Current Starlink Deployment Status

3,700+ satellites launched into low Earth orbit
1,000,000+ customers on all seven continents

200 Mbps (improving to 1 Gbps) speeds far exceed other satellite systems and are competitive with some terrestrial systems

Gen-2 system critical to fulfilling customer orders and scaling Starlink service approved in 2022, as part of license SpaceX completed a coordination agreement with the US National Science Foundation

The Brightness of VisorSat-Design Starlink Satellites by Anthony Mallama, 2021-01-02

Altitude Impact ->

Brightness Target

\[ V > 7.0 + 2.5 \log_{10}(r_{\text{orbit}}/550 \text{ km}) \]
Mechanism for Satellite Reflections

- Mag 7 target corresponds to ~8U (0.08m²) white cubesat so every single component must be considered.
Mitigations in Three Areas

Hardware and satellite design
- Shade the reflective surfaces
- Specular materials can scatter light away from Earth
  - Dielectric Bragg mirror film
- Dark materials can be used to absorb light
  - Pigmenting solar arrays and black paint
- Other accommodations
  - Oversize solar arrays so they can off-point to reduce reflections
  - Robust thermal design to accommodate more absorbed heat energy

Satellite Operations
- Off-pointing solar array during orbit raise
- Autonomous attitude adjustments as satellite approaches terminator
  - Off-pointing solar array
  - Biasing bus pointing to reduce likelihood of light reflections toward Earth’s surface

Satellite position predictions
- Publish accurate ephemeris predictions that include planned maneuvers and make them publicly available
- Publish Two Line Elements (TLEs) with planned maneuvers included
Conclusion

• Starlink is making a huge positive impact around the world, while keeping space safe and sustainable

• Through coordination with astronomers and industry-leading standards on space sustainability, SpaceX continues to innovate and implement mitigation solutions

• We welcome collaboration with other operators, and are making in-house products available to other companies

• We agree with NSF that our astronomy coordination agreement and collaboration should be a model moving forward!