Day 2 – Sunday, 8th May 2022

BST	EDT	PDT	Section	Title	Description	Speaker
11:10	06:10	03:10		Welcome		Dr Paul A. Daniels *(see Day 1, 11:00 BST above)*
11:15	06:15	03:15	Challenges	The Megaconstellation Geometry: what do we see and when?	With many thousands of Megaconstellation satellites in orbit, hundreds or even thousands of them will be in the sky above an observer on Earth. We will quantify this, and discuss which of those are visible and when depending on the time of the night, the season, the latitude, *etc.* We will also see the implications for naked-eye observers.	Dr Olivier R. Hainaut *Full Astronomer,* *End-to-End Operations Scientist,* *ESO, Germany* 
11:40	06:40	03:40		Photometric Characterization of Mega-Constellation Satellites In All Geometries	The apparent brightness of a satellite in Earth orbit depends on many factors, paramount of which is the relative geometry to the Sun and the observer. With the *Pomenis LEO Satellite Mega-Constellation Survey* we have made over 10,000 separate photometric measurements of Starlink and OneWeb satellites. Our survey observes satellites across a broad range of geometries encompassing the entire hemispherical sky. Plotting the measurements across the sky shows the reflection pattern characteristic to each satellite model and reveals where the satellites reflect more or less light. With these sky plots we show what astronomers can expect with regards to apparent satellite brightness and how they may avoid the brightest and most impactful reflection geometries on the sky.	Harrison Krantz *PhD Candidate,* *University of Arizona Steward Observatory, Arizona, USA* 
12:05	07:05	04:05		40 Minute Lunch/Breakfast		
12:45	07:45	04:45	Challenges	Quantifying the impact on optical observations	Using detailed simulations, we evaluate and quantify the impact of Megaconstellations on existing and upcoming optical telescopes, for observations in the visible and infrared, and for various observation techniques ranging from imaging to spectroscopy, transit, transient events, *etc*. We will also discuss the case of space-based telescopes.	Dr Olivier R. Hainaut *(see 11:15 BST above)*
13:10	08:10	05:10		Large LEO satellite constellations and their impact on radio astronomy	Radio astronomy is the science of studying celestial phenomena with the observation of radio waves, radio observatories employ different types of antennas (*e.g.* fixed single dish, steerable dish, aperture arrays) tracking celestial sources in the sky. Satellite transmissions have always been a feature in the sky, and radio astronomers are used to dealing with them in low numbers or fixed positions. The recent developments on large low earth orbit constellations, with plans for several thousand of satellites using X, Ku, K and Ka bands (8 GHz to 70 GHz), will change the way radio astronomical observations will be conducted on these frequency ranges. The situation will shift from satellites being few in LEO orbit or being bound to the geo-stationary orbits, to a potential situation where a large number of satellites will be visible above the horizon and moving at great speed. This talk presents an introduction to radio astronomy and to the challenges it faces with these constellations. Touching on the regulatory aspects of the use of the radio spectrum, exiting compatibility studies between constellations and radio astronomy, and the use of Radio Quiet Zones.	Federico di Vruno *Spectrum Manager,* *SKA Observatory,UK* 
13:35	08:35	05:35		15 Minute Break		
13:50	08:50	05:50	Mitigations	An introduction to the challenges of satellite avoidance and mitigating the impact to astronomy	Since the launch of the first batch of Starlink low Earth orbit (LEO) communication satellites in May 2019, both the amateur and professional astronomical communities have expressed major concern, due to their bright apparent magnitude, caused by their very low orbits following launch and their clustering in "trains". What makes these new types of communication satellites very different from previous satellites in geostationary orbit, is the dramatically reduced orbital height and their sheer numbers, with an expected 100,000 satellites in LEO by the end of the decade. The two primary observational mitigation strategies for astronomers are avoidance and streak removal from the images, though for sensitive detectors in which the pixels are saturated, this is not a viable option. Therefore, generally, the best option is to plan observations to avoid satellite contamination. At present, this involves using publically accessible TLEs (Industry standard Two Line Elements) or ephemerides of the satellites to predict their paths across the night sky. However, this approach is limited at present due to the lack of uncertainties in the TLEs and when combined with fixed eight hourly updates, it becomes very difficult to provide accurate forecasts.	Dr Jeremy Tregloan-Reed *Assistant Professor at the Instituto de Investigación en Astronomia y Ciencias Planetarias,* *Universidad de Atacama,* *Copiapó, Atacama, Chile* 
14:40	09:40	06:40		PassPredict and TrailMask	Processing images to attempt masking of the satellite streaks. Problems with tumbling satellites. Use of ephemerides and AI to improve the masking process.	Dr Paul A. Daniels *(see Day 1, 11:00 BST above)*
14:55	09:55	06:55		Q&A		Dr Paul A. Daniels & Panel
15:20	10:20	07:20		20 Minute Break		
15:40	10:40	07:40	Future	Sharing the Sky: The IAU **C**entre for the **P**rotection of the Dark and Quiet **S**ky from Satellite Constellation Interference	The mission of the IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (CPS) is to coordinate collaborative multidisciplinary international efforts with institutions and individuals and to work across multiple geographic areas to help mitigate the negative impact of satellite constellations on ground-based optical and radio astronomy observations as well as humanity's enjoyment of the night sky. The IAU CPS is co-hosted jointly by the US NSF's NOIRLab and the SKA Observatory. The Centre will bring together regulators, astronomers, industry and the wider community and act as a bridge between all stakeholders to protect the Dark and Quiet Skies. The Centre will build on the vast work done by the community recognizing different interests of observatories according to wavelength, existing protections, and expected impact among other aspects. The vision of the Centre is to become a leading voice for astronomical matters that relate to Dark and Quiet Sky protection from satellite constellations and to act as a hub of information and resources to which any stakeholder group will be able to contribute and from which they can draw in support of their own activities.	Dr Connie Walker *Co-Director, IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (CPS)* *Scientist and Head of the Office of Observatory Site Protection, NOIRLab, USA* 
16:10	11:10	08:10	Observations	A central repository of satellite observations and what observations are required to evaluate and help mitigate the impact to astronomy	To assess the true impact from low Earth orbit (LEO) mega constellation satellites to astronomy and help develop suitable mitigation strategies, requires the use of detailed models. The development of such models will need a statistically significant amount of data. To aid in this endeavour, NOIRLab and SKAO are forming a centralised data repository, SatHub to allow both the professional and amateur astronomical communities a place to upload their images of LEO satellites. Such a large ensemble of data will greatly aid in the development of models and forecasting software whilst providing an opportunity to assess new mitigation designs, such as the Starlink Darksat and Visorsat satellites. Here we will discuss the type of observations required to measure the satellite's brightness, BRDF, and the accuracy of the TLE along with how the amateur astronomical community can help in this international effort.	Dr Jeremy Tregloan-Reed *(see 13:50 BST above)*
16:45	11:45	08:45	Future	Satellite Constellations: international law, national policy, and industry perspectives	In 2020 and 2021, the United Nations Office for Outer Space Affairs (UNOOSA) and the International Astronomical Union (IAU), with support from NSF's NOIRLab, organized the Dark and Quiet Skies Conference I and II to mitigate the impact of artificial interferences affecting the visibility of the sky. In this context, the Satellite Constellations Working Group brought together international law experts, national regulators, satellite constellations operators and astronomers to find an equal balance in the use and access of the night sky and outer space. This presentation will summarize the findings from the working group, with a particular focus on: 1. Critical issues in international law and recommendations for continuing the discussion in international fora. 2. Recommendations to national policy-makers and regulators. 3. Best practices for satellite manufacturers and operators.	Dr Giuliana Rotola *PhD candidate,* *Sant'Anna School of Advanced Studies, Pisa, Italy* 
17:10	12:10	09:10		Q&A		Dr Paul A. Daniels & Panel
17:40	12:40	09:40		Meeting Close		Dr Paul A. Daniels