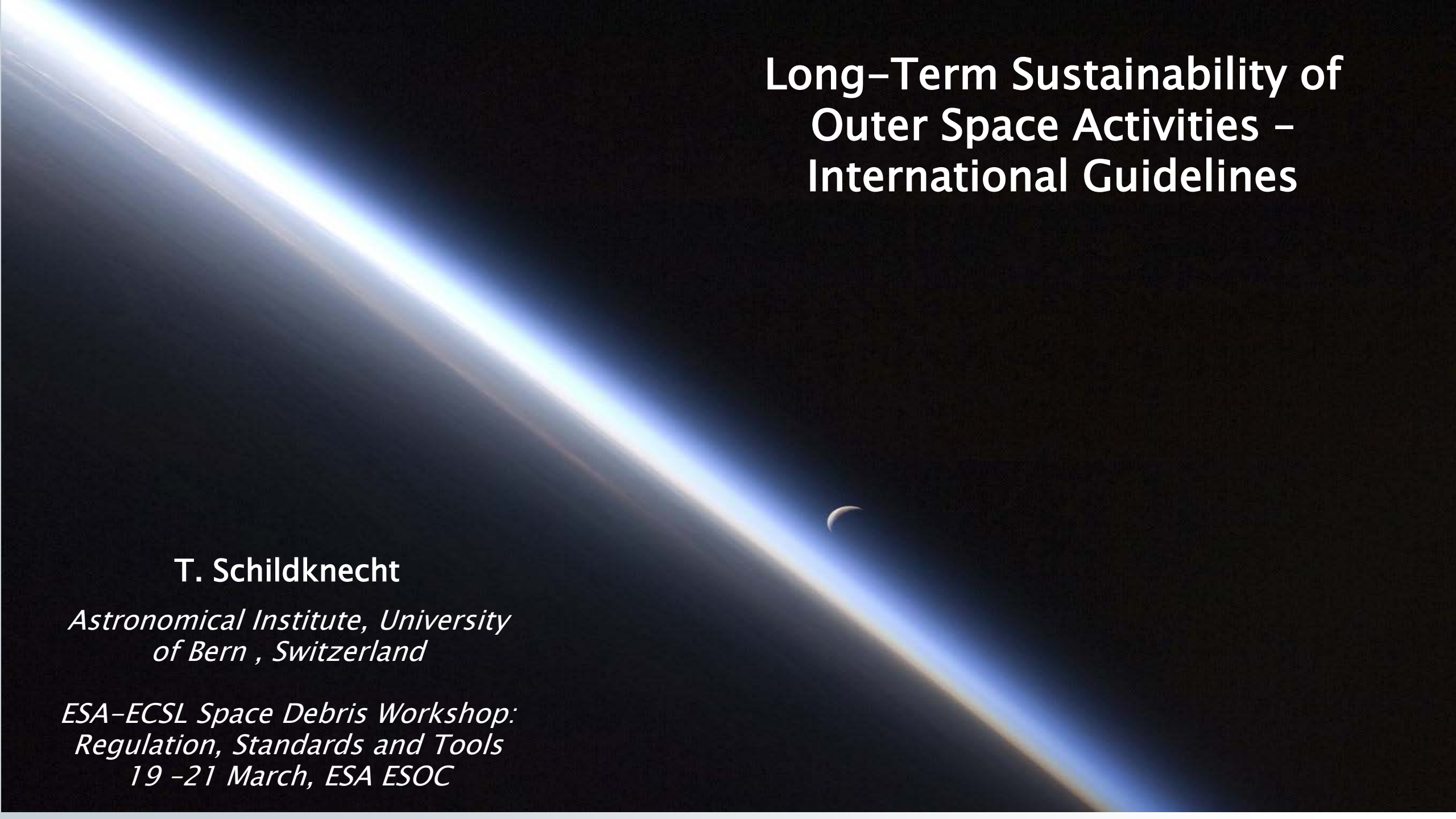
Long-Term Sustainability of Outer Space Activities – International Guidelines

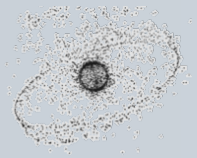


T. Schildknecht

Astronomical Institute, University of Bern , Switzerland

ESA-ECSL Space Debris Workshop: Regulation, Standards and Tools
19 -21 March, ESA ESOC

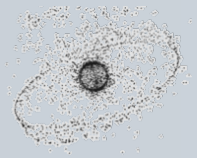
Collision 10.2.2009, 04:50



Why Should we Care?

- S/C Owners/Operators
  - Safety of flight
  - Prevent collisions (traffic management, collision avoidance maneuvers)
  - Contingency: cause?
- S/C designers
  - Risk analysis
  - Shielding (shields, passive shielding)
- Mission analysts, launch campaigns
  - Risk analysis, trajectory optimization
  - Launch conjunction analysis
- Governments, Space Agencies, Scientists
  - Protecting vital space services
  - Long term sustainable use of space
  - Evolution

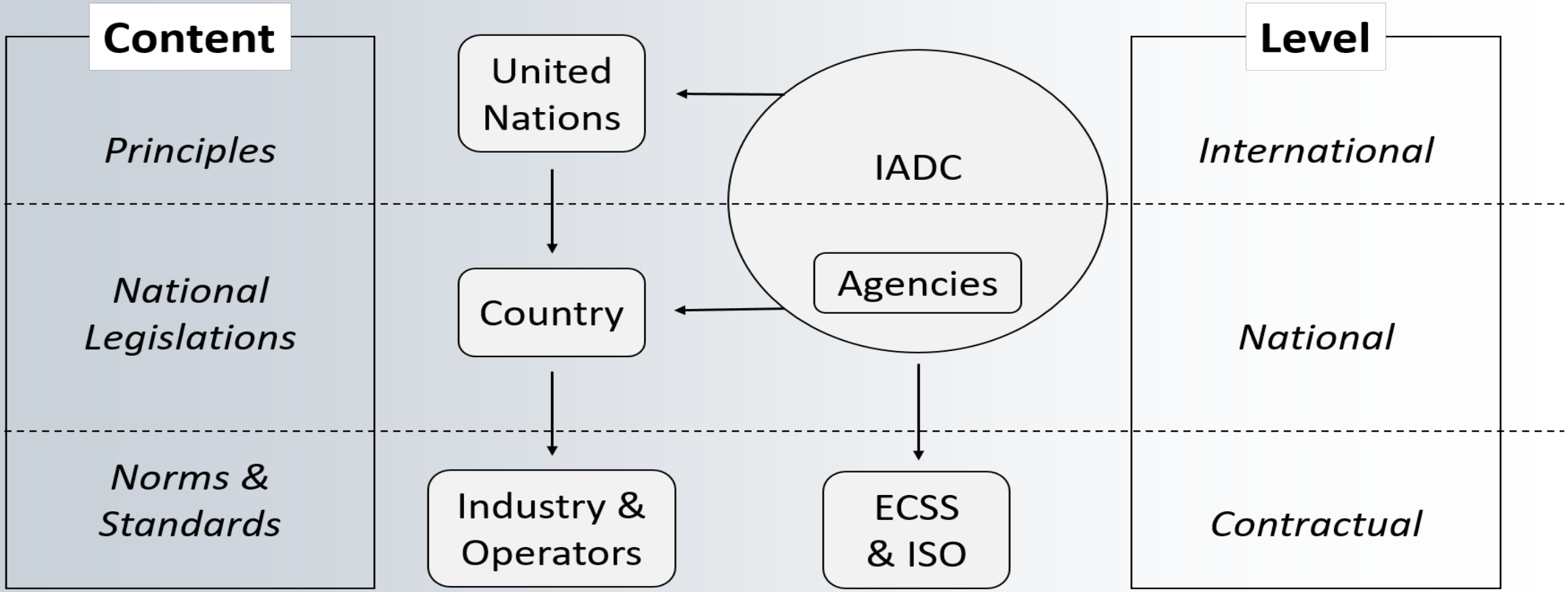

business
as usual
object
count
time
2010



International Guidelines

- **2005 IADC Space Debris Mitigation Guidelines**
  revised 2007
- **2007 UN Space Debris Mitigation Guidelines**
  UN General Assembly Resolution 62/217
  (7 guidelines)
- **2010 EU Draft International Code of Conduct for Outer Space Activities**
- **2010 – 2018 UN COPUOS Working Group on the Long-term Sustainability of Outer Space Activities**
  (A/AC.105/2018/CRP.20, A/AC.105/2018/CRP.21)
  (21+ guidelines)
  (author was member of Swiss delegation)

→ **All non-binding guidelines**


Content
Principles
National Legislations
Norms & Standards
United Nations
Country
Industry & Operators
IADC
Agencies
ECSS & ISO
Level
International
National
Contractual

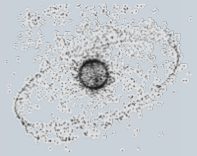
IADC Space Debris Mitigation Guidelines

IADC-02-01
Revision 1
September 2007

INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE

IADC Action Item number 22.4

IADC Space Debris Mitigation Guidelines

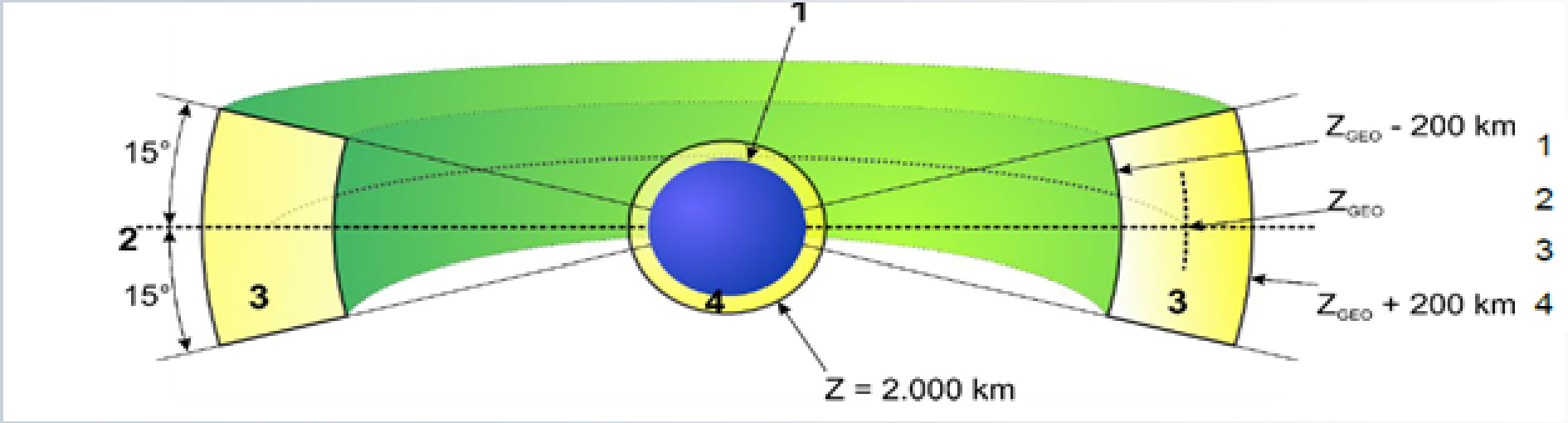


IADC Mitigation Guidelines

- **IADC Space Debris Mitigation Guidelines** IADC2005 (rev. 1 2007)
  - Measure 1: Limit Debris Released during Normal Operations
  - Measure 2: Minimise the Potential for On-Orbit Break-ups
    - Minimise the potential for post mission break-ups resulting from stored energy
    - Minimise the potential for break-ups during operational phases
    - Avoidance of intentional destruction and other harmful activities
  - Measure 3: Post Mission Disposal
    - Geosynchronous Region (“graveyard” disposal)
    - Objects Passing Through the LEO Region (“25y lifetime rule”)
    - Other Orbits
  - Measure 4: Prevention of On-Orbit Collisions

IADC Mitigation Guidelines

IADC protected orbital regions for debris mitigation guidelines



GEO Post Mission Disposal

1. A minimum increase in perigee altitude of:

$$235\ \text{km} + (1000 \cdot C_R \cdot A/m)$$

where C_R is the solar radiation pressure coefficient

A/m is the aspect area to dry mass ratio (m^2kg^{-1})

235 km is the sum of the upper altitude of the GEO protected region (200 km) and the maximum descent of a re-orbited spacecraft due to luni-solar & geopotential perturbations (35 km).

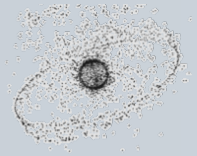
2. An eccentricity less than or equal to 0.003.

IADC Mitigation Guidelines

LEO Post Mission Disposal

… This IADC and some other studies and a number of existing national guidelines have found 25 years to be a reasonable and appropriate lifetime limit.

If a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk to people or property. …

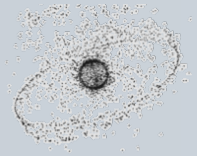


UN Mitigation Guidelines

- **UN Mitigation Guidelines** UN General Assembly Resolution 62/217
  adopted by UN Committee on the Peaceful Uses of Outer Space (COPUOS) in 2007:
  - Guideline 1: Limit debris released during normal operations
  - Guideline 2: Minimize the potential for break-ups during operational phases
  - Guideline 3: Limit the probability of accidental collision in orbit
  - Guideline 4: Avoid intentional destruction and other harmful activities
  - Guideline 5: Minimize potential for post-mission break-ups resulting from stored energy
  - Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission
  - Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission

UN Mitigation Guidelines

- NO definition of
  - space debris
  - spacecraft, launch vehicles, orbital stages
  - orbit regions
- NO protected regions
- Post mission disposal
  - NO definition of GEO “graveyard” orbit region
  - NO specification of LEO post mission lifetime
- Less technical details and recommendations than IADC Mitigation Guidelines



Space Debris / Orbital Debris

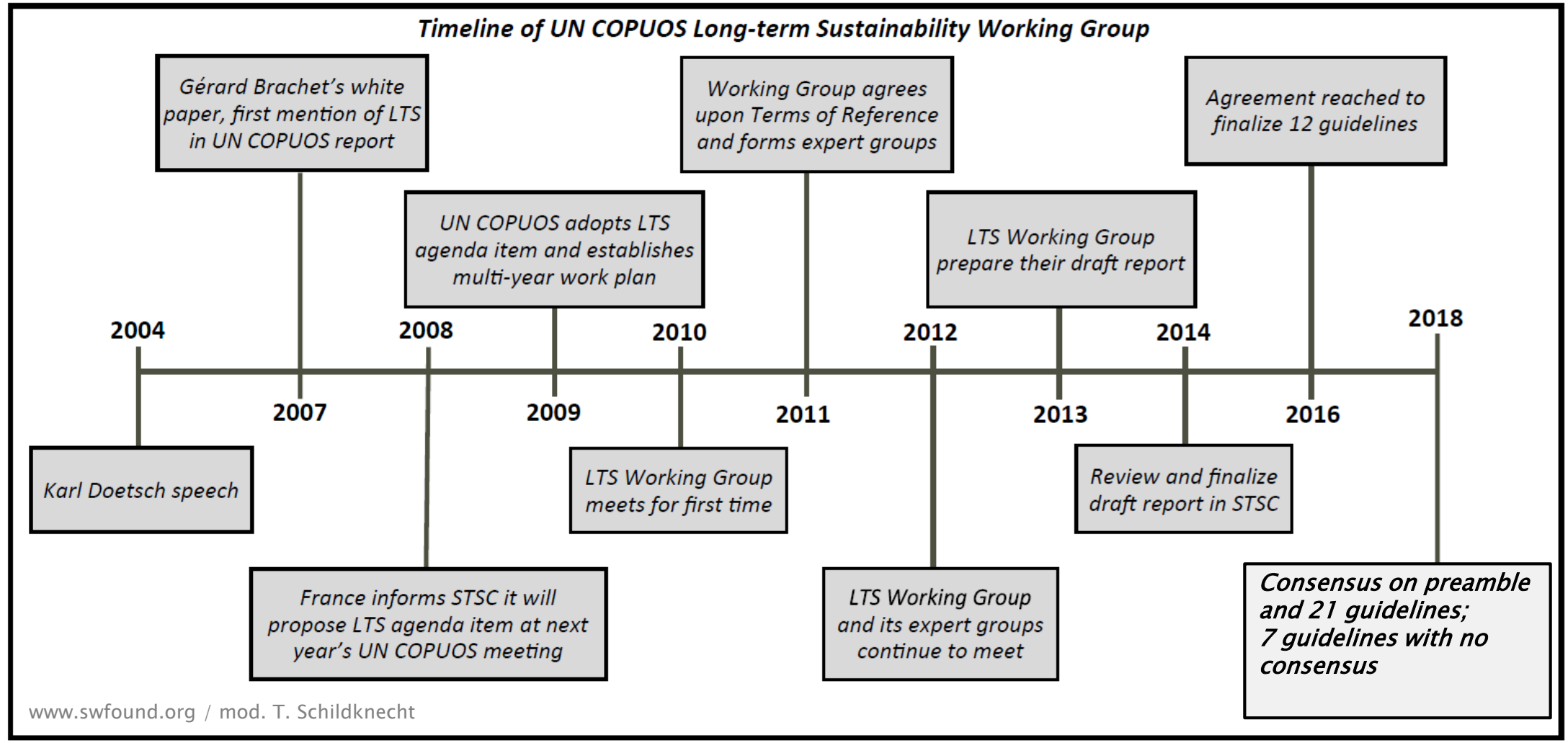
Definition of Space Debris / Orbital Debris

- IADC Space Debris Mitigation Guidelines
  Space debris are all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional.
- UN Space Debris Mitigation Guidelines
  NO definition
- IAA Position Paper (1993, 2001)
  Orbital debris is herein defined as any man-made Earth-orbiting object which is non-functional with no reasonable expectation of assuming or resuming its intended function, or any other function for which it is or can be expected to be authorized, including fragments or parts thereof.

UN COPUOS LTSSA

- 2010 Working Group on the Long-Term Sustainability of Outer Space Activities (LTSSA) established
- 2012-2014 Four expert groups (experts from governments, industry, academia)
  - A — Sustainable space utilization supporting sustainable development on Earth
  - B — Space debris, space operations, and tools to support collaborative space situational awareness
  - C — Space weather
  - D — Regulatory regimes and guidance for new actors in the space arena
- 2014-2018 Working group taking over again (official delegation members)
- 2016 COPUOS consensus on first 12 guidelines of a compendium
  (COPUOS report A/71/20)
- 2018 COPUOS consensus on preamble and 21 guidelines, 7 guidelines with no consensus (A/AC.105/2018/CRP.20, A/AC.105/2018/CRP.21)
  "The Committee noted that the Working Group had discussed, but had not been able to reach consensus on how to refer the preamble and guidelines on the long-term sustainability of outer space activities to the General Assembly."
  (COPUOS takes decisions by absolute consensus of its member States; currently 87)

UN COPUOS LTSS



UN COPUOS LTSSA – Expert Group B

Expert Group B

- **B.1** Promote the collection, sharing and dissemination of space debris monitoring information
- **B.2** Implement space debris mitigation measures
- **B.3** Limit the risk to people and property from controlled re-entries
- **B.4** Promote techniques and investigation of new methods to improve the accuracy of orbital data for spaceflight safety
- **B.5** Perform conjunction assessment during orbital phases of controlled flight
- **B.6** Provide appropriate contact information
- **B.7** Promote use of standards when sharing orbital information on space objects
- **B.8** Provide registration information to assist in the identification of space objects

for each GL: *Rationale, current practices, gaps*

UN COPUOS LTSSA – Expert Group B

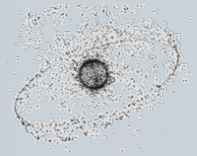
Expert Group B, Issues for further consideration (by the STSC)

- **A.** Technical developments and possibilities regarding space debris removal
- **B.** On-orbit servicing
- **C.** Ensuring information consistency and transfer reliability

UN COPUOS LTSSA Guidelines

Guidelines – Preambula

- *The guidelines address the policy, regulatory, operational, safety, scientific, technical, international cooperation and capacity-building aspects of space activities. … Therefore, the guidelines are relevant to both governmental and non-governmental entities.*
- *The guidelines are voluntary and not legally binding under international law, but any action taken towards their implementation should be consistent with the applicable principles and norms of international law.*
- **Definition of LTS**
  The long-term sustainability of outer space activities is defined as the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations. (Based on language of Brundtland Commission report, OST,…)



UN COPUOS LTSSA Guidelines

Policy and regulatory framework for space activities

- **A.1** Adopt, revise and amend, as necessary, national regulatory frameworks for outer space activities
- **A.2** Consider a number of elements when developing, revising or amending, as necessary, national regulatory frameworks for outer space activities
- **A.3** Supervise national space activities
- **A.4** Ensure the equitable, rational and efficient use of the radio frequency spectrum and the various orbital regions used by satellites
- **A.5** Enhance the practice of registering space objects

UN COPUOS LTSSA Guidelines

Safety of space operations

- **B.1** Provide updated contact information and share information on space objects and orbital events
- **B.2** Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects
- **B.3** Promote the collection, sharing and dissemination of space debris monitoring information
- **B.4** Perform conjunction assessment during all orbital phases of controlled flight
- **B.5** Develop practical approaches for pre-launch conjunction assessment

UN COPUOS LTSSA Guidelines

Safety of space operations

- **B.6** Share operational space weather data and forecasts
- **B.7** Develop space weather models and tools and collect established practices on the mitigation of space weather effects
- **B.8** Design and operation of space objects regardless of their physical and operational characteristics (small-size objects: “same rules for all”)
- **B.9** Take measures to address risks associated with the uncontrolled re-entry of space objects
- **B.10** Observe measures of precaution when using sources of laser beams passing through outer space

UN COPUOS LTSSA Guidelines

International cooperation, capacity-building and awareness

- **C.1** Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities
- **C.2** Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange
- **C.3** Promote and support capacity-building
- **C.4** Raise awareness of space activities

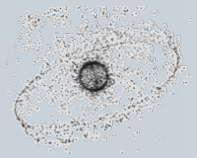
UN COPUOS LTSSA Guidelines

Scientific and technical research and development

- **D.1** Promote and support research into and the development of ways to support sustainable exploration and use of outer space
- **D.2** Investigate and consider new measures to manage the space debris population in the long term

UN COPUOS LTSSA Draft Guidelines

- Provide, in national legal and/or policy frameworks, for a commitment to conducting space activities solely for peaceful purposes
- Take measures to identify, mitigate and manage the risk to terrestrial infrastructure that supports the operation of orbital systems [, launch vehicles and spacecraft]
- Observe procedures for preparing and conducting operations on active removal [and intentional destruction] of space objects
- Develop procedures for outer space activities involving non-registered objects
- Observe measures for the safe conduct of proximity space operations
- Observe measures of precaution when using of natural space environment modification techniques for peaceful purposes
- Raise awareness of the need to exclude the use of information and communications technology products compromising the safety and security of space objects and related equipment



UN COPUOS LTSSA Guidelines – Implementation

- Effective implementation will require international cooperation
- States with limited capability or capacity to implement the guidelines are encouraged to seek the support of other States or international intergovernmental organizations
- States and international intergovernmental organizations are encouraged to share their practices and experiences
- International cooperation required to monitor impact and effectiveness of guidelines

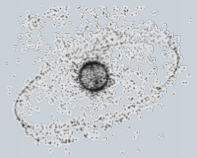
UN COPUOS LTSSA – Way Forward?

2018 COPUOS

- mandate of LTSSA WG ended
- agreed that LTSSA be permanent agenda item of STSC
- No consensus on way forward, options (inter alia)
  - extend mandate of WG (to finalize 7 GL with no consensus)
  - *new working group on safety and transparency (Swiss proposal)*

2019 COPUOS STSC

- no consensus to forward 21 GL to UN GA
- *"working meeting" to identify possible topics (for a "future mechanism") at margins of COPUOS 2019 (Swiss initiative)*



Some Practical Aspects…

- Information
  - we can only “manage” what we know
    we can only know what we measure (Moriba Jah)
  - information needs to be timely, reliable, accurate and complete (traceable)
  - be aware of uncertainty vs ignorance

- Identification *(DO NOT take for granted!)*
  - key for… legal implications; ADR, debris nudging, etc.
  - unique identification
    - enrolment, verification, identification
    - unique ID
    - fingerprint
    - many examples of miss tagging (CubeSats!)

Space Safety – Challenges

Holistic SSA

- exchange of observation data (verification, traceability, transparency …)
- need data sharing standards/mechanisms
- …

→ change of paradigms needed…

- hiding in space not anymore an option (during peace times) → resort to resilience
- open exchange of basic SSA data (among “actors”) → collaborative SSA
- “open source” SSA …

Long-term evolution of space debris environment driven by collisions of non-maneuverable objects


Thank you for your time!