INTERNATIONAL SPACE CENTRE
THE UNIVERSITY OF WESTERN AUSTRALIA

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International Space Centre
The University of Western Australia

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The Manager
Economics and Market Analysis
Australian Communications and Media Authority
PO Box 13112 Law Courts
Melbourne Vic 8010

Dear Madam / Sir,

The below is the response from the University of Western Australia's International Space Center [1] to ACMA document IFC-39-2020-Response-to-implementation-of-SPR-paper.docx

The University of Western Australia (UWA) is establishing the Western Australian Optical Ground Station in collaboration with several national international partners. These include the Australian Research Council Center of Excellence for Engineered Quantum System (EQUS) and Goonhilly Earth Station Pty. [2]; as well as the SmartSat Cooperative Research Center, which includes the University of South Australia, the Department of Defence's Defence Science and Technology Group, Thales Australia, and Thales Alenia Space [3].

The mission of this optical ground station is to develop and test advanced optical communications technologies to support fundamental physics [4], secure quantum key distribution [5]; next-generation position, navigation, and timing technologies [6], and free-space optical data communications [7].

For optical communications, we anticipate for the optical ground station to support inspirational global space missions, including NASA's Artemis program, which aims to land the first woman and next man on the Moon by 2024 [8]; as well as the European Space Agency's (ESA) Scylight program, to demonstrate the first Tbps-scale optical communications link from low earth orbit [9].

A major concern for the operation of UWA's free-space optical communications research programs, and the operation of the Western Australian Optical Ground Station, is that ACMA currently regulates and taxes spectrum use up to 420 THz; whereas the International Telecommunications Union (ITU), and many the majority of other countries, regulate only up to frequencies of 3 THz.

This is critical, as free-space optical communication typically operates at around 1550 nm (193 THz) or 1064 nm (300 THz), putting this scheme within the licensing regime which was initially created for the traditional radio- and microwave-frequency (RF and MW) communications systems. As the resultant beam size is a physical product of the emitting aperture and signal wavelength, RF and MW signal domains that have relatively poor spatial directivity. Hence why efficient and well-regulated spectrum management is critical for the harmonious operation of transmission systems by multiple users.

This is not the case for optical communications, and therefore we believe ACMA should reduce its licensing to below 3 THz. As an example, a 193 THz optical beam emitted from a 10 cm aperture from a spacecraft in low earth orbit at 500 km, would result in a beam size of only around 10 m on the Earth's surface. This is around 4,000 times smaller than the beam size generated by MW transmission at the highest frequencies (51.4 GHz) specified in the ACMA licence tax tables.

This physical property therefore allows multiple optical transmission systems to operate completely independently of each other without the issue of interference. Furthermore, even if a satellite were to accidently (or nefariously) were to target another ground station (or vice versa), the 'gain' of the receiving telescope is similarity high; so that unless it is pointing directly at the other target, it will not be impacted by the addition optical signal.

Failure to change the licencing structure would severely limit all Australian research and industry organisations and their collaborators to not only innovate but also commercialise communication technologies. This would force these technology developments to be realised by other countries and Australia would be unable to enable and strengthen their comparative advantage in this sector. For example, we had planned to conduct a horizontal point-to-point free-space trial of a new optical-comb-based data communications system capable of 40 Tbps data communications per optical channel, which requires a bandwidth of around 10 THz [10]. In our case the emitted beam is 5 cm which has diverged to a 10 cm by the time it reaches its target many kilometres away. Our previous related work, publishing in the journal Nature Communications [4], was conducted in France, in collaboration with the French space agency (CNES) and the French metrology laboratory SYstèmes de Référence Temps Espace (SYRTE); and this breakthrough work was made possible because the maximum regulated frequency in France is 3 THz.

ACMA's proposed Apparatus License Fee Schedule for generally assigned licenses for transmissions above 51.4 GHz specified a tax of A$0.0003 per kHz of bandwidth for High and Medium density locations. While this cost might seem very low in the context of typical RF and MW transmission system used in currently; to deploy the optical-comb-based data communications technology, using the proposed ACMA costing, would total A$3M (or A$28M under the current scheme). Considering that any number of ground stations and satellites, or fixed terrestrial point-to-point links can operate concurrently with no possibility of interference, this cost structure is completely inappropriate in our view.

For the reasons outlined above we strongly recommend ACMA specifies the upper frequency of the licencing to be 3 THz, in line with the ITU and most other countries. Please do not hesitate to contact me should you have any questions or require further clarification.

Yours faithfully,

Danail Obreschkow

A/Prof. Danail Obreschkow

Head of the International Space Centre

References:

[1] International Space Centre. https://internationalspacecentre.org/.
[2] Western Australian Optical Ground Station. https://www.icrar.org/uwa-space-station/.
[3] Coherent Free-Space Optical Communications. https://smartsatcrc.com/projects/advanced-communication-connectivity-iot-technologies/coherent-free-space-optical-communications/.
[4] Dix-Matthews et al. *Nat. Commun.* **12**, 515 (2021).
[5] Hua-Ying Liu et al. *Phys. Rev. Lett.* **126**, 020503 (2021).
[6] Dix-Matthews et al. *J. Geod.* **94**, 55 (2020).
[7] Dix-Matthews et al. *IEEE Commun. Lett.* (2021).
[8] NASA Artemis Program. https://www.nasa.gov/specials/artemis/.
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[10] Corcoran et al. *Nat. Commun.* **11**, 2568 (2020).