Bluejay Mining Technical Report:

Overview of current and emerging telecommunication systems relevant for Dundas Titanium A/S and as alternatives to service provided through Tele Greenland A/S

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Content:

Frontispiece: The uplifted ilmenite-bearing beaches at Moriusaq along the south-coast of the Steensby Land Peninsula, 80 km south of Qaanaaq. The abandoned settlement Moriusaq is seen at the coastal stretch before the small tombola.

1 Review of systems & conclusion

Based on the Arctic Council 2019 report: Improving Connectivity in the Arctic (see footnote 1) is an overview of current and emerging telecommunication systems relevant for Dundas Titanium A/S and as alternatives to service provided through Tele Greenland A/S given in Table 1.

Especially the systems OneWeb[2] , Starlink (SpaceX)[3] and Iridium Next25[4] as well as the system Space Norway[5] (see Table 1) provide alternative solutions to the current and future setup used by towns and settlements in North-West Greenland through TELE-POST – and will remove any potential negative impacts on the telecommunication capacity available for other users in North-West Greenland.

[1] Arctic Council Secretariat 2019: Arctic Council Task Force on Improved Connectivity in the Arctic (2019). Improving Connectivity in the Arctic. https://oaarchive.arctic-council.org/bitstream/handle/11374/2369/SAOXFI205_2019_RUKA_06_TFICA_Report-3rd-Draft%206%20May.pdf?sequence=1&isAllowed=y

[2] Venturebeat.com article 04/09/2019 article on OneWeb - https://venturebeat.com/2019/09/04/onewebs-first-commercial-satellite-service-will-bring-broadband-to-the-arctic/

[3] Wikipedia 2020 - SpaceX Starlink - Wikipedia article, edition 29 January 2020, at 1531 (UTC) – including reference material on this site about SpaceZ Starlink. https://en.wikipedia.org/wiki/SpaceX_Starlink

[4] See Iridium NEXT website: https://www.iridiumnext.com/ and eWeek February 06, 2019 article: How Iridium Next-Gen Satellites Will Boost IoT Performance https://www.eweek.com/networking/how-iridium-next-gen-satellites-will-boost-iot-performance

[5] Space Norway 2019 - Press release 03.07.2019: https://spacenorway.no/home/ and https://nordicspace.net/2018/12/26/broadband-for-the-arctic-from-2023/

Table 1 Current and emerging telecommunication systems relevant for Dundas Titanium A/S as alternatives to services and solutions provided by Tele Greenland A/S. Unless stated otherwise is the summary of information based on the report Arctic Council 2019 report: Improving Connectivity in the Arctic (see footnote 1).

Company / System	Location	Technology	2019 Arctic	Planned Arctic
Low Earth Orbit (LEO) Satellites: - broadband services (including internet access), narrowband services (including short message delivery), telecommunications services, remote sensing, as well as scientific usage.				
OneWeb	Kingdom and United States	LEO constellation of 600 satellites that will provide data and broadband direct to end users and telecommunication service providers (*i.e.*, wholesale operations).	Not available	Full Pan-Arctic (and global) coverage. Service offerings are expected to begin in 2019 with initial and full Arctic coverage expected in service by 2020-2021. A very relevant solution for Dundas Titanium that could fulfil all needs outside the setup provided to other users in North-West Greenland.
Company / System	**Location**	**Technology**	**2019 Arctic Coverage**	**Planned Arctic Coverage**
SpaceX (Starlink)	United States	LEO constellation of 4,500 satellites that will provide data and broadband direct to end users as well as to service providers. SpaceX is applying its manufacturing expertise and space operations skillset toward developing its constellation.	Not available	Full Pan-Arctic (and global) coverage. Service offerings are expected to begin in 2019 with full Arctic coverage to follow. Full globally coverage A very relevant solution for Dundas Titanium that could fulfil all needs outside the setup provided to other users in North-West Greenland.

Iridium Next (Iridium)		Global LEO constellation of 66 satellites that provides voice and data connections for a range of applications. Iridium has completed the replacement of its current satellite system with a new system, Iridium NEXT.	Pole-to-pole global coverage.	Iridium foresees that the Internet of Things (IOT) will be an important area of growth driven by the increasing need for global tracking capability. A very relevant solution for Dundas Titanium that could fulfil all needs outside the setup provided to other users in North-West Greenland.
Narrow-band communications: Narrow-band LEO or Medium Earth Orbit (MEO) systems usually have direct end user access. These systems could transport short messages and voice that require limited bandwidth. They are meant to offer services for users of ship and air traffic tracking system, for safety and rescue services, for sensor systems (Internet of Things) as well as for individuals and business.				
Gomspace	Denmark and Sweden	Nanosatellites that provides a variety of data and scientific services.	Launched a demonstration for surveillance in the Arctic.	Nanosat for Arctic surveillance. For Dundas Titanium could this solution be relevant for data traffic related to Internet of Things/sensors.
Company / System	**Location**	**Technology**	**2019 Arctic Coverage**	**Planned Arctic Coverage**
Omnispace	United States	Operates in the S-band,with about 60 megahertz globally.	Limited pole-to-pole global coverage.	Omnispace intends to provide 24/7 coverage at the poles, and in the future, the company will be focused on mobile satellite services. For Dundas Titanium could mobile satellite services be relevant.
Highly Elliptical Orbit (HEO) Satellites: - broadband services (including internet access), narrowband services (including short message delivery), telecommunications services, remote sensing, as well as scientific usage.				

Space Norway[6]	Norway	Space Norway will cooperate with the satellite operator Inmarsat and the Norwegian Ministry of Defence to offer mobile high-speed broadband coverage to civilian and	Unavailable.	Pan-Arctic coverage will be in place 2023. A very relevant solution for Dundas Titanium that could fulfil all needs outside the setup provided to other users in North-West Greenland.
Other wireless technologies: - 4G Long-Term Evolution (LTE) technology is a mature technology that can be used as a mobile wireless solution in communities and other sites (e.g., mining camps; ships; research stations). Recent developments in High-Frequency (HF) radio and networking technology provide increasing reliability and availability for communication.				
KNL Networks		High Frequency (HF) radio technology with cognitive networking combined with mobile radio technology. It focuses on offering connectivity and communications used by the maritime industry, as well as information security providers.	Global coverage, including the circumpolar Arctic.	As the number of radios in use increases in the future, the reliability andservices could be expected to increase Network through the HF solution could be relevant for Dundas Titanium A/S..
Company / System	**Location**	**Technology**	**2019 Arctic Coverage**	**Planned Arctic Coverage**
COSPAS – SARSAT Programme	International Organization (44 overnments and agencies) with headquarters in Canada	Search and rescue beacon network connecting end users via satellites to ground stations. It provides accurate, timely and reliable distress alert and location data in 228 countries and territories to help search and rescue (SAR) authorities assist persons and vessels in distress.	Global coverage using various satellites systems (e.g., GALILEO).	Exploring ways to add two-way communications co-located with radio messenger devices and improving the payload (i.e., data). When two-way communication and payload could this solution potentially be relevant for Dundas Titanium A/S.

[6] Space Norway 2019 - Press release 03.07.2019: https://spacenorway.no/home/ and https://nordicspace.net/2018/12/26/broadband-for-the-arctic-from-2023/