

Challenges in Arctic Navigation

Introduction

The purpose of this survey is to identify what are the most significant challenges in Arctic navigation as experienced from the users' perspective. The survey is part of a [research project](#) conducted by the [Finnish Geospatial Research Institute](#).

Although we have chosen the word "navigation" to describe the activity of interest, we would like to emphasize that the scope of the survey comprises various applications that involve the use of geospatial information. Examples include

- Transport at road, rail, sea, or air
- Situational awareness
- Satellite positioning (GPS/GLONASS/Galileo/BeiDou/GNSS) and its applications, e.g., construction and mining (in addition to transport)

Also note that the scope is not strictly tied to "Arctic" in terms of the Arctic Circle: similar challenges are applicable to certain areas at lower latitudes, such as Iceland, and sharing such experience is warmly welcome.

The questionnaire is divided into four parts. First, we would like to know about your background. The second part asks about your experiences concerning "navigation" in the Arctic. Then, you are asked about your opinion on how severe these challenges are, i.e., what are their possible outcomes for human safety and business. Finally, we would like to know if you have opinions or suggestions on how the challenges could be solved most efficiently.

Answering the survey is expected to take ten minutes. We are grateful for your effort!

Background information

1. What is your position in your work?

- End-user of (Arctic) navigation
- Manager of end-users
- Scientist/researcher studying navigation-related topics
- Manager of researchers/Professor
- Representative of a public authority
- Other - please specify

2. In which country are you mainly located?

- Canada
- Denmark
- Finland
- Iceland
- Norway
- Russia
- Sweden
- United States
- Other - please specify

3. Do your activities take place above the Arctic Circle?

- Yes, at least sometimes
- Never

4. Which market segment(s) are you active or involved in?

- Road transport
- Rail transport
- Maritime
- Aviation
- Other application (e.g., surveying, mining, mobile LBS) - please specify

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Your experience on the challenges

Page description:

On this page, we would like to know what Arctic-related challenges you actually have encountered in your professional activity. Note that the purpose of this page is not to ask if you find these challenges difficult or dangerous; you can tell your opinion about the potential impact of these challenges on the subsequent page.

5. How often have you encountered different challenges related to navigation in the Arctic?

	Regularly	Sometimes	Never, but I would know if I had	I don't know
Considerable outage in satellite-based navigation (GPS, GLONASS, Galileo, BeiDou)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack or unavailability of augmentation services for satellite-based navigation (e.g. SBAS/EGNOS/WAAS/SDCM, DGPS/DGNSS, VRS/PPP services)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unavailability of terrestrial radionavigation systems (e.g., eLORAN, Distance Measuring Equipment)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lacking maps or nautical charts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Untimely weather or ice information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Insufficient telecommunications capability (coverage, bandwidth, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inadequate road maintenance or icebreaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ionospheric scintillation (satellite signal power fading caused by atmospheric activity)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unawareness of accidents (wildlife, oil spills, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text" value="Enter another option"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text" value="Enter another option"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Further comments on how you have experienced challenges in Arctic navigation [optional]

Potential consequences of the challenges in Arctic navigation

Page description:

Please give your impression on the potential impact of the following challenges. The scale of severity is defined as follows:

1. **Negligible:** People may be alerted and feel uncomfortable. Possibility of damage to people, property, or business is very unlikely.
2. **Minor:** Incident causes mainly economic loss. There is a small chance on damage to property. May cause minor distress.
3. **Major:** Incident may cause damage to property and economic impact. Reasonable chance that people may panic or get distressed. A small chance that people get injured.
4. **Critical:** Incident may cause severe damage to property and significant economic impact. Small chance that a person gets killed, still a reasonable chance of injuries.
5. **Catastrophic:** Incident may lead to persons being killed or severely injured, severe damage to property and significant economic impact.

In addition to rating the challenges mentioned in the survey, you can give comments to explain your answers or bring up challenges that were not mentioned in the questionnaire. Answers to these optional fields are highly appreciated.

7. Snow, ice, and situational awareness

	Negligible	Minor	Major	Critical	Catastrophic	No opinion
Darkness and bad visibility	<input type="radio"/>					
Untimely weather or ice information	<input type="radio"/>					
Lacking road maintenance or ice breaking services	<input type="radio"/>					
Unawareness of accidents (e.g., oil spills, wildlife)	<input type="radio"/>					

8. Further comments on snow, ice, and situational awareness related challenges [optional]

9. Telecommunications

	Negligible	Minor	Major	Critical	Catastrophic	No opinion
Lacking coverage of telecommunications	<input type="radio"/>					
Insufficient bandwidth (or other similar property)	<input type="radio"/>					
Unability to access a necessary (online) service (e.g., VRS for satellite navigation augmentation)	<input type="radio"/>					

10. Further comments on communications [optional]

11. Satellite-based navigation

	Negligible	Minor	Major	Critical	Catastrophic	No opinion
Inadequate availability (bad satellite visibility)	<input type="radio"/>					
Accuracy does not meet the requirements	<input type="radio"/>					
Ionospheric scintillation (fading of signal power caused by atmospheric activity)	<input type="radio"/>					
Lacking coverage/availability of satellite-based augmentation (EGNOS/WAAS/SDCM)	<input type="radio"/>					
Lacking coverage of differential corrections (DGPS/DGNSS)	<input type="radio"/>					
Lacking coverage of precision correction services (VRS, PPP)	<input type="radio"/>					

12. Further comments on satellite navigation [optional]

16. Further comments on maps and charts [optional]

17. Other challenges [optional]

	Negligible	Minor	Major	Critical	Catastrophic	No opinion
<input type="text" value="Enter another option"/>	<input type="radio"/>					
<input type="text" value="Enter another option"/>	<input type="radio"/>					
<input type="text" value="Enter another option"/>	<input type="radio"/>					
<input type="text" value="Enter another option"/>	<input type="radio"/>					
<input type="text" value="Enter another option"/>	<input type="radio"/>					

18. Any other comments? [optional]

Solutions to the challenges

Page description:

Please share your views on what would be - or would not be - worthwhile solutions to the problems in Arctic navigation.

19. Feasibility of solutions

	Not very useful	Useful but impractical (cost, size, etc.)	Definitely useful	Indispensable
Densified collection of information, e.g., crowdsourcing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Extended assistance/augmentation services for satellite navigation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Telecommunications technology/services, e.g., Iridium satellite communications or 5G	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enhanced Spatial Data Infrastructures (framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Remote sensing (e.g., Earth observation, Sentinel satellites, Copernicus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nanosatellites (e.g., Iceye radar imaging)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text" value="Enter another option"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text" value="Enter another option"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text" value="Enter another option"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

20. Comments, other solutions, etc.? [optional]

Thank You!

Thank you for taking our survey. Your views and experience will be used to identify the most significant challenges to build an action plan to improve navigation in the Arctic.

For more information, you can refer to our web page at <http://arkki-project.org>