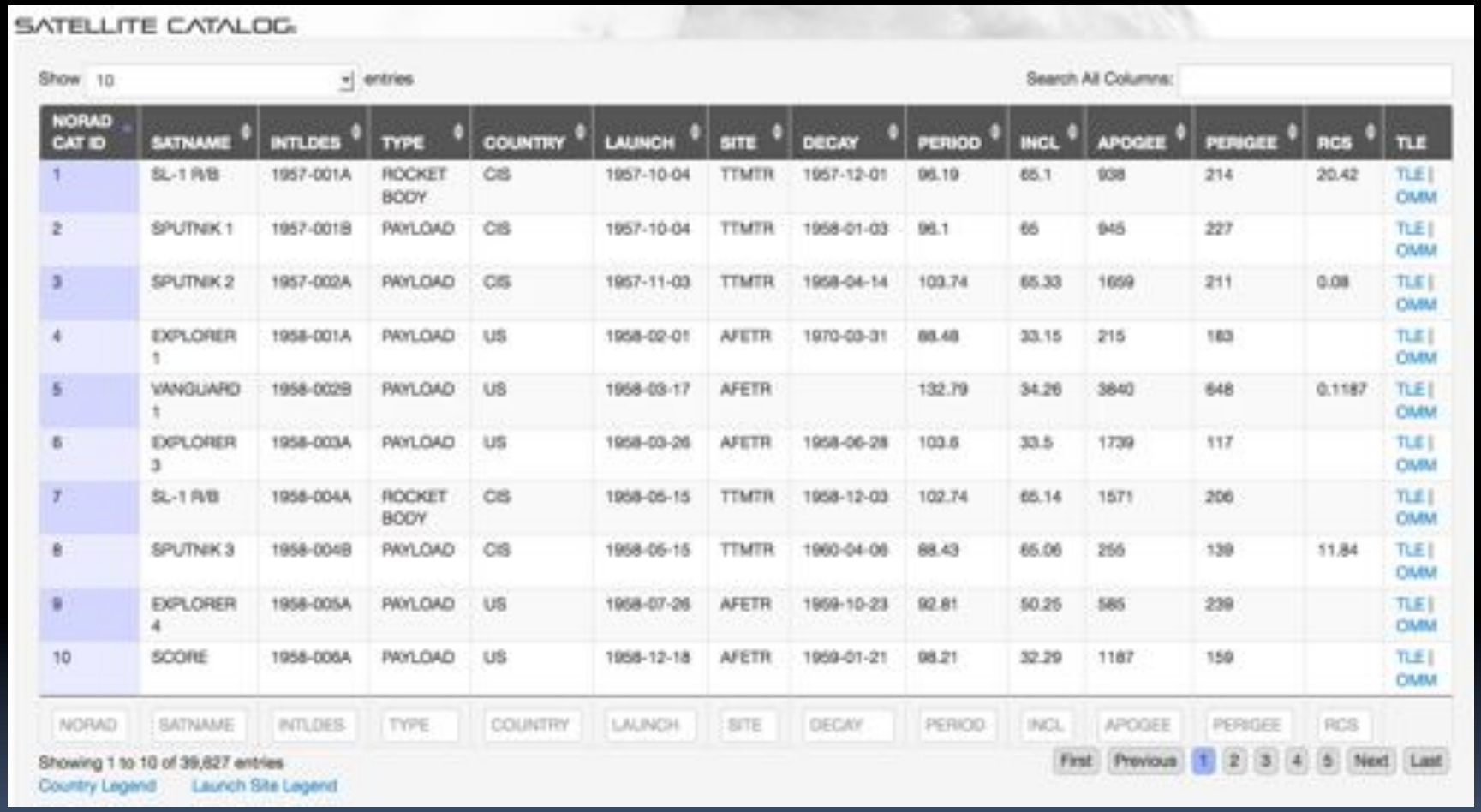
The document gets translated into the five other UN languages

SSA & Space Surveillance



- Space Command maintains catalog of space objects
  - Utilizes ground-based optical & radar, space-based optical
- ISON has a network of small telescopes
- Emerging commercial SSA networks

The "Catalog"…



SATELLITE CATALOG

Show 10 entries

Search All Columns:

NORAD CAT ID	SATNAME	INTLDES	TYPE	COUNTRY	LAUNCH	SITE	DECAY	PERIOD	INCL	APOGEE	PERIGEE	RCS	TLE
1	SL-1 R/B	1957-001A	ROCKET BODY	CIS	1957-10-04	TTMTR	1957-12-01	96.19	65.1	938	214	20.42	TLE | OMM
2	SPUTNIK 1	1957-001B	PAYLOAD	CIS	1957-10-04	TTMTR	1958-01-03	96.1	65	945	227		TLE | OMM
3	SPUTNIK 2	1957-002A	PAYLOAD	CIS	1957-11-03	TTMTR	1958-04-14	103.74	65.33	1659	211	0.08	TLE | OMM
4	EXPLORER 1	1958-001A	PAYLOAD	US	1958-02-01	AFETR	1970-03-31	88.48	33.15	215	183		TLE | OMM
5	VANGUARD 1	1958-002B	PAYLOAD	US	1958-03-17	AFETR		132.79	34.26	3840	648	0.1187	TLE | OMM
6	EXPLORER 3	1958-003A	PAYLOAD	US	1958-03-26	AFETR	1958-06-28	103.6	33.5	1739	117		TLE | OMM
7	SL-1 R/B	1958-004A	ROCKET BODY	CIS	1958-05-15	TTMTR	1958-12-03	102.74	65.14	1571	206		TLE | OMM
8	SPUTNIK 3	1958-004B	PAYLOAD	CIS	1958-05-15	TTMTR	1960-04-06	88.43	65.06	255	139	11.84	TLE | OMM
9	EXPLORER 4	1958-005A	PAYLOAD	US	1958-07-26	AFETR	1959-10-23	92.81	50.25	585	239		TLE | OMM
10	SCORE	1958-006A	PAYLOAD	US	1958-12-18	AFETR	1959-01-21	98.21	32.29	1187	159		TLE | OMM

NORAD | SATNAME | INTLDES | TYPE | COUNTRY | LAUNCH | SITE | DECAY | PERIOD | INCL | APOGEE | PERIGEE | RCS

Showing 1 to 10 of 39,827 entries

First Previous 1 2 3 4 5 Next Last

Country Legend Launch Site Legend

"TLE" for the ISS

```
0 ISS (ZARYA)
1 25544U 98067A   14094.03144353 -.00138552  00000-0 -24245-2 0    65
2 25544 051.6463 107.0810 0003978 337.2202 062.8076 15.50434083879826
```

Solving the problem- moving beyond the SSN

Data Sharing… for active space objects

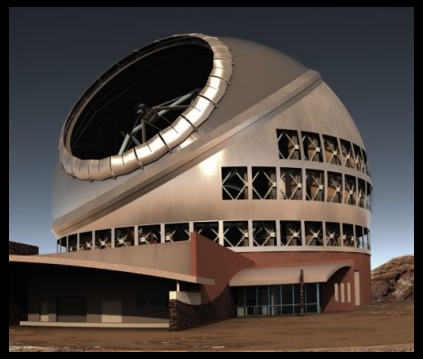
International space debris data sharing

No international public repository for space debris information…

- The Model:
- Minor Planet Center
- Associated with IAU
- Located at SAO
- Funded by NASA
  - 6 FTE's
  - Collates and associates observations of natural space objects

- Proposal:
- Space Debris Data Center
- Ties to UN COPUOS
- Initial DARPA Demo
- Funded by NASA
  - Orbital Debris Program Office
  - Located at MHPCC
    - UH- Pan-STARRS
    - Collates and associates observations of artificial space objects

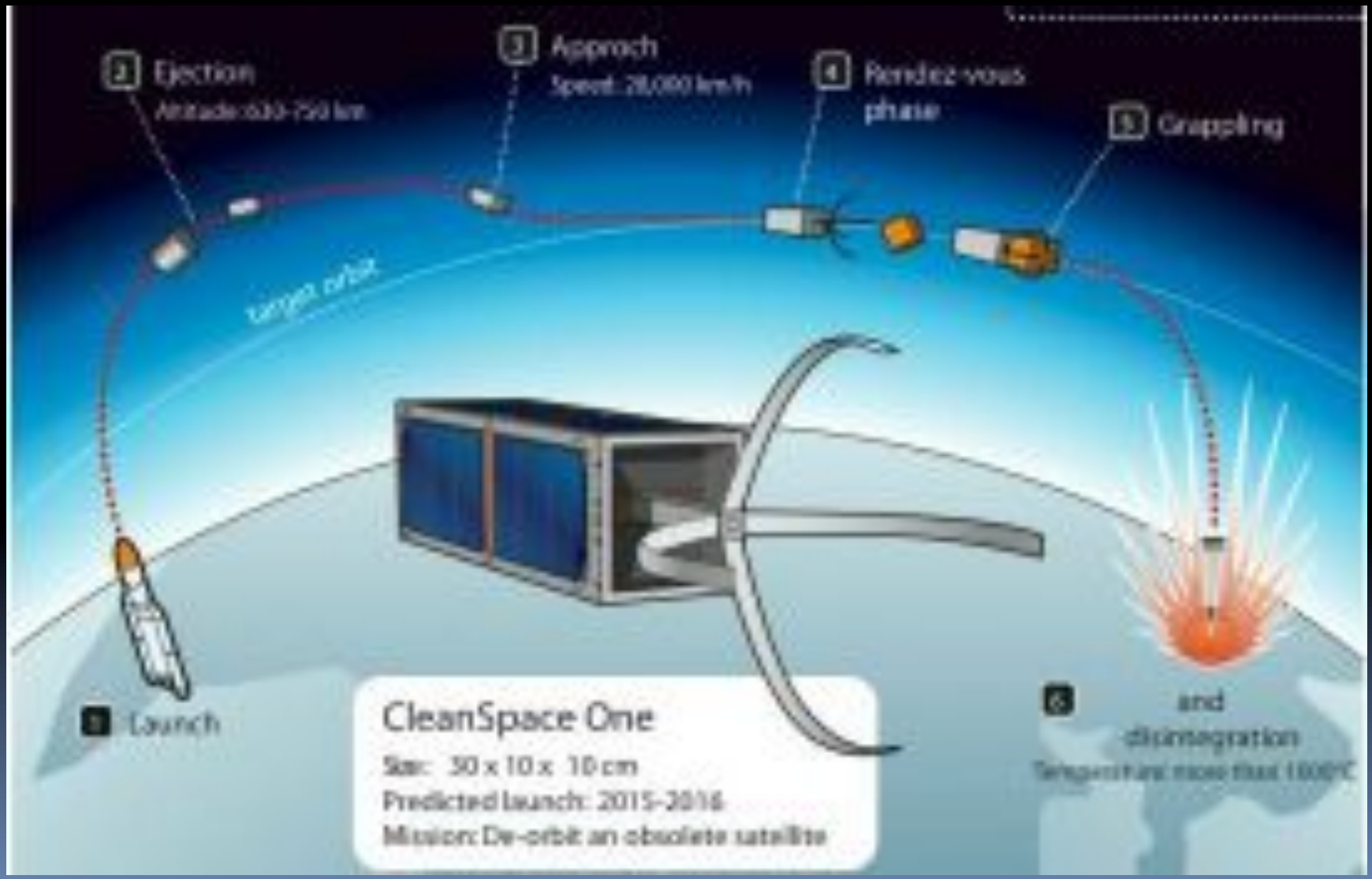
Additional SSA for debris on a commercial/civil basis; telescope requirements* are modest…



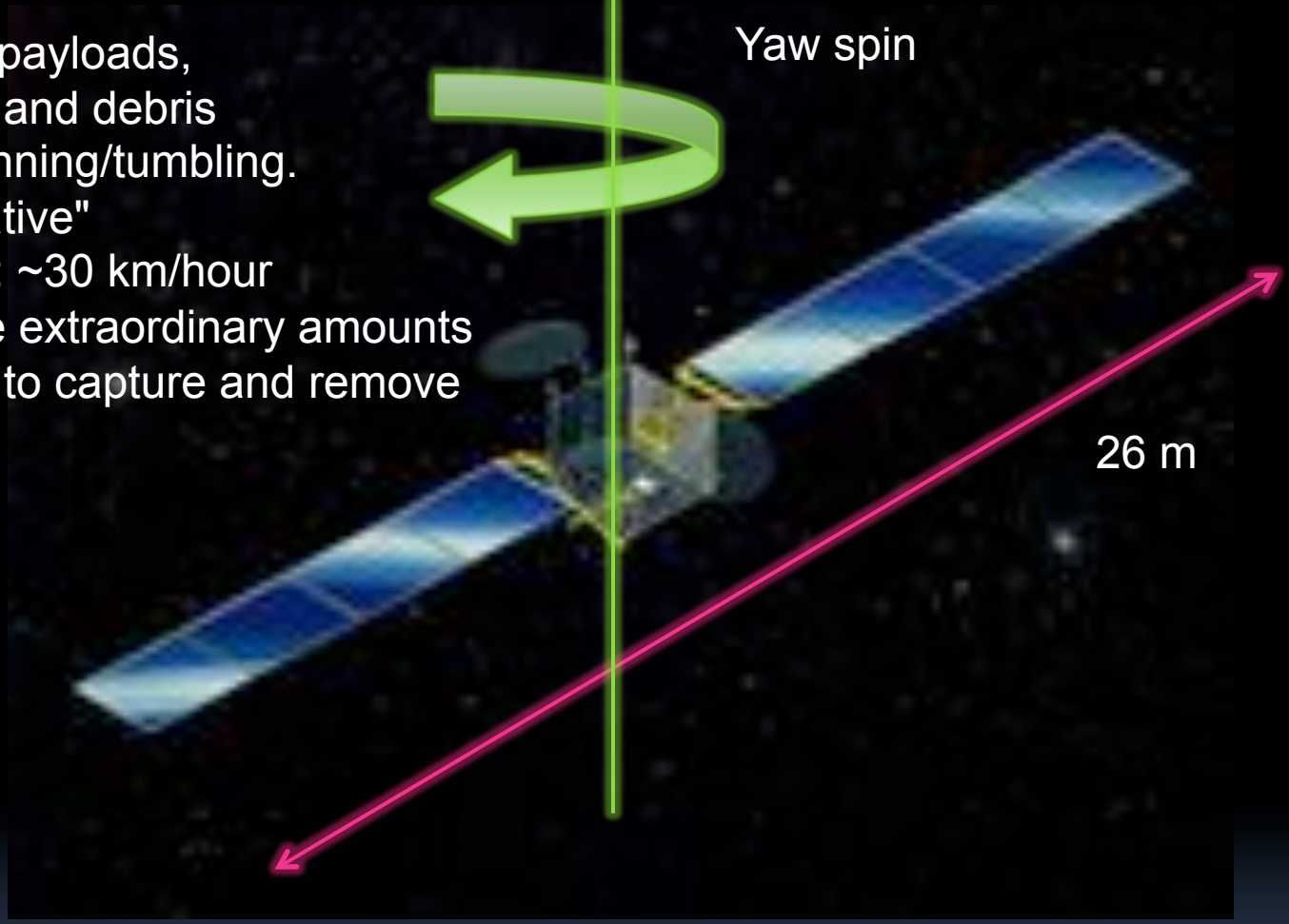
Euro 50	50 m	2035?
TMT	30 m	2030?
GMT	21.4 m	2024
Gran Telescopio Canarias (GTC)	10.4 m	2009
Keck 1	10 m	1993
BTA-6	6 m	1976
Hale Telescope (200 inch)	5.08 m	1948
Hooker 100-Inch Telescope	2.54 m	1917
Leviathan of Parsonstown	1.83 m	1845
Herschel 40-foot (126 cm d.)	1.26 m	1789–1815
Rev John Michell's Gregorian reflector	75 cm	1780–1789
Fr Noel's Gregorian reflector	60 cm	1761
James Short's Gregorian reflector	50 cm	1750
James Short's Gregorian reflector	38 cm	1734
Christiaan Huygens 210 foot refractor	22 cm	1686
Christiaan Huygens 170 foot refractor	20 cm	1686
Christiaan Huygens 210 foot refractor	19 cm	1686
Hooke's reflector	18 cm	16??
Hevelius refractor	12 cm	1645
Hevelius Scheiner's helioscope	6 cm	1638
Galileo's 1620 telescope	3.8 cm	1638
Galileo's 1612 telescope	2.6 cm	1612
Galileo's 1609 telescope	1.5 cm	1609

*But need a sensitive camera

Active Debris Removal (ADR)



- Most defunct payloads, rocket bodies, and debris pieces are spinning/tumbling.
- "Non-cooperative"
- 0.33-20 RPM: ~30 km/hour
- Would require extraordinary amounts of energy (Δv) to capture and remove



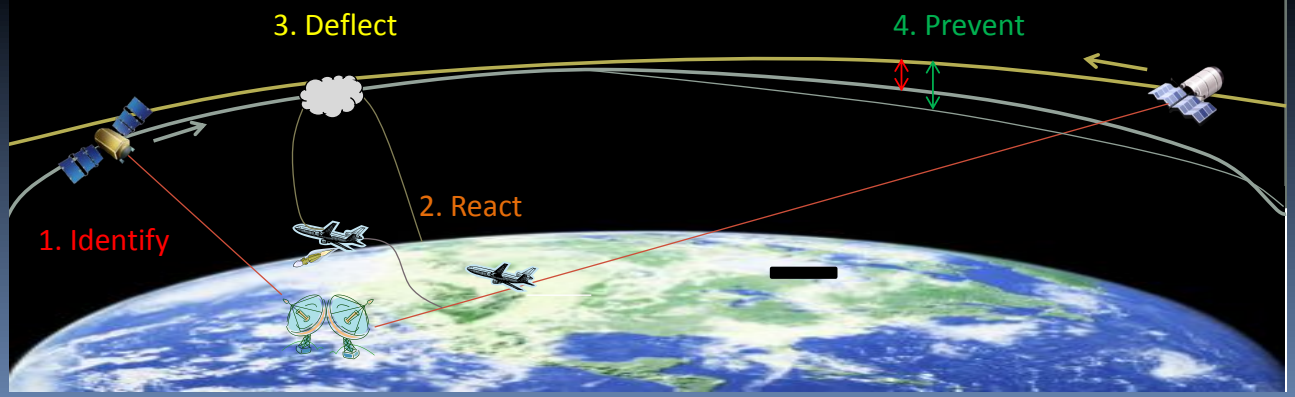
One "hard" technical problem with ADR…

ADR alternatives….

JCA Operations:
Prevent imminent orbital collision w/o going into orbit

1. Identify: Ground and orbital systems detect imminent collision.
2. React: Air-launch system is mobilized with JCA system on board.
3. Deflect: JCA system is deployed to induce a slight change in the orbit of one of the objects involved by deploying cloud of high density gas.
4. Prevent: If the object's orbit is changed enough the collision will be prevented.

Original Orbit
Ground Detection
Aircraft Trajectory
Launch Vehicle Trajectory
New Orbit



So where should we spend the next dollar?

- Additional SSA capabilities provide most efficient use of any additional funding
- Need to share data on debris internationally
  - New low-cost *Space Debris Data Center*
- Continue international discussions to develop best practices & guidance
- Research into how to accomplish collision avoidance

Conclusions

- Space debris is caused by us
- 10,000's of objects
- Danger to the near-Earth space environment and the long-term sustainable use of space
- Danger to humans; astronauts and people on the ground
- Studied by governments and industry
- Under international discussion
- Need to do something now and in the future-
  - multi-phased approaches
- Need better knowledge of objects in space