

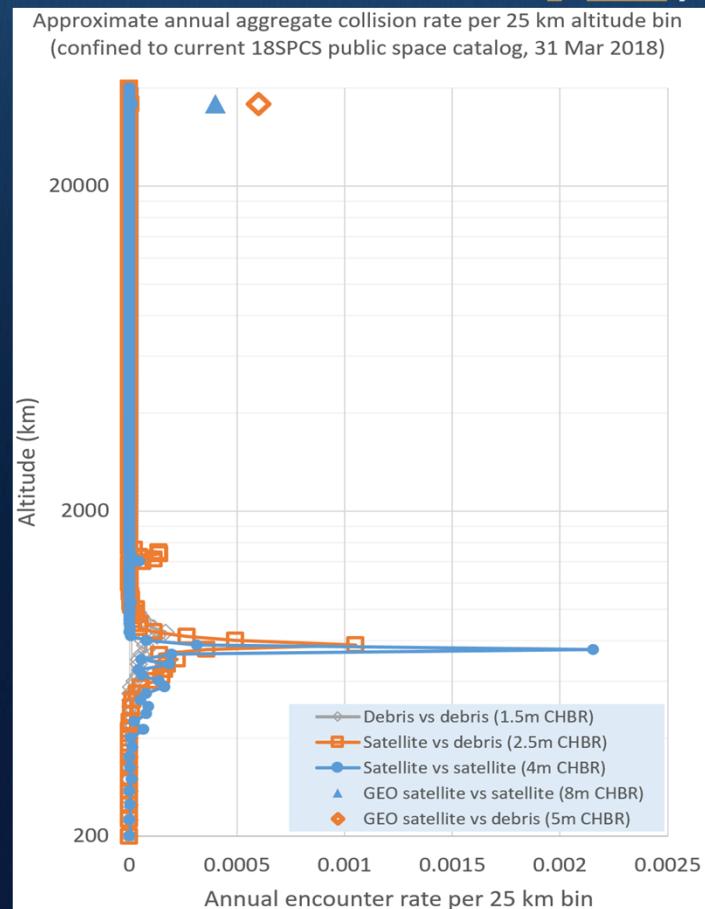
STM lessons learned and suggested solutions

Spring 2018 Meeting Of The
Aeronautics And Space Engineering Board
Focus Session on Orbital Debris
Dan Oltrogge
1 May 2018

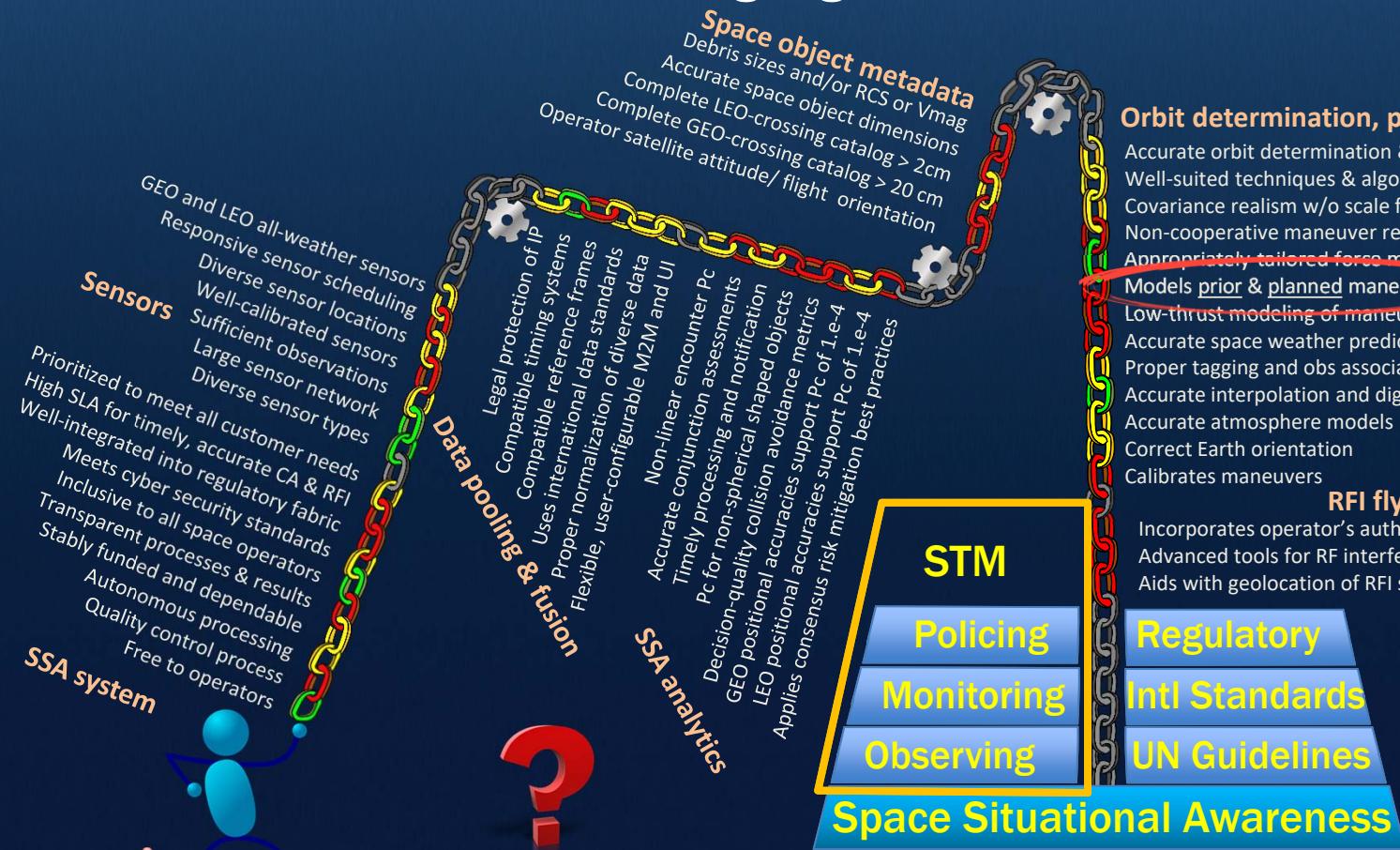
Why SSA is challenging and disagreements abound



- Operators and analysts often differ on actionability and risk in orbit regimes
 - Not all orbit regimes are created equal !
 - Positional accuracy is highly altitude-dependent
 - Space weather poses challenge below 700 km
 - High-eccentricity LEO-crossing satellites and debris difficult
 - GEO accuracy challenging, particularly for active satellites
 - Estimated collision risk and encounter rates are highly regime- & category-specific
 - Active-on-active satellites
 - Active-on-debris
 - Debris-on-debris
- Errors in the many “moving parts” of an SSA system can invalidate SSA:
 - SSA system
 - Sensors
 - Data pooling and fusion
 - SSA analytics
 - Space object meta-data
 - Orbit determination, propagation
 - RFI flyby and mitigation



What makes SSA challenging? Answer: Everything must work!



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Centralized STM Challenges (Oltrogge, 2002)



- Who funds the threat monitoring?
- Mission conflict: STM entity must have Safety of Flight (SoF) as its top priority
- Disparate tracking and operator orbit determination systems
 - Unmodelled (or mis-modeled) maneuvers is perhaps the single biggest challenge!
 - Need to create, adopt internationally-standardized data messages
 - Shared understandings of coordinate frames, timing systems, units
 - Biases in tracking and operator data must be identified and removed
- Insufficient model fidelity and data consistency
- Latency of debris and operator positional knowledge
 - Must continually update tracking data for non-cooperative or debris objects
 - Need to increase ops cadence of tracking, OD and data sharing
 - Need servers to receive and automatically process owner/operator data
- Protection of company or country-proprietary data
 - Data recipients and analysis generation systems must maintain sanctity and privacy of pooled data
 - Legal and cyber protections for proprietary data

To effectively avoid collisions, must evolve to:



- Highly accurate, precise, complete and timely results
- To get there requires:
 - STM framework leveraging **collaboration** & **input data pooling**
 - Increased tracking sensors, sensor sites and sensor sensitivity
 - Advanced sensor data processing techniques
 - Data fusion of multiple sensor phenomenologies
 - Meaningful Common Operating Pictures and SSA displays
 - Advanced OD, CA and SSA algorithms
 - OD thru non-cooperative maneuvers, aspherical and non-linear P_c , ...

The SDA: Providing operational STM since 2010.



- Self-organized in 2008 to promote safe and efficient use of space
 - Safety-of-flight
 - RFI mitigation
- SDC is largest single contributor of owner/operator ephemerides
- SDC frequently alerts JSpOC to any issues with JSpOC SSA products
 - Voluntary; part of we are committed to “always do the right thing”
 - Quality assurance and consistency checks are imperative
 - JSpOC (18th) has been very receptive to this assistance

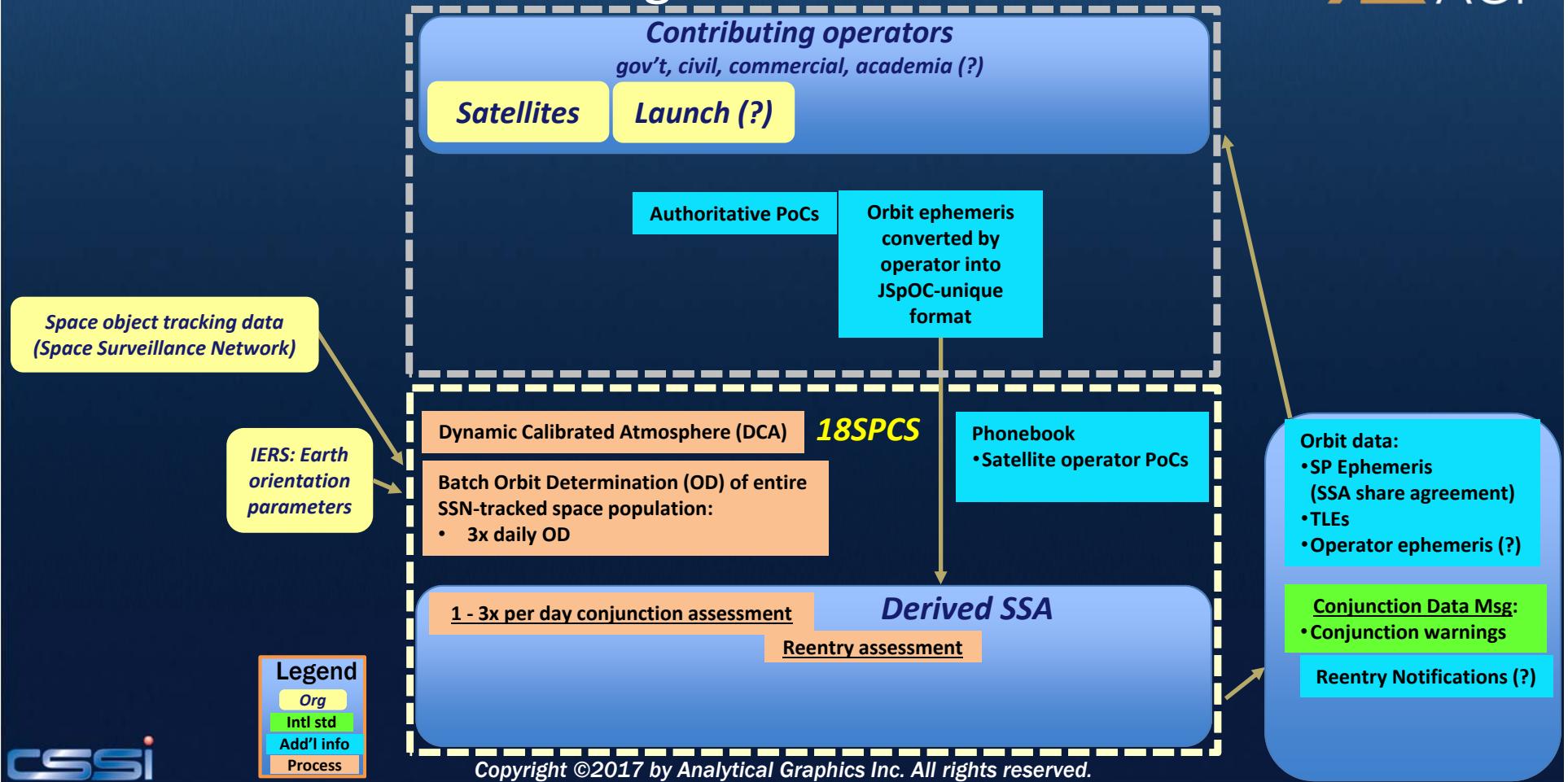


- O/O-Data Flow to JSpOC:
 - Normalized & Validated Ephemerides, Maneuvers

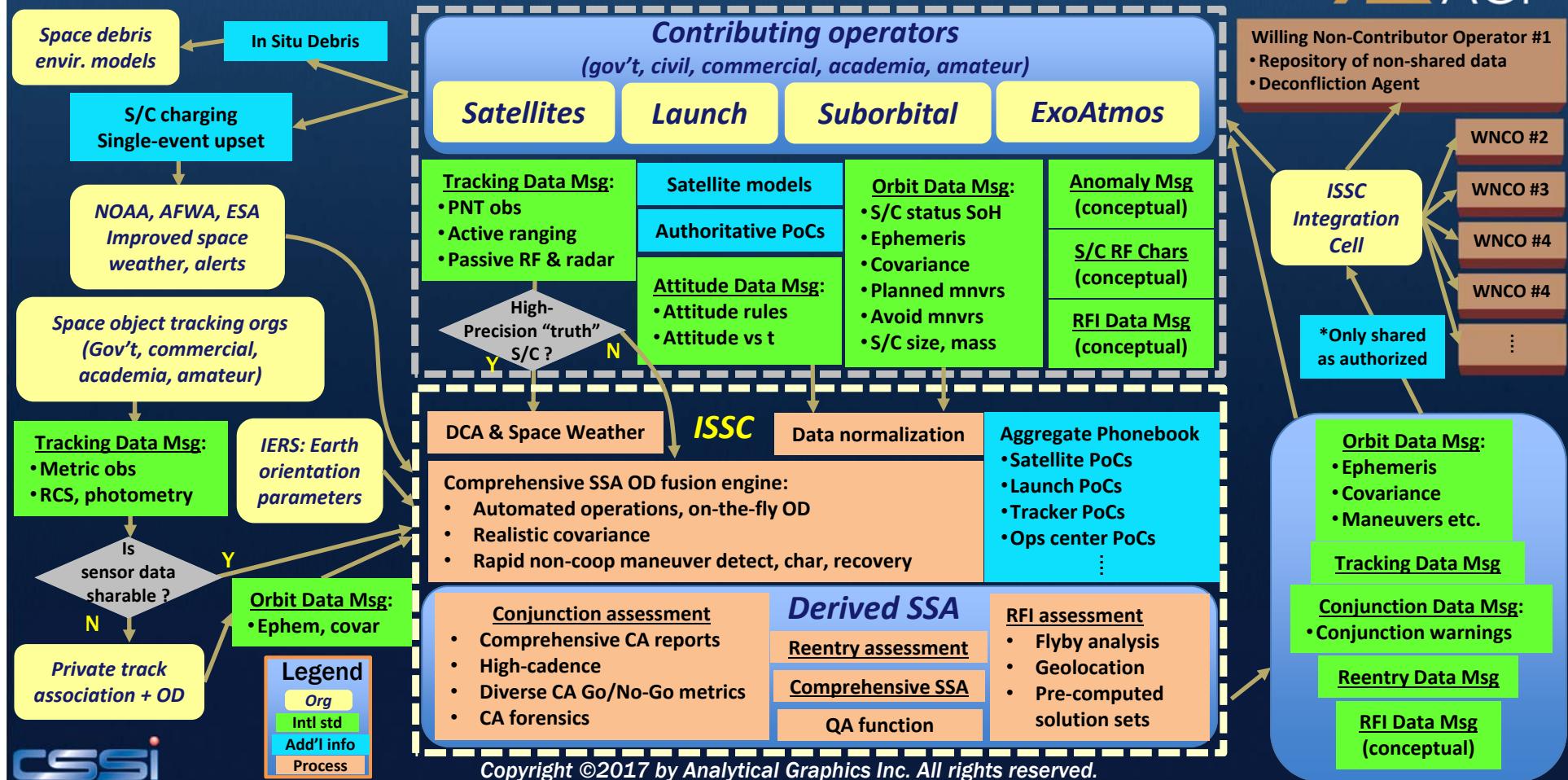
- Notify JSpOC of significant JSpOC issues/errors



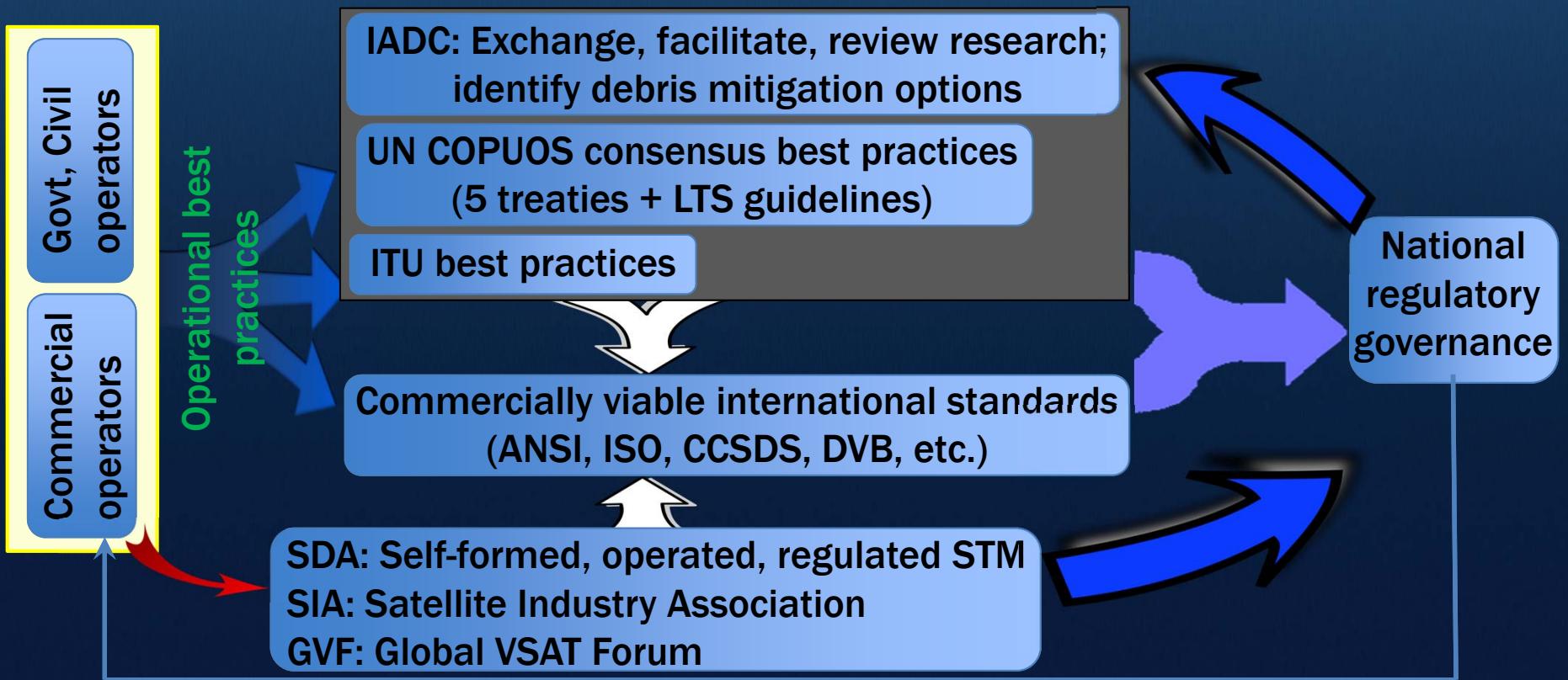
Current U.S. STM Paradigm



Suggested STM Paradigm: Int'l Satellite Safety Center



Confluence of all things: A holistic STM perspective



Conclusions



- Collision risk in both LEO and GEO is real but is manageable
- SSA and STM:
 - The “terminology battle” continues...
 - Differing views (or understanding) on current SSA performance
 - Differing views (or understanding) on current STM performance
- A single “weak link” breaks the entire SSA analysis chain
 - No partial credit given for having SSA “mostly correct”
 - Some of SSA’s weak links can be addressed by holistically and inclusively “crowd-sourcing” data from proven, trusted sources
- A “crowd-sourcing” approach to STM (similar to SDA or the International Space Safety Center concept) is required

Thank you! Questions?

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