Space Traffic Management

Brian Weeden

Ben-Baseley Walker
Overview

- ISU Report
  - Collision Avoidance
  - Human Zone
  - Sun Synchronous Zoning
  - Geosynchronous Maneuvers
  - Legal / Management / Implementation

- Our Rationale

- Our Next Steps
ISU Report Findings and Recommendations
Team Traffic

Anilkumar AK, India
Satoru Aoyama, Japan
Ben Baseley-Walker, United Kingdom
Karl Bilimoria, United States
Cian Curran, Ireland
Karina Drees, United States
Donato Giorgi, Italy
Evelyne Greneche, France
R. Brogan Hetrick, United States
Muchun Jing, China
Richard B. Leshner, United States
Xuejun Liao, China
Kenta Maruyama, Japan
Ricardo Marvao, Portugal
Lex Meijer, Netherlands
Xavier Michalski, France
Ayako Ono, Japan
Angeline Asangire Oprong, Kenya
Sascha Pillokeit, Germany
Kevin Shortt, Canada
Tim Smallhorn, Australia
Erin Tegnerud, United States
Antonio Yukio Ueta, Brazil
Meritxell Viñas Tió, Spain
Brian Weeden, United States
Weibin Gao, China
Weiguo Shen, China
Ole Kristian Western, Norway
Guangming Zhang, China
Jhony Zavaleta, United States
Proposed Solution

- A set of Space Traffic Management (STM) rules providing a strong foundation for further research covering four areas of immediate concern:
  - Collision avoidance
  - Sun-synchronous orbit (SSO) congestion
  - Dangers to human-rated craft
  - Improved utility of geo-synchronous orbit

These rules:

- Are not focused on debris mitigation
- Allow more efficient use of crowded orbits
- Give owner-operators the tools to protect their spacecraft
Areas of Focus

- **Conjunction Assessment / Collision Avoidance**
  - Standardized warnings and maneuver planning to help owner/operators with risk management
- **Human Spaceflight**
  - Created a human-rated zone with more stringent traffic rules
- **Sun-Synchronous Orbit**
  - Developed new slot architecture to eliminate spacecraft-spacecraft conjunctions
- **Geosynchronous Orbit**
  - Proposed voluntary data sharing to enhance maneuver planning
Collision Avoidance

- STM provides standard data set, warnings, and recommendations of avoidance maneuvers to help owner-operators that might not have the tracking or analytical ability in-house.
- Gives owner/operator flexibility to maneuver based on internal cost/benefit analysis unless inaction could threaten other spacecrafts.

Rules provide the spacecraft owner-operators with the information and tools to help make educated choices and to improve satellite safety.
Human Rated Zoning

- Allows for non-human rated spacecraft to co-exist with human-rated in a safe manner
- Improves long-term viability of human orbital zone
- Improves tracking ability for small satellites

Creates a protected zone for human traffic with minimal impact to current and future non-human rated operators
Sun-Synchronous Zoning

- Designed zoning architecture that creates slots for over 12,000 satellites spaced in altitude, inclination, and true anomaly.
- No orbits will cross unless an owner-operator loses station keeping.

Room for more than an order of magnitude growth over today’s SSO population is provided and ensuring minimal collision risk.
Geosynchronous Data Sharing

- More accurate conjunction assessment predictions and more efficient collision avoidance maneuver planning
  - Public data error: 20-50 km
  - Owner-Operator data error: 7 km
- Clear separation between station-keeping spacecraft and maneuvering satellites
- Allows for more efficient planning for station-keeping maneuvers

**Rules increase efficiency of existing GEO slotting and operations and reduce energy costs**
Potential Policy Issues

- Legitimacy of STM organizational body to implement and enforce rules
- Limitations on freedom of action by all actors
- Reluctance to share data due to privacy and competitive advantage concerns
- Arenas for arbitration and legal recourse
Next Legal Steps

- Mandate expansion (ITU or ICAO)
- Amendments and repeals of current laws
Path to Implementation

Key steps for a STM System

Phase 1: Develop Rules
Phase 2: Build Consensus
Phase 3: Implement the system
## Potential STM Organizations

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<th>Managing Body</th>
<th>Phase I: Rule Development</th>
<th>Phase II: Consensus</th>
<th>Phase III: Implementation of the System (1)</th>
<th>Phase III: Arbitration Procedures (2)</th>
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**Recommendations**
A Road Map to ISMO

Space Traffic Management
Our Rationale and the Way Ahead
Our approach over the next year is to start assessing in clear practical terms:

- When STM will be needed,
- The effects of varying a timescale of implementation
- Investigating whether it really is beneficial for key actors to engage with STM
- When is it most beneficial for them to do so.

Our Goal: To develop a technically sound and politically viable STM system

- Acceptable to key stakeholders
- Effectively put forward the case for these actors to take part in its implementation
Our Next Steps

- Secure World Foundation is funding further research and engagement activities with the following goals:
  - Rigorous analysis of technical proposals (conjunction assessment, SSO zoning) and legal issues
  - Economic analysis and development of policy and industry motivators
  - Active engagement with the international community for feedback and involvement in moves towards more effective management of STM
Questions?
Space Traffic Management
The Effect of Data Accuracy

Number of Conjunctions

Daily Cost of Maneuvers

Box Size: Longitudinal Axis (km)
Size of box along other axes has a scale factor of 0.2

Number of Daily Conjunctions

Total Daily Cost of Avoidance Maneuvers (USD)

Box Size: Longitudinal Axis (km)
Size of box along other axes has a scale factor of 0.2

Space Traffic Management
Orbital Lifetime vs Altitude

Figure 1-1: Orbital Lifetime as a Function of Altitude (Jehn 2007)
Current On-Orbit Trackable Population (~12,000 Objects)

Key question: at what number of collisions do critical orbits become unusable?
Relative Velocity of Conjunctions

40% of calculated conjunctions are head-on