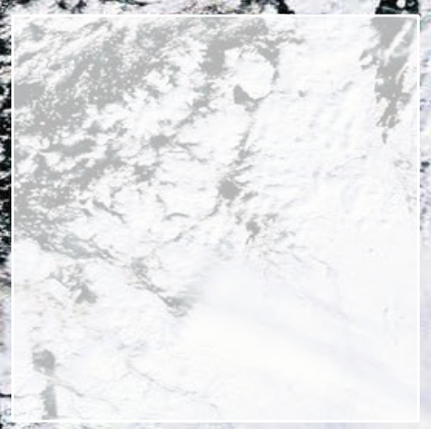
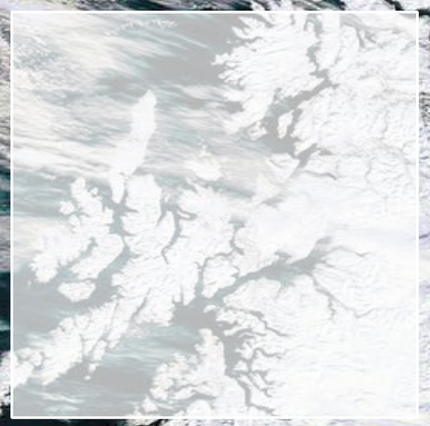
Polar View





THE CONTRIBUTION OF SPACE TECHNOLOGIES TO ARCTIC POLICY PRIORITIES

esa

HICKLING ARTHURS LOW

c-core

UNIVERSITY OF TROMSØ UiT

UNEP GRID ARENDAL



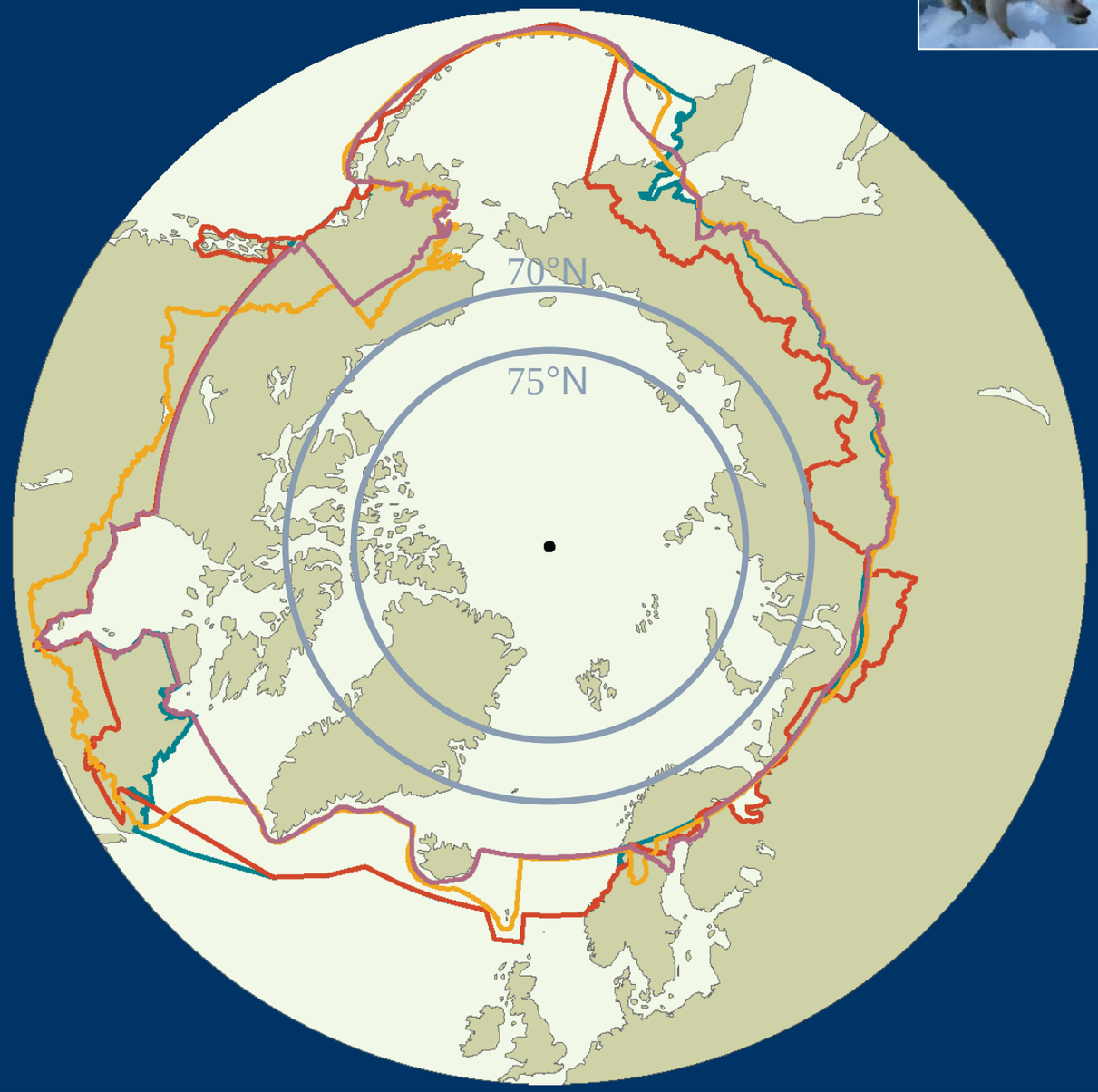
Study Background

- Objective:
  - "To provide a comprehensive, coherent perspective on how space-based technologies can support Arctic policies at national, regional, and international levels."
- Team:
  - Polar View Partners (GRID Arendal, Tromsø Centre for Remote Sensing, C-Core, Hickling Arthurs Low) on behalf of the European Space Agency.
  - Input and advice from a wide range of stakeholders through a document and web review, interviews, and a workshop held in conjunction with the Space and the Arctic 2012 Conference in Copenhagen.

Arctic Boundaries



- No single boundary exists to delineate the extent of the Arctic regions.
- Rather, the boundary will change with its application: environmental, biological, economic, jurisdictional, or social.
- For the purposes of this study, a precise definition is not important.



Polar View

Arctic Characteristics



- Sensitive eco-systems
- Changing environment
- Rich resources
- Increasing human activity

Increasing Arctic Interest

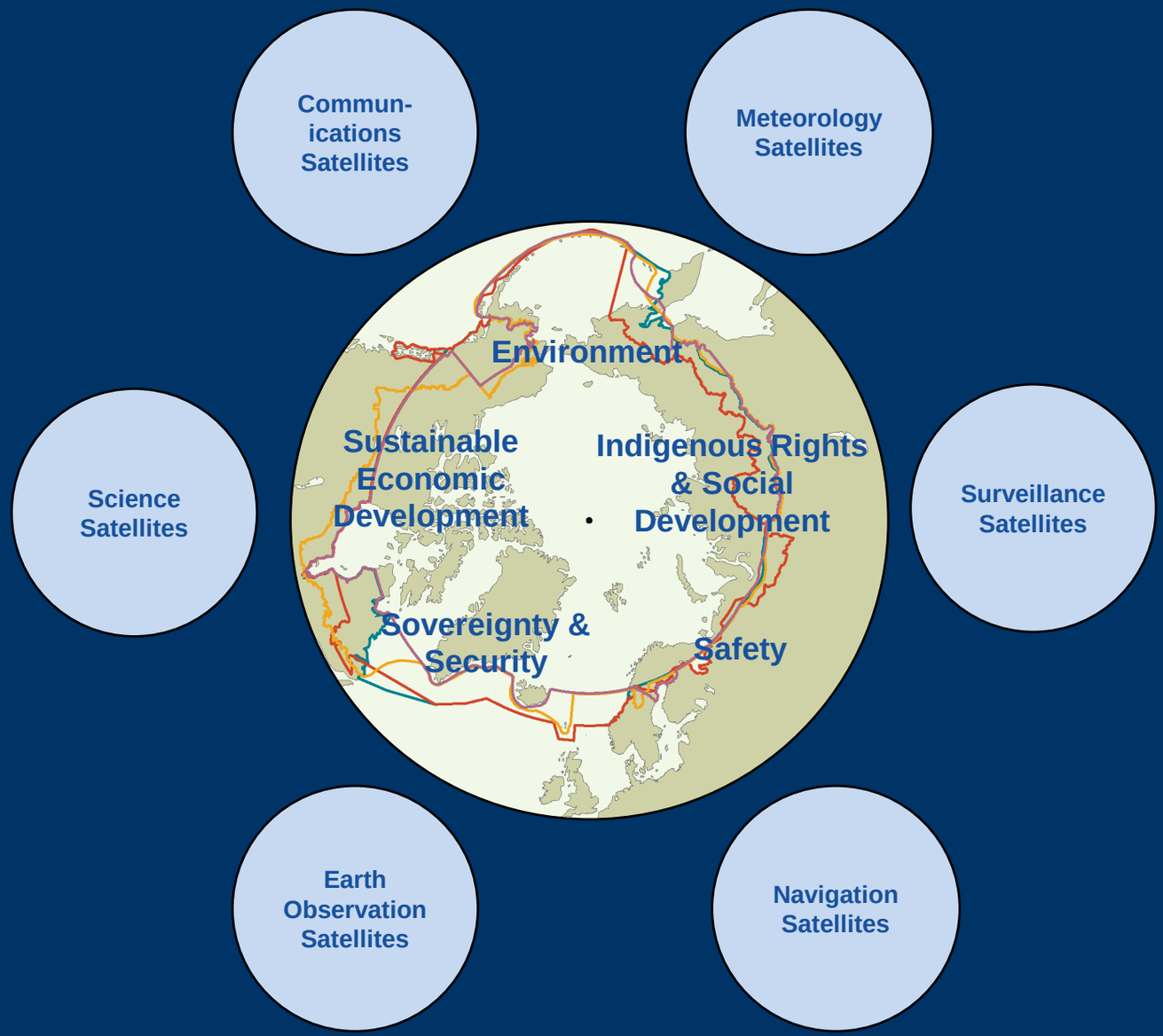
- Immense area
- Limited accessibility
- Harsh conditions
- Sparsely populated

Applicability of Space Technologies

Polar View



Study Components



Polar View

Policy Area Interest
Safety



- ❿ Marine Transportation – High
- ❿ Air Transportation – Low
- ❿ Land Transportation – Low
- ❿ Policing – Low
- ❿ Search and Rescue – High
- ❿ Disaster Management – Medium

Policy Area Interest
Environment



- Pollution – High
- Climate Change – Medium
- Biodiversity – High
- Environmental Protection – High

Policy Area Interest
Sustainable Economic Development



- ⑩ Resource Development – High
- ⑩ Infrastructure – Medium
- ⑩ Transportation Efficiency – Medium

Policy Area Interest
Sovereignty and Security



- National Boundaries – Medium
- Border Protection – Medium
- Defence – Medium
- Maintaining Presence – Low

Policy Area Interest
Indigenous and Social Development



- Traditional Livelihoods – High
- Health – Medium
- Education – Low
- Connectivity – Low

Policy Area Interest
Arctic States



Legend

- Low Priority
- Medium Priority
- High Priority

Arctic States	Policy Areas: Safety						Environment				Economic Development			Sovereignty				Indigenous and Social Development			
	Marine Transportation	Air Transportation	Land Transportation	Policing	Search and Rescue	Disaster Management	Pollution	Climate Change	Biodiversity	Environmental Protection	Resource Development	Infrastructure	Transportation Efficiency	National Boundaries	Border Protection	Defence	Maintaining Presence	Traditional Livelihoods	Health	Education	Connectivity
Canada	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Denmark, Greenland and the Faroe Islands	■				■			■		■	■	■		■		■		■	■		
Finland	■		■				■	■			■	■						■			
Iceland	■				■	■	■	■	■	■	■		■	■				■			■
Norway	■	■	■	■		■	■	■			■	■		■	■	■	■	■			
Russia	■	■	■		■	■	■		■	■	■	■	■	■	■	■		■	■	■	■
Sweden					■			■	■	■	■	■	■					■	■	■	
United States	■			■	■			■	■	■	■	■	■	■	■	■	■	■		■	

Polar View

Policy Area Interest
Non-Arctic States



Legend	
Low Priority	
Medium Priority	
High Priority	

		Policy Areas																						
		Safety						Environment				Economic Development			Sovereignty				Indigenous and Social Development			
		Marine Transportation	Air Transportation	Land Transportation	Policing	Search and Rescue	Disaster Management	Pollution	Climate Change	Biodiversity	Environmental Protection	Resource Development	Infrastructure	Transportation Efficiency	National Boundaries	Border Protection	Defence	Maintaining Presence	Traditional Livelihoods	Health	Education	Connectivity
Non-Arctic States	The European Union	■							■		■	■		■					■			
	China									■		■			■							
	France	■							■			■		■			■					
	Germany	■				■			■		■	■			■		■					
	India								■			■										

Policy Area Interest
Industry Interests

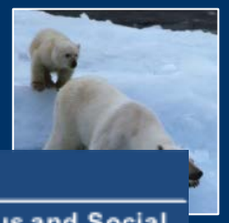


Legend	
Low Priority	
Medium Priority	
High Priority	

		Policy Areas																				
		Safety						Environment				Economic Development			Sovereignty				Indigenous and Social Development			
		Marine Transportation	Air Transportation	Land Transportation	Policing	Search and Rescue	Disaster Management	Pollution	Climate Change	Biodiversity	Environmental Protection	Resource Development	Infrastructure	Transportation Efficiency	National Boundaries	Border Protection	Defence	Maintaining Presence	Traditional Livelihoods	Health	Education	Connectivity
Industry Interests	Shipping - Royal Arctic Line																					
	Shipping - Tschudi Arctic Transit																					
	Fishing - Nordland Havfiske																					
	Mining - Baffinland's Mary River Project																					
	Mining - Norilsk Nickel																					
	Oil and Gas - Overview																					

Policy Area Interest
International Agreements





Legend

- Low Priority
- Medium Priority
- High Priority

International Policies	Safety						Environment				Economic Development			Sovereignty				Indigenous and Social Development			
	Marine Transportation	Air Transportation	Land Transportation	Policing	Search and Rescue	Disaster Management	Pollution	Climate Change	Biodiversity	Environmental Protection	Resource Development	Infrastructure	Transportation Efficiency	National Boundaries	Border Protection	Defence	Maintaining Presence	Traditional Livelihoods		Education	Connectivity
Convention for the Protection of the Marine Environment of the North-East Atlantic	■						■		■	■											
Convention on the Protection of the Marine Environment of the Baltic Sea Area							■		■	■											
Stockholm Convention on Persistent Organic Pollutants	■						■											■	■		
United Nations Declaration on the Rights of Indigenous Peoples							■			■	■							■	■	■	■
Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic					■																
C169 Indigenous and Tribal Peoples Convention, 1989 - ILO169										■	■			■	■			■	■		
Convention on Biological Diversity									■		■							■			
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal						■	■			■					■				■		
SOLAS - International Convention for the Safety of Life at Sea	■				■																
The MARPOL Convention	■					■	■			■											
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)									■		■				■			■			
Convention on the Conservation of Migratory Species of Wild Animals (CMS)									■	■											
Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR Convention)									■	■											
Nordic Cooperation on Foreign and Security Policy					■	■									■						
1982 United Nations Convention on the Law of the Sea (UNCLOS)	■				■		■		■	■	■			■							

Space Technologies
Communications Satellites



- Most communications needs below 75°N can be met by geostationary orbit satellites.
- In the future, there will be increasing needs for high bandwidth services above 75°N. Most of this demand will be from vessels and aircraft.
- Several systems are being explored to fill this gap using highly-elliptical polar orbits.

Space Technologies
Meteorology Satellites



- Many weather satellites are geostationary and, as with communications satellites, cannot see above 75°N.
- Some low earth orbit satellites currently provide high-latitude information.
- EUMETSAT, ESA, and NOAA work jointly.
- Several polar missions are proposed over the next 10 years.

Space Technologies
Surveillance Satellites



- Search and Rescue alerting and search is aided by COSPAS/SARSAT satellites. Transponders will also be added to GNSS satellites.
- Ship locations can be monitored using space-based Automatic Identification Systems (AIS).
- Aircraft locations can be monitored using Automic Dependent Surveillance – Broadcast (ADS-B).

Space Technologies
Navigation Satellites



- Global Navigation Satellite Systems provide position, navigation, and timing information.
- GPS is the primary GNSS used and GLONASS is also operational.
- Galileo will not be fully operational before 2019. It will provide better coverage at high latitudes.
- EGNOS provides augmentation over Europe, and WAAS over North America, up to about 70°N.
- Ionospheric activity at the poles can degrade the signal.

Space Technologies
Earth Observation Satellites



- EO is frequently the only cost effective and technically feasible method of observing the Arctic.
- Synthetic Aperture Radar is particularly useful for monitoring ice and snow.
- Optical sensors are limited by cloud cover and darkness.
- The recent loss of Envisat increases the importance of proceeding with Sentinel 1 and Radarsat Constellation.

Space Technologies
Science Satellites



- Earth Observation provides a vital contribution to scientific research.

In addition:

- Gravity satellite missions contribute to the study of geology and tectonics. Coverage by these satellites is poor at the poles.
- Space weather effects are pronounced at the poles, impacting communications, electric power distribution, and pipelines. A variety of existing and proposed satellite missions monitor space weather.

Space Technologies Applicability

Legend	
Low Applicability	
Medium Applicability	
High Applicability	

Space Technologies	Policy Areas: Safety						Environment				Economic Development			Sovereignty				Indigenous and Social Development			
	Marine Transportation	Air Transportation	Land Transportation	Policing	Search and Rescue	Disaster Management	Pollution	Climate Change	Biodiversity	Environmental Protection	Resource Development	Infrastructure	Transportation Efficiency	National Boundaries	Border Protection	Defence	Maintaining Presence	Traditional Livelihoods	Health	Education	Connectivity
Communications																					
Weather and Climate																					
Navigation																					
Earth Observation																					
Surveillance																					
Science																					

Polar View



Conclusions

- The Arctic is changing
- The Arctic is important
- The Arctic is challenging
- Space technologies can contribute
- Space technology priorities in the Arctic
  - Communications
  - Earth Observation
  - Surveillance

Discussion
Communications



- The gap in Arctic communications is above 75°N. The majority of the need will be from vessels and aircraft. Is there a business case to justify the investment in specialized satellites to serve that need?

Discussion
Earth Observation



⑩ Envisat is lost and Radarsat 1 is well beyond its life expectancy. A wide variety of users depend on EO data in the Arctic. What can be done to ensure that the Sentinels and Radarsat Constellation proceed?

Discussion
AIS



- Ground-based AIS is not feasible in the Arctic. There are now two nascent commercial space-based AIS services. Norway is also experimenting with the technology. The primary clients for such services are governments. What should be the relationship between the public and private sectors in providing S-AIS?

Discussion
Navigation



⑩ With the addition of Galileo, the world will be well covered by GNSS. However, some applications, especially the approach phase of aviation, require augmentation services that currently do not reach above 70°N. Is there a business case to justify the investment in specialized satellites to serve that need?