# Powering the Future of Polar Operations

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## Introduction

The polar regions have not seen a peer conflict since WWII, and 80 years of advancement in military technology has since passed. As such, the tools and tactics of modern militaries have not been tested against peer adversaries in such environments. This piece explores key technologies, considerations thereof, and potential commercial synergies for two areas critical to the success of US forces in the Arctic: telecommunications and batteries. Both are critical components of modern operations, yet both are critically underdeveloped for use in the polar domain.

## Telecommunications

US doctrine relies on timely, reliable communications with on-demand access to support and intelligence. Uniquely, the infrastructure and geography of the Arctic significantly challenges such. Firstly, Arctic latitudes preclude access to traditional SATCOM satellites in geostationary orbits. Secondly, electrical storms in the ionosphere intermittently prevent use of traditional HF radios. Thirdly, the extreme temperatures and sparse population of the Arctic provide almost no existing communications infrastructure. In concert, these create a harsh environment for use of current technologies. To maintain communications access and security, new infrastructure development within the Arctic is a must.

There are several telecommunications infrastructure options which can be developed at an enterprise level. No single option will be a magic bullet, but a tailored combination thereof can create a robust, competitive solution.

- Satellites purpose-built for Arctic communications can bridge the SATCOM gap. USSF operates two Enhanced Polar System satellites in Molniya orbits which provide 24/7 Arctic access.
- Fixed cables, particularly fiber optic, provide terrestrial solutions. Quintillion has recently laid 1,200 miles of cable to provide broadband to the North Slope.
- Fixed wireless solutions like microwave towers provide an untethered alternative to cables. These have been successfully deployed commercially above the Arctic Circle.

Chief considerations for infrastructure center around building a mixed solution which resolves key shortcomings of any individual approach. The below framework is not exhaustive but illustrative of such critical dimensions.

- Accessibility: The ability to interface with a network. This can include both integration with existing equipment (e.g., PRC-152) as well as access range.
- Cost profile: This includes both pecuniary and "soft" costs. For example, an additional block of EPS satellites would incur significant initial costs. Alternatively, while it may be cheaper to proactively lay fiber optic cables along key corridors, it would require engagement of key allies (e.g., Canada, Finland) if done within their territory.
- Reliability: The share of "uptime" allowing use. Snowstorms, electromagnetic interference, and sub-zero temperatures can compromise reliability. For example, solar

storms prohibit use of SATCOM, and snowstorms prevent use of microwave towers. Different natural phenomena force a mixed technology solution.

- Resiliency: The ability to function despite enemy action. Solutions with singular points of failure are at high risk for compromise. For example, the two current EPS satellites could be easily crippled with an ASAT weapon, and undersea cables are vulnerable to attack by submarines. However, microwave towers deployed on-demand via helicopter are more dynamic and difficult to permanently disrupt.

## Batteries

In the non-permissive environment of the Arctic, SOF members and near-peer-adversaries rely heavily on drones, all-terrain vehicles, and various telecom devices to ensure continuous operations in the region. One of the most salient limiting factors in reliability of electronic equipment is the sparsity of cold-resistant batteries (able to withstand -80°F or less).

Li-based batteries are rendered useless when exposed to extreme cold temperatures. At -40°F , lithium-ion batteries retain a mere 12% of battery capacity. The majority of small, hand-launched UAVs are powered by LiPo batteries, which begin to see performance decay at temperatures below 50°F. In addition to compromising battery life, cold temperatures induce lower output voltages and frequency drift in handheld and vehicular-mounted transceivers. The existing caliber of battery performance is unacceptable for future SOF operations in the Arctic.

The sense of urgency is clear: China's dominance in cold-resistant battery research, battery supply chains, and the EV industry should be of concern to SOF. Aside from the inherent tactical advantages of Russia's vast arctic territory, the Russian military continues to develop arctic-capable hand-launched drones as well as cold-weather ATVs. In both cases, establishing synergies with the US electrical vehicle (EV) industry and heavy investment in battery research would close this capability gap.

To compete with near-peer-adversaries, SOF must consider the following:

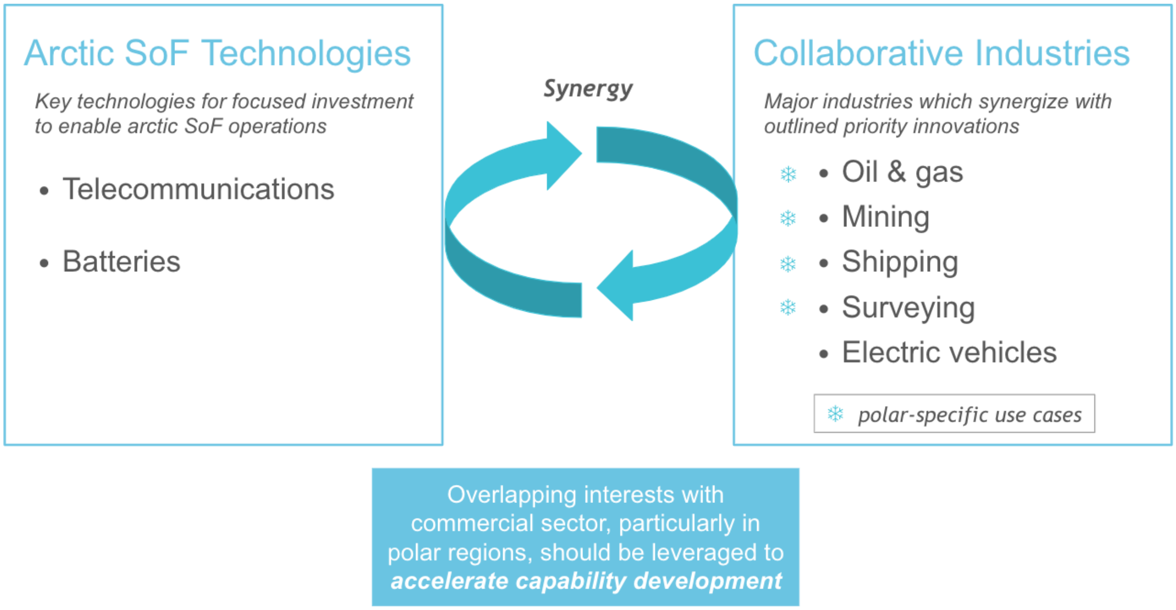
- Investment in developing next-generation battery technologies for sUAS and portable devices
- Alignment with the US EV industry to develop cold-resistant battery trains for CATVs and autonomous land vehicles

| *Arctic-Deployed Technology* | **Shortcomings** | **Post-Synergy Outcomes** |
|---|---|---|
| *Manpack radio transceivers* | ❖ Lithium-ion battery life | Reliable, all-weather portable electronics that ensure uninterrupted connectivity for:<br>❖ Daily Sitreps<br>❖ Emergency Sitreps |
| *Vehicular-mounted radio transceivers* | ❖ Constant exposure to elements<br>❖ Frequency drift<br>❖ Complicated starting procedures to prevent circuit arcing | Reliable, all-weather vehicular electronics |
| *Bandvagn 206 (CATV)* | ❖ Noisy internal combustion engine<br>❖ Delay in delivery of high-torque | ❖ Stealthier operations<br>❖ On-demand torque<br>❖ Alignment with DoD hybrid-electric initiatives |
| *Small unmanned aerial systems (sUAS)* | ❖ LiPo battery life | Reliable, all-weather sUAS<br>❖ Mapping, IED detonation, search & rescue |

***Common Denominator:*** *Optimized Mean-Time Between Failure (MTBF)*

*Minimize frequency of equipment maintenance needed, as resources are limited in this underdeveloped theater*

Equipment failure is inevitable; however, extending mean-time between maintenance for Arctic equipment can lend SOF an incredible tactical advantage. This will ensure the ability to maintain continuous, low-visibility operations such that ODAs can proactively address resource crises in the polar regions.




## Closing remarks

The solution space for telecom and battery technologies should be considered with a rigorous evaluation framework. Furthermore, a critical component for success is engagement and collaboration with commercial interests, as depicted above -- these technologies are also of interest to industry, especially those which are aligned with US interests and have a growing Arctic footprint. Targeted use of SBIRs, DIU, and other tools will accelerate development to mutual benefit. The results of such engagement will both further the leadership of US industry and enable US forces to compete and win against peer adversaries in this evolving domain.

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## Bios

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