Inter-Agency Space Debris Coordination Committee (IADC)

Presented to:
34th Session of the
Scientific and Technical Subcommittee
of the United Nations'
Committee on the Peaceful Uses of Outer Space

On Behalf of the IADC:
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Inter-Agency Space Debris Coordination Committee

Purpose -

- To exchange information on space debris research activities between member space agencies
- To review progress of ongoing cooperative activities
- To facilitate opportunities for cooperation in space debris research
- To identify debris mitigation options

History of the IADC

- There have been bilateral discussions on space debris between spacefaring nations since 1986
- NASA/ESA/Japan multilateral discussions began in late 1992 in Houston
- RSA invited to join multilateral discussions at ESOC in 1993
- IADC formally founded 1993. Founding members are ESA, Japan, NASA, and RSA
- CNSA(China) joined IADC in 1995
- BNSC(UK), CNES(France), and ISRO(India) joined IADC in 1996

Highlights of IADC Terms of Reference(TOR)

- Initial Terms of Reference agreed to at 10th IADC meeting in Kaliningrad, October 1993
- Terms of Reference are modified as appropriate
- Working Group Chairs are elected to serve a term of two consecutive meetings
- Working Group Deputy automatically succeeds to Chair and new Deputy Chair is elected
- All agreements of IADC are made by consensus

Highlights of IADC Terms of Reference(TOR) Continued

- Membership in IADC limited to nations and organizations consistent with the aims and objectives agreed to in IADC TOR
- Each member of IADC must be represented in the Steering Group and in Working Group 4 (Mitigation).
  - Representation in other Working Groups is desirable but not mandatory
- Host of IADC meeting acts as the Chair of that meeting and preceding Steering Group meeting.

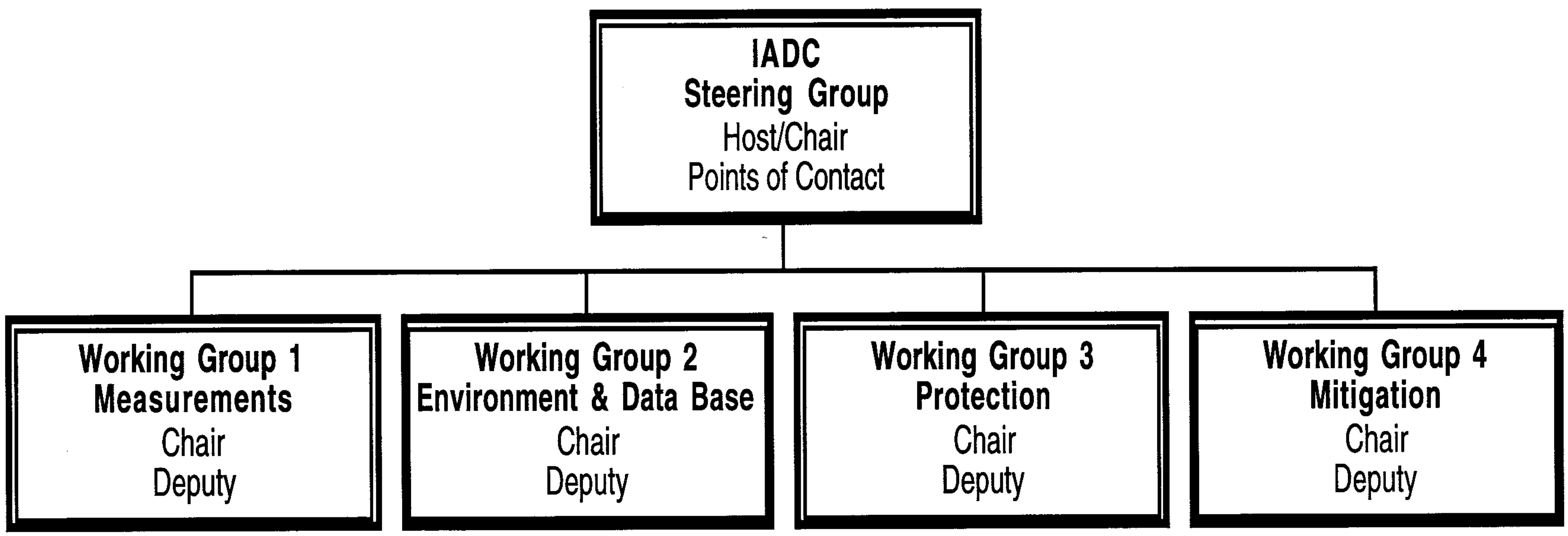
Highlights of IADC Terms of Reference(TOR) Continued

- Host is responsible for coordinating meeting dates, location, agenda as well as drafting and distributing meeting minutes
- Cost to participate in IADC is borne by each IADC member.
  - Country hosting an IADC meeting pays for general meeting arrangements

IADC Operations

- Formal meetings of the full IADC are scheduled about once a year
- Location of meetings rotate among IADC members as appropriate
- IADC Steering Group meets between full IADC meetings
- Working Group and Steering Group Members pursue action items between formal meetings of the full IADC or of the Steering Group

Inter-Agency Space Debris Coordination Committee Structure



Inter-Agency Space Debris Coordination Committee

(Contact Points of IADC Members)

BNSC: Mr. Richard J. Tremayne-Smith

CNES: Mr. Yves Trempat

CNSA: Dr. Wang Xiuting

ESA: Dr. Walter Flury

ISRO: Mr. J. Ninan

Japan: Dr. Susumu Toda

NASA: Mr. George M. Levin

RSA: Dr. Sergey V. Kulik

Working Group Chairs/Deputies*

- Working Group 1: Measurements
  - **Chair: Tadashi Takano, Japan**
  - **Deputy: Andrey Nazarenko, RKA**
- Working Group 2: Environment & Data Base
  - **Chair: Heiner Klinkrad, ESA**
  - **Deputy: Robert Reynolds, NASA**
- Working Group 3: Protection
  - **Chair: Jeanne Crews, NASA**
  - **Deputy: Evgeni Ulanov, RKA**
- Working Group 4: Mitigation
  - **Chair: Akira Takano, Japan**
  - **Deputy: Walter Naumann, ESA**

* As of 13th Meeting - March 1996

Major Issues Before IADC

- Planning for a cooperative international geostationary observation campaign
- Planning of coordinated space debris radar measurement campaigns
- Development of joint space debris data bases
- Exchange of results of damage prediction codes
- Recommendation for end of life geostationary reboost and passivation
- In-orbit breakup events
- Plan for coordinating/sharing data on reentry of risk objects

Space Debris Models

- Purpose
- Applications
- Limitations
- Overview

Space Debris Environment Modeling and Applications (1)

Space debris environment models describe:

- Historic and future traffic scenarios (deployment frequency and injection orbits of spacecraft, rocket stages, and mission related objects)
- Historic and future debris sources (explosions, collisions, SRM slag, ejecta, ...)
- Debris sinks (natural decay, de-orbit, retrieval)
- Spatial object densities, transient velocities, and collision fluxes in three dimensions (by altitude, latitude, and longitude) for a given particle size threshold.
- Current and future particle flux (direction and velocity) for given target orbits and mass or size thresholds.

Space Debris Environment Modeling and Applications (2)

Space debris models can be applied to:

- Risk and damage assessment for given impact fluxes and shield designs
- Prediction of debris detection rates for ground based sensors
- Prediction and avoidance maneuver frequencies of operational spacecraft for known orbit determination accuracies and detection thresholds
- Long-term analysis of the effectiveness of debris mitigation measures and their impact on the evolution and stability of the on-orbit population

Space Debris Environment Modeling and Applications (3)

Space debris models can be verified by:

- Ground based radar and telescope observations, producing full orbit states and cross-sections, or statistical detection rates
- Analysis of the impacts of hardware retrieved from space
- On ground explosion and collision tests to verify fragmentation models

Space Debris Environment Modeling and Applications (4)

Limitations

- Space debris models make use of all available information on cataloged objects, sub-millimeter particles, historical break-ups, etc.
- Assumptions must be made in order to characterize the unobservable population (use of break-up models, etc.)
- Assumptions must be made for the future evolution (e.g. future traffic scenarios, applications of mitigation measures).

Space Debris Environment Modeling and Applications (5)

Limitations

Therefore, space debris models are not perfect. They are of limited accuracy, consistent with the measurement capabilities of tracking sensors and the ability to mathematically describe the unobserved population.

Space debris models have to be updated and validated.

Overview of Space Debris Models (1)

- EVOLVE (NASA/JSC): short term and medium term forecast of the LEO debris environment with extensive source terms and detailed traffic models, based on quasi-deterministic population propagation techniques
- Orbital Debris Engineering Model, ORDEM96 (NASA/JSC): semi-empirical LEO satellite population model based on extensive remote and in situ observations and used to support US Space Shuttle and International Space Station design and operations. ORDEM96 is available from NASA/JSC

Overview of Space Debris Models (2)

- MASTER (ESA/ESOC, TUBS): semi-deterministic space debris environment model based on a 3D discretisation of spatial densities and transient velocities; applicable to altitudes from LEO to GEO with no restriction on target orbits. The 1996 ESA MASTER Model is available from ESA/ESOC.
- IDES (DERA/UK): a suite of programs with modeling approaches and features similar to MASTER. Applicable to short-term and long-term predictions (under development).

Overview of Space Debris Models (3)

- CHAIN (NASA/JSC, TUBS): and CHAINEE (ESA/ESOC, TUBS): particle-in-a-box model for long-term predictions of the LEO debris environment dependent on the traffic model assumptions and the mitigation measure applications.
- SDM/STAT (ESA/ESOC, CNUCE): semi-deterministic or stochastic tool (alternatively) for the long-term analysis of the debris population. It is based on the background population which is modulated by traffic and mitigation dependent overlay populations. SDM/STAT has similar features as CHAIN and CHAINEE.

Overview of Space Debris Models (4)

- Nazarenko Model (CPS): semi-analytical, stochastic model for medium and long-term forecast of the LEO debris environment, provides spatial density and velocity distributions. It is based on Russian and U.S. catalog data.