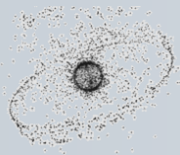


The Need for Enhanced Information Exchange on Space Objects and Events

T. Schildknecht

*Astronomical Institute, University
of Bern, Switzerland*

*United Nations/Germany High
Level Forum, 13 – 16 November
2018 in Bonn, Germany*

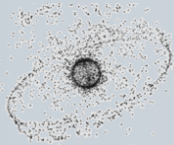


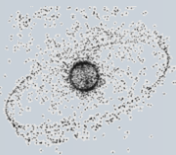
Collision 10.2.2009, 04:50



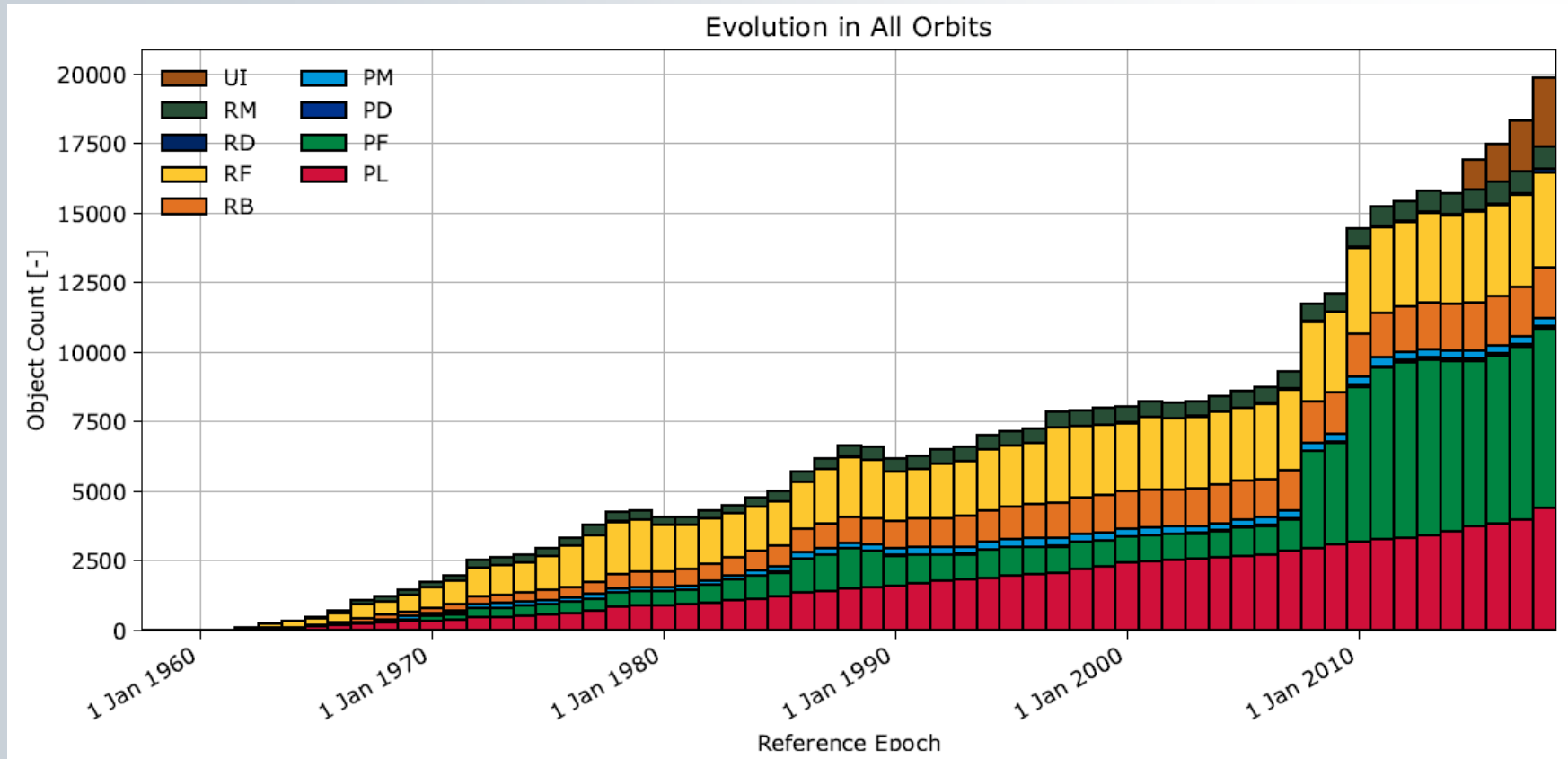
16:05
2009/02/10

What do we know?

- 
- Different actors – different data
→ different information
 - Catalogues of “known” objects
Information:
 - orbits
 - uncertainty (ignorance?)
 - events
 - ...
 - Statistical data
 - small-size objects (densities, statistical orbits)



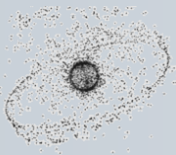
Evolution of “Known” Objects



Space Debris

- > 10cm ~25'000 (~1700 operational s/c)
- > 5cm ~57'000
- > 1cm ~700'000 (energy of hand grenade)



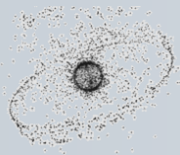


Future? Mega-Constellations...

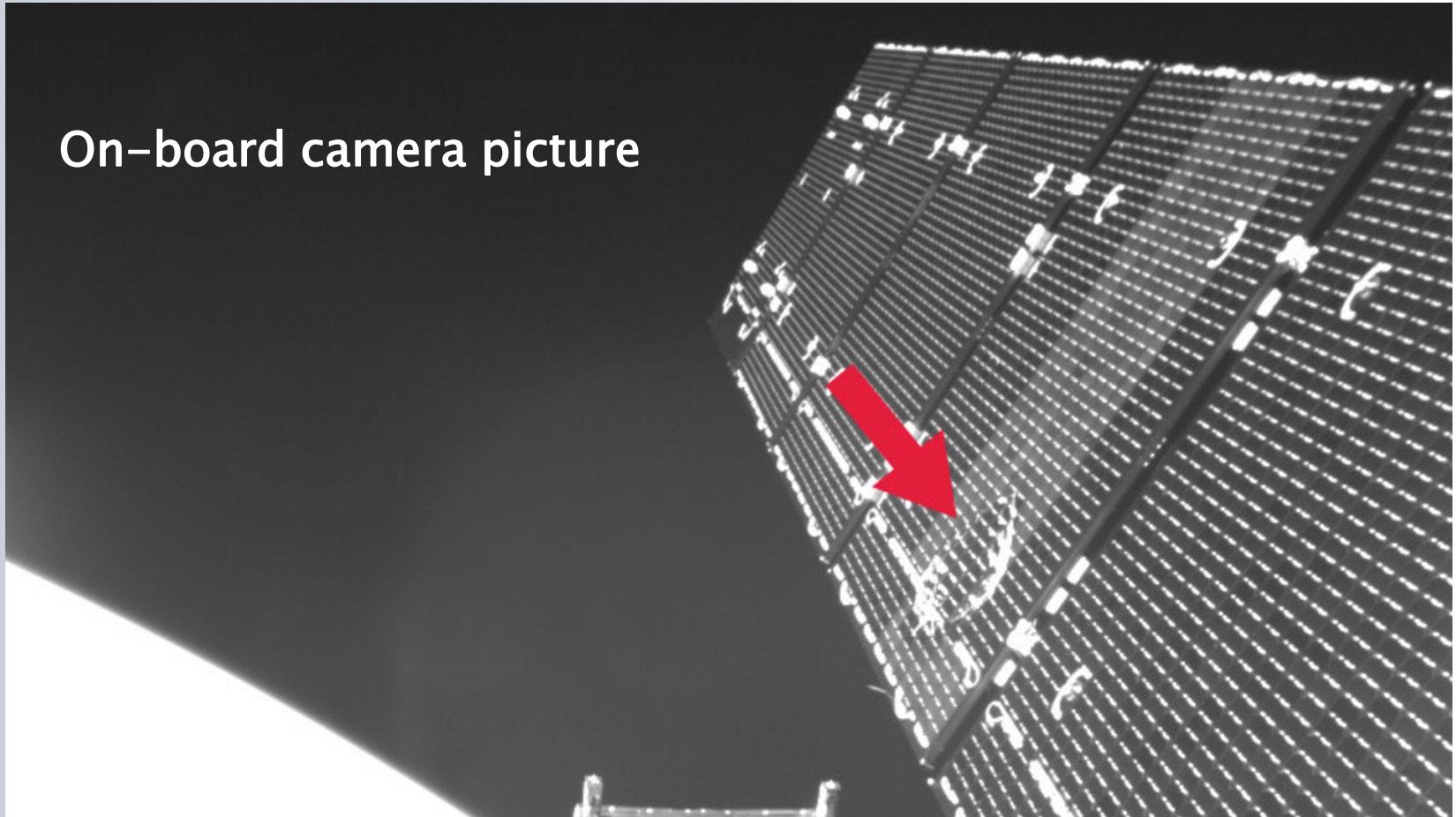
SpaceX	4,425	(LEO 1100–1300km; 2019–24)
SpaceX	~7500	(low LEO ~350km – 550km)
OneWeb	1,972	(LEO ~1200km; 2019 – ...)
Boeing	2,956	(LEO ~1200km)



Events: Sentinel-1A

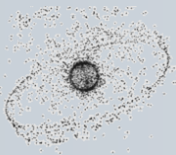


On-board camera picture



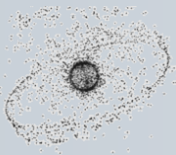
Impact on August 23, 2016

Small power loss (5%) → analysis revealed attitude & orbit changes → mm-size impactor (SSN found 5 obj. in vicinity)

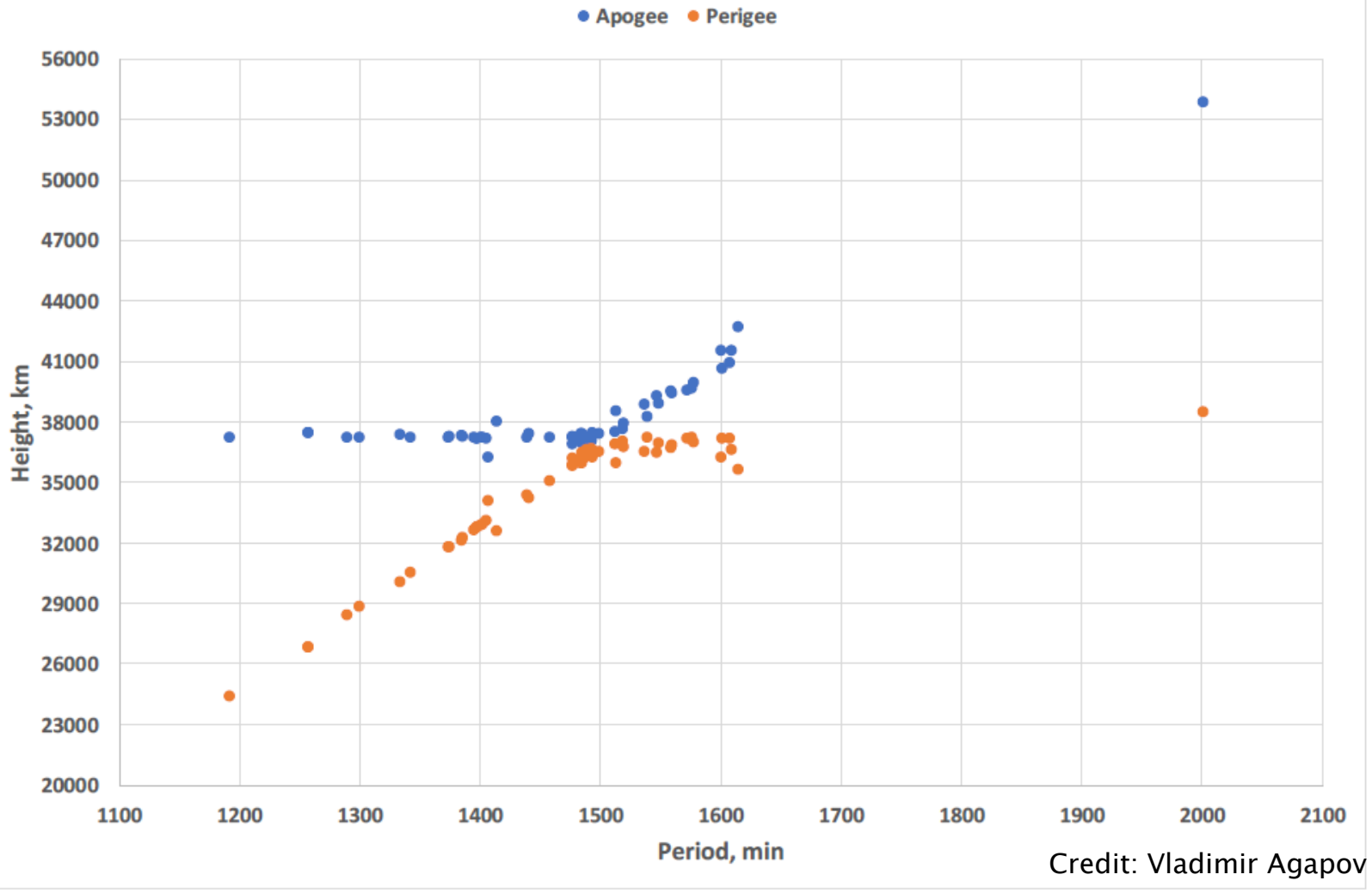


28 Feb 2018: Breakup in GEO

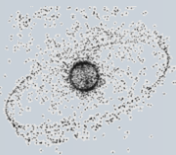
- **Fragmentation of Transtage 17 1969-013B, (SSN #3692)
Feb 28, 2018; dV: 1.7 m/s**
- Detected through routine observations by telescopes of the Russian ASPOS OKP, the Astronomical Scientific Center, and the International Scientific Optical Network (ISON).
- **> 100 fragments detected** until today
~65% crossing GEO protected region
- **ESA/AIUB conducted dedicated search campaign** for fragments from Oct 1 to 13 using the ESA 1 m telescope in Tenerife and telescope of the Swiss Optical Ground Station and Geodynamics Observatory Zimmerwald.



Gabbard Diagram for Breakup Epoch

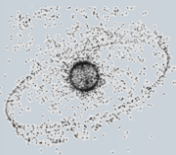


Credit: Vladimir Agapov

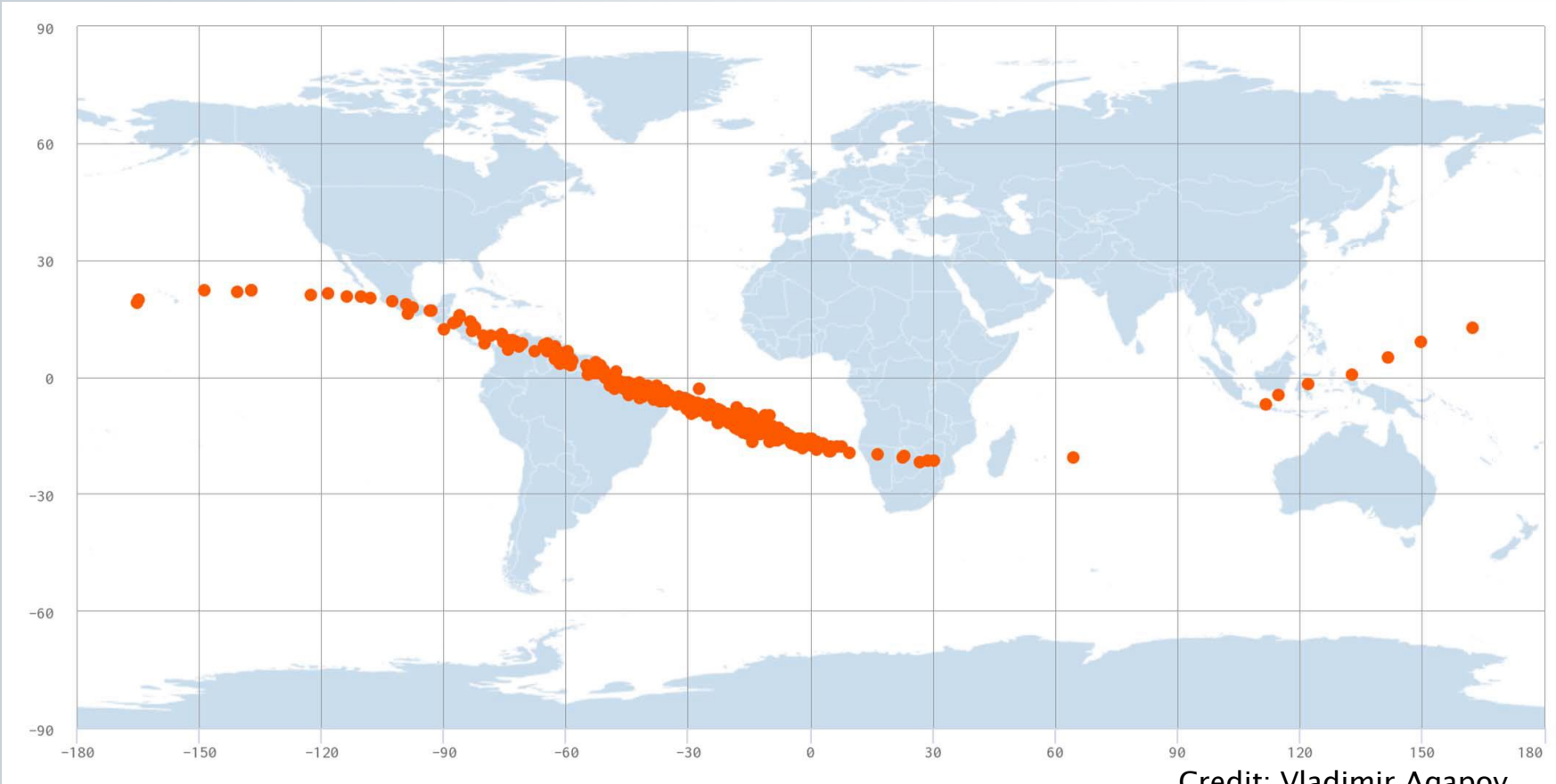


30 Aug 2018: Breakup in GTO

- **Fragmentation of Atlas 5 Centaur upper stage 2014-055B (SSN #40209)**
Aug 30, 2018 at 22:03:49 UT; dV : 9.3 m/s
- Detected through routine observations by telescopes of the Russian ASPOS OKP, the Astronomical Scientific Center, and the International Scientific Optical Network (ISON).
- **>500 fragments detected** until today
25% instantaneous increase of population of objects tracked in GTO !
- **ESA/AIUB conducted dedicated search campaign** for fragments from Oct 1 to 13 using the ESA 1m telescope in Tenerife and telescope of the Swiss Optical Ground Station and Geodynamics Observatory Zimmerwald.



Debris Cloud Evolution over 48h



Credit: Vladimir Agapov



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



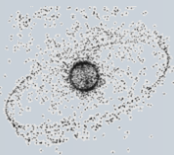
What do we need?

- **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)
- information sharing should be based on community-accepted methodology and parameters (many to be established yet)
- be aware of uncertainty vs ignorance

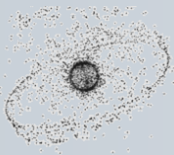
- **Identification**

- key for... legal implications; ADR, debris nudging, ...
- unique identification
 - enrolment, verification, identification
 - unique ID
 - fingerprint
 - many examples of miss tagging (CubeSats!)




Identification – Inconsistencies ...





Identification – Inconsistencies ...



AstriaGraph

Resident space object search criteria

IRIDIUM 64 (25287)

Data source: All

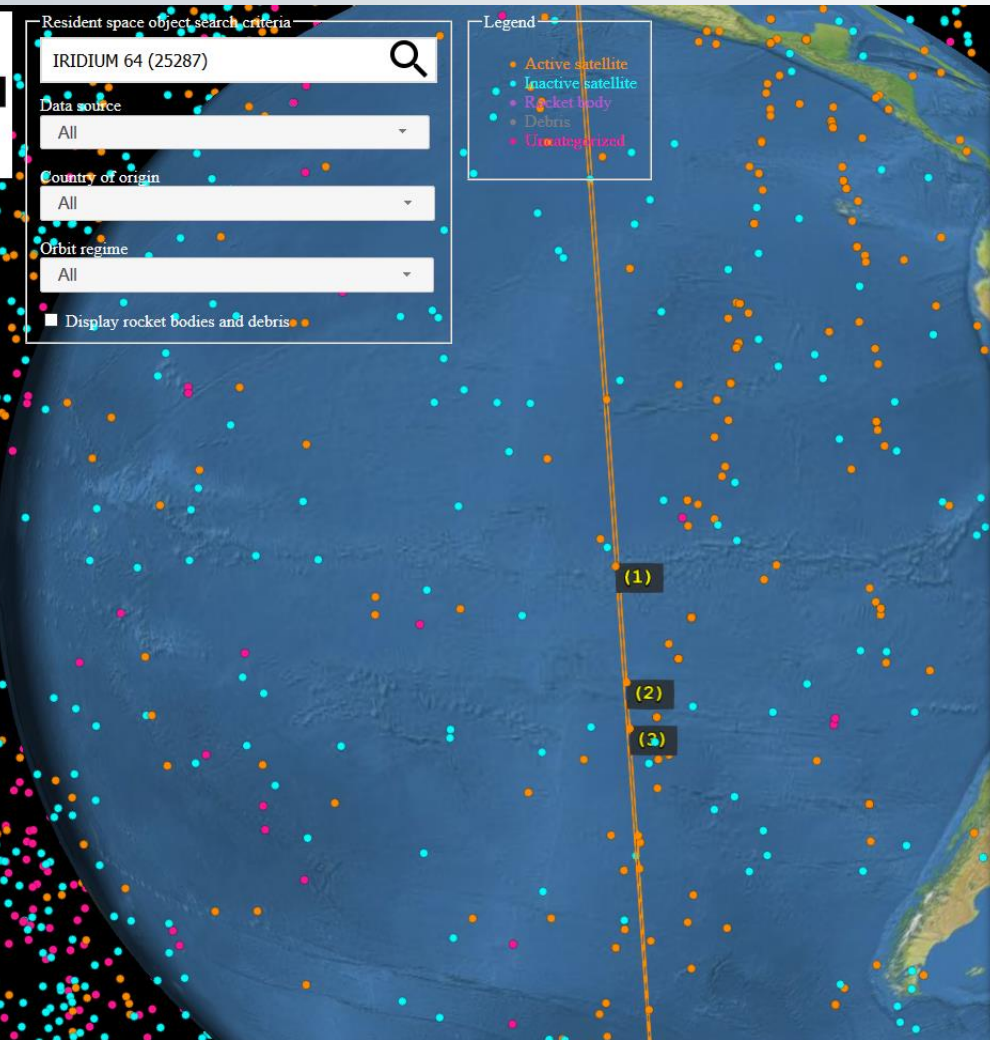
Country of origin: All

Orbit regime: All

Display rocket bodies and debris

Legend

- Active satellite
- Inactive satellite
- Rocket body
- Debris
- Unidentified

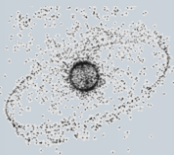


IRIDIUM 64

Data Source	(1) USSTRATCOM
Name	IRIDIUM 64
Country	US
Object ID	25287
Launch date	1998-04-07
Data epoch	2018-11-12T09:38:20.3721
Semi-major axis	7147.4 km
Eccentricity	0.0013
Inclination	86.4441°
RA of ascending node	9.2123°
Argument of perigee	109.1212°
Mean motion	0.0599 °/s
Orbital speed	7.5 km/s
Orbital period	100.2 min
Ballistic coefficient	5.42 cm ² /kg

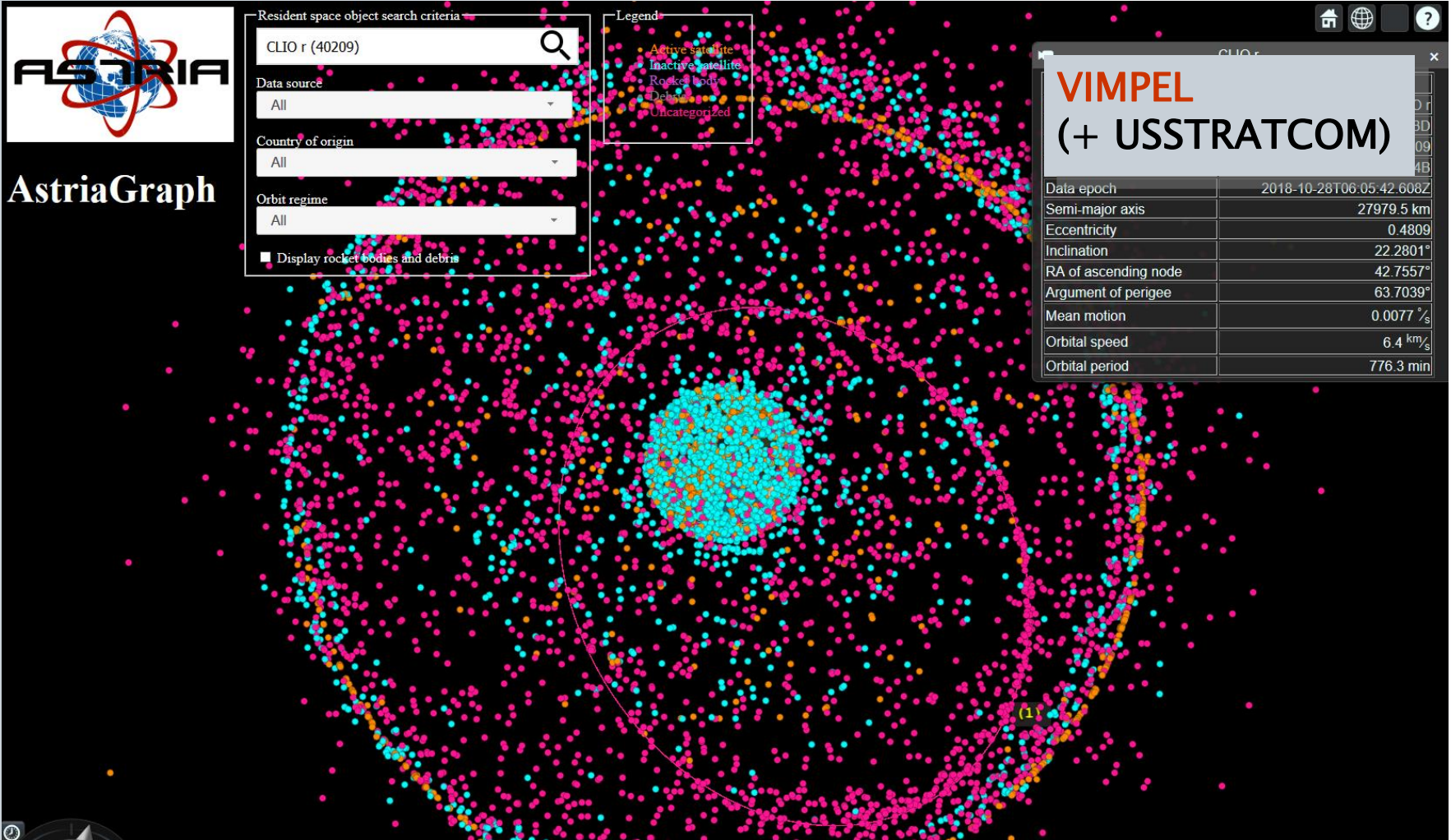
Data Source	(2) LeoLabs
Name	IRIDIUM 64
Country	US
Data epoch	2018-11-11T23:00:01.000Z
Semi-major axis	7137.9 km
Eccentricity	0.0013
Inclination	86.4433°
RA of ascending node	9.4006°
Argument of perigee	125.3978°
Mean motion	0.0600 °/s
Orbital speed	7.5 km/s
Orbital period	100.0 min
Drag coefficient	0.0447

Data Source	(3) Astria OD/LeoLabs data
Click here for orbit determination statistics	
Name	IRIDIUM 64
Country	US
Data epoch	2018-11-11T23:00:02.000Z
Semi-major axis	7134.7 km

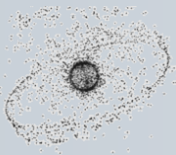


Atlas 5 Centaur Breakup Fragments

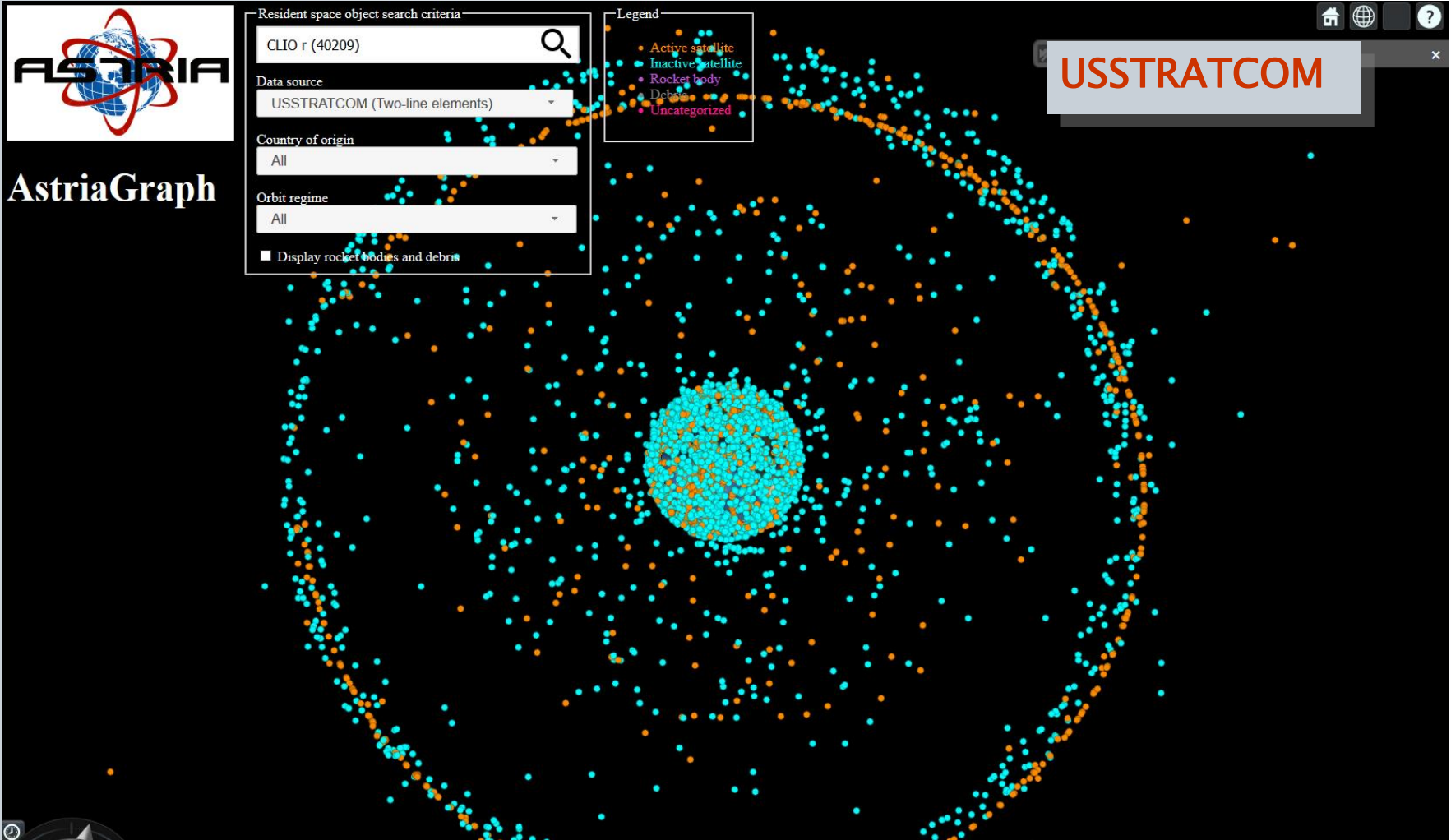
T. Schildknecht: The need for enhanced information exchange on space objects and events
UN/Germany High Level Forum, 14.11.2018, Bonn, Germany

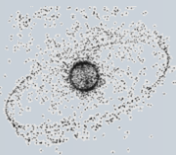


Slide 16



Atlas 5 Centaur Breakup Fragments





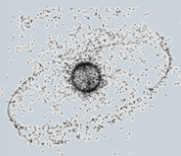
Space Safety – Challenges

Holistic SSA

- need to include data from any trusted source: governments, commercial, civil, academia, ...
- exchange of sensor data, observations (openly) (verification, traceability, transparency ...)
- need data sharing standards/mechanisms
- development of algorithms to cope with massive data volumes (multi source/multi sensor data fusion, ...)
- improved astrodynamics algorithms
- ...

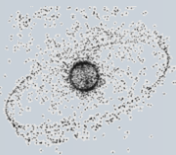
→ change of paradigms needed...

- 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 ...



Information Exchange/Sharing

- **International Effort Required**
 - **sharing and fusing of data from different international sources is key**
 - **international information sharing is indispensable for operators in countries with no space object catalogue and/or conjunction assessment capability**



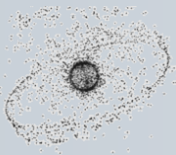
TP3 – Swiss Proposal for Working Group

A/AC.105/2017/CRP.27, Non-paper UNCOPUOS 2018

Safety and Transparency in Space Activities

● Objectives

1. To identify and address issues relevant the enhancement of the safety, the transparency and the long-term sustainability of outer space activities, and to propose, as appropriate, recommendations and/or non-legally binding guidelines to address the issues identified;
2. To identify and address issues associated with information exchange and notification procedures relating to the international cooperation in the monitoring of objects and accidental events in orbit, including the development of requirements for enhanced exchange and notification procedures under the United Nations Register of Objects launched into Outer Space, and to propose cooperation mechanisms to support this;
3. To encourage capacity building and outreach activities on transparency and confidence-building measures.



TP3 – Swiss Proposal for Working Group

- Possible tasks (inter alia)
 1. Address the **topics** which were discussed in the WG on LTSSA but **on which no consensus was reached**;
 2. Examine **options for collaborative information-sharing** with the aim of ensuring the safety and sustainability of space operations;
 3. Examine the **topics** which were **identified** by the WG on LTSSA **as topics for further considerations**;
 4. Identify and address **new topics relevant to enhance safety, transparency and sustainability of space activities**.

A diagonal streak of bright blue light cuts across a black background from the top-left to the bottom-right. A small, dark crescent moon is positioned just above the light streak in the middle-right area.

Thank you for your time!