



**INTERNATIONAL
ASTRONAUTICAL
FEDERATION**

Space Traffic Management
The IAF initiative

Status of Working Group #3.4.6
Future operations
Impact of constellations on Astronomical observations

Special Session
Wednesday 27 October 2021



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WG#3.4.6:

Membership

| Name | First name | Country |
|--------------|------------|-------------|
| Bonnal | Christophe | France |
| Cheng | Haowen | China |
| Foing | Bernard | Netherlands |
| Hainaut | Olivier | Germany |
| Kebe | Fatoumata | France |
| Masson-Zwaan | Tanja | Netherlands |
| Nassey | Charlotte | France |
| Romero | Marco | Angola |
| Rossi | Alessandro | Italy |
| Seitzer | Pat | USA |
| Ubertini | Pietro | Italy |
| Urdampilleta | Igone | Spain |

Connecting @ll Space People



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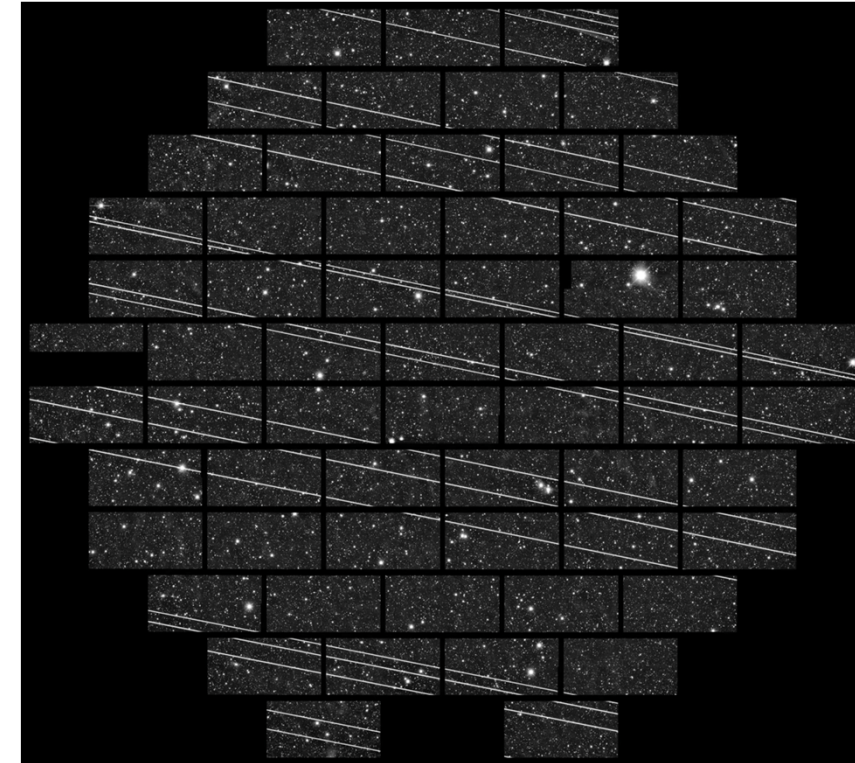
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Connecting @ll Space People

- The increasing number of large, bright (600 million times brighter than faintest stars and galaxies) objects related to the mega-constellations (MC) coupled with the advent of big ground telescopes (8 m class) with large field of view (e.g., Vera Rubin Telescope, LSST) is prone to pose serious challenges to optical astronomy and to exacerbate the (already present) issue of undesired streaks in astronomical images.
- Satellite trails generate a number of problems:
 - There is a loss of information in the pixels covered by the trails.
 - There could be cross-talk in the electronics if the trail brightness exceeds a threshold.
 - There can be ghost images due to reflections in the camera optics.
 - The trail could saturate the detector.
 - A trail could leave non-linear artifacts in an image.
- MC operators, such as SpaceX, are aware of the issue and have already undertaken mitigation steps: *DarkSat* and *VisorSat* (*four times fainter than the original satellites*). Thus, the trails in the image on the right would be fainter in an equivalent image taken today.



2019-Nov-18 0800 UT

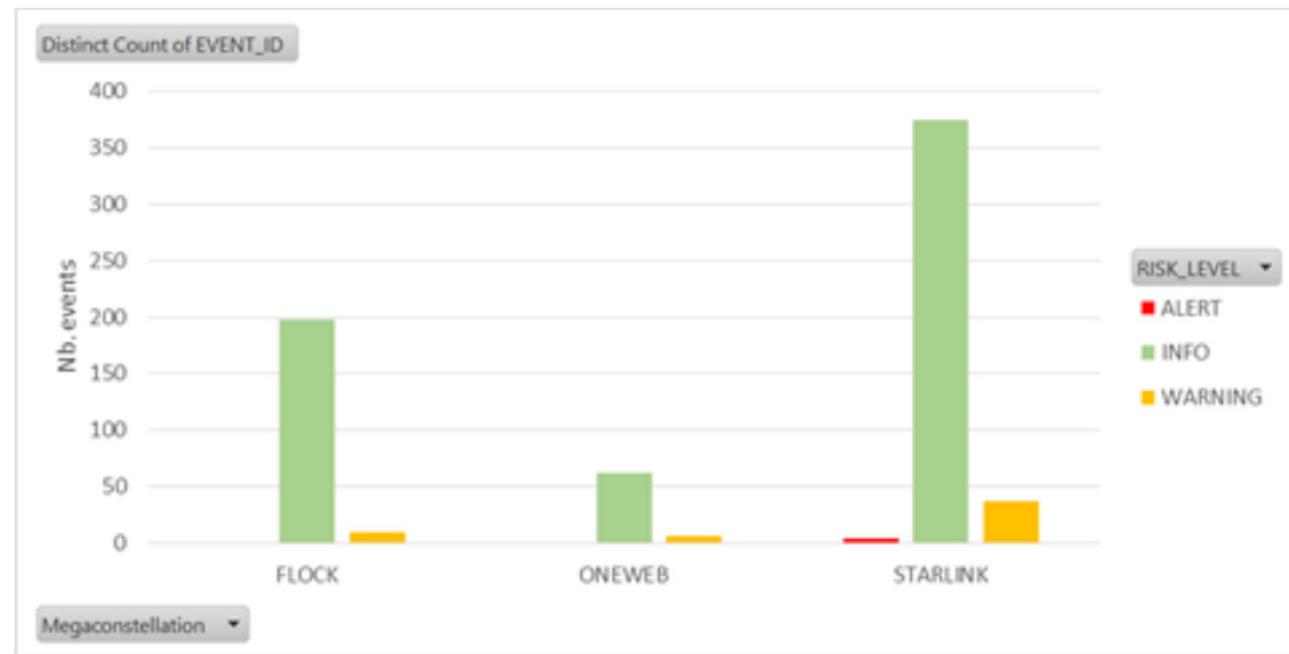
NSF Blanco 4.0-m telescope

DECAM

Cerro Tololo, Chile

- 19 Starlinks crossing.
- 2019-Nov-11 launch.
- ~4 sec to cross field of view.
- 4 x diameter of full moon.
- **Current Starlinks dimmer but still bright.**

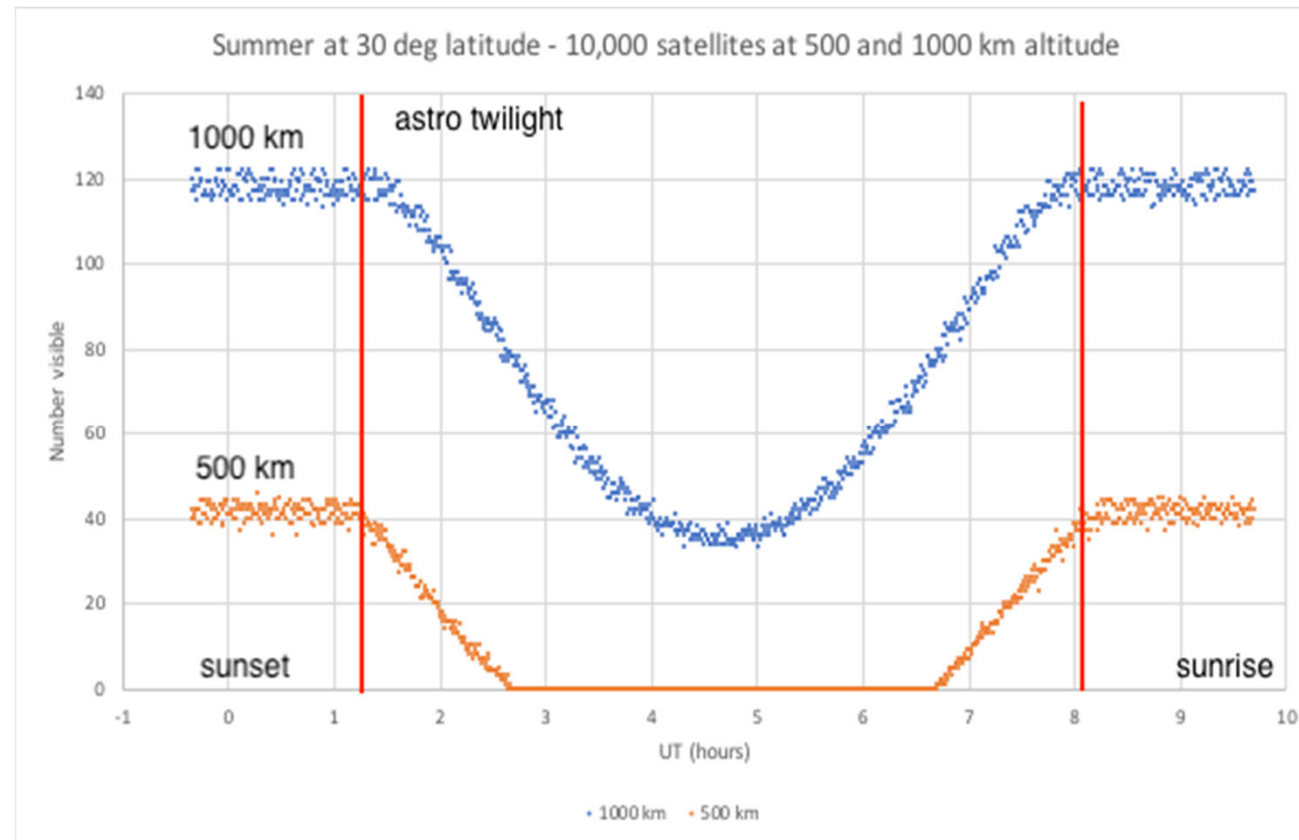
- The MC satellites constitute a substantial increment of the number of objects in LEO orbits and hence of potential **conjunction events**.
- Due to their size the MC satellites can be tracked with high precision for different sensor networks and effective Collision Avoidance Maneuvers can be implemented in the maneuverable satellite in order to mitigate this risk.
- On the other hand, failures and loss of control can complicate this optimistic picture.
- We should also take into account that:
 - space telescopes might have limited maneuvering capabilities
 - Frequent collision avoidance maneuvers could disrupt the tight observation schedules.



- Incorporate '*Design to be faint*' in design phase.
- Fainter than $V = 7^{\text{th}}$ magnitude to be invisible to naked eye under excellent conditions.
- For large telescopes like the Vera Rubin :
 - design to be fainter than $44 \times (550 \text{ km}/r_{\text{orbit}})$ watts/steradian
- Reflected sunlight should be slowly varying with orbital phase – best effort to avoid flares.
- During immediate post-launch phase, satellites are clumped together as closely as possible
- Respects and protect the radio astronomy portion of the spectrum.

WG#3.4.6 Space Debris Mitigation Steps that benefit Astronomy

- Launch as few satellites as possible.
- Minimize number and time in deployment and disposal phase.
- Deorbit as quickly as possible – within 1 year if possible.
- Provide timely and accurate orbital elements of all satellites, including those in deployment and disposal phase.
- Fly in lower orbits – less visible in middle of the night.





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WG#3.4.6

Special Session

Impact of Satellite Constellations on Astronomy and Society: a Multi-disciplinary Approach

Time: 11:30-13:00

Room: Sheikh Rashid B

Format: Campfire

This special session will address the impacts of the commercial uses of space on astronomy and the night sky. Following a set of interdisciplinary short speeches, participants will discuss the possible coordination between the stakeholders involved, and balance the conflicting interests at stake. The session gives the opportunity to any stakeholder to share its knowledge and ideas but also to get help on the challenges raised by satellite constellations.

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